Item 610
Roadway Illumination Assemblies

1. DESCRIPTION

1.1. **Installation**. Furnish, fabricate, and install roadway illumination assemblies.

1.2. **Relocation**. Remove and relocate existing roadway illumination assemblies.

1.3. **Removal**. Remove existing roadway illumination assemblies.

1.4. **Replace Luminaires (Light Fixtures)**. Remove and replace existing luminaires.

2. MATERIALS

Provide new materials ~~that comply with the details~~as shown on the plans~~, the requirements of~~ and in accordance with this Item~~, and the pertinent requirements of~~ and the following Items~~:~~.

- Item 416, "Drilled Shaft Foundations"
- Item 421, "Hydraulic Cement Concrete"
- Item 441, "Steel Structures"
- Item 442, "Metal for Structures"
- Item 445, "Galvanizing"
- Item 449, "Anchor Bolts"
- Item 616, "Performance Testing of Lighting Systems"
- Item 618, "Conduit"
- Item 620, "Electrical Conductors"

Fabrication plants that produce roadway illumination poles, including luminaire arms, must be approved in accordance with DMS-7380, "Steel Non-Bridge Member Fabrication Plant Qualification." This includes fabricators of aluminum roadway illumination poles and luminaire arms. The ~~Construction~~Materials and Tests Division maintains a list of approved fabrication plants of roadway illumination poles.

Furnish light fixtures from new materials that are in accordance with DMS-11010, "Roadway Illumination Light Fixtures."

Provide prequalified light fixtures from the Department's MPL. When required by the Engineer, notify the Department in writing of selected materials from the MPL intended for use on each project.

Do not provide shop drawings for complete assemblies that are fabricated in accordance with this Item and the details shown on the plans. Electronically submit shop drawings in accordance with Item 441~~, "Steel Structures,"~~ for optional multi~~-~~sided steel pole designs; optional aluminum pole designs; and non-standard designs, required when basic wind speeds or pole base mounting heights at the installation locations ~~are in excess of~~exceed those shown ~~on~~in the Roadway Illumination Pole (RIP) standard. Manufacturers may request that the Department add their submitted shop drawings and design calculations to a pre-approved list of optional and non-standard pole designs, maintained by the Traffic ~~Operations~~Safety Division.

Hot-dip galvanize fabricated pole sections and associated parts in accordance with Item 445~~, "Galvanizing." Punch~~. Provide punched, drilled, or ~~drill~~mechanically guided thermal-cut holes in steel parts or members, when allowed, before galvanizing. Mechanically guided thermal-cut hole quality will be in accordance with Item 445.

When shown on the plans, paint galvanized poles in accordance with ~~the plans for uncoated structures and in accordance with~~ Item 445~~, "Galvanizing" for galvanized structures~~.

3. CONSTRUCTION

Perform work ~~in accordance with the details~~as shown on the plans and ~~the requirements of~~ in accordance with this Item. Permanently mark roadway illumination pole base plates, at a visible location when erected, with the fabrication plant's insignia or trademark. ~~Sample fixtures for testing in accordance with Tex-1110-T.~~

Use established industry and utility safety practices when installing, relocating, or removing poles or luminaires located near overhead or underground utilities. Consult with the appropriate utility company before beginning work.

Prevent scarring or marring of the poles, luminaire arms, and luminaires. Replace damaged components. Repair damaged galvanizing in accordance with Section 445.3.~~5~~4., "Repairs." Repair damaged painted areas of a roadway illumination assembly in accordance with Item 441~~, "Steel Structures"~~ or Item 445~~, "Galvanizing."~~.

Stake, install, and align each roadway illumination assembly as shown on the plans.

The Engineer may shift an assembly's location, if necessary, to secure a more desirable location or avoid conflict with utilities.

Construct foundations for roadway illumination assemblies in accordance with Item 416~~, "Drilled Shaft Foundations," and the details~~ and as shown on the plans.

3.1. **Installation**. Furnish and install roadway illumination assembly components ~~in accordance with the details, dimensions, and requirements~~as shown on the plans. Do not use screw-in type foundations. Install anchor bolts and coat anchor bolt threads in accordance with Item 449~~, "Anchor Bolts."~~. Erect structures after foundation concrete has attained its design strength as ~~required~~shown on the plans and in accordance with Item 421~~, "Hydraulic Cement Concrete."~~. Tighten anchor bolts for poles with shoe bases and concrete traffic barrier base poles in accordance with Item 449~~, "Anchor Bolts."~~. Do not place grout between base plate and foundation. Test installed roadway illumination assemblies in accordance with Item 616~~, "Performance Testing of Lighting Systems."~~.

3.2. **Relocation**. Relocate roadway illumination assembly components ~~in accordance with the details, dimensions, and requirements~~as shown on the plans. Do not use screw~~-~~in type foundations. Install existing structures on new foundations in accordance with Section 610.3.1., "Installation." Do not place grout between base plate and foundation. Test installed roadway illumination assemblies in accordance with Item 616~~,~~ ~~"Performance Testing of Lighting Systems."~~.

Disconnect and remove conductors from abandoned circuits. Remove abandoned conduit or ducts to a point 6 in. below final grade. Reconnect conduit and ducts to be reused. Replace damaged conduit and ducts. Replace conductors.

Unless otherwise shown on the plans, remove abandoned concrete foundations and replace surfacing in accordance with Section 610.3.3., "Removal." Do not remove existing concrete bridge lighting brackets.

Furnish and install new internal conductors, fused and unfused connectors, and lamps~~.~~ if present. Clean optical assembly. Furnish and install new transformer bases that meet AASHTO and plan requirements when relocating transformer base poles. Destroy existing transformer bases to prevent reuse.

Accept ownership and dispose of unsalvageable materials ~~and dispose of~~ in ~~accordance~~conformance with federal, state, and local regulations.

3.3. **Removal**. Remove roadway illumination assembly components in ~~accordance~~conformance with established industry and utility safety practices.

Remove transformer bases from transformer base poles. Destroy removed transformer bases to prevent reuse. Remove luminaires and luminaire arms from the pole shaft. Stockpile pole shafts, luminaire arms, and assembly hardware at a location designated by the Department. Pole shafts, luminaire arms, and assembly hardware will remain Department property unless otherwise shown on the plans or ~~as~~ directed.

Disconnect and remove conductors from abandoned circuits. Remove abandoned conduit and ducts to a point 6 in. below final grade.

Unless otherwise shown on the plans, remove abandoned concrete foundations, including steel, to a point 2 ft. below final grade. Backfill the hole with material that is equal in composition and density to the surrounding area. Replace surfacing material with similar material to an equivalent condition. Do not remove existing concrete bridge lighting brackets.

Accept ownership and dispose of unsalvageable materials ~~and dispose of~~ in ~~accordance~~conformance with federal, state, and local regulations.

3.4. **Replace Luminaires**. Remove existing luminaires. Furnish and install luminaires ~~in accordance with the details, dimensions, and requirements~~as shown on the plans. Replace conductors and breakaway fuse holders when necessary. Test installed luminaires in accordance with Item 616~~, "Performance Testing of Lighting Systems."~~.

4. MEASUREMENT

This Item will be measured as each roadway illumination assembly installed, relocated, or removed~~;~~, or by each luminaire replaced.

5. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Install Roadway Illumination Assemblies" of the types specified, "Relocate Roadway Illumination Assemblies" of the types specified, "Remove Roadway Illumination Assemblies" of the types specified, or "Replace Luminaires" of the types specified. The Department will pay for electrical energy consumed by the lighting system.

New drilled shaft foundations will be paid for under Item 416~~, "Drilled Shaft Foundations."~~. New concrete riprap placed around foundations will be paid for under Item 432, "Riprap." New conduit will be paid for under Item 618~~, "Conduit."~~. New conductors, except the conductors internal to the pole, will be paid for under Item 620~~, "Electrical Conductors."~~. New duct cable will be paid for under ~~Item 622~~Special Specification, "Duct Cable." New ground boxes will be paid for under Item 624, "Ground Boxes." New electrical services will be paid for under Item 628, "Electrical Services."

5.1. **Installation**. This price is full compensation for furnishing, installing, and testing luminaires; furnishing and installing lamps, luminaire arms, brackets, poles, anchor bolt assemblies, templates, internal conductors, and connections; conducting system performance testing; and materials, equipment, labor, tools, and incidentals.

