

2501
Pipe Culverts

2501.1 DESCRIPTION

This work shall consist 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**

Culvert pipe shall be one of the following kinds as specified or permitted as an option. Unless higher strength pipe is specified, pipe conforming to the lowest strength class covered in the referenced Specification will be acceptable. Special fabrication or jointing details shall be as required by the Plans.

A1	Corrugated Aluminum (CA).....	3225
A2	Corrugated Steel (CS).....	3226
A3	Corrugated Polyethylene (CP).....	3247
A4	Bituminous Coated-Corrugated Steel (BC-CS).....	3227
A5	Aramid Bonded-Corrugated Steel (AB-CS).....	3228
A6	Reinforced Concrete (RC).....	3236
A7	Polymeric Coated-Corrugated Steel (PC-CS).....	3229
A8	Corrugated Aluminized Steel (CAS).....	3222

Coating Type shall be as specified in the Plans or Special Provisions.

B Structural Plate

B1	Corrugated Aluminum (CA).....	3233
B2	Corrugated Steel (CS).....	3231

C Aprons

Aprons shall be the type designated in the Contract. Galvanized steel aprons may be furnished for attachment to corrugated steel, corrugated polyethylene, bituminous coated-corrugated steel, aramid bonded-corrugated steel, and polymeric coated-corrugated steel pipe. Galvanized steel aprons may be furnished for attachment to corrugated aluminum and corrugated aluminized steel pipe provided that geotextile Type II or other insulation material approved by the Engineer is applied between the contact surfaces of the different materials.

C1	Reinforced Concrete (RC).....	3236
C2	Galvanized Steel (GS).....	3226
C3	Aluminum Alloy (AA).....	3225C4
	Bituminous Coated-Galvanized Steel (BC-GS).....	3227
C5	Aluminized Steel.....	3222
C6	Corrugated Polyethylene (CP).....	3247
C7	Polymeric Coated-Corrugated Steel (PC-CS).....	3229
C8	Corrugated Aluminized Steel (CAS).....	3222

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D	Flap Gates	3399
E	Anti-seepage Diaphragms	3351
F	Pipe Joint Sealer Materials	
F1	Preformed Rubber, Type A.....	3726
F2	Preformed Plastic, Type B.....	3726
F3	Bituminous Mastic.....	3728
G	Granular Materials.....	3149
H	Geotextile, Type II	3733
I	Blank	
J	Reinforced Concrete Dissipator Ring	3236

2501.3 CONSTRUCTION REQUIREMENTS

The following construction requirements shall apply to the installation of all types of pipe culvert, whether new or old materials are used.

A General

The provisions of 2451 relating to prefabricated structures shall apply to the excavation, foundation construction, and backfilling of the culvert, together with the additional requirements or modifications contained herein.

B Foundations

Entrance culverts may be installed to the required grade without special foundation shaping, except that the foundation shall be shaped as required in 2451.3C2 when the culvert is installed in a trench or when special bedding is specifically designated in the Plans.

C Laying Pipe

C1 General

Pipes that connect with inlet structures shall terminate flush with the inside of the structure wall.

Jacking of culverts through the existing earth structure into position may be required by the Plans or permitted by the Engineer. The flow line elevation at the starting point for jacking shall be within 30 mm (**0.1 foot**) of the staked grade; the flow line shall not be reversed at any point; and the line and grade at any point within the pipe shall not vary by more than 150 mm (**½ foot**) from the line and grade designated. Metal pipe installed by this method shall have bolted or riveted field connections.

C2 Metal Culvert

Corrugated metal pipes having circumferential joints shall be laid with the outside laps pointing upgrade and with the longitudinal joints on the sides.

Metal pipe sections shall be joined by the use of metal connecting bands, centered over the joint, and with the pipe sections as close together as possible. The band shall be tightened sufficiently to ensure a tight joint.

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Structural plate culverts shall be assembled according to the instructions of the manufacturer, using approved fasteners. Where bolts are used, the bolts shall be tightened, after assembly, to a torque of 135 to 400 N•m (**100 to 300 foot pounds**). The Contractor shall furnish a calibrated torque wrench to prove, to the Engineer's satisfaction, the adequacy of the bolt tightening.

Bituminous coated pipe shall be handled with special care to preserve the coating. All exposed metal shall be recoated with a grade of asphalt similar to that originally applied. Fuel oil or similar solvent may be used to facilitate the installation of coupling bands.

The paved portion of bituminous coated and paved corrugated metal pipe shall be centered on the flow line.

Where beveled ends are required on metal pipe, the bevels shall be cut at right angles to a vertical plane through the longitudinal axis of the pipe.

C3 Concrete Culvert

Concrete pipe shall be laid with the groove end of each section up and the sections shall be tightly joined. Each joint shall be effectively protected against infiltration of backfill soil by filling the joint space with an approved sealer material or by providing a full circumferential wrap of geotextile material extending 300 mm (**12 inches**) or more on each side of the joint and being secured in place. A combination of sealer and geotextile materials will be permitted.

Where so required by the Contract, the joints in concrete pipe shall be effectively sealed to provide a flexible water-tight joint, using an approved elastic joint sealer material (preformed rubber, preformed plastic, bituminous mastic). Where the pipe specified is specifically designed to accommodate preformed gasket type seals, the joints shall be sealed with the gasket type designed especially for that type of joint as shown in the Plans and the joints shall meet the performance requirements of AASHTO M 198.

Mastic joint sealer materials shall be applied in accordance with the recommendations of the manufacturer. All joints shall be wiped clean on the inside after sealing. Lifting holes shall be plugged with a precast concrete plug, sealed, and covered with mastic or mortar.

Concrete culvert sections shall be tied together with approved fasteners, unless otherwise specified in the Plans or Special Provisions.

C4 Blank

C5 Extending In-Place Culverts

To the extent feasible, in-place culverts shall be cleared of any obstructions to water flow, before placing the extension pipe. Removal of sediment will only be required to the extent that improved flow is likely to be maintained. This work shall be incidental to the pipe extension, with no direct compensation being made therefor.

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Where the pipe ends differ because of changed design, the connection to the in-place culvert shall be made as indicated in the Plans or to the satisfaction of the Engineer.

When cast-in-place concrete box culverts are to be extended with plant-fabricated pipe, details of the connection shall be as shown in the Plans.

When a box-type concrete cattle pass is to be extended using precast concrete sections, a transition section as shown in the detailed Plans shall be used. The ends of the in-place structure shall be exposed and concrete removed to the extent indicated in the Plans. The cast-in-place portion of the transition shall be constructed according to the applicable material and construction requirements of 2411.

D Culvert Appurtenances

Appurtenant items such as aprons, safety aprons, and grates, diaphragms, dissipator rings, flap gates, and safety grates (this includes special grates for concrete pipe and large size pipe, trash racks and other devices of this nature requiring a special design) shall be furnished and installed as required by the Plans or Special Provisions.

E Induced Trench Installation

When required by the Plans, the backfill over the culvert shall be constructed as follows:

The embankment shall be constructed according to 2105 for a width on each side of the installed culvert at least equal to 3 pipe widths and to an elevation over the top of the culvert equal to the pipe height plus 300 mm (**1 foot**). Where specified density is called for, the density in each layer shall be not less than 100 percent of maximum density.

A trench shall then be excavated to a level 300 mm (**1 foot**) above the top of the culvert, for the width and length of the pipe, and with vertical sides. The trench shall be loosely filled with highly compressible soil, after which the remainder of the embankment shall be constructed in accordance with 2105.

F Culvert Cleaning

Before final acceptance of the Project, all culverts installed under the Contract shall be inspected and cleared of any sedimentation or other debris existing inside the pipe.

2501.4 METHOD OF MEASUREMENT

A Culvert Excavation

When the proposal contains separate items for Culvert excavation under the payment provisions of this Specification, the excavations for culverts will be classified and measured in accordance with the applicable provisions of 2451.

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B Culvert Pipe

Culvert pipe will be measured by length, as determined by summation of the nominal laying lengths of the individual pipe sections incorporated in each structure. Measurements will be separated as to size, type, kind, and strength class, to the extent indicated in the item name.

Elbow, tee, and wye sections will be measured for payment as pipe, with the measurements being made along the centerline of the culvert barrel. No length allowance will be made for branch legs, except as included in the measurements for a connecting structure. Transition sections will be measured for payment as pipe of the larger (or more costly) size, except for such special sections as may be designated for measurement as a unit.

On metal pipe installations requiring special fabrication such as skewed or sloped ends, length measurements will be to the extreme ends such as to include waste material, unless other limits are shown in the Plans.

C Culvert Appurtenances

Appurtenant items such as aprons, safety aprons, and grates, diaphragms, dissipator rings, flap gates, and other specially designed and identified units designated for payment on a per each basis, will be measured separately by the number of units of each type and size incorporated in the culvert structures. A safety apron and grate is to be considered as a unit.

No direct compensation will be made for cast-in-place concrete work required in connection with the construction of pipe culverts.

D Granular Materials

Granular materials for special backfill or bedding will be measured in accordance with 2451.4B.

2501.5 BASIS OF PAYMENT

Payment for culvert pipe of each size, type, kind, and strength class, at the appropriate Contract prices per unit of measure, will be compensation in full for all costs of furnishing and installing the pipe complete in place as specified, except as otherwise provided herein.

Aprons, safety aprons and grates, flap gates, dissipator rings, diaphragms, and other specially designed and identified appurtenant items, as required by the Plans, will be paid for separately by type, size, and number of units incorporated in the structures, which payment will be compensation in full for all costs of furnishing and installing those items complete in place.

Granular materials for special backfill or bedding will be paid for separately in accordance with the payment provisions of 2451.5.

Culvert Excavation will be paid for separately, to the extent that the Proposal contains specific items and unit prices therefor, in which case

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payment will be subject to 2451.5. Otherwise, all excavating costs shall be included in bid prices for culvert pipe and appurtenant items.

For any culvert elbows, tee or wye sections and necessary additional connectors that are ordered by the Engineer but that are not indicated in the Plans, additional compensation will be made in the amount of the actual invoice cost of the materials involved.

Payment for installing culvert materials provided by the Department will be made under the applicable installation items indicated in the Proposal, and, except for Extra Work or work designated under other items, will be considered as full compensation for all the work and additional materials required for the installation complete in place.

Where installation by the jacking method is required or permitted in the absence of a separate bid item, payment will be made on the same basis as if the culvert were installed by the trenching method.

Payment will be made on the basis of the following schedule:

Item No.	Item	Unit
2501.501	Culvert Excavation, Class (1)	cubic meter (cubic yard)
2501.511	___ mm (inch) (2) Pipe Culvert (3)	meter (linear foot)
2501.515	___ mm (inch) (2) Pipe Apron	each
2501.517	Anti-seepage Diaphragm for (4) Pipe	each
2501.519	Flap Gate for (4) Pipe	each
2501.521	___ mm (inch) Span (2) Pipe-Arch Culvert (3)	meter (linear foot)
2501.525	___ mm (inch) Span (2) Pipe-Arch Apron	each
2501.527	Anti-seepage Diaphragm for (4) Pipe-Arch	each
2501.531	___ mm (inch) (2) Elliptical Pipe Culvert (5)	meter (linear foot)
2501.535	___ mm (inch) (2) Elliptical Apron	each
2501.541	___ mm (inch) High (2) Cattle Pass Culvert (3)	meter (linear foot)
2501.543	___ mm (inch) High (2) Cattle Pass Transition Section (3)	each
2501.545	___ mm (inch) High (2) Cattle Pass Apron Culvert (3)	each
2501.551	___ mm (inch) (2) Structural Plate Pipe Culvert (3)	meter (linear foot)
2501.555	___ mm (inch) Span (2) Structural Plate Pipe-Arch Culvert (3)	meter (linear foot)
2501.561	___ mm (") (2) Pipe Culvert, Design (6) (3)	meter (linear foot)
2501.565	___ mm (inch) Span (2) Pipe-Arch Culvert, Design (6) (3)	meter (linear foot)
2501.567	___ mm (inch) (2) Safety Apron & Grate Design (6)	each
2501.569	___ mm (inch) (2) (7)	each

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- 2501.571 Install (7) meter (**linear foot**)
- 2501.573 Install (7) each
- 2501.575 ___mm (**inch**) RC Dissipator Ring.....each

- NOTE:
- (1) Specify Class U, E, or R only---See 2451.3B2
 - (2) Specify Kind---See 2501.2
 - (3) Specify Strength Class, if other than minimum requirement.
 - (4) Specify Size and Kind.
 - (5) Specify HE or VE, and Strength Class, if other than minimum requirement.
 - (6) Give Standard Plate Number for special pipe or joint designs.
 - (7) Specify item name.

2502

Subsurface Drains

2502.1 DESCRIPTION

This work shall consist of the construction of subsurface drains, using plant-fabricated pipe and appurtenant materials, installed to:

- (a) collect and discharge water infiltrating into the pavement system (pavement edge drain).
- (b) collect and discharge water accumulated in the bottom of a granular-backfilled subcut (subcut drain).
- (c) cut off or intercept ground water flowing toward the roadway (cut-off drain).

Subsurface drains include all materials used to collect ground water and conduct it to a discharge point either at a structure or on a side slope. The typical system will include a drain pipe, radial connecting pipe, discharge pipe, and drain outlet.

Subsurface drains for high bridge abutments, installed to intercept and carry off underground water, shall include all appurtenances, including geotextiles, metal oversleeves with rodent screens, and precast concrete headwalls. The work shall be performed in accordance with applicable provisions of 2502, 3245, 3733, and as detailed in the Plans.

2502.2 MATERIALS

Drain pipe shall be one of the following kinds as specified or permitted as an option. Fittings connecting multiple length of drain pipe shall be of the same material as the pipe. Nonperforated pipe shall be furnished except where the perforated type is specified. Unless higher strength pipe is specified, pipe conforming to the lowest strength class covered in the referenced specification will be acceptable. All discharge pipe, radial connecting pipe, and associated fittings shall be

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nonperforated TP pipe. Special fabrication or jointing details shall be as required by the Plans or as approved by the Engineer.

A	Drain and Discharge Pipe	
A1	Thermoplastic (TP).....	3245
A2	Corrugated Polyethylene Drainage Tubing (PE)	3278
B	Precast Concrete Headwall (Drain Outlet).....	Standard Plate 3131
C	Granular Materials.....	3149
D	Geotextile, Type I.....	3733
E	Erosion Blanket, Category 1	3885
F	Seed.....	3876
G	Marking Tape	3354

2502.3 CONSTRUCTION REQUIREMENTS

The following shall apply unless otherwise provided in the Plans or Special Provisions:

A Excavation

The trench shall be excavated to the designated lines and grades, as shown in the Plans and as necessary to permit placement of the drains in accordance with the provisions hereof. Minimum trench width at the bottom of the excavation shall be the nominal pipe width plus two times the pipe diameter (for example, a 100 mm (**4 inch**) diameter pipe would be placed in a 300 mm (**12 inch**) wide trench). Corrugated polyethylene drainage tubing (PE) may be used only when placed in a narrow, controlled-width trench as typically constructed by a chain- or wheel-type trenching machine designed and used for this application. Other types of rigid pipe shall be used for all other uses where compaction is not controlled in a narrow trench. Installation of PE tubing by plowing is not permitted.

Rock encountered within the excavation shall be removed to a minimum width as specified above, and to a minimum depth of one pipe diameter below the pipe. Except where granular material is required, the backfill up to the bottom of the pipe may be made with suitable material removed from elsewhere in the excavation, which shall be compacted uniformly to provide a proper foundation.

B Laying Drains

All perforated pipe drains shall be bedded on fine filter aggregate meeting 3149.2J, placed to a minimum thickness of one pipe diameter below the bottom of the pipe, and extending upwards under the haunches, for the full width and length of the trench, to such elevation as will permit the specified foundation preparations. Granular bedding will not be required on nonperforated pipe installations unless specifically required by the Plans. Stones in excess of 25 mm (**1 inch**) will not be permitted in the trench. The foundation for all drains, whether bedded on granular material or not, shall be carefully shaped

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to fit at least the lower 30 percent of the outside circumference of the pipe. Drains shall be laid carefully to line and grade, with uniform bearing throughout and with the perforations down unless otherwise directed.

All perforated pipe shall be wrapped with geotextile that is factory seamed or produced as a continuous knit weave. The fabric seam shall be placed at the top of the pipe (opposite the perforations). Where seams are necessary at fittings or connectors, the adjoining geotextiles shall be mechanically fastened, or overlapped a minimum of 150 mm (**6 inches**).

Pipe sections shall be joined securely with the appropriate coupling bands or fittings. Solvent type joints shall be cemented unless otherwise specified. Upgrade ends of all subdrain pipe shall be closed with suitable caps. All junctions and turns shall be made with wyes or bends and be suitable for cleaning and inspection.

Where a drain connects with a structure or catch basin, the Contractor shall make a suitable and secure connection through the wall of the structure. Unless otherwise specified, drainage outlets to the surface shall terminate at a standard precast concrete headwall.

C Backfill

Backfilling of drains shall proceed without delay as the installations are made. On all perforated pipe installations, fine filter aggregate shall be placed adjacent to and to a minimum height of 150 mm (**6 inches**) above the top of the pipe, and to the extent indicated in the Plans. Above that elevation, and on all nonperforated pipe installations, the backfill may be made with suitable material removed from the excavations. In all applications, stones greater than 25 mm (**1 inch**) shall not be used adjacent to, and for 150 mm (**6 inches**) above the pipe.

Fine filter aggregate need not be compacted, unless otherwise indicated in the Plans, but all other backfill material shall be compacted to a density equivalent to that of the adjacent soils, or to specified density where applicable.

D Drain Outlets

D1 Precast Concrete Headwall

Headwall outlets shall be kept 300 mm (**12 inches**) above ditch grades whenever possible, with the absolute minimum being 150 mm (**6 inches**). The uppermost point of the headwall shall be placed flush with the in-slope at a minimum downward grade of 2 percent to provide easy water exit. The earthen side slopes adjacent to the headwall shall then be shaped to conform to the sides and toe of the headwall. All soils around and under the concrete headwall outlet shall be compacted to the satisfaction of the Engineer to minimize future movement.

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D2 Discharge Pipe

The discharge pipe to the drain outlet shall be constructed concurrently with the drains and be laid at roughly right angles to the roadway centerline. The discharge pipe shall be fully inserted/coupled to the headwall. Connections shall be made with 3A Grout, rubber gasket on the pipe, rubber or plastic gasket cast into the headwall, or by solvent or gasket joint into a TP coupling securely cast into the headwall. The coupling method shall secure the pipe well enough so that small movements of the headwall will not cause separation. The Engineer shall approve the method of coupling. The radial connection between the drain pipe and the discharge pipe shall have a minimum radius of 300 mm (**12 inches**) and will provide easy access for probes, cleaners, and video cameras. All connections and solvent joints shall be secure to the extent that they will not decouple during backfilling and will prevent soil intrusion. The Engineer shall approve connection and coupling methods.

The discharge trench shall be constructed similar to the drains, but shall be backfilled with compacted mineral soil to the satisfaction of the Engineer. Discharge pipe grades shall be no less than the drain pipe and a minimum of 2 percent. Crushed or deformed discharge pipe or connection shall be replaced by the Contractor at no cost to the Department. All discharge pipes shall have concrete headwalls attached before termination of the construction season.

D3 Turf Establishment

The Contractor shall use seed and an erosion control blankets at the drain outlets except when outlets are placed at a location that will normally be sodded under terms of the Contract.

An erosion control blanket, Category 1, meeting 3885, shall be placed to a minimum width of 2 m (**6.5 feet**) with the headwall centered along the width of the blanket. The blanket shall also extend 1 m (**3 feet**) above the headwall, and 2 m (**6.5 feet**) or to the bottom of the ditch which ever is less below the headwall. Anchor staples shall be placed at ½ m (**1.5 feet**) maximum intervals. When a headwall is placed at a location that will normally be sodded under terms of the Contract, the seed and mulch shall be deleted in favor of sod. Installations shall be watered and maintained in accordance with 2575.3L. Seed installed under the erosion control blanket shall be the same mixture and rate as that designated in the Plan for the immediate surrounding area. In the absence of a seed mixture specified in the Plan, seed mixture 250 shall be placed at the rate of 1 kg/m² (**2 pounds per square yard**) before anchoring the blanket.

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D4 Marking Outlet Locations

The Contractor shall permanently mark the location of all outlets with a 150 by 450 mm (**6 by 18 inch**) strip of white marking tape according to 3354. The Contractor shall place the tape at the outside edge of the bituminous shoulder, at right angles to the roadway, and roll the tape into the shoulder while the bituminous is still hot. When two runs of drain pipe come together at a low point and discharge via a "Y" to a single outlet, the Contractor shall place two markings side-by-side with a 150 mm (**6 inch**) spacing. If there is no bituminous shoulder, the Contractor shall place the tape on the bituminous pavement or spray a white paint strip on concrete pavements. If paint or tape marking is not appropriate, the Engineer may approve alternate methods. The furnishing of, and placement of the tape or paint, is incidental work.

D5 Inspection and Cleanout

It shall be the responsibility of the Contractor to ensure that once installed, the discharge pipe and headwalls remain clean and operative so that water is not trapped in the pipe, and also to make a final inspection, with the Engineer, of all discharge pipes and headwalls to ensure that they have the proper grade, are clean, properly landscaped, erosion control has been properly installed and maintained, and are generally in satisfactory operating condition.

The inspection shall be conducted with a probe mounted on the end of a flexible fiberglass rod that has the dimensions of 100 mm (**4 inches**) long and a diameter of one nominal pipe size smaller than the drain pipe that is being inspected. The inspection will be conducted through the discharge pipe, radius connection, and at least 1 m (**3 feet**) into the main drainage line to verify that it is open and operative. Discharge pipe and connections that are judged to be inoperative, shall be cleaned or repaired to the satisfaction of the Engineer. Inspections and any required remedial work shall be at no cost to the Department.

2502.4 METHOD OF MEASUREMENT

A Subsurface Drains

Drains will be measured by installed length along the centerline of the pipe. Terminal points of measurement will be the pipe end at free outlets; the point of junction with in-place pipe; or the center of structures, catch basins, or multiple junction points as they apply.

Where subsurface drains are furnished as a part of the Contract, the lengths of each size and type of pipe will be measured separately.

B Granular Materials

Granular materials for special backfill or bedding will be measured in accordance with 2451.4B.

Measurement on the basis of compacted volume will be limited to the minimum dimensions shown in the Plans.

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C Precast Concrete Headwalls

Measurement will be by the number of precast concrete headwalls furnished.

2502.5 BASIS OF PAYMENT

Payment of subsurface drains and outlets of each size, type, kind and strength class, at the appropriate Contract prices per unit of measure will be compensation in full for all costs of furnishing and installing the item as specified, except as otherwise provided herein.

For any subdrain elbow or wye sections and necessary additional connectors that are ordered by the Engineer but that are not indicated in the Plan, additional compensation will be made in the amount of the actual invoice cost of the materials involved.

Unless otherwise provided, granular materials for special bedding or backfill will be paid for separately in accordance with 2451.5.

Payment for the drain outlet (precast concrete headwall and discharge pipe) is full compensation for furnishing and placing the unit, erosion control blanket and seed, marking, inspecting, and all other associated work. Where sodding is required, the Engineer will include the sod with other sod quantities on the Project.

No direct compensation will be made for geotextiles or other joint wrapping or sealing materials.

Any trench excavation required below an elevation more than 300 mm below the bottom of the pipe or tile as shown in the Plans will be paid for as Extra Work.

Unless its existence is shown in the Plans, the removal of ledge rock or rocks larger than 0.4 m³ (½ cubic yard) volume from the excavation will be paid for as Extra Work.

Payment for subsurface drains will be on the basis of the following schedule:

Item No.	Item	Unit
2502.501	___mm (inch) Precast Concrete Headwall	each
2502.502	Drainage System Type _____	lump sum
2502.521	___mm (inch) (1) Pipe Drain (2).....	meter (linear foot)
2502.541	___mm (inch) Perforated (1) Pipe Drain (2)	meter (linear foot)
2502.571	___mm (inch) Install (3)	meter (linear foot)
2502.573	___mm (inch) Install (3)	each

- NOTE: (1) Specify Kind---See 2502.2B
(2) Specify Strength Class, if other than minimum requirement.
(3) Specify item name.

2503
Pipe Sewers

2503.1 DESCRIPTION

This work shall consist of the construction of pipe sewers, using plant-fabricated pipe and other appurtenant materials, installed for conveyance of sewage, industrial wastes, or storm water.

Manhole and catch basin construction shall be in accordance with 2506. Where aprons are required, they shall be furnished and installed under the provisions of 2501.

2503.2 MATERIALS**A Pipe**

Sewer pipe shall be one of the following kinds as specified or permitted as an option. Unless higher strength pipe is specified, pipe conforming to the lowest strength class covered in the referenced Specification will be acceptable. Special fabrication or jointing details shall be as required by the Plans.

A1	Nonreinforced Concrete (NC)	3253
A2	Reinforced Concrete (RC)	3236
A3	Corrugated Aluminum (CA).....	3225
A4	Corrugated Steel (CS)	3226
A5	Corrugated Aluminized Steel (CAS)	3222
A6	Bituminous Coated-Corrugated Steel (BC-CS)	3227
A7	Aramid Bonded-Corrugated Steel (AB-CS)	3228
A8	Blank	
A9	Corrugated Polyethylene (CP)	3247
A10	Plastic Truss (PT)	3241
A11	Vitrified Clay (VC).....	3251
A12	Polymeric Coated-Corrugated Steel (PC-CS)	3229
	Coating Type shall be as specified in the Contract.	
A13	Thermoplastic	3245

B Flap Gates 3399**C Pipe Joint Sealer Materials**

C1	Hot-Poured Sealing Compound	3724
C2	Preformed Rubber, Type A.....	3726
C3	Preformed Plastic, Type B	3726
C4	Bituminous Mastic	3728

D Granular Materials..... 3149**2503.3 CONSTRUCTION REQUIREMENTS****A General**

All sewer installations shall be made according to the following requirements.

The requirements of 2451, as they related to the excavation, foundation construction, and backfilling of prefabricated structures,

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shall apply together with the additional requirements or modifications contained herein.

B Excavation

Where the cover over the top of the pipe will be 4.5 m (15 feet) or more, that portion of the required excavation that is below an elevation 300 mm (1 foot) above the top of the pipe shall have side slopes as nearly vertical as practicable and, at a point 300 mm (1 foot) above the top of the pipe, the width of the trench shall be no wider than the widths given in the following tabulation:

<u>Pipe Diameter</u>	<u>Maximum Trench Width (300 mm (1 foot) above pipe)</u>
Less than 1050 mm (42 inches) Outside Diameter plus 600 mm (24 inches)
1050 mm to 1350 mm (42 to 54 inches) 1.5 times Outside Diameter
Over 1350 mm (54 inches) Outside Diameter plus 900 mm (36 inches)

If the trench is excavated to a greater width than that authorized according to the above tabulation, the Engineer may direct the Contractor to provide a higher class of bedding, a higher strength pipe, or both, than that required by the Contract; without additional compensation therefor; as the Engineer deems necessary to satisfy the design requirements.

C Laying Pipe

The pipe shall be laid to the required line and grade, each section having a firm and uniform bearing throughout its entire length.

Corrugated metal pipes having circumferential joints shall be laid with the outside laps pointing upgrade and with the longitudinal joints on the sides.

Metal pipe sections shall be joined by use of approved metal connecting bands, centered over the joint, and with the pipe sections as close together as possible. The band shall be tightened sufficiently to ensure a tight joint.

Bituminous coated pipe shall be handled with special care to preserve the coating. All exposed metal shall be recoated with a grade of asphalt similar to that originally applied. Fuel oil or similar solvent may be used to facilitate the installation of coupling bands. The paved portion of bituminous coated and paved pipe shall be centered on the flow line.

Clay and concrete pipe shall be laid with the bell or grooved ends upgrade.

All joints in concrete pipe shall be effectively sealed to provide a flexible water tight joint, using an approved elastic joint sealer material (rubber gasket, preformed plastic, bituminous mastic). Where the pipe

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specified is specifically designed to accommodate preformed gasket type seals, the joints shall be sealed with the gasket type designed especially for that type of joint as shown in the Plans and the joints shall meet the performance requirements of AASHTO M 198.

All joints in bell-and-spigot type clay pipe, which are not provided with factory fabricated compression seals, shall be effectively sealed with an approved mastic joint sealer, or by being caulked with asphalt impregnated oakum and filling the remainder of the annular space within the bell with hot-poured joint sealing compound. A pouring collar or other device shall be used to hold the hot sealer until set. When the air temperature is below 0°C (32°F), the pipe shall be heated before pouring the sealer.

Mastic joint sealer materials shall be applied in accordance with the recommendations of the manufacturer. All joints shall be wiped clean on the inside after sealing. Lifting holes shall be plugged with a precast concrete plug, sealed, and covered with mastic or mortar.

Pipe junctions and turns shall be made using standard or specially fabricated fittings.

When a sewer connects with an existing manhole or catch basin, the Contractor shall make a suitable connection through the wall of the manhole or catch basin.

All branch openings or service connections provided for future use shall be plugged with vitrified clay or concrete stoppers sealed in place.

Where specifically required by the Contract, concrete pipe sections shall be tied together with approved fasteners.

D Backfill

The sewer installations shall be backfilled as required by the Plans and in accordance with 2451.

Excavated materials not required for backfill shall be disposed of as directed by Engineer.

E Installation by Jacking

The applicable requirements of 2501.3C1 shall apply to installation of pipe by jacking.

F Cleanout

The sewers shall be free of any debris before final acceptance.

2503.4 METHOD OF MEASUREMENT

A Excavation

Trench excavation shall be incidental to the sewer installation. Measurement of any Extra Work excavation will be as described in 2451.4 for prefabricated structures.

B Sewer Pipe

Each pipe, as classified by Proposal item, will be measured separately by length along the line of the sewer. Terminal points of measurement will be the pipe end at free outlets; the point of junction

2503.4

with in-place pipe; or the center of manholes, catch basins or multiple junction points as they apply.

Pipe transition sections will be measured as the larger size pipe.

Sections of metal pipe at the outlets of clay or concrete sewers will be considered as metal sewers.

Sewer materials that are furnished by the Department for installation under the Contract will be measured as length of installed sewer, separated as to type but without regard to size.

C Sewer Appurtenances

Flap gates and other specially identified appurtenant items designated for payment on a per Each basis will be measured separately by the number of units of each type and size incorporated in the sewer structures.

D Granular Materials

Granular materials for special backfill and bedding will be measured in accordance with 2451.4B.

Measurement on the basis of compacted volume will be limited in width to the maximum trench widths allowed under 2503.3, Excavation.

2503.5 BASIS OF PAYMENT

Payment for sewer pipe of each size, type, kind, and strength class, at the appropriate Contract prices per unit of measure, will be compensation in full for all costs of furnishing and installing the pipe complete in place as specified, except as otherwise provided herein.

For elbow, tee or wye sections and the necessary additional connectors that are ordered by the Engineer but that are not indicated in the Plans, additional compensation will be made in the amount of the actual invoice cost of the materials involved.

Payment for installing sewer materials provided by the Department will be made under the applicable installation item indicated in the Proposal and, except for Extra Work or work designated under other items, will be considered as full compensation for all the work and additional materials used in installing the sewer complete in place.

Granular materials for special bedding or backfill will be paid for separately in accordance with 2451.5.

Where installation by jacking is permitted, in the absence of a specific pay item therefor, payment will be made on the same basis as if the sewer were installed by the trenching method.

Payment for flap gates at the Contract price per unit will be compensation in full for furnishing and installing the gates complete in place as specified.

Any aprons required in connection with the sewer construction will be paid for separately in accordance with 2501.5.

2506.1

Any required excavation more than 300 mm (**1 foot**) below the bottom of the pipe, as shown in the Plans, will be paid for as Extra Work.

Unless its existence is shown in the Plans, the removal of ledge rock or rocks larger than 0.4 m³ (**½ cubic yard**) in volume from the excavation will be paid for as Extra Work.

Payment for sewers will be made on the basis of the following schedule:

Item No.	Item	Unit
2503.511	___mm (inch) (1) Pipe Sewer (2).....	meter (linear foot)
2503.519	Flap Gate for (3) Pipe	each
2503.521	___mm (inch) Span (1) Pipe-Arch Sewer (2).....	meter (linear foot)
2503.531	___mm (inch) (1) Elliptical Pipe Sewer (4)	meter (linear foot)
2503.541	___mm (inch) (1) Pipe Sewer, Design (5) (2)	meter (linear foot)
2503.571	Install (6)	meter (linear foot)
2503.573	Install (6)	each

- NOTE: (1) Specify Kind---See 2503.2A.
(2) Specify Strength Class, if other than minimum requirement.
(3) Specify Size and Kind.
(4) Specify HE or VE, and Strength Class, if other than minimum requirement.
(5) Special Pipe or Joint Designs---Give Standard Plate Number.
(6) Special item name.

2506

Manholes and Catch Basins

2506.1 DESCRIPTION

This work shall consist of constructing or reconstructing brick or concrete block masonry, cast-in-place concrete, precast sectional concrete, or pipe structures, built for the purpose of providing access to underground drainage or other systems for the ingress of surface water into underground drainage systems.

For the purposes of this Specification, precast concrete median drains will be considered to be casting assemblies.

2506.2

2506.2 MATERIALS

A Concrete 2461

3B42 concrete shall be used for cast-in-place structures of Designs A, C, F, or G; and for drop inlet surface block.

3Y43 concrete shall be used in all other cast-in-place structures.

B Mortar

Mortar shall conform to ASTM C 270. The cement shall be either Type S masonry cement or 2 to 4 parts of Portland cement to 1 part of Type S hydrated lime. Mortar sand shall have a volume equal to 2.25 to 3 times the total of the volume of cement and lime. Sufficient water shall be added for proper consistency.

The cement and lime shall be air-entrained unless approved otherwise by the Concrete Engineer. The entrained air content of the mortar shall be within the range of 7-10 percent.

B1	Portland Cement	3101
B2	Hydrated Lime (Type S)	3106
B3	Masonry Cement (Type S)	3107
B4	Mortar Sand	3128
C	Clay Brick	3612
D	Concrete Brick	3616
E	Concrete Masonry Units	3621
F	Sectional Concrete Manhole/Catch Basin Units	3622
G	Clay Pipe, Standard Strength	3251
H	Nonreinforced Concrete Pipe	3253
I	Blank	
J	Reinforced Concrete Pipe	3236
K	Corrugated Steel Pipe	3226
L	Metal Drainage Castings	3321
M	Concrete Drainage Castings	3622
N	Granular Materials	3149
O	Blank	
P	Corrugated Aluminum Pipe	3225
Q	Corrugated Aluminized Steel (CAS)	3222

2506.3 CONSTRUCTION REQUIREMENTS

A General

A1 Combination Construction

The Engineer may permit a combination of cast-in-place and prefabricated concrete construction for those structures where a type of construction is not specified and where structural strength and continuity is maintained.

A2 Intercepting Existing Facilities

Where the new structure will intercept an existing underground facility, the existing facility shall be incorporated into the structure to the extent required, including any necessary removal, replacement, or

2506.3

special connections, without detriment to the planned function of the facility.

A3 Abandoned Pipes

Any abandoned pipes that enter a structure that will not be abandoned shall be detached from the structure and the wall opening shall be permanently plugged with concrete or masonry. The upgrade end of the abandoned pipes shall also be plugged with concrete or masonry.

A4 Excavation, Bedding, and Backfill

Excavation, bedding, and backfill construction requirements shall be as indicated in 2451.

A5 Inspection Before Construction

Mortar shall not be placed in any unit or section of work, until the Engineer has inspected and approved the required foundation preparations, materials, and provisions for cold weather protection.

A6 Temperature Restrictions

A6a Mortar shall not be placed on a frozen foundation or against any surface with a temperature below freezing.

A6b Concrete or mortar production shall not commence or continue when the air temperature at the construction site in the shade or away from artificial heat is below 2°C (**36°F**):

- (1) Unless authorized by the Engineer when the air temperature is rising and has reached 1°C (**34°F**).
- (2) Unless provisions satisfactory to the Engineer have been made in advance for cold weather protection.

A6c Masonry units or aggregate whose temperature is 0°C (**32°F**), or less, shall not be used except under direct supervision of the Engineer.

A6d All concrete or mortar mixes shall have a temperature of not less than 10°C (**50°F**) nor more than 32°C (**90°F**). The mix shall be maintained within this temperature range until it is deposited in the work.

A6e The Engineer may approve heating of masonry units, mix materials, or mortar by an approved heating system operated in an acceptable manner. Spot heating of such materials by means of steam jets or direct application of combustion heating devices, as the work progresses, will not be permitted.

B Cast-In-Place Concrete 2411

C Masonry

The following requirements shall apply when part or all of the structure is constructed using clay brick or concrete masonry units. The term, "unit", as applied herein, shall refer to either the brick or concrete block unless otherwise qualified.

2506.3

Concrete masonry units shall not be moistened prior to placement in the work, but all other types of masonry units shall be moistened before being laid.

Units shall be laid in a full mortar bed, in horizontal courses, using the "shove joint" method. All joints shall be filled with mortar. Joints on the inside of the structure shall be no more than 13 mm ($\frac{1}{2}$ inch) wide and shall be struck. The outside of the structure shall be plastered with mortar to a smooth surface.

Steps, pipes, or other required fixtures shall be installed as the work progresses. The units shall be fitted carefully around any pipes that penetrate the structure, using only part of a unit as necessary to form a neat juncture at the pipe. All attachments to the structure shall be bonded using mortar to fill all voids.

Where the manhole/catch basin is constructed of brick, the following additional requirements shall apply:

- (1) In circular type structures, the bricks shall be laid flat and radially, with the ends exposed on the inside of the structure. Where the thickness of the wall is greater than the length of one brick, the outside bricks may be laid circumferentially, using full header construction in at least each sixth course.
- (2) In rectangular type manholes, the bricks shall be laid in regular courses of stretchers, using full header construction in at least each sixth course. No bats or spalls shall be used except for shaping around openings or for finishing out a course, in which case full bricks shall be placed in the corners and the bats in the interior of the course. The least dimension of the exposed faces of bats shall be not less than 50 percent of the width of a brick.

Where the Contractor elects to use the alternate method of constructing the tapered portion of a manhole with concrete block, as shown in the Plans, specially shaped concrete units shall be used to transition between the vertical and the sloped walls.

D Sectional Concrete

The bottom pre-cast section shall be set in a full mortar bed and the joints between sections and around pipes shall be filled with mortar or an approved plastic cementing compound.

E Pipe

Metal or concrete pipe manholes shall be constructed in accordance with the details shown in the Plans.

F Castings

The frame or ring castings shall be set to the designated elevation on a full mortar bed except when metal pipe construction is used.

Where the Plans indicate that the casting shall not be bonded to the manhole/catch basin, the mortar bed shall be finished to the required

2506.4

grade and allowed to set, after which an approved lubricant shall be applied thereto and the casting installed.

G Adjusting Frame or Ring Castings

Vertical adjustment of access castings shall be made to the planned elevation on the existing structure, based on the criteria that full support for the casting is obtained above the cone section and that the structure construction above the cone does not exceed 600 mm (2 feet). Where these criteria cannot be maintained in the adjustment work, the structure shall be reconstructed.

For upward adjustment of castings, any of the structure materials or applicable construction methods indicated herein which are compatible with the in-place construction may be used. Auxiliary ring castings and adjusting rings, as indicated in the Plans, may be used as they apply.

H Reconstructing In-Place Structures

When the Plans call for a portion of the manhole/catch basin to be reconstructed, or when the frame or ring casting is to be raised or lowered beyond the limits defined in 2506.3G above, the structure shall be reconstructed to the extent shown in the Plans or directed by the Engineer.

Reconstruction shall be consistent, so far as possible with the type of construction used for the in-place structure. The work shall conform to the requirements specified above for new construction except that the salvaged material may be used if of acceptable quality. New work shall be thoroughly bonded to the old.

I Blank

J Construction in Conjunction with Pavement Construction

When manholes/catch basins are constructed, reconstructed or adjusted, in connection with the construction of a concrete pavement or base, the telescoping type of ring shall be used unless otherwise specified in the Plans.

When the telescoping type of ring is required, the frame or ring casting shall be set to the proper elevation before the pavement is placed.

K Backfilling

When the structure is made of cast-in-place concrete or of bricks or blocks laid in mortar, the backfilling shall not be made until at least 3 days have elapsed after the completion of the manhole or catch basin.

Excavated materials not required for backfill shall be disposed of as directed by the Engineer, within a haul distance of 1 km (½ mile).

2506.4 METHOD OF MEASUREMENT

Manholes and catch basins will be measured as drainage structures.

2506.4

A Constructing Drainage Structures

When measurement by length is specified, for vertical structures constructed on a concrete base, the length measurement will be the difference in elevation between the bottom of the casting and the invert elevation of the outlet pipe, plus an allowance of 0.20 m (**0.70 foot**) for the depth of the concrete base, regardless of its actual thickness.

When measurement by length is specified, for pipe structures where the design provides for the use of a "tee" section in the sewer or culvert line, the length measurement will be the difference in elevation between the bottom of the casting and the flow line elevation of the sewer or culvert pipe in the case of vertical construction, or as shown in the Plans in the case of other special designs not constructed vertically. The "run" of the "tee" section will also be measured and paid for as culvert or sewer pipe, as the case may be.

When measurement by the structure is specified, drainage structures of each design will be measured separately as individual units complete in place, including any castings furnished and installed.

B Reconstruction

Measurement will be made, to the nearest 30 mm (**1/10 foot**), of the height from the bottom of the reconstructed portion to the bottom of the newly set casting, with no regard as to type.

C Castings

Measurements for casting assembly will be by the number of casting assemblies furnished and installed.

Measurements for install casting will be by the number of castings installed by the Contractor.

No measurement will be made of castings for structures that are measured as a unit. All castings required for an individual structure will be considered as one assembly.

D Adjusting Castings

Measurement will be by the number of casting assemblies adjusted, all castings in any one structure being considered as one assembly.

2506.5 BASIS OF PAYMENT

Manholes and catch basins will be paid for as drainage structures.

Payment for constructing or reconstructing drainage structures at the appropriate Contract prices will be compensation in full for all costs of the work (including all necessary excavation) except those costs for which the Proposal contains specific items, subject to the following additional provisions:

- (a) Any excavation that is in ledge rock and the removal of boulders or detached rocks each having a volume of more than 0.4 m³ (**½ cubic yard**) will, unless the existence of such rock is shown in the Plans, be paid for as Extra Work.

2506.5

- (b) Payment for reconstructing drainage structures includes removal of the existing casting but does not include placement of a casting on the reconstructed structure.
- (c) Payment will be made for the removal and replacement of concrete base or concrete pavement when, except for the structure construction, the surface would not otherwise have been disturbed. Payment will be at the appropriate unit prices on the basis of the area, to the nearest 0.1 m² (**1/10 square yard**), within a rectangle having sides that lie ½ m (**1 ½ feet**) outside of the structure limits. No direct compensation will be made for removing and replacing any pavement outside of these limits or for replacing any other type of surfacing.
- (d) Payment for drainage structure construction by the structure as individual units complete in place will be compensation for furnishing and installing any castings required.
- (e) No direct payment will be made for removal and replacement of concrete surfacing in connection with the item of adjust frame and ring castings.
- (f) Granular materials for special bedding or backfill will be paid for in accordance with 2451.5.

Payment for drainage structures will be made on the basis of the following schedule:

Item No.	Item	Unit
2506.501	Construct Drainage Structure,.....	
	Design ____	meter (linear foot)
2506.502	Construct Drainage Structure, Design ____	each
2506.503	Reconstruct Drainage Structure	meter (linear foot)
2506.516	Casting Assembly	each
2506.521	Install Casting	each
2506.522	Adjust Frame and Ring Casting.....	each

2511

**2511
Riprap**

2511.1 DESCRIPTION

This work shall consist of furnishing and placing stone riprap, with or without grouting as specified, at the locations shown in the Plans or ordered by the Engineer, as a protective covering on earth slopes, piers, abutments, walls, or other structures, where the soil is susceptible to erosion.

Riprap will be classified by type as random riprap, handplaced riprap, or quarry-run riprap, depending on the method of placement and the stone size specified. Riprap shall be grouted when specified in the Contract or ordered by the Engineer. The riprap shall be placed on a filter layer consisting of granular material or geotextile unless otherwise specified.

2511.2 MATERIALS

A	Riprap Materials	3601
B	Filter Materials	
B1	Granular Filter	3601
B2	Geotextile Filter	3733
C	3A-Grout	2461

2511.3 CONSTRUCTION REQUIREMENTS

A General

The foundation for the riprap, with or without filter material, shall be excavated and shaped to the cross-sections indicated in the Plans, unless otherwise directed by the Engineer. All loose foundation material shall be thoroughly compacted before placement of the riprap or filter material.

When riprap is required, the Contractor shall place a thickness of 300 mm (**1 foot**) of riprap on a filter material unless otherwise indicated in the Contract or ordered by the Engineer.

B Filter Material

The Contractor shall place filter material under the riprap unless otherwise specified in the Contract. Filter material shall cover the entire area on which the riprap is to be placed. The Contractor may choose the type of filter material, except as restricted for geotextile filters, unless the type is specified in the Contract.

B1 Granular Filter

When granular filter is used, the thickness shall be 150 mm (**6 inches**) unless other dimensions are specified.

Granular filter materials shall be spread to uniform thickness over the prepared foundation. Granular material placed under water shall be deposited directly on the foundation by means of a bucket or similar container. Discharging the granular material above the water surface will not be permitted.

2511.3

B2 Geotextile Filter

Wherever geotextile filter material is placed, the Contractor shall ensure that:

- (a) The foundation surface is relatively smooth and free of stones, sticks, and other debris or irregularities that might puncture the fabric.
- (b) Placing material or conducting construction operations do not tear, puncture, or shift the fabric.

Where multiple fabric widths or lengths are required, they shall be placed with the longest dimension parallel to the direction of water flow. If not seamed, splices and joints shall be overlapped a minimum of 0.5 m (**18 inches**), except that under water the overlap shall be 1 m (**36 inches**). The joint laps shall be shingled (both in the flow direction and from top of slope to bottom) so as to direct water flow over the joint without undermining. In lieu of joint overlapping, multiple fabric pieces may be sewn to meet appropriate sections of 3733. Upgrade edges of the fabric area shall be buried sufficiently to direct water flow over the fabric without undermining. If not seamed, washered steel pins, edge stakes, stones, etc. shall be placed at locations and in quantities as approved by the Engineer, to prevent movement of the geotextile filter during placement of the riprap.

Dumping of stone at the top of the slope and rolling of stone down the slope will not be permitted. When stones are placed directly on the geotextile filter without a granular cushion, equipment will not be permitted to operate on top of the stones once they are placed. Construction equipment shall not operate directly on top of the geotextile.

Geotextile filter material shall not be used under handplaced or grouted riprap unless so specified.

Geotextile filter may be used only on 1 vertical to 3 horizontal or flatter slopes, unless slopes up to 1 vertical to 2 horizontal are stepped (terraced) before fabric placement.

C Riprap Stone

Stones shall not be dropped on the fabric from a height greater than 0.3 m (**1 foot**) unless the fabric is covered with a 150 mm (**6 inch**) thick granular cushion course, in which case the riprap stone may be dropped from a height not greater than 1 m (**3 feet**).

Riprap shall generally be placed by starting at the lowest elevations and working 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 3 m² (**4 square yards**) of riprap to inspect for fabric damage, subject to 1511.

2511.3

C1 Random Riprap

Random riprap shall be positioned in a manner that will provide uniform distribution of the various sizes of stone and produce a dense, well-keyed layer of stones with the least practical quantity of void space. The surface shall be leveled as necessary, to produce a reasonably uniform appearance and the required thickness.

C2 Hand-Placed Riprap

The stones for hand-placed riprap shall be firmly embedded in the foundation material, with the axis of the stone that most nearly approximates the specified thickness of riprap laid perpendicular to the foundation slope. Stones shall be laid with minimum practicable quantity of space between them and positioned to stagger the joints up the slope. Each stone shall be so placed that its mass is carried by the foundation material as well as adjacent stones.

The ends and edges of each riprap area shall be well defined using selected stones set to line and grade.

After the larger stones have been laid, the spaces between the stones shall be filled with firmly seated, smaller stones to produce a uniform surface.

C3 Quarry-run Riprap

Quarry-run riprap shall be placed as specified for random riprap.

D Grouting

For grouted riprap, the Contractor shall eliminate some of the smaller stones so that the spaces between stones, throughout the entire thickness of the riprap, are filled with grout.

Immediately before placing the grout for grouted riprap, the stones shall be thoroughly wetted with water. Grout shall not be poured over stones that have become surface dry. The surface of the grouted riprap shall be finished by sweeping with a stiff broom.

E Thickness Requirements

The riprap on each separate area shall have, upon completion, a minimum thickness of not less than 80 percent of the specified thickness and an average thickness of not less than 95 percent of the specified thickness, as measured at right angles to the face.

2511.4 METHOD OF MEASUREMENT

A Riprap

Riprap of each type and class measured by volume will be computed on the basis of actual surface dimensions as staked and the specified thickness.

Riprap of each type and class measured by mass will be based upon scale tickets of materials delivered and placed within the staked areas.

2512.2

B Filter Materials

Filter materials measured by mass will be based upon scale tickets of material delivered and placed within the staked areas.

Filter materials measured by volume will be computed on the basis of actual surface dimensions as staked and the specified thickness.

Geotextile filter material measured by area will be computed on the basis of actual surface dimensions as staked, with no allowance for overlaps or seams.

2511.5 BASIS OF PAYMENT

The Contractor will accept payment for riprap of each type and class at the Contract price per unit of measure as compensation in full for all costs of furnishing the required materials; excavating and preparing the foundations; and placing the riprap stone, grouting, and filter materials as specified. The Contractor will receive separate compensation for filter materials only when the Contract contains the appropriate pay items.

Payment will be as follows:

Item No.	Item	Unit
2511.501	Random Riprap, Class ____	cubic meter (cubic yard)
2511.502	Random Riprap, Class ____	metric ton (ton)
2511.503	Quarry-run Riprap	cubic meter (cubic yard)
2511.504	Quarry-run Riprap	metric ton (ton)
2511.505	Hand-placed Riprap.....	cubic meter (cubic yard)
2511.507	Grouted Riprap	cubic meter (cubic yard)
2511.511	Granular Filter ____	cubic meter (cubic yard)
2511.513	Granular Filter Material	metric ton (ton)
2511.515	Geotextile Filter, Type ____	square meter (square yard)

2512

Gabions and Revet Mattresses

2512.1 DESCRIPTION

Furnish and construct gabions and revet mattresses (placing stone in wire baskets) at the locations shown in the Plans or ordered by the Engineer.

2512.2 MATERIALS

A	Riprap Materials	3601
B	Filter Materials	
B1	Granular Filter	3601
B2	Geotextile Filter	3733
C	Gabions	3602
D	Revet Mattresses	3602

2512.3

2512.3 CONSTRUCTION REQUIREMENTS

A General..... 2511.3

The Contractor shall:

- (1) Excavate, shape, and compact the foundation to the elevation and alignment indicated in the Contract.
- (2) Furnish and place filter material, unless otherwise stated in the Contract.
- (3) Furnish and place gabions and revet mattresses.

B Filter Material

The Contractor shall place filter material over the entire area on which the gabions and revet mattresses are to be placed.

- B1 Granular Filter 2511.3
- B2 Geotextile Filter 2511.3

The Contractor may place geotextile filter material under gabions and revet mattresses on slopes without stepping when specified in the Contract or approved by the Engineer.