5.2. **Relocation**. This price is full compensation for salvaging and relocating the existing conduit and duct; removing existing foundations, backfilling, and surface placement; removing, erecting, connecting, and testing illumination assemblies; removing existing conductors; furnishing and installing new anchor bolt assemblies, templates, transformer bases, lamps, connections, and conductors; replacing damaged components; disposing of unsalvageable materials; and materials, equipment, labor, tools, and incidentals.

5.3. **Removal**. This price is full compensation for removing, salvaging, disassembling, and stockpiling illumination assemblies; salvaging and relocating existing conduit; removing existing foundations; backfilling and surface placement; splicing existing conductors; disposing of unsalvageable materials; and materials, equipment, labor, tools, and incidentals.

5.4. **Replace Luminaires**. This price is full compensation for removing, salvaging, disassembling, and stockpiling existing luminaires; furnishing and installing new luminaires, connections, and conductors internal to the pole; replacing damaged components; disposing of unsalvageable materials; and materials, equipment, labor, tools, and incidentals.

Item 613
High Mast Illumination Poles

1. DESCRIPTION

Furnish and install high mast illumination poles.

2. MATERIALS

Provide new materials that comply with the details shown on the plans~~,~~ and the requirements of this Item~~,~~ and the ~~pertinent requirements of the~~ following Items~~:~~.

- Item~~-~~ 416, “Drilled Shaft Foundations”
- Item~~-~~ 421, “Hydraulic Cement Concrete”
- Item 432, “Riprap”
- Item~~-~~ 441, “Steel Structures”
- Item~~-~~ 442, “Metal for Structures”
- Item~~-~~ 445, “Galvanizing”
- Item~~-~~ 449, “Anchor Bolts”
- Item~~-~~ 618, “Conduit”

Use alloy steel or medium strength mild steel anchor bolts that comply with Section~~-~~ 449.2.1., “Bolts and Nuts.”

3. CONSTRUCTION

Perform work ~~in accordance with the details~~as shown on the plans~~,~~ and ~~the requirements of~~ in accordance with this Item. Provide components that fit together properly.

Use established industry and utility safety practices when installing high mast poles located near overhead or underground utilities. Consult with the appropriate utility company before beginning work.

3.1. **Standard Design**. Fabricate poles in accordance with this Item and the plans. Alternate designs are not permitted.

3.2. **Shop Drawings**. Do not submit shop drawings for high mast illumination poles fabricated in accordance with this Item and the plans.

3.3. **Fabrication**. Fabricate and weld in accordance with Item 441, ~~“Steel Structures,”~~ AWS D1.1, ~~*Structural Welding Code—Steel,*~~ and ~~the requirements of~~ this Item. Match-mark pole shaft sections as shown on the plans.

Fabrication plants that produce high mast illumination poles must be approved in accordance with DMS-7380, “Steel Non-Bridge Member Fabrication Plant Qualification.” The ~~Construction~~Materials and Tests Division maintains ~~a list~~an MPL of approved high mast illumination pole fabrication plants.

Provide circumferential welds only at the top attachment and base plates. Grind or smooth the longitudinal seam welds to the same radius as contacted shaft corners for the length of the lap plus at least 6 in. at each slip~~-~~joint splice. Ensure acceptable seam weld profiles for the remainder of the pole ~~exterior~~shaft. Provide full~~-~~penetration longitudinal seam welds for a length of 1.5 diameters plus at least 6 in. in outer sections at splices and base plates. Provide 85% minimum penetration in longitudinal seam welds at other pole sections.

Perform at least 10% ultrasonic testing (UT) of longitudinal seam welds using a Department-approved procedure to ensure 85% minimum penetration where specified. Perform testing at a minimum of three locations on each shaft (top, middle, and bottom). The minimum length of each test area must be 10 in. If minimum penetration is not achieved in any of the tested areas, test an additional 24 in. beyond the originally selected test areas requiring 85% penetration. Test the entire shaft seam weld if any locations within the additional 24 in. test areas do not achieve 85% penetration. Repair the deficient areas using a Department-approved repair procedure and retest to confirm minimum penetration. Provide longitudinal seam weld and fit-up that will minimize acid entrapment during later galvanizing. Use at most ~~2~~ two longitudinal seam welds in each section.

Permanently mark each pole base plate with the insignia ~~or trademark~~ of the fabrication plant. Place the mark on the pole base plate adjacent to the handhole access compartment.

Hot-dip galvanize fabricated pole sections and associated parts in accordance with Item 445~~, "Galvanizing."~~ ~~Punch~~. Provide punched, drilled, or ~~drill~~mechanically guided thermal-cut holes in steel parts or members, when allowed, before galvanizing. Mechanically guided thermal-cut hole quality will be in accordance with Item 445. Fabrication tolerances are ~~given~~shown in Table 1.

~~Provide ultrasonic testing (UT)~~ Perform UT of the shaft to base plate weld joint after galvanizing with a Department-approved procedure ~~approved by~~to determine if any toe cracks are present in the ~~Department. Perform UT at this joint after galvanizing~~ground sleeve. Remove and repair toe cracks with an approved repair procedure and retest.

Table 1
Fabrication Tolerances

Part	Dimension	Tolerance (in.)
Pole shaft	Length (unassembled sections)	±1
	Shaft ~~Thickness~~[1]thickness[1]	+0.12, ~~–~~-0.02
	~~I.D.~~Inside diameter of outside slip fitting	+1/8, ~~–~~-1/16
	~~O.D.~~Outside diameter of inside slip fitting	+1/32, ~~–~~-1/8
	Difference between flats or ~~diameter~~diameter[2]	±1/4
	Straightness	1/8 in 10 ft.
	Attachment locations	±1
Assembled pole shaft	Perpendicular to base plate	1/8 in 24 in.
	Shaft centered on base plate	±1/4
	Twist in ~~shaft~~[2]shaft[3]	4° in 100 ft.
	Position of winch channel	±1/4
Base plate	Overall	±1/4
	Thickness	+1/4, ~~–~~-1/16
	Deviations from flat	3/16 in 24 in.
	Spacing between holes	±3/16
	Bolt hole size	±1/16
Anchor bolt templates	Outside diameter	±1/8
	Inside diameter	+1/4
	Thickness	+1/4, ~~–~~-1/32
	Spacing between holes	±1/16
	Bolt hole size	±1/16
Anchor bolts	Length	±1/2
	Threaded ~~Length~~length	±1/2
	Galvanized ~~Length~~length	~~–~~-1/4
~~Misc.~~Miscellaneous	Bolt hole spacing	±1/16

1. Adjust pole diameter if shaft thickness exceeds nominal thickness by 0.02 in. or more. Change the splice length for this adjustment.
2. Applies only to bottom end of bottom shaft section, and top end of the top shaft section.
~~2.~~3. The Department may accept an excessive twist for individual pole sections, provided the top of pole is within twist tolerance for assembled sections.

3.4. **Installation**. Stake and install high mast illumination poles as shown on the plans. The Engineer may shift the assembly locations, within design guidelines, where necessary to secure a more desirable location or to avoid conflict with utilities.

Use established industry and utility safety practices when installing poles located near overhead or underground utilities. Consult with the appropriate utility before beginning work.

Prevent scarring or marring of the poles. Repair galvanized surfaces damaged in assembly, transit, or installation~~;~~, or for steel parts or members welded after galvanizing, in accordance with Section 445.3.~~5~~4., "Repairs."

Provide riprap around pole foundations in accordance with Item 432~~, "Riprap,"~~ and ~~the details~~as shown on the plans.

3.4.1. **Foundations**. Construct foundations for high mast illumination poles in accordance with Item 416~~, "Drilled Shaft Foundations," and the details~~ and as shown on the plans.

Before placing concrete for the drilled shaft foundation, inspect anchor bolts to verify proper projecting length of bolts, bolt pattern, orientation of pattern, bolt alignment, and bolt galvanizing are as shown on the plans. Orient anchor bolts to provide ~~2~~ two bolts on the reference line as shown on the plans. Ensure the anchor bolts are electrically bonded to the reinforcing steel as shown on the plans.

Ensure anchor bolts and templates are rigidly held in position during concrete placement. Positioning devices may be tack welded to steel template, but not to any portion of the anchor bolts. Hold conduit in place with a bar attached to the upper template and cap conduit before placing concrete. Ream conduit to remove burrs and sharp edges after placing concrete. Install bell ends or bushings on the conduit.

3.4.2. **Pole Assembly**. Assemble poles on blocking using ~~a minimum of 2~~at least two hydraulic rams at the splices. Support the free end of the section being assembled ~~with~~using hoist equipment. Apply assembly force using hydraulic rams with sufficient capacity to properly draw the sections together with little or no remaining gaps. Mark poles with permanent ink to indicate designed lap length. Ensure splices are a minimum of 90% or a maximum of 110% of the planned lap. Mark the 90% and 110% locations before assembling the pole. Obtain written approval from the Department for splices that do not meet lap tolerances before erecting the pole.

3.4.3. **Pole Installation**. Install structures after foundation concrete has attained its design strength as ~~required~~shown on the plans and in accordance with Item 421~~, "Hydraulic Cement Concrete."~~. Coat anchor bolt threads and tighten anchor bolts in accordance with Item 449~~, "Anchor Bolts."~~. Erect and align the poles within 12 in. of vertical. Use enough temporary slings, chains, or wire rope to prevent unintentional separation of the pole sections. Orient poles so a worker can see into the access hole while facing oncoming traffic.

After the high mast pole has been plumbed and all nuts are tight, tack weld each anchor bolt nut to its washer in ~~2~~two places and tack weld each washer to the base plate in ~~2~~two places. Tack weld in accordance with Item 441, ~~"Steel Structures," the~~ AWS D1.1, ~~*Structural Welding Code—Steel,*~~ and ~~the requirements of~~ this Item. Never weld components to the bolt. Repair galvanizing damage on bolts, nuts, and washers in accordance with Section 445.3.~~5~~4., "Repairs," after tack welding. Do not grout between the base plate and foundation.

4. MEASUREMENT

This Item will be measured as each high mast illumination pole installed.

5. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "High Mast Illumination Poles" of the wind design and

height specified. This price is full compensation for furnishing, fabricating, galvanizing, assembling, and installing the pole on a foundation; anchor bolts, nuts, washers, and templates; conduit, ground rods, and wiring; and materials, equipment, labor, tools, and incidentals.

New drilled shaft foundations will be paid for under Item 416, ~~"Drilled Shaft Foundations."~~. New riprap will be paid for under Item 432, ~~"Riprap."~~. New high mast illumination assemblies will be paid for under Item 614, "High Mast Illumination Assemblies." New ground boxes will be paid for under Item 624, "Ground Boxes." New electrical services will be paid for under Item 628, "Electrical Services."

Item 614
High Mast Illumination Assemblies

1. DESCRIPTION

1.1. **Installation**. Furnish and install high mast illumination assemblies.

1.2. **Replace Luminaires (Light Fixtures)**. Remove and replace existing luminaires.

2. MATERIALS

Provide new materials that comply with the details shown on the plans, the requirements of this Item, and the pertinent requirements of the following Items~~:~~.

- Item 441, "Steel Structures"
- Item 442, "Metal for Structures"
- Item 445, "Galvanizing"
- Item 616, "Performance Testing of Lighting Systems"
- Item 620, "Electrical Conductors"

Fabrication plants that produce high mast rings and support assemblies must be approved in accordance with DMS-7380, "Steel Non-Bridge Member Fabrication Plant Qualification." The Department maintains an MPL of approved high mast ring and support assembly fabrication plants.

Furnish light fixtures from new materials ~~that are~~ in accordance with DMS-11020, "High Mast LED Light Fixtures."

Furnish other high mast components from new material ~~that are~~ in accordance with DMS-11021, "High Mast Illumination Assembly Kits."

Provide ~~prequalified~~pre-qualified high mast illumination assembly kits and light fixtures from the Department's MPL. When required by the Engineer, notify the Department in writing of selected materials from the MPL intended for use on each project.

Do not provide shop drawings for high mast ring and support assemblies fabricated in accordance with this Item and ~~the details~~as shown on the plans. For proposed deviations that do not affect the basic structural behavior of the high mast ring and support assembly, electronically submit shop drawings in accordance with Item 441~~, "Steel Structures."~~. The submission of shop drawings is only required the first time each proposed non-structural deviation is used. Structural deviations from the approved drawings are not permitted.

3. CONSTRUCTION

Perform work ~~in accordance with the details~~as shown on the plans and ~~the requirements of~~ in accordance with this Item.

3.1. **Installation**. Permanently mark each high mast ring and support assembly with the insignia ~~or trademark~~ of the fabrication plant. Place the mark at an approved location. Galvanize the ring assemblies, assemble the ring halves and support assembly in the shop to ensure proper fit, and match-mark the ring halves and support assembly before shipping. Prevent scarring or marring of the ring assemblies. Replace damaged components.

Repair damaged galvanized areas of the ring assembly in accordance with Section 445.3.5., "Repairs."

~~Before installation, sample and test fixtures in accordance with Tex-1110-T.~~ Test installed ~~fixtures~~luminaires in accordance with Item 616~~, "Performance Testing of Lighting Systems."~~.

3.2. **Replace Luminaires**. Remove existing luminaires. Furnish and install luminaires in conformance with the details, dimensions, and requirements shown on the plans. Orient and aim luminaires in the same direction as the original luminaires or as shown on the plans. Test installed luminaires in accordance with Item 616.

4. MEASUREMENT

This Item will be measured as each high mast illumination assembly installed, or by each luminaire set replaced.

5. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Install High Mast Illumination Assemblies" or "Replace High Mast Luminaires" of the types specified. The Department will pay for electrical energy consumed by the lighting system.

New poles for high mast illumination assemblies will be paid for under Item 613, "High Mast Illumination Poles." New electrical services will be paid for under Item 628, "Electrical Services."

5.1. **Installation**. This price is full compensation for furnishing, installing, and testing light fixtures, ~~ballasts, lamps,~~ wire rope, rings, and ring support assemblies; aiming light fixtures; furnishing and installing obstruction lights, hoisting assemblies, power drive assemblies, transformers, conductors on the load side of the high mast pole's disconnect, electrical equipment, electrical cord, and junction boxes and enclosures; conducting system performance testing; and materials, equipment, labor, tools, and incidentals.

5.2. **Replace Luminaires**. This price is full compensation for removing, salvaging, disassembling, and stockpiling existing luminaires; furnishing and installing new luminaires, connections, and conductors on the high mast ring; replacing damaged components; disposing of unsalvageable materials; and materials, equipment, labor, tools, and incidentals.

~~New poles for high mast illumination assemblies will be paid for under Item 613, "High Mast Illumination Poles." New electrical services will be paid for under Item 628, "Electrical Services." The Department will pay for electrical energy consumed by the lighting system.~~

Item 616
Performance Testing of Lighting Systems

1. DESCRIPTION

Test the performance of roadway and high mast lighting systems.

2. CONSTRUCTION

Perform tests on the lighting system and tests required by Item 618, "Conduit~~,~~"; Item 620, "Electrical Conductors~~,~~"; and ~~Item 622~~Special Specification, "Duct Cable." Ensure all components are properly installed.

Place the lighting system in operation for a 14-day test period. Burn the lighting system steadily for 48 hr~~. Then~~., then cycle the photocell or other control device for 12 days.

Pass a 14-day performance test of the lighting system.

Replace materials that are damaged or have failed before acceptance. Damaged illumination assemblies, except those damaged by the Contractor, and minor failures of lamps, ballasts, and photocells are not cause for modifying or restarting the performance test.

Replace failed or damaged existing lighting system components when caused by the Contractor.

The Department will relieve the Contractor of maintenance responsibilities upon passing a 14-day performance test of the lighting system~~ and acceptance of the Contract~~.

3. MEASUREMENT AND PAYMENT

The work performed, materials furnished, equipment, labor, tools, and incidentals will not be measured or paid for directly, but will be subsidiary to pertinent Items. The Department will pay for electrical energy consumed by the lighting system.

Item 617
Temporary Roadway Illumination

1. DESCRIPTION

- **Setup and Removal**. Furnish ~~and~~, install, relocate, and remove temporary roadway illumination.
- **Maintenance.** Operate and maintain temporary roadway illumination.

2. MATERIALS

Furnish new or used materials that comply with the details shown on the plans, the requirements of this Item, and the pertinent requirements of the following Items, except for ~~measurement~~"Measurement" and ~~payment:~~"Payment."

- Item 416, "Drilled Shaft Foundations"
- Item 610, "Roadway Illumination Assemblies"
- Item 613, "High Mast Illumination Poles"
- Item 614, "High Mast Illumination Assemblies"
- Item 618, "Conduit"
- Item 620, "Electrical Conductors"
- Item 621, "Tray Cable"
- ~~Item 622~~Special Specification, "Duct Cable"
- Item 624, "Ground Boxes"
- Item 627, "Treated Timber Poles"
- Item 628, "Electrical Services"

Provide utility-grade aluminum service drop cable consisting of one bare aluminum conductor, steel -reinforced (ACSR), supporting ~~2~~ two or more insulated conductors for overhead electrical work.