C Baskets and Fasteners

C1 Documentation

The Contractor shall provide:

- (a) Certification that the baskets and fasteners meet the requirements.
- (b) Manufacturer's drawings of the baskets and fasteners.
- (c) Manufacturer's assembly recommendation and instructions for the baskets and fasteners.

C2 Construction

The Contractor shall install the baskets to the dimensions, profile, and alignment shown in the Contract or ordered by the Engineer.

The Contractor shall:

- (a) Assemble the baskets according to the manufacturer's recommendations unless the following requirements, 3602, or the Plan state otherwise.
- (b) Place and fasten the diaphragms in the baskets to the side and bottom mesh so that cell dimensions are not more than 1 m (**3 feet**).
- (c) Fasten adjoining empty baskets together at their perimeters.
- (d) Place stones in the cells of baskets in a manner that will minimize voids, does not allow sharp edges to protrude through the mesh, and maintains the basket in the dimensions shown in the Plans. This will require some stones to be hand-placed.
- (e) Generally fill cells in 300 mm (**12 inch**) lifts. Fill cells of up to 300 mm (**12 inches**) in one lift. Fill cells of up to 450 mm (**18 inches**) in two equal lifts. Do not fill cells more than 300 mm (**12 inches**) higher than stone layers in adjacent cells or baskets.

2512.5

- (f) For twisted wire gabions place horizontal connecting wires on top of the stone layer in both directions where there is not a supporting basket, to prevent the sides from bulging. For welded wire gabions install preformed stiffeners across the corners of the gabions before filling. Two rows of stiffeners (4 per cell) are required for the front face and the side faces. A single row of stiffeners (2 per cell) is required on the back face. No stiffeners are required in interior cells. Preformed stiffeners shall have a nominal length of 450 mm (**18 inches**). The stiffeners should be hooked at crossing wires. Lacing wire may be used as a stiffener.
- (g) Fold the top of baskets shut and fasten to the ends, sides, diaphragms, and adjacent baskets, after the basket is filled.
- (h) Stack empty baskets on filled baskets and fasten to the filled baskets at front, exposed sides, and back before filling.
- (i) Blank
- (j) Stagger the vertical joints between the baskets of adjacent rows and layers unless otherwise shown in the Contract.
- (k) Blank
- (l) Backfill behind a gabion structure simultaneously with the cell filling operation.

C3 Fasteners

The Contractor may use either lacing wire, an approved alternative fastener, or a combination, to fasten the baskets.

C3a Lacing Wire

The Contractor shall place lacing wire at each joint alternating single and double loops every 75 to 150 mm (**3 to 6 inches**).

C3b Alternative Fastener

The Contractor shall place alternative fasteners at each joint at every mesh opening. If spiral binders are used they shall be adequately secured at the ends to prevent unwinding.

D Acceptance

The Engineer may consider the work as unacceptable if visible baskets have a variation of more than 150 mm (**6 inches**) from the profile or alignment shown in the Plans or as directed by the Engineer.

2512.4 METHOD OF MEASUREMENT

A Gabion and Revet Mattress

The Engineer will measure the gabion and revet mattress construction by volume, based on the nominal basket dimensions and the number of baskets incorporated into the work.

B Filter Materials 2511.4

2512.5 BASIS OF PAYMENT

The Department will make payment for gabions and revet mattresses at the Contract price per unit of measure as full

2512.5

compensation for all costs of furnishing the required materials, excavating and preparing the foundations, furnishing and installing filter materials, and constructing and filling the gabions and revet mattresses as specified.

The Department will make separate compensation for filter materials only when the Contract contains the appropriate pay items as listed in 2511.

The Department will pay as follows:

Item No.	Item	Unit
2512.517	Gabion	cubic meter (cubic yard)
2512.519	Revet Mattress	cubic meter (cubic yard)

2514
Slope Paving

2514.1 DESCRIPTION

This work shall consist of paving embankment slopes and waterways with Portland cement concrete or crushed aggregate, as specified, to provide erosion protection.

2514.2 MATERIALS**A Concrete 2461**

Unless otherwise specified, the concrete shall meet the requirements for Mix Designation 3A34, except that the slump requirement may be adjusted as approved by the Engineer to achieve the desired results.

B Reinforcement Bars 3301

Reinforcement shall be either Grade 300 or Grade 420 (**Grade 40 or Grade 60**) deformed billet Steel, of ASTM A 615/A 615M.

C Preformed Joint Filler 3702**D Bituminous Material 3151**

Bituminous material for stabilizing aggregate slope paving shall be Liquid Asphalt, Grade MC-250, MC-800, or Emulsified Asphalt, Grade CSS-1, CSS-1H, RS-1, or CRS-2.

E Aggregate

The material for aggregate slope paving shall conform to 3137 for gradation class CA-1, CA-2, or CA-3, except that the fourth paragraph of 3137.2E (multiple fraction requirement) shall not apply.

2514.3 CONSTRUCTION REQUIREMENTS**A Foundation Preparations**

The foundation upon which the paving material is to be placed shall be prepared as necessary to achieve the specified paving dimensions and surface elevations as indicated in the Plans or directed by the Engineer. Foundation preparations shall include the excavating of high spots and the filling and compacting of low spots until the foundation conforms to the required elevation and slope and is of uniform density.

In the event the rough grading was performed by others under another contract and the Engineer determines that there is either a shortage or excess of material to construct to the planned foundation elevations, the Engineer may make such minor adjustments in grade to balance out the available material or may order the placement of additional material from other sources or the removal and outside disposal of excess material, as may be required to achieve acceptable foundation elevations. The furnishing and placing of additional material and the removal and outside disposal of excess material by order of the Engineer will be compensated for as Extra Work to the extent that loading and hauling of the material is necessary. Excess material disposed of on areas adjoining the slope paving as directed by

2514.3

the Engineer, without loading and hauling, will not be compensated for separately as Extra Work but will be considered as being incidental to the slope paving item.

B Aggregate Slope Paving

The aggregate shall be deposited, spread, consolidated, and shaped by mechanical or hand methods that will provide uniform depth and density and produce uniform surface appearance. Liquid asphalt shall be applied when ambient air temperature is not less than 5°C (40°F), at an approximate rate of 8 L/m² (1.8 gallons per square yard). Emulsified asphalt shall be applied when ambient air temperature is not less than 10°C (50°F), at an approximate rate of 11 L/m² (2.5 gallons per square yard). Bituminous materials shall penetrate to a depth of not less than one-half the required thickness of the aggregate slope paving. Adjacent structure surfaces shall be protected against bituminous splatter.

C Concrete Slope Paving

Construction shall be in accordance with the applicable provisions of 2401. The concrete shall be placed, consolidated, struck-off, and hand floated as will secure dense pavement relatively free of voids and cavities and produce uniform surface appearance. Side forms shall be so set and supported and the concrete so finished as to result in surfaces that do not deviate from a true plane and the prescribed grade by more than plus or minus 13 mm (½ inch). Metal reinforcement and preformed filler material shall be placed as required by the Plans and shall be suitably supported to maintain correct position during concrete placement.

Toe walls and side walls shall be formed and cast prior to placing concrete for contiguous slope paving. The subgrade shall be moist at the time of concrete placement, and care shall be taken to prevent subgrade displacement and contamination of the concrete. The slope paving shall either be placed in equally spaced alternate strips running in the direction of maximum slope, or in full width sections when mechanical equipment adequate for such placement and finishing is provided.

Immediately after placement the concrete shall be consolidated and struck off. When the concrete has set sufficiently to maintain shape, the surface shall be struck off again, after which the surface shall be given a final finish by hand floating with a cork or wood float and then broomed to produce a uniform texture and appearance.

After the final floating, all edges not formed with v-strip inserts shall be finished with a suitable edging tool and all panel lines shall be cut with suitable grooving tools or they may be sawed as directed by the

2520.3

Engineer. All edging and grooving flange trails shall be obliterated by floating to secure uniform surface appearance.

After completion of the concrete finishing operations, all exposed surfaces shall be given curing protection in accordance with 2401.3G until a strength gain of at least 30 percent has been attained.

2514.4 METHOD OF MEASUREMENT

Slope paving of each type will be measured separately by area of top surface, bounded by the outside edges of abutment faces, toe walls, side walls or timber planks, as constructed and accepted for payment.

2514.5 BASIS OF PAYMENT

Payment for slope paving of each type specified at the Contract price per unit of measure of surface area will be compensation in full for all costs of constructing the work complete in place as specified.

Payment for slope paving will be made on the basis of the following schedule:

Item No.	Item	Unit
2514.501	Concrete Slope Paving	square meter (square yard)
2514.503	Aggregate Slope Paving	square meter (square yard)

2520

Lean Mix Backfill

2520.1 DESCRIPTION

This work shall consist of placing a lean cementitious backfill into utility and culvert trenches, or other such excavations, where the use of conventional compacting equipment is deemed inappropriate or impractical. It is neither a low strength concrete nor a soil cement, but is a controlled-density backfill material.

2520.2 MATERIALS

A	Cement	3101
B	Fly Ash	3115
C	Fine Aggregate	3126
D	Coarse Aggregate	3137

The provisions of 3137.2C and 3137.2D shall not apply.

E	Water	3906
F	Admixtures	3113

2520.3 MIX REQUIREMENTS

A Mix Design and Control

Lean mix backfill design shall be governed by the absolute volume relationships; and basic mix proportions set forth herein for the control of cement, fly ash, water, and aggregate content; and the degree of workability necessary for proper placement.

2520.3

A1 Tentative Material Proportioning

The proportions shall be such as to obtain the flowability, workability, and consistency required for the Project. Once the Contractor provides the Concrete Engineer with the source of materials, the Concrete Engineer will, within 10 days, furnish a mix design for the use on this Project. This design will be based on the following proportions per unit batch (volume approximately 1 m³ (**cubic yard**)).

Cement 75 kg (**125 lbs**)
Fly Ash..... 150 kg (**250 lbs**)
Water..... 225 kg (**375 lbs**)

The remaining volume* will consist of:

Fine Aggregate50%
Coarse Aggregate50%

Gradation Range 6 as shown in 2461.3B4

*Up to 30 % of the aggregate by volume may be replaced by pre-formed foam. The foaming agent shall comply with ASTM C-869 when tested in accordance with ASTM C-796. Other admixtures may be used when specifically approved by the mix designer and Mn/DOT's Concrete Engineer.

A2 Mix Requirements

Slump 250 mm ± 25 mm (**10 inch ± 1 inch**)

Unconfined Compressive Strength:

Minimum desirable: 500 kPa (**75 psi**) at 28 days

Maximum desirable: 2750 kPa (**400 psi**) at 28 days

A3 Job Mix Proportions

The tentative job mix will be designed based on the above proportions for use at the start of construction and until the required water content and strengths can be determined. Experience from previous work using the same material sources may be used to modify the tentative proportions.

A4 Mix Adjustments

The Department reserves the right to make adjustments in the mix any time as may be found necessary to maintain the specified consistency and strengths.

B Production Controls

The production shall meet the requirements of 2461.4 A1, A2, A3, and A5 except where the word concrete is used it shall be understood to mean lean mix.

C Batching and Mixing Requirements

C1 Proportioning Methods

Lean mix batch materials shall be proportioned by mass (weight) except where volumetric proportioning is authorized in writing by the Engineer.

2520.5

C2 Other Batching and Mixing Requirements

These requirements shall meet 2461.4 B2, B3, B4, B5, and 2461.4C except that the word concrete shall be understood to mean lean mix.

D Ready-Mixed Lean Mix Backfill

The provisions of 2461.4D, Ready-Mix Concrete, shall apply except that the word concrete shall be understood to mean lean mix.

E Construction Requirements

The mix has a very high slump, flowability and workability, that eliminates the need for labor-intensive vibration and compaction. The mix consistency is similar to that of a slurry and as such will seek its own level; therefore, it is the responsibility of the Contractor to plug openings below the level of the desired backfill that would permit escape of the mix. The lean mix shall be placed so that it flows around and beneath such footings, foundations, walls, pipes, or other structures it was designed to support. When properly placed, the material is self-compacting, self-densifying, and has sufficient plasticity that compaction or mechanical vibration is not required. Air pockets that water would normally fill must be vented or otherwise eliminated so as to preclude voids remaining in the completed backfill.

E1 Curing and Protection

The air in contact with lean mix backfill surfaces should be maintained at temperatures above freezing for a minimum of 72 hours.

There is a substantial water gain (bleeding) on the surface that is normal. Once this water has evaporated no other means of curing is deemed necessary.

2520.4 METHOD OF MEASUREMENT

Only when payment is prescribed under the following provision will the quantity of lean mix backfill produced and furnished be measured as a separate pay item. Then, the volume of the lean mix backfill will be measured as the computed, theoretical volume based on the mass of the individual batch ingredients. The quantities so determined will be reduced for payment by all accountable waste.

2520.5 BASIS OF PAYMENT

In general payment for lean mix backfill will be considered as incidental to other work as would common backfill.

Should the Department determine a need exists for such a pay item, it will be shown in the Plans. Payment will be made at the Contract price per unit of measure. This will be compensation in full for all costs of producing and furnishing the lean mix backfill and for all costs of forming, plugging, placing, venting, protecting as required except for such costs that are specifically compensated for under other Contract items.

2520.5

Item No.	Item	Unit
2520.501	Lean Mix Backfill	cubic meter (cubic yard)

**2521
Walks**

2521.1 DESCRIPTION

This work shall consist of bituminous or concrete walkway construction in accordance with these Specifications and close conformity with the lines and grades indicated in the Plans or established by the Engineer.

2521.2 MATERIALS

A	Concrete, Mix No. 3A32.....	2461
	Concrete, Mix No. 3A36.....	2461
B	Preformed Joint Filler.....	3702
C	Blank	
D	Concrete Treating Oil	3917
E	Bituminous Mixture, Type as Specified	2360
F	Curing Materials	
F1	Curing Paper.....	3752
F2	Plastic Sheeting	3756
F3	Membrane Curing Compound	3754
F4	Extreme Service Membrane Cure	3755
G	Granular Materials	3149

2521.3 CONSTRUCTION REQUIREMENTS

A Foundation Preparations

The foundation shall be excavated, shaped, and compacted to a firm, uniform bearing surface, conforming to the planned section and established grade. Unsuitable subgrade soils shall be removed and replaced as directed. Granular material, as specified and where required by the Plans, shall be furnished, placed, and compacted thoroughly to the required depth.

A1 Sawing Concrete Walk

This work shall consist of sawing existing concrete walk to produce a neat line from which to extend the new work.

B Forms

Forms shall be of wood or metal, coated on the contact face with form treating material, and in a condition that will allow proper finishing and subsequent form removal. The form height shall be at least that of the planned walk thickness.

C Concrete

C1 Placing and Finishing Concrete

The foundation and forms shall be thoroughly wetted immediately prior to the placing of the concrete. The concrete shall be placed,

2521.3

consolidated to fill all voids, struck off to the required grade, and floated smooth. After the water sheen has disappeared, the joints shall be edged and the surface lightly brushed to a uniform texture.

The surface shall not vary more than 5 mm (**3/16 inch**) from a 3 m (**10 foot**) straight edge, and the formed concrete shall be within 13 mm (**½ inch**) of the required location.

Forms shall remain in place for a minimum 12 hours after placing the concrete therein unless earlier removal is authorized by the Engineer.

C1a Exposed Aggregate Finish

Concrete Mix No. 3A36, modified for exposed aggregate construction shall conform to the requirements of Mn/DOT 3137 CA-50 and be multi-colored rounded stone.

Provide an exposed aggregate finish using surface retardation to produce a medium to deep exposure, so that the aggregate becomes the dominant surface feature. Embedment or top seeding of aggregate is not permitted.

Apply retardant coating as soon after the concrete surface has been screeded, edged, and jointed. Retardant shall be applied in accordance with the manufacturer's instructions to produce a 6 mm (± 2 mm) (**1/4 inch ($\pm 1/8$ inch)**) etch of mortar removal after final set.

Surface mortar shall be removed by washing with water under pressure. Avoid excessive pressure which loosens individual aggregate particles.

Following approval of the exposed aggregate finish obtained, a 10 percent muratic acid wash shall be applied to the exposed aggregate surfaces. Surfaces shall be flushed thoroughly with water following a 5 to 10 minute interaction period between the acid solution and the surface.

Curing of the concrete shall be continued by covering with white polyethylene sheeting. Any staining or streaking of the exposed aggregate surface resulting from the moist curing shall be removed before applying the sealer.

The exposed aggregate finish shall be sealed with two coats of a clear acrylic based compound with 18 percent minimum solids conforming to ASTM C309.

C2 Joint Construction

The walk shall be divided into panels of uniform size, outlined with contraction or expansion joints as required by the Plans. The panels shall be square where practicable and generally have not more than 3 m² (**36 square feet**) of area.

Joints shall be vertical and straight, and be parallel with or at right angles to the walk centerline where possible. The joints shall align with

2521.3

like joints in adjoining work unless the work is isolated by 13 mm (**½ inch**) preformed joint filler.

All joints and edges of the walk shall be rounded with a 6 mm (**¼ inch**) radius edging tool.

Contraction joints shall extend to at least 30 percent of the walk thickness and shall be approximately 3 mm (**1/8 inch**) wide.

Expansion joints shall be 13 mm (**½ inch**) wide and shall be equal in depth to the full thickness of the walk.

Joint construction at locations where a fixed object or structure extends through the walk shall be modified to the extent deemed necessary by the Engineer. Preformed joint filler material, 13 mm (**½ inch**) thick, shall be placed adjacent to all fixed objects so as to separate the object from the abutting concrete edges.

C3 Concrete Curing and Protection

After the finishing operations have been completed and as soon as the set of the concrete permits, the concrete shall be cured for a minimum period of 72 hours. The curing shall be in accordance with one of the methods prescribed herein. Where side forms are used, the edges shall receive the curing media within 30 minutes after removal of the forms. During cold weather, the Contractor shall protect the concrete from frost damage prior to and throughout the duration of the cure.

After September 15th, in that part of the State which is north of the 46 degree Parallel, and after October 1st in that part of the State which is south of the 46 degree Parallel, or before April 15th, only the blanket curing or extreme service membrane methods of curing will be permitted.

With the blanket method, after being cured the prescribed minimum period of 72 hours, the concrete shall be treated with two applications totaling approximately 1 L/4 m² (**1 gallons per 150 square feet**) of Type II concrete treating oil or extreme service membrane curing compound applied over all concrete surfaces that will remain exposed in the completed work. The concrete shall be clean and dry when the treating oil is applied.

C3a Blanket Curing Method

The concrete shall be covered with waterproof paper or plastic sheeting as soon as possible (without marring the concrete) after completion of the finishing operations. The curing blankets shall be in such condition and be utilized in such manner as to envelop the exposed concrete and prevent loss of water vapor.

C3b Membrane and Extreme Service Membrane Curing Method

All Surfaces exposed to air at the time of cure shall be coated with membrane curing compound within 1 hour after finishing the concrete

2521.5

surfaces. The compound shall be applied by an approved airless spraying machine at the approximate rate of 1 L/4 m² (**1 gallon per 150 square feet**) of surface curing area.

As conditions for approval, the spraying machine shall have as essential elements; a recirculating bypass system that provides for continuous agitation of the reservoir material; separate hose and nozzle filters; and a multiple or adjustable nozzle system that will provide for variable spray patterns.

Before application, the curing compound as received in the shipping container shall be agitated until a homogeneous mixture is obtained. Application shall be such that a uniform coating is obtained. Any areas that, by visual inspection, appear to have received too light a coating shall be resprayed immediately. Also, should the membrane film become damaged at any time within the required curing period, the damaged areas shall be repaired immediately by respraying. Wherever the initial or corrective spraying is such as to result in unsatisfactory curing, the Engineer may require use of the blanket curing method at no additional cost to the Department.

D Bituminous

The bituminous mixture shall be placed on the compacted foundation material in one or more courses as indicated in the Plans, so as to give the required thickness.

E Backfilling

Following removal of the forms, the area adjacent to the walk shall be finished in a neat and workmanlike manner using material obtained from the excavation. Surplus excavated materials shall be disposed of by the Contractor in a manner satisfactory to the Engineer.

2521.4 METHOD OF MEASUREMENT

Each uniform thickness item will be measured separately by top surface area.

Measurement for sawing concrete walk will be made by the length of concrete walk sawed.

2521.5 BASIS OF PAYMENT

Payment for the concrete or bituminous construction provided for herein, at the Contract prices per unit of measure, will be compensation in full for all costs of furnishing the materials and constructing the work complete in place as specified, except that any granular materials furnished and placed by order of the Engineer in the absence of specific Plan requirements will be paid for separately under 2451.5. Payment for sawing concrete walk shall be compensation in full for all costs relative thereto.

Concrete and Bituminous walk construction will be paid for on the basis of the following schedule:

2521.5

Item No. Item	Unit
2521.501 ___mm (___inch) Concrete Walk square meter (square foot)	
2521.503 ___mm (inch) Concrete Terrace square meter (square foot)	
2521.511 ___mm (inch)Bituminous Walk square meter (square foot)	
2521.513 ___mm (inch)Bituminous Terrace square meter (square foot)	
2521.515 ___Sawing Concrete Walk meter (linear foot)	

2531

Concrete Curbing

2531.1 DESCRIPTION

This work shall consist of constructing cast-in-place concrete curbs, curb and gutter, medians, driveway pavement, pedestrian ramps, and other similar traffic delineation or service items.

2531.2 MATERIALS

A Concrete 2461

Mix designations shall be as given below for the method of placement:

A1	Manual Placement	Mix No. 3A32
A2	Slip-form Placement	Mix No. 3A22
B	Reinforcement Bars.....	3301
C	Steel Fabric	3303
D	Preformed Joint Filler.....	3702
E	Blank	
F	Concrete Treating Oil	3917
G	Curing Materials	
G1	Curing Paper.....	3752
G2	Plastic Sheeting	3756
G3	Membrane Curing Compound	3754
G4	Extreme Service Membrane Cure	3755
H	Granular Materials	3149

2531.3 CONSTRUCTION REQUIREMENTS

A Foundation Preparations

The foundation shall be excavated, shaped, and compacted to a firm, uniform bearing surface, conforming to the planned section and established grade. Unsuitable subgrade soils shall be removed and replaced as directed. Granular material, as specified and where required by the Plans, shall be furnished, placed and compacted thoroughly to the required depth.

B Forms

Forms shall be of metal, wood, or other suitable material, and shall be capable of sustaining the concrete in its proper position until set. Face forms for curbing shall conform to the required shape and design. Side forms shall have a depth at least equal to the edge thickness of the concrete being formed. The forms shall be fully supported on the foundation and be adequately restrained at the proper line and grade.

Approved flexible or curved forms of proper radius shall be used on curves having a radius of 45 m (**150 feet**) or less.

The contact surfaces of all forms shall be coated with form treating material conforming to 3902, prior to placing the concrete.

C Joint Construction

Transverse expansion joints, filled with 13 mm (**½ inch**) preformed joint filler material, shall be placed at the ends of all curved sections; and at the ends of the curved portions of entrance and street returns. Longitudinal expansion joints shall be placed as shown in the Plans. Expansion joints with filler material shall also be placed at locations where the concrete surrounds or adjoins any existing fixed objects such as fire hydrants, building foundations, and other rigid structures.

Contraction joints shall be provided at 3 m (**10 foot**) intervals in curb or curb and gutter construction when adjacent to bituminous mainline and at 6 m (**20 foot**) intervals in solid median construction, except as otherwise provided in the Plans. The contraction joints shall match the adjacent concrete pavement joints. The contraction joints shall generally be formed to the full depth of the concrete, using 3 mm (**1/8 inch**) thick removable inserts conforming to the cross sectional shape of the concrete. Where practicable, such as in driveway pavement or where a curb machine is used, the contraction joints may be formed or sawed as approved by the Engineer to a depth of at least 50 mm (**2 inch**) from all exposed surfaces.

Joints shall be constructed perpendicular to the subgrade and shall align with similar joints in adjoining work when practicable. Transverse joints shall be placed at right angles to the longitudinal axis of the work unless otherwise indicated in the Contract.

Longitudinal construction joints between a concrete median or gutter section and a concrete pavement shall have a surface groove, either formed or sawed, that is approximately 10 mm (**3/8 inch**) wide and at least 13 mm (**½ inch**) in depth.

D Metal Reinforcement

Metal reinforcement shall be provided and placed as required by the Plans and in conformance with the applicable provisions of 2472.

2531.3

E Placing and Finishing Concrete

Immediately before placing the concrete, the inside faces of the forms shall be wetted and the foundation moistened with water.

The concrete shall be placed in a manner that will prevent segregation; consolidated by hand tamping or internal vibrating to fill all voids; struck off to the required grade; and floated smooth. Curb face forms and contraction joint inserts shall be removed as soon as the concrete has set sufficiently to retain its molded shape.

The top surface and face of curbs shall be hand-floated with a suitable trowel as soon after the face forms have been removed as the condition of the concrete will permit.

After the water sheen has disappeared, joints and edges shall be rounded to the radii shown in the Plans or as directed by the Engineer, and all concrete surfaces exposed to view shall be lightly brushed to a uniform texture.

Side forms shall remain in place for at least 12 hours after the concrete has been cast. All cavities shall be filled with mortar, upon removal of the side forms.

F Slipform Machine Placement

Instead of using fixed side forms, concrete may be placed and formed to the required shape by using an approved type of extrusion machine that will produce a finished product meeting the standards for dimension, quality, workmanship, and appearance as would be achieved with fixed-form construction provided for herein. Hand finishing will be required only to the extent necessary to obtain the specified surface finish and texture.

G Concrete Curing and Protection

After the finishing operations have been completed and as soon as the set of the concrete permits, the concrete shall be cured for a minimum period of 72 hours. The curing shall be in accordance with one of the methods prescribed herein. Where side forms are used, the edges shall receive the curing media within 30 minutes after removal of the forms. During cold weather, the Contractor shall protect the concrete from frost damage prior to and throughout the duration of the cure.

After September 15th, in that part of the State that is north of the 46 degree Parallel, and after October 1st in that part of the State that is south of the 46 degree Parallel, or before April 15th, only the blanket curing or extreme service membrane methods of curing will be permitted.

With the blanket method, after being cured the prescribed minimum period of 72 hours, the concrete shall be treated with two applications totaling approximately 1 L/4 m² (1 gallon per 150 square feet) of

2531.3

Type II concrete treating oil or extreme service membrane cure applied over all concrete surfaces that will remain exposed in the completed work. The concrete shall be clean and dry when the treating oil is applied.

G1 Blanket Curing Method

The concrete shall be covered with waterproof paper or plastic sheeting as soon as possible (without marring the concrete) after completion of the finishing operations. The curing blankets shall be in such condition and be utilized in such manner as to envelop the exposed concrete and prevent loss of water vapor.

G2 Membrane and Extreme Service Membrane Curing Method

All surfaces exposed to air at the time of cure shall be coated with membrane curing compound within 1 hour after finishing the concrete surfaces. The compound shall be applied by an approved airless spraying machine at the approximate rate of 1 L/4 m² (**1 gallon per 150 square feet**) surface curing area.

As conditions for approval, the spraying machine shall have as essential elements, a recirculating bypass system that provides for continuous agitation of the reservoir material; separate hose and nozzle filters; and a multiple or adjustable nozzle system that will provide for variable spray patterns.

Before application, the curing compound as received in the shipping container shall be agitated until a homogeneous mixture is obtained. Application shall be such that a uniform coating is obtained. Any areas that, by visual inspection, appear to have received too light a coating shall be resprayed immediately. Also, should the membrane film become damaged at any time within the required curing period, the damaged areas shall be repaired immediately by respraying. Wherever the initial or corrective spraying is such as to result in unsatisfactory curing, the Engineer may require use of the blanket curing method at no additional cost to the Department.

H Blank

I Blank

J Backfill Construction

As soon as possible without subjecting the concrete work to damaging stresses, the required backfill or embankment construction shall be completed to the elevations indicated in the Plans, using selected materials from the excavations where no other material is provided by the Contract. Placement and compaction of the material shall be in accordance with the applicable provisions of 2451.

All surplus excavated materials shall be disposed of by the Contractor in a manner satisfactory to the Engineer.

2531.3

K Workmanship and Finish

The complete concrete work shall give the appearance of uniformity in surface contour and texture, and shall be accurately constructed to line and grade.

Edge and surface alignment on curved construction shall conform closely to the planned curvature, and the flow line surface of gutters shall be finished as necessary to eliminate low spots and avoid entrapment of water.

Concrete edges and surfaces designed to straight lines or grades will be checked with a 3 m (**10 foot**) straightedge, and any deviations therefrom in excess of 8 mm (**5/16 inch**) will be considered to be unacceptable work.

Unacceptable work shall be removed and be replaced with acceptable work as ordered by the Engineer. In the absence of an order to remove and replace, the Contractor shall have the option of so doing or may elect to leave the unacceptable work in place and accept the following price reductions:

- (1) For 10 to 14 mm (**3/8 to 9/16 inch**) deviation, payment at 75 percent of Contract price.
- (2) For deviation over 14 mm (**9/16 inch**), payment at 50 percent of Contract price.

2531.4 METHOD OF MEASUREMENT

The construction provided for herein will be measured, as indicated in the Proposal, by the length, area, or volume. No deductions will be made for any castings or minor fixtures encompassed in the work.

A Length

Length measurements on curbs and curb and gutter will be made along the face of the curb at the gutter line. In the case of transitions from one size or design to another, the entire transition will be measured for payment under the item bid at the higher unit price of the two involved.

Length measurements on solid medians and other construction having uniform width and symmetrical cross section will be made along the center of the longitudinal axis. Unless a variance from the basic design results in increased cross sectional area, short sections of modified design (such as tapers and depressions) will be included for payment with the basic design if there is no separate item provided therefore.

At entrances and alleys, any curbing constructed beyond the curb returns or driveway pavement will be measured for payment as shown in the Plans.

2531.5

B Area

When measurement is by area, computations will be based on the length as staked and the extreme width between outside faces as shown in the Plans or otherwise authorized, without regard to variations in concrete thickness caused by integral construction such as curbs, drainage openings, etc. However, driveway pavement of each specified thickness, and other items of different design will be measured separately as provided for in the Contract.

C Volume

When measurement is by volume, computations will be based on the length as staked and the cross sectional dimensions shown in the Plans or otherwise authorized.

All concrete structures not otherwise designated for payment by type or design will be included for payment under the item of structural concrete.

D Pedestrian Curb Ramps

Measurement for pedestrian curb ramps will be made by the number of pedestrian curb ramps constructed as specified.

Measurement for pedestrian curb ramps Type will be made by the top surface area. The measurement will be taken from the outer most edge of the concrete walk, curb, or curb and gutter.

2531.5 BASIS OF PAYMENT

Payment for the concrete construction provided for herein, at the Contract prices per unit of measure, will be compensation in full for all costs of furnishing the materials and constructing the work complete in place as specified, except that any granular materials furnished and placed by order of the Engineer in the absence of specific Plan requirements will be paid for separately under 2451.5.

Payment for concrete curbing, median, and driveway construction will be made on the basis of the following schedule:

Item No.	Item	Unit
2531.501	Concrete Curb and Gutter, Design.....	meter (linear foot)
2531.502	Concrete Curb, Design	meter (linear foot)
2531.503	Concrete Median	square meter (square yard)
2531.505	Concrete Median	meter (linear foot)
2531.507	___mm (inch) Concrete Driveway Pavement	square meter (square yard)
2531.511	Concrete (Type of Structure).....	cubic meter (cubic yard)
2531.521	Structural Concrete	cubic meter (cubic yard)
2531.530	Concrete Entrance Nose, Design 7107	each
2531.531	Concrete Entrance Nose, Design 7108	each
2531.532	Pedestrian Curb Ramp (Type ___)	each

2531.5

2531.533 Pedestrian Curb Ramp (Type ___)
.....square meter (**square yard**)

2533

Concrete Median Barriers

2533.1 DESCRIPTION

This work shall consist of constructing or reconstructing cast-in-place or precast median barriers built for the purpose of providing traffic lane separation.

2533.2 MATERIALS

A Concrete 2461

A1 3Y32 concrete shall be used for all fixed form cast-in-place concrete median barriers.

A2 3Y12 concrete shall be used for all slipform concrete median barriers.

A3 3Y32 concrete shall be used for all precast concrete median barriers.

B Reinforcement Bars 3301

C Precast Concrete Median Barrier 3630

2533.3 CONSTRUCTION REQUIREMENTS

A General

The Engineer may permit a combination of cast-in-place and precast concrete construction for those structures where a type of construction is not specified and where structural strength and/or continuity are maintained.

Where a new median barrier will join to an existing barrier the connection shall be interlocked by a tongue and groove joint with tied reinforcement bars or other positive connection, acceptable to the Engineer, to prevent movement.

The foundation shall be excavated, shaped, and compacted to a firm, uniform bearing surface, conforming to the planned section and established grade. Unsuitable subgrade soils shall be removed and replaced as directed by the Engineer. Granular material, when specified in the Plans or required by the Engineer, shall be furnished, placed, and compacted thoroughly to the required depth.

B Cast-In-Place Fixed Form Construction

Forms shall be of metal, wood or other suitable material, and shall be capable of sustaining the concrete in its proper position until set. All forms shall conform to the required shape and design. The forms shall be fully supported on the foundation and be adequately restrained at the proper line and grade.

Immediately before placing the concrete, the inside faces of the forms shall be wetted and the foundation moistened with water.

2533.3

The concrete shall be placed in a manner that will prevent segregation; consolidated by internal vibration to fill all voids; struck off to the required grade; and floated smooth. Forms for the roadway face of the median barrier may be removed as soon as the concrete can retain its molded shape. Non-roadway face forms shall remain in place for at least 12 hours after the concrete has been cast.

After roadway face forms have been removed all edges shall be rounded to the radii shown in the Plans or as directed by the Engineer.

C Cast-In-Place Slipform Construction

Concrete may be placed and formed to the required shape by using an approved type of extrusion machine that will produce a finished product meeting the standards for dimension, quality, workmanship and appearance as would be achieved with fixed form construction provided for herein. Hand finishing will be required only to the extent necessary to obtain the specified surface finish and texture.

D Surface Finishes

D1 Cast-In-Place

Cast-In-Place concrete median barriers shall receive an Ordinary Surface Finish as specified in 2401.3. The ordinary surface finish shall start immediately after the removal of the forms and shall be carried on continuously to completion. As the ordinary surface finish progress, it shall be followed by immediately rubbing the surface with a cork float or fine carborundum stone (depending on the set of the concrete) to produce a paste on the surface and to expose and fill all depressions and all surface cavities. The paste shall be floated to a smooth surface free of coarse texture, swirls, and ridges and before it is set, shall be brushed lightly with a fine bristled brush until all cement films present are removed and the surface has a uniform, fine grained sanded texture.

Concrete placement, form removal, and finishing operation shall be planned and carried out so that the surface finishing of the formed surface can be completed within 48 hours after concrete placement of that section has been completed.

D2 Precast

Precast concrete median barriers shall receive the special surface finish as specified in 2401.3. The object of this operation is to obtain a surface that is reasonably smooth and uniform in texture and appearance and blends in with any cast-in-place concrete median barrier.

The Contractor shall not apply the special surface finish on the precast concrete median barrier until the barrier is placed in its final location and the Engineer has approved the surface condition of the barrier.

2533.3

E Concrete Curing and Protection

Newly placed concrete shall be properly cured by providing protection against rapid loss of moisture, freezing temperatures, high temperatures, abrupt temperature changes, vibrations, shock waves, and prematurely applied loads. This protection shall be provided when directed by the Engineer, and for a period of time that is not less than that specified in 2401.3, Concrete Curing and Protection.

F Workmanship and Finish

Irregularities in any 3 m (**10 feet**) length of the finished concrete median barrier shall not exceed 6 mm (**¼ inch**) (horizontal and vertical). Surfaces and edges not meeting this tolerance shall be considered to be Unacceptable Work. Unacceptable Work shall be removed and replaced with acceptable work when so ordered by the Engineer. Extensive areas with deviations greater than 13 mm (**½ inch**) shall be removed and replaced. In the absence of an order to remove and replace, the Unacceptable Work may be left in place with the following price adjustments:

- (1) For 8 to 13 mm (**5/16 to ½ inch**) deviations, payment at 75 percent of the Contract price.
- (2) For minor areas with deviations over 13 mm (**½ inch**), payment at 50 percent of Contract price.

2533.4 METHOD OF MEASUREMENT

The concrete median barrier will be measured on the top of the barrier along the centerline of Type A barriers and 75 mm (**3 inches**) back of the front face of Type AA barriers. In the case of transitions, special and modified barriers, the length will be measured on the top of the barrier and 75 mm (**3 inches**) back of the front face. Each concrete median barrier will be measured separately.

2533.5 BASIS OF PAYMENT

Payment for the concrete median barriers provided for herein, at the Contract prices per unit of measure, will be compensation in full for all costs of furnishing the materials, placement of the work to the lines and grade of the Plan and surface finish as specified.

Payment for the concrete median barrier will be made on the basis of the following schedule:

Item No.	Item	Unit
2533.501	Concrete Median Barrier, Design (1) Type (2) meter	(linear foot)
2533.506	Concrete Median Barrier & Glare Screen, Design (1) Type (2).....	meter (linear foot)
2533.507	Portable Precast Concrete Barrier, Design (1)	meter (linear foot)

2533.5

2533.508 Relocate Portable Precast Concrete Barrier, Design (1)
.....meter (**linear foot**)

- (1) Current Standard Plate
- (2) Type A, AA, AL, Transition, A Step, or AA Step

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Bituminous Curb

2535.1 DESCRIPTION

This work shall consist of constructing bituminous curbing composed of a mixture of aggregate and bituminous material.

2535.2 MATERIALS

The bituminous mixture for the curb shall be produced in accordance with the requirements for wearing course mixtures as provided in 2360, subject to the following provisions:

- (a) The mixture shall be of the same type as that used in the wearing course upon which the curb is to be constructed, unless the use of another type is specified or approved by the Engineer.
- (b) The bitumen content of the mixture may be increased if necessary, at the discretion of the Engineer. The Engineer may require the substitution of a lower penetration asphalt cement for the specified grade.

2535.3 CONSTRUCTION REQUIREMENTS

Bituminous curb shall be placed under the same restrictions as those that apply to the wearing course construction 2360. If so directed by the Engineer, a tack coat shall be applied to the area on which the curb is to be constructed, as provided for in 2357.

The bituminous mixture shall be placed by an approved automatic curb machine that shapes and compacts the mixture to the specified cross section. The use of manual methods of placement will only be permitted where machine placement is not feasible, and then in a manner approved by the Engineer.

The alignment of the finished curb shall be true to line and grade, within reasonable tolerances. The finished curb shall be uniform in appearance and texture.

2535.4 METHOD OF MEASUREMENT

Bituminous curb will be measured by length along the face of curb at the gutter line.

2535.5 BASIS OF PAYMENT

Payment for bituminous curb at the Contract price per unit of measure will be compensation in full for all costs of its construction, including the costs of producing and furnishing the bituminous mixture.

Payment for bituminous curb will be made on the basis of the following schedule:

Item No.	Item	Unit
2535.501	Bituminous Curb	meter (linear foot)

2545

2545

Electric Lighting Systems

2545.1 DESCRIPTION

A General

This work includes constructing complete and operational electric lighting systems, electric power systems, sign lighting systems, or the required portion thereof, as specified in the Contract.

B Definitions

Abbreviations and definitions of words and phrases pertaining to electric lighting systems or related type work shall be as defined in 1101, 1103, these Specifications, or in the Special Provisions.

C Electrical Distribution System

The distribution circuits of the electric lighting system shall be of the multiple type consisting of three conductors plus equipment ground. The three conductors shall constitute two photoelectric controlled 120 volt or 240 volt circuits as indicated in the Plan. Both lighting circuits and the equipment ground shall be installed complete to each standard.

The Power Company requires that the cabinet be opened for visual inspection before making the service connection. The Contractor's electrician shall be present when the Power Company makes the visual inspection.

2545.2 MATERIALS

A General

A1 Regulations and Code

The Contractor shall furnish electrical equipment in accordance with 2565.2, and in conformance to IES, ANSI, ICEA, AASHTO, and ASTM; whichever is applicable.

All electrical conductors for electric lighting systems shall be copper or aluminum as specified in the Contract and all wire sizes shall be based on the American Wire Gage (AWG).

A2 Materials and Electrical Equipment..... 2565.2

A3 Material Samples for Testing..... 2565.2

A4 Tests 2565.2

A5 Warranties, Guarantees, and Instruction Sheets

Warranties, Guarantees, and Instruction Sheets shall be in accordance with 2565.2 except that the first paragraph of (b) is modified as follows:

(b) The Contractor shall warrant and guarantee satisfactory in-service operation of all materials and electrical equipment for a period of one (1) year. The one (1) year in-service warranty period shall begin with the "turn-on" of the electric lighting system. "Turn-on" shall be defined as the time when the complete and operational electric lighting system meets all installation, operational and testing requirements of the

Contract. The in-service warranty is in addition to individual warranties provided by product Manufacturers.

B Hardware

All ferrous metal hardware, except stainless steel, shall be galvanized according to 3392.

B1 Fasteners 3391

B2 Anchor Rods 3385

B2a Lighting Service Cabinet Anchorages

High strength bolts, nuts and washers for lighting service cabinet installation shall be in accordance with 3391; shall be galvanized in accordance with 3392; and shall be sized in accordance with 3850.

B2b Lighting Unit Anchorages

Anchor rods, nuts and washers for lighting unit installation on concrete foundations shall be in accordance with 3385; Type A – Carbon Steel Anchor Rods; shall be galvanized the top 300 mm (**1 foot**) of the anchor rod and nuts; and shall be sized as specified in the Contract.

Threaded studs and nuts for lighting unit installation on steel screw-in foundations shall be in accordance with 3391; shall be galvanized in accordance with 3392; and shall be sized as specified in the Contract.

B2c Rust Inhibitor

Threaded portions of all anchor rods above concrete foundations shall be coated with a rust inhibitor before installation of lighting service cabinets, lighting units, or other type cabinets on the anchor rods.

B3 Cap Screws, Set Screws, and Tap Bolts

Cap screws, set screws, and tap bolts shall be made of commercial brass or bronze. Washers shall be made of galvanized steel or commercial brass.

C Conduit and Accessories

C1 Rigid Steel Conduit (RSC) 3801

C2 Intermediate Metal Conduit (IMC)..... 3802

C3 Non-metallic Conduit (NMC)..... 3803

C4 Conduit Fixtures

Fixtures for metal conduit, where required, shall be made of cast or malleable iron, galvanized according to 3394, and shall have threaded connections. All access covers shall be made of the same material as the fixture and shall provide a watertight fit.

Fixtures for NMC shall be non-metallic intended for use with the type of conduit used.

C5 Expansion Fittings 3839

2545.2

D Electrical Cables and Conductors

Conductors for main circuits shall be No. 8 or larger, and those for single lamp branch circuit shall be No. 10 or larger.

D1	Armored Underground Cable, Polyethylene	3815
D2	Electrical Conductors	3815
D3	Overhead Light Cable.....	3815

E Light Standards 3811

Light standards shall be of the style and type specified in the Contract.

F Light Fixtures

Light fixtures shall be of the style and type specified below or in the Contract.

F1	Roadway Lighting Luminaires	3810
F2	Sign Lighting Fixtures	3810
F3	Underpass Lighting Fixtures.....	3810
F4	Lamps	3810

Lamps for the luminaires or fixtures shall be the wattage and type specified in the Contract, and shall be universal or base-down to horizontal burning type.

G Concrete 2461

G1 General

Concrete for light standard foundations shall be Mix. No. 3Y43.

Concrete for equipment pad foundations shall be Mix. No. 3A32.

Concrete meeting the requirements for Type 3, Grade A shall be furnished where use of a specific mix designation is not specified in the Contract.

Concrete pavement or base removed because of trenching or construction operations shall be constructed or replaced with Mix. No. 3Y43 high early strength concrete.

G2	Reinforcement Bars	3301
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H Service Equipment..... 3837

I Blank

J Lighting Service Cabinet..... 3850

K Electrical Junction Boxes..... 3838

L Wood Poles..... 3840

M Handholes

Handholes shall be of the type specified in the Contract.

N Photoelectric Control 3812

O Blank

P Miscellaneous Materials

Materials and electrical equipment for which no requirements are included in the Contract shall be in accordance with the best standard

practices and workmanship. All materials and electrical equipment shall be approved by the Engineer before installation.

Q Safety Switch 3837

R Lighting Units

Lighting Units shall be of the style and type specified below or in the Contract.

Lighting units shall consist of a light standard, mast arm(s), 50 mm (2 inch) slipfitters, luminaire(s), lamps, wire holder, and all miscellaneous equipment required fro a complete lighting unit installation.

Lighting units shall be as specified in the Contract, and conform to the requirements of 3810, 3811, and 3812.

Within 15 days after the Contract approval notice mailing date, the Contractor shall furnish evidence to the Engineer, in writing, that orders have been place for all components of the lighting units required on the project.

2545.3 CONSTRUCTION REQUIREMENTS

A General

The locations of component parts, as indicated in the Contract, are approximate only. The exact locations will be established at the job site by the Engineer.

The Contractor shall perform no work on the job site until all underground utilities are located in accordance with 1507. Electrical cable damaged, due to Contractor's negligence, shall be replaced between handholes and light poles within 24 hours at no expense to the Department. Damaged electrical cable shall not be spliced underground.

Highways, streets, and roads shall be kept open to traffic during construction, subject to 1404. Any openings or uncompleted work that may, after working hours or during construction, cause a hazard to vehicle or pedestrian traffic shall be suitably protected to the satisfaction of the Engineer.

A1 Compliance with Electrical Codes and Standards 2565.3

A2 Permits and Inspections 2565.3

A3 Utility Property And Service 2565.3

B Existing Electrical Systems 2565.3

C Excavation and Backfill 2565.3

D Conduit and Fitting Installation 2565.3

E Handhole Installation 2565.3

2545.3

F Concrete Foundation Installation

F1 General

Light foundations (light bases and equipment pads) shall be constructed in accordance with 2565.3, as specified in the Contract, and the following:

F2 Light Bases

Light bases shall contain one 50 mm (**2 inch**) NMC 90 degree elbow for each direct buried cable that enters the base, and one spare 50 mm (**2 inch**) NMC 90 degree elbow, capped at each end, for expansion of the lighting system. These conduit elbows are in addition to extra conduit elbows called for in the Contract.

Where light bases are located in a cut section or a fill section, the Contractor shall shape the backslope or mound the foundation excavation around the base, to ensure that the light base breakaway supports meet AASHTO Stub Height Requirements for Breakaway Supports.

Where the required ground rod electrode is separated from the light base, a 25 mm (**1 inch**) NMC elbow having bushings at each end shall be installed to carry the grounding wire. The electrode shall be 75 mm to 150 mm (**3 to 6 inches**) below the ground line, within 300 mm (**1 foot**) of the foundation.

Where ground rod electrodes are installed in concrete foundations, the top of the ground rod electrode shall extend not more than 75 mm (**3 inches**) nor less than 50 mm (**2 inches**) above the foundation.

F3 Equipment Pad

Where the required ground rods are separated from the equipment pad, NMC elbows of the size indicated in the Contract, having threads and bushings at each end shall be installed to carry the grounding wire. The electrode shall be 75 to 150 mm (**3 to 6 inches**) below the ground line within 300 mm (**1 foot**) of the foundation.

Where ground rod electrodes are installed in concrete foundations, the top of the ground rod electrode shall extend not more than 75 mm (**3 inches**) nor less than 50 mm (**2 inches**) above the foundation.

G Wiring and Conductor Installation

G1 General

The installation of wiring and conductors shall be in accordance with the applicable provisions of 2565.3, and the following:

Service conductors shall be run in a separate conduit system from all other conductors.

Separate lighting branch circuits may be placed in a single conduit but shall be electrically independent. All conductors of a lighting branch circuit shall be run in a single conduit.

G2 Underground Wiring

Armored cable shall be installed by trenching or plowing methods and shall be installed at a depth of not less than 610 mm (**2 feet**). Where solid rock or other obstructions are encountered, installation of the cable shall be permitted at a depth of not less than 460 mm (**18 inches**) provided a 50 mm (**2 inch**) thick concrete slab is placed in the trench over the cable. Installation of the cable shall be permitted at a depth of not less than 153 mm (**6 inches**) provided the cable is run through rigid steel conduit and a 50 mm (**2 inch**) thick concrete slab is placed above the cable and conduit.

Armored cable shall be installed at the same distance behind the bituminous shoulder or back of curb as the light bases. An additional 600 mm (**2 feet**) of slack armored cable shall be installed near the light base before the cable enters the base conduit.

Armored cable shall extend at least 600 mm (**2 feet**) above the light base foundation with a minimum of 100 mm (**4 inches**) of the outer jacket extending above the conduit.

Wiring in conduit shall be installed with sufficient slack to allow for contraction.

An independent grounding wire shall be run through all non-metallic conduit systems and electrically connected to all metal fixtures and equipment along the run.

For all expansion sleeves in metallic conduit, a No. 8 grounding jumper shall be installed internally between conduit sections.

All pulling of wires through conduit or raceways shall be done by hand and without damage to the wires or their covering. The conduit shall be clean and dry at the time the wiring is installed. The cable or conductors shall be dry and clean, except powdered graphite or soapstone that may be used to ease the pulling.

G3 Above Ground Wiring

Within roadway lighting standards, unless otherwise specified, the wires connecting the luminaire to the underground cable or base mounted ballast shall be 14-2 UF cable with ground and a 6 A cartridge type fuse. The fuse shall be mounted in an inline molded fuse connector/holder with casing that shall be located at the level of the handhole. Fuses in breakaway poles shall be of the breakaway type. Sufficient excess conductor length shall be provided to allow withdrawal of the connected fuse holder. The neutral and grounding wires shall not be fused.

Neutral-supported aluminum cable, conforming to 3815 may be used to provide temporary power distribution through aerial lines. The overhead cable shall be attached to the poles in a manner acceptable to

2545.3

the Engineer. Overhead light cable shall not be supported by the luminaires.

G4 Splices 2565.3

No underground splices will be permitted that are not called for in the Contract or authorized in writing by the Engineer. When underground splices are permitted, the underground splices shall be the type as specified in the Contract.

G5 Terminal Blocks 2565.3

H Lighting Standard Installation

Light standards with balanced fixtures or luminaires shall be set plumb. Standards with unbalanced fixtures or bracket arms, or standards that act as supports for overhead wires or guy lines, shall be set with a rake sufficient to counterbalance lateral deflection.

Standards shall be adjusted to the proper position by shims or double nuts before being anchored in position.

Damage to the lighting standard, mast arm, brackets, or other appurtenances to the light standard shall be repaired and restored to the satisfaction of the Engineer.

I Blank

J Sign Lighting Installation

J1 General

Construction of sign lighting shall be as specified in the Contract and the applicable sections of this Specification.

Power distribution to the sign structure shall, unless otherwise required, be by trench laid cable.

J2 Safety Switch

Install the safety switch in a vertical upright position.

J3 Safety Switch Wiring

Install No. 12 conductors in 21 mm (**¾ inch**) RSC between the switch and the fixtures. All splicing shall be accomplished with a wire nut and waterproof coating. All conduit connections shall be rain tight.

Install a No. 12 green conductor in 21 mm (**¾ inch**) RSC between safety switch and fixtures, to provide ground. The No. 12 conductor shall be connected to the grounding lug attached to the safety switch enclosure (enclosure isolated from the neutral terminal) and the grounding screw attached to each fixture housing.

Wiring installed between the sign post and the safety switch shall be run in 21 mm (**¾ inch**) RSC. Install No. 12 conductors between the switch and the sign base.