Use materials provided by the Department only in authorized locations on the Contract for which the materials were intended. Materials furnished by the Department and the location for pickup will be shown on the plans or as directed.

3. CONSTRUCTION

Perform work as shown on the plans and in accordance with the ~~details shown on the plans, the~~ NEC, the NESC, and ~~the requirements of~~ this Item.

Use established industry and utility safety practices when installing, relocating, or removing electrical and lighting equipment located near overhead or underground utilities. Consult with the appropriate utility before beginning work.

Tension and sag overhead conductors ~~with~~using guys and anchors in ~~accordance~~conformance with utility distribution practices.

Install conduit and electrical conductors, tray cable, or duct cable as shown on the plans. Install ground boxes as shown on the plans. Install electrical services as shown on the plans. Install concrete foundations as shown on the plans.

Install roadway illumination assemblies (poles with luminaire arms and light fixtures) as shown on the plans. The Engineer may shift the locations, within design guidelines, where necessary to secure a more desirable location or to avoid conflict with utilities.

Use utility- grade materials for overhead electrical work. Maintain a minimum of 22- ft. clearance above the roadway for overhead electrical work. Do not support overhead wiring with existing luminaire poles or breakaway luminaire poles.

Operate and maintain the temporary illumination system. Relocate temporary illumination system as shown on the plans.

Remove temporary illumination system when no longer needed. Remove abandoned concrete foundations to a point 2 ft. below final grade. Backfill the hole with material equal in composition and density to the surrounding area. Replace surfacing material with similar material to an equivalent condition.

Replace materials furnished by the Department that are scarred, battered, broken, or lost. Replace damaged temporary illumination materials intended for permanent installation. Return all Department-owned material not used during the Contract upon completion of the work, in original condition, to the location from which the material was obtained, or as directed.

4. MEASUREMENT

This Item Setup and removal of temporary roadway illumination will be measured by each roadway illumination assembly installed or relocated; orand removed. Each relocation of temporary roadway illumination will be measured as an instance of "Setup and Removal." Maintenance of temporary roadway illumination will be measured by the month the system is operated and maintained.

5. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Setup and Remove Temporary Roadway Illumination" of the typetypes specified. This price is full compensation for installing, relocating, and removing illumination assemblies temporary wiring, foundations, and electrical services; and materials, equipment, labor, tools, and incidentals."Maintain Temporary Roadway Illumination."

Electrical energy consumed by the Contractor on an existing Department electrical service will be paid for by the Department.

Costs for utility-owned power line extensions, connection charges, meter charges, consumption charges, and other charges Applications for a temporary utility service will be paid for by the Department designate the Contractor as the service owner, unless otherwise shown on the plans. The Department will reimburse the Contractor the amount billed by the utility for utility-owned service line extensions and consumption charges, plus an additional 5% of the invoice cost will be paid for labor, equipment, administrative costs, superintendence, and profit.

5.1. **Setup and Removal**. This price is full compensation for furnishing, installing, relocating, and removing illumination assemblies, temporary wiring, foundations, and new temporary electrical services, and materials, equipment, labor, tools, and incidentals.

5.2. **Maintenance**. This price is full compensation for operation, maintenance, and repair of temporary illumination assemblies and their associated wiring and electrical services, and materials, equipment, labor, tools, and incidentals. Energy consumed will be paid for in accordance with the second paragraph under "Payment."

Item 618
Conduit

1. DESCRIPTION

Furnish and install conduit; prepare existing conduit.

2. MATERIALS

Provide new materials that comply with the details shown on the plans, the requirements of this Item, and the pertinent requirements of the following Items:

- Item 400, "Excavation and Backfill for Structures"
- Item 476, "Jacking, Boring, or Tunneling Pipe or Box"

When specified on the plans, provide:

- rigid metal conduit (RMC);
- ~~intermediate metal conduit (IMC);~~
- ~~electrical metallic tubing (EMT);~~
- polyvinyl chloride (PVC) conduit;
- high density polyethylene (HDPE) conduit;
- ~~liquidtight~~liquid-tight flexible metal conduit (LFMC); or
- ~~liquidtight~~liquid-tight flexible nonmetallic conduit (LFNC).

Furnish conduit from new materials in accordance with DMS-11030, "Conduit."

Provide prequalified conduit from the Department's MPL. When required by the Engineer, notify the Department in writing of selected materials from the MPL intended for use on each project.

Provide other types of conduit not on the MPL that comply with the details shown on the plans and the NEC. Fabricate fittings such as junction boxes and expansion joints from a material ~~similar to~~like the connecting conduit, unless otherwise shown on the plans. Use watertight fittings. Do not use set screw ~~and pressure cast~~ fittings. Steel compression fittings are permissible. When using HDPE conduit, provide fittings that are UL-listed as electrical conduit connectors, or ~~thermally fused using~~connect conduit by thermal fusing with an electrically heated ~~wound wire resistance~~ welding method.

Use red 3-in. 4-mil polyethylene underground warning tape that continuously states, "Caution Buried Electrical Line Below."

3. CONSTRUCTION

Perform work ~~in accordance with the details~~as shown on the plans and ~~the requirements of~~ in accordance with this Item.

Use established industry and utility safety practices when installing conduit located near underground utilities. Consult with the appropriate utility company before beginning work.

3.1. **Installation of Conduit.** Install conduit ~~a minimum of~~at least 18 in. deep below finished grade to top of conduit unless otherwise shown on the plans. Meet the requirements of the NEC when installing conduit. Secure and support conduit placed for concrete encasement ~~in~~ such ~~a manner~~ that the alignment will not be

disturbed during placement of the concrete. Cap ends of conduit and close box openings before concrete is placed.

Ream conduit to remove burrs and sharp edges. Use a standard conduit cutting die with a 3/4-in. taper per foot when conduit is threaded in the field. Galvanize or paint threads in accordance with Item 445, "Galvanizing." Fasten conduit placed on structures with conduit straps or hangers as shown on the plans or as directed. Fasten conduit within 3 ft. of each box or fitting and at other locations shown on the plans or as directed. ~~Use metal conduit clamps that are galvanized malleable or stainless steel unless otherwise shown on the plans. Use 2~~Use two-hole type clamps for 2-in. diameter or larger conduit.

Fit PVC and HDPE conduit terminations with bushings or bell ends. Fit metal conduit terminations with a grounding type bushing, except conduit used for duct cable casing that does not terminate in a ground box and is not exposed at any point. Conduit terminating in threaded bossed fittings does not need a bushing. Before installation of conductors or final acceptance, pull a properly sized mandrel or piston through the conduit to ensure that it is free ~~from~~of obstruction. Cap or plug empty conduit placed for future use.

Perform trench excavation and backfilling as shown on the plans or as directed, and in accordance with Item 400~~, "Excavation and Backfill for Structures."~~. Excavation and backfilling will be subsidiary to the installation of the conduit.

Jack and bore as shown on the plans or as directed, and in accordance with Item 476~~, "Jacking, Boring, or Tunneling Pipe or Box."~~.

Place warning tape approximately 10 in. above trenched conduit. Where existing surfacing is removed for placing conduit, repair by backfilling with material equal in composition and density to the surrounding areas and by replacing any removed surfacing, such as asphalt pavement or concrete riprap, with like material to equivalent condition. Mark conduit locations as directed.

3.2. **Preparation of Conduit**. Pull a mandrel through empty conduits. Use a mandrel with a diameter greater than 70% of the inside diameter of the conduit and 2-in. length. Repair or replace conduit runs that will not allow passage of the mandrel. Replace conduit deemed impractical to repair or that remains unsuitable in accordance with Item 618, "Conduit." Clean the conduit by pulling a rubber swab slightly larger in diameter than the conduit.

Blow compressed air through conduits that contain wires. Remove debris from the conduit by pushing a fish tape through the conduit. Do not use water to clear debris. Retest the conduit by blowing compressed air.

Install one pull cord in each conduit for use in installing the conductors, cables, or innerduct.

4. MEASUREMENT

This Item will be measured by the foot of conduit installed, or by the foot of conduit cleared, tested, replaced, and repaired.

This is a plans quantity measurement Item. The quantity to be paid is the quantity shown in the proposal, unless modified by Article 9.2., "Plans Quantity Measurement." Additional measurements or calculations will be made if adjustments of quantities are required.

5. PAYMENT

5.1. **Installation of Conduit**. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Conduit" of the type and size specified and the installation method specified as applicable~~.~~, or for "Conduit (Prepare)." This price is full compensation for furnishing and installing conduit; cleaning and testing conduit; hanging, strapping, jacking, boring, tunneling, trenching, and furnishing and placing backfill; encasing in steel or concrete; replacing

pavement structure, sod, riprap, curbs, or other surface; marking location of conduit (when required); furnishing and installing fittings, junction boxes, and expansion joints; and materials, equipment, labor, tools, and incidentals.

Flexible conduit will not be paid for directly, but will be subsidiary to pertinent Items. Unless otherwise shown on the plans, no payment will be allowed under this Item for conduit used on electrical services or in foundations.

Repair of existing conduit will be paid for by the Department in accordance with Article 9.7., "Payment for Extra Work and Force Account Method."

~~Special Specification 6016~~Item 619

Intelligent Transportation System (ITS) Multi-Duct Conduit

1. DESCRIPTION

Furnish and install ~~Intelligent Transportation System~~intelligent transportation system (ITS) multi-duct conduit identified for fiber optic communication use of the type and size specified. Provide conduit suitable for installation in an outdoor underground environment, including constant immersion in water, mounted to retaining walls, and mounted above ground on the underside of a bridge without any degradation to the conduit.

2. MATERIALS

Provide new materials that comply with the details shown on the plans, the requirements of this Item, and the requirements of the following Items~~:~~.

- Item 400, "Excavation and Backfill for Structures~~,""~~
- Item 401, "Flowable ~~Fill,"~~Backfill"
- Item 402, "Trench Excavation Protection~~,""~~
- Item 421, "Hydraulic Cement Concrete~~,""~~
- Item 445, "Galvanizing~~,""~~
- Item 476, "Jacking, Boring, or Tunneling Pipe or Box~~,""~~
- Item 618, "Conduit~~," and~~"
- Item 620, "Electrical Conductors~~.,"~~

~~In addition, provide~~ Furnish ITS multi-duct conduit ~~meeting the requirements of the following Items:~~

- ~~Underwriters Laboratories (UL) 651,2420, and 2515,~~
- ~~National Electrical Manufacturers Association (NEMA) Standard TC-2,~~
- ~~NEMA TC-7,~~
- ~~NEMA TC-14B,~~
- ~~National Electrical Code (NEC), and~~
- ~~Departmental Materials Specification DMS 11030, "Conduit".~~

~~Provide underground ITS multi-duct conduit~~ from new materials ~~that have been tested and listed as defined~~ in ~~the NEC for the specific use to meet the following industry standards:~~

- ~~Bellcore/Telcordia Technologies document GR-356,~~
- ~~American Society for Testing and Materials (ASTM) D1784, Standard Specification for Rigid (PolyVinyl Chloride) (PVC) Compounds and (Chlorinated Poly Vinyl Chloride) (CPVC) Compounds,~~
- ~~ASTM-D1785, Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120,~~
- ~~ASTM-D2122, Standard Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings,~~
- ~~ASTM-F2160, Standard Specification for Solid Wall High Density Polyethylene (HDPE) Conduit Based in Controlled Outside Diameter,~~
- ~~ASTM-D2412, Standard Test Method for Determination of External Loading, and~~
- ~~ASTM-D3350, Standard Specification for Polyethylene Plastic Pipe and Fittings Materials.~~

Provide above ground ITS multi-duct conduit materials that have been tested and listed as defined in the NEC for the specific use to meet the following industry standards:

- ASTM-A90, Standard Test Method for Weight of Coating on Iron and Steel Articles with Zinc-Alloy Coatings,
- ASTM-D2105, Standard Test Method for Longitudinal Tensile Properties of "Fiberglass" (Glass-Fiber-Reinforced Thermoplastic Resin) Pipe and Tube, and
- ASTM-D2444, Standard Test Method for Determination of the Impact Resistance of Thermoplastic Pipe and Fittings by Means of a Tup (Falling Weight).

3. EQUIPMENT

3.1. General Requirements.

3.1.1. **Pre-Assembled Multi-Duct.** Provide a pre-assembled multi-duct conduit system of the material type specified with a nominal 4 in. inner diameter round outer duct containing 4 factory installed 1.25 in. nominal diameter round inner ducts. Inner ducts must be held together in a square configuration by a system of spacers. The design of the spacers, which hold the individual conduits in formation, must be capable of locking them tightly together to prevent free twisting of the inner ducts.

For pre-assembled multi-duct, provide a single protective end cap for each bundled 10 ft. or 20 ft. conduit sections, factory bends, and fittings.

3.1.2. **Fittings**. Provide all required sweeps, bends, repair couplings, ground box termination kits, alternative outer ducts, adapters, preassembled split repair kits, lubrication access fittings, tug-plugs, slit-inner duct plugs, hangers, brackets, expansion joints, and accessories to complete the conduit system as incidentals.

3.1.3. **Flexural Modulus.** Do not exceed the ovality of the conduit system by 5%.

3.1.4. **Environmental Requirements.**

For underground construction, provide conduit that will perform in an ambient temperature range of -30ºF to 122ºF without degradation of material properties In accordance with the NEC.

For above ground conduit construction, provide conduit that performs in an ambient temperature range of -60ºF to 200ºF without degradation of material properties.

3.1.5. **Corrosion Resistance.** Provide a conduit system that is resistant to most harsh chemicals and protected against degradation due to oxidation or general corrosion.

3.1.6. **Direct Bury**. Provide a conduit system capable of being installed by trenching or boring as shown on the plans.

3.1.7. **Free of Defects.** Provide a conduit system free of visible cracks, holes, or other physical defects that would degrade its performance.

3.1.8. **Uniformity**. Provide conduit that is uniform as practical in respect to overall dimensions, color, density, and thickness.

3.1.9. **Stabilization.** Provide conduit with a UV light stabilizer which will protect it, for a minimum of 12 mo., from degradation due to prolonged exposure to direct sunlight.

Conduit Identification. Provide conduit with a durable identification labeling showing the name and trademark of the manufacturer, conduit size, date of manufacture and "TxDOT - Fiber Optic CableDMS-11035, "Intelligent Transportation System" identification. (ITS) Multi-Duct Conduit."

3.1.10. **Grounding.** Provide a bare copper No. 8 AWG system grounding conductor, in accordance with Item 620, "Electrical Conductors", in 1 inner duct of the conduit duct system if no other cable is to be installed in the conduit system for use as a grounding conductor between ground boxes.

3.2. **Outer Duct.**

3.2.1. **PVC Multi-Duct**. Provide heavy walled Schedule 40 polyvinyl chloride (PVC) or heavy walled Schedule 80 PVC outer duct with a nominal inside diameter (ID) of 4 in. as shown on the plans or as directed for underground construction. Provide minimum 20 ft. sections of conduit.

Incorporate a longer integral bell in place of the standard 3-1/2 in. bell to accommodate the length of the coupling body.

Provide 4 in. Schedule 40 conduit with an average outside diameter (OD) of 4.5 in. and a minimum wall thickness of 0.237 in..

Provide 4 in. Schedule 80 conduit, or equivalent with an average OD of 4.75 in. and a minimum wall thickness of 0.337 in. When providing an equivalent to Schedule 80, provide independent laboratory testing certifications showing the equivalent product meets or exceeds performance and testing requirements to that of Schedule 80.

3.2.2. **Rigid Metal Multi-Duct.** Provide galvanized rigid metal conduit (RMC) outer duct with a nominal ID of 4 in. as shown on the plans or as directed. Provide a minimum 10 ft. section of conduit.

Provide 4 in. RMC with an average OD of 4.5 in. and a minimum wall thickness of 0.225 in.

3.2.3. **Fiberglass Multi-Duct.** Provide, bullet resistant, pure, high grade, reinforced thermosetting resin conduit outer duct with a nominal ID of 4 in. as shown on the plans or as directed. Provide a minimum 10 ft. section of conduit.

Provide 4 in. fiberglass conduit with a minimum OD of 4.25 in. and a minimum wall thickness of 0.250 in.

3.3. **Inner ducts.** Provide inner duct Schedule 40 PVC or High Density Polyethylene (HDPE) conduit with a 1.25 in. nominal diameter. Extrude inner ducts in a controlled OD fashion.

3.3.1. **Spacers.** Hold together the inner ducts with spacers located throughout each section of conduit. Factory install the system of spacers to hold inner ducts in place during transport and maintain alignment within the outer duct. Mold spacers from high impact plastic, and be factory certified to withstand all handling pressures and stresses.