Splice the existing or new power conductors to the conductors from the safety switch with split bolt type connectors as detailed in the Contract. The splices shall be insulated to the level of insulation of the power conductors and shall be waterproofed. The splices shall be

2545.3

dressed in the center of the post and up from the base plate with sufficient excess conductor length provided to permit withdrawal of the splices through the handhole.

Upon completion of new or modified sign lighting system(s) for each feed point, a burn test shall be performed as specified in 2545.3K2.

J4 Feed Point Identification Plate

Furnish and install a feed point identification plate for each new lighted overhead sign in accordance with the details shown in the Contract. The plate shall incorporate the feed point identification number appearing in parenthesis directly below or along side the sign number in the Contract.

Strap mount the plate to the overhead sign post in accordance with the details in the Contract. The plate shall be installed on the right post when looking in the direction of traffic flow. When signs face both directions of travel on a single structure, two plates will be required. The plate shall be installed at a height of approximately 2.2 m (7 feet) above the base plate elevation and facing traffic.

For bridge mounted signs, the feed point identification plate shall be installed on a 3 kg/m (2 pound per foot) delineator post in accordance with 3401. The feed point identification plate and post should be installed as close to the bridge as possible and behind the guardrail, if present. If no guardrail is in place, the feed point identification plate and post shall be installed at least 3.7 m (12 feet) outside the edge of the shoulder or face of curb. The bottom of the FPID plate shall be approximately 2.2 m (7 feet) above the edge of the pavement.

J5 Safety Cable

The Contractor shall furnish and install brackets, aircraft cable and all necessary hardware, in accordance with the applicable provisions of 2564, to assemble and attach a safety cable as detailed in the Plan.

K Electrical System Testing and Acceptance

Before completion of the work, the Contractor shall test the entire system for unwanted grounds and conduct a 12-hour burn test for each feed point.

K1 Megohm meter test (Test for unwanted grounds)

A megohm meter test, at 500 VDC, indicating the insulation resistance of each circuit shall be made. The megohm tester shall be energized for 15 s on the circuits to check if any break down of the circuits occurs. The Contractor shall furnish the Engineer with a written report of the megohm meter readings for the permanent record. The report shall contain the following information:

- (a) PROJECT NUMBER AND LOCATION
- (b) FEEDPOINT NUMBER - As indicated in the Plans.

2545.3

- (c) BRANCH CIRCUIT - Identify each lighting branch circuit being tested by indicating the number of the first light connected to that circuit, as indicated in the Plans.
- (d) PHASE CONDUCTOR INSULATION RESISTANCE - Measure the resistance between the phase conductors, and the resistance between each phase conductor and the equipment ground bar in the service cabinet with the fuses removed from the inline fuse connectors in the lighting poles. The resistance shall not be less than 100 M Ω .
- (e) NEUTRAL CONDUCTOR INSULATION RESISTANCE - Measure the resistance between each neutral conductor and the equipment ground bar in the service cabinet with the fuses removed from the inline fuse connectors in the lighting poles. The resistance shall not be less than 100 M Ω .
- (f) CIRCUIT INSULATION RESISTANCE - Measure the resistance between each phase conductor and the equipment ground bar in the service cabinet with all fuses in place in the lighting poles. The resistance shall not be less than 100 M Ω .

The Contractor shall make sure that the circuit's conductors are connected to the circuit breaker of the opposite phases (some manufacturers alternate every other breaker with opposite phases, and other manufacturers split the top and bottom halves of the circuit breaker with opposite phases).

All tests shall be made at the service cabinet, in the presence of the Engineer, with all grounding connections in place. The phase and neutral conductors shall be disconnected at the service cabinet for the insulation resistance tests.

Where test results indicate faulty insulation or a faulty connection within the circuit, all necessary corrections shall be made and the circuit retested, all at no expense to the Department. No additional payment will be made for replacing any part of or the entire circuit as required to make the circuits meet the test requirements.

K2 12-Hour Burn Test

Upon completion of a feed point and before no more than 90 percent of the feed point cost is paid, the service cabinet must be energized and the entire electrical system must operate successfully without interruption for 12 hours, during daylight hours only. The Contractor shall pay all power costs incurred and all such costs shall be incidental to the cost of the Project.

L Lighting Service Cabinet Installation

Pad mounted lighting service cabinets shall be securely bolted to the concrete foundation.

All components of the lighting service cabinet shall be installed in a workable first class condition and shall include all miscellaneous hardware required for a complete lighting service cabinet installation. The Contractor shall coordinate with the power company for connection of power to the lighting service cabinet.

M Painting

Painting of all nongalvanized ferrous metalwork, except for stainless steel, shall be in accordance with the applicable requirements of 2478.

Painting of all galvanized ferrous metalwork, shall be in accordance with 2478.

For steel lighting service cabinets, unless otherwise specified in the Contract, the finish coats shall be two field coats of Dark Green Acrolon 218, or approved equivalent polyurethane finish coat matching Color Number 14062 of the Federal Standard 595B.

The finish coats shall be applied by brush or spray application. The inside of light standard shafts need not be painted.

Aluminum service cabinets, unless otherwise specified, shall be anodized to match Duranodic finish #311.

If a manufacturer's shop coat paint is accepted or specified in the Contract, the Contractor shall make every effort during erection of a painted pole to protect the factory applied finish. The collar used for handling the pole shall be lined with a felt pad and the protective wrapping on the pole shall be left on at the lift point area to protect the finish of the pole. Any nicks, scratches, paint chips or other damage to the finish shall be repaired and restored to the satisfaction of the Engineer.

N Restoration and Cleanup 2565.3

O Blank

P Light Standard, Light Fixture, and Lighting Service Cabinet Numbering

The Contractor shall number the light standards or light units (underpass luminaires, tunnel luminaires, high mast luminaires, special luminaires, etc.) and the outside of lighting service cabinets with decals in accordance with the numbering shown in the Plans.

Pole numbering shall consist of the feed point numbers and letters placed immediately above the pole number at a height of 1.8 m (**6 feet**) above the concrete base at an angle of 45 degrees facing oncoming traffic.

Each letter and number shall be black, 50 mm (**2 inches**) high on a 38 x 64 mm (**1 ½ x 2 ½ inches**) gray background.

Decals shall be self-sticking acrylic with optical lens elements, 127 µm (**5 mil**) low temperature permanent acrylic adhesive with a

2545.3

-23°C (-10°F) rating, and a service temperature rating of -48°C (-55°F) to +34°C (94°F).

A sample decal shall be submitted to the Engineer for approval before the decals are installed.

The pole shaft shall be "lightly sanded" to remove oxidation, and wiped with isopropyl alcohol before applying numbers and letters.

Wood pole lighting standards shall be numbered to the satisfaction of the Engineer.

Underpass lighting units shall be numbered with the last letter of the feed point and with the luminaire number.

Branch circuit breakers on the interior of the lighting service cabinets shall be labeled indicating the color of the circuit conductor (Red or Black) and the luminaire number. The Contractor shall ensure that the type of labeling used is legible and has sufficient durability to withstand the environment involved.

Q Luminaire Installation

The Contractor shall install and level luminaires in accordance with the manufacturer's recommendations and to the satisfaction of the Engineer.

Place a level on the area provided on the top of the luminaire, and level in a side to side and front to back direction. Adjust the luminaire as required to completely level the luminaire.

R Bonding and Grounding

All bonding, grounding, ground rod electrodes, grounding electrode conductors, and grounding connections shall be in accordance with the applicable provisions of 2565.3, the NEC and the following:

All metal poles, conduit, service cabinets, service equipment, and other non-current-carrying metal surfaces shall be made mechanically and electrically secure to form a continuous, bonded, grounded system and to provide a low impedance path from any exposed metal surface to the system ground at the service cabinet or service equipment.

Any equipment grounding conductor in the armored cable, bronze tape armor of the armored cable, equipment grounding conductor in conduit, rigid steel conduit, the grounding lug of the light standard or sign post, and ACSR equipment ground messenger of overhead light cable indicated in the Plans shall be bonded together and used as the equipment ground. The bonding and grounding jumper shall be a copper conductor no less than No. 6. The neutral conductor shall be grounded only at the feedpoint.

The grounding and bonding jumper shall be connected to the bronze tape armor with a bronze or copper lug type connector or bolt. Other attachments of the grounding and bonding jumper shall be by means of

2545.4

cast clamps or grounding bushings with a bronze or integral lug to accommodate the jumper.

Where indicated in the Contract, a supplemental ground rod electrode shall be installed. Ground rods used for this purpose shall be copper coated, have a minimum diameter of 16 mm (**5/8 inch**) and be 3 m (**10 feet**) in length.

Ground rod electrodes shall be provided at every other light base and the light base located at both ends of a run, unless otherwise indicated in the Contract.

All main switch cabinets, control cabinets, or service cabinets shall have a direct grounding connection to a ground rod. When installed on bridges or buildings, each cabinet or metal structure shall be bonded to the bridge or building grounding system. Grounding conductor runs shall be as short as possible.

S Service Equipment Installation 2565.3

T Existing Materials and Electrical Equipment

Existing materials and electrical equipment required by the Contract or as directed by the Engineer to be removed, salvaged, reinstalled, or stockpiled shall be in accordance with 2565.3.

U Wood Pole Installation 2565.3

V Lighting Units

All components of lighting units shall be installed in a workable first class condition and shall include all miscellaneous hardware required for a complete lighting unit installation.

2545.4 METHOD OF MEASUREMENT

A Complete Systems

When separate items are listed in the Contract for various types of complete electrical systems, each separate system will be measured in accordance with the following:

A1 Electric Lighting System

Each separate electric lighting system will be measured as a single unit, complete in place.

A2 Electric Power System

Each separate electric power system will be measured as a single unit, complete in place.

A3 Sign Lighting System - ___ Fixtures

Each separate sign lighting system - ___ fixtures, will be measured as an integral unit, complete in place.

A4 Sign Lighting System Bridge Mounted - ___ Fixtures

Each separate sign lighting system bridge mounted - ___ fixtures, will be measured as an integral unit, complete in place.

2545.4

A5 Conduit System

Each separate conduit system will be measured as an integral unit, complete in place.

B Electrical System Components

When separate Items are listed in the Contract for the various component parts of an electrical system, they will be measured in accordance with the following:

B1 Lighting Units

Lighting units of each type of mounting and fixture design will be measured separately by the number of units of each type, complete in place.

B2 Luminaires

Luminaires of each type and wattage will be measured separately by the number of luminaires complete in place.

B3 Light Bases

Concrete bases of each design for lighting units will be measured separately as integral units, complete in place.

B4 Conduit

Conduit of each kind and diameter will be measured separately by the length between end terminals along the centerline of the conduit as actually installed.

B5 Underground Wire

Underground wire of each kind and size will be measured separately by the length between end terminals along the centerline of the wire as actually installed.

B6 Armored Cable

Armored cable of each kind and size will be measured separately by the length between end terminals along the centerline of the cable as actually installed.

B7 Overhead Light Cable

Overhead light cable of each kind and size will be measured separately by the length between end terminals along the centerline of the wire as actually installed.

B8 Service Cabinets

Service cabinets of each type will be measured separately by the number of cabinets, complete in place.

B9 Equipment Pads

Equipment pads of each type will be measured separately by the number of equipment pads complete in place.

B10 Junction Boxes

Junction boxes will be measured by the number of junction boxes complete in place.

2545.5

B11 Handholes

Handholes of each design will be measured separately by the number of handholes complete in place.

B12 Underpass Lighting Fixtures

Underpass lighting fixtures of each design will be measured separately by the number of underpass lighting units complete in place.

B13 Wood Poles

Wood poles will be measured by the number of wood poles complete in place.

2545.5 BASIS OF PAYMENT

Payment for lighting systems, power systems, sign lighting systems, modify sign lighting systems, and conduit systems at the appropriate Contract price per system will be compensation in full for all costs of furnishing and installing the complete system as specified.

Payment for lighting units of each type at the Contract price per unit will be compensation in full for furnishing and installing the lighting unit as specified, including lamps, luminaire, ballast, pole base, pole and bracket, inline fuse, wiring between pole base and fixtures, luminaire wire holder, splice to power circuit, numbering of the light standard, and all other miscellaneous items required for a complete installation.

Payment for luminaires of each type and wattage at the Contract price per luminaire will be compensation in full for furnishing and installing the luminaire as specified, including the housing, reflector, glassware, lamp, ballast, mounting, mounting hardware, wiring, connections, numbering of the luminaire if not installed on a light standard, and all other miscellaneous items required for a complete installation.

Payment for light bases of each design at the Contract price per base will be compensation in full for furnishing and installing the light base as specified, including excavation, concrete, reinforcement, anchor rods, ground rod, ground lead, grounding connections, conduit elbows and bushings, and all other miscellaneous items required for a complete installation.

Payment for conduit of each kind and diameter at the Contract price per unit of measure will be compensation in full for furnishing and installing the conduit as specified, including the conduit, trenching, jacking, augering, conduit sleeves, couplings, weatherheads, elbows, bushings, sealing around the conduit where it enters a pull box, sealing conduit ends in concrete foundations and in pull boxes, grounding and bonding of conduit, backfilling and restoring sod, sidewalks, pavements, and the like, and all other miscellaneous items required for a complete installation of the conduit.

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Payment for underground wire of each kind and size at the Contract price per unit of measure will be compensation in full for furnishing and installing the wire as specified, including the wire, pulling, splicing, terminals, making required connections, testing, and all other miscellaneous items required for complete installation of the wire.

Payment for armored cable of each kind and size at the Contract price per unit of measure will be compensation in full for furnishing and installing the cable as specified, including the cable, trenching, armor grounding, connections, fittings, fastenings, hangers, backfilling and surface restoration, testing, and all other miscellaneous items required for a complete installation of the cable.

Payment for overhead light cable of each kind and size at the Contract price per unit of measure will be compensation in full for furnishing and installing the cable as specified, including the cable, grounding of the messenger wire, connections, fastenings, hangars, testing, and all other miscellaneous items required for a complete installation of the cable.

Payment for service cabinet of each type at the Contract price per cabinet will be compensation in full for furnishing and installing the lighting service cabinet as specified, including panelboard enclosure, circuit breakers, switches, relays, photoelectric control, internal wiring, service entrance circuit, service entrance conduit and weatherhead for wood pole mounted cabinets, mounting hardware, grounding, painting, sealing around cabinet base, numbering of the service cabinet, and all miscellaneous items required for a complete installation.

Payment for equipment pads of each type at the Contract price per equipment pad will be compensation in full for furnishing and installing the equipment pads as specified, including excavation, concrete, reinforcement, anchoring hardware within the pad, conduits within the pad, ground rods, grounding connections, mounting brackets, mounting hardware, surface restoration, and all other miscellaneous items required for a complete equipment pad installation.

Payment for junction boxes at the Contract price per box will be compensation in full for furnishing and installing the boxes as specified, including the junction box, bushings, covers, gaskets, and all appurtenances required for a complete installation.

Payment for handholes of each design at the Contract price per handhole will be compensation in full for furnishing and installing the handholes as specified, including the handhole, metal frame and cover, excavation, aggregate drain bed, backfilling, sealing conduit entrances, surface restoration, and all miscellaneous items required for a complete installation.

2545.5

Payment for underpass lighting fixtures of each type and wattage at the Contract price per unit will be compensation in full for furnishing and installing the underpass lighting unit as specified, including the housing, reflector, glassware, lamp, ballast, mounting, mounting hardware, wiring, connections, numbering of the lighting fixtures, and all other miscellaneous items required for a complete installation.

Payment of wood poles at the Contract price per wood pole will be compensation in full for furnishing and installing wood poles as specified, including class of wood pole, surface restoration, and all other miscellaneous items required for a complete installation.

Payment for electrical systems will be made on the basis of the following schedule:

Item No.	Item	Unit
2545.501	Electric Light System	lump sum
2545.503	Electric Power System	lump sum
2545.505	Sign Lighting System - ____ Fixtures	system
2545.506	Sign Lighting System Bridge Mounted - ____ Fixtures.....	system
2545.509	Conduit System	lump sum
2545.511	Lighting Unit, Type ____	each
2545.513	Luminaire	each
2545.514	Underpass Lighting Fixture, Type ____	each
2545.515	Light Base, Design ____	each
2545.521	____ mm (inch) Rigid Steel Conduit	meter (linear foot)
2545.522	____ mm (inch) Intermediate Metal Conduit	meter (linear foot)
2545.523	____ mm (inch) Nonmetallic Conduit.....	meter (linear foot)
2545.531	Underground Wire, ____ Conductor No. ____	meter (linear foot)
2545.533	Armored Cable, ____ Conductor No. ____	meter (linear foot)
2545.537	Overhead Light Cable, ____ Conductor No. ____	meter (linear foot)
2545.541	Service Cabinet, ____ Type ____	each
2545.542	____ m (____ foot) Wood Pole, Class ____	each
2545.545	Equipment Pad	each
2545.551	Junction Box.....	each
2545.553	Handhole	each

2550

2550

Traffic Management System

2550.1 SCOPE

This work includes furnishing and installing Traffic Management System (TMS) components including communications system components, traffic control system components, surveillance system components and motorist information system components.

Communication system components include the cable plant (fiber optic cables, electronic/telephone cables), conduit, hand holes, splice cabinets, equipment cabinets, equipment shelters, fiber distribution equipment (splice panels, patch panels, and fiber distribution frame), fiber optic cable pulling vaults, fiber optic splice vaults, and outdoor fiber splice enclosures.

Traffic control system components include ramp meters, lane control signals, control cabinets, control cable and power cable.

Surveillance system components include CCTV system hardware and vehicle detection devices. CCTV system hardware includes the folding television standard (pole), lightning protection, video cable, control cable, power cable, pole-mounted control cabinet, and junction box. Vehicle detection devices include detector loops (preformed and saw cut), lead-in cable, and loop/lead splice encapsulator).

Motorist information system components include variable message signs and guide signs.

Electrical service is also provided for TMS components.

Each bidder shall submit a written statement with the bid. The statement shall comply with 1201 and shall identify all subcontractors.

Acronyms

BD-4	TWP Distribution Pedestal (Splice Cabinet)
BD-7	TWP Distribution Pedestal (Splice Cabinet)
C-C	Center to Center
CAD	Computer Aided Drafting
CMS	Changeable Message Sign
CTS	Clear To Send
DIP	Dual In-line Package
DSX	Digital Signal Crossconnect
EIA	Electronics Industry Association
FC-PC	Fiber Connector
FDF	Fiber Distribution Frame
FNBT	Facing NSEW Bound Traffic
FO	Fiberoptic
HD	Heavy Duty
JB	Junction Box
LD	Light Duty

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LED	Light Emitting Diode
MM	Multimode Cable
NMS	Network Management System
OH	Overhead sign
OTDR	Optical Time Domain Reflectometer
PC	Printed Circuit
PCB	Printed Circuit Board
PDA	Power Distribution Assembly
p-p	peak to peak
PTZ	Pan Tilt and Zoom
SM	Singlemode Cable
ST	Fiber Connector
TIA	Telecommunication Industry Association
TWP	Twisted Wire Pair
ZDS	Zero Dispersion Slope
ZDW	Zero Dispersion Wavelength

2550.2 MATERIALS

A General

All materials, work methods, and equipment shall comply with the standards of the National Electrical Manufacturers Association; the Electronic Industries Association; the Underwriters Laboratory, Inc; the National Electrical Code; local codes and ordinances; these specifications; and with the requirements of the Contract.

Each component is designed for 10 years of industrial use. The Contractor warranties all materials and workmanship for 6 months after completion and acceptance of the Contract. The warranty period begins on the date all construction obligations of the Contractor are completed as documented by the final completion date on the change in construction status report.

During the warranty period the Contractor shall, at no cost to the Department, make repairs to all equipment and devices furnished and installed during the Project. The Engineer will notify the Contractor that a warranted item needs repair. The Contractor will acknowledge the notification within 24 hours and furnish the repair with 48 hours. The repair must satisfy the Engineer.

B Foundations.....	3951
C Conduit and Accessories	3952
C1 Conduit.....	3952
C2 Handhole	3952
C3 Junction Box.....	3838
C4 Locator Ball.....	3952

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C5	Locator Ball Detector	3952
C6	Fiberoptic Splice Vault.....	3953
C7	Outdoor Fiber Splice Enclosure.....	3954
D	Electrical Cable and Conductors.....	3815
D1	Armored Cable	3815
D2	Signal Control Cable	3815
D3	Power Cable	3815
D4	Loop Detector Conductor.....	3815
D5	Loop Detector Lead-in Cable	3815
D6	Telephone Cable.....	3815
D7	Video Cable	3815
D8	Radio Frequency Transmission Cable	3815
D9	Camera Control Cable	3815
D11	Optical Pigtails and Patch Cord.....	3815
E	Fiberoptic Cables.....	3815
E1	Trunk Cables	3815
E2	MM Pig Tails	3815
E3	MM Patch Cord	3815
E4	Armored Pigtails	3815
F	Cabinets.....	3826
F1	334Z Series Cabinet	3826
F3	336 Series Cabinet.....	3826
F4	Shelter Cabinet	3826
F5	480 mm (19 inch) EIA Cabinet	3826
F6	Splice Cabinet (BD-4 and BD-7).....	REA approved
G	TMS Electric Service.....	3964
H	Ramp Control Signal and Advance Flasher	3965/Plan
H1	Signal Pedestal	3832/Plan
H2	Signal Face	Plan
H3	Lane Control Signal.....	3836
H4	Advance Flasher	3965/Plan
I	BLANK	
J	Closed Circuit Television Assembly	
J1	Standard.....	3827/Plan
K	Changeable Message Sign	
L	Buried Cable Sign.....	3973
M	Fiberoptic Components	
M1	Fiber Distribution Frame	3974
N	System Integration.....	3976
O	Blank	
P	Loop Detector	
P1	Loop Detector.....	3966
P2	Loop Detector Splice.....	3967

2550.3

2550.3 CONSTRUCTION REQUIREMENTS

The Contractor shall do the work, or ensure that the work is completed as follows.

A Cable Installation

The Contractor shall place conduit and direct buried cables in the same trench only when the cable is installed 900 mm (**36 inches**) deep, 150 mm (**6 inches**) of fill is added, and the conduit is installed on the fill.

Install direct burial cable by trenching or by plowing, as far from the paved portion of the roadway as practical. Install direct burial cable under bituminous or concrete surfaces in conduit.

Permanently secure 6 mm (**¼ inch**) character labels to each cable in each handhole and in each cabinet. The Department will provide the cable identifiers.

A1 Cable Installed In Conduit

The Contractor shall pull cable into conduit by hand or machine. Use a limiting device to prevent exceeding the pulling tension specified by the manufacturer.

The Contractor shall: apply a material compatible, industry accepted lubricant to the cables to reduce pulling tension; install each cable with enough slack to compensate for contraction; and permanently secure 6 mm (**¼ inch**) character labels to the cable(s) in each handhole and cabinet with the identification provided by the Department. Damaged cable is not acceptable. Remove abandoned cable(s) from each conduit. The operating TMS must remain active while the cables are removed.

A2 Direct Buried Cables

Trench or plow direct buried cables at a minimum of 900 mm (**36 inches**) deep. Locate the cable route as far from the paved portion of the roadway as practical.

Install an 80 mm (**3.15 inches**) wide, stretchable, orange, warning tape, between 460 mm (**18 inches**) above the cable and 300 mm (**12 inches**) below the surface. The tape bears the permanent legend "CAUTION: Mn/DOT CABLE BELOW".

Place buried cable warning signs, described in 3973, at less than 150 m (**500 foot**) intervals, offset 1 m (**3 feet**), along the cable route.

Install an orange-colored plastic resin sheath to enhance the visibility of buried cable signposts. The plastic resin sheath is:

- (a) Triangular in shape, having a wall thickness of 2.03 ± 0.25 mm (**0.08 ± 0.01 inches**) with a 84.07 ± 0.51 mm (**3.31 ± 0.02 inch**) width of each side;
- (b) Temperature stable from -40 °C (**-40 °F**) to 65 °C (**150 °F**),
- (c) UV resistant;

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- (d) Made of Polypropylene; and
- (e) Installed on the above ground portion of each post below the bottom of the sign.

A3 Copper Cable Installation

The Contractor has full and immediate responsibility to repair every existing TMS cable damaged by Contractor activity. The repair includes everything needed for a complete repair. The quality of the repair must satisfy the project Engineer.

- (a) Replace damaged radio frequency (RF) transmission cable with new cable between the existing terminations. Splices in RF transmission cable or telephone cable are not allowed between existing terminations. Below ground splices are never allowed.
- (b) Terminate RF transmission cables (COAX and telephone cables) _____/PR No. 19 in above ground cabinets to amplifiers, or with connectors designed for use with that specific cable.
- (c) Install the cables inside CCTV standards to the cable supports.
- (d) Test power cables in accordance with 2545.
- (e) Splice telephone cables in BD-4 and BD-7 cabinets with a weather resistant, crimp connector designed to splice three No. 19 conductors.

A4 Fiberoptic Cable Installation

The Contractor shall submit a plan detailing each fiberoptic cable installation, the installation method, and the calculated pulling tension. The cable is taken up at intermediate pulling points with a device made for that purpose. The cable pulls are continuous and steady between pull points.

The Contractor shall:

- (a) Accomplish direction changes of fiberoptic cable before entering a handhole or other conduit access point. Do not change the direction of fiberoptic cables in handholes.
- (b) Install fiberoptic cable in split conduit through the handholes. Extend the conduit 50 mm (**2 inches**) beyond the wall of each handhole and seal the conduit to the handhole with duct seal.
- (c) Splice optical fibers only in outdoor fiber splice enclosures and fiber splice panels. Splices between cabinets and splice vaults are not allowed.
- (d) Continuously monitor the tensile load on the cable. The fiberoptic cable route is pre-ripped to prevent harm to plowed-in cable.
- (e) Place 150 mm (**6 inches**) of aggregate that complies with 3149.2G, beneath cables placed in a trench before backfilling the trench. The backfilling shall comply with 2451.
- (f) Provide a smooth transition from one elevation to the other when installing fiberoptic cable in existing conduits, that are in existing

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handholes. This may require re-installing existing conduits and is incidental to the cable installation.

- (g) Label the destination of each trunk cable onto the cable in each vault. The Contractor shall label the fiberoptic patchcords and pigtailed at terminations with their source, destination, and cable function. The labels are permanent and have 6 mm (**¼ inch**) characters.

B Cabinet Installation

B1 Cabinet Labels

Label each control cabinet with permanent 40 mm (**1.6 inch**) high characters, using the cabinet name provided by the Department.

B2 Two Days Notice

The Contractor shall notify the TMC Operations Supervisor 2 days before removing an active cabinet from service.

B3 Secure and Seal

Secure the cabinets to the concrete foundation with anchor rods, nuts and washers.

Seal the cabinet base to the foundation with a 6 mm (**¼ inch**) high x 50 mm (**2 inch**) wide, one piece neoprene gasket.

B4 Conduit

Install conduits at the center of the cabinet base and 80 mm (**3.15 inches**) above the foundation.

C Changeable Message Signs (CMS)

The changeable message sign structures and mounting hardware shall comply with 2564.

The electrical equipment located on the sign structure shall not protrude over the walkway, shall not interfere with moving the walkway safety rail or with opening the sign door.

The Contractor installs 120/240 VAC to the sign within 1 week after installation to enable operating the ventilation units.

D Lane Control Signals (LCS)

Make the clearance between the bottom of the lane control signal and the pavement at least 5.3 m (**17 feet**). The mounting hardware complies with 2564.

E Restore Shrubs and Bushes

The Contractor shall restore all shrubs and bushes damaged by Contractor activities, in accordance with 1712.

F Handholes (HH)

Make all openings in the side of handholes water tight with a material compatible compound.

Cast the Light Duty metal cover frame and the heavy duty metal cover frame in concrete.

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Fill Handholes abandoned in sodded areas, with tamped granular material that complies with 3149.2E. Salvage useable handhole covers from abandoned Handholes, to Department's Electrical Services Section.

Secure the HH ball to an eye bolt with a 6 mm (¼ **inch**) wide wire wrap. The HH ball is located within 0.3 m (**1 foot**) of the HH cover.

G Ramp Control Signal (RCS)

Cover each installed RCS and keep it covered until the beginning of the system operational test.

H Conduit

Conduit installation complies with 2565.3D and the following additions.

H1 Conduit on Bridges

Conceal conduit on bridges behind the fascia girder, in a location not readily visible to motorists. Install deflecting expansion joints, as per NEC requirements.

H2 Factory Bends

Factory bends in 76 mm (**3 inches**) and larger conduit are greater than 900 mm (**36 inch**) radius.

H3 Foundation Locations

The Contract foundation locations are approximate. The Engineer stakes the actual locations, outside the clear zone, as far from the paved portion of the roadways as practical.

I Blank

J Bonding and Grounding.....2565.3J

Each foundation includes a ground rod.

J1 Insulated Cable

Insulated cable may be used instead of bare ground cable if 300 mm (**12 inches**) of the cable is wrapped with green electrical tape in the cabinet and in each handhole through which the cable passes.

J2 Shield Continuity

Maintain the electrical continuity of the cable shields while terminating and splicing cables. The shield bonding conforms to REA splicing Standard PC-2, Section 3.3. The bonding connectors comply with REA Specification PE-33 for Cable Shield Connectors. Bond and ground the cable sheaths to a 4.6 m (**15 feet**) long x 16 mm (**5/8 inch**) diameter ground rod.

K Loop Detector Installation

Loop Detector Installation complies with the Contract detail and these requirements.

K1 Loop Detector Conductors

Loop Detector Conductors end in the near handhole. Splice the conductors to the lead-in cable with a soldered butt splice. Wrap the

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splice with one wrap of electrical tape before placing it into the splice encapsulator device.

K2 Detector Test

Test all detectors in the presence of a Department inspector and furnish all items required for the test. Use copies of the Loop Detector Test Report, detailed in the Contract, when recording the Loop Detector values.

L Fiberoptic System

The system integrator proves the fiberoptic system functions as specified before the operations test begins.

L1 Blank

L2 Blank

L3 Ensure that each outdoor fiber splice enclosure:

- (a) Is bonded to the cable armor by a cable clamp;
- (b) Is bonded to the closest ground rod by a 1/C No. 6 ground wire and clamp;
- (c) Has non-oxidizing coating on all connections.

L4 Fiber Splice Panel

Mount the fiber splice panel where indicated in the Contract. Secure the fiberoptic cable(s) and pigtail(s) to the panel. Bond the shields to the splice panel ground lug.

L5 Fiberoptic Splice Vault

Place the fiberoptic splice vault on 300 mm (**12 inches**) of filter aggregate complying with 3149.2H. Seal and flash test the vault as per the manufacturer recommendations.

Coil 18 m (**60 feet**) of cable in each vault containing splices. This allows moving the splice enclosure to the splicing vehicle.

L6 Optical Link Attenuation Test

The test equipment includes a light source emitting light at the required wavelength and an optical power meter. Calibrate the light source and the power meter at the beginning of each day of testing and after every 20 measurements. Design the light source and power meter to couple to an optical fiber through an ST or FC-PC connector, or through a bare fiber adapter to fibers that have no connector.

To calculate the attenuation, subtract the difference in the received power from the light source before and after measurement through the link.

Record these values during the Optical Link Attenuation tests:

- (a) The length of the link.
- (b) The attenuation of each splice (0.3 dB maximum).
- (c) The mean attenuation of each splice in the link.
- (d) The attenuation of each MM link at 1300 nm.
- (e) The attenuation of each SM link at 1550 nm.

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Label optical links with the identifier, the source, and the destination of each cable.

M CCTV Assembly Installation

Do not degrade the existing CCTV signals during CCTV Assembly installation.

Orient the environmental housing lightning protection away from the road at approximately 90 degrees to centerline. Install the horizontal lockout for the pan and tilt unit over the lightning rod support and set the vertical lockout to 30 degrees above horizontal. The housing mounting bolts do not hit the pan and tilt unit cover in any tilt position.

N Blank

2550.4 METHOD OF MEASUREMENT

The Engineer will only measure items for payment that are completed and accepted.

A Complete Systems

Measure _____ system separately by the number of systems installed.

B Traffic Management System Components

The Engineer will measure the various system components by the units of measure listed in the Contract.

2550.5 BASIS OF PAYMENT

The Department will:

- (a) Retain 10 percent of the amounts payable on each partial estimate, in accord with 1906.
- (b) Pay for material on hand.
- (c) Pay the remaining percentage retained upon completion of the work to the Engineer's satisfaction.

The Department will make payment according to the following:

Payment for _____ system, at the Contract price, is compensation in full for all costs incidental to furnishing and installing the system specified, complete in place.

Payment for system integration at the Contract price, is full compensation for all costs incidental to incorporating the work and material of the Contract, into the existing system. Payment is based on the percent of the Contract completed, as indicated on the project progress chart. When the chart indicates 10 percent of the Contract has been completed, 10 percent of the systems integration item bid price is paid.

Payment for _____ foundation, at the appropriate Contract price per unit of measure, includes all work materials and costs involved in furnishing and installing the foundation specified.

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When the cabinet foundation is part of a larger pad, the cabinet foundation includes the concrete and conduit under and adjacent to the cabinet.

When the service foundation is part of a larger pad, the service foundation includes the concrete, conduit and conductors under and adjacent to the service equipment.

Payment for each of the pay items at the appropriate Contract price per unit, is compensation in full for all costs incidental to furnishing and installing that item.

Payment for TMS is made on the basis of this schedule:

Item No.	Item	Unit
2550.501	__ System	lump sum
2550.509	Systems Integration	lump sum
2550.511	__ Foundation	each
2550.512	Handholes, Type __	each
2550.513	Junction Box	each
2550.514	Fiberoptic Splice Vault	each
2550.515	Outdoor Fiber Splice Enclosure	each
2550.516	Buried Cable Sign	each
2550.519	Truck Pad	each
2550.521	__ mm (inch) Rigid Steel Conduit	meter (linear foot)
2550.523	__ mm (inch) Non metallic Conduit	meter (linear foot)
2550.524	__ mm (inch) Pushed Conduit	meter (linear foot)
2550.531	__ Cable __ Pr. No. __	meter (linear foot)
2550.532	__ Cable __ Conductor No. __	meter (linear foot)
2550.533	__ Cable	meter (linear foot)
2550.534	Fiberoptic Trunk Cable __ MM __ SM	meter (linear foot)
2550.535	Armoured Fiberoptic Pigtail	each
2550.541	__ m (foot) X __ m (foot) Loop Detector, Design __	each
2550.542	Loop Detector Splice	each
2550.551	Ramp Control Signal, Design __	each
2550.552	Flasher Signal	each
2550.553	Lane Control Signal	each
2550.561	Closed Circuit Television Assembly	each
2550.562	Changeable Message Sign, Design __	each
2550.571	__ Cabinet	each
2550.572	Service	each
2550.581	Loop Detector Module	each

2554

2554
Traffic Barriers

2554.1 DESCRIPTION

This work shall consist of the installation of guardrail, barrier, end treatments, barrier fencing, permanent barricades, and similar devices that protect or prohibit traffic at the locations indicated in the Plans or as directed by the Engineer. It shall also include the installation of posts, guide posts, and the resetting of existing barriers.

2554.2 MATERIALS

A Metal Posts

A1 Flanged Channel Sign Post..... 3401
A2 Structural Metal Posts..... 3406

B Blank

C Wood Posts 3412

D Timber Plank, S4S 3426

E Wire Rope 3381

F Steel Beams

F1 Steel Plate Beams 3382

F2 Rub Rail 3306

G Hardware and Fittings 3381, 3382

H Paints, as specified in the Contract

I Blank

J Concrete 2461

Concrete for anchor blocks and bearing blocks shall develop a compressive strength of not less than 19 MPa (**2750 psi**) at 14 days. No air entrainment will be required.

K Anchorage Rods 3385

2554.3 CONSTRUCTION REQUIREMENTS

A Excavation and Foundations

Post holes may be dug by hand or mechanical methods. The depth of each excavation shall be that required to place the rail elements at the specified height above the ground surface and meet the requirements for post top and side alignment. Anchorage excavations shall be made in a manner that will provide bearing on firm, undisturbed earth at the proper depth.

The foundation of line, guide, and permanent barricade posts shall be the natural soil at the bottom of the excavation, tamped to provide firm bearing. End posts and posts at intermediate guardrail anchorages shall be founded on concrete bearing blocks of the dimensions shown in the Plans, which shall be installed firmly on a properly prepared foundation.

B Installing Posts

Posts of the required size and type shall be installed at the intervals indicated in the Plans and to the staked lines. Post tops shall be within 10 mm (**3/8 inch**) of the required elevation and grade.

Type A guide posts shall be 140 mm (**5 ½ inch**) nominal diameter (120 to 160 mm (**4 ¾ to 6 ¼ inch**) by 1.8 m (**6 feet**) long, treated wood conforming to 3412, and installed with the top of the post 760 mm (**30 inches**) above the shoulder P.I. elevation, unless otherwise indicated.

Type B guide posts (culvert markers) shall be flanged channel steel posts with a mass of 3.0 kg/m (**2 pounds per foot**) of length conforming to 3401 and shall be installed as shown in the Plans.

Mechanical driving of posts, where required or permitted, shall be accomplished by means that will give the necessary accuracy of placement without damage.

Required backfill materials shall be installed and consolidated thoroughly in a manner that will maintain the post plumb and in the correct position.

C Installing Barriers

Traffic barriers of the required design shall be installed as shown in the Plans. Proprietary barrier items shall be installed per manufacturers specifications.

Holes drilled in wood posts shall be the same diameter as the bolts or fittings to be accommodated. In metal posts, drilled holes for bolts or other fittings shall have a diameter no more than 1.6 mm (**1/16 inch**) greater than that of the bolt or fitting. Field cuts in treated wood shall be given two applications of copper naphthenate or another compatible preservative material meeting AWPAC Standard M4, with a minimum time lapse of 2 hours between applications. Field bored holes may be left untreated.

Bolt length shall not be any longer than necessary to allow full nut contact after tightening at the overall nominal depth of the assembled parts, plus reasonable allowance for oversize components. Wherever vehicle contact is possible, bolt end projections beyond the rail contact face shall be avoided, or the excess length shall be cut off within 15 mm (**9/16 inch**) of the nut head.

C1 Wire Rope Installations

Except where cable clips are permitted, free ends of wire rope shall be wire wrapped to prevent unraveling.

At intermediate anchorages, the cables shall be properly spaced to prevent contact between the separate cables.

2554.3

C2 Steel Plate Beam Barriers

When offset blocks are required, the blocks shall be of treated timber or other material on the approved list on file with the Materials Engineer. The Contractor shall treat field cuts on treated wood according to 2554.3C.

Rail and end sections shall overlap the adjacent section in the direction of traffic.

End treatments shall be installed in accordance with the details as shown in the Plans and as staked in the field. Proprietary end treatments shall be installed per manufacturers specifications. Installation of the required guardrail end treatments shall be done concurrently with the installation of the guardrail.

C3 Chain Link Fence Barriers

Installation shall be in accordance with the Plans. Tension on the fence shall be that which will allow no visible sag of the fence between supports.

C4 Permanent Barricades

Permanent barricades shall be fabricated as shown in the Plans.

D Painting and Field Repairs

Steel that is not coated according to 3406 and is above the ground shall be given two coats of paint as shown in the Plans and in accordance with the applicable provisions of 2479. The Contractor shall make other field repairs according to the manufacturer's recommendations.

E Disposal of Surplus Excavated Material

All surplus excavated material shall be disposed of by the Contractor, at no expense to the Department, and in a manner satisfactory to the Engineer.

2554.4 METHOD OF MEASUREMENT

A Traffic Barriers

Traffic barriers of each design designation will be measured by length, to the nearest 0.3 m (**1 foot**), between the centers of end posts in each continuous section, with no deduction for expansion assemblies.

B Permanent Barricades

Permanent Barricades will be measured by length, to the nearest 0.3 m (**1 foot**), from end to end of the planks of each unit.

C Guide Posts

Guide posts will be measured by the number of posts placed. Each type, as indicated in the Plans, will be measured separately.

D Anchorage Assemblies

Anchorage assemblies will be measured by the number of assemblies installed. Each assembly shall consist of the anchor and the fittings required to connect it to the end post.

2554.5

E End Treatments

End treatments will be measured by the number of units of each type installed complete-in-place.

2554.5 BASIS OF PAYMENT

Payment for the installation of traffic barriers at the Contract price per unit of measure for each design specified will be compensation in full for furnishing all required materials and installing the barrier as specified, except that anchorage assemblies will be paid for as separate items, complete as shown in the Plans.

Payment for the installation of end treatments of each type at the Contract price per unit of measure will be compensation in full for furnishing and installing steel plate beam rail, all necessary posts, appropriate anchorage, offset blocks, hardware, and required materials as specified.

Payment for the installation of guide posts at the Contract price per unit of measure for each type specified will be compensation in full for all costs of furnishing and installing the posts as specified.

Payment for the installation of traffic barriers or guide posts at the Contract price per unit of measure will be compensation in full for all costs of installing the work as specified, using materials furnished by the Department.

Payment for permanent barricades at the Contract price per unit of measure will be compensation in full for all costs of furnishing the required materials and installing the barricades complete-in-place as specified.

Payment for traffic barriers and barricades will be made on the basis of the following schedule:

Item No.	Item	Unit
2554.501	Traffic Barrier, Design ____	meter (linear foot)
2554.505	Permanent Barricades	meter (linear foot)
2554.509	Guide Post, Type ____	each
2554.511	Install Traffic Barrier, Design ____	meter (linear foot)
2554.515	Install Guide Post, Type ____	each
2554.521	Anchorage Assembly.....	each
2554.523	End Treatment - ____	each

2557

**2557
Fencing**

2557.1 DESCRIPTION

This work consists of constructing fences.

2557.2 MATERIALS

If the type of material for metal products is not specified in the Contract, the Contractor may select the type of material. The Contractor shall use the same type of metal fence components on the entire Project.

All tubular metal posts shall be capped.

When coated metal posts are indicated in the Contract, the Contractor shall use the same coating on posts, post supports, rails, gate frames, expansion sleeves, and other hardware items or fittings. The Contractor shall use:

- (a) Zinc coating with zinc coated fence fabric.
- (b) Aluminum or zinc coating with aluminum coated steel fabric.
- (c) Vinyl coating with vinyl coated fence fabric. The vinyl coated posts, hardware, and fabric shall be black with a low to medium gloss, unless otherwise stated.

The Contractor shall use aluminum alloy posts, rails, frames, and other hardware items with aluminum alloy fence fabric.

A	Fence Wire	3376
B	Fence Gates	3379
C	Fence Posts	
C1	Rolled Steel Posts	3403
C2	Structural Metal Posts.....	3406
C3	Blank	
C4	Treated Wood Posts.....	3413
D	Hardware and Fittings	3406
E	Concrete	

Concrete shall meet the requirements for Grade B, Type 3 concrete as specified in 2461.

2557.3 CONSTRUCTION REQUIREMENTS

A General

All brush, trees, and other obstructions that interfere with construction of the fence shall be removed and disposed of according to the applicable provisions of 1405, 2101, and 2104.3C. A smooth ground profile shall be provided at the fence line. The work necessary to accomplish these purposes shall, unless the Contract specifically provides payment for any part or all of the work, be incidental to fence construction and no direct compensation will be made therefor.

In general, the bottom of the fence shall follow the contour of the ground. At small stream crossings, drainage ditches, and other

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locations where it is impractical to conform the fence to the ground contour the fence shall span the depression and, unless the Plans or the Engineer require otherwise, the space below the bottom of the fence shall be closed with extra fabric or wire as the Engineer directs. If extra length posts are needed at such locations, the Contractor shall furnish and install the longer posts in lieu of the standard length posts, together with any intermediate posts, stakes, braces, extra fabric, or wires as may be required. All such work and materials will be incidental to fence construction and no direct compensation will be made therefore except where the Contract specifically provides payment for any part or all of such work under separate items.

The Contractor shall make field repairs according to the manufacturer's recommendations.

B Installing Posts, Rails and Braces

B1 General

Posts shall be set plumb except at locations where the Engineer deems it more practical for the posts to be set perpendicular to the slope of the ground.

Corner posts, pull posts, end posts, and gate posts shall be installed at locations shown in the Plans or designated by the Engineer. In general, corner post assemblies will be required at all horizontal angle points where the deflection exceeds 20 degrees. Where practical, pull posts shall be spaced to provide a braced post at all points where:

- (a) The vertical alignment deflects by more than 20 degrees.
- (b) The post anchorage is necessary to counteract wire uplift.
- (c) An abrupt grade change on short runs cannot be avoided by shaping the ground to a uniform contour.

When fence posts are driven, the post top shall be protected against damage. All posts that are damaged during installation shall be removed and replaced.

When posts are placed on concrete walls, curbs or other concrete structures, methods and materials used for anchoring posts shall be as specified in the Plans.

If solid rock is encountered above the required elevation of the bottom of a post, the post shall be set at least 300 mm (**12 inches**) into the rock or with its bottom at the required elevation, whichever requires the lesser excavation into the rock. In such cases, the post shall be cut off at the bottom to provide the required height above the ground surface. Holes in rock shall provide a minimum clearance of 25 mm (**1 inch**) around the post, and shall be filled around the post with grout consisting of one part Portland cement, 0.1 part hydrated lime (if desired) and 2 parts mortar sand, with sufficient water to give the proper consistency.

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Concrete for setting posts and braces shall be thoroughly compacted around the posts and allowed to cure for not less than 3 days before the fence wire is installed.

The concrete may be poured into prebored holes without forming, provided the earth is firm enough to permit satisfactory placement and care is taken to prevent contamination of the concrete during placement.

Except as otherwise required for posts and braces set in rock or concrete, the annular space around all posts set in prebored holes shall be backfilled in layers using selected material from the excavation (unless special material is provided), with each layer thoroughly compacted to produce a rigid post setting.

All surplus excavated material shall be disposed of in low areas along the fence line, or as directed by the Engineer, and the adjacent area shall be finished neatly.

B2 Metal Post Installations

All posts for chain-link fabric fencing shall be set in concrete as provided for in the Plans, except that line posts may be driven provided that posts of sufficient extra length are furnished to allow drive setting at least 1.2 m (**4 feet**) into the ground.

Rolled steel line posts shall be driven.

Rolled steel end posts, corner posts and pull posts (together with the required braces) may be provided with anchor plates and brace plates and set in dug holes, or the anchor and brace plates may be omitted and the posts and braces set in concrete. All excavations around the posts and braces shall be backfilled, using the excavated material, and the backfill shall be thoroughly compacted.

Rolled steel gate posts shall be set in concrete.

At those locations where the Plans require the use of metal post extensions, the Contractor shall furnish and install posts of such extra length as may be directed by the Engineer. Where post splicing is necessary, the pipe ends at the splice shall be threaded and joined, employing a standard thread with coupling of the same material. Splices in the exposed upper portion of the post shall be avoided where practicable. A suitable plug shall be provided in the bottom end of each extended post.

B3 Wood Post Installations

Wood posts may be driven or set in prebored holes. In either case the larger end of the post shall be placed in the ground. When posts are driven, the end placed in the ground may be cut square or pointed. Except for holes in rock, the diameter of post holes shall be sufficiently large to provide a clearance of at least 75 mm (**3 inches**) around the post so as to permit proper backfill and compaction.

Wood braces shall conform to 3413, so far as they are applicable. The diameters of wood braces as shown in the Plans shall be construed to be the minimum permissible diameter at the small end, but the diameter at the small end shall be no greater than the top diameter of the smaller adjacent post.

C Installing Fence Wire

All fence wire shall be installed and pulled tight in accordance with standard practice and the recommendations of the manufacturer.

C1 Chain Link Fabric

Chain link fabric shall be placed in continuous runs between corner, end, and gate posts. The fabric shall be installed on the side of line posts that face away from the main road; except when the Engineer directs otherwise because of snow plowing or other concerns. Impacts from snow plowing should stress the posts rather than the fasteners.

At all ends of chain link fabric, a stretcher bar shall be threaded through the fabric loops and fastened to the posts by means of clamps as shown in the Plans.

Splices in the chain link fabric shall be made by weaving in a pre-bent wire of the same kind as that in the fabric.

C2 Barbed Wire and Woven Wire

Unless otherwise directed by the Engineer, barbed wire and woven wire to be installed on tangent alignment or on curves of 1 degree or less shall be placed on the side of line posts that faces away from the main roadbed. Where the fence is placed on horizontal curves exceeding 1 degree, the wire shall be placed on the side of line posts that is on the outside of the curve. At all corners the post shall be offset to the inside so that the wire will bear against the post.

Fence wire shall be fastened to end, corner, gate, or pull posts before being fastened to intermediate line posts. Woven wire shall be stretched until all longitudinal wires are taut and approximately 30 percent of the factory fabricated fence crimp (tension curves) has been removed.

At all major vertical grade changes, woven wire shall be cut and spliced at the pull post as may be necessary to obtain and maintain uniform tension in all horizontal wires. To the extent feasible, tension curves may be increased in number or depth, by use of a wire crimping tool, so as to accomplish the same objective.

Wires shall be fastened to metal line posts by means of approved wire clips or clamps and to wood posts by means of galvanized staples. Where the wire is looped around end, corner, or pull posts, the wire shall be wrapped around itself not less than 4 complete turns.

Wire staples of the U-shaped type shall be at least 45 mm (1 ¾ inches) long when used in pine posts and at least 50 mm

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(2 inches) long when used in cedar posts. L-shaped staples (with serrated, barbed or ring shanks) may be of a length not less than 38 mm (1 ½ inches).

U-shaped staples shall be driven diagonally across the wood grain so that both points do not enter between the same grain. Staples shall be sloped slightly upward, against the pull of the wire, in depressions where wire up-lift occurs, and shall be sloped slightly downward on level ground and over knolls. Wires shall be stapled tightly at corner, end, and pull posts, but on line posts the staples shall not be driven so tightly as to prevent movement of the wire. In no case shall staples be driven so tight as to damage the wire.

Splicing of wire at locations between posts shall be accomplished with an approved type of splicing sleeve or by wrapping each wire end around the other wire a sufficient number of turns to ensure a lasting connection. From 4 to 6 turns will be required, depending on the splicing method used, the type of wire, and the quality of workmanship. The Engineer will require that a splicing tool be used to obtain uniformly tight wraps where hand wrapping is not satisfactory.

Where splicing sleeves are used on woven wire, the horizontal distance between vertical wires shall be maintained approximately the same as that in the wire as fabricated. When woven wire is spliced by the wrap method, the two end stay wires shall abut each other and be enclosed within the wrap.

D Installing Gates

Where the Plans require gates, each gate shall be equipped with a "padlock keeper" of a design that will permit locking the gate with a padlock. The padlock will be furnished by the Department.

E Electrical Grounds

Electrical grounds consisting of copper coated steel rods having a nominal diameter of 15 mm (5/8 inch) or more and a minimum length of 2.4 m (8 feet) shall be installed along each fence line at the staked locations.

Ground rods shall be driven to an elevation approximately flush with the ground surface, at points directly below or adjacent to the fence wire, and each ground rod shall be connected to the fence with a solid No. 6 copper wire. The ground wire shall be attached to the ground rod and to the fence wires with approved type metal clamps in such a manner that each longitudinal fence wire is electrically grounded. No more than one connection will be required on woven wire and chain link fabric, that being near the bottom at each ground rod.

Electrical grounds are to be installed at locations established in accordance with the following requirements:

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- (1) An electrical ground shall be installed on each fence line at the approximate point of crossing of each electric power line, and two grounds shall be installed at each pedestrian gate, one on each side of the gate opening and as close to the gate post as practicable.
- (2) Additional grounds shall be installed on each fence line as necessary to maintain a desired maximum spacing between grounds of 450 m (**1500 feet**) on fences where metal posts are used and 300 m (**1000 feet**) on fences where wood posts are used.
- (3) A minimum of one electrical ground shall be installed on each separate section of fence. A separate section of fence shall be defined as a run on which the electrical continuity has not been broken by gates, terminal posts, etc.
- (4) On each separate section of fence, the spacing of electrical grounds shall be as uniform as practicable and such that a ground will be located within a distance from each end not greater than one-half the desired maximum spacing interval.