3.3.2. **Longitudinal Ribbing.** For HDPE inner ducts, incorporate longitudinal ribbing and permanent dry lubricant that is extruded to provide friction reduction in cable installation.

3.3.3. **Identification by Color.** Provide inner ducts that are uniquely defined by the extrusion of a different color for each of the inner ducts; colors must be orange, yellow, red, and black.

Provide black inner duct that is placed directly in line with the manufacturer's identification on the outer duct for ease of identification and installation.

Duct designated for backbone fiber will be black in color; duct designated for distribution fiber will be orange and red in color; and duct designated for drop (field cabinet) fibers cable will be yellow in color.

3.3.4. **Pull Cord.** Provide a flat pull cord in all empty inner ducts. Provide a pull cord with a tensile strength of 1,250 lb. minimum and have foot markings to determine length installed.

3.4. **Fittings.** Provide fittings with the same material to the connecting conduit unless otherwise shown on the plans.

3.5. **Coupling Body.** Provide a factory installed primary coupling body that is manufactured as a hard plastic coupling body incorporating conical shaped target areas to accommodate self-alignment of each inner duct upon field assembly.

Provide a coupling body that incorporates sealing devices to facilitate field assembly and prevent water and foreign material leakage from outside the multi-duct system and to prevent air leakage from inside the inner ducts. Assemble solely by hand without use of special tools such that no lubricant will be required for field assembly of this conduit system.

Provide the coupling body with its sealing members sealing the outer walls of the inner ducts and the inner wall of the outer duct providing an airtight seal from within the inner duct system and a watertight seal from the outside of the outer duct.

Provide the gasket or sealing members that is an anti-reversing design in such that the lengths of conduit stay joined together without the need for solvent cement.

Provide the field connection end of the internal coupling body that incorporates shaped target areas to accommodate self-alignment of the inner ducts with bore openings during field assembly.

Provide the coupling body that has one of the bore openings on the field assembly side uniquely identified to facilitate proper continuous inner duct alignment during field assembly.

The coupling body must seal the inner duct so that after the application of 100 psi to an inner duct, the inner duct must be capable of maintaining a minimum of 15 psi for 24 hr. Employ an approved independent commercial testing laboratory to perform the above test. Submit certified reports of test to Department.

3.6. **Expansion Joints.** Provide expansion joints having a material similar to the connecting conduit unless otherwise shown on the plans.

Use conduit expansion fittings at structure expansion joint crossings.

3.7. **Termination Kits.** Provide end or pass-through termination kits from the same conduit manufacturer for termination in ground boxes and junction boxes.

Ensure a watertight seal of conduit to structure wall when terminating conduit.

3.8. **Multi-Duct Sweeps.** Conduit deflection should not deviate more than 1 in. horizontally or vertically per foot (1:12) of running length of conduit. Long conduit sweeps should be used wherever possible to change conduit direction in order to reduce the pulling tension required during cable installation.

For conduit deflection at obstructions, utilities, or transitions to structures where the 1:12 deflection requirement above or long sweeps are not possible, use complete conduit manufactured minimum 36 in. radius sweeps (11-1/4º , 22-1/2º, 30º, 45º, and 90º angles) complete with bell and spigot. Do not field bend conduit.

3.9. **Fiber Optic Cable Route Markers.** Furnish tubular delineator markers, minimum 6 ft. in length and a minimum 3 in. OD, and constructed of Type III HDPE material. Provide marker assemblies that are orange in color and ultraviolet stabilized to help prevent components from color fading, warping, absorbing water, and deterioration with prolonged exposure to the elements. Refer to the Standard Details for details of the text on the decal that should be affixed to each marker. Ensure that all markers furnished on this project are new and consistent in appearance.

Install markers using a method that firmly and securely anchors the marker a minimum of 1 ft. into the ground to prohibit twisting and easy removal. When located at an ITS ground box, marker may be placed within the concrete riprap apron avoiding rebar reinforcement. Spacing between markers should not exceed 1,000 ft. or as shown on the plans and placed at significant changes in direction such as a 90º turn. Do not place markers in any roadway paved surface.

4.3. CONSTRUCTION

4.1.3.1. **Underground Construction**. Place conduit in accordanceconformance with the lines, grades, details, and dimensions shown on the plans or as directed. Maintain constant slope to prevent water from being trapped in the conduit system.

Ream all conduit ends to remove burrs and sharp edges.

Install underground conduit system a minimum of 42 in. from ground surface to the top of the conduit unless otherwise directed or to avoid utility conflicts or field conditions. When conditions require trench depths greater than 5 ft., provide trench protection in accordance with Item 402, "Trench Excavation Protection.". Install conduit in accordance with the requirements of the NEC and USDA RUSthe United States Department of Agriculture Rural Utilities Service.

Fasten all external conduit placed on structures with conduit straps or hangers as shown on the plans or as directed. Conduit straps, hanger systems, and junction boxes are incidental to this Item.

Fit the conduit terminations with bushings or bell ends with duct plugs. Seal inner ducts with duct plugs within 24 hr. of conduit placement. This includes but is not limited to intermediate or incomplete sections of conduit system prior tobefore conduit splicing or termination in ground boxes.

Document Global Positioning System (GPS) coordinate points, in North American Datum of 1983 (NAD83), and provide to the Department for shifts or deviations of the ITS multi-duct alignment from the plans required to avoid obstructions or utilities. Record GPS coordinate points to be recorded at the point of curvature and point of tangent for horizontal of vertical transitions and include installed depth.

Ensure a watertight seal of conduit to structure wall when terminating conduit.

Install markers using a method that firmly and securely anchors the marker a minimum of 1 ft. into the ground to prohibit twisting and easy removal. When located at an ITS ground box, marker may be placed within the concrete riprap apron avoiding rebar reinforcement. Spacing between markers should not exceed 1,000 ft. or as shown on the plans, and markers should be placed at significant changes in direction, such as a 90° turn. Do not place markers in any roadway paved surface.

4.1.1.3.1.1. **Proofing**. Prior toBefore installation of cables or final acceptance, pull a spherical template having a diameter of not less than 75% of the inside diameter of the inner duct through the inner duct to insureensure that the inner duct is free fromof obstruction. At the conclusion of proofing, fit ends of all empty inner ducts with duct plugs or caps within 24 hr.

4.2.3.2. **Trench Construction**. Provide minimum Schedule 40 polyvinyl chloride (PVC) conduit when conduit is installed throughby trenching method unless otherwise shown on the plans or as directed.

Provide a 2 in. minimum layer of sand at the bottom of the trench to serve as a bedding material for construction.

Provide conduit spacers made of a non-metallic material designed for installation underground and encased in concrete. Spacers should be of the type recommended by the conduit manufacturer and designed with an interlocking device, and stackable to reliverelieve the conduit of both horizontal and vertical stress. Provide spacers sized appropriately for the conduit with a minimum height of 2 in. spaced at 5 ft. intervals throughout

the trench. Set conduit spacers directly on the sand bedding. Spacers must be anchored to prevent floating of conduit system and maintain constant slope.

Conduit system will be encased in the following materials based on depth of trench~~:~~.

~~4.2.1.~~3.2.1. **Greater than 24 in**. For trench depths greater than 24 in. from the ground surface to the top of the ITS multi-duct conduit, encase the conduits in flowable fill to an elevation of 6 in. above the top of conduit in accordance with Item 401, ~~"Flowable Backfill,"~~ or ~~Class~~BClass B concrete, maximum aggregate size 5, in accordance with Item 421~~, "Hydraulic Cement Concrete."~~. Use of Class B concrete will be at the Engineer's discretion ~~of the Engineer~~ and ~~will be~~as shown on the plans. Backfill above encasement as defined in Section ~~4~~619.3.2.3~~.~~., "Excavation and Backfill."

~~4.2.2.~~3.2.2. **Less than 24 in**. When a trench depth less than 24 in. is required, encase the conduits in Class B concrete, maximum aggregate size 5, to an elevation of 6 in. above the top of conduit in accordance with Item 421~~, "Hydraulic Cement Concrete."~~. Backfill above encasement as defined in Section ~~4~~619.3.2.3~~.~~., "Excavation and Backfill."

~~4.2.3.~~3.2.3. **Excavation and Backfill**. Trench, excavate, and backfill as shown on the plans and in accordance with Item ~~400, "Excavation and Backfill for Structures."~~ 400.

~~4.2.4.~~3.2.4. **Marking Tape**. Place a 4~~-~~ in. wide detectable underground metalized ~~mylar~~Mylar conduit marking tape over the ITS conduit at a minimum depth of 1 ft. below grade when no other electrical marking tape is required, or 8~~-~~ in. below electrical marking tape when provisioned under Item 618~~, "Conduit"~~.

Imprint the marking tape "TxDOT Conduit and Fiber Optic Cable System~~ ~~~~ ~~Call TxDOT Before Proceeding" every 18 in.

~~4.2.5.~~3.2.5. **Restoration of Trench Areas**. Where existing surfacing is removed for placing conduit, repair by backfilling with material equal in composition and density to the surrounding areas and by replacing any removed surfacing, such as asphalt pavement or concrete riprap, with like material to equivalent condition in accordance with Item 400~~, "Excavation and Backfill for Structures."~~ .

~~4.3.~~3.3. **Boring Construction**. Jacking and boring when required will be in accordance with Item 476~~, "Jacking, Boring, or Tunneling Pipe or Box"~~..

When boring under pavement shallower than 48 in. from ~~finish~~finished grade to top of conduit, provide Schedule~~-~~ 40 steel casing under pavement to encase the conduit system as shown on the plans unless otherwise directed. ~~-~~Provide steel casing of a size to accommodate all conduits in addition to 20% space capacity for pulling conduits through the steel casing. Steel casing will be furnished in accordance with this Item.

During boring operation, locate bore head every 10 ft. along the bore path and before traversing underground utilities or structures. Use digital walkover locating system to track bore head during boring operation. Ensure locating system ~~is capable of determining~~can determine pitch, roll, heading, depth, and horizontal position of the bore head, and document this information at the intervals specified above for as-built information~~.~~.

~~4.4.~~3.4. **Above Ground Construction**. Place conduit in ~~accordance~~conformance with the lines, grades, details, and dimensions shown on the plans or as directed. Maintain constant slope to prevent water from being trapped in the conduit system.

Provide rigid metal conduit or fiberglass conduit for outer duct when system is mounted externally along a bridge or above ground structure. Provide fiberglass or other non-corrosive outer duct for coastal Districts where conduit is exposed to corrosive environments due to salt in the air.

Provide rigid metal conduit outer duct that is hot-dippeddip galvanized in accordance with Item 445, "Galvanizing.".

Ground rigid metal conduit in accordanceconformance with the Department's Electrical Details and in accordance with the NEC.

Provide fiberglass conduit that is bullet resistant, heavy walled, pure, high grade, reinforced thermosetting resin conduit.

Provide conduit, elbows, and fittings that are manufactured from the same resin, hardener, or glass systems manufactured by the same filament wound system.

Use conduit expansion fittings at structure expansion joint crossings.

Fasten all external conduit placed on structures using conduit straps or hangers as shown on the plans or as directed. Conduit straps, hanger systems, and junction boxes are incidental to this Item.

4.5.3.5. **Testing**. Perform tests in accordanceconformance with industry testing requirements identified in Article 619.2., "Materials."

4.5.1.3.5.1. **General**. Furnish certified documentation from an independent testing laboratory documenting compliance with all ASTM, NEMA, NEC, UL, and Telcordia Technologies standards as referenced in this Item.

Provide test procedures and blank test forms and conduct performance tests for all materials and equipment not previously tested and approved. If technical data isare not considered adequate for approval, samples may be requested for testtesting. The Contract period will not be extended for time lost or delays caused by testing prior tobefore final approval of any items.

Compare the results of each test with the requirements of this Item. Failure to conform to the requirements of any test must be identified as a defect and the materials will be subject to rejection by the Engineer. Offer rejected materials again for retest provided all non-compliances have been corrected and retested by the Contractor with evidence submitted to the Engineer.

4.5.2.3.5.2. **Examination of Product**. Examine each conduit system component prior tobefore installation carefully to verify that the materials, design, construction, markings, and workmanship comply with the requirements of this Item.

4.5.3.3.5.3. **References**. The ITS multi-duct conduit system supplier must submit 3three references, preferably State Departments of Transportation, where thisthe supplier's conduit system has functioned successfully for a period of no less than 1 yr. Include current name and address of organization, and the current name and telephone number of an individual from the organization who can be contacted to verify system installation. Provide this information with documentation submittal. Failure to furnish the above references will be sufficient reason for rejection of the supplier's equipment.

4.6.3.6. **Documentation Requirements**. Submit documentation of the conduit system consisting of the following for Engineerthe Engineer's approval 30 days prior tobefore installation:

- manufacturer specifications or cut sheets for all components of the conduit duct system,
- laboratory--certified material test reports documenting conformance with pertinent standards identified under Article 619.2, "Materials",",
- GPS coodinatescoordinates,
- pre-installation test procedures,
- post-installation test procedures, and
- as-built of installed conduit system.

5.4. MEASUREMENT

ITS multi-duct conduit This Item will be measured by the linear foot of the multi-duct conduit systeminstalled.

Fiber optic cable road marker will be measured by each maker furnished and installed.

6.5. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided for under "Measurement" will be paid for at the unit price bid for "ITS Multi-Duct Conduit" of the types and construction method specified. This price is full compensation for furnishing and installing conduit; for jacking, boring, steel encasement, excavating, furnishing, and placing backfill; concrete encasement; replacing pavement structure, sod, riprap, curbs, or other surface; testing of the conduit system; for furnishing and installing all fittings, clamps, sweeps, bends, repair couplings, adapters, ground box or manhole termination kits, pre-assembled split repair kits, lubrication access, fittings, hangers, brackets, junction boxes, expansion joints, concrete, and detectable underground metalized mylarMylar conduit marking tape; pull cords,; and for all labor, tools, equipment, and incidentals necessary to complete the work.

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Fiber Optic Cable Road Marker." This price is full compensation for furnishing and installing all cable markers,; and for materials, equipment, labor, tools, documentation, warranty, training, and incidentals.

Copper grounding conductor will be paid for under Item 620, "Electrical Conductors.".

This Item applies only to ITS multi-duct conduit. Any other conduit for communication or electrical use will be in accordance with and paid for under Item 618, "Conduit.".

Item 620
Electrical Conductors

1. DESCRIPTION

Furnish and install electrical conductors, except conductors specifically covered by other Items.

2. MATERIALS

Provide new materials that comply with the details shown on the plans and the requirements of this Item. Use stranded insulated conductors that are rated for ~~600 volts;~~600V, approved for wet locations~~;~~, and marked in ~~accordance~~conformance with UL, NEC, and Canadian Standards Association (CSA) requirements. Furnish electrical conductors in accordance with DMS-11040, "Electrical Conductors."

Provide ~~prequalified~~pre-qualified electrical conductors from the Department's MPL. When required by the Engineer, notify the Department in writing of selected materials from the MPL intended for use on each project.

Ensure all grounding conductors ~~size~~Size 8 AWG and larger are stranded, except for the grounding electrode conductor at the electrical service, which will be a 6-AWG solid conductor.

Use white insulation for grounded (neutral) conductors, except grounded conductors ~~size~~Size 4 AWG and larger may be black with white tape marking at every accessible location. Do not use white insulation or marking for any other conductor except control wiring specifically shown on the plans.

Ensure insulated grounding conductors are green, except insulated grounding conductors ~~size~~Size 4 AWG and larger may be black with green tape marking at every accessible location. Do not use green insulation or marking for any other conductor except control wiring specifically shown on the plans.

3. CONSTRUCTION

Perform work ~~in accordance with the details~~as shown on the plans and ~~the requirements of~~in accordance with this Item.

Splice conductors only in junction boxes, ground boxes, and transformer bases, and in poles and structures at the handholes. Splice as shown on the plans. Do not exceed the manufacturer's recommended pulling tension. Use lubricant as recommended by the manufacturer. Install conductors in accordance with the NEC.

~~Make~~Test insulation resistance ~~tests~~ on the conductors before making final connections~~,~~ and ensure each continuous run of insulated conductor has a minimum direct-current (DC) resistance of 5 megohms (MΩ) when tested at 1,~~000 volts~~ 000V DC. The Engineer may require verification testing of all or part of the conductor system. The Engineer will witness these verification tests. Replace conductors exhibiting an insulation resistance of less than 5 ~~megohms~~MΩ at no additional cost to the Department.

4. MEASUREMENT

This Item will be measured by the foot of each single conductor.