2557.4 METHOD OF MEASUREMENT

A Wire Fence

Fence of each design will be measured separately, by length along the bottom of the fence, from center to center of end posts, exclusive of the lengths of gates as measured between gate posts.

B Brace Assemblies

Brace assemblies of each kind (wood or metal) will be measured separately by the number of each kind constructed complete-in-place, regardless of length, design, or anchorage. A brace assembly shall consist of a single wood or metal brace, installed as either a leg brace or as a horizontal brace between two consecutive posts (brace assemblies for chain link fences shall consist of two brace bars and a truss rod), together with the required brace plate or concrete anchor, post anchorages, and guy wires or truss rods.

C Electrical Grounds

Measurement will be by the number of ground rods and connections furnished and installed complete-in-place.

D Gates

Measurement will be by the number of individual units constructed complete-in-place.

E Metal Post Extensions

Metal post extensions will be measured by length of extensions, determined as the difference between the standard driven post length and the actual post length as installed.

2557.5 BASIS OF PAYMENT

Payment for fence of each design at the Contract price per unit of measure will be compensation in full for all costs of the installation and

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materials except those that the Contract specifically designates as having been included for payment under separate items.

Payment for brace assemblies of each kind at the Contract price per unit of measure will be compensation in full for furnishing and installing the braces as specified, including the required brace plate or concrete anchor, post anchorages, and all guy wires or truss rods.

Payment for electrical grounds at the Contract price per unit of measure will be compensation in full for all costs of furnishing and installing the ground rods as specified, complete with ground wire and connectors.

Payment for gates of each kind at the Contract price per unit of measure will be compensation in full for all costs of furnishing and installing the complete gate assembly as specified.

Payment for furnishing and installing metal fence post extensions as directed by the Engineer, at the Contract price per unit of measure will be compensation in full for all costs of furnishing and installing the post extensions as specified.

Payment for fencing will be made on the basis of the following schedule:

Item No.	Item	Unit
2557.501	Wire Fence, Design ____	meter (linear foot)
2557.516	Pedestrian Gate	each
2557.517	Vehicular Gate.....	each
2557.519	Metal Post Extensions	meter (linear foot)
2557.521	Wood Brace Assembly	each
2557.522	Metal Brace Assembly	each
2557.523	Metal Brace Assembly (Chain Link Fence)	each
2557.527	Electrical Ground	each

2560

Highway-Railroad Grade Crossing Signals

2560.1 DESCRIPTION

This work shall consist of furnishing materials for and installing electrically operated highway-railroad grade crossing signals of the flashing light type, together with crossing gates and cantilever type signals if so required by the Contract.

2560.2 MATERIALS

A General Requirements

All materials and signal parts furnished by the Contractor shall meet the applicable requirements of the Association of American Railroads, the Railroad on whose line the signal will be installed, and the Rules and Specifications for Signs and Signals for Installations at Highway-Railroad Crossings contained within Chapter 8830 of

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Minnesota Rules, as last issued prior to the date of advertisement for bids.

A1 Manufacturer's Drawings, Details, Catalog References and Specifications

The bidder shall furnish, with the Proposal, manufacturer's drawings, catalog references, and specifications for any and all materials and apparatus that may be required to furnish but that are not covered by these Specifications or the Plans. Materials and apparatus covered by such drawings, catalog references or specifications shall not be used unless approved, in writing, by the Engineer. No change or changes shall be made in any approved manufacturer's drawings without the written consent of the Engineer.

After award of the Contract, the Contractor shall furnish the Engineer 5 sets of all such drawings as have been approved. Any work done before the approval of these drawings will be done at the Contractor's own risk and expense. The Contractor shall not substitute any materials or apparatus for those specified herein without the written approval of the Engineer.

A2 Tests

The Contractor shall make, at the Contractor's expense, such tests as may be necessary to demonstrate to the satisfaction of the Department and the Railroad Company that the materials, apparatus and installation will meet the requirements of the Specifications.

The Contractor shall provide, without separate compensation therefore, such instruments, apparatus, tools, and labor as may be necessary to make the required tests. The instruments and apparatus shall remain the property of the Contractor.

2560.3 CONSTRUCTION REQUIREMENTS

A General

The location for the signal as shown in the Plans shall be considered as being approximate only. The exact location will be determined at the site, and shall be such that the clearance distances for the several units will conform to the rules and regulations established therefore.

A1 Inspection of Material, Apparatus and Workmanship

The Railroad Company on whose line the signal system is to be installed, although not a party to the Contract, shall be permitted, through its accredited representative, to inspect any or all of the materials, the apparatus and workmanship of installation, at any time during the construction or installation.

A2 Work by Railroad Company

Under a special agreement with the Department, the Railroad Company will, without cost to the Contractor, perform so much of the work described hereafter (in paragraphs A2a to A2f inclusive) as is

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specified in the Special Provisions and will furnish all labor and tools required therefore. However, the Contractor shall furnish all materials and apparatus shown in the Plans as being necessary to complete such work.

- A2a Place switch rod insulation and insulated joints in the tracks, as shown in the Plans.
- A2b Make such rearrangements of existing wiring systems as may become necessary because of the signal installation.
- A2c Make such relocation of any existing signal apparatus or device as may become necessary because of the signal installation, as shown in the Plans.
- A2d Make all connections between the new signal installation and any existing signal system.
- A2e Remove and replace crossings if necessary for bonding the rails or installing underground cables.
- A2f Insulate metal crossings where necessary because of the signal installation.
- A3 Precaution and Traffic Provisions

Any information concerning traffic movements on the Railroad that the Contractor may need will be furnished at the Contractor's request by the Railroad Company's Dispatcher.

During construction operations when it becomes necessary for the Contractor to perform work that may interfere with traffic on the Railroad, the Contractor shall notify the Railroad Company through its Signal Engineer, Superintendent of Signals, or other authorized official, at least 48 hours in advance of starting such work. Such work shall not be started, however, until authorized by the Railroad Company.

The Contractor shall not place a colored glass signal light so that it will face an approaching train. Open flame torches shall be used in lieu of flashing lights in all places where such lights might confuse the crews of approaching trains.

Any or all openings or uncompleted work that may, after working hours, cause a hazard or unnecessary inconvenience to traffic, shall be suitably and substantially covered by the Contractor to protect traffic on either the Railroad or the highway.

The Contractor shall properly cover the signal or screen it from view, immediately after it is mounted, and shall maintain this covering or screening until authority is given to place the installation in service.

A4 Final Inspection of Installation

The final inspection, as provided for in 1516, shall be made in the company of the Department's Director of Railroad Administration and the Signal Engineer of the Railroad Company or their authorized

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representatives. Final acceptance will not be made until the Contractor has complied with 2560.3A5.

A5 Placing in Service

The Contractor shall place the system in service when authorized to do so by the Engineer, and it shall be placed in charge of competent attendants for a period of not less than 24 hours after being placed in service.

2560.4 METHOD OF MEASUREMENT

The signal system (including crossing gates if required by the Contract) and the advance warning signs will be measured as an integral unit complete in place.

2560.5 BASIS OF PAYMENT

Payment for the signal system will be made on the basis of the following schedule:

Item No.	Item	Unit
2560.501	Highway-Railroad Grade	
	Crossing Signal System	lump sum

2564

Traffic Signs and Devices

2564.1 DESCRIPTION

This work includes the fabrication, packaging, and delivery or installation of traffic signs and devices.

2564.2 MATERIALS

A General

Electrical materials and equipment shall conform to 2545.2. Where a particular material (fixture, device, or component) is specified, an alternate material, equal to or better than the material specified, may be used provided the Contractor obtains the written approval of the Engineer before incorporating such alternate material into the work.

B Structural Steel

All structural steel posts and trusses shall be fabricated from steel conforming to 3306, unless otherwise specified in the Contract.

Structural bolts, nuts, and washers shall conform to 3391.2B and 3392.

Bolt anchorages shall be as specified in the Contract or, if not so specified, as approved by the Engineer.

C Concrete (Mix 3Y43) 2461

D Reinforcement Bars 3301

All reinforcement bars, except spiral bars, shall be as indicated in the Contract and shall be epoxy coated.

E Spiral Reinforcement 3305

F Signs and Markers..... 3352

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All sign panels shall be fabricated in accordance with the following, unless otherwise specified in the Contract. Types of sign panels, route markers, and overlays contained in this Specification are referenced in the Mn/DOT Traffic Engineering Manual or the Mn/DOT Standard Signs Manual, or both.

F1 Sign base material for sign panels Type C, Type D, Type Overlay, delineators, markers and Type OH sign panels on sign supports shall be sheet aluminum in accordance with 3352.2A1a except the sign base material for cylinder style delineators shall be non-reflectORIZED lexon black flexible plastic.

F2 Sign base material for sign panels Type A, Type EA, Type EO and Type OH sign panels on panel mounting posts shall be extruded aluminum in accordance with 3352.2A1b and covered with 1600 μm (**0.063 inch**) sheet aluminum conforming to Mn/DOT 3352.2A1a covering the extruded panel. Fasteners to attach the sheet aluminum to the extruded panel shall be 5 mm (**3/16 inch**) aluminum alloy pull through rivets. The sheet aluminum shall be butted tightly vertically and riveted to the extruded panel on 300 mm (**12 inch**) centers maximum vertically and horizontally. All edges and corners of each sheet shall be riveted. Rivets shall not be placed within 25 mm (**1 inch**) of the extruded panel joints. After being attached, the sheet aluminum shall be substantially free of any waviness.

F3 Sign face material for all sign panels, delineators and markers shall be reflective sheeting conforming to 3352.2A2e(a) (Type IX), except as specified below:

Sign face material for standard sign I-X1 shall be reflective sheeting conforming to 3352.2A2b(a) (Type III).

Sign face material for standard signs W1-8 and W14-3 and X4-2 Hazard Markers, X4-3 Culvert Markers and X4-4 Clearance Markers shall be reflective sheeting conforming to 3352.2A2e(b) (Type IX FL Fluorescent yellow).

Sign face material for standard signs W11-1, W11-2, S1-1, S4-3 and S5-1 shall be reflective sheeting conforming to 3352.2A2e(b) (Type IX FL Fluorescent yellow-green). Sign face material for standard signs W16-7p, W16-9p, W20-100P, and W13-1, when used with the aforementioned signs, shall be reflective sheeting conforming to 3352.2A2e(b) (Type IX FL Fluorescent yellow-green).

For the sign face material on the M1-5A Route Marker and the M1-5B Type Overlay, the gold color shall be obtained by means of screen processed color using a transparent gold paint. The blue color shall be obtained by means of screen processed color using a transparent blue paint. The overlap of the blue and gold screen processed colors shall not exceed 3 mm (**3/32 inch**).

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Sign face material for sign panels with brown background shall be white reflective sheeting conforming to 3352.2A2e(a) (Type IX).

Yellow sign face material for cylinder style delineators, reboundable drums, and channelizers shall be reflective sheeting conforming to 3352.2A2b(c) (Type III MD).

Orange and white sign face material for cylinder style delineators, reboundable drums, and channelizers shall be reflective sheeting conforming to 3352.2A2d(b) (Type VII MD).

Sign face material for X4-2 Hazard Markers shall be non-reflectorized black or non-reflectorized yellow as specified in the Contract.

Sign face material for X4-11 End of Roadway Markers shall be non-reflectorized red or non-reflectorized black as specified in the Contract.

Sign face material for traffic cones shall be reflective sheeting conforming to 3352.2A2b(b) (Type III MC).

Sign face material for tubular markers shall be reflective sheeting conforming to 3352.2A2b(d) (Type III MT).

Sign face material for roll up signs shall be reflective material conforming to 3352.2A2c (Type VI).

Sign face material for all rigid work zone signs shall be reflective sheeting conforming to 3352.2A2d(a) (Type VII) except as specified below:

Sign face material for standard signs W20-7a, G20-4, W21-X4, W21-X4a, W21-X7 (SLOW side), M4-8, M4-8a, M4-9, M4-10, all signs for paint striping operations, and any other sign requiring extraordinary emphasis, as determined by the District Work Zone Coordinator, shall be reflective sheeting conforming to 3352.2A2d(c) (Type VII MF).

F4 Sign legend material for all sign panels, the numerals on M1-5A Route Markers and M1-5B Type Overlays, delineators and markers, and colors other than yellow on warning signs, shall be reflective sheeting conforming to 3352.2A2e(a) (Type IX), except as specified below:

The sign legend material on sign panels with brown sheeting shall be brown (1179) electronic cuttable (EC) film produced by the same manufacturer that fabricates the reflective sheeting conforming to 3352.2A2e(a) (Type IX). If applying brown EC film on sign panels requires splicing, splices shall be vertical, butt spliced and spaced so that splices do not occur through letters or arrows.

The sign legend material for colors other than black may be screened in accordance with 3352.2A5c.

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The sign legend material for black legend shall be in accordance with 3352.2A4c or 3352.2A4d.

G Anchor Rods..... 3385
H Flanged Channel Sign Posts..... 3401

2564.3 CONSTRUCTION REQUIREMENTS

A General

Fabrication and installation of traffic signs and devices shall conform to the Minnesota Manual on Uniform Traffic Control Devices (MN MUTCD) for Streets and Highways and to the AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals.

The Contractor shall not perform work on the job site until all underground utilities are located in conformance with 1507. Electrical cable damaged due to the negligence of the Contractor shall be replaced at no expense to the Department. Damaged electrical cable shall be replaced, by the Contractor, from terminal point to terminal point.

Construction of any kind or type of electrical system or conduit system for the conveyance of electrical cables and conductors, or the required portions thereof, as specified in the Contract, shall conform to 1702 and 2545.3.

Sign locations and post lengths indicated in the Contract are approximate. Final determination of sign locations will be made in the field by the Engineer. The required post lengths for Type A and Type OH Signs will be determined by the Engineer. The required post lengths for all other signs shall be determined by the Contractor.

If the legend on an existing sign is pertinent to traffic and the sign is to be refurbished, down time for the sign shall not extend beyond the 8-hour period from 8:00 a.m. to 4:00 p.m., unless a suitable replacement sign is provided by the Contractor at no expense to the Department.

If, in the opinion of the Engineer, the message on a sign panel is not pertinent to existing traffic, the Contractor shall delay installation of that sign panel until such time as the message does become pertinent or, in lieu thereof, the sign panel may be installed provided an effective covering is placed over the non-pertinent message. The cover shall be opaque, and shall prevent moisture from being held against the sign face. Burlap will not be accepted as an effective covering for reflective signs. The Contractor shall install the sign panel with the required covering and the Department will assume the responsibility for maintaining and removing the cover after acceptance of the work. Unless the Contractor has arranged to reclaim the covering material, it shall become the property of the Department upon final acceptance of the work. The covering, maintaining, and uncovering of sign panels

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with non-pertinent messages shall be done by the Contractor with no direct compensation.

The removal and replacement of any existing guardrail solely for the convenience of the Contractor shall be considered as being incidental work.

The Contractor shall replace all topsoil, sodded, and seeded areas disturbed by the operations and dispose of any excess excavated materials in a manner satisfactory to the Engineer.

B Concrete Structures

Concrete for footings shall be produced in accordance with 2461 and meet the requirements for Grade Y, Type 3 Concrete as specified therein.

All exposed concrete surfaces shall be given a rubbed surface finish.

The Contractor shall not install sign posts on concrete footings until after a minimum 7 days of curing period has elapsed.

B1 Concrete Footings

The Contractor may substitute spread footings for drilled shaft footings or vice versa, subject to the approval of the Engineer.

Footings shall be constructed in accordance with the Contract requirements and there shall be no adjustment in Contract quantities and prices.

If the Contract specifies drilled shaft footings, the Contractor may submit, for approval by the Engineer, an alternate design in lieu of detailed in the Contract. If approved by the Engineer, the Contractor may elect to construct the shaft footing accordingly without adjustment of any Contract quantities and prices. Design details shall be in accordance with either of the following:

- (a) Use a constant diameter shaft at least 153 mm (**6 inches**) greater than the diagonal dimension of the column base plate. Use the planned longitudinal reinforcement bars without bending. Either spiral reinforcement or tie bars spaced at 153 mm (**6 inches**) centers may be used for the full length of the shaft, or
- (b) Install a horizontal construction joint at the bottom of the tapered section of the shaft [about 1.8 m (**6 feet**) below the top]. Before placing new concrete above the construction joint, the surface of the in place concrete shall be coated with an approved bonding agent. Vertical reinforcement bars shall be lapped 40 bar diameters.

The footings shall be constructed in accordance with 2401.3 except as modified by the following:

The Contractor may use undisturbed earth as the form for concrete placement, provided the earth is firm enough to permit satisfactory placement of the concrete and precautions are taken to prevent contamination of the concrete.

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B2 Median Barrier Footing

The Contractor shall provide NMC conduit and fittings to connect to the non-metallic conduit in adjacent median barrier as required.

The surface finish and color shall match that of adjacent median barrier.

C Sign Support

The Contractor shall furnish and install a sign support in accordance with the Contract, current AASHTO "Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals" and the following:

The concrete footings shall be as specified in the Contract. The Contractor shall determine the reinforcement steel and the anchor rods in accordance with the details in the Contract.

The Contractor shall furnish and install an Overhead Sign Identification Plate in accordance with 2564.3P.

D Overhead Sign Structure Repair

The Contractor shall repair an existing overhead sign structure in accordance with the applicable provisions of 2123 and the following:

The Contractor shall contact the Department's Structural Metals Inspection Unit (DSMIU) to schedule inspection of sign structures. This inspection shall be completed before removal of the sign structure from storage, or after the Contractor's salvage of the structure.

The following conditions, if encountered, shall be corrected as determined by the DSMIU: rusted or missing nuts, bolts or washers, defective shop and field splices on main chord angles, missing welds, cracking of welds or structural elements, section loss on post base plate, flame gouges on base plate or at bolt holes, cracks around post handhole, zinc coating loss or deterioration, and rusting. All repairs shall be performed in accordance with 2471.

The Contractor shall verify that each locking pin will completely fit into the locking pin hole in the handrail hinge with the handrail in the raised position. For locking pins that do not fit, the Contractor shall drill out the handrail hinge to make a proper fit. Damage to galvanized surfaces shall be repaired in accordance with 2471.3L1.

The Contractor shall obtain reinspection by the DSMIU after the repair has been completed and before installation.

E Structural Steel

The manufacture and fabrication of structural metals shall conform to 2471, subject to the following additional requirements and limitations:

Shop drawings for overhead sign structures and for Type A sign structures shall be furnished in accordance with 2471.3B.

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Steel trusses shall be constructed true to dimensions and shall be uniform in appearance. The truss sections and posts shall be assembled in the shop before galvanizing; shall be checked for straightness, alignment and dimensions; and any variations shall be corrected. Warpage from galvanizing shall be corrected before installation of structural steel will be permitted.

All main chord angles for overhead sign structures 13 mm (**½ inch**) or greater in thickness shall meet a Charpy V-notch impact strength requirement of 20 N•m (**15 foot•pounds**) at 5 °C (**40 °F**).

The overhead sign post base plate anchor rod holes shall be made by use of a drill or other mechanical cutting tool of proper size.

The Contractor shall lubricate the threads of nuts before installation. The following minimum torque values shall be used:

ANCHOR ROD DIAMETER	TORQUE
51 mm (2 inches)	400 N•m (300 foot•pounds)
57 mm (2 ¼ inches)	500 N•m (375 foot•pounds)
64 mm (2 ½ inches)	600 N•m (450 foot•pounds)
70 mm (2 ¾ inches)	750 N•m (550 foot•pounds)
76 mm (3 inches)	950 N•m (700 foot•pounds)

The Contractor shall mar the threads of the anchor bolts in accordance with 2402.3H.

The Contractor shall furnish and install galvanized structural steel posts (H-Pile) as footings for Type A signs, unless otherwise specified in the Contract, in accordance with the applicable provisions of 2452, 2471, and the following:

The footing shall be constructed in accordance with the details in the Contract. A 4.3 m (**14 foot**) H-Pile post may be utilized instead of welding a 0.6 m (**2 foot**) stub post to the 3.7 m (**12 foot**) H-Pile. The required 107-125 kN (**12-14 ton**) bearing capacity for each H-Pile shall be obtained in accordance with 2452. If the required bearing capacity is not obtained after driving the length of H-Pile specified in the Contract, the Contractor shall splice additional length of H-Pile in accordance with 2452 and drive to the required bearing capacity. All damage to galvanized surfaces shall be repaired in accordance with 2471 before back filling.

F Flanged Channel Sign Posts

F1 Furnish Flanged Channel Sign Post

The Contractor shall fabricate, package, and deliver flanged channel sign posts in accordance with 2564, 3352, and 3401.

- (a) Posts of the same mass and length shall be banded together, with suitable banding materials, in lots of no more than 20 posts per bundle. Each bundle shall be plainly labeled with the post mass per

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meter, the name of the Contractor, the Project number, source of the material and the supplier's name.

- (b) The posts shall be delivered to the Department as specified in the Contract. The Contractor shall give at least 3 working days notice to the Engineer.
- (c) Posts shall be deposited where and as directed by Department personnel. All damage detected during unloading shall be cause for immediate rejection of damaged materials. Final inspection and acceptance of the posts will be made by the Department within 14 days of the delivery date.

F2 Furnish and Install Flanged Channel Sign Posts

The Contractor shall install the posts plumb above ground and located and oriented as directed by the Engineer. Any post that is bent or otherwise damaged to the extent that, in the opinion of the Engineer, it is not acceptable, shall be removed from the site and replaced by the Contractor at no expense to the Department.

Posts shall be firm in the ground. After driving, the top of the post shall have the same cross-sectional dimensions as the body of the post.

When mounting a delineator on a bridge rail, a bracket as shown in the Contract shall be furnished and installed by the Contractor in lieu of a conventional steel post.

All costs and work of installing posts in surfaced medians or sidewalks shall be considered incidental to the installation.

G Modify Post

Splices will not be permitted in the lower 1.5 m (**5 feet**) of Type A sign posts.

The Contractor shall extend Type A sign posts located above the friction fuse, and panel mounting posts, by welding a section (new or salvaged under this Contract of the same size) to an existing post in accordance with the applicable provisions of 2471. Only S100 x 11 (S4x7.7) panel mounting posts may be extended by bolt splicing in accordance with the details in the Contract and with the applicable provisions of 2471. Post extensions shall be galvanized in accordance with 2471.

When shortening a post, the removed section of post shall be disposed of in accordance with 2104.

Thermal cutting will be permitted in accordance with 2471. Galvanized areas marred due to cutting or welding shall be repaired in accordance with 2471.

H Sign Panels

Type Overlays are separate panels mounted on the face of signs to form a part of the legend. Type Overlays shall be attached to the sign panels with rivets spaced on 300 mm (**12 inch**) centers except the edges

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of each Type Overlay shall be attached with rivets spaced on 150 mm (**6 inch**) centers maximum. No rivets are to be installed within 25 mm (**1 inch**) of extruded panel joints.

The Contractor shall fabricate the sign panels in accordance with the standard sign drawings contained in the Mn/DOT Standard Signs Manual or as detailed in the Contract. For sign panels detailed in the Contract, sign panel layouts are dimensioned as follows:

Vertical dimensioning

The dimension given is for the legend component having the largest vertical dimension in the particular line of copy. Other legend components are centered on the larger legend component unless indicated otherwise.

Horizontal dimensioning

The horizontal dimensions given within the sign panel are to the tenth of an inch and are cumulative representing the distance from the left edge of panel to the extreme left edge of the legend component.

Sign Panel Recap

The position of an arrow is measured in degrees counterclockwise from a right horizontal reference line. The abbreviation MOD used in the sign panel recap = Modified.

The Contractor shall screen a fabrication sticker with the following information: Company name and address, the twelve months of the year in numeric order (1 through 12) and the current and following 4 years (last two digits of each year). The Contractor shall affix the sticker to the backside of each new Type C (single post installations only) and Type D sign panels in the lower right corner (when facing the back of the sign panel). On installations of two or more posts for Type C sign panels, the Contractor shall install the sticker in the center at the bottom of the sign panel. The Contractor may indicate the month and year of fabrication of the sign panel on the sticker by either of the following methods:

Punch out the month and year of fabrication of the sign panel on the completed sticker.

Block out the month and year of fabrication on the screen prior to applying the black ink so that the month and year of fabrication will not be displayed.

The Contractor shall provide a full size mockup (75 mm x 40 mm) (**3 inches x 1 ½ inches**) of the sticker (black legend on a white reflectorized background) to the Department for approval.

The Contractor shall attach all extruded sign panels to sign posts or panel mounting posts with new post clips. Each post clip shall be

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torqued to 16 to 19 N•m (**12 to 14 foot•pounds**) when attaching all extruded sign panels to posts.

The Contractor shall package, deliver, store, and install sign panels in accordance with 1607, 3352, and the retroreflective sheeting manufacturer's recommended practices and procedures.

For signs or sign panels being furnished and installed, the Contractor shall affix a Department furnished warning sticker to the backside of each sign panel directly above the fabrication sticker. Warning stickers are available at the Department's Transportation District Office specified in the Contract. The Transportation District's contact person and phone number are specified in the Contract. Thirty calendar days advance notice shall be given prior to picking up the stickers.

For sign panels being furnished only, the Contractor shall group all sign panels by type (e.g. R1-2) and then by size. Each package shall contain only those sign panels destined for a specific location and no more than 20 sign panels per package. Each package shall be plainly labeled with the Sign Number (e.g. Sign R1-2), name of the Contractor, the Project number, source of the material, the supplier's name, quantity of sign panels, and the delivery location as specified in the Contract.

The Contractor shall give at least 3 working days notice to sign shop personnel before delivery of sign panels to the Department.

Sign panels shall be deposited where and as directed by Department personnel. Any damage detected during unloading shall be cause for immediate rejection of the damaged materials. Final inspection and acceptance of the sign panels will be made by the Department within 14 days of the delivery date.

I Blank

J Saw Sign Panels

The Contractor shall saw cut extruded aluminum sign panels straight and the resulting panel edge shall be smooth. Excess material shall be disposed of in accordance with 2104.

K Sign Panel Overlay Type __

The Contractor shall furnish and install overlay panels on existing extruded aluminum sign panels, including legend. Fasteners to attach the overlay sheets to the extruded panel shall be 5 mm (**3/16 inch**) aluminum alloy pull through rivets.

The sign base material for overlay sheets shall be 1600 µm (**0.063 inch**) aluminum conforming to 3352.2A1a. The sign face material shall be reflective sheeting conforming to 3352.2A2e(a) (Type IX). The sign legend material shall be reflective sheeting conforming to 3352.2A2e(a) (Type IX), except where black legend is specified the

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sign legend material shall be Direct Applied conforming to 3352.2A4c or 3352.2A4d.

The Contractor shall remove the demountable legend conforming to 3352.2A2e(a) (Type IX) on the existing sign panel and dispose of in accordance with 2104.

The Contractor shall butt the overlay sheets tightly vertically and rivet them to the existing panel on 300 mm (**12 inch**) centers maximum vertically and horizontally. All edges and corners of each overlay sheet shall be riveted. Rivets shall not be within 25 mm (**1 inch**) of the extruded panel joints. The overlay sheets after being attached to the existing panel shall be substantially free of any waviness.

L Install Sign Panel Type __

The Contractor shall install a sign panel (either salvaged or Department furnished) of the type specified in the Contract in accordance with the details in the Contract and the following:

Type A and Type OH sign panels shall be installed using new post clips. Type EA and Type EO sign panels shall be installed with new flanged channel posts and post clips. The Contractor shall torque each post clip to 16 to 19 N•m (**12 to 14 foot•pounds**) when attaching all extruded sign panels to posts.

Type C and Type D sign panels shall be installed with new nuts, bolts and washers.

Type OH sign panels, being installed on sign supports, shall include new sign bracket assemblies in accordance with the details in the Plan.

M Install Sign Type __

The Contractor shall install Type A signs on breakaway supports at the locations indicated in the Contract. Salvaged or Department furnished Type A sign panels shall be installed using new post clips. The Contractor shall torque each post clip to 16 to 19 N•m (**12 to 14 foot•pounds**) when attaching all extruded sign panels to posts. Completed installations shall be in accordance with Contract requirements and details. A new friction fuse (includes friction fuse plate and hinge plate) new bolts, nuts and washers shall be furnished and installed on each post. Damage to galvanized surfaces shall be repaired in accordance with 2471.

The Contractor shall furnish and install a new sign structure for Type C and Type D signs and install the salvaged sign panel(s) in accordance with the details in the Contract using new nuts, bolts, and washers. The salvaged sign panel(s) shall be installed to the mounting height requirements specified in the Contract.

The Contractor shall install each mast arm mounted Type D sign at the location indicated in the Plan, to the satisfaction of Engineer, and as follows:

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The Structural Details For Signal Mast Arm Mounted Signs are specified in the Mn/DOT Standard Signs Manual, Page No. 105A. Each mast arm mounted Type D sign panel shall be provided with a mounting system approved by the Department. Approval shall be obtained by submitting product specifications and strength calculations, demonstrating compliance with the current AASHTO "Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals". Submittal shall be made to: Fabrication Methods Engineer, Mn/DOT Office of Bridges and Structures, Mail Stop 610, 3485 Hadley Avenue North, Oakdale, Minnesota 55128.

The Contractor shall furnish new flanged channel posts for Type EA and Type EO sign panel(s), and install the salvaged sign panel(s) with new post clips in accordance with details in the Contract. The Contractor shall torque each post clip to 16-19 N•m (12-14 foot•pounds).

The Contractor shall install the Type OH sign structure (either salvaged or from storage) on new concrete footing(s) in accordance with the torque requirements under 2564.3E and with the details in the Contract.

The Contractor shall remove the following and furnish and install new: safety chains and components of safety chain snap assemblies, safety rail locking pins, and chains welded to the locking pin heads (one chain/locking pin). This work shall be incidental to the installation of the sign structure. Items removed shall be disposed of in accordance with 2104.

The Contractor shall verify that each locking pin will completely fit into the locking pin hole in the handrail hinge with the handrail in the raised position. For locking pins that do not fit, the Contractor shall drill out the handrail hinge to make a proper fit. Damage to galvanized surfaces shall be repaired in accordance with 2471.3L1.

N Sign Legend Revision

The Contractor shall revise the sign legend of existing sign panels in accordance with the details in the Contract and the following:

Clean the sign faces with a mild detergent and water solution before installing the new sign legend.

New sign legend for Type A, Type EA, Type EO and Type OH sign panels shall be reflective sheeting conforming to 3352.2A2e(a) (Type IX), except where black legend is specified the sign legend material shall be direct applied non-reflectorized conforming to the 3352.2A4c or 3352.2A4d.

O Blank

P Overhead Sign Identification Plate

The Contractor shall furnish and install an overhead sign identification plate for each overhead sign being installed under the Contract. The plate shall incorporate the overhead sign number appearing directly below the sign panel on the Plan layout and shall comply with the details in the Contract.

For post mounted signs, the plate shall be strap mounted to the overhead sign post in accordance with the details shown in the Contract.

The plate shall be installed on the right post when looking in the direction of traffic flow. When signs face both directions of travel on a single structure, two plates will be required. The plate shall be installed at a height of 1.8 m (**6 feet**) above the base plate elevation and facing traffic.

For bridge mounted Type OH signs with sign lighting, the overhead sign identification plate shall be installed at a mounting height of approximately 1.9 m (**6 feet**) above the edge of the pavement on the feed point identification plate delineator post specified in 2545.3J4. For bridge mounted Type OH signs with no sign lighting, the plate shall be installed on a 3 kg/m (**2 pounds per foot**) delineator post in accordance with 3401. The plate and post should be installed as close to the bridge as possible and behind the guardrail, if present. If no guardrail is in place, the plate and post shall be installed at least 3.7 m (**12 feet**) outside the edge of shoulder or face of curb. The bottom of the plate shall be approximately 1.8 m (**6 feet**) above the edge of pavement.

Q Extend Walkway Support

The Contractor shall extend each walkway support on existing Type OH sign structures in accordance with the details in the Contract.

R Friction Fuse

The Contractor shall furnish and install a friction fuse on each sign post of existing Type A sign installations in accordance with the details in the Contract and the following:

Remove the in place friction fuse (friction fuse plate, hinge plate, and all in place mounting hardware) and dispose of in accordance with 2104.

Furnish and install a new friction fuse (includes friction fuse plate and hinge plate), new bolts, nuts and washers on each post in accordance with the details in the Contract. Damage to galvanized surfaces shall be repaired in accordance with 2471.3L1.

S Keeper Plate

The Contractor shall furnish and install a keeper plate on each sign post of existing Type A sign installations in accordance with the details in the Contract.

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The Contractor shall verify the sign post dimensions in the field. Immediately before installing the keeper plates, the base connection plate shall be cleaned and be free of grit, dirt, etc. The post shall be reinstalled in accordance with the base connection bolting procedure. Missing, damaged or rusty bolts, nuts and washers shall be replaced by the Contractor.

T Traffic Control

This work shall consist of furnishing, installing, maintaining, and removing traffic control devices.

All signs shall conform to the Mn/DOT Standard Signs Manual. All barricades shall conform to current Mn/DOT Standard Plate 8000. All other traffic control devices shall conform to the MN MUTCD. Nylon washer spacers shall be installed between the temporary traffic construction sign panel(s) and the in place sign panel.

The Contractor shall provide all necessary traffic control devices (TCD's) as required by the Contract and the MN MUTCD.

The Contractor shall install all TCD's where required, before the beginning of any work. The Contractor shall maintain all TCD's and remove them when not required.

U Scheduling of Work

The Contractor shall schedule the work in compliance with the following requirements:

- (1) One of the following signs shall be in service at all times for each exit:
 - (a) The Exit sign in the gore, or
 - (b) The Exit direction sign just in advance of the gore.
- (2) One directional sign shall be in service at all times for each exit. This may be the Advance guide sign or the exit directional sign.
- (3) Sign structures shall not be removed until permitted by the Engineer. The Engineer's approval for removing an existing sign is contingent upon Item 1 and 2 above and upon a satisfactory replacement being constructed and functional.

V Delineators and Markers

The Contractor shall fabricate delineators and markers in accordance with the standard sign drawings contained in the Mn/DOT Standard Signs Manual, Mn/DOT Traffic Engineering Manual or as detailed in the Contract. The Contractor shall furnish and install the tubular or flanged channel sign post, mounting bracket or strap mounting hardware, and attach the delineator or marker with mounting hardware as detailed in the Contract.

W Safety Cable

For Type OH signs with walkway and no sign lighting, the Contractor shall furnish and install brackets, aircraft cable and all

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necessary hardware, in accordance with the applicable provisions of 2564, to assemble and attach a safety cable as detailed in the Plan.

2564.4 METHOD OF MEASUREMENT

A General

Items modify post, install sign panel Type __, sign legend revision, overhead sign identification plate, extend walkway support, friction fuse, and keeper plate will individually be measured by the each.

B Concrete Structures

All necessary excavation for a concrete structure will be considered as being incidental to construction of the structure and no measurement will be made thereof except under the following conditions:

- (1) Excavation required 300 mm (**12 inches**) below the bottom of the concrete structure will be measured as actual material removed within the limitations set forth in 2451.4A and the volume will be paid for as Extra Work.
- (2) Payment as Extra Work will be made where Class R excavation is encountered and cannot be avoided by adjustment of the concrete structure location.
- (3) All reinforcement bars in concrete structures will be incidental to the construction and with no measurement being made.

B1 Concrete Footings

Concrete footings for Type OH signs will be measured separately by volume, based on specified dimensions in the Contract with no deductions for the volume of metal reinforcement, anchorages, conduit, etc., except that the anchorage assemblies will be measured separately.

B2 Median Barrier Footing

Median barrier footing will be measured separately by the unit based on specified dimensions in the Contract with no deductions for the volume of metal reinforcement, anchorages, conduit, etc., except that the anchorage assembly will be measured separately.

C Sign Support

The sign support will be measured as a complete unit including the concrete footing(s) and overhead sign identification plate.

D Overhead Sign Structure Repair

Overhead sign structure repair will be measured by the actual number of hours required to complete the repair, including use and operation of equipment, travel time within the Project limits, and work and materials involved. However, crane work and materials required to position and block the truss up off the ground shall be paid for under install sign type OH, with no additional compensation. Overhead sign structure repair is exempt from 1903 as no unit price adjustments will be made in the event of a quantity underrun or overrun.

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E Structural Steel

The structural steel items: trusses for overhead signs (Design A); posts for overhead signs (Design A); trusses for overhead signs (Design B); posts for overhead signs (Design B); walkway supports for overhead signs (Design B); walkway grating for overhead signs (Design B); panel mounting posts for overhead signs (Design B); trusses for overhead signs (Bridge Mounted); and posts and H-piles for Type A signs will be measured separately by computed mass (weight) of structural steel incorporated in each item in accordance with the measurement provisions of 2402.4A, subject to the following:

- (1) The mass (**weight**) measurement for trusses for overhead signs (Design A) will include the structural members of the truss, the lower chord juncture plate, cap plates, tie plates, collar, panel mounting posts, walkway grating, walkway supports, safety rail, and fixture mounting channel.
The mass (**weight**) measurement for posts for overhead signs (Design A) will include the posts, the base juncture plate, lower chord juncture post plate, gusset plates, baseplate, overhead sign identification plate, and the anchorage assembly.
The mass (**weight**) measurement for trusses for overhead signs (Bridge Mounted) will include the structural members of the truss, the panel mounting posts, walkway grating, walkway supports, safety rail, and fixture mounting channels.
- (2) The computed mass (**weight**) will be based on the quantity tables included in the Contract.
- (3) No measurement will be made of any bolts, nuts, rivets, washers, and shims used in the fabrication and erection of signs. The provisions of 2402.4A providing a percentage increase in mass (**weight**) therefore will not apply.

F Flanged Channel Sign Posts

Flanged channel sign posts will be measured by computed mass (**weight**) for each size of post being furnished.

G Sign Panels

Sign panels of each type will be measured separately by area based on the nominal dimensions of the sign panels. All signs will be considered as being rectangular for the purpose of measurement except that, for triangular shaped sign panels, the measurement will be the actual area of the triangle. No deduction will be made for rounding of corners.

H Saw Sign Panels

Sawing of extruded sign panels will be measured by the length of the saw cut.

I Sign Panel Overlay Type __

Sign panel overlays will be measured separately by the area and type of sign panel(s) overlaid.

J Install Sign Type __

Signs of each type will be measured by the number of complete units in place as specified under 2564.3M, except that the posts and concrete footings or H-Pile footings for Type A signs, and the footings for Type OH signs, will be paid for separately.

K Delineators and Markers

Delineators and markers of each type will be measured by the number of complete units furnished and installed. A complete unit will consist of the delineator or marker panel, tubular or flanged channel sign post, mounting bracket or strap mounting hardware, and delineator or marker panel mounting hardware as specified in the Mn/DOT Standard Signs Manual, Mn/DOT Traffic Engineering Manual, or as detailed in the Contract.

2564.5 BASIS OF PAYMENT

The Department will pay for traffic signs and devices at the Contract price per unit of measure. The Contractor will accept the payment as compensation in full for all costs relating to furnishing and installing or furnishing the item except those costs that the Contract specifically designates as included for payment under a separate item.

Payment for concrete footings at the Contract price per cubic meter (cubic yard) will be compensation in full for all costs of constructing the footings and will include replacing all topsoil and sodded areas disturbed by the operations and disposal of any excess excavated materials in a manner satisfactory to the Engineer, except that anchorage assemblies will be paid for under Structural Steel - Post for OH Signs (Design __).

Payment for median barrier footing at the Contract price per unit of measure will be compensation in full for all costs of constructing the footing in place as specified, except that the anchorage assembly will be paid for under Structural Steel-Posts for OH signs (Design __).

Payment for sign support at the Contract price per unit of measure will be compensation in full for furnishing and installing the sign support (including the concrete footings) and overhead sign identification plate.

Payment for overhead sign structure repair at the Contract price per hour will include compensation in full for all costs involved in performing the work as specified in the Contract, except that the crane work and materials required to position and block the truss up off the ground shall be paid for under install sign type OH.

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Payment for structural steel items by weight at the Contract price per mass (**weight**) of steel will be compensation in full for all costs of fabricating and erecting the structural steel items as specified in the Contract.

Payment for modify post at the Contract price per unit of measure will be compensation in full for all costs of modifying each post as specified in the Contract.

Payment for flanged channel sign posts at the Contract price per kilogram (**pound**) will be made under structural steel, and will be compensation in full for all costs involved in manufacturing, packaging and delivering the posts as specified in the Contract.

Payment for furnishing and installing sign panels of each type separately at the Contract price per square meter (**square foot**) will be compensation in full for all costs of fabricating and erecting panels as specified, except for those components that are specifically noted as Type Overlays. Payment for Type C and Type D sign panels will include compensation for furnishing and installing the tubular or flanged channel sign posts, stringers, brackets, and attachment angles or strap mounting hardware on which the sign panels are attached. Payment for Type EA and Type EO sign panels will include compensation for furnishing and installing the flanged channel sign posts. Payment for Type A Sign Panels will include compensation for the hardware required to assemble the panel sections and attach the assembled sign panels to the sign posts. Payment for Type OH Sign Panels will include compensation for the hardware required to assemble the panel sections and attach the assembled sign panels to the panel mountings posts or the sign support. Torquing post clips will be incidental to furnishing and installing extruded sign panels. Screening and installing fabrication stickers and installing warning stickers will be incidental to furnishing and installing Type C and Type D sign panels.

Payment for furnishing sign panels of each type separately at the Contract price per square meter (**square foot**) will be compensation in full for fabricating packaging, and delivering the sign panels as specified in the Contract.

Payment for saw sign panels at the Contract price per unit of measure will be compensation in full for all costs of sawing sign panels as specified in the Contract.

Payment for sign panel overlay Type __ at the Contract price per square meter (**square foot**) will be compensation in full for all costs involved in performing the work as specified in the Contract, including the removal and reinstallation of the existing sign panel, if necessary, except that furnishing and installing new Type Overlays will be paid for as sign panels Type Overlay.

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Payment for install sign panel Type __ at the Contract price per unit of measure will be compensation in full for all costs of installing each sign panel as specified in the Contract.

Payment for install sign Type __ at the Contract price per unit of measure will be compensation in full for all costs of installing each sign as specified in the Contract, except that the posts and H-Piles for Type A signs will be paid for under Structural Steel Posts for Type A signs; the anchorage assembly(ies) will be paid for under Structural Steel Posts for Type OH Signs (Design _) and concrete footing(s) for Type OH signs will be paid for under Concrete Footings (Type Spread or Shaft) or median barrier footing(s).

Payment for sign legend revision at the Contract price per unit of measure will be compensation in full for all costs of revising each sign panel as specified in the Contract.

Payment for overhead sign identification plate at the Contract price per unit of measure will be compensation in full for all costs of furnishing and installing each overhead sign identification plate as specified in the Contract.

Payment for extend walkway support at the Contract price per unit of measure will be compensation in full for all costs of extending each walkway support as specified in the Contract.

Payment for friction fuse at the Contract price per unit of measure will be compensation in full for all costs of removing an in place and furnishing and installing a new friction fuse as specified in the Contract.

Payment for keeper plate at the Contract price per unit of measure will be compensation in full for all costs of furnishing and installing a new keeper plate as specified in the Contract.

Payment for delineators and markers at the Contract price per unit of measure will be compensation in full for all costs of furnishing and installing each delineators and marker as specified in the Contract.

Payment for traffic signs and devices will be made on the basis of the following schedule:

Item No.	Item	Unit
2564.511	Concrete Footings-Type	cubic meter (cubic yard)
2564.513	Median Barrier Footing	each
2564.515	Sign Support	each
2564.518	Overhead Sign Structure Repair	man-hour
2564.522	Structural Steel --- (Specify Item & Use)	kilogram (pound)
2564.524	Modify Post	each
2564.531	Sign Panels Type ____	square meter (square foot)
2564.533	Furnish Sign Panels Type __ ..	square meter (square foot)
2564.534	Saw Sign Panel Type __	meter (linear foot)

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2564.535	Sign Panel Overlay Type ____	square meter (square foot)
2564.536	Install Sign Panel Type ____	each
2564.537	Install Sign Type ____	each
2564.538	Sign Legend Revision	each
2564.539	Overhead Sign Identification Plate	each
2564.540	Extend Walkway Support	each
2564.541	Friction Fuse	each
2564.542	Keeper Plate	each
2564.550	Delineator, Type ____	each
2564.551	Reference Post Marker	each
2564.552	Hazard Marker X4-2	each
2564.553	Clearance Marker X4-4	each
2564.554	Snowplow Marker X4-5	each
2564.555	End of Roadway Marker X4-11	each

2565**Traffic Control Signals****2565.1 DESCRIPTION****A General**

This work includes furnishing and installing materials and electrical equipment, or installing Department furnished materials and electrical equipment, or both, to provide a complete, operating signal system.

These Specifications also apply to: revised signal systems, temporary signal systems, automatic traffic recorder (ATR) systems, temporary bridge signal systems, conduit systems, detector systems, materials for a future signal systems, interconnection systems, flasher systems, emergency vehicle pre-emption (EVP) systems or combinations thereof, all as specified in the Contract.

B Definitions

Definitions of words and phrases pertaining to traffic control signal systems and related type work are as defined in the standards of the Institute of Transportation Engineers (ITE), in the Minnesota Manual on Uniform Traffic Control Devices (MN MUTCD), 1101, and 1103. Definitions of words and phrases in conjunction with traffic signal control equipment and controller units are defined in the National Electrical Manufacturers Association (NEMA) Standards Publication for "Traffic Control Systems". The definitions in the above referenced publications shall govern unless otherwise defined in these Specifications or in the Contract.

2565.2 MATERIALS**A General****A1 Regulations and Code**

All electrical equipment to be furnished shall conform to the standards of the requirements of the NEMA; the Underwriters' Laboratories, Inc. (UL); or the Electronic Industries Association (EIA), whichever is applicable.

Materials, electrical equipment, and workmanship shall conform to the standards of the National Electrical Code (NEC), the standards of the American Society of Testing and Materials (ASTM), the standards of the American National Standards Institute (ANSI), the standards of the Institute of Transportation Engineers (ITE), Minnesota Manual on Uniform Traffic Control Devices (MN MUTCD), and to local laws and ordinances that apply.

All electrical conductors shall be copper and all wire sizes for electrical conductors shall be based on the American Wire Gauge (AWG).

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A2 Materials and Electrical Equipment List

The Contractor shall submit to the Engineer, within 15 calendar days following the date of the Award of Contract, a list of all materials and electrical equipment to be furnished by the Contractor. The list shall include the name of the manufacturer, size, and where the item will be obtained.

A3 Material Samples for Testing

The Contractor shall furnish samples of materials for testing and inspection. Materials may be accepted by the Engineer on the basis of the manufacturer's certification that the material has been sampled, tested, and inspected for compliance with the Contract. The Department reserves the right to accept or reject any material on the basis of its own tests and inspections.

A4 Tests

The Contractor shall make, at no expense to the Department, all tests necessary to demonstrate to the satisfaction of the Engineer that the materials, electrical equipment, and the installation thereof are in accordance with and meet the requirements of the Contract.

The Contractor shall provide, at no expense to the Department, such instruments, apparatus, tools, materials, and labor necessary to make the required tests. Such instruments, apparatus, tools, and materials shall remain the property of the Contractor after the tests are completed.

A5 Warranties, Guarantees, and Instruction Sheets

Warranties and guarantees on new materials and electrical equipment shall apply to the items furnished by the Contractor.

Manufacturers' warranties and guarantees furnished for materials and electrical equipment, and instruction sheets and parts lists supplied with materials and electrical equipment, shall be submitted to the Engineer before final acceptance of the Project or when requested by the Engineer.

The Contractor shall warrant and guarantee all materials and electrical equipment furnished to the Project to be free from defects in materials and workmanship in accordance with the following:

- (a) Warranties and guarantees that are offered by the material and electrical equipment manufacturer as a customary trade practice shall be turned over to the Department. The Department shall be named as the obligee on all manufacturers' warranties and guarantees.
- (b) The Contractor shall warrant and guarantee satisfactory in-service operation of all materials and electrical equipment for a period of one (1) year. The one (1) year in-service warranty period shall begin with the "turn-on" of the traffic control signal system, except that the one (1) year period for materials and electrical equipment

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components placed into operation after the "turn-on" of the traffic control signal system, such as interconnect materials, shall begin on the date the materials and electrical equipment are individually placed in satisfactory service initially. "Turn-on" shall be defined as the time when the complete traffic control signal system meets all installation and operational requirements of the Contract and is placed in automatic operation.

The Contractor shall replace or correct any part or parts of materials and electrical equipment that are found defective within the one (1) year in-service warranty period. No compensation will be made to the Contractor for such replacements or corrections.

The above warranty and guarantee requirements shall not apply to any part or parts of materials and electrical equipment that have been, in the opinion of the Engineer, subject to misuse, negligence, or accident by anyone other than the Contractor.

B	Conduit and Accessories	
B1	Rigid Steel Conduit (RSC) and Conduit Fittings	3801
B2	Intermediate Metal Conduit (IMC) and Conduit Fittings	3802
B3	Non-Metallic Conduit (NMC) and Conduit Fittings	3803
B4	Conduit Expansion fittings	3839

C	Handholes	
	Handholes shall be as required by the Contract.	
D	Electrical Junction Boxes	3838
E	Concrete	2411
E1	General	

Concrete for mast arm pole foundations and light standard foundations shall be Mix No. 3Y43.

Concrete for ground-mount cabinet foundations (for traffic signal cabinets, signal service cabinets, automatic traffic recorder cabinets, etc.), equipment pad foundations, pedestrian push button station foundations, flasher pedestal foundations, and for any new sidewalk construction or sidewalk replacement shall be Mix No. 3A32.

Concrete meeting the requirements for Type 3, Grade A concrete shall be furnished where the use of a specific mix designation is not indicated in the Contract.

Concrete pavement or base removed because of trenching or construction operations shall be constructed or replaced with Mix No. 3Y43 high early strength concrete.

Plastic curing blankets, when used, shall be in accordance with 3756.

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F Anchor Rods..... 3385

F1 Traffic Signal Pedestals and Mast Arm Pole Standards

Anchor rods, nuts, and washers for traffic signal pedestals and mast arm pole standards shall be as indicated in the Contract.

F2 Traffic Signal Cabinets

Anchor rods, nuts, and washers for traffic signal cabinets shall be Type A; shall be galvanized full length in accordance with 3392; shall be four in quantity; and shall be 19 mm ($\frac{3}{4}$ inch) nominal diameter by minimum 460 mm (**18 inches**) long before bending a 50 mm (**2 inch**) ell on one end and threaded minimum 100 mm (**4 inches**) on the other end.

F3 Signal Service Cabinets

Anchor rods, nuts, and washers for signal service cabinets shall be Type A; shall be galvanized full length in accordance with 3392; shall be four in quantity; and shall be 19 mm ($\frac{3}{4}$ inch) nominal diameter by minimum 460 mm (**18 inches**) long.

F4 Rust Inhibitor

Threaded portions of all anchor rods above concrete foundations shall be coated with a rust inhibitor before installation of mast arm pole standards, traffic signal pedestals, the traffic signal cabinet and other type cabinets on the anchor rods.

G Electrical Cables and Conductors 3815

H Mast Arm Pole Standards and Luminaires 3831

I Blank

J Traffic Signal Pedestal 3832

K Vehicle Signal Faces 3834

L Pedestrian Signal Faces..... 3835

M Wood Poles..... 3840

N Service Equipment..... 3837

O Blank

P Pedestrian Push Buttons and Signs 3833

Q Signs..... 2564

Each pedestal mounted, pole shaft mounted, or mast arm mounted sign shall be the size indicated in the Contract and shall be fabricated in accordance with the Mn/DOT Standard Sign Manual and 3352.

R Traffic Signal Cabinet and Control Equipment

The Contractor shall furnish the traffic signal cabinet (or other pad mounted cabinet and control equipment) as specified in the Contract.

S Miscellaneous Materials

Materials and electrical equipment that have no requirements included in the Contract shall be in accordance with the best standard practices and workmanship. All materials and electrical equipment shall be approved by the Engineer before installation.

2565.3 CONSTRUCTION REQUIREMENTS

A General

The location of component parts (including pedestrian curb ramps), as indicated in the Contract, are approximate only. The exact locations will be established by the Engineer.

Highways, streets, and roads shall be kept open to traffic during construction, subject to 1404. Any openings or uncompleted work that may cause a hazard to vehicle or pedestrian traffic shall be suitably protected to the satisfaction of the Engineer.

A1 Compliance with Electrical Codes and Standards

Construction operations shall conform to the National Electrical Code, to the State of Minnesota Board of Electricity Examiners, and to all State of Minnesota laws and local ordinances governing electrical installations.

A2 Permits and Inspections

The Contractor shall secure all necessary permits and inspections with no cost to the Department.

Bidders are advised that compliance with 1702 will be enforced in conjunction with the construction of any kind or type of electrical system or conduit system for the conveyance of electrical cables and conductors, or the required portions thereof, as specified in the Contract. The Minnesota Electrical Act requires that a permit be obtained for the performance of all such work, including the installation of conduits.

A3 Utility Property and Service 1507

The electrical utility company will determine the minimum clearance of overhead electrical lines to other overhead structures and equipment operations. The Contractor shall conform to these minimum clearance requirements.

B Existing Electrical Systems

Existing electrical systems (traffic signal, automatic traffic recorders [ATR], flasher systems, street lighting, etc.), or approved Temporary replacements thereof, shall be kept in effective operation for the benefit of the traveling public during the progress of new work, except when turn-offs are permitted. Turn-offs shall be as specified in the Contract or as directed by the Engineer. The Contractor shall notify the Engineer at least 48 hours in advance of scheduled turn-offs and before performing work on existing electrical systems. The Contractor shall not turn-off an existing traffic signal system without the specific approval of, and only in the presence of the Engineer.

The Department responsible for maintenance will continue maintenance while the Contractor is performing work on existing electrical systems. The Department responsible for maintenance will

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furnish electrical energy for operation and will repair or replace any component parts of an existing electrical system damaged by public traffic or natural causes.

During periods of authorized work suspension, the Department will maintain the existing traffic signal cabinet and control equipment and will maintain the existing traffic control signal system.

Where damage is caused by the Contractor's operations, the Contractor shall, at no expense to the Department, repair or replace any damaged component parts of an existing electrical system promptly to meet all governing specifications for new construction for the component damaged. Should the Contractor fail to perform the required repairs or replacements, the cost of performing such repairs or replacements will be deducted from any moneys due or becoming due the Contractor.

C Excavation and Backfill

Excavation and backfill required for the installation of concrete foundations, cable, conduit, handholes, and other items specified shall be in accordance with the applicable provisions of 2451. Trenches for conduit and holes for concrete foundations and handholes shall not be excavated wider than necessary. Installation of concrete foundations, conduit, and handholes shall follow as soon as practicable after the excavation. Material from excavation shall be placed in locations that will neither cause damage nor obstruction to vehicle or pedestrian traffic nor interfere with surface drainage.

Trenching shall be located at a distance from the edge of the pavement, back of curbing, or edge of surfaced shoulders as indicated in the Contract, or as directed by the Engineer. The distance shall be such that no damage will be done to the pavement, curbing, or surfaced shoulders. The trench shall be of uniform alignment for accurate referencing of the underground installation.

At locations scheduled for guardrail, utilities, cable, or other below ground structures, the Contractor shall modify locations to preclude damage to the cable or conduit by the installation of these other components. Before installation, the Contractor shall coordinate with and obtain approval from the Engineer for the modified locations. Cable damaged by Contractor's operation, and for which the location was not coordinated with and approved by the Engineer, shall be replaced at no expense to the Department.

Where trenching and excavation operations require the removal of concrete pavement or concrete sidewalk, the concrete shall be cut with a concrete saw to a depth of not less than 35 percent of the thickness of the concrete along the removal lines before breaking and removing, or the concrete shall be removed to existing joints.

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All excavations shall be backfilled around the installed concrete foundations, conduit, and handholes and the backfill material shall be like in kind to the adjacent soils and compacted to approximately the same density. Backfill material shall be placed to avoid the placement of stones immediately adjacent to conduits or direct buried cable. If indicated in the Contract, or if directed by the Engineer, designated layers or portions of the backfill shall be made with granular material furnished in accordance with 2451. Any roadway surfacing (concrete pavement, bituminous surface, or gravel surface, including underlying base courses), sidewalks, curbs and gutters, sod, railways, etc., that are removed by construction operations shall be restored to approximately its original condition by the Contractor at no expense to the Department expense, all to the satisfaction of the Engineer.

Surplus material from excavation and backfill shall be expeditiously removed and disposed of outside the Right of Way in any manner that the Contractor may elect, subject to 2104.3C3.

D Conduit and Fittings

D1 General

Conduit and fittings shall be of the type and size as specified in the Contract. It is the Contractor's option to install conduit and fittings of a larger size than specified. Where conduit size is not specified in the Contract, the conduit shall be 21 mm ($\frac{3}{4}$ inch) minimum and shall be sized such that not more than 40 percent of inside cross-sectional area will be occupied by all electrical cables and conductors to be installed within the conduit run.

Conduit installation shall be in accordance with the NEC. All conduit in any one conduit run shall be of the same size and type and shall be continuous from outlet to outlet. Special conduit fittings may be incorporated for pulling electrical cables and conductors or for making short radius bends as necessary within the run.

Damaged conduit, having sharp kinks or reduced cross section will be rejected.

Conduit installation shall be made at the appropriate time to preserve the conduit from damage and to provide for its proper incorporation into the system. Conduit that will be encased in concrete or masonry shall be rigidly supported in position during the casting.

The Contractor shall install all electrical cables and conductors in conduit, except as otherwise specified in the Contract.

D2 Conduit Placement

Conduit shall be installed in as straight a run as practicable and shall enter handholes and foundations in line with the general direction of the conduit run as much as practicable.

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D2a Aboveground

All conduit attached aboveground to wood poles shall be secured with galvanized two-hole pipe straps spaced not more than 1.2 m (**4 feet**) apart.

All conduit attached aboveground to metal poles shall be secured with minimum 19 mm (**¾ inch**) wide stainless steel banding spaced not more than 1.5 m (**5 feet**) apart.

Conduit shall be supported within 900 mm (**3 feet**) of each termination or fitting

Expansion devices shall be installed at each structure expansion joint as indicated in the Contract, or as directed by the Engineer.

All conduit attached aboveground to cabinets, bridges, and other structures shall be secured to the satisfaction of the Engineer.

D2b Underground

Conduit shall be placed by the trenching method, except that the Engineer may direct the Contractor to place conduit under existing pavement by augering, directional boring, or other method approved by the Engineer. If a method other than trenching is used and a distortion in excess of 6 mm (**¼ inch**) is created in the existing roadway surface, the Contractor shall remove the distortion and shall restore, at no expense to the Department, the roadway to its original condition.

Conduit shall not be placed under existing concrete or bituminous surfaces or railways by the trenching method or by pushing with pneumatic compaction tools unless authorized by the Engineer. Where conduit is placed below existing roadway pavements by the trenching method, the Contractor shall submit to the Engineer for approval, before starting work, details and description of the planned method of trenching construction including traffic control and restoration of the roadway to its original condition. When augering or boring operations through a roadbed are abandoned for any reason, the resultant voids shall be grouted at no expense to the Department and to the satisfaction of the Engineer.

Where conduit is required to be placed underground below new or reconstructed roadway surface areas or sidewalk, the conduit shall be placed and backfilled by the trenching method to the satisfaction of the Engineer before any new roadway surface or new sidewalk is placed.

Underground conduit shall be placed not less than 450 mm (**18 inches**) below the surface of any ground area and shall be placed not less than 600 mm (**24 inches**) below any roadway surface area. All underground conduit placed under railroad tracks shall not be less than 1.10 m (**42 inches**) below the bottom of the railroad ties or as required by the Railroad Company.

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Conduit runs specified in the Contract may be changed, with the approval of the Engineer, to avoid underground obstructions.

Underground conduit placed by the trenching method shall be to a uniform depth below the surface of the adjacent ground line or finished roadway. No conduit shall be placed before inspection of the trench by the Engineer.

Underground conduit runs shall have provisions for drainage of moisture. Horizontal conduit runs shall be sloped to drain at a rate of not less than 0.25 percent (**3 inches per 100 feet**), and all low points shall be drained. At the low points (not at the open ends of conduit runs) a standard tee conduit fitting shall be installed and a nipple at least 150 mm (**6 inches**) long shall be extended into a hole approximately 600 by 600 mm (**24 by 24 inches**) square deep backfilled with crushed rock or approved granular material.

Conduit terminating in handholes or in concrete foundations shall be positioned such that the conduit will be inside the handhole, pole bases, cabinet bases, or structure bases and shall extend from 50 to 75 mm (**2 to 3 inches**) beyond the top or inside surface of the handhole or concrete foundation and where necessary shall be sloped towards the access opening to facilitate the pulling of cables. The conduit shall be sloped out of the foundation toward the handhole opening for drainage. Conduit couplings shall be located at least 150 mm (**6 inches**) from the structure surface.

Conduit entering an existing concrete foundation shall be placed by sawing and breaking the concrete in such a manner that the conduit will enter the foundation below the adjacent ground surface and project 25 to 50 mm (**1 to 2 inches**) above the top of the foundation and inside the pole shaft or cabinet base. The foundation shall be returned to approximately its original form by patching with concrete to the satisfaction of the Engineer.

Conduit to be stubbed out of a concrete foundation for future use shall be threaded and capped on both open ends with standard pipe caps. The conduit shall extend 450 to 600 mm (**18 to 24 inches**) out from the concrete foundation in the direction specified or as directed by the Engineer.

All open ends of conduits entering a cabinet or pole foundation shall be sealed by use of paraffin or other approved sealing compound following the installation of the cables and conductors.

D3 Conduit Bends

Conduit bends, except factory bends, shall have a radius of not less than 6 times the nominal diameter of the conduit used and shall be made so that the conduit will not be damaged and the internal diameter of the conduit will not be effectively reduced.

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Bends in runs of conduit shall be held to the minimum required, not to exceed 360 degrees of bend per run between handholes or foundations.

D4 Rigid Steel Conduit and Intermediate Metal Conduit

D4a Joints

The ends of conduit shall be threaded and a standard threaded conduit coupling shall be used to join all standard length conduit. Where standard length conduit is cut, the end shall be threaded and reamed to remove burrs and rough edges. Field cuts shall be made square and true.

All conduit ends joined by coupling shall butt or come together for the full circumference thereof to provide an electrical bonding and grounding connection throughout the entire length of the conduit run.

Coating on the conduit that is damaged by handling or installing, shall be painted with rust preventative paint to the satisfaction of the Engineer.

D4b Open Ends

All open ends of conduit in handholes and conduit extending above any concrete foundation shall be threaded and capped with standard pipe caps, or other method approved by the Engineer, until the wiring is to be installed. When the caps are removed, a grounding type insulated threaded conduit bushing shall be installed on the open ends. The bushing shall be in accordance with the UL Standard 467 for Grounding and Bonding Equipment. The lug shall be compatible with a No. 6 copper bonding conductor. The lug material shall consist of stainless steel, copper, brass, bronze, or be integral to the bushing. The lug and copper bonding conductor at each bushing shall be covered with a corrosion inhibiting compound.

Open ends of conduit terminating on the side of wood poles or other structures shall be capped with weatherhead entrance fittings.

D4c Existing Conduit

Existing underground conduit that is incorporated into a new or revised electrical system shall be cleaned and blown out with compressed air before placing new electrical cables and conductors therein. The Contractor shall replace old grounding bushings and ground wire in existing handholes to maintain a continuously grounded system.

Where a new handhole is to be placed in an existing conduit run, the conduit shall be cut and extended into the new handhole in a manner approved by the Engineer. The open ends of conduits shall be threaded and fitted with grounding type insulated threaded conduit bushings and shall be properly bonded and grounded.

D5 Non-Metallic Conduit

D5a Joints

The Contractor shall trim the inside and outside of cut ends of non-metallic conduit to remove rough edges. The Contractor shall use standard non-metallic couplings or non-metallic conduit with an attached preformed coupling. The Contractor shall clean non-metallic conduit sections with a joint cleaner and shall cement joints with a PVC cement. The PVC cement shall be allowed to set for twenty-four (24) hours before pulling conduit through a directional bored channel. The conduit ends shall butt or come together for the full circumference thereof.

D5b Open Ends

All open ends of non-metallic conduit shall immediately be capped or plugged to prevent the entrance of moisture until the installation of the electrical cables and conductors. Prior to installation of the electrical cables and conductors, the non-metallic conduit shall be furnished with standard non-metallic conduit bell ends to prevent damage to the electrical cables and conductors.

Open ends of non-metallic conduit not containing electrical conductors shall be capped or plugged utilizing standard non-metallic conduit caps or plugs.

D5c Conduit Encasement

If specified in the Contract, non-metallic conduit placed by the trenching method shall be granular encased or concrete encased. Granular encased non-metallic conduit shall have the bottom and sides of the trench free of sharp irregularities before the conduit is placed. The trench shall be backfilled the first 150 mm (**6 inches**) with granular material conforming to 3149.2K. Concrete encased non-metallic conduit shall have the trench width extend approximately 75 mm (**3 inches**) from each side of the conduit. Concrete shall be Mix No. 3A32 or equal and shall encase the conduit approximately 75 mm (**3 inches**) on all sides.

D6 Conduit Attached to a Bridge

Conduit shall be mounted and attached to the satisfaction of the Engineer. Conduit supports and spacing of the supports shall be as required by the NEC. Hangers or pipe clamps shall be used for supporting conduit and shall be approved by the Engineer before installation. The hangers or pipe clamps shall be attached using two unit threaded bolt anchorages conforming to the Contract or, if not specified, be approved by the Engineer. The required hardware shall permit removal of the hanger or pipe clamp and shall be installed to permit conduit expansion and contraction.

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Expansion fittings shall be furnished in conduit runs attached to a bridge as required by the NEC or as directed by the Engineer. RSC or IMC conduit runs with expansion fittings installed shall be made electrically continuous by a copper bonding jumper having the ampacity as required by the NEC. The bonding jumper shall be internal to the expansion fitting.

E Handholes

The Contractor shall install handholes as specified in the Contract to the satisfaction of the Engineer. It is the Contractor's option to install additional handholes to facilitate the work at no expense to the Department.

The tops of handholes shall be set so that the cover is 25 mm (**1 inch**) below grade, except in sidewalk areas, where the cover shall be flush or as directed by the Engineer.

To facilitate drainage, handholes shall be set on a 1 m (**3 foot**) diameter or square by 300 mm (**12 inches**) deep aggregate drain bed using 3149.2H coarse filter aggregate.

The Contractor shall remove any excess material inside of existing handholes that are to be used in the new system.

After handhole and conduit installation at each handhole location, all inside handhole sidewalls shall be made as watertight as possible by patching with either concrete for pre-cast concrete handholes, or material compatible caulking compound or other compatible sealing material for PVC Handholes, all to the satisfaction of the Engineer.

Pre-cast concrete handholes with Type HD or other type metal frames and covers required to be placed in areas not surfaced with concrete shall be supported by concrete to the satisfaction of the Engineer. Other type handholes with metal frames and covers are not required to be supported by concrete unless otherwise indicated in the Contract.

F Concrete Foundations

F1 General

Concrete foundations shall be constructed in accordance with the applicable provisions of 2411 and shall be of the size and shape as specified in the Contract.

Concrete foundations shall be formed (except portions of concrete foundations that extend into solid rock) by using forming tubes or wood forms that shall be true to line and grade. Where soil conditions permit, the Engineer may allow the foundation to be cast with forms or tubes used only on the upper portion of the foundation. Forms shall be rigid and securely braced. Entering conduits, anchor rods, ground rods, etc., shall be placed in proper position and to the proper height, and shall be

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held in place until the concrete has cured. Forms shall not be removed until the concrete has cured.

The concrete shall be consolidated by means of portable vibrators supplemented by hand spading to ensure a smooth dense surface free of air or water blisters.

Where unstable foundation conditions are encountered, concrete foundation construction may be altered to secure a stable foundation to the satisfaction of the Engineer. Where obstructions (such as solid rock) prevent construction of a concrete foundation as planned, foundation dimensions may be adjusted, as indicated in the Contract, or as the Engineer determines appropriate, to provide a stable foundation.

Concrete foundations shall have an ordinary surface finish conforming to 2401.3F on all sides to approximately 150 mm (**6 inches**) below the adjacent ground line. The top shall be floated smooth and the edges shall be beveled or chamfered to present a neat appearance.

The exposed concrete above the adjacent ground line, sidewalk, or paved area shall be formed to present a neat appearance and shall be treated with treating oil conforming to 3917.

F2 Anchor Rods

In pole foundations, the anchor rods shall be held in a rigid cage in a manner acceptable to the Engineer to maintain good alignment while the concrete is being poured. The anchor rod cage shall be designed without welding or tack welding on the anchor rods. Anchor rods that show evidence of welding or tack welding will be rejected. An accurate template shall be provided for the anchor rod projections. The template shall be left in place until the concrete has cured. Work shall not start on the concrete foundation until the anchor rods have been approved by the Engineer. Foundations in which anchor rods are improperly aligned after the concrete has cured will be rejected. Bolt holes in transformer bases shall not be enlarged to allow for shifted anchorages.

G Loop Detectors

G1 General

Each loop detector shall be an inductive loop detector. One complete loop detector installation shall consist of the following:

- (a) An electrical conductor embedded loop or group of loops installed in the roadway as required by the Contract, and
- (b) A loop detector lead-in cable to the traffic signal cabinet or other cabinet.
- (c) Loop detectors shall be either in non-metallic conduit (N.M.C.) or saw-cut in the roadway as required by the Contract.

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G2 Installation

(a) NMC Loop Detector

Loop detectors encased in non-metallic (NMC) conduit shall be in accordance with the NMC Loop Detector Details in the Contract.

(b) Saw Cut Loop Detectors

Saw cut loop detectors shall be installed as specified in the Contract and as follows:

In the event that minor adjustments of the size or shape of the loop detector are made in the field by the Engineer, no additional payment will be made to the Contractor for those adjustments.

An individual saw cut shall be made from each loop detector to the conduit leading to the handhole.

Each loop detector shall have 4 turns of wire.

G3 Loop Detector Test Report

The Contractor shall furnish to the Engineer, in triplicate, a signed and dated "LOOP DETECTOR TEST REPORT" for each loop detector and lead-in cable system furnished and installed as part of the Contract with the following information:

(a) Project numbers, intersection, and location identification.

(b) Loop detector number (as shown in the Plans), dimensions of loop detector (width and length in meters) as installed, and number of turns of wire in loop detector as installed.

(c) Continuity Test--Each loop detector circuit shall be tested for continuity at two locations:

(1) Loop detector at the handhole or junction box before splicing with the loop detector lead-in cable (shall have a value less than 0.5 Ω), and

(2) Loop detector and lead-in cable system at the intersection traffic signal cabinet after splicing in the handhole

or junction box shall have a value less than 5.0 Ω . The continuity test ohm reading at the intersection traffic signal cabinet shall be greater than the ohm reading measured at the loop detector adjacent handhole or junction box.

(d) Inductance Test--Each loop detector and lead-in cable system shall have an inductance test measured at the intersection traffic signal cabinet. The inductance shall be in the range of from 50 to 900 μ H.

(e) Insulation Resistance Test--An insulation resistance test at 500 V direct current shall be made at the intersection traffic signal cabinet between one loop detector lead-in cable conductor and the "Equipment Ground Bus" in the cabinet. The insulation resistance shall have a value of not less than 100 M Ω .

NOTE: The continuity test, inductance test, and insulation resistance test shall be made at the intersection traffic signal cabinet

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before the loop detector lead-in cable conductors are terminated on the terminal facilities.

The three final loop detector test reports for the intersection will be distributed by the Engineer as follows:

- (a) Original report to the official Project file.
- (b) Copy in the traffic signal cabinet.
- (c) Copy to the Department's Electrical Services Unit or maintaining agency.

All loop detector tests shall be made by the Contractor, in the presence of the Engineer, at no expense to the Department. Loop detector tests shall demonstrate to the satisfaction of the Engineer that the materials and installation of each loop detector and lead-in cable system are in accordance with the Contract. The Contractor shall provide the electrical instruments, apparatus, tools, and labor as may be necessary to make the required loop detector tests on each loop detector and lead-in cable system. Such electrical instruments, apparatus, and tools shall remain the property of the Contractor after the tests are completed.

In the event that a loop detector or lead-in cable system fails any one of the above-mentioned loop detector tests, the Engineer may direct the Contractor to replace any part of or the entire loop detector and lead-in cable system, all at no expense to the Department. All of the above-mentioned loop detector tests shall be repeated and recorded for the "revised" loop detector and lead-in cable system.

Each loop detector and lead-in cable system furnished and installed as part of the Contract shall pass the above-mentioned loop detector tests and be operational to the satisfaction of the Engineer. These tests shall not preclude the Department from testing each loop detector and lead-in cable system with their own test equipment to ensure proper operation.

H Bonding and Grounding

All bonding, grounding, ground rod electrodes, grounding electrode conductors, and grounding connections shall be in accordance with the NEC.

All ground rod electrodes required by the Contract shall be at least 16 mm (**5/8 inch**) in diameter by 4.6 m (**15 feet**) in length and fabricated of a material as specified in the NEC.

Metal conduit, metal traffic signal pedestals, mast arm pole standards, light standards, service equipment, metal junction boxes, down guys, span wire, microwave and sonic detector units, traffic signal cabinet or other type cabinet, etc., shall be made mechanically and electrically secure to form a continuous bonded grounded system. The bonding and grounding jumper shall be a copper conductor no less than

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No. 6. Grounding of the system and neutral at the service point shall be as required by the NEC, except that the grounding electrode conductor shall be not less than a No. 6.

Attachment of the grounding and bonding jumper to metal traffic signal pedestals, mast arm pole standards, and light standards shall be by means of a 5 mm (**3/16 inch**) (or larger) brass, bronze, or stainless steel bolt installed in the lower part of the shaft or base. A solder or sheet metal strap connection shall not be used.

In addition to the bonding and grounding provisions described above, if the Plans utilize traffic signal cables with a green conductor, then the green conductor shall be used as an equipment ground. The green conductor of each traffic signal cable shall be attached in a similar manner as the grounding and bonding jumper to the lower part of all metal traffic signal pedestal and pole shafts or bases in which the run of cable terminates. An "Equipment Ground Bus", separate from the neutral terminal strip, will be provided in the traffic signal cabinet or other type cabinet and the green conductor of each traffic signal cable shall be terminated on the "Equipment Ground Bus". The "Equipment Ground Bus" shall be grounded to the cabinet ground rod electrode (if ground rod electrode installed) with not less than a No. 6 grounding electrode conductor.

A No. 6 equipment grounding conductor shall be furnished and properly connected from the "Equipment Ground Bus" in the traffic signal cabinet or other type cabinet to the neutral bonding bar of the service equipment and to each incoming conduit grounding bushing lug.

Ground rod electrodes shall be driven at all service points, at all cabinet locations housing control equipment and electrical equipment, and at locations specified in the Contract. Ground rod electrodes and grounding connections shall be installed in accordance with the NEC. The top of the ground rod electrode installed in the ground shall be level with the surface of the adjacent ground. Where installed in a concrete foundation, the top of the ground rod electrode shall extend not more than 75 mm (**3 inches**) nor less than 50 mm (**2 inches**) above the foundation. The service equipment shall be bonded to the ground rod electrode by use of a ground clamp and a No. 6 grounding electrode conductor. If the grounding electrode conductor is in a location subject to physical damage, it shall be enclosed in a 13 mm (**1/2 inch**) diameter rigid steel conduit.

Where a bonded grounded continuous rigid steel conduit system is not installed, metal poles, pedestals, cabinets, and other structures requiring a ground rod electrode shall be bonded to the ground rod electrode by a No. 6 grounding electrode conductor enclosed in a 25 mm (**1 inch**) diameter rigid steel conduit stubbed out of the concrete

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foundation. One end of the bonding jumper shall be attached to the lower part of the pole, pedestal, cabinet, or structure shaft or base and the other end attached to the ground rod electrode by a grounding connection.

For bonding and grounding in all non-metallic conduit systems, an equipment grounding conductor shall be run with all electrical circuits. The equipment grounding conductor may be one conductor of a multi-conductor cable, or, where no cables within the conduit run contain an equipment grounding conductor, a No. 6 green, equipment grounding conductor shall be installed in the conduit run. Where non-metallic conduit is to be installed for future use, the equipment grounding conductor may be omitted.

In addition to the required bonding and grounding jumper and required threaded grounding conduit bushings on open ends of new conduit, the Contractor shall, at the in-place locations directed by the Engineer, furnish and install new bonding and grounding jumpers and new threaded grounding conduit bushings on open ends of in-place conduit.

I Blank

J Wiring

J1 General

Installation of electrical cables and conductors and all electrical wiring shall be in accordance with the NEC.

Insulated spade lugs shall be used for terminal connections of conductors.

The ends of all spare electrical conductors not terminated shall be taped to exclude moisture.

Approximately 1 m (**3 feet**) of slack cable shall be left in each handhole through which a run of cable passes.

Approximately 600 mm (**24 inches**) of slack cable shall be left in each mast arm pole base, light standard base, and traffic signal pedestal base.

The Contractor shall install unmetered service conductors in a separate conduit system from all other conductors. All conductors of a branch circuit shall be run in a single conduit.

All electrical cables and conductors shall be run continuous without splices from the terminal appliances in the traffic signal cabinet to the terminal blocks or terminal appliances in mast arm pole bases, pedestal bases, junction boxes, etc.

Loop detector lead-in cable shall be installed continuous without splices or terminals from the loop detector conductor and lead-in cable splice to the traffic signal cabinet or other type cabinet.

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Interconnect cable between cabinets shall be continuous without splices and shall be run in as straight a line as possible with a minimum number of bends in the cable run.

The size and number of conductors in each cable and the number of cables in a given conduit run shall be furnished exactly as shown in the Plans. For example, the notation on the Plans "2-3/c No. 12" requires two 3-conductor No. 12 cables to be installed in the particular conduit run, plus any other cables and conductors indicated in the conduit run. No additional spares are required.

The Contractor shall wire the electrical system in accordance with the field wiring diagram shown in the Plans. Cables shall be identified as shown on the field wiring diagram in all handholes, junction boxes, traffic signal pedestal bases, mast arm pole bases, light standard bases, and the traffic signal cabinet or other type cabinet. Labels to identify cables shall be plastic or cloth adhesive tape that is embossed or printed with numerals and letters and wrapped around the cable. In addition to labeling each cable within the cabinet, the Contractor shall label in a similar manner each conductor of each cable terminated on the fuse panel or a terminal block (i.e. RED 2-1, YEL 2-1, GRN 2-1, RLTA 5-1, YLTA 5-1, GLTA 5-1, RRTA 4-1, YRTA 4-1, GRTA 4-1, DWK P6-1, WLK P6-1, etc., or the like, indicating the signal indication and the signal face number). The label shall be applied within 75 mm (**3 inches**) of the terminal point. Terminal blocks in traffic signal pedestal bases and pole bases shall have an identification strip as part of the terminal block and each conductor shall be identified in a similar manner as above as to the signal indication it serves.

J2 Underground Wiring

Electrical cables and conductors shall be pulled through rigid steel conduit (R.S.C.) by hand such that no damage is done to the cable and conductor insulation. The conduit shall be clean at the time of installation and the ends of all electrical cables and conductors shall be taped to exclude moisture until spliced or terminated.

The Contractor shall pull cables and conductors through non-metallic conduit (N.M.C.) by hand, in such a manner, as to not split or otherwise damage the N.M.C. conduit due to "pull rope abrasion". If the Contractor damages the N.M.C. conduit, the Contractor shall replace the damaged portion of the N.M.C. conduit to the satisfaction of the Engineer.

Interconnect cable not placed in conduit shall be placed direct buried by the trenching method or plowing method to a minimum depth of 915 mm (**36 inches**), except where required to enter a handhole. Interconnect cable entering a handhole shall be installed in the *side* of the handhole 150-200 mm (**6-8 inches**) above the bottom of the

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handhole [the interconnect cable minimum depth requirement of 915 mm (**36 inches**) shall be maintained to within 600-915 mm (**2-3 feet**) of the handhole].

A 75-mm (**3-inch**) wide, permanent orange, stretchable, non-biodegradable, plastic warning tape shall be placed a minimum of 460 mm (**18 inches**) above the interconnect cable (or conduit containing the interconnect cable) and at least 300 mm (**12 inches**) below the surface. The tape shall be imprinted with the inscription: CAUTION - Mn/DOT COMMUNICATION CABLE BELOW.

The Contractor shall sleeve direct buried cable that enters or exits handholes.

J3 Cabinet Field Lead Wiring

No field lead entering a traffic signal cabinet or other type cabinet shall be cut shorter than the farthest terminal in the cabinet. After all field connections are made to the cabinet terminal facilities, field leads shall be neatly dressed and banded together to provide an orderly arrangement within the cabinet.

J4 Splices

No splices will be permitted that are not called for in the Contract or authorized in writing by the Engineer. When splices are authorized, they shall be permitted only in handholes, control cabinets, junction boxes, or in bases of poles, unless the Contract requires underground cable splices. When underground cable splices are specified, they shall be made with an approved epoxy splice kit.

All splices of conductors and cables shall be good quality electrical splices and shall be waterproof. Splices, except loop detector splices, shall be electrically and mechanically secure without solder, and shall utilize split bolt connectors, or other type connectors as specified in the Contract. Pressure spring type connectors shall not be used. Loop detector splices shall be as specified in 2565.3G (Loop Detectors).

All spliced conductors, except grounding wires, shall be taped with rubber tape (except as otherwise specified in the Contract) to a thickness of at least 1.5 times that of the original insulation. Two layers of protective plastic electrical tape shall be applied over the rubber tape and extend at least 25 mm (**1 inch**) over the regular conductor insulation. The entire splice shall be made waterproof with waterproofing electrical coating.

Where the Contract requires splices between aluminum and copper conductors in a temporary system, the connectors shall be UL listed for use with the cable materials and for the conditions of use, and shall be designed so that there is no direct contact between the aluminum and copper conductors. Terminals for terminating the aluminum conductors

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shall be UL listed for use with aluminum wire. The connections shall be tightened to the manufacturer recommended torque.

J5 Terminal Blocks

Each mast arm pole base, traffic signal pedestal base, light standard base, etc., with vehicle and pedestrian signal indications or pedestrian signal indications, shall have a terminal block for terminating field conductors and traffic signal conductors.

Each terminal block shall be a one-piece phenolic molding with 12 double-point terminals with strap screw contacts for size 10-32 binder head screws. Barriers between terminals shall be minimum 13 mm (½ **inch**) in height. The holes for the binder head screws shall not extend through the plastic. The slots shall be of sufficient size to fit the spade lugs used for terminating conductors.

Each terminal block shall meet 600 V requirements of NEMA and UL for general industrial control devices.

The terminal blocks, screws, and spade lugs in each base shall be covered with an approved electrical insulating coating as specified in the Contract. The Contractor shall remove the white plastic marking strip from the terminal block before application of the electrical insulating coating and reinstall the white plastic marking strip after the coating of the terminal block is complete.

Terminal blocks in bases shall be installed in such a manner that the terminal block screws face the door opening and are accessible.

J6 Aboveground Wiring

All electrical cables and conductors installed aboveground, except where run on overhead span wire, shall be installed in conduit attached to wood poles, metal poles, cabinets, or other structures, or shall be run inside metal poles, pedestals, cabinets, or other structures.

The Contractor shall provide slack (generally 5 percent of the span length) where electrical cables and conductors are installed overhead unsupported and spanned between wood poles or other type supports. Electrical cables and conductors installed overhead in conjunction with a messenger wire shall be attached to the messenger wire using metal or sunlight resistant nonmetallic straps (maximum spacing 450 mm (**18 inches**) or lacing. All nonmetallic straps shall be approved by the Engineer.

K Service Equipment Installation

Service equipment installation shall be in accordance with the NEC and local laws and ordinances governing such installations.

The service point shown in the Plans is approximate. The exact location will be determined in the field by the power company or the Engineer.

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For installation on a wood pole, the Contractor shall install the meter socket at an appropriate height directly above the disconnecting means. Service conduit risers shall terminate near the top of the wood pole or structure and shall be capped with a weatherhead to prevent the entrance of water. Sufficient length of power conductors shall extend beyond the weatherhead (including a sufficient drip loop) for connection to the power conductors from the source of power, which connection will be made by the power company at no cost to the Contractor, unless otherwise specified in the Contract.

For installation on a mounting bracket assembly, the meter socket and disconnecting means shall be located as detailed in the Contract.

The Contractor shall install signal service cabinets as specified in the Contract.

Lugs for terminating conductors shall be sized appropriately for the associated conductors. Trimming strands of conductors to fit into undersized lugs is not acceptable.

The Contractor shall make all arrangements with the power company for power connection.

L Vehicle and Pedestrian Signal Face Installation

L1 Pedestal Mounted (With Signal Bracketing)

Vehicle signal faces and pedestrian signal faces required to be mounted atop a traffic signal pedestal shall be mounted as specified in the Contract. The pedestal mounted assemblies shall be plumb or level, symmetrically arranged, securely assembled and provide for internal wiring within the pedestal shaft signal brackets and pipe fittings.

A one-way pedestal mounted vehicle signal face shall be mounted directly above the pedestal slipfitter collar and shall have a bracket attached to the top of the vehicle signal face and to the pedestal shaft.

L2 Vertical Pole Shaft Mounted (With Signal Bracketing)

Vehicle signal faces and pedestrian signal faces required to be mounted on a vertical pole shaft shall be mounted as specified in the Contract. Threaded 38 mm (**1 ½ inches**) half-couplings shall be welded into the vertical pole shaft approximately 3 m (**10 feet**) above the pole foundation. The threaded couplings shall be capable of receiving threaded 38 mm (**1 ½ inch**) signal brackets and shall provide for internal wiring within the vertical pole shaft. Threaded couplings shall be positioned on the vertical pole shaft as specified in the Contract.

Vehicle signal faces and pedestrian signal faces shall be mounted as specified and all pole mounted assemblies shall be plumb, securely assembled, and provide for internal wiring within the vertical pole shaft, signal brackets, and pipe fittings.

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L3 Vertical Pole Mounted (With One Way Mounts)

Vehicle and pedestrian signal faces mounted on vertical pole shafts shall be mounted plumb utilizing signal head mounts.

Two vehicle signal sections shall be mounted below the mount and the remaining vehicle signal sections mounted above. The two signal sections below the mount and the signal sections above the mount shall be fastened together and shall be fastened to the mount by means of a noncorrosive 3-bolt mounting assembly. The 3-bolt mounting assembly shall utilize locknuts to prevent the assembly from loosening due to vibration.

The pedestrian indication shall be mounted below the one way mount by means of a noncorrosive 3-bolt mounting assembly. The indication shall be attached to the one way mount by utilizing a 3-bolt sealed cap assembly. The 3-bolt mounting assembly shall utilize locknuts to prevent the assembly from loosening due to vibration.

L4 Pedestal Mounted (With One Way Mounts)

Vehicle and pedestrian signal faces mounted on vertical pole shafts shall be mounted plumb utilizing signal head mounts. Two vehicle signal sections shall be mounted below the mount and the remaining vehicle signal sections mounted above. The two signal sections below the mount and the signal sections above the mount shall be fastened together and shall be fastened to the mount by means of a noncorrosive 3-bolt mounting assembly. The 3-bolt mounting assembly shall utilize locknuts to prevent the assembly from loosening due to vibration. The one way mount shall be attached to the pedestal shaft by utilizing a universal hub. A PVC wireway shall be installed between the universal hub and the entrance of the one way mount.

The pedestrian indication shall be mounted below the one way mount by means of a noncorrosive 3-bolt mounting assembly. The indication shall be attached to the one way mount by utilizing a 3-bolt sealed cap assembly. The 3-bolt mounting assembly shall utilize locknuts to prevent the assembly from loosening due to vibration. The one way mount shall be attached to the pedestal shaft by utilizing a universal hub. A PVC wireway shall be installed between the universal hub and the entrance of the one way mount.

L5 Mast Arm Mounted

Vehicle signal faces mounted on traffic signal mast arms, either at the extended end of the mast arm or at mid-arm, shall be mounted plumb utilizing signal head mounts. Two signal sections shall be mounted below the mount and the remaining signal sections mounted above.

The two signal sections below the mount and the signal sections above the mount shall be fastened together and shall be fastened to the

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mount by means of a noncorrosive 3-bolt mounting assembly. The 3-bolt mounting assembly shall utilize locknuts to prevent the assembly from loosening due to vibration.

The vertical clearance from the bottom of the signal heads (including the background shields) to the pavement shall not be less than **seventeen (17) feet** nor greater than **nineteen (19) feet**.

L6 Bagging

The Contractor shall bag all vehicle signal faces and pedestrian signal faces immediately after installation (until such time that the traffic control signal is to be placed in operation) to clearly indicate that the traffic control signal is not in operation. All bagging material shall be "gunnysacks", or other material as approved by the Engineer. The Contractor shall maintain all bagging to the satisfaction of the Engineer.

M Wood Pole Installation

Wood poles shall be placed in the ground to a depth of approximately 20 percent of the pole length. Excavations should be approximately 200 mm (**8 inches**) larger than the diameter of the base of the pole and free from loose material. The pole shall be hoisted into place without damage and plumbed or raked as directed by the Engineer. Backfill material shall be selected earth or sand and free from rocks and excessive organic material and placed in several lifts. Each lift shall be moistened and thoroughly compacted. The placed wood pole shall not display a void area between the wood pole and backfill at the ground plane when placed under load.

N Traffic Signal Pedestal Installation

The Contractor shall plumb with "U" shaped galvanized metal shims or metal shims as approved by the Engineer and securely bolt Traffic signal pedestals to the cast-in-place anchor rods of the concrete foundations.

O Blank

P Mast Arm Pole Standard Installation

Mast arm pole standards shall be hoisted into position without damage and plumbed by means of the two nuts and washers on each anchor rod to ensure that the pole face opposite the arm is vertical. Enlargement or alteration of holes in the base plate to accommodate misaligned anchorages will not be permitted.

The transformer base access door shall be placed 180 degrees from the mast arm.

Mast arms, brackets, and other appurtenances to be attached to the vertical pole shaft shall be placed without damage.

Any damage (such as nicks, scratches, and paint removal) shall be repaired and restored to original condition as specified in the Contract. Other damage shall be repaired to the satisfaction of the Engineer.

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Q Sign Installation

Q1 Pedestal or Pole Shaft Mounted

Each pedestal or pole shaft mounted sign shall be furnished with two standard sign mounting bracket assemblies utilizing a minimum 19 mm ($\frac{3}{4}$ inch) wide stainless steel banding and shall be mounted on the pedestal or pole shaft at the height as directed by the Engineer. At the option of the Engineer, the Contractor shall drill and tap shaft and mount signs to the satisfaction of the Engineer.

Q2 Mast Arm Mounted

Each mast arm mounted sign shall be furnished with mast arm mounting bracket assemblies in accordance with the mast arm sign mounting details in the Mn/DOT Standard Signs Manual and mounted at the specified location on the mast arm to the satisfaction of the Engineer.

Q3 Sign Post Mounted

Each sign post mounted sign panel shall be mounted utilizing U-channel sign posts in accordance with the Contract.

R Cabinet Installation

Pad mounted cabinets shall be securely bolted to the concrete foundations to the satisfaction of the engineer.

The Department will furnish to the Contractor rubber gasket sections that the Contractor shall install between the bottom of the aluminum cabinet base and the concrete foundation. The Contractor shall leave one 13 mm ($\frac{1}{2}$ inch) gap in the gasket to ensure proper water drainage.

S Emergency Vehicle Pre-emption (EVP) Installation

The Contractor shall install EVP detectors and EVP indicator lamps atop traffic signal mast arms, and if required by the Contract, atop traffic signal pedestal shafts, in accordance with the following provisions:

- (1) The detector, indicator light, wiring, and connections shall be installed in accordance with manufacturer's instructions.
- (2) In the event an obstruction is in line with the detector, the Contractor shall advise the Engineer before installation.
- (3) The detector and indicator light shall be attached to the traffic signal mast arm or traffic signal pedestal shaft to the satisfaction of the Engineer.
- (4) Any extension hardware shall be the same outside diameter as the traffic signal bracketing framework, a reducer conduit fitting shall be used to attach the detector and indicator light assembly to the traffic signal mast arm.
- (5) All extension hardware shall be painted the same color as the traffic signal mast arm. The detector and indicator light assembly

shall not be painted.

- (6) All hardware shall be tightened securely.
- (7) The detector and indicator light shall be installed and mounted in such a way so as to ensure the watertight integrity of the assembly.
- (8) The detector and indicator light combination shall have a vertical separation of approximately 150 mm (**6 inches**).
- (9) The detector shield tube shall be installed with the drain hole at the bottom.
- (10) There shall be no detector cable splices from the EVP detector on the mast arm to the traffic signal cabinet.
- (11) The detector cable shall be appropriately marked in the traffic signal cabinet as to which street and direction it is associated.
- (12) All one-way or two-way EVP detectors and one-way or two-way EVP indicator lights shall be operational when the signal system is initially turned on.

T Painting

Painting metal structures and metal component parts of a traffic control signal system shall conform to all applicable provisions of 2478.

Finish coat paint shall be as follows:

- (1) Dark Green Acrolon 218 or approved equivalent polyurethane finish coat matching Color Number 14062 of the Federal Standard 595B shall be applied on the traffic signal pedestal bases and mast arm pole standard transformer bases.
- (2) Yellow Acrolon 210 or equivalent polyurethane finish coat matching color Number 13538 of the Federal Standard Color 595B shall be applied on vehicle and pedestrian signal indication housings, mast arm pole standard vertical pole shafts, traffic signal pedestal shafts, pedestal slipfitter collars, pedestal reinforcing collars (wind collars), all signal brackets and pipe fittings, and pedestrian push button stations.
- (3) Corothane I Mio Aluminum Paint or equivalent moisture-cured polyurethane finish coat shall be applied on mast arm pole vertical shafts, traffic signal mast arms, luminaire vertical pole shaft extensions, and luminaire mast arms.
- (4) Dull Non-Reflective Black on visors, directional louvers, background shields, and vehicle and pedestrian signal indication housing doors (inside and outside).

In lieu of field painting, equivalent manufacturer's shop coat paint may be accepted by approval of the Engineer, with field touch-up of damaged portions of the finish. If a manufacturer's shop coat paint is accepted or specified in the Contract, the Contractor shall make every effort during installation to protect the factory applied finish. Any nicks, scratches, paint chips or other damage to the finish shall be

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repaired and restored to the satisfaction of the Engineer.

Mast arm pole standards (includes vertical pole, mast arm, transformer base, and luminaire extension) shall be painted at the manufacturer. Any protective wrap provided by the manufacturer during shipping shall be removed immediately after receipt of the shipment on the project. The Contractor shall make every effort during erection of a painted mast arm pole standard to protect the factory applied finish. The collar used for handling the pole shall be of a material that will ensure protection of the painted finish of the pole. Field painting of mast arm pole standards, other than touch up painting, shall not be permitted. Any nicks, scratches, paint chips or other damage to the finish shall be repaired and restored using the touch up paint provided by the Manufacturer. All touch up painting shall be to the satisfaction of the Engineer.

U Existing Materials and Electrical Equipment

U1 Removing and Salvaging

Where required by the Contract, or directed by the Engineer, materials and electrical equipment of an existing electrical system shall be removed and salvaged in accordance with 2104 and as specified in the Contract. Care shall be exercised in removing salvageable materials and electrical equipment so that they will remain in their existing condition.

Materials and electrical equipment of an existing electrical system required to be removed, but not salvaged, shall become the property of the Contractor and shall be disposed of outside the Right of Way in any manner that the Contractor may elect, subject to 2104.3C3, and as specified in the Contract.

U2 Reinstalling

Where salvaged materials and electrical equipment are to be reinstalled at new locations, the Contractor shall furnish and install all necessary new materials, such as anchor rods, nuts, and washers, concrete foundations, etc., required to complete the new installation.

Existing materials and electrical equipment required to be removed, salvaged and reused, but found to be unsatisfactory for reuse by the Engineer, shall be replaced by new materials and electrical equipment, the cost of which will be paid for as Extra Work in accordance with 1403.

U3 Stockpiling

Materials and electrical equipment of an existing electrical system required to be removed and not reused may be stockpiled at the job site until removed outside the Right of Way. Stockpiling shall be in an acceptable manner approved by the Engineer.

2565.5

V Field Testing

Before completion of the work, the Contractor shall make a functional test in which it is demonstrated to the Engineer that each and every component part of the traffic control signal functions as specified or intended. The Contractor shall not place the traffic control signal in operation until all required field tests have been completed and accepted.

Before final acceptance of the work, the Contractor shall furnish to the Engineer and all manufacturers' warranties, instructions, wiring diagrams, etc., of the materials and electrical equipment furnished by the Contractor.

W Activating Signals

When the traffic control signal system is to be placed in operation, all vehicle signal faces and pedestrian signal faces shall be aimed as directed by the Engineer. The Contractor shall notify the Engineer at least 48 hours in advance of the scheduled traffic signal turn-on.

If directed by the Engineer, the Contractor shall initially place the traffic control signal in the flashing mode of operation for a period of time determined by the Engineer. Upon completion of the period of flashing mode operation, and when directed by the Engineer, the Contractor shall place the traffic control signal in its normal mode of operation. The Contractor shall not turn the signal system ON or OFF without the specific approval of, and in the presence of the Engineer.

X Restoration and Cleanup

Sidewalks, curbs and gutters, pavements, base materials, sod, plants, and other items removed, broken, or damaged by the Contractor's construction operations shall be replaced or reconstructed with the same kind or type of original material or material of equal quality. The reconstruction work shall be done in an acceptable manner for the class or type of work involved and shall be undertaken and completed as soon as practicable. All reconstruction work shall be maintained by the Contractor in a satisfactory condition until final acceptance.

2565.4 METHOD OF MEASUREMENT

The new traffic control signal system will be measured as an integral unit complete in place and operating with the complete installation at one intersection being considered as one unit.

2565.5 BASIS OF PAYMENT

A new traffic control signal system will be paid for on the basis of the following:

Item No.	Item	Unit
2565.511	Traffic Control Signal System.....	Signal System

2571

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Plant Installation

2571.1 DESCRIPTION

This work consists of furnishing and planting trees, shrubs, vines, and perennials of the species, variety, grade, size, or age, and root category specified, complete in place at the locations designated in the Plan or as directed by the Engineer. It may also consist of planting or transplanting plants furnished by the Department.

The Contractor shall become familiar with the Project site and the Contract documents before submitting a Proposal, as specified in 1205 (Examination of Plans, Specifications, Special Provisions, and Site Work).

The Contractor shall comply with the current edition of "Inspection and Contract Administration Guidelines for Mn/DOT Landscape Projects," published by the Mn/DOT Landscape Unit, as the minimum and maximum criteria and standard for all operations.

2571.2 MATERIALS

A Nursery Plant Stock 3861

Plants of the species specified shall be furnished in the variety, grade, and size, or age indicated.

A1 Supply of Planting Stock

By submitting a Proposal and accepting award of the Contract, the Contractor acknowledges investigating the supply of planting stock, obtaining firm commitments from suppliers, and assuring delivery of the specified plant stock as required to complete the Contract.

A2 Plant Stock Documentation

As a condition for delivery and approval of the plant stock, the Contractor shall furnish the Engineer with:

- (a) A copy of a valid nursery stock (dealer or grower) certificate registered with the Minnesota Department of Agriculture and/or a current nursery certificate/license from a state or provincial department of agriculture for each plant stock supplier.
- (b) A Mn/DOT Certificate of Compliance for Plant Stock, Landscape Materials, and Equipment (preliminary and final, with all revisions). The Certificate of Compliance shall state the species, sizes, quantities furnished, and name and location of the original source (nursery growing operation), in accordance with 1603 (Materials: Specifications, Samples, Tests, and Acceptance).
- (c) A copy of the most recent Certificate of Nursery Inspection for each plant stock supplier.
- (d) All plant material shipped from out-of-state nursery vendors subject to quarantines (Gypsy moth and Japanese beetle) must be accompanied by current documentation certifying that all plants

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shipped are free from regulated pests. To determine if Minnesota vendors are subject to quarantines, call the MDA Supervisor of Plant Regulatory Services at 651-296-8388.

- (e) Bills of lading (shipping documents) for all plant stock and landscape materials delivered to the Project.
- (f) Invoices (billing statements) for all plant stock and landscape materials used on the Project.

The required documentation shall verify that the plants are in conformance with the Project requirements.

All required plant stock documentation shall be supplied to the Engineer no later than one week prior to the proposed beginning of planting (exception--bills of lading are required when plants are delivered and invoices are required prior to payment to the Contractor. If the documentation is not supplied as specified, Mn/DOT will assess a daily charge of \$200.00, on a calendar day basis, until the Engineer notes compliance or until the eligible 50% of the Contract price for initial plant operations and/or a maximum of 10% of plant establishment operations (for replacement plants) is forfeited. The Contractor shall not start planting operations until the Engineer has reviewed and accepted all required plant stock documentation. Work performed with plant stock, materials, and equipment that are misrepresented on the documentation will be considered unauthorized work.

A3 Substitutions

Substitutions may be allowed in accordance with 1605 (Substitute Materials). However, the Contractor shall provide written documentation that a specified plant is not available (wholly or partially in sufficient quantities to meet contract requirements) from the individual suppliers on the Mn/DOT Partial List of Nursery Stock Growers and Suppliers. The list of nursery stock suppliers can be found in the most current "Inspection and Contract Administration Guidelines for Mn/DOT Landscape Projects." All substitute plants shall meet the Contract and site requirements. The Engineer may either approve the substitute plant or extend the Contract time to ensure availability of the specified plant.

B Department Furnished Stock and Transplant Stock

Department furnished stock and transplant stock shall be obtained from sources designated in the Plan or Special Provisions.

C Incidental Materials

C1 Soil Additives

The Contractor may use soil additives to modify the physical, biological, or chemical properties of the soil to enhance plant growth whether specified or not. The Department will not pay for these soil

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additives unless the Contractor can demonstrate that unspecified additives are absolutely necessary to ensure plant growth and survival. The Contractor shall submit soil tests, analysis, and recommendations that support the need for the additives and for compensation as Extra Work. If the Engineer approves such soil additives and if the Contractor incorporates the additives into the work, the Contractor will receive compensation based upon the submitted information.

C1a	Select Topsoil Borrow	3877
C1b	Agricultural Lime	3879
C1c	Blank	
C1d	Peat Moss	3880
C1e	Fertilizer	3881
C1f	Compost	3890
C1g	Iron Sulfate	

Iron sulfate, used to lower pH, shall be ferric sulfate or ferrous sulfate in pellet or granular form containing not less than 18.5 percent iron expressed as metallic iron. Acceptance will be on the basis of information contained on the product label.

C1h Activated Charcoal

When activated charcoal is used to neutralize or deactivate residual organic pesticide or chemical contaminants in the soil, the Contractor shall use ordinary charcoal, finely ground to increase absorptive surfaces, and electrically charged to attract the molecules of organic chemicals. The Engineer will accept the charcoal on the basis of information provided by the product label and the manufacturer's recommendations.

C1i Biological Soil and Root Hormones and Inoculants

Soil and root hormones and inoculants, used to modify the biological characteristics of poor soils by balancing or managing the rhizosphere, will be accepted based on the information provided by the product label and the manufacturer's recommendations.

C1j Porous Ceramics and Hydrophilic Polymers

Porous ceramics and hydrophilic absorbing polymers, used to modify the physical characteristics of poor soils by balancing or managing water and oxygen in the soil, will be accepted based on the information provided by the product label and the manufacturer's recommendations.

C1k Fertilizer

Refer to the Plan and special provisions for fertilizer requirements.

C2 Water

Water shall be free of oil, acids, alkalis, salts, and other substances harmful to plants. Water suitable for human consumption will be acceptable without testing. Water from streams, ponds, and lakes shall

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not be used without the Engineer's approval. When the Engineer requires testing, an approved testing laboratory shall perform the tests at no expense to the Department.

- C3 Mulch, Type 6 3882
- C4 Rodent Protection

Rodent protection consists of 6 mm (**¼ inch**) grid welded and galvanized wire mesh (hardware cloth) formed in a double-layered 375 mm (**15 inch**) diameter cylinder. The Contractor shall place and secure the rodent protection with a 25 by 25 mm (**1 inch by 1 inch**) heartwood white oak stake to the height shown in the Plan.

- C5 Wound Dressing

Wound dressing material shall be latex paint, shellac, or other acceptable material suitable to brush or spray on bruised, abraded, wounded, or cut plant surfaces, as approved by the Engineer. The paint color shall blend with the bark color.

- C6 Tree Paint

Tree paint consists of undiluted exterior grade white latex paint, as approved by the Engineer.

- C7 Staking and Guying

Staking and guying shall be as shown in the Plan. Posts and straps shall be uniform in style and color. The guying straps shall be non-abrasive to the tree and provide equal tension through the length and width of the straps.

- C8 Seedling Tree Shelters

Shelters for seedling trees shall be from the approved list that is on file with the Mn/DOT Landscape Unit. The shelter shall be a seamless, extruded, twin-wall, rigid copolymer polypropylene tube with a laser-line perforation. The shelter material shall be beige-colored, 30 to 40 percent translucent, and resistant to sunlight decomposition for a minimum of 5 years. The shelter shall have a flared top rim, formed stake recess, photo-degradable mesh sleeve covering, and shall conform to the height and diameter as shown in the Plan. The Contractor shall install the shelters with 25 by 25 mm (**1 inch by 1 inch**) heartwood white oak stakes as shown in the Plan.

- C9 Replacements

Replacements consist of plants or incidental materials required to replace dead, defective, or missing plants and incidental materials. The quality of replacements shall be equal to or better than the initially specified material.

- C10 Miscellaneous Materials and Equipment

Miscellaneous materials and equipment consists of preparatory work, staking items, herbicides, insecticides, fungicides, and equipment

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necessary to install plants as specified and to maintain plants in a healthy and vigorous condition, free from weed encroachment.

2571.3 CONSTRUCTION REQUIREMENTS

A General

An Mn/DOT Certified Landscape Specialist shall be on the Project site at all times to perform or directly supervise the plant installation and establishment, together with all other incidental work. The certification is obtained by completing a 1-day Mn/DOT Landscape Project Installation, Inspection, and Administration training class and passing a take-home test provided by the Mn/DOT Landscape Unit. The certification is valid for 3 years. At least one owner or operations manager of the general contracting firm and the landscape subcontracting firm shall hold valid Mn/DOT certification. The Contractor shall provide experienced crews working under the direct supervision of the certified specialist.

The Contractor shall conduct temporary vegetation protection measures in accordance with 2572 (Protection and Restoration of Vegetation) as incidental work. However, the Department will make payment for protection of specimen, high value, threatened, or endangered vegetation when a bid item is indicated in the Plan.

The Contractor shall conduct temporary erosion control measures in accordance with 2573 (Storm Water Management) as incidental work. The Contractor will not receive compensation for restoring areas damaged by erosion, sedimentation, and other causes when the damage results from the Contractor's operations, neglect, or failure to implement adequate temporary erosion control measures. However, the Department will make payment to prevent serious erosion and sedimentation when a bid item is indicated in the Plan or when the damage is not the result of the Contractor's neglect or operations.

A1 Definitions

A1a Preparatory Work

Preparatory work involves:

- 1) Attending a Preconstruction Conference.
- 2) Submitting completed Preconstruction documentation to the Engineer at, or prior to, the Preconstruction conference. If the documentation is not supplied as specified, Mn/DOT will assess a daily charge of \$200.00, on a calendar day basis, until the Engineer notes compliance, or until the eligible percentage of the contract amount for Preparatory Work has been forfeited.

Preconstruction documentation includes:

- a. A preliminary Mn/DOT Certificate of Compliance for all Plant Stock, Landscape Materials, and Equipment (2571.A2(b)). The

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Contractor's authorized representative shall sign the Certificate of Compliance.

- b. A copy of a valid nursery stock dealer or grower certificate registered with the Minnesota Department of Agriculture.
- c. A preliminary progress schedule.
- 3) Mobilizing for work on the site, including moving equipment and supplies to the Project site.
- 4) Protecting or staying away from existing plants in accordance with 1712 (Protection and Restoration of Property), 2031 (Field Office and Laboratory), 2557 (Fencing), and 2572 (Protection and Restoration of Vegetation) during all operations.

The Contractor shall obtain the Engineer's approval before moving equipment and supplies (including mulch and other incidental items) to the Project site prior to performing any work on the site.

A1b Preparation of Planting Holes and Beds

The preparation of planting holes and beds involves:

- 1) Layout staking of planting beds and isolated plant locations.
- 2) Applying herbicide and/or conducting other weed control operations.
- 3) Cultivating the soil and incorporating additives to improve soil properties and drainage.
- 4) Providing temporary erosion control measures.

A1c Initial Planting Operations

The initial planting operations involves:

- 1) Providing required plant stock, materials, and equipment that meet all the Contract requirements. Provide plant stock documentation as specified in 2571.2A2.
- 2) Digging planting holes.
- 3) Installing plants and required soil and/or root additives.
- 4) Conducting initial watering.
- 5) Placing mulch.
- 6) Protecting plants: including placing rodent guards, staking and guying plants, painting trees, installing seedling tree shelters, and conducting continuous weed control.
- 7) Cleaning up and Restoring the Project site.
- 8) Repairing the Project site.

A1d Blank

A1e Plant Establishment Period

The plant establishment period is 2 calendar years from the date all of the initial planting operations on the Project are completed, unless specified otherwise. The work during this period involves watering, weed control, turf maintenance, replacing unacceptable material and plants, and other incidental plant care necessary to protect and establish

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plants. Establishment operations shall prevent rutting or include repairing rutting and other damage that may lead to soil erosion and weed infestation.

A2 Plant Layout

The planting locations and layouts shown in the Plan are approximate. The Contractor shall stake the exact locations and layout for the Engineer's approval. In order to remedy localized problems and seasonal conditions that may hinder plant establishment, according to the species and locations specified, the Contractor may request approval to relocate plantings, to make plant substitutions, or to modify soil or drainage characteristics.

The Contractor shall locate plantings:

- a. So that a minimum sight distance of 360 m (**1200 feet**) exists in front of all traffic signs and extends 15 m (**50 feet**) beyond the sign.
- b. So that trees remain outside of the safety clear zones, safety sight corners, and sight lines, all in accordance with the Plan as directed by the Engineer.

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A4 Start of Operations

The Contractor shall not start planting hole or bed preparations, planting operations, or delivery of planting stock to the Project site until the Engineer determines that weather and soil conditions are suitable for such work and are in accordance with the dates shown in the Contract.

The Contractor shall not start planting operations until the documentation requirements of 2571.2 (Materials) and 2571.3B3 (Competence Test) operations have been demonstrated and accepted by the Engineer.

A5 Notices by Contractor

The Contractor shall notify the Engineer at least 3 days prior to the planned delivery date of planting stock and replacement planting stock to the Project site to allow for inspection scheduling.

The Contractor shall notify the Engineer at least 24 hours in advance of beginning and of changing planting hole and bed preparations, plant installation, and establishment operations, including layout staking, clearing, weed spraying, material deliveries, soil cultivation, planting, watering, mulching, plant protection, dead plant removal, weeding, cleanup, and restoration work. The Contractor's notice must include the Project number, Engineer's name, notification date, intended operation(s), intended operation date and duration, estimated start time, and the approximate location where work will begin and occur.

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The Contractor shall give the notice in writing unless otherwise designated by the Engineer. A confirmed facsimile notification is acceptable.

A6 Unauthorized Work

The Engineer will consider work performed with uncertified plant stock, without plant stock documentation, without landscape specialist certification, without notification, or in conflict with the working hours of 1803 (Prosecution of Work) as unauthorized work.

A7 Equipment Required

The Contractor shall provide equipment conforming to 1805 (Methods and Equipment) and have the following on the Project at all times:

- a. One portable compaction tester capable of measuring compaction in the soil to a minimum depth of 300 mm (**12 inches**).
- b. One soil recovery probe.
- c. Calipers with measurement readings in millimeters (**inches**).
- d. One rain gauge per kilometer (**mile**) of project.

B Preparing Planting Holes and Planting Beds

The Contractor shall conform to 1507 (Utility Property and Service) before cultivating soil or excavating holes on the Project.

B1 Weed Control and Cultivation

The Contractor shall use one or both of the following methods. Method 1, Herbicide Application may begin in spring or fall and shall be applied to actively growing vegetation. Method 2, Cultivate-Fallow-Disk requires fall and spring activity.

B1a Method 1 - Herbicide Application

Before cultivating isolated plant locations and plant beds, the Contractor shall kill turf and weed growth within the areas that will receive mulch in accordance with the following steps.

- Step 1. Mow existing vegetation to no less than 75 mm (**3 inches**) at least one week prior to any herbicide spraying. Remove the cuttings. The vegetation shall be allowed to re-grow to a height of at least 100 mm (**4 inches**) and no more than 200 mm (**8 inches**) prior to applying the herbicide.
- Step 2. At least 3 days prior to the proposed application date, submit labels of all intended herbicides and a copy of a valid pesticide applicator license to the Engineer for review and approval.
- Step 3. Spray any regrowth and kill all vegetation (top growth and roots) using a non-selective, non-residual post emergence herbicide containing 41% glyphosate as the active ingredient. Crews licensed by the Minnesota Department of Agriculture and experienced in the use of chemical pesticides shall

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perform the work in accordance with the manufacturer's recommendations. The herbicide shall be applied to dry foliage on actively growing vegetation. The application shall be made in August or September preceding fall or spring planting, or in May if August or September application is not possible. If precipitation occurs within 6 hours after spraying, the Contractor shall respray. Additional herbicides may be applied on a prescriptive basis if approved by the Engineer.

- Step 4. Prior to placing any specified soil additives, deep cultivate the planting holes and beds by thoroughly loosening the soil to a minimum depth of 200 mm (**8 inches**), as measured from the existing grade elevation of the soil. Operations (in this step and the following step) shall not result in soil compaction due to excessively wet soil conditions (field capacity or wetter) or improper methods. The Contractor shall demonstrate proper methods and equipment in a competence test for this operation as specified in 2571.3B3.
- Step 5. Unless otherwise specified, add soil additives and thoroughly incorporate them into the previously deep-cultivated soil to a minimum depth of 200 mm (**8 inches**), as measured from the finished grade elevation of the soil. The equipment and methods shall be in conformance with 2571.3B3 (Competence Test).
- Step 6. Use a compaction tester to verify that planting areas have been loosened to less than 1400 kPa (**200 psi**) at the initial minimum cultivation depth of 200 mm (**8 inches**) plus the depth of added soil additives as measured from the finished grade elevation of the soil.

B1b Method 2 - Cultivate-Fallow-Disk

The Contractor shall cultivate, fallow, and disk isolated plant locations and plant beds to kill turf and weed growth within the areas that will receive mulch in accordance with the following steps:

- Step 1. Mow the planting area to a maximum height of 75 mm (**3 inches**).
- Step 2. In late summer or early fall, and prior to placing any specified soil additives, thoroughly deep cultivate the planting areas to a minimum depth of 200 mm (**8 inches**), as measured from the existing grade elevation of the soil. Operations (in this step and the following step) shall not result in soil compaction due to excessively wet soil conditions (field capacity or wetter) or improper methods. The Contractor

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- shall demonstrate proper methods and equipment in a competence test for this operation as specified in 2571.3B3.
- Step 3. Unless otherwise specified, add soil additives and thoroughly incorporate them into the previously deep-cultivated soil to a minimum depth of 200 mm (**8 inches**), as measured from the finished grade elevation of the soil. The equipment and methods shall be as specified in 2571.3B3 (Competence Test).
- Step 4. Use a compaction tester to verify that planting areas have been loosened to less than 1400 kPa (**200 psi**) at the initial minimum cultivation depth of 200 mm (**8 inches**) plus the depth of added soil additives as measured from the finished grade elevation of the soil.
- Step 5. Allow the planting areas to lie fallow until spring with tilling ridges or other temporary erosion control methods, as approved by the Engineer.
- Step 6. In the spring, shallow disk or till the planting areas to a depth of no more than 75 mm (**3 inches**) to break the soil crust without exposing the underlying weed seed bank in the soil.

B2 Planting Soil

Planting soil for planting holes and beds shall consist of 100 mm (**4 inches**) of Grade 2 compost thoroughly mixed with the in-place cultivated soils. Planting soil also consists of the underlying deep-cultivated soil without compost (see 2571.3B1 and as shown in the Plan). This mixture shall be excavated when planting holes are dug and then replaced as backfill for all planting holes and beds.

B3 Competence Test

Prior to conducting ongoing operations throughout the Project site, the Contractor must obtain approval from the Engineer by demonstrating competence. For preparation of planting hole and bed operations, cultivate the soil and incorporate soil additives for one shrub bed and one individual tree. For initial planting operations, conduct one individual test planting for each root category or method of planting. The test planting shall include a coniferous tree, coniferous shrub, deciduous tree, deciduous shrub, seedling, vine and perennial, as it applies. The test shall include initial watering, guying, painting, protective devices, and mulching. The Contractor may continue only when the Engineer has approved the methods, equipment, and procedures.

B4 Wet Soils, Rock, and Debris

If excessively wet soils, bedrock, or excessive quantities of boulders and construction debris are encountered, the Contractor shall

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reconfigure, relocate, or delete the affected planting area as approved by the Engineer.

B5 Temporary Erosion Control

The Contractor shall employ temporary erosion prevention methods in cultivated planting hole and bed areas when necessary and to the satisfaction of the Engineer.

B6 Hardpan Layers or Compacted Soil

If hardpan layers or compacted soil layers are exposed below the normal planting depth, the Engineer may require additional deep ripping or other measures to ensure proper root development and drainage. Work shall conform to 2105.3G (Finishing Operations, Compaction Correction) and will be paid for as Extra Work when approved by the Engineer.

If it becomes evident that the Contractor's operation are compacting the planting soil, the Engineer will require additional preparation to re-aerate and loosen the affected planting soil. This work shall be provided at no cost to the Department.

B7 General

Planting hole cultivation will not be required for machine-moved (hydraulic spade) transplanted stock other than loosening the soil outside the soil ball perimeter as specified in the Plan. This loosening shall be 500 mm (**18 inches**) wide adjacent to the spade-moved soil and 300 mm (**12 inches**) deep. Loosen the soil prior to placing mulch. Soil additives are not required, unless specified in the Contract.

The Contractor shall not stockpile soil, compost, or other materials on the Project without approval and direction by the Engineer.

If the Contractor wishes to place woodchip mulch in prepared planting areas as temporary erosion control prior to planting, the Engineer must provide approval prior to placement. The Contractor shall rake woodchip off all prepared planting areas prior to digging planting holes. Woodchip mulch that is contaminated with soil must be removed from the Project site. Planting holes contaminated with woodchip mulch will not be accepted.

C Delivery and Storage of Plants

Plant stock shall be installed on the day of delivery to the Project site, unless temporary storage methods are approved by the Engineer. From the time of delivery until planting, storage methods shall prevent plant damage from exposure to drying winds, direct sunlight, excessive heat, freezing, low humidity, inadequate ventilation, and animal or human harm. If roots become frozen, the plant will be rejected. Prior to being installed, the roots of all plants shall be kept completely covered with a suitable moisture-holding material such as woodchips, straw, sawdust, moss, or soil and there shall be no discernable voids or

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air pockets. This material shall be kept continuously moist. Immerse the roots of bare root stock in water for at least one hour, and no more than 24 hours, immediately prior to planting. Plants shall be properly cared for at all times and shall not remain stored from one planting season to the next.

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E Pruning - Top Growth and Roots

Immediately prior to planting, the Contractor shall prune, as necessary, the roots of all bare root plants and the top growth of all deciduous plants to the Engineer's satisfaction. Broken or badly bruised roots and dry root tips shall be cut back to sound, healthy tissue. Pruning shall include removing dead, rubbing, damaged, or diseased branches, and unwanted suckers and may be necessary to improve plant symmetry, structure, and vigor. Coniferous trees and shrubs shall be pruned only to the extent of removing damaged growth or a competing leader.

When pruning any woody vegetation, the Contractor shall use good horticultural practices, as shown in the "Inspection and Contract Administration Guidelines for Mn/DOT Landscape Projects". Pruning cuts shall leave a branch collar (Shigo method) and shall produce a clean cut in live wood without bruising or tearing the bark. No pruning stubs shall be left. When trees that typically exhibit a dominant central leader have multiple stem leaders, the stem that will best develop as a central leader shall be preserved. The remaining stems shall be removed or cut back so they will not compete with the selected leader.

All pruning shall be done at the Project site, using a bypass scissor-type pruner or a pruning saw. A bypass pole pruner may be used only during the plant establishment period and only if approved by the Engineer. The use of hedge shears or anvil action pruners will not be permitted at any time.

The Contractor shall avoid pruning oak trees during April, May, June, and July in order to prevent the spread of oak wilt. Any accidental cuts or wounds to oaks shall be immediately treated (within 5 minutes) with an approved wound dressing. The dressing shall conform to 2571.2C5. The Contractor shall have wound dressing on the Project at all times during the oak wilt season.

F Installation of Plants

F1 General

The Contractor:

- (a) Shall conform to 2571.3B3 (Competence Test) prior to beginning any initial planting operations.
- (b) Shall dig all planting holes to the configuration and minimum dimensions shown in the Plan. The Contractor shall not work in

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planting holes and beds unless soil moisture is at field capacity or drier.

- (c) Shall provide adequate drainage where planting holes and beds are dug in heavy clay or impervious soils and a percolation rate of at least 12 mm (**½ inch**) per hour is not observed after partially filling presaturated test holes with water. Do not install plants in standing water. The Contractor may:
- (1) Raise the planting area,
 - (2) Install a granular filter,
 - (3) Install a tile drainage system, or
 - (4) Construct a combination of the features as shown in the Plan and as approved by the Engineer.

Due to nursery practices, the root flare of balled and burlapped and container plants may be found below the soil grade. In no case will plants be accepted if more than 100 mm (**4 inches**) of soil is found above the bottom of the root flare or if plants are installed with the bottom of the root flare below the finished soil elevation. Plants with less than 100 mm (**4 inches**) of excess soil over the root flare may be accepted if the excess soil can be removed without damaging the plant. Plants shall be installed plumb and set so that after installation and backfill consolidation, the bottom of the root flare is at the finished soil elevation, as shown in the Plan and the current edition of "Inspection and Contract Administration Guidelines for Mn/DOT Landscape Projects." Care shall be taken to ensure that roots are not damaged while placing and compacting the backfill.

The backfilling operations shall be accomplished in more than one stage in accordance with the Plan. Sufficient planting soil shall be placed prior to the initial watering in order to cover the root system completely and provide firm support for the plant in the hole. The remaining backfill shall be placed within 5 days after the initial watering following water permeation and soil settlement.

F2 Balled and Burlapped Stock

Balled and burlapped plants may be installed without removing the entire burlap covering or wire baskets. Before completing the planting hole backfilling, remove the top third or the top two horizontal rings of the wire basket, whichever is greater. Remove all burlap and nails to expose the entire top third of the soil ball. Remove all twine or rope entirely. Dispose of all waste off the Project site. Treated burlap will be allowed on the root balls but vertical slits must be cut through the burlap at the time of installation. The slits shall be at 150 mm (**6 inch**) intervals around the circumference of the root ball in a manner that does not damage the root system.

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If desired or necessary, staking and guying may be used to provide additional support between the stem and root ball. In the case of trees, especially conifers, with light textured soil balls and/or exposure to high winds, steep slopes, and wet soils, it is recommended that the Contractor install staking and guying prior to removing the twine, wire baskets, burlap, and nails. Staking and guying plants with broken soil balls will not be acceptable. Plants with broken soil balls shall be rejected. Staking and guying shall be installed in accordance with 2571.3J1.

F3 Container Stock

Plants supplied in containers shall be installed immediately upon being removed from the containers. Remove plants from all plastic, metal, and wood containers so as not to disturb the root system or the soil in which they were planted. Under no conditions shall plants be removed from the container by pulling on the main stems or plant growth. The outside of the root ball shall be scored or pruned in order to redirect circling roots. Paper fiber pots need not be removed, however, the container must be slit vertically at 150 mm (**6 inch**) intervals around the circumference of the pot. The top of the paper fiber pot must be removed to at least 25 mm (**1 inch**) below the soil grade.

F4 Bare Root Stock

Before installing bare root trees and shrubs, place and firm the planting soil in the bottom of the hole so plants are installed with the roots evenly distributed and spread in their natural position and at the proper depth. Carefully place and compact the growing medium around the roots.

F5 Machine Moved Stock

The Contractor shall install trees as designated in the Contract by hydraulic spade-type mechanized digging equipment.

The Contractor shall not install trees until the Department of Agriculture has inspected and found the trees to be free from plant pests.

Trees supplied by Mn/DOT are an exception.

The Contractor is responsible for all appropriate permits and certifications required for plants moved off of the Department's Right of Way.

The Contractor shall:

- (a) Apply at least 40 L (**10 gallons**) of water to the root ball during the digging operations.
- (b) Cover the spade portion of the digger with a tight hood during transport to ensure soil does not shift out of the digger.

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- (c) Cover trees with a tarp when trees are transported during the growing season and if the transport speed exceeds 48 kph (**30 mph**).
- (d) Support the tree in a manner that will prevent shifting and root ball damage.
- (e) Fill holes created by tree removal from public property within 24 hours. Fill holes so that after settling, the fill will be the same as the surrounding ground surface.
- (f) Reset trees that are not plumb with a spade of the same size or larger. To avoid mixing soil and mulch, pull mulch away from the planting hole. Straightening trees by tightening guy wires will not be permitted.
- (g) Prune trees to remove double leaders and broken, dead, diseased, or crossed branches. Pruning methods shall be in conformance with 2571.3E. To avoid spreading oak wilt, prune all oak trees as specified in 2571.3E.

(h) Blank

F6 Seedling Stock

The Contractor shall:

- (a) Prevent damage to the fine root hairs on seedlings during storage, handling, or planting. The Contractor shall not prune roots of seedlings unless approved by the Engineer.
- (b) Prevent tangled or turned up root ends (J-root).
- (c) Set the root collar to the depth shown in the Plan and current edition of "Inspection and Contract Administration Guidelines for Mn/DOT Landscape Projects."
- (d) Place seedlings in the ground so that the seedling assumes a position within 20 degrees of vertical.
- (e) Plant and tamp the ground around seedling roots firmly, without excessive compaction. Air pockets or voids around the roots will not be permitted. The Engineer will determine acceptable planting by a tug test and by inspecting for air pockets and excessive compaction in the root zone. The tug test is satisfied if gently pulling the seedling, at its base, does not pull the roots out of the ground or loosen the soil in the root area.
- (f) Protect deciduous seedlings with seedling tree shelters according to the Plan, when specified in the Contract.
- (g) Apply mulch to the depth specified in the Mulch Placement Detail in the Plans.

F7 Preparing Planting Holes and Planting Beds by Plant Type

1) Vine Planting Locations

The Contractor shall use the Herbicide Application Method (2571.3B1a) to control undesirable turf and weed growth. Spray to kill

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a continuous area 600mm (**2 feet**) wide that extends 1.5 m (**5 feet**) beyond the terminal vines. For each vine, loosen the soil to the Planting Hole Dimensions specified in the Plan. A dead turf strip shall remain between prepared planting holes. Mulch to continuously cover all sprayed and loosened areas along the planted side of walls or fences. Apply mulch to the depth and width specified in the Plan.

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H Following Plant Installation

H1 Watering and Backfill

Within 2 hours of installation, water each plant to thoroughly saturate the backfill soil, provide for soil settling, and fill voids in the backfill. Additional planting soil and multiple waterings may be necessary for thorough backfilling to eliminate soil air pockets.

Within 5 days after installation, the Contractor shall add sufficient planting soil around each plant, if necessary, to bring the soil to the specified level shown in the Plan. Plants shall be thoroughly watered unless soil moisture is at optimum or excessive levels. Plants that are improperly positioned with respect to depth and plumbness shall be reset or replaced. Reset and replaced plants shall be watered within 2 hours to thoroughly saturate the backfill soil.

At all times, the Contractor shall have sufficient watering equipment and forces available to completely water all plants once each week. Watering intervals shall be varied and based on prevailing soil moisture and weather conditions.

H2 Mulch Placement

Planting bed soil shall be fine-graded and leveled with hand tools prior to placing mulch to avoid impeding or puddling surface drainage and to prevent mulch depth irregularities. Mulch material shall be placed no later than seven days after installation. In cases where soil moisture is excessive, to allow for evaporation, delayed mulch placement may be requested by the Contractor and approved by the Engineer. Place mulch as shown in the Plan.

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J Protection of Plants

The Contractor shall take precautionary and protective measures to ensure healthy growth and survival of all plants.

J1 Staking and Guying

The Contractor shall:

- (a) Stake and guy trees in accordance with the details shown in the Plan.
- (b) Stake and guy trees only when necessary to maintain the plant in a plumb condition. Circumstances that may warrant staking and guying include excessive soil moisture, light-textured soil, steep

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slopes, high wind, or vandalism. Staking and guying shall be installed at no cost to the Department unless specified otherwise in the Contract.

(c) Remove the staking and guying after 1 year.

J2 Rodent Protection

The Contractor shall place rodent protection around all trees in accordance with the details in the Plan unless specified otherwise.

J3 Tree Painting

To prevent bark from splitting in the winter, the Contractor shall paint trees in accordance with the species, notes, and details shown in the Plan. The Engineer may require additional applications to achieve opaque coverage.

K Disposal of Excavated Materials

Excess and unwanted excavated materials shall be removed from the planting areas and disposed of to the Engineer's satisfaction within 3 days after the excavation.

L Cleanup and Restoration Work

Cleanup and restoration work shall be accomplished as the final step of the initial planting operations and throughout the plant establishment period, to the Engineer's satisfaction. Turf disturbed during plant installation or establishment operations shall be repaired with the seed mix(es) specified in the Plan. The Contractor shall:

- (1) Repair turf in all disturbed areas including, but not limited to, roadway access points, equipment circulation areas and pathways, and all stockpile or staging locations.
- (2) Remove all woodchip or material stockpiles to the Engineer's satisfaction.
- (3) Immediately prior to sowing seed or laying sod, roughen the soil surface. Soil shall be prepared as specified in 2575.3B (Soil Preparations).
- (4) Uniformly broadcast a slow release fertilizer. The fertilizer analysis and application rates will be as specified in the Plan or as directed by the Engineer.
- (5) Lay sod or uniformly hand broadcast seed at 1.5 times the rate specified in Table 2575-1, Seed Mixture Application Rates. For large areas, the Engineer may require or approve other establishment methods. Seed shall be in accordance with the requirements of 3876 and seeding shall occur in accordance with Table 2575-2, Season of Planting.
- (6) Rake and firm the seeded areas to ensure seed/soil contact.
- (7) Broadcast or disc anchor mulch, Type 1 in all seeded areas.
- (7) Install erosion control measures as necessary or as directed by the Engineer.

M Plant Establishment Period**M1 Establishment Period**

The Contractor shall maintain the work and care for the installed plants from completion of the initial planting operations until final acceptance at the end of the Plant Establishment Period.

M2 Establishment Work

The Contractor shall keep all plants in a healthy growing condition, using good horticultural practices generally and continuously throughout the establishment period. A prerequisite for work being continuously acceptable during the plant establishment period is that non-compliance conditions which require work by the Contractor cannot remain out of compliance for more than a continuous three week period, on a calendar day basis. Work shall be performed on a day to day basis during the growing season and as necessary during the remainder of the year, with necessary replacements being made as required.

If at any time, inspection shows that the plant establishment operations have not been generally and continuously in compliance, the Engineer will notify the Contractor in writing of such default and the Contractor shall comply with the instructions. If the Contractor does not proceed satisfactorily within 3 working days after receiving written notice from the Engineer to remedy plant establishment deficiencies, Mn/DOT will assess a daily charge of \$200.00, on a calendar day basis, until the Engineer notes compliance with the notice or until the eligible percentage of the annual contract amount for plant establishment work has been forfeited. The charge will continue until defaults are corrected to the Engineer's satisfaction and without further notice from the Engineer. The Contractor shall replace plant stock as required in the Contract but only within the optimum planting dates specified, extended, or shown in the Plan or as required by the Engineer.

M2a All Plants

In plant establishment work, the Contractor shall generally and continuously:

- (1) Maintain adequate (but not excessive) soil moisture in conformance with 2571.3H and watering guidelines provided in the Plan. It is advised that the Contractor use a soil moisture meter to determine soil moisture levels.
- (2) Repair, adjust, or replace, the staking and guying, mulch material, planting soil, rodent protection, seedling tree shelters, tree painting, and other incidental items in conformance with the Plan.
- (3) Apply insecticides, fungicides, and other cultural procedures, as necessary, to maintain healthy, vigorous plants free from harmful insects, fungus, and disease. All chemical applications shall be

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performed by an operator licensed by the Minnesota Department of Agriculture.

- (4) Remove dead plants. Furnish and install replacement plants with new mulch, planting soil, and other incidental items in conformance with 2571.3M3 (Replacement Requirements) and at no cost to the Project. The Contractor shall remove dead, dying, and unsightly plants on a continuous basis as these conditions occur, or as directed by the Engineer. Plant stock documentation for replacements shall conform to 2571.2A2.
- (5) Maintain the plants in a plumb condition at the appropriate planting depth.
- (6) Maintain all planting areas in a weed-free condition by continuously removing all weed growth in the mulched planting areas as necessary.
 - (a) Remove all weeds (top growth and roots) within the mulch limits by hand pulling (pre-watering is advised) or other methods as approved by the Engineer. Remove all County-regulated noxious weeds to at least 900 mm (**3 feet**) beyond the mulch limits with a method approved by the Engineer. Remove all weed parts from the Project site in such a manner as to avoid spreading weeds.
 - (b) Spray application of chemicals for weed control in the mulched planting areas will not be permitted during the plant establishment period unless the Engineer authorizes otherwise. A non-selective, non-residual post emergence herbicide containing 41 percent glyphosate as the active ingredient may be applied, with a surfactant, on a spot treatment basis only, with a brush or wick applicator, if authorized by the Engineer. Additional herbicides may be applied on a prescriptive basis if approved by the Engineer. A broad-spectrum dichlobenil based granular herbicide (pre-emergent) may be applied in conformance with product labeling and manufacturer's recommendations for residual weed control, if authorized by the Engineer.
 - (c) Weed whips and weed clippers will not be accepted as weed control.
 - (d) Mow the turf areas to at least 900 mm (**3 feet**) beyond the mulch limits and to a height no shorter than 100 mm (**4 inches**) when that turf grows taller than 230 mm (**9 inches**) adjacent to the mulched planting areas.
 - (e) Mow areas of Contractor-installed turf establishment or turf repair if the vegetation grows to a height of 500 mm (**18 inches**). Using a rotary mower, mow to a height of 150-300 mm (**6 -12 inches**). It is anticipated mowing may be necessary as early as June 30 and as late as August 15 (when the cover crop is setting seed). The

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Engineer may also require mowing in September. The Contractor shall control County-listed noxious weeds at all times. Unless specified, mowing shall be incidental to the Project.

- (9) Prune to remove dead, rubbing, damaged or diseased branches, unwanted suckers, and to improve plant form and structure.
- (10) Scout to assess the condition of the plants and the planting site. The Contractor shall look for abiotic and biotic factors that may influence a plant's health, vigor, and performance. Twice-monthly scouting is advised. The Contractor shall submit a written report to the Engineer whenever scouting or plant establishment work has been performed on the Project. The report frequency and content will be used by the Engineer to assess plant establishment compliance. The report must include the Project number, Engineer's name, employee's name, date the work was performed, work location, and the work completed. The report may be a copy of the Plan with the Contractor's notes, if approved by the Engineer. Items noted on the report may include, but are not limited to weather conditions, soil moisture, watering, repairing or adjusting rodent protection and tree shelters, staking and guying, painting, insect or disease problems and treatment recommendations, assessment of overall plant conditions, weeding, mowing, dead plant removals, and replacing plant stock.
- (11) Perform other plant establishment operations consistent with proper plant care.

M3 Replacement Requirements

The Contractor shall:

- (a) Replace all dead, defective, or missing plants and incidental materials as required in the Contract or when ordered by the Engineer. Replacements ordered by the Engineer shall be made within 2 weeks of the Engineer's notice, unless approved otherwise. Replacements of initially installed plants and materials will be made at no cost to the Project because the Contractor will receive payment for the initially installed plant.
The Contractor will not be responsible for replacement trees when the transplant trees are furnished by Department. However, the Contractor shall remove the dead or defective trees at no expense to the Department or as directed by the Engineer.
- (b) Replace all installed plants that are lost due to accidents, vandalism, theft, rodent damage, and other causes.
- (c) Repair or replace all damage caused by the Contractor's operations.

The requirements for all replacement plantings shall be the same as for initial planting including preparatory work.

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Within the first year of the 2-year plant establishment period, the Contractor is responsible for determining which plants need to be replaced. The Contractor shall assess the plant's condition and base the replacements on present or probable compliance with the Project requirements. At least one week prior to the anticipated plant replacements, the Contractor will submit a summary report of proposed plant replacements. The report shall include, by attachment, copies of plan sheets with the proposed replacement quantities and locations clearly identified. The Contractor shall also clearly mark the plants to be replaced with brightly colored paint in the field.

When less than a full year remains in the plant establishment period, the Contractor will not be required to replace plants unless the period is extended by a Supplemental Agreement or Change Order to provide one full year of establishment care.

After initial replacements, if additional replacements are required, the Engineer will decide if replacements will be at the Contractor's expense, deleted from the Plan, or replaced with compensation. Replacements with compensation will only be considered when plant failure is not a consequence of the Contractor's operations. Replacements with compensation require at least one year of plant establishment care and must be installed during the optimum planting dates, as shown in the Plan, unless approved by the Engineer.

N Acceptance of Work

For acceptance at full payment, plants shall meet all requirements including the criteria listed in the current edition of "Inspection and Contract Administration Guidelines for Mn/DOT Landscape Projects," published by the Mn/DOT Landscape Unit. The plants shall be healthy, vigorous, and structurally sound.

N1 Acceptance of Preparatory Work

The Engineer will accept the preparatory work after the Contractor has satisfactorily secured commitments for required materials (Mn/DOT Certificate of Compliance for Plant Stock, Landscape Materials, and Equipment), obtained the Engineer's approval for the progress schedule, moved equipment and supplies to the Project site, and provided for protection of existing plants.

N2 Acceptance of Preparation of Planting Holes and Beds

The Engineer will accept the preparation of planting holes and beds after the Contractor has satisfactorily completed staking, initial weed control, soil cultivation with incorporation of additives, and temporary erosion prevention measures.

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N3 Acceptance of Initial Planting Operation

Initial acceptance will be made upon satisfactory completion of the initial planting operation for the individual plant.

N4 Final Acceptance

Final acceptance will be made after final inspection of the completed Project at the end of the plant establishment period.

N4a Final Inspection

On or about the date on which the plant establishment period expires, the Engineer will make an inspection of the Project and notify the Contractor of any dead, defective, or missing plants and work that must be performed prior to acceptance. Dead or defective plants shall be removed where so ordered and turf shall be restored as specified in the Plan or as directed by the Engineer. Restoration shall be consistent with the surrounding turf.

As a condition for acceptance of the work, plant establishment operations shall not be past due at the time of the final inspection. Every plant shall have received a thorough watering within the preceding 10 days before inspection, unless soil moisture is at sufficient levels. The mulched planting areas shall be weed-free (top growth and roots). All work shall be in good order and in compliance with all plant establishment requirements. Work shall include, but is not limited to replenishing mulch, tree painting, straightening and imbedding rodent protection, pruning, and removing replacement plant staking and guying as necessary or as directed by the Engineer.

The Engineer will make a determination as to which plants will be accepted for payment at the Contract unit prices, at a reduced payment, or at no payment. The Engineer may consider as unacceptable any machine transplanted trees that are mechanically damaged and trees with reduced vigor and growth resulting from improper transplanting operations. The Engineer may accept these trees at an adjusted payment according to 1503 (Conformity with Plans and Specifications) or at no payment.

Upon final acceptance, the Contractor will not be required to provide any further care for the plantings. However, final acceptance of the work will not be made until cleanup and restoration work are completed to the Engineer's satisfaction.

N5 Blank

2571.4 METHOD OF MEASUREMENT

A Plants Furnished and Planted

Trees, shrubs, vines and perennials of each species, variety, size, or age, and root category furnished, planted, and maintained by the Contractor will be measured separately by the number of acceptable plants.

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B Plants Planted

Trees, shrubs, vines and perennials of each species, variety, size, or age, and root category furnished by the Department and planted and maintained by the Contractor will be measured separately by the number of acceptable plants.

C Plants Transplanted

Trees, shrubs, vines, and perennials of each size and type furnished by the Department and transplanted will be measured separately by the number of plants moved and maintained in an acceptable manner.

2571.5 BASIS OF PAYMENT

Payment for plant installation at a percentage of the Contract price per unit of measure will be compensation for all costs relating to furnishing, installing, and maintaining, or installing and maintaining, the required plants and materials specified.

If the Engineer requires additional materials and work beyond that specified or shown in the Contract, the Contractor will receive compensation for the additional materials and work as Extra Work.

A Initial Payment

Initial payment of up to but not exceeding 80 percent of the Contract unit price will be paid in partial payment amounts for satisfactory completion of the following work:

A1 Preparatory Work

Up to but not exceeding 10 percent of the Contract amount for the plants to be planted.

A2 Preparation of Planting Holes and Beds

Up to but not exceeding 20 percent of the Contract amount for the plants to be planted.

A3 Initial Planting Operation

Up to but not exceeding 50 percent of the Contract amount for the plants planted.

A4 Maximum

Up to but not exceeding 80 percent of the Contract amount for the plants planted.

B Interim Payment

The Engineer may authorize an interim partial payment of up to but not exceeding 10 percent of the Contract amount for the plants planted, at the end of the first calendar year of the plant establishment period when required plant establishment operations on the entire Project have been acceptable generally and continuously throughout this period. The Engineer will not authorize interim partial payment if these conditions are not met.

C Final Payment

Final payment will be made after final inspection and upon final acceptance of the completed Project at the end of the plant establishment period. Final payment may involve full payment, reduced payment, or no payment for the individual plants.

Payment will be made on a per unit basis.

No payment will be made for replacement plants unless authorized by the Engineer.

The amount of the initial and interim payments will be deducted from the final payment to the Contractor.

Any percentage of initial and interim payment that is withheld may continue to be withheld from the final payment.

Any assessments charged during the Contract period will not be reimbursed at final payment.

If the final voucher shows that the total of all initial and interim payments made exceeds the total amount due the Contractor, the Contractor shall promptly refund the overpayment. Final payment shall conform to 1908 (Final Payment).

C1 Full Payment

Full payment up to 100 percent of the Contract unit price will be made for the individual plant that is acceptable at final inspection if the Contractor has met the following requirements:

- (a) Acceptance of the preparatory work.
- (b) Acceptance of the preparation of the planting hole or bed.
- (c) Acceptance of the initial planting operations.
- (d) Compliance with all plant establishment work requirements generally and continuously and at the time of inspection and the plant has had the minimum 2-year plant establishment period or, in the case of a replacement plant, the plant has had a minimum of 1 year of plant establishment.

C2 Reduced Payment and No Payment**C2a Reduced Payment**

Reduced payment at up to a percentage of the Contract unit price will be made for the individual plant that is not acceptable at the final inspection, for one or more of the following reasons:

- (1) The plant is acceptable at final inspection and the Contractor has brought the plant establishment operations into compliance, with the exception that all plant establishment work requirements were not generally or continuously acceptable during the plant establishment period. General and continuous acceptance shall conform to 2571.3M2 (Establishment Work).
- (2) The plant is acceptable at final inspection with the exception that the protection of existing vegetation, the preparation of the

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planting holes or beds, or the initial planting operations were unacceptable.

- (3) The plant is acceptable at final inspection with the exception that all plant establishment work requirements are not acceptable at the time of inspection, or the plant has not had the minimum 2-year plant establishment period or the minimum 1-year plant establishment period in the case of a replacement plant.
- (4) The Department-furnished plant or machine transplant is not acceptable at final inspection but the protection of existing vegetation, the preparation of the planting hole or bed, the initial planting operations, and the continuous plant establishment operations have all been acceptable.
- (5) The plant is not acceptable at final inspection but all protection of existing vegetation, the preparation of the planting holes or beds, and the initial planting operations were acceptable, and the Contractor has been in general compliance continuously with the plant establishment work requirements for the minimum 2-year plant establishment period and the minimum 1-year plant establishment period in the case of a replacement plant.

C2b No Payment

No payment will be made for an unacceptable plant with unacceptable establishment care.

C2c Reduced Payment or No Payment

Reduced payment for the individual plant at up to a percentage of the Contract unit price or no payment will be made in accordance with the following:

TABLE 2571-1. Plant Installation: Condition of Acceptance

Condition of Acceptance	Total Payment Percentage
The plant is acceptable at final inspection but existing vegetation was not protected.	Payment to the extent the Engineer determines acceptable to compensate for damages
The plant is acceptable at final inspection and the Contractor has brought the plant establishment operations into compliance, but the Contractor was not generally or continuously in compliance with all plant establishment requirements.	80% - 95%
The plant is acceptable at final inspection but the preparation of the planting hole or bed or the initial planting operation was unacceptable.	50 %
The plant is acceptable at final inspection but, the Contractor is not currently in compliance with all plant establishment-requirements.	50 %
The Department-furnished plant or machine transplant is not acceptable at final inspection but the protection of existing vegetation, the preparation of the planting hole or bed, and the initial planting operation were acceptable and the Contractor has been generally and continuously in compliance with the plant establishment requirements.	50 %
The plant is not acceptable at final inspection but the protection of existing vegetation, the preparation of the planting hole or bed, and the initial planting operation were acceptable and the Contractor has been generally and continuously in compliance-with the plant establishment requirements.	35 %
The plant is not acceptable at final inspection and the Contractor has not been generally and continuously in compliance-with the plant establishment requirements.	0 %

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D Bonus Payment

A bonus payment of 10 percent of the total final Contract price for plant installation will be paid when 90 percent or more of all initially installed plants, and related contract operations have been accepted generally and continuously throughout the Contract period.

The qualifying percentage will be based upon the number of initially installed individual plants receiving full payment divided by the total Plan quantity of individual plants in the Contract. Any replacements made within the first Plant Installation Period (PIP) are considered initially installed plants.

To be eligible for the bonus payment, plants must be installed within the Plant Installation Period (PIP) identified in 1806 (Determination and Extension of Contract Time). This shall apply unless the PIP has been modified and approved otherwise in writing by the Engineer.

E Payment Schedule

Payment for plant installation will be made on the basis of the following schedule:

Item No.	Item	Unit
2571.501	Coniferous tree (size & root category)	tree
2571.502	Deciduous tree (size & root category)	tree
2571.503	Ornamental tree (size & root category)	tree
2571.504	Coniferous shrub (size & root category)	shrub
2571.505	Deciduous shrub (size & root category)	shrub
2571.506	Vine (age or size & root category)	vine
2571.507	Perennial (age or size & root category)	plant
2571.541	Transplant tree (spade size (1))	tree
2571.544	Transplant shrub	shrub
2571.546	Transplant vine	vine
2571.547	Transplant perennial	plant

NOTE: State Root Category: -Seedling, -Bare Root, -Machine Moved
- Container Grown - Balled & Burlapped

(1) Spade size 1.1 m (**42 inch**), 1.5 m (**60 inch**), 1.9 m (**78 inch**), 2.1 m (**85 inch**), 2.3 m (**90 inch**).

2572

Protection and Restoration of Vegetation

2572.1 DESCRIPTION

This work consists of protecting and preserving vegetation from damage and taking corrective action when damage occurs. Vegetation includes but is not limited to trees, brush, roots, woody vines, and perennial forbs and grasses.

2572.2 MATERIALS

A Plant Materials 2571 and 2575

B Temporary Fence

The Contractor shall provide temporary fence that is:

- (1) At least 1.2 m (**4 feet**) high.
- (2) Conspicuous in color.
- (3) Commercially available snow fence or other fencing material acceptable to the Engineer.

C Water 2571.2

D Sandy Loam Topsoil

The Contractor shall provide well-drained sandy loam topsoil, with a coarse sand component, meeting the requirements of Table 2572-1 and the Mn/DOT Grading and Base Manual. The Engineer may determine acceptability of topsoil without the test data specified in Table 2572-1.

**TABLE 2572-1
SANDY LOAM TOPSOIL GRADATION**

	Minimum	Maximum
Clay (by mass)	5 %	20 %
Silt (by mass)	10 %	30 %
Coarse Sand and Gravel (by mass) (A)	50 %	70 %
Organic Matter (by mass)	3 %	20 %
pH	6.1	7.5
Soluble Salts	--	0.15 siemens/m (1.5 mmho)

(A) Gravel not to exceed 10 percent by mass.

2572.3 CONSTRUCTION REQUIREMENTS

A Protecting and Preserving

The Contractor shall protect and preserve:

- (1) Specimen trees.
- (2) Threatened and endangered plants, as listed on the Federal and state threatened and endangered species list.

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- (3) Vegetation designated in the Contract to be preserved.
- (4) Trees, brush, and natural scenic elements within the Right of Way and outside the actual limits of clearing and grubbing consistent with 2101.3.
- (5) Other vegetation the Engineer identifies to be protected and preserved.

The Contractor shall not place temporary structures, store material, or conduct unnecessary construction activities within a distance of 8 m (**25 ¼ feet**) outside of the dripline of trees designated to be preserved without approval from the Engineer.

The Contractor shall not place temporary structures or store material (including common borrow and topsoil) outside of the construction limits in areas designated in the Contract or by the Engineer to be preserved.

The Contractor shall not place or leave any waste material on the project site, including bituminous and concrete waste, so as to interfere with 2105.3 (Finishing Operations) or 2575 (Turf Establishment). Concrete waste is defined to include all excess material not used on the project, including excess material ground to form rumble strips. The Contractor may dispose of excess material in accordance with 2104.3C (Disposal of Materials and Debris).

A1 Temporary Fence

The Contractor shall place temporary fences to protect vegetation before starting construction. The Contractor shall place temporary fence at the construction limits and at other locations adjacent to vegetation designated to be preserved when specified in the Contract, directed by the Engineer, or allowed by the Engineer. The Contractor shall place tree protection signs supplied by Mn/DOT) along the temporary fence at 15.25 m (**50 foot**) intervals or no fewer than two per fence or as specified by the Engineer. The Contractor shall not remove the fence until all work is completed or until removal is allowed by the Engineer.

The fence shall prevent traffic movement and the placement of temporary facilities, equipment, stockpiles, and supplies from harming the vegetation.

A2 Clean Root Cutting

The Contractor shall cleanly cut all tree roots at the construction limits when specified in the Contract or directed by the Engineer.

The Contractor shall immediately and cleanly cut damaged and exposed roots. Trees designated for protection shall have damaged roots cut back to sound healthy tissue and shall have topsoil immediately placed over the exposed roots. The Contractor shall immediately cover root ends that are exposed by excavation activities

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with 150 mm (**6 inches**) of topsoil as measured outward from the cut root ends. The Contractor shall limit cutting to a minimum depth necessary for construction and shall use a vibratory plow or other approved root cutter prior to excavation.

A3 Watering

The Contractor shall water root-damaged trees during the growing season when root damage occurs in order to maintain adequate but not excessive soil moisture. The Contractor shall saturate the soil within the undisturbed portion of the dripline of impacted trees to a depth of 500 mm (**20 inches**). The Contractor shall adjust the intervals and frequency of watering according to prevailing moisture and weather conditions.

A4 Sandy Loam Topsoil

The Contractor shall place sandy loam topsoil, instead of common borrow fill, within the dripline of specimen trees when specified in the Contract or directed by the Engineer.

The Contractor shall place the topsoil in a manner that will avoid over-compaction, as approved by the Engineer. The Contractor shall establish turf consistent with the adjacent areas as approved by the Engineer.

A5 Utility Construction

The Contractor shall bore (tunnel) under roots of trees that are to be preserved when utility installations take place within the tree protection zone as defined in Table 2572-2. Open trenching will not be permitted within this zone.

**TABLE 2572-2
TREE PROTECTION ZONE**

Tree Diameter at 1.4 m (4.5 feet) Above Ground mm (inches)	Minimum Distance from Face of Tree Trunk M (feet)	Minimum Depth of Tunnel m (feet)
Under 50 (2)	0.6 (2)	0.6 (2)
51-100 (2 to 4)	1.2 (4)	0.75 (2.5)
101-225 (4 to 9)	1.8 (6)	0.75 (2.5)
226-350 (9 to 14)	3.0 (10)	0.9 (3)
351-480 (14 to 19)	3.6 (12)	1.0 (3.25)
Over 480 (19)	4.8 (15)	1.2(4)

A6 Blank

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A7 Pruning

The Contractor shall prune trees specified in the Contract or as directed by the Engineer in accordance with 2571.3. Pruning shall include the removal of dead, broken, rubbing branches, and those limbs that may interfere with the existing and proposed structures.

A8 Destroyed or Disfigured Vegetation

If the Contractor destroys or disfigures vegetation designated to be preserved, the Contractor shall, at no expense to the Department, restore the damaged vegetation to a condition equal to what existed before the damage was done. The Engineer may assess damages against the Contractor on vegetation where an equal level of restoration is not accomplished. The Engineer will assess damages of trees and landscaping at not less than the appraisal damages as determined by the International Society of Arboriculture appraisal guide. The Engineer will determine and assess damages of other vegetation.

A9 Oak Trees

The Contractor shall avoid wounding of oak trees during April, May, June, and July in order to prevent the spread of oak wilt. If the Engineer determines that work must take place near oak trees during those months, resulting wounds shall immediately be treated with a wound dressing material consisting of latex paint or shellac. Paint colors shall blend with the bark color. The Contractor shall have an approved wound dressing on the project at all times during this period.

A10 Other Vegetation Protection Measures

The Contractor shall provide other vegetation protection measures; including root system bridging, compaction reduction, aeration, and retaining walls; as specified in the Contract or as directed by the Engineer.

B Plant Installation 2571

C Disposal of Material and Debris 2104.3

2572.4 METHOD OF MEASUREMENT

A Temporary Fence

The Engineer will measure temporary fence by length along the bottom of the fence between end posts. Measurement will only be made for fence placed, maintained, and removed.

B Clean Root Cutting

The Engineer will measure clean root cutting by length along the plow line. The beginning and ending points will be where the construction limit intersects the dripline of the tree or brush or in accordance with lines shown on the Plan.

C Water

The Engineer will measure water by volume used to protect and

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restore vegetation. No measurement will be made of other water used in conjunction with the work, whether for maintenance of sod, or otherwise.

D Sandy Loam Topsoil

The Engineer will measure sandy loam topsoil used by authority of the Engineer by compacted volume furnished and placed. The material may come from the Project.

E Pruning

The Engineer will measure pruning by the hours of actual pruning work.

2572.5 BASIS OF PAYMENT

The Department will pay for the acceptable quantities at the appropriate Contract price per unit of measure. In the absence of a Contract bid price, the Contractor will receive compensation for the work specified in the Contract or directed in writing by the Engineer according to the following unit prices; or in the absence of both, as Extra Work. This payment is full compensation for all costs relating to the specific pay item.

A No Payment

The Contractor will not receive compensation for:

- (1) Boring under roots in the tree protection zone, dressing of wounds, and disposal of material and debris.
- (2) Pruning that is necessary to allow for the Contractor's operations or to remedy damage caused by the Contractor's operations.

B Payment at Unit Prices

The Department will pay at the following unit prices for protection and restoration of vegetation items in the absence of a Contract bid price:

Item	Unit Price
(1) Temporary Fence	\$8.00 per meter (\$2.50 per linear foot)
(2) Clean Root Cutting	\$11.50 per meter (\$3.50 per linear foot)
(3) Water	\$8.00 per cubic meter (\$3.00 per 100 gallons)
(4) Sandy Loam Fill ...	\$10.00 (\$7.65) per cubic meter (cubic yard)
(5) Prune Trees	\$75.00 per hour

C Payment at Contract Bid Prices

The Department will pay at the Contract bid price as follows:

Item No. Item	Unit
2572.501 Temporary Fence	meter (linear foot)
2572.502 Clean root cutting	meter (linear foot)
2572.503 Water	liter (gallon)
2572.504 Sandy loam fill	cubic meter (cubic yard)
2572.505 Prune trees	hour

2573

Storm Water Management

2573.1 DESCRIPTION

This work consists of: 1) managing storm water runoff and project related water discharges in order to minimize sediment pollution during construction and over the life of the contract and 2) managing the discharges associated with dewatering and basin draining activities as set forth in the NPDES permit. The work includes furnishing, installing, maintaining and utilizing storm water best management practices and any work specified in conjunction therewith as well as removing temporary sediment control devices when no longer necessary.

2573.2 MATERIALS

A	Bale Barriers, as specified for Type 1 Mulch	3882
B	Silt Fence	3886
C	Flotation Silt Curtain	3887
D	Temporary Ditch Checks	3889
E	Storm Drain Inlet Protection	3891
F	Temporary Downdrain	3892
G	Sandbags.....	3893
H	Sediment Mat.....	3894
I	BLANK	
J	Filter Logs	3897
K	Flocculants	3898

2573.3 CONSTRUCTION REQUIREMENTS

A General Also refer to: 1701, 1716, 1717, 2105.5, 2575

In accordance with 1716 the Contractor has responsibility for charge and care of the Project and shall take necessary precautions against injury or damage to the Project by action of the elements. In addition, the Contractor shall take necessary precautions to prevent off site damage resulting from work conducted on the Project or Project related storm water runoff.

The Contractor is responsible for preventing or minimizing sediment loss from the Project by directing storm water runoff to constructed ponds and sediment traps as well as installing temporary sediment control devices in drainage locations where runoff can leave the Project limits and/or enter into environmentally sensitive areas.

The Contractor shall schedule, construct and/or install temporary sediment control and storm water management measures as required by the Contract and as stated in the permits required for the Project without having to obtain prior approval or having to be so directed by the Engineer. In the case of errors or omissions, the Contractor shall inform the Engineer upon immediate discovery.

The Contractor shall install temporary storm water management and sediment control devices in conformity with the details, typical sections, and elevation controls shown in the Contract. The actual installation location of temporary storm water management and sediment control devices may be slightly adjusted from that indicated in the Plan to better accommodate the actual field conditions and increase the effectiveness of a device. The Department will not conduct location staking unless requested by the Contractor. Errors, omissions, and changed site conditions affecting the location or placement of the temporary storm water management or sediment control devices shall be brought to the attention of the Engineer by the Contractor.

A1 Erosion Control Supervisor

The Contractor shall provide an Erosion Control Supervisor with a valid certification to direct the Contractor and subcontractor(s) operations and insure compliance with Federal, State and Local ordinances and regulations. The certification is obtained by completing a two (2) day Erosion/Sediment Control Site Management training class and passing the required test, from a Mn/DOT approved provider as listed in the Mn/DOT certification schedule.

The Erosion Control Supervisor shall implement the SWPPP and conduct the Contractor's erosion and sediment quality control program. In addition, the Erosion Control Supervisor shall be available to be on the Project within 24 hours at all times from initial disturbance to final stabilization as well as perform the following duties:

1. Coordinate and schedule the work of subcontractors such that erosion and sediment control measures are fully executed for each operation and in a timely manner over the duration of the Contract.
2. Oversee the work of subcontractors so that appropriate erosion and sediment preventive measures are undertaken at each stage of the work.
3. Prepare the required weekly erosion control schedules and present it to the Engineer.
4. Attend all weekly construction meetings to discuss the findings of the NPDES inspection log and other related issues.
5. Prepare the erosion/sediment control site plans requested by the Engineer.
6. Provide for erosion/sediment control methods for Contractor's temporary work not shown on the plans, such as work platforms, temporary construction, pumping operations, plant and storage yards, and cofferdams.
7. Ensure that applicable permits are acquired and complied with for borrow pits, dewatering and any temporary work conducted by the Contractor in rivers, lakes and stream

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8. Ensure that all erosion/sediment control work is conducted in a timely manner.
9. Ensure that erosion/sediment control work is installed to the fullest extent prior to suspension of the work.
10. Coordinate with Federal, State and Local Regulatory agencies on resolution of erosion/sediment control issues due to the Contractor's operations.
11. Ensure that proper cleanup occurs from vehicle tracking on paved surfaces and/or any location where sediment leaves the Right-of-Way.

If the Contractor fails to provide a certified Erosion Control Supervisor for the Project, the Engineer shall issue a written order to the Contractor. The Contractor shall respond within 24 hours and provide the required Erosion Control Supervisor or be subject to a \$1000 per calendar day deduct for noncompliance.

A2 Construction of Temporary Storm Water Basins

Temporary storm water basins shall be constructed concurrently with the start of soil disturbing activities whenever possible. The basins must be made fully functional and have storm water runoff from the localized watershed directed to the basins. The exposed sideslopes of the basins must be mulched and/or seeded within the time periods as set forth in 1717, or as directed by the Engineer.

A3 Temporary Sediment Control Measures

Sediment control measures must be installed down gradient prior to or in conjunction with soil disturbing activities. The Contractor shall schedule, install and maintain temporary sediment control measures as an ongoing effort on a site-by-site basis over the life of the Contract. The Contractor is responsible for minimizing the potential for sedimentation after temporary sediment control devices have been installed by implementing a good quality erosion control program and staging construction as needed. If the Engineer determines that the Contractor has not followed good erosion control practices that result in sedimentation outside of the Right of Way, the Contractor shall retrieve all sediment that has left the Right of Way and restore the property to the pre-existing condition, to the fullest extent possible at the Contractor's expense.

A4 Dewatering and Pumping

If dewatering or pumping of water is necessary, the Contractor is responsible for obtaining any necessary permits in accordance with 1701 and 1702. If the discharge from the dewatering or pumping process is turbid or contains sediment-laden water, it must be treated through use of sediment traps, vegetative filter strips, flocculants, or other sediment reducing measures such that the discharge is not visibly

different from the receiving water. The discharge location of the dewatering process must also be protected from excess erosion. Unless otherwise provided in the Contract, the best management practices used to control erosion and suspended sediment during the dewatering or pumping operation shall be furnished by the Contractor. The Contractor shall submit a dewatering plan to the Engineer prior to initiating dewatering activities.

A5 Vehicle Tracking onto Paved Surfaces

The Contractor shall use wood chip pads, temporary paving, or other appropriate Best Management Practices (BMPs) at major vehicle exit locations to minimize vehicle tracking of sediment from the Project onto paved surfaces. BMPs to protect vehicle exit sites shall be furnished by the Contractor and shall be incidental to the Project for which no direct compensation will be made.

The Contractor is responsible for insuring paved streets are clean at the end of each working day. Tracked sediment on paved surfaces must be removed by the Contractor within 24 hours of discovery, in accordance with 1717.2. Payment for street sweeping to provide safe conditions for the traveling public, environmental reasons or regulatory requirements shall be as provided in accordance with 1514.

A6 Infiltration Areas

Infiltration areas and constructed infiltration systems should not be constructed until the contributing drainage area and/or adjacent construction site have been completely stabilized. When this timing of construction is not possible, the Contractor shall insure sediment from exposed soil areas of the Project does not enter into the infiltration area or system. Payment for constructing infiltration areas shall be as provided for in the Contract.

A7 Critical Resources

The Contractor shall schedule and phase construction in critical resource areas to the best of his ability in order to minimize the potential of sediment entering into a critical resource. Critical resources include but are not limited to, protected wetlands, surface waters, trout streams, Special Waters, impaired waters, rivers, and endangered species habitat. Measures to minimize sediment potential include practices such as hand clearing and grubbing, limited bare soil exposure time, and immediate final establishment of vegetation.

B Installation of Bale Barriers

Bales shall be trenched into the ground 100 mm (**4 inches**) and staked with two 50 mm x 50 mm (**2 inch x 2 inch**) wood stakes. The stakes shall be of sufficient length such that at a minimum the top of the stakes are flush with the top of the bale and are also embedded into the ground a minimum of 250 mm (**10 inches**).

2573.3

C Silt Fence Installation

C1 Machine Sliced

The geotextile shall be inserted by a machine in a slit in the soil 200-300 mm (**8-12 inches**) deep with the salvaged edge on top. The slit shall be created such that a soil-slicing blade slightly disrupts soil upward as the blade slices through the soil. Directly behind the soil-slicing blade, the geotextile shall be mechanically inserted down into the soil slit such that 200-300 mm (**8-12 inches**) of the geotextile is below the ground surface. Soil slicing and installation is a simultaneous operation, achieving consistent placement and depth. No turning over (plowing) of soil is allowed for the slicing method. Compact the soil immediately next to the geotextile by operating the wheels of a tractor or skid steer on each side of the geotextile a minimum of 2 times. Posts shall be installed adjacent to the back face of the geotextile with the nipples facing away from the geotextile fabric. Posts shall be embedded a minimum of 0.6 m (**2 feet**) into the ground and installed a maximum of 1.8 m (**6 feet**) apart for general use and 1.2 m (**4 feet**) apart in ditch check applications. Secured at each post, three plastic zip ties shall be inserted through the geotextile within the top 200 mm (**8 inches**) of the fabric, puncturing holes vertically a minimum of 25 mm (**1 inch**) apart.

C2 Heavy Duty

The heavy duty silt fence system shall be hand installed with the salvaged edge on top. The bottom edge of the geotextile shall be placed into a 150 mm (**6 inch**) deep by 100 mm (**4 inch**) wide trench with the bottom edge of the geotextile wrapping back up to the soil surface. The trench shall be backfilled and tamped for compaction. Posts shall be installed adjacent to the back face of the geotextile with the nipples facing away from the geotextile fabric. Post shall be embedded a minimum of 0.6 m (**2 feet**) into the ground and installed a maximum of 1.8 m (**6 feet**) apart. Secured at each post, three plastic zip ties shall be inserted through the geotextile within the top 200 mm (**8 inches**) of the fabric, puncturing holes vertically a minimum of 25 mm (**1 inch**) apart.

C3 Super Duty

The bottom edge of the geotextile shall be placed 100-150 mm (**4 to 6 inches**) underneath the face of the median barrier exposed to direct storm water runoff. The median barriers shall be placed end to end in such a way to minimize the gap between each barrier. The geotextile shall be attached to the face of the barrier with wire or plastic zip tie inserted into the top 200 mm (**8 inches**) of the geotextile and tied to each eyelet on the barrier.

C4 Preassembled

The geotextile shall be installed with the salvaged edge on top. The bottom edge of the geotextile shall be placed into a 150 mm (**6 inch**)

deep by 150 mm (**6 inch**) wide trench. The trench shall be backfilled and tamped for compaction. Post shall be embedded a minimum of 450 mm (**18 inches**) into the ground and installed a maximum of 1.8 m (**6 feet**) apart.

D Flotation Silt Curtain Installation

The curtain shall be constructed with connecting devices at each end so that sections can be joined together. Connecting devices shall be designed to prevent silt from permeating through the connection and at the specified strength to prevent ripping out. The depth of the curtain shall be a minimum of 0.6 m (**2 feet**) to a maximum of 3.0 m (**10 feet**). Unless otherwise specified in the Contract, the depth of curtain shall be 1.2 m (**4 feet**). Installation shall typically be on the bottom of the water body.

D1 Still Water

The curtain shall be anchored along its length with enough weight to hold it in place. Both ends of the curtain shall be secured to land.

D2 Moving Water

The curtain shall be anchored out in the waterway in a herring bone configuration. The curtain shall be placed at an approximate 30 degree angle from shore, pointing up stream. Curtains shall not be placed across flowing water courses. Anchors shall be 136 kg (**300 pounds**) and located a maximum of 14.2 m (**50 feet**) spacing along the curtain. Each anchor shall be marked by a buoy. One end of the curtain shall be secured to land.

D3 Work Area

The curtain shall extend at a 45 degree angle from both ends secured to shore to enclose the work area. The work area shall extend a maximum of $\frac{1}{4}$ of the stream width. The curtain shall extend a maximum of $\frac{1}{2}$ of the stream width. The curtain shall be anchored out in the waterway with a minimum of 18 kg (**40 pounds**) at a maximum of 30 m (**100 feet**) intervals along the length of the curtain.

E Temporary Ditch Check Installation

All ditch checks shall be sufficiently long perpendicular to the ditch gradient such that the top of the device in the middle of the ditch is lower in elevation than the bottom of the terminating points on the ditch sideslopes.

E1 Type 1- Sliced in Silt Fence

Installation procedures are in accordance with 2573.3 C1. Maximum post spacing shall be 1.2 m (**4 feet**).

E2 Type 2- Bioroll

The bioroll shall be installed and anchored with wood stakes. The stakes shall be at a minimum nominally 13 mm x 50 mm (**½ inch x 2 inch**) and a minimum of 400 mm (**16 inches**) long with a pointed end.

2573.3

The stakes shall be driven through the back half of the bioroll at an angle of approximately 45 degrees with the top of the stake pointing upstream. The maximum spacing between stakes shall be 0.3 m (**1 foot**). When more than one bioroll is needed for length, the ends shall be overlapped 150 mm (**6 inches**) with both ends staked.

E3 Type 3- Bioroll Blanket System

The blanket shall be rolled out on bare soils and across the ditch with the leading edge that is subject to flow buried in a 100 mm (**4 inch**) deep by 100 mm (**4 inch**) wide trench. The trench shall be backfilled and compacted. The blanket shall form a minimum width of 3.7 m (**12 feet**) perpendicular to the ditch gradient. The blanket shall be stapled with either U shaped, 11 gage or heavier steel wire having a span width of 25 mm (**1 inch**) and a length of 150 mm to 200 mm (**6 to 8 inches**) at a maximum spacing of 3 m (**1 foot**) on center.

The bioroll shall be installed on top of the blanket and anchored with wood stakes. The stakes shall be at a minimum nominally 13 mm x 50 mm (**½ inch x 2 inch**) and a minimum of 400 mm (**16 inches**) long with a pointed end. The stakes shall be driven through the back half of the bioroll at an approximate angle of 45 degrees with the top of the stake pointing upstream. The maximum spacing between stakes shall be 0.3 m (**1 foot**). When more than one bioroll is needed for length, the ends shall be overlapped 150 mm (**6 inches**) with both ends staked.

E4 BLANK

E5 Type 5- Rock Weeper

A Type IV geotextile (3733) shall line the bottom of the rock weeper. The rock weeper shall be created such that the side profile forms a triangle with 1:6 (V:H) slopes on both the front and back slopes. Coarse concrete aggregate shall be installed on the front half of the triangle with a 1:6 slope to a height of ½ m (**1 ½ feet**). The riprap shall be installed on the back half of the triangular section. The center cross-section of the weeper shall be constructed such that center point of the rock weeper is approximately 100 mm (**4 inches**) lower than the end points of the weeper at the ditch side slopes.

E6 Type 6- Geotextile triangular dike

The leading edge subject to flow of the geotextile apron shall be buried in a 100 mm (**4 inch**) deep by 100 mm (**4 inch**) wide trench. The trench shall be backfilled and compacted. The flat geotextile portion shall be stapled with U shaped, 11 gage or heavier steel wire having a span width of 25 mm (**1 inch**) and a length of 150 mm to 200 mm (**6 to 8 inches**) at a maximum spacing of 300 mm (**1 foot**) on center.

E7 Type 7- Rock check

Riprap shall be installed on top of a Type IV geotextile liner (3733). Class II crushed riprap shall be used in the absence of a specified class. Rock shall be configured in a trapezoidal shaped berm with respect to the side profile such that the bottom of the berm is approximately 1.5 m (**5 feet**) wide, the top of the berm is approximately ½ m (**1 ½ feet**) wide, and the depth of the berm is approximately ½ m (**1 ½ feet**) deep. The center cross-section shall be constructed such that the center point of the rock check is approximately 100 mm (**4 inches**) lower than the end points of the rock check at the ditch side slopes.

F Storm Drain Inlet Protection

Storm drain inlet protection shall consist of the best management practices and devices for preventing sedimentation into and through underground drainage systems. Storm drain inlet protection applies to manholes, catch basins, curb inlets and other drop type inlets constructed for the ingress of surface water runoff into underground drainage systems. Storm drain inlet protection as described herein, will not include practices to protect culverts. See Section G for culvert protection.

The Contractor must protect storm drain inlets with sediment capture devices prior to soil disturbing activities that would result in sediment laden storm water runoff entering the inlet. The Contractor shall provide effective storm drain inlet protection over the life of the Contract until all sources with potential for discharging to an inlet have been paved or stabilized. As the Contractor's operations change, the storm drain inlet Best Management Practice for sediment control must be modified by the Contractor to ensure proper effectiveness for sediment capture.

The Contractor is responsible for preventing or minimizing the potential for unsafe, flooding, or siltations problems. For example, devices must be regularly cleaned out and emergency overflow must be an integral part of the device to reduce the flooding potential; and devices must be placed such that driving hazards or obstructions are not created. Sediment deposited in and/or plugging drainage systems will be the responsibility of the Contractor and shall be removed at no expense to the Department.

G Culvert Protection

Methods to protect the various types of culverts both at the inlet and/or outlet shall be as indicated in the Plan. Unless otherwise provided for in the Contract, materials and/or devices used shall be paid for separately.

2573.3

H Sediment Mat Installation

Mats shall be laid flat on the bottom of the streambed and anchored with wood stakes. The stakes shall be nominally 50 mm x 50 mm (**2 inch x 2 inch**) with a pointed end. Stakes shall be of sufficient length to be embedded a minimum of 0.45 m (**18 inches**) into the streambed and also appear above the water surface. The maximum spacing between stakes shall be 0.6 m (**2 feet**) along all edges of the mat. When more than one mat is necessary, the upstream mat edge shall overlap the downstream mat a minimum of 0.15 m (**6 inches**). The sides of adjoining mats shall overlap a minimum of 0.15 m (**6 inches**).

I BLANK

J Filter Log Installation

Filter logs shall be placed in accordance with the Plan. Straw and wood fiber filter logs shall be staked in place with wood stakes. Wood stakes shall be at a minimum 13 x 51 mm ($\frac{1}{2}$ x **2 inch**) nominal size by 400 mm (**16 inches**) long. The stakes shall be driven through the back half of the log at an angle of approximately 45 degrees with the top of the stake pointing upstream. When more than one log is needed for length, the ends shall be overlapped 150 mm (**6 inches**) with both ends staked. Staking shall be every 0.3 m (**1 foot**) along the log unless precluded by paved surface or rock.

K Flocculants

Flocculants shall not be applied directly to surface waters unless regulatory approval has been obtained. Flocculants shall be applied within containment areas such as temporary storm water ponds, temporary sediment traps, and containment systems. Before applying a flocculant, the pH and temperature of the storm water must be tested and be within the manufacturer's specified ranges. Adequate retention time for chemical reaction (approximately 15-20 minutes) for clay-sized particles to settle must be achieved such that the discharge of the treated water is visually the same as the receiving water.

K1 Liquid Flocc

Liquid Flocculant shall be hydraulically applied over the surface of the water to be treated. The liquid flocculant concentrate shall be diluted to form a stock solution. The stock solution shall be applied at the appropriate rate to yield 1ppm in the final treated water volume.

K2 Flocculant Log

The flocculant log shall be securely anchored in an area where the water to be treated will flow over the flocculant log. Flocculant logs are not to be left in standing, stagnant water.

K3 Granular Flocc

Granular based flocculant shall be mixed with water in a tank to form a stock solution. The stock solution shall be hydraulically applied at the appropriate rate to yield 1ppm in the final treated water volume.

L BLANK**M Maintenance****M1 General**

The Contractor shall maintain all temporary sediment control devices until they are no longer necessary and are removed. Maintenance consists of keeping the devices functioning properly. The Contractor shall repair or replace plugged, torn, displaced, damaged, or nonfunctioning devices to the satisfaction of the Engineer.

M2 Temporary Sediment Control Devices

The Contractor shall remove sediment from devices such as bale barriers, silt fences, ditch checks and storm water filter logs when the sediment reaches one-third of the height of the device and reshape the area to the Plan specifications. If sediment removal causes damage to a device or the device is non-functional, the Contractor shall replace the device. Sediment removal shall occur within 24 hours of discovery or as soon as field conditions allow access. Removal of sediment shall be incidental to the Project for which no direct compensation will be made.

M3 Sediment Basins and Traps

When the depth of sediment collected in the basin reaches 50 percent of the height of the riser, or 50 percent of the storage volume, the basin shall be drained and the sediment removed. Drainage and removal shall be completed within 72 hours of discovery, or as soon as field conditions allow access. Removal of sediment shall be paid for separately.

After the entire Project has undergone final stabilization, all temporary sedimentation basins to be used as permanent water quality management basins must be cleaned out and shaped by the Contractor to the Plan's specifications.

M4 Storm Drain Inlet Protection Devices

The Contractor shall clean, remove sediment or replace storm drain inlet protection devices on a routine basis such that the devices are fully functional for the next rainstorm event. Removal and disposal of trapped sediment in inlet protection devices shall be incidental to the Project. Sediment deposited in and/or plugging drainage systems is the responsibility of the Contractor and shall be removed at no expense to the Department.

N Sediment Removal

The Contractor shall remove sediment deposited in sediment basins and traps once the sediment reaches 50 percent of the basin or trap's

2573.3

sediment storage capacity within 72 hours of discovery. Sediment removal shall consist of excavating and other associated operations to remove sediment and restore the capacity of the temporary sediment control device. Sediment shall be removed to the original grade or as necessary to restore the function of the device. Sediment removed shall be spread or disposed of to the satisfaction of the Engineer. The Contractor will be compensated for sediment removal on an equipment rental hourly basis in accordance with 2123. Spreading, hauling, and disposing of material shall be at no expense to the Department.

Sediment removal shall be accomplished with a backhoe or other suitable equipment capable of reaching out and excavating semi-solid material. The backhoe shall be of the full-revolving crawler type and shall have a minimum bucket size 0.4 m³ (½ cubic yard). Size of the boom and the power unit shall be as recommended by the manufacturer for use with the bucket size. Depending on site conditions, the Engineer may allow a rubber tired tractor type backhoe to be used. Payment for the rubber tired tractor backhoe will be prorated based on rated capacity of the machine.

O Removal of Temporary Devices

The Contractor shall remove all temporary sediment control devices upon completion of the Contract work unless otherwise specified in the Contract or directed by the Engineer. All removed materials become the property of the Contractor.

The Contractor shall spread accumulated sediment to form a suitable surface for turf establishment or dispose of the sediment elsewhere. The Contractor shall shape the area to permit natural drainage. All work shall be done to the satisfaction of the Engineer.

P Workmanship and Quality Control

The Contractor is responsible for maintaining quality control on the project by ensuring that all work performed and all materials furnished are in conformance with the dimensions, installation requirements and material specifications shown in the Plans or indicated in the Specifications. Quality workmanship shall be used in all aspects of the work and shall be uniform in character throughout the project.

P1 Certified Installers

When erosion or sediment control practices are installed, a certified installer shall be on the Project to install the practices or direct the installation. Certified installer requirements shall apply to the following operations:

- Seeding
- Sodding
- Mulching
- Silt fence or other perimeter sediment control device installations

Erosion control blanket installation
 Hydraulic Soil Stabilizer installation
 Silt curtain installation
 Ditch check installation
 Compost installation
 Erosion Stabilization Mat installation

Each Contractor or subcontractor installing erosion or sediment control practices shall provide at least one certified installer at the time of installation. The certification is obtained by completing and passing an Erosion/Sediment Control Inspector/Installer training course that is taught by a Mn/DOT approved provider as listed in the Mn/DOT certification schedule.

If the Contractor or subcontractor(s) fails to provide the required certified installer(s), the Erosion Control Supervisor shall notify the Engineer. If either the Erosion Control Supervisor or the Engineer determines that one or more required certified installers have not been provided, the Contractor shall respond to the Engineer's notification within 2 days with the appropriately certified or provisionally certified person(s), or be subject to a \$500.00 per required installer per calendar day deduction for noncompliance.

Q Workmanship Rework Schedule

Performance of the work shall be controlled by the Contractor so that the materials installed and the workmanship practices are of good quality. When the quality falls below the threshold level defined in Table 2573-1, the Contractor shall take immediate action to correct the situation and prevent it from reoccurring. As indicated in the table, the Contractor shall correct unacceptable workmanship to qualify for payment.

2573.3

**TABLE 2573-1
Temporary Erosion Control: Corrective Action**

Item	Corrective action required when
Silt Fence	Improper geotextile used
	Insufficient geotextile embedment
	Insufficient compaction of soil
	Soil turned over and/or loosened due to inadequate equipment for sliced type
	Inadequate fastening of geotextile, posts, etc.
	Incorrect post spacing
Bale Barriers	Not notched in
	Not properly staked into the ground
Floation Silt Curtain	Curtain not anchored on land
	Curtain not weighted sufficiently in water
Ditch Checks	Not trenched in for silt fence, blanket or triangular dike
	Not stapled properly for blanket or triangular dike
	Water flows around the end rather than over the middle
	Incorrect post spacing for silt fence or bioroll/blanket system
	Biorolls not staked properly
	No geotextile used for Type 5 or 7
Storm Drain Inlet Protection	Inlet opening is not protected.
	Emergency overflow is not provided where required
	Device not cleaned out
Filter Logs	Not staked properly resulting in under mining or movement of logs
	Log ends not overlapped when more than one is needed in a line

The above table pertains to a threshold level of workmanship only and does not pertain to the use of nonconforming materials. The disposition of nonconforming materials shall be in accordance with 1503. The Contractor at no cost to the Department shall perform any corrective actions required for acceptance of the work.

2573.4 METHOD OF MEASUREMENT**A Bale Barriers**

Bale barriers will be measured by the length furnished and acceptably installed.

B Silt Fence

Silt fence will be measured by length furnished and acceptably installed. Measurement will be along the base of the fence from outside to outside of the end posts for each section of fence.

C Sandbag Barriers

Sandbag barriers will be measured by surface area acceptably installed based on actual measurement taken along the length of the barrier times its height. When more than one thickness of bags is installed, the surface area of each layer of thickness will be measured and added to the quantity.

D Flotation Silt Curtain

Flotation silt curtain will be measured by length furnished and acceptably installed.

E Sediment Traps

Sediment trap quantities will be measured by volume for basin excavation and construction. Excavation will be measured by volume of the material in its original position. Quantities will be based on actual field measurement and increases or decreases to the estimated Plan quantity will not be considered as a basis of claim for adjusted unit prices. Materials used to provide an overflow will be measured and paid for separately.

F Temporary Pipe Downdrains

Temporary pipe downdrains will be measured by length finished and acceptably installed. Materials, such as riprap, used to provide an outlet will be measured and paid for separately.

G Bituminous Lined Flumes

Bituminous lined flumes will be measured by area on the basis of actual surface dimensions as placed without regard to the type of bituminous mixture used or number of courses placed. The type of bituminous used shall be as provided for in the Contract or as directed by the Engineer. Damaged areas restored, by order of the Engineer, will be added to the original quantity. Materials, such as riprap, used to provide an outlet will be measured and paid for separately.

H Diversion Mounds

Diversion mounds will be measured by volume after compaction and in its final configuration. Quantities will be based on actual field measurement.

I BLANK**J BLANK**

2573.4

K Sediment Removal

Sediment removal will be measured by the number of hours of actual equipment working time in accordance with 2123.4. Sediment removed may be fluid or semi-solid and its consistency shall not be considered a basis of claim for adjusted unit prices.

L Sediment Mats

Sediment mats will be measured by the area furnished and acceptably installed.

M Temporary Ditch Checks

Types 1, 2, 3, 6 temporary ditch checks will be measured by length furnished and acceptably installed. Types 5 and 7 will be measured by volume based on field measurement.

N Culvert Protection

Culvert protection devices will be measured by the quantity of each device furnished and installed. Quantities for new devices to replace the original device installed will be measured and added to the total quantity.

O Storm Drain Inlet Protection

O1 Each Storm Drain Inlet

Storm drain inlet protection will be measured by the number of individual inlets properly protected over the life of the Contract without regard to the various types or number of devices used at each storm drain inlet.

O2 Lump Sum

Storm drain inlet protection will be measured by lump sum. Lump sum shall be considered to include all materials and labor as necessary to provide proper inlet protection over the life of the contract regardless of quantities required. Under this provision, no measurement will be made of any individual device or inlet location.

P Filter Logs

Filter logs will be measured by the length furnished and acceptably installed.

Q BLANK

R Flocculants

R1 Type A will be measured by the volume of liquid flocculant concentrate used and acceptably placed. No measurement will be made for the amount of water used to dilute the concentrate.

R2 Type B will be measured by each flocculant log furnished and acceptably placed.

R3 Type C will be measured by the mass of granular flocculant used and acceptably placed. No measurement will be made for the amount of water used to dissolve and dilute the granular flocculant.

S Erosion Control Supervisor

No direct measurement will be made of the various duties that the Erosion Control Supervisor performs or of the number of hours required, but all such work will be construed to be included in the single Lump Sum Payment. Upon satisfactory completion of either one-half the allowable Working Days for the Project, or one-half of the anticipated Project duration time, the Engineer may authorize partial payment not exceeding 50 percent of the Contract bid price. The remaining percentage will be paid upon satisfactory performance of duties at the Engineer's discretion and completion of the Project.

2573.5 BASIS OF PAYMENT

Payment for storm water management and sediment control items will be compensation in full for all labor, materials, equipment, and other incidentals necessary to complete the work as specified, including the costs of maintenance and removal as required by the Contract. The Contractor will receive compensation at the appropriate Contract prices, or in the absence of a Contract bid price, according to the following unit prices, or in the absence of a Contract price and unit price, as Extra Work.

A General

Upon satisfactory installation of temporary sediment control devices, the Engineer may authorize partial payment not exceeding 80 percent of the Contract bid price for that item, unless otherwise indicated in the Contract. The remaining percentage will be paid after the devices are removed.

B Storm Drain Inlet Protection

B1 Partial Payments

Storm drain inlet protection will be paid in partial payment amounts for satisfactory completion of the following work.

Initial Installation	25% payment
Maintenance during first half of Contract period	25% payment
Maintenance during last half of Contract period and removal of the devices.....	50% payment

B2 Deductions

If the Contractor fails to properly install, remove sediment, or maintain storm drain inlet protection, the Contractor shall be subject to a \$500.00 per calendar day deduction for noncompliance. The deduction shall apply to each inlet that is out of compliance and shall be deducted from monies owed to the Contractor.

C BLANK

D BLANK

2573.5

E Unit Prices

The Department will pay the following unit prices for temporary sediment control items in the absence of a Contract bid price:

- (1) Bale Barrier \$6.00/m (**\$1.85 per linear foot**)
- (2) Silt Fence, Heavy Duty \$10/m (**\$3.00 per linear foot**)
- (3) Flotation Silt Curtain, Type: Still Water, 1.2 m (4 foot) depth
..... \$52/m (**\$16.00 per linear foot**)
- (4) Sediment Trap Excavation
..... \$4/m³ (**\$3.00 per cubic yard**)
- (5) Bituminous Lined Flume
..... \$6/m² (**\$5.00 per square yard**)
- (6) Silt Fence, type Machine Sliced
..... \$6.50/m (**\$2.00 per linear foot**)
- (7) Sediment Removal, Backhoe \$120 per hour
- (8) Filter Log, Type Straw Biolog.....\$1.00/m (**\$3.00/foot**)
- (9) Filter Log, Type Rock Log.....\$0.55/m (**\$1.80/foot**)
- (10) Flocculant Sock \$200 each

F Pay Items

Payment for temporary erosion control items will be made on the basis of the following schedule:

Item No.	Item	Unit
2573.501	Bale Barrier	meter (linear foot)
2573.502	Silt Fence, Type (1)	meter (linear foot)
2573.504	Sandbag Barrier	square meter (square foot)
2573.505	Flotation Silt Curtain, Type (1)	meter (linear foot)
2573.506	Sediment Trap Excavation.....	cubic meter (cubic yard)
2573.507	Temporary Pipe Downdrain	meter (linear foot)
2573.508	Bituminous Lined Flume.....	square meter (square yard)
2573.509	Diversion Mound.....	cubic meter (cubic yard)
2573.511	Sediment Mat	square meter (square foot)
2573.512	Temporary Ditch Check, Type (1)	meter (linear foot)
2573.513	Temporary Ditch Check, Type (1)	cubic meter (cubic yard)
2573.520	Sediment Removal, Backhoe.....	hours
2573.530	Storm Drain Inlet Protection	each
2573.531	Storm Drain Inlet Protection.....	Lump Sum
2573.540	Filter Log, Type (1)	meter (linear foot)
2573.541	Liquid Flocculant	cubic meter (gallon)
2573.542	Flocculant Sock	each
2573.543	Granular Flocculant.....	kg (lb)
2573.550	Erosion Control Supervisor	Lump Sum

Note: (1) Specify Type

2575

Controlling Erosion and Establishing Vegetation

2575.1 DESCRIPTION

This work shall consist of reducing the risk of soil erosion by: 1) providing temporary shaping and grading; 2) applying temporary soil covers; and 3) establishing a perennial ground cover. Temporary shaping and grading includes measures such as shaping to temporarily direct water flow, smooth-rough grading to allow for adequate installation of temporary erosion control materials, cat-tracking and other measures effective at reducing the soil erosion potential. The use of temporary soil covers includes but is not limited to, mulch, establishment of an annual vegetative cover, erosion control blanket and hydraulic soil stabilizers. Establishment of a perennial vegetative cover shall include soil tilling, liming, fertilizing, seeding, sodding, mulching, and any other work specified in conjunction therewith.

2575.2 MATERIALS

A	Seed, mix as specified	3876
B	Blank	
C	Sod	3878
D	Lime	3879
E	Fertilizer	3881
F	Mulch	3882
G	Erosion Control Netting	3883
H	Erosion Control Blanket	3885
I	Hydraulic Soil Stabilizer	3884
J	Compost.....	3890
K	Blank	
L	Erosion Stabilization Mat	3888

2575.3 CONSTRUCTION REQUIREMENTS

A General Also refer to: 1701, 1716, 1717, 2105.5, 2573

The Contractor is responsible for minimizing soil erosion and preventing damage from sedimentation over the various stages of construction at all seasonal times during the year for the duration of the Contract by utilizing the best management practices established in 2573 in conjunction with the erosion control practices contained herein. The Contractor shall use other erosion control best management practices such as limiting the amount of exposed erodible soils, and providing horizontal cat track indentation to enhance the effectiveness of the sediment and erosion control devices. The Contractor shall protect slopes, ditch outlets, drainage outlets, and storm water discharge points from erosion in accordance with the time schedules established in the permit requirements.

2575.3

A1 Concurrent Critical Area Stabilization

The Contractor shall use the various methods provided in Section N- Rapid Stabilization, to temporarily stabilize disturbed areas within 61 m (**200 feet**) of surface waters as necessary for the duration of the Contract. The Contractor shall schedule, construct and/or install rapid stabilization measures in critical areas designated in the Contract or in accordance with permit requirements without having to obtain prior approval or having to be so directed by the Engineer.

A2 Spring and Fall Growing Seasons

The Contractor shall schedule and install temporary and permanent erosion control measures, finish earthwork operations, place topsoil, and establish turf in a continuous operation on an area by area basis to the fullest extent practical. The Contractor shall establish turf on the completed sections as required, without unnecessary delay and before weed growth or soil erosion occurs.

The dates for the season of planting for the various seed mixtures are listed in 2575-1. The Engineer may adjust a specified date by up to 10 days depending on prevailing weather conditions.

**TABLE 2575-1
SEASON OF PLANTING**

Seed Mixture Number	Spring	Fall
100	---	Aug. 1 – Oct. 1
110	May 1 – Aug. 1	---
150, 190	April 1 - July 20.	July 20 – Oct. 20
240, 250, 260, 270	April 1 - June 1	July 20 - Sept. 20
280	April 1 – Sept. 1	---
310, 325, 328, 330, 340, 350	April 15 – July 20	Sept. 20 – Oct. 20

For the portion of Minnesota north of, and including TH 2, the Season of Planting for Mixtures 150 through 280 shall be April 15 through September 20.

A3 Summer Season

When the dates in the season of planting prohibit seeding of the specified seed mixture, the Engineer may specify an alternative seed mixture or temporary mulch may be placed and seeding be conducted at a later date.

A4 Early Winter Season

Early winter season work shall consist of the erosion control operations necessary to protect the site through the following spring snowmelt conditions. Early winter season is defined as the period where soil temperatures are such that seed will not germinate and normal plant rooting does not occur. The soil may be cold and friable, frozen or lightly snow covered.

A4a Dormant Seeding

Dormant seeding shall be defined as seeding done on exposed cold soils so that normal seed germination does not occur until the following spring. Dormant seeding shall occur after October 20 and when soil temperatures at a depth of 25 mm (**1 inch**) are at or below 4 °C (**40 °F**).

In wind swept areas, exposed sites, and areas where dormant seeding does not typically establish well, temporary mulch may be ordered by the Engineer in lieu of dormant seeding.

Snow seeding shall be defined as seeding over the top of snow so that the seed melts through the snow and germinates upon warm up in the spring. Snow seeding can be done during the thawing days in February and March.

A4b Winter Mulching

Snow mulching shall be defined as mulch material spread over the top of snow so that the mulch melts through the snow and sticks to the site. All mulch materials listed under specification 3882 may be placed as snow mulching.

Frozen ground mulching shall be defined as mulch material spread over frozen ground. Mulch materials Type 4, 5, 6 and 9 that do not require disc anchoring into the soil may be placed without modification. Mulch Types 1, 7 and 8 may be anchored with Type 1 or Type 6 hydraulic soil stabilizers or may be "frozen" to the soil by applying water over the mulch. Applying water at the rate of 19 m³/ha (**2000 gallons per acre**) can be used as a direct substitution for disc anchoring.

A4c Dormant Sodding

The Contractor may place sod at locations at least 3 m (**10 feet**) from the shoulder, on slopes, and in ditches as dormant sodding after November 1 when all of the following conditions are met:

- (a) The Engineer authorizes dormant sodding.
- (b) The soil is prepared for sodding, either frozen or unfrozen.
- (c) The sod on slopes and in ditches is pegged or stapled.
- (d) The sod is watered to saturation immediately after placement.
- (e) The sod is watered a second time, or receives 25 mm (**1 inch**) of rain, 7 to 10 days after placement. The Engineer may also accept a heavy snowfall instead of the second watering.

A4d Winter Erosion Control Blanket Installation

Erosion control blankets may be installed over frozen ground. However, 150 mm (**6 inch**) long nails with washers can be used to anchor the blanket in lieu of staples.

2575.3

A4e Application of Commercial Fertilizer

Commercial fertilizer shall not be placed over frozen ground or snow. The application of fertilizer shall occur after the runoff from spring snowmelt has ceased.

B Grading Preparations Prior to Seeding

All washouts on the areas to be permanently seeded, sodded or have temporary erosion control materials installed shall be filled prior to the soil loosening operations. Topsoil shall be placed to the depths indicated in the Plans. Fill material shall be compacted sufficiently to provide reasonably uniform density in the upper soil layer to resist erosion. Drainageways shall be shaped and the soil loosened prior to placing sod or erosion control blankets.

B1 Grading Prior to Temporary Seeding or Erosion Control Installation

When installing erosion control materials in locations where the final topsoil grade has not be established, the Contractor shall provide smooth-rough grading to allow for adequate installation of erosion control materials and/or temporary seeding. The smooth-rough grading shall remove large clods of soil greater than 75 mm (**3 inches**) in diameter and ruts deeper than 75 mm (**3 inches**) and shall be incidental to the Project for which no direction compensation will be made.

B2 Tillage

Immediately prior to sowing the seed or placing sod, the Contractor shall loosen the soil to a minimum depth of 75 mm (**3 inches**) on all areas except slopes steeper than 1 vertical to 2 horizontal, using disks, harrows, field diggers or other suitable cultivating equipment. All track imprints from wheeled or tracked equipment shall be tilled out of the soil surface. In compacted areas, the Contractor shall rip, use additional equipment, or other necessary measures to ensure proper soil loosening.

On slopes the cultivating equipment shall be operated in a general direction at right angles to the direction of surface drainage wherever practical. The soil surface shall be left in a roughened condition with clods, lumps, and tillage ridges approximately 75 mm (**3 inches**) high left in place for maximum resistance to erosion. No additional loosening of the soil will be required on slopes steeper than 1 vertical to 2 horizontal, other than that obtained with the equipment used in removing vegetation or performing the finishing operations. Vegetation other than undesirable weeds shall be disked into the soil, cleared, or chopped up with a rotary or flail mower.

On all areas to be sodded, the Contractor shall prepare the soil surface as necessary to provide a reasonably smooth, moist, and evenly textured foundation. The soil shall be loosened to a minimum depth of 75 mm (**3 inches**) prior to sodding.

C Applying Fertilizer and Conditioners

The Contractor shall apply fertilizers, compost, and liming materials, where specified, at the rates indicated in the Contract, using mechanical spreading devices to the fullest extent practical, and providing uniform distribution of the material over the designated areas. Lime application rates specified in the Contract are based on 500 kg ENP per metric ton (**1000 pounds ENP per ton**) of Agricultural Liming Material. The actual lime application rate shall be adjusted to supply 500 kg ENP per metric ton (**1000 pounds ENP per ton**) of liming material.

The Contractor shall apply fertilizer, lime or compost prior to the seeding or sodding. The soil shall be tilled at least once, within 24 hours, following the application of fertilizer, lime or compost and prior to the seeding or sodding. Where fertilizer is required on sodding areas, it shall be applied prior to placing the sod. Where fertilizer is required on seeded areas, the time between fertilizing and seeding shall not exceed 48 hours.

When approved by the Engineer, the Contractor may use Grade 1 compost at an equivalent nutrient application rate in lieu of commercial fertilizer.

D Sowing Seed

The Contractor shall ensure that the seed is stored properly between the time of purchase and installation. Industry standards for seed storage are **50 degrees Fahrenheit** and 50% humidity. The Contractor shall protect the seed from moisture until it is sown. Wet or moldy seed shall not be used.

The Contractor shall sow the seed uniformly at the rate of application specified in Table 2575-2.

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**TABLE 2575-2
SEED MIXTURE APPLICATION RATES**

Seed Mixture Number	Application Rate (kg/ha)	Application Rate (pounds/acre)
100, 110	112	100
150	44.8	40
190	67.2	60
240	84	75
250	78.6	70
260	112	100
270	134.4	120
280	56	50
310	91.8	82
325	92.8	84
328	96.8	88
330, 340, 350	94.6	84.5

The Contractor shall sow seed on a prepared seedbed prior to applying mulch and as otherwise directed by the Plan or approved by the Engineer. The Contractor shall firm the seeded areas after seeding and prior to mulching. The soil firming shall be done with a drag, cultipacker, or other approved soil firming equipment. On slopes too steep to operate mechanical equipment, the seed shall be covered by hand raking or other approved means prior to mulching. Soil firming or seed covering shall be accomplished immediately after seeding.

On all seeding areas within 3 m (**10 feet**) of the shoulder, the Contractor shall seed and immediately firm the seedbed, mulch, and anchor the mulch as a continuous operation. Should the mulch application or mulch anchoring be delayed so that the seed or mulch becomes dislodged by traffic or wind, the affected areas shall be reseeded and remulched at no expense to the Department.

On areas outside 3 m (**10 feet**) of the shoulder, no more seed shall be sown on any day than can be mulched within 24 hours. Should the mulch application be delayed more than 24 hours, the Engineer may order the area reseeded and remulched at no expense to the Department.

The Contractor shall not broadcast seed or hydroseed when the wind velocity exceeds 25 km/h (**15 mph**) or during gusts that would affect seed placement.

D1 Temporary Seeding

Temporary seeding may be required on graded areas where the permanent seeding cannot be performed. For this purpose winter wheat, oats or other seed mixtures as determined by the Engineer will be used.

Topsoil covering may not be required for temporary seeding if the subsoil is reasonably suitable for plant growth, as determined by the Engineer. Soil preparation for temporary seeding shall be the same for permanent seeding except for areas such as stockpiles.

Temporary seeding shall be accomplished in accordance with Seeding of Traditional Mixes.

D2 Seeding Traditional Seed Mixes

Mixtures 100 through 280 inclusive shall be sown by means of mechanical or hydro spreading of the seeds at the specified rate of application. The use of hand operated mechanical spreaders will be permitted only on areas that are inaccessible to, or too small for, the specified equipment.

If a seed drill of the agricultural type is used, the drill shall be operated in a general direction at right angles to the direction of surface drainage, wherever practical, and the seed shall not be sown to a depth greater than 10 mm (**3/8 inch**). Small seed species such as timothy, alfalfa, white clover, red clover, etc., shall be sown through the grass seed attachment or by other approved means.

D3 Seeding Native Mixes

Native mixes (305-350) can be seeded with a native seed drill, a drop type seeder or a hydroseeder. The drill shall accurately meter the types of seed to be planted and keep all seeds uniformly mixed during drilling. The drill shall be equipped with disk furrow openers and packer assembly to compact the soil directly over the drill row. Maximum row spacing shall be 200 mm (**8 inches**). Depth of seed placement shall be such to obtain a final planting depth of 3 to 10 mm (**1/8 to 3/8 inch**). In lieu of a drill with disc openers, a drop type seeder that is equipped with a fluffy seed box and a "Brillion type" soil packer assembly may be used. All drill seeding shall be done at a right angle to surface drainage. The Engineer may allow the use of a cyclone or spinner type seeder on small areas (0.4 ha (**1 acre**) or less) or on areas that are inaccessible to other equipment. The rate of application must be adjusted according to the percent Pure Live Seed (PLS) in the mixture combined with the bulk portion of seed mixture. The bulk seeding rate for PLS species is determined by the following formula:

$$\text{Bulk Application (kg or lbs)} = (\text{kg or lbs. PLS}) / (\% \text{ PLS})$$

$$\% \text{ PLS} = \% \text{ Germination} \times \% \text{ Purity}$$

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D4 Hydroseeding

When a hydroseeder is used, every effort shall be taken to obtain a uniform distribution over the seeded area. A tracer, 22.5 kg **(50 pounds)** of 3884 Type 5 or 6, shall be added to each 1.9 m³ **(500 gallons)** of water in the hydroseeder tank to visually inspect the uniformity of the seed application. The hydroseeder shall have continuous agitation action that keeps the seed mixed in the water slurry until pumped from the tank and the pump pressure shall be such that a continuous nonfluctuating stream is maintained. Flood type nozzles shall be used to the fullest extent possible along with sufficient water volume to obtain total ground coverage. During application the spray shall be directed to obtain a uniform material distribution as evidenced by a uniform wetting of the soil surface. If a non-uniform distribution results (such as skipped areas and saw tooth patterns), the affected areas shall be reseeded at no expense to the Department. The seed or seed/fertilizer mixture shall be emptied within 1 hour after the seed is added to the tank. Seed that is allowed to remain mixed with the fertilizer for a period longer than 1 hour will not be accepted for use and no compensation will be made for seed so rejected.

D5 Interseeding

Interseeding may be used for seeding into temporary mulched areas or for drilling additional seed into previously seeded areas. The interseeding drill shall contain trash rippers and at least two seed boxes, a fine seed box and a box for larger or fluffy seeds. The drill shall slice through the vegetative mat and make a 25 mm **(1 inch)** wide by 10 to 25 mm **(3/8 to 1 inch)** deep furrow into the underlying soil. The drill seed disk openings shall place seeds in the furrows. The drill shall drop the seed onto the ground surface from the fine seed box and place the large or fluffy seed to a final planting depth of 6 to 10 mm **(1/4 to 3/8 inch)**.

D6 Permanent Seeding into Temporarily Mulched/Blanketed Areas

The Contractor shall permanently seed areas that have previously been temporarily mulched. Without additional tillage or site prep work, the Contractor may use an approved interseeding drill and 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 and then conduct the seeding. Fertilizer shall be applied within 24 hours of interseeding or light disking. The Contractor shall leave existing cover in place as practical for its mulching value.

Seeding into previously placed erosion control blankets can be accomplished by attaching a hose to a hydroseeder and "blasting" a

seed/water solution into the blanket. Blasting the seed/water solution shall be done from a distance of approximately 2 m (**6 feet**) away.

E Temporary Mulching

Temporary mulching shall be defined as placing mulch over broad large areas, generally 0.8 ha (**2 acres**) or more, to protect the overall site during the period of time when seeding cannot be performed. Temporary mulching shall be used to supplement other erosion control best management practices of establishing permanent vegetation or the rapid stabilization of critical areas within 61 m (**200 feet**) of surface waters. The provisions for temporary mulching may be used where the provisions for rapid stabilization (Section N) do not apply. In areas where temporary mulch is placed, the Contractor shall shape the area, loosen the soil as necessary, mulch and anchor the mulch.

F Applying Mulch

The Contractor shall spread mulch by mechanical means to provide a uniform distribution at the target application rate specified. When poor mulch distribution occurs, the Contractor will be required to remulch areas where coverage is too light and remove the excess where coverage is too heavy as determined by the Engineer.

The Contractor shall not operate mulch-blowing equipment on slopes that are too steep for the equipment or that cause rutting of the soil surface (slopes 1:4 and steeper). Blower attachments shall be used such that the mulch can be applied without having to traverse the slopes. The Contractor shall regrade, reseed and remulch slopes that are rutted up at the Contractor's expense.

F1 Type 1, 3, 7, and 8 Mulches

Wherever possible, Type 1, 3, 7, and 8 mulches shall be placed with blower equipment. The target rate of application shall be 4.5 metric tons (t) per hectare (**2 tons per acre**). The actual rate of application shall be as directed by the Engineer to match varying material or Project conditions so that approximately 10 percent of the soil surface is visible through the mulched areas.

F2 BLANK

F3 BLANK

F4 Type 4 Mulch

Type 4 mulch shall be applied as a dual operation with the Type 1 mulch blown on the soil surface at 3.4 metric tons per hectare (**1 ½ tons per acre**) and immediately over-sprayed with Type 5 hydraulic soil stabilizer at 840 kg/ha (**750 pounds per acre**). Seeding and fertilizing shall be done prior to mulching, not in conjunction with Type 5 hydraulic soil stabilizer placement. Disk anchoring will not be required.

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F5 Type 5 Mulch

Type 5 mulch shall be applied at a rate of 150 m³/ha (**80 cubic yards per acre**) when specified as an erosion control material.

F6 Type 6 Mulch

The rate and application procedure for Type 6 mulch shall be as specified in the Plans or Special Provisions.

F7 BLANK

F8 BLANK

F9 Type 9 Mulch

The Contractor shall apply Type 9 (aggregate) mulch at a rate of application as stated in the Contract. Prior to placing the mulch, the Contractor shall uniformly compact and smooth the foundation, cover the foundation with a 150 µm (**6 mil**) plastic sheeting, and then uniformly spread the aggregate mulch to the Plan thickness by a method that does not harm the foundation. The Contractor shall level the finished aggregate surface so that it is flush with adjacent areas. The plastic sheeting is an incidental cost to the completed work.

F10 Shoulder Mulch Overspray

Shoulder mulch overspraying shall consist of Type 1 Hydraulic Soil Stabilizer sprayed onto Type 1 mulch on a 1 meter (**yard**) wide strip immediately abutting a gravel or paved shoulder. During placement, the Contractor shall seed, firm the seedbed, place Type 1 mulch, immediately disk anchor the mulch (if provided for in the Contract), and then uniformly overspray with, Type 1 Hydraulic Soil Stabilizer as a continuous operation. Wherever possible, the Type 1 Hydraulic Soil Stabilizer shall be sprayed with a distributor spray bar. Application rate for the Type 1 Hydraulic Soil Stabilizer shall be 220 kg/ha (**200 pounds per acre**). Shoulder mulch overspray will be for those areas designated in the Plans and will be paid for under the Type 1 Hydraulic Soil Stabilizer pay item.

G Disk Anchoring

Where provided for in the Contract, the Contractor shall anchor Type 1, Type 3, Type 7, and Type 8 mulches with a disk anchoring tool. This equipment shall anchor the mulch by punching it into the soil to a depth of 50 to 75 mm (**2 to 3 inches**). Spacing between the blades or disks shall not exceed 200 mm (**8 inches**). The mulch shall be anchored immediately after placement unless otherwise authorized by the Engineer.

H Hydraulic Soil Stabilizers

H1 Type 1 Natural Tackifier

Natural tackifiers are added to water and applied by a hydrosprayer. Natural tackifiers can be used by themselves, as an additive to other soil stabilizers, or as an overspray on mulched areas. When used as an

additive to other soil stabilizers, they shall be added at the rate specified by the manufacturer. When used as an overspray on mulched areas, they shall be applied at the rate specified by the manufacturer. During placement, every effort shall be taken to obtain a uniform distribution over the target area.

- H2 BLANK
- H3 BLANK
- H4 BLANK
- H5 Type 5 and 6

Type 5 or 6 shall be applied with hydraulic spray equipment in a water-slurry at the rate of 2353 kg/ha (**2100 pounds per acre**). For planning purposes, the approximate water to bale ratio is 475 L of water per 22.7 kg bale (**100 gallons of water per 50 pound bale**); however the actual water to bale ratio shall be in accordance with the manufacturer's recommendations. Using the color of the material as a metering agent, the slurry shall be uniformly sprayed on the prepared seedbed. The Engineer may verify, by inspection of tank loading and spray application, that materials applied correspond with the application requirements within reasonable limitations.

- H7 BLANK
- H8 Type 8 Bonded Fiber Matrix (BFM)

Type 8 hydraulic soil stabilizer shall be applied with hydraulic spray equipment by a manufacturer's certified applicator. Seeding shall be done as a separate operation prior to the BFM application whenever possible. The combination of seed and BFM as a single operation will be allowed in small or inaccessible areas as determined by the Engineer. Installation rate shall be between 3300 and 4620 kg/ha (**3000 and 4200 pounds per acre**) depending on site characteristics as provided for in the plans. The general application rate shall be 3850 kg/ha (**3500 pounds per acre**). For planning purposes, the approximate water to bale ratio is 380 L/22.7 kg (**100 gallons per 50 pound**) bale; however the actual water to bale ratio shall be in accordance with the manufacturer's recommendations. In all cases 100% continuous ground coverage shall be obtained. Application shall be done on dry soils (field capacity or less) and at least 24 hours in advance of projected rainfall to allow adequate drying time. The BFM shall be applied from at least two alternate directions, preferably 90 degrees apart, to ensure all soil surfaces are covered. For application rates of 3850 kg/ha (**3500 pounds per acre**) and above, the BFM shall be applied in two stages (one half rate each) with ample time between stages for the first application to de-water. BFM shall not be used in water bearing soils or by itself in ditch bottoms carrying concentrated flow. After the BFM soil stabilizer is applied and dries for 24 to 48 hours, the Engineer may sample and

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quantify a portion of the installation to ensure the minimum specified rate has been applied. If it is found that the specified quantity per acre has not been achieved, the Contractor shall apply an additional amount to equal the specified rate within 48 hours of receiving the test results. The Contractor shall not be paid extra mobilization costs for spraying additional material.

I Placing Sod

Before sod is delivered to the work site, the Contractor shall have all necessary equipment and forces available and shall have prepared the sodding areas sufficiently in advance in accordance with 2575.3B to avoid delays in placing the sod. The Contractor shall place sod according to the Plan and these requirements.

The Contractor shall place sod strips with staggered end joints and without stretching, in such a manner that all edges will firmly abut the edges of adjoining strips. In no case shall the sod be placed so loosely or under such tension that it will cover an area larger than the area from which it was originally lifted.

Joints between the sod and in-place improvements such as curbs, walks, and existing turf, shall abut tightly and shall be such that drainage will be conducted over the surface. Elsewhere, the outside edges of the sodded areas shall be rolled in or banked flush with soil, thoroughly compacted to form a flush surface as directed by the Engineer. The Contractor shall place the sod in such a manner that surface drainage along the boundary of the sodded area will not erode or undermine the sod.

The Contractor shall water and compress the sod into the soil by rolling or tamping while laying the sod or immediately after completing the sod placement on each area. The initial watering and rolling or tamping shall be sufficient to provide a firm contact and bond between the sod and the underlying soil and provide a smooth, even surface free of humps and depressions, but in no case shall the rolling or tamping result in excessive compaction. The Engineer may require the watering of areas to be sodded prior to the sod placement.

The Contractor shall repair damaged areas within 5 working days after completing the sod placement and rolling or tamping operations. This repair work shall include reseeding and mulching of any seeded or mulched areas adjacent to the sod. All waste sod, together with any stones or other debris removed from the sodding areas, shall be disposed of in a manner satisfactory to the Engineer.

The Contractor is responsible for successful establishment of the sod and shall replace or repair displaced or damaged sod during the maintenance period. The Contractor may peg or staple sod to prevent displacement.

I1 Slopes

The Contractor shall carefully place sod strips from the bottom of the slope and progress upward. The sod shall be placed with the longitudinal axis of each strip at right angles to the slope. Staking or stapling may be required to prevent slumping or displacement of the sod. At the top of the slope, the sod must be trenched 75 mm (**3 inches**) into the topsoil on slopes steeper than 1V:4H.

I2 Ditch Bottoms

In ditch bottoms and other waterways where a concentrated flow of water is expected, the sod shall be placed so that the longitudinal axis of each strip is parallel to the direction of water flow in the main channel. The end of the strips will overlap a minimum of 100 mm (**4 inches**) with the upstream end on top of the downstream end. The sod will also be shingled and overlap a minimum of 75 mm (**3 inches**) on the sides of the strips. When shingled properly, the water will flow over, NOT under, from one roll of sod to the next. The uppermost strip of sod will have 75 mm (**3 inches**) of sod trenched into the topsoil on side-slopes steeper than 1:4.

The sod shall have netting material that is either incorporated into the rooting material of the sod during initial growth, or placed on the bottom of the sod mat at the time of harvest. Alternatively, Type 1 netting may first be secured in the ditch bottom followed by sod placement.

The sod shall be stapled once it has been put in place. All joints and outer edges of the sod shall be stapled at 0.9 m (**3 feet**) intervals or less. Staples shall be placed throughout the sod at a minimum spacing of 2 staples/m² (**square yard**). All staples shall be inserted flush with the ground surface.

J Placing Erosion Netting, and Blankets

J1 Erosion Control Netting

Netting placed in ditch bottoms, flumes or water courses shall be rolled out flat, parallel to the direction of water flow. Netting placed on cut or fill slopes shall be rolled out flat, parallel or perpendicular to the direction of water flow. The edges of adjacent strips shall overlap a minimum of 50 mm (**2 inches**) and a maximum of 100 mm (**4 inches**), with the net on the upstream side of any lateral water flow being on the top.

The netting shall be secured in place by means of wire staples driven reasonably vertical into the soil. The netting shall not be stretched prior to stapling. Staples shall be placed 1 m (**3 feet**) apart along the ends and edges of each strip. Additional rows of staples shall be placed parallel to the edge row of staples so that the distance

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between adjacent rows does not exceed 1 m (**3 feet**). Staples shall be placed 1 m (**3 feet**) apart within these rows. Where possible, staples of adjacent rows shall be placed so as to form a sawtooth pattern.

J2 Erosion Control Blankets

The Contractor shall shape and prepare the site so it is free of large rocks, soil clumps or vehicle imprints that would prevent the blanket from lying flush to the surface contours. The Contractor shall place the blankets as specified in the Contract on the specified areas within 24 hours after sowing of the seed on that area.

The Contractor shall roll out or lay the blankets parallel to the direction of water flow, with the netting on top. For blankets with netting on two sides, the bottom side of the blanket shall show the majority of the thread stitching. The blankets shall be spread evenly without stretching, and so the fibers are in direct contact with the soil over the entire area. Adjacent strip edges shall overlap each other at least 102 mm (**4 inches**). Strip ends shall overlap each other at least 178 mm (**7 inches**). All overlaps shall be made with the upgrade strip placed over the down grade blanket strip. All overlaps for all Categories, excluding category 0, shall be stapled at ½ m (**1 ½ foot**) intervals.

At the top of slopes and the beginning of each blanket in ditch bottoms the Contractor shall bury the upgrade end of the blanket strip in a check slot. The check slot, or trench, shall be approximately 150 mm (**6 inches**) wide by 150 mm (**6 inches**) deep. The blanket end shall be inserted into the check slot such that the blanket is in contact with all three sides of the check slot. The blanket shall be stapled in the bottom of the trench every 0.3 m (**1 foot**). The check slot shall be backfilled and compacted. When a slope length is greater than 30 m (**100 feet**), a second check slot shall be dug perpendicular to the slope gradient one-third up from the bottom of the slope. The blanket shall follow the slope down into the check slot and back up to the slope gradient. This check slot shall also be stapled, backfilled and compacted.

Category 00 blankets shall be stapled on the edge of the blanket every 1 m (**3 feet**) and watered in to bond the blanket to the soil. All other blankets, excluding category 00, shall be anchored to the soil surface with evenly distributed staples through out the blanket at the rate specified in Table 2575-3. All staples shall be inserted flush with the ground surface.

**TABLE 2575-3
STAPLING OF BLANKETS**

Slope (V:H)	Minimum Number of Staples per square meter (square yard)
Flatter than 1:2	1 (1.2)
1:2 – 1:1	1.4 (1.7)
Channel or Ditch applications	2.9 (3.5)

K Placing Erosion Stabilization Mats

The Contractor shall shape and prepare the site so it is free of large rocks, soil clumps or vehicle imprints that would prevent the Mat from lying flush to the surface contours. The erosion stabilization mat shall conform to the class shown in the Plan. All Erosion stabilization mats shall be soil filled.

The Contractor shall install the mat, seed, fertilize, place topsoil, and blanket all in one continuous operation. The Contractor shall roll out or lay the mat parallel to the direction of water flow. The mat shall be spread evenly without stretching, and so the fibers are in direct contact with the soil over the entire area. The beginning edge of each mat shall be buried and stapled in a check slot as described in K2. Adjacent strip edges shall overlap each other at least 102 mm (**4 inches**). The mat shall be stapled at a uniform density of 2.9 staples/m² (**3.5 staples per square yard**).

The mat shall be directly seeded and fertilized at ½ of the amounts specified in the Plan. On top of the seed and fertilizer, topsoil meeting the criteria of 3877 "Select Topsoil Borrow" that has been screened and pulverized shall be backfilled over the mat at a depth of 12-25 mm (**½ - 1 inch**). A sample of the topsoil shall be provided to the Engineer prior to installation. The remaining ½ of the seed mix and fertilizer shall be spread on top of the topsoil. The soil filled mat shall have a Category 4 blanket, meeting 3885 installed in accordance with K2 on top of the seeded topsoil to prevent erosion of the topsoil. No tracked equipment or sharp turns shall be made on the mat.

L Maintenance

L1 Sod

After the sod is placed and until it is accepted, the Contractor shall water and maintain sod in a condition satisfactory to the Engineer. The sod shall be cared for on a timely day by day basis. Watering and replacement of sod shall be accomplished as the need arises and without the Engineer having to so order.

The Contractor shall maintain the sod for 30 calendar days. The Engineer will then make the final inspection and consider acceptance of the sod.

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During the maintenance period, the Contractor shall promptly replace all sod that dries out to the point where it is presumed dead, and all sod that has been damaged, displaced, or weakened to the point where its replacement is necessary, or has become heavily infected with weeds. Areas replaced with new sod shall be maintained by the Contractor for at least 20 calendar days after placement.

L2 **Erosion Control Blanket and Erosion Stabilization Mats**

The Contractor shall maintain the erosion control blanket installation for 30 days when specified in the Contract or when the Engineer allows erosion control blankets and seed to be substituted for sod. All Erosion Stabilization Mats shall be maintained by the Contractor for 30 calendar days. Maintenance consists of thoroughly watering the blankets and mat systems immediately after placement (28 m³/ha (**3000 gallons per acre**)), with additional watering performed as necessary. Until acceptance, the Contractor shall be responsible for controlling erosion and establishing a permanent vegetative cover to the satisfaction of the Engineer. In the event of seeding failure or erosion during the maintenance period, the Contractor shall restore such areas at no additional cost to the Department.

L3 Sod Alternatives

When other products and methods are used in lieu of sod, the area shall be maintained by the Contractor ensuring the same outcome as a sodded area. Weeds shall be controlled and the maintenance requirements of specification 2575.3L2 shall apply.

L4 Mulch

When so directed by the Engineer, the Contractor shall, at any time before completion of the Project, remulch any areas on which the original mulch has eroded, washed away, or blown off, and reseed any areas on which the original seed has failed to grow, using the project seed mixture or one prescribed by the Engineer.

L5 Mowing and Weed Spraying

When the Contract includes items for mowing or weed spraying, the Contractor shall perform the specified work one or more times, wherever and whenever the Engineer directs, either on the areas seeded or sodded under the Contract. The equipment used shall not be so heavy that it causes soil slips or ruts on the slopes or in the ditches.

The Engineer may order weed spraying wherever heavy weed growth exists within the Right of Way. The weed spray mixture to be furnished and used shall be as provided in the Plans. The Contractor shall be responsible for performing the work at such time and in such a manner that will avoid spray drift outside the areas designated for spraying.

L6 General

Until final inspection and acceptance of the work is made, the Contractor shall use due care to protect the site during the time vegetation is establishing. Additional seed and mulch material used for reseeded and mulching and repairing damaged areas beyond the Contractor's control will be measured and paid for at the Contract prices, provided the original work was performed satisfactorily in accordance with requirements.

M Turf Establishment, Lump Sum

Turf Establishment may be specified in the Plans as a lump sum bid item for establishing vegetation on small areas of 1 ha (**2 ½ acres**) or less per Contract. The lump sum item shall be considered to provide for restoring disturbed areas. Such work shall include tilling, fertilizing, mulching and establishment of vegetative cover. Under this provision the Contractor shall be responsible for controlling erosion and establishing a permanent vegetative cover to the satisfaction of the Engineer.

Unless otherwise specified in the Plans, the Contractor may establish vegetative cover by sodding or by seeding and mulching. If the Contractor elects to establish vegetative cover by seeding, seed furnished and placed shall consist of a mixture of desirable perennial grasses and legumes equivalent to that contained in 3876 for Mixture 250. Upon seeding, the areas shall be fertilized with 22-5-10 analysis slow release fertilizer (see 3881.2) at 330 kg/ha (**300 pounds per acre**) and mulch equivalent to 3882, Type 1 shall be furnished and placed to prevent erosion and siltation. Acceptance of the areas by the Engineer will not be made until it is evident that the seed so placed has germinated and will establish an adequate protective cover. In the event of seeding failures, the Contractor will be required to correct and reseed such areas at no expense to the Department until adequate turf is established. When sod is used, the placement, maintenance, and acceptance shall be as specified in 2575.3.

N Rapid Stabilization

This work shall consist of operations necessary to rapidly stabilize small critical areas within 61 m (**200 feet**) of Surface Waters, to prevent off site sedimentation and/or to comply with permit requirements. The work shall be performed numerous times during the Contract and will be conducted on several small areas that may or may not be accessible with normal equipment. This work shall be done in accordance with the applicable details and locations shown in the Plan. The methods may be conducted independently or in combination. One or several locations may be stabilized by the Contractor per site visit per calendar

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day. The number of locations stabilized per site visit or per calendar day will not justify an adjustment in the Contract unit price.

The materials required shall be as follows:

Method 1	Type 1 Mulch @ 4.5 metric ton/ha (2 tons per acre) Disc anchoring
Method 2	Type 1 Mulch @ 3.4 metric ton/ha (1.5 tons per acre) Type 5 Hydraulic Soil Stabilizer @ 840 kg/ha (750 pounds per acre)
Method 3	Type 6 Hydraulic Soil Stabilizer @ 160 kg/ 3.8 m ³ of slurry mix (350 pounds per 1000 gallons of slurry mix) Seed mixture 190 @ 4.5 kg/3.8 m ³ of slurry mix (10 pounds per 1000 gallons of slurry mix) Fertilizer 10-10-20 @ 22.7 kg/ 3.8 m ³ of slurry mix (50 pounds per 1000 gallons of slurry mix) Water @ 3.3 m ³ /3.8 m ³ of slurry mix (875 gallons per 1000 gallons of slurry mix) Note: 3 m ³ (1000 gallons) of slurry mix will cover 0.067 ha (1/6 acre).
Method 4	Erosion Control Blanket Category 3 Seed mixture 190 @ 1.1 kg/100 m ² (2 pounds per 100 square yards) Fertilizer 10-10-20 @ 4.3 kg/100 m ² (8 pounds per 100 square yards)
Method 5	Rip Rap Class II Geotextile Type III

N1 Placement

Method 1

Prior to placement the soil surface should be in a loose condition so that the mulch can be anchored. The mulch shall be placed to obtain approximately 90% ground coverage. Wherever possible, the mulch shall be placed by blower equipment. In inaccessible areas the mulch may have to be placed by hand. Immediately after placement, the mulch shall be anchored with a disc anchoring tool. The approximate area of coverage is 0.2-0.8 ha (**½-2 acres**).

Method 2

Prior to placement the soil surface should be in a loose condition. The mulch shall be placed to obtain approximately 75% ground coverage. Wherever possible, the mulch shall be placed by blower equipment. In inaccessible areas the mulch may have to be placed by hand. Immediately after placement, the mulch shall be over-sprayed

with Type 5 Hydraulic Soil Stabilizer at a rate of 840 kg/ha (**750 pounds per acre**). The approximate area of coverage is 0.2-0.8 ha (**1/2-2 acres**).

Method 3

Rate of slurry application shall be variable depending on surface roughness, slope configuration and degree of undulation but it is expected that 56 m³ of slurry will be needed per hectare (**6 M gallons per acre**). This rate is equivalent to applying Type 6 Hydraulic Soil Stabilizer at 2353 kg/ha (**2100 pounds per acre**). Amount of material applied shall be such to obtain 100% soil surface coverage. In inaccessible areas, the mix may be pumped through a hose. The approximate quantity of coverage is 11.4-34 m³ (**3000-9000 gallons**) of slurry.

Method 4

The fertilizer, seed and erosion control blanket shall be placed as described in 2575.3. The upgrade end of each blanket strip shall be buried at least 150 mm (**6 inches**) in a vertical check slot. Staples shall be placed at seams and throughout the blanket at a maximum spacing in all directions of 0.6 m (**2 feet**). The approximate area of coverage is 75 – 650 m² (**100 – 800 square yards**).

Method 5

Rock and geotextile shall be placed in the areas and to the configurations as directed by the Engineer. The approximate quantities per Project visit are 9-18 metric tons (**10-20 tons**).

O Acceptance of Work

The Contractor shall notify the Engineer at least 24 hours in advance of beginning and also of changing turf establishment operations. The Contractor shall schedule working hours according to 1803. Work done without notification, without inspection according to 1511, or outside of the scheduled working hours without prior approval will be considered as unauthorized work. Turf establishment that is not verified by inspection in accordance with 1511 will be considered as unauthorized work.

O1 Seeding

The Engineer will generally accept permanent seeding in area increments once the seed has been properly placed in accordance with the specifications. After acceptance of seeding by the Engineer, the Contractor is relieved of responsibility for further maintenance and repair of the seeding and mulching performed on the area accepted, except for the repair of damages due to causes entirely within the Contractor's control.

2575.3

O2 Mulching

The Engineer will accept mulching 2 days after initial placement. Areas where the mulch has blown off or washed away during the 2 day period will be remulched at no expense to the Department.

O3 Sod

Upon satisfactory placement of the sod, the Engineer may authorize partial payment not exceeding 80 percent of the Contract bid price. The remaining percentage shall not become due and payable until expiration of the sod maintenance period, and then only as otherwise provided for in the Contract.

Upon expiration of the sod maintenance period on individual areas or sections of the Project, the Engineer will make an inspection of the work and will accept all sod that is in normal, healthy growing condition. No payment will be made for sod that is not in acceptable condition at the time of the final inspection an amount will be deducted from any moneys due or that may become due the Contractor equal to 100 percent of the Contract bid price per unit of measure of unacceptable sod. Sod that is within 3 m (**10 feet**) of the shoulder or is directly abutting a roadway surface that is acceptably maintained, but dies out due to salt or winter maintenance activities beyond the Contractor's control, may be paid for at 100 percent of Contract price provided that the sod has been maintained for at least 20 calendar days prior to December 1.

O4 Erosion Netting, Blankets and Stabilization Mats

When maintenance is not specified in the Contract, the Engineer will accept blankets and erosion control netting and mats, at the time of acceptance of the sodding or seeding over which the materials are properly placed.

When maintenance is specified as an integral part of a erosion control blanket installation or stabilization mat the Engineer may authorize partial payment for the installation in an amount not exceeding 80 percent of the Contract bid price. The remaining percentage shall not become due and payable until final acceptance by the Engineer.

O5 Products Used in lieu of Sod

When other products or methods are used in lieu of sod, the Engineer may authorize partial payment not exceeding 80% of the substituted product price upon proper placement. The remaining percentage shall not become due and payable until the expiration of the maintenance period, and then only as acceptable to the Engineer.

O6 Hydraulic Soil Stabilizers

Hydraulic soil stabilizers, except for Type 8, will be accepted upon satisfactory placement. Acceptance of acres covered by Type 8 will be

made by the Engineer when it is evident that the seed placed has germinated and will establish an adequate protective cover. In the event of seeding failures or erosion, the Contractor will be required to correct and reseed such areas at no expense to the Department until adequate vegetative cover is established. Upon proper placement of Type 8 the Engineer may authorize partial payment for the installation in an amount not exceeding 80% of the Contract bid price. The remaining percentage shall not become due and payable until final acceptance by the Engineer.

P Restoration

After acceptance of turf establishment in an area, the Engineer may order the Contractor to restore areas damaged by erosion and sedimentation that occurred beyond the Contractor's control. Restoration work consists of scarifying, grading, shaping, excavating, tilling, and any other operation the Engineer considers necessary to restore eroded areas and clean up sedimentation. Depressions and washouts resulting from erosion shall be shaped, filled with suitable material, and compacted to the satisfaction of the Engineer. Sedimentation shall be removed to the original grade or as necessary to properly restore the area as determined by the Engineer. Sediment removed shall be spread or disposed of to the satisfaction of the Engineer.

The Engineer will determine the seed, mulch, erosion blankets, and sod used in the restoration.

The Contractor will be compensated for restoration costs at the Contract unit prices. If no Contract unit prices are provided for in the Contract, the Contractor will be compensated for restoration costs as Extra Work. No compensation, however, will be made when the damage results from the Contractor's neglect or operations.

Q BLANK

R BLANK

S BLANK

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V Workmanship and Quality Control

The Contractor is responsible for maintaining quality control on the project by ensuring that all work performed and all materials furnished are in conformance with the dimensions, installation requirements and material specifications shown in the Plans or indicated in the Specifications. Quality workmanship shall be used in all aspects of the work and shall be uniform in character throughout the project.

2575.4

W Workmanship Rework Schedule

Performance of the work shall be controlled by the contractor so that the materials installed and the workmanship practices are of good quality. When the quality falls below a threshold level defined in Table 2575-4, the contractor shall take immediate action to correct the situation and prevent it from reoccurring. As indicated in Table 2575-4 the contractor shall correct unacceptable workmanship to qualify for payment.

**TABLE 2575-4
REQUIRED CORRECTIVE ACTION**

Item	Corrective action required when:
Seeding	Not uniform placement Not seeded with drill when required Depth of seed incorrect No seedbed firming Incorrect rate of seed application Less than 76 mm (3 inches) tillage Not mulched within 24 hours
Fertilizer and lime	Incorrect rate of application Not uniform placement Not incorporated properly
Mulch material, hydraulic soil stabilizer	Incorrect rate of application Not uniform placement Rutting of slopes with equipment
Erosion control blankets and mats	Inadequate soil loosening or preparation Upgrade ends not embedded on slopes Improper overlaps and joints Insufficient number of staples Improper stapling pattern No embedment of joints in drainageways
Turf establishment lump sum	Erosion not controlled Insufficient vegetative cover established

2575.4

The above table pertains to a threshold level of workmanship only and does not pertain to the use of nonconforming materials. The disposition of nonconforming materials shall be in accordance with 1503. The Contractor at no cost to the Department shall perform any corrective actions required for acceptance of the work.

2575.4 METHOD OF MEASUREMENT

A Fertilizer

Fertilizer will be measured by the weight of each kind furnished and applied. When a different analysis fertilizer than in the Plans, is used it will be converted to equivalent of planned fertilizer.

B Lime

Agricultural lime will be measured by the weight of material furnished and applied. Industrial Slag will be measured by mass on the same basis as Agricultural Lime.

C Seeding

Seeding will be measured by the area seeded, regardless of the seed mixture or quantity of seed used, and regardless of whether the seed was furnished by the Contractor or the Department. Areas reseeded by order of the Engineer, after the original seeding of the area was accepted, will be measured and added to the area originally seeded.

D Seed

The Engineer will measure seed by mass of each mixture or species except when pure live seed (PLS) is indicated. When PLS is indicated, the Engineer will measure the portion of the seed mixture by mass of PLS and add it to the mass of seed mixture specified as bulk mass.

E Mulch

The Engineer will measure:

- (1) Mulch material of Types 1, 3, 4, 7, and 8 by the mass of each type furnished and applied acceptably. Type 4 mulch shall consist of a measurement of Type 1 mulch and Type 5 hydraulic soil stabilizer.
- (2) Type 5 and 6 mulch material by volume (vehicular measure) of the material furnished and acceptably used.
- (3) Type 9 (aggregate) mulch by volume, based on the area of aggregate furnished and acceptably placed to the Plan thickness.
- (4) Additional mulch materials ordered by and then accepted by the Engineer in remulched areas will be added to the mulch quantities originally used and accepted.

F Water

Water used by order of the Engineer for establishment of areas covered with mulch will be measured by volume.

2575.4

G Disk Anchoring

Disk anchoring of Type 1, Type 3, Type 7 and Type 8 mulches will be measured by the area of mulch disked acceptably.

H Sodding

The Engineer will measure sodding that is acceptably installed and maintained by the surface area based on field measurement. Where sod is authorized to be placed shingle-style, the overlapped portion of the sod will also be measured.

I Hydraulic Soil Stabilizers

The Engineer will measure Type 1 by the area acceptably covered taking into account the type of material used and the manufacturer's recommended application rate. The Engineer will measure all other hydraulic soil stabilizers by the mass or weight of each type used. The Engineer may convert the mass or weight of material used to a square meter (**square yard**) basis.

J Lump Sum Turf Establishment

The item of turf establishment, lump sum will be considered to include all materials and labor as necessary to accomplish the work regardless of quantities involved. Measurement will be by lump sum unit, and under this provision, no measurement will be made of any individual turf establishment item.

K Erosion Netting, Blankets and Stabilization Mats

Erosion netting and blankets of each kind will be measured separately by the area covered. Overlapped portions will not be added additionally to the area measured.

Erosion Stabilization mats will be measured by the area covered. Overlapped portions will not be added additionally to the area measured. Seed, fertilizer, topsoil and blankets placed in conjunction with the erosion stabilization mat system will be measured separately.

L Mowing

Mowing will be measured by the area acceptably mowed.

M Weed Spraying

Weed spraying will be measured by the area acceptably sprayed.

N Weed Spray Mixture

Weed spray mixture will be measured by the volume of ingredients furnished and used.

O Blank

P Compost

Grade 1 compost will be measured by mass of material furnished and applied. Grade 2 compost will be measured by loose volume determined by vehicular measurement of material delivered.

Q Rapid Stabilization

Method 1 and 2 will each be measured by the hectare (**acre**) acceptably installed. Disc anchoring or hydraulic soil stabilizer shall be considered incidental for which no direct payment will be made.

Method 3 will be measured by the cubic meter (**M Gallons**) of slurry furnished and acceptably placed. Seed, fertilizer, and hydraulic soil stabilizer shall be considered incidental for which no direct payment will be made.

Method 4 will be measured by the square meter (**square yard**) of blanket acceptably installed. Seed and fertilizer shall be considered incidental for which no direct payment will be made.

Method 5 will be measured by the metric ton (**ton**) of rock furnished and acceptably installed. Geotextile shall be considered incidental for which no direct payment will be made.

2575.5 BASIS OF PAYMENT

Payment for any of the turf establishment items at the Contract prices per unit of measure will be compensation in full for all labor, materials, equipment, and other incidentals necessary to complete the work as specified, including the costs of maintenance, replacement, and repair as required by the Contract.

A Erosion Control Items

Payment for erosion control blankets may include maintenance, when so specified. If no maintenance is specified, payment shall be compensation in full for all labor, materials, equipment, and other incidental items necessary for proper installation of the blankets. If maintenance is specified, payment shall also include the cost of watering, replacement, and repair as required by the Contract.

Payment for hydraulic soil stabilizers will be based upon acceptance of the application by the Engineer. Payment for Type 1, 5, and 6 shall be compensation in full for all labor, materials, and equipment, for proper installation of the materials. Type 8 shall be eligible for partial payment not to exceed 80% of the contract bid price upon satisfactory installation of the material. The remaining 20% shall be made available when final acceptance is made based on adequate vegetative cover and erosion control.

B Temporary Seeding

Interim seeding, and the application of fertilizer and mulch as required in conjunction therewith, will be paid for at the Contract prices or, in the absence of a Contract bid price, according to the established unit prices, or in the absence of a Contract price and unit price, as Extra Work.

C Seed

Seed will be paid for by the mass of each mixture or species except

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when pure live seed (PLS) is indicated. When PLS is indicated on a portion of the seed mixture, payment will be made by mass of the PLS species plus the mass of the bulk portion of the seed mixture. Payment for seed not meeting germination and purity requirements of 3876 shall be subject to 1503. When components are missing from the specified mixture the affected seeded areas shall be reseeded with the correct mixture by the Contractor at no additional cost to the Department and a deduction of the value of the missing ingredients shall also be applied.

D Mulch

D1 Type 4 Mulch

Type 1 mulch and Type 5 hydraulic soil stabilizer will be paid for separately.

D2 Shoulder Mulch Overspray

Type 1 hydraulic soil stabilizer shall be paid for independent of the Type 1 mulch and disk anchoring or shoulder mulch overspray.

E Mowing and Weed Spraying

Payment for mowing and weed spraying at the Contract prices per unit of measure will be compensation in full for all labor and equipment employed in the work, and for all materials used, except that separate payment will be made for the weed spray mixture furnished and applied in conjunction with the item of weed spraying.

F Sod

Netted and stapled sod shall be paid at 150% of unnetted sod.

G Products in Lieu of Sod

Payment for products used in lieu of sod, that are not as labor intensive or do not require the same watering sequence as sod shall be paid for at 75 percent of the sod Contract price.

H Rapid Stabilization

Payment for the various items of work required for Rapid Stabilization will be made in accordance with the appropriate Contract bid price per unit of measure for each method specified. Such payment, in each instance, shall be construed to be compensation in full for all costs incidental thereto including mobilization.

I Unit Prices

The Department will pay the following unit prices for erosion control and vegetation establishment items in the absence of a Contract bid price:

- (1) Additional tillage ordered by the Engineer before seeding interim mulched areas will be paid for at the same unit price as disk anchoring.
- (2) Disk Anchoring \$75 per hectare (**\$30 per acre**)

- (3) Temporary Seed Mixtures
 - Mixture 100-110 @ \$0.44 per kilogram (**\$.20 per pound**)
 - Mixture 150 @ \$3.00 per kilogram (**\$1.35 per pound**)
 - Mixture 190 @ \$2.75 per kilogram (**\$1.25 per pound**)
- (4) Erosion Control Blanket Category 4
 -\$2.20 m² (**\$2.00/square yard**)
- (5) Rapid Stabilization Methods
 - Method 1.....\$900/ha (**\$400/acre**)
 - Method 2.....\$1235/ha (**\$500/acre**)
 - Method 3.....\$86/m³ (**\$325/M gallon**)
 - Method 4.....\$3.00/m² (**\$2.50/sq yd**)
 - Method 5.....\$27/metric ton (**\$25/ton**)
- (6) Water\$4.65/cubic meter (**\$17.00/MGal**)

J Payment Schedule

Payment for turf establishment and maintenance will be made on the basis of the following schedule:

Item No.	Item	Unit
2575.501	Seeding	hectare(acre)
2575.502	Seed, Mixture __, or (Species)	kilogram(pound)
2575.505	Sodding Type__	square meter(square yard)
2575.511	Mulch Material, Type __	metric ton (ton)
2575.513	Mulch Material, Type __	cubic meter (cubic yard)
2575.519	Disk Anchoring	hectare (acre)
2575.521	Erosion Control Netting	square meter (square yard)
2575.523	Erosion Control Blankets, Category __ (1)	square meter(square yard)
2575.525	Erosion Stabilization Mat, Class__	square meter (square yard)
2575.531	Fertilizer, Type__	metric ton (ton)
2575.532	Fertilizer, Type __	kilogram (pound)
2575.533	Agricultural Lime	metric ton (ton)
2575.535	Water	cubic meter (M Gallons)
2575.541	Mowing	hectare(acre)
2575.545	Weed Spraying	hectare (acre)
2575.547	Weed Spray Mixture.....	liter (gallon)
2575.550	Compost, Grade 2.....	cubic meter (cubic yard)
2575.551	Compost, Grade 1.....	metric ton (ton)
2575.555	Turf Establishment	lump sum
2575.560	Hydraulic Soil Stabilizer, Type __	kilogram (pound)
2575.561	Hydraulic Soil Stabilizer, Type 1	square meter (square yard)
2575.570	Rapid Stabilization Method 1 or 2.....	hectare (acre)

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2575.571 Rapid Stabilization Method 3
..... cubic meter (**M Gallons**)

2575.572 Rapid Stabilization Method 4
.....square meter (**square yard**)

2575.573 Rapid Stabilization Method 5metric ton (**ton**)

Note: (1) If maintenance applies, a subnote will be placed on the pay item shown in the summary of quantities in the Plan: "Includes Maintenance."

2577

Soil Bioengineered Systems

2577.1 DESCRIPTION

This work shall consist of installing vegetation in conjunction with geosynthetic or natural materials for stabilizing areas susceptible to erosion. Soil Bioengineering may be used as a permanent soil stabilization system in ditches, along stream banks, on shorelines or on slopes. The work shall consist of furnishing and installing a composite system by the Contractor on site.

2577.2 MATERIALS

A Seed, mix as specified	3876
B Mulch, Type as specified	3882
C Erosion control blankets	3885
D. Erosion control netting.....	3883
E. Nursery plant stock	3861
F. Fiber log	3895
G. Riprap.....	3601
H. Concrete Armor Units.....	3608

2577.3 CONSTRUCTION REQUIREMENTS

A General

The installation locations and layouts shown in the Plans are approximate only. The exact locations and layout shall be as determined by the Engineer.

The harvest and installation of plant material shall be performed by qualified nurserymen or landscape specialists, or shall be performed by experienced crews working under the direct supervision of a qualified nurseryman or landscape specialist.

Planting operations shall not be started, nor shall any planting stock be delivered to the Project site, until it has been determined by the Engineer that weather and soil conditions are suitable for planting and that all necessary preparations have been made.

During placement, the Contractor shall install all components consecutively without significant lapse of time between each phase of the operation. On slopes, installation of material shall start at the

bottom of slope and proceed in horizontal lifts upward. On shorelines and banks, installation of material shall start below the water line and proceed up the bank.

During the work, the Contractor shall take all necessary precautions and actions to prevent siltation and turbidity of flowing or impounded waters of the State. When working in water, the Contractor shall protect the work site if necessary with curtains, barriers or other containment devices so that sediment and debris does not enter the receiving water body.

B Harvesting Plant Stock

Plant stock and cuttings shall be obtained from the regions and/or zones indicated in the Plans.

At least 3 days prior to harvesting of planting stock for the Project site, the Contractor shall notify the Engineer of the contemplated harvest date to allow for inspection.

C Season of Placement

The approximate dates for season of placement are listed in Table 2577-1. The Engineer may adjust a specified date by up to 20 days depending on prevailing weather conditions.

Plant material must be in dormant stage, prior to buds bursting open in spring or after leaves have changed color and dropped in fall.

TABLE – 2577-1

APPROXIMATE SEASON OF PLACEMENT

SYSTEM	SPRING	FALL
Wattling	Prior to April 15 th	After Nov 1 st
Brush Layering	Prior to April 15 th	After Nov 1 st
Live Stake	Prior to April 15 th	After Nov 1 st
Root-Rap	April 15 - June 10 th	July 20 - Sept 20 th

D Wattling

This work shall consist of making trenches along the contours of the slope, placing bundles of dormant plant cuttings into the trenches, and tamping loose soil over the bundles. Prior to trenching, the Contractor shall drive wooden stakes 50 mm (**2 inches**) in diameter x ½ m (**2 foot**) long, 0.4 m (**16 inches**) on center along each trench location. The stakes shall be driven to a firm hold with the tops about 150 mm (**6 inches**) above grade. Trenching shall not precede installation of plant materials by more than 1 hour to minimize drying of soils. The overall soil surface shall be left in a rough condition with clods, and ridges left in place for maximum resistance to erosion. Immediately following trenching, the Contractor shall place bundles of dormant plant cuttings into the trench. Bundles shall have cuttings laid together with the buttends located at alternate ends of the bundle and tightly tied with binder twine at a minimum of three points along the

2577.3

bundle. Bundles shall consist of 9.5-50 mm (**3/8-2 inch**) diameter, 1-2.4 m (**3-8 foot**) length dormant woody cuttings. The bundle should be approximately 150-200 mm (**6-8 inches**) in diameter. Wattle ends shall overlap in the trench. Additional stakes shall be driven through the bundles at a maximum spacing of ½ m (**2 feet**) on center. During placement of the bundles, the Contractor shall cover the bundles with loose soil working it into the wattles leaving a uniform fringe of plant material that is exposed approximately 50 to 80 mm (**2-3 inches**) high.

E Brush Layering

This work shall consist of making horizontal slots the length of the slope and embedding dormant green plant cuttings into the slots and tamping loose soil over the cuttings. The slots are 0.61 m (**2 feet**) in depth angled downward into the slope. The plant cuttings shall consist of stems approximately 1 m (**3 feet**) long, 10 to 50 mm (**½ - 2 inches**) in diameter. Cuttings shall be placed in containers of water to transport until installed. As soon as practical after the slots are made, the Contractor shall place the plant cuttings into this slot with the butt end placed as far into the slot as possible with a minimum of 150 mm (**6 inches**) protruding out of the slot. The stems shall be placed randomly with some crisscrossing. As the plant cuttings are being placed, the Contractor shall immediately backfill the slot cuttings with soil and firm the backfill to the satisfaction of the Engineer.

F Live Stakes

This work involves the insertion of dormant live cuttings into the soil. Cuttings shall consist of stems at least 1 m (**3 feet**) in length and 25-50 mm (**1-2 inch**) in diameter. Materials should be cut and placed in a container of water to be transported to the site and kept in water until installed. Tamp the cutting with the bottom end going into the ground at right angles to the slope face, 2/3 - 3/4 of their length. Care shall be taken not to split the ends or damage the bark of the cuttings. Placement shall be .67 m (**2 feet**) on center using a triangular spacing. Density of the installation will range from 2-4 stakes/m² (**square yard**).

Rip rap can be staked (joint planting) if it is not too thick (less than 0.67 m (**2 feet**)). The Contractor shall make a pilot hole by driving a tool, as a pry bar or rebar, through the rip rap and filter layer, reaching the ground soil. Tamping can best be done with a dead blow hammer, avoiding damage to the bark. Place the cuttings in a random configuration 0.67 m (**2 feet**) on center.

G Placing Fiber log

This work shall consist of placing biodegradable fiber log for stabilizing a shoreline. Prior to installing the fiber log, the Contractor shall drive wooden stakes 50 mm (**2 inches**) in diameter x 1 m (**3 feet**) long, 0.3 m (**1 foot**) on center along the proposed alignment of the fiber

2577.4

log. The stakes shall extend 200 to 250 mm (**8-10 inches**) above the elevation of the water surface indicated on the plans. After the stakes are placed, the Contractor shall install the fiber log so that the upper surface of the fiber log is parallel to the water surface with 50 mm (**2 inches**) protruding above the normal water level. Fiber logs shall be lace together end to end with woven nylon twine 3 mm (**1/8 inch**) in diameter to create a continuous length. The Contractor shall bury both ends of the fiber rolls 1 ½ m (**5 feet**) laterally into the bank.

H Root-Rap

This work shall consist of placing a gravel channel lining or riprap, and overseeding or planting the completed channel. The Contractor shall conduct this work in conformity with the details, typical sections and elevation controls shown in the contract. Actual alignment shall be as staked by the Engineer. During the work, the Contractor shall place the granular channel lining or riprap and shape the channel to completed section as a continuous operation. Seeding or planting shall be initiated within 48 hours.

I BLANK

J BLANK

K Acceptance of Work

Except as otherwise provided for in the Contract, the Engineer will accept soil bioengineered systems upon satisfactory placement.

2577.4 METHOD OF MEASUREMENT

A Wattling

Wattling will be measured by the meter (**linear feet**) of each trench made and planted. When several trenches are made and planted, each length of trench acceptably planted shall be added to the total. Plant cuttings, bundles and stakes shall be incidental.

B Brush layering

Brush layering will be measured by the meter (**linear feet**) of each horizontal slot made and planted. When several slots are made and planted, each length of slot acceptably planted shall be added to the total. Plant cuttings and stakes shall be incidental.

C Fiber log

Fiber log will be measured by the meter (**linear feet**) furnished and installed including buried portions. Stakes and rope to fasten logs in place shall be incidental.

D Granular channel liner

Granular channel liner will be measured by volume in cubic meter (**cubic yard**) placed and in its final configuration.

E Concrete Armor Units

Concrete Armor Units will be measured by surface area covered by each size furnished and acceptably installed including the buried

2577.4

portions. The outermost extremity of the units shall be used in the measurement. On small projects, concrete armor units will be accepted by the number of complete units (two individual halves) assembled and installed.

2577.5 BASIS OF PAYMENT

Payment for bio-engineered system items will be compensation in full for all labor, materials, equipment, and other incidentals necessary to complete the work as required by the Contract. The Contractor will receive compensation at the appropriate Contract prices, or in the absence of a Contract bid price as Extra Work.

A Pay Items

Payment for bioengineered system items will be made on the basis of the following schedule:

Item No.	Item	Unit
2577.501	Wattling.....	meter (linear feet)
2577.502	Brush Layering.....	meter (linear feet)
2577.503	Fiber Log.....	meter (linear feet)
2577.504	Granular channel Liner.....	cubic meter (cubic yard)
2577.505	Live Stakes.....	Each
2577.506	Concrete Armor Units (1).....	Each
2577.507	Concrete Armor Units (1)....	square meter (square yards)

(1) Specify Size

2581

Removable Preformed Plastic Pavement Marking

2581.1 DESCRIPTION

This work shall consist of furnishing, placing and removing temporary pavement marking material on those pavements open to traffic where traffic markings are necessary and temporary lane markings are not appropriate.

2581.2 MATERIALS

Removable Preformed Plastic Pavement Marking for Traffic Lane Delineation and Legends 3355

2581.3 CONSTRUCTION REQUIREMENTS

Removable preformed plastic pavement marking shall be furnished and placed by the Contractor at locations and with proper dimensions as indicated in the Plans or as directed by the Engineer immediately prior to modification of traffic flow. Placement shall be on a clean and dry surface in accordance with the contract documents. Removed marking material shall be disposed of properly.

2582.2

2581.4 METHOD OF MEASUREMENT

Removable preformed plastic pavement marking will be measured by the actual length of pavement marking furnished, placed, and removed as specified.

The measurement is based on a 100 mm (4 inches) wide marking, regardless of color or type. Measurement for marking widths differing from the 100 mm (4 inches) width will be adjusted by the ratio of the actual width to the 100 mm (4 inches) width. Broken line marking will be measured by the actual length of material used and will not include gaps between the broken lines.

2581.5 BASIS OF PAYMENT

Payment for removable preformed plastic pavement marking at the Contract price per unit of measure will be compensation for all costs of furnishing, placing, maintaining, replacing, and removing the marking.

Payment for the marking will be made on the basis of the following schedule:

Item No.	Item	Unit
2581.501	Removable Preformed Plastic Marking	
meter (linear foot)	

2582

Permanent Pavement Markings

2582.1 DESCRIPTION

A Pavement Messages

Pavement messages are word and symbol pavement markings installed in the roadway. These markings include all word and symbol messages that are not line segments.

B Linear Pavement Markings

Linear pavement markings are those pavement markings installed in the roadway that are line segments of various widths. These markings include lane lines, center lines, no passing zone lines, and edge lines, airplane markings, and stop lines. These markings do not include crosswalk markings or messages.

C Crosswalk Markings

These markings include crosswalk blocks that are installed parallel to the direction of travel on the roadway. Crosswalk markings are blocks installed in the roadway parallel to the direction of travel in a pattern that is transverse to the direction of travel.

2582.2 MATERIALS

Qualified materials can be found on Mn/DOT's Qualified Products List on the Office of Traffic, Security and Operations website. Other materials may be used on a provisional basis as detailed in the QPL

2582.2

process and as approved by the Engineer. Type of material used will be as specified by contract documents.

2582.3 CONSTRUCTION REQUIREMENTS

A Prequalification

This Pavement Marking Qualification and Acceptance Program has been developed and implemented to insure that quality materials and workmanship are used on Mn/DOT pavement marking projects.

A1 Certification of Materials

Acceptance of pavement marking materials under the Pavement Marking Qualification and Acceptance Program is based on the product's certification and quality control testing verified by Mn/DOT Laboratory testing of verification samples and spot checks on samples obtained from contractor stock or from project sites. Products meeting the requirements of the Pavement Marking Qualification and Acceptance Program will be placed on the Qualified Products List. Products can be removed from the Qualified Products List due to poor field performance.

A2 Approved Contractors

Only contractors approved through Mn/DOT's Pavement Marking Qualification and Acceptance Program will be awarded contracts. Contractors may be removed from the approved contractor list due to poor performance.

B Application

Place markings on roadways in accordance with contract documents.

C ACCEPTANCE

Pavement markings in Minnesota shall retain a satisfactory level of retroreflectivity, demonstrate good adhesion, resisting chipping, and exhibit consistency of color in all lighting conditions.

C1 Alignment

Minimum linear pavement marking shall not be less than the specified width and shall not vary by more than 6 mm (.25 in). The width will not vary by a rate more than 6 mm / 3 m (.25 in/10 ft). The length of broken line segments shall not vary by more than 75 mm (3 in) and the number of broken line segments shall be between 102 and 108 per mile of marked pavement. Alignment deviations from the control guide or existing lines specified by the Engineer shall not exceed 50 mm (2 in). The transverse position of linear markings shall not vary more than the rate of 25 mm / 3 m (1 in/10 ft). Pavement marking material shall not be applied over a longitudinal joint.

C2 Color

The color of white pavement marking shall be a pure flat white and free of tints. The color of the yellow epoxy shall match Color Number

33538 of Federal Standard 595 and shall conform to the following CIE Chromaticity limits using illuminant "C".

C3 Retroreflectivity – minimum initial pavement marking retroreflectivity using 30 m geometry shall be:

	White	Yellow
Tape	600 mcd	500 mcd
Epoxy	300 mcd	200 mcd
Latex	275 mcd	180 mcd

D Pavement Marking Warranty

All warranties shall be transferred to Mn/DOT after construction.

E Correction of Defects

Pavement markings that do not conform to the requirements of the contract shall be replaced or repaired to the satisfaction of the Engineer.

Removal of unacceptable work shall be accomplished using suitable methods as approved by the Engineer.

F Penalties

Penalties will be assessed by the Engineer where initial retroreflectivity fall below the minimum acceptable levels. If the retroreflectivity deficiency is greater than 20% the work shall be removed or repaired to the satisfaction of the Engineer. If the deficiency is 20% or less, the Engineer may require satisfactory repair or may accept the work at a reduced unit price. The unit price will be reduced by the percent of retroreflectivity deficiency.

G Striper Operations Daily Form

Contractors applying pavement markings for Mn/DOT under a contract **are required** to fill out the "Construction Striper Operations Daily Log" form which is shown in the special provisions and as approved by the Engineer. **No payment for pavement markings shall be made until the form is completed and submitted to the Engineer.**

2582.4 METHOD OF MEASUREMENT

A Pavement Messages

Pavement messages of each type will be measured by the number of each type installed as specified

B Lines

Pavement markings will be measured by the length of each type constructed in place as specified. Broken lines will be measured by the actual length of line marked and will not include the gap between the broken lines.

C Crosswalk Blocks

Crosswalks shall be measured by area of material sq m (**sq ft**) installed as specified and by type.

2582.5

2582.5 BASIS OF PAYMENT

Payment for pavement markings installed at contract prices per unit of material shall be compensation in full for all costs incurred in materials, traffic control, installation, surface preparation, use of primers, in accordance to contract documents or as approved by the Engineer.

Item No.	Item	Unit
2582.501	Pavement Message (1) (2)	Each
2582.502	Linear Markings __ mm (__ inch) width (2) (3) (4) meter (linear foot)	
2582.503	Crosswalks (2).....	square meter (square foot)
(1)	Specify Message	
(2)	Specify Material	
(3)	Specified Type of Line (Solid, Broken or Dotted)	
(4)	Specify Color	