This is a plans quantity measurement Item. The quantity to be paid is the quantity shown in the proposal, unless modified by Article 9.2., "Plans Quantity Measurement." Additional measurements or calculations will be made if adjustments of quantities are required.

5. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Electrical Conductors" of the types and sizes specified. This price is full compensation for furnishing, installing, and testing electrical conductors; furnishing and installing breakaway connectors; and for materials, equipment, labor, tools, and incidentals, exceptwith the following exceptions:

- conductors used in connecting the components of electrical services will be paid for under Item 628, "Electrical Services";
- conductors inside roadway illumination assemblies will be paid for under Item 610, "Roadway Illumination Assemblies";
- conductors inside of traffic signal pole assemblies will be paid for under this Item; and
- conductors used for internal wiring of equipment will not be paid for directly, but will be subsidiary to pertinent Items.

Item 621
Tray Cable

1. DESCRIPTION

Furnish and install tray cable.

2. MATERIALS

Provide new materials that comply with the details shown on the plans and meet the requirements of Item 620, "Electrical Conductors."

Furnish tray cable from new materials in accordance with DMS-11050, "Tray Cable."

Provide ~~prequalified~~pre-qualified tray cable from the Department's MPL. When required by the Engineer, notify the Department in writing of selected materials from the MPL intended for use on each project.

3. CONSTRUCTION

Perform work ~~in accordance with the details~~as shown on the plans and ~~the requirements of~~in accordance with this Item.

Provide an additional 5 ft. of cable coiled in each ground box when installing cable in underground conduit. Splice tray cable conductors only at locations shown on the plans. Obtain the Engineer's written approval for each splice. Ensure ~~allowed~~ splices are watertight. Test the cable's conductors after installation and before any connection. Remove and replace tray cable exhibiting a direct-current (DC) insulation resistance of less than 5 megohms at 1,~~000 volts~~000V DC at no additional cost to the Department.

4. MEASUREMENT

This Item will be measured by the foot of tray cable.

This is a plans quantity measurement Item. The quantity to be paid is the quantity shown in the proposal, unless modified by Article 9.2., "Plans Quantity Measurement." Additional measurements or calculations will be made if adjustments of quantities are required.

5. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Tray Cable" of the types and sizes specified. This price is full compensation for furnishing and installing materials and for equipment, labor, tools, and incidentals.

~~Special Specification 6186~~Item 623

Intelligent Transportation System (ITS) Ground ~~Box~~Boxes

1. DESCRIPTION

Construct, furnish, install, or remove Intelligent Transportation System (ITS) ground boxes for fiber optic communication infrastructure complete with lids.

2. MATERIALS

Provide new materials that comply with the details shown on the plans, the requirements of this Item, and the requirements of the following ~~items:~~Items.

- Item 420, "Concrete Substructures~~,~~"
- Item 421, "Hydraulic Cement Concrete~~,~~"
- Item 432, "Riprap~~,~~"
- Item 440, "Reinforcement for Concrete~~,~~"
- Item 471, "Frames, Grates, Rings, and Covers~~,~~"
- Item 618, "Conduit~~", and~~"
- Item 620, "Electrical Conductors~~."~~"

Provide new ITS ground boxes constructed of precast concrete or polymer concrete in accordance with the ~~National Electrical Code (~~NEC~~)~~ and ~~National Electrical Manufacturers Association (~~in conformance with NEMA~~)~~ standards~~, most current version~~. Faulty fabrication or poor workmanship in materials, equipment, or installation will be justification for rejection. Provide manufacturer's warranties or guarantees when offered as a customary trade practice.

2.1. **Precast Concrete**. Provide precast concrete ground boxes and aprons ~~that comply with the details~~as shown on the plans~~, the requirements of this Item,~~ and in accordance with the following~~:~~.

- ~~construct~~Construct ground boxes with Class A concrete in accordance with Item 421, ~~"Hydraulic Cement Concrete,"~~ unless otherwise directed~~,~~.
- ~~provide American Society for Testing and Materials (~~Provide ASTM~~)~~ ~~A 615~~ A615 Grade 60 reinforcement steel in accordance with Item 440~~, "Reinforcing Steel," and~~.
- ~~provide~~Provide steel for the frames and covers in accordance with Item 471, ~~"Frames, Grates, Rings, and Covers,"~~ unless otherwise approved ~~by the Engineer~~.

2.1.1. **Loading Requirements**. Designed to withstand ~~American Association of State Highway and Transportation Officials (~~AASHTO~~)~~ H-20 loading. Manufacturer must furnish certification of conformance with H-20 loading.

2.2. **Polymer Concrete**. Manufacture ground box and ground box cover from polymer concrete reinforced with ~~2~~two continuous layers of fiberglass fabric. Provide fabricated precast polymer concrete ground boxes and aprons ~~that comply with the details~~as shown on the plans~~, the requirements of this Item,~~ and in accordance with ~~American Standards Institute (~~ANSI~~)~~/Society of Cable Telecommunications Engineers (SCTE) ~~- ANSI/SCTE 77, most current version~~77.

- **Polymer Concrete**. Construct polymer concrete from catalyzed polyester resin, sand, and aggregate. Polymer concrete containing chopped fiberglass or fiberglass-reinforced plastic is prohibited. Ensure a minimum compressive strength of 11,000 psi.

- **Fiberglass Fabric**. The base glass on the fiberglass fabric must be alumina-~~lime~~borosilicate ~~type "~~lime borosilicate Type E~~"~~ glass. The reinforcing fabric must line the entire inner and outer surfaces. Obtain approval for the fabric ~~prior to~~before production.

2.2.1. **Loading Requirements**. All polymer concrete boxes and covers must meet all test provisions ~~of the~~in accordance with ANSI/SCTE 77 Tier 22 requirements. All polymer concrete boxes and covers will be UL ~~Listed~~ listed, or ~~manufacture~~manufacturer must provide a certification from ~~an NRTL~~a Nationally Recognized Testing Laboratory or documentation of factory~~-~~ testing~~-documentation~~ witnessed and certified by professional engineer licensed in Texas.

Ensure ground box withstands 800 lb. per sq. ft. of force applied over the entire sidewall with less than 1/4~~-~~ in. deflection per foot length of box. Ensure ground box and ground box cover withstand a test load of 33,750 lb. over a 10 ~~in. x~~x 20~~-~~in. area centered on the cover with less than 1/2~~-~~in. deflection at the design load of 22,500~~-~~ lb.

3. EQUIPMENT

3.1. **Size**. Provide ITS ground boxes meeting the configuration types ~~detailed~~shown in Table 1.

Table 1
Ground Box Inside Dimensions

Type	Width (~~Inches~~in.)	Length (~~Inches~~in.)	Depth (~~Inches~~in.)
Type 1 (~~Precast~~precast)	~~—~~24	~~—~~36	36, 48, or 60
Type 2 (~~Precast~~precast)	~~—~~36	~~—~~60	36, 48, or 60
Type 1 (~~Polymer~~polymer)	~~—~~24	~~—~~36	24, 36, or 48
Type 2 (~~Polymer~~polymer)	~~—~~36	~~—~~60	24, 36, or 48

3.2. **Shape**. Provide ITS ground boxes rectangular in shape.

3.3. **Aprons**. Provide concrete aprons for ground boxes installed in native ground as shown on the plans. Aprons will be omitted when the ground boxes are located in riprap, sidewalk, or landscape pavers.

3.4. **Bolts**. Provide stainless steel penta bolts or special keyed bolts, as required by Department, with associated hardware as shown on the plans. Provide self-draining bolt holes. Washers must be provided with all bolts.

3.5. **Accessories**. Include all necessary provisions for knockouts, cable racking, adapters, and terminators for proper conduit and cable installation.

3.5.1. **Knockouts**. Provide knockouts at the factory to accommodate the appropriate number and size of conduits entering the ground box as shown ~~in~~on the plans. Within the factory, score or provide indention on each outside wall identifying additional conduit entry points for future expansion that does not impact the rebar structure. ~~-~~Place a bell fitting on the end of each conduit to ensure a flush fit inside the ground box. Place concrete grout in the knockout (inside and out), around the conduit and bell fitting, to ensure a neat and watertight fit. Ensure that the grout does not enter the inside of the conduit.

3.5.2. **Cable Racking**. Provide steel (in accordance with ASTM ~~A-153~~A153), non-metallic glass reinforced nylon, or equivalent cable rack assemblies ~~with the dimensions~~as shown on the plans.

3.5.3. **Terminators**. Terminators must be appropriately sized for the conduits ~~indicated~~shown on the plans and must be an airtight and watertight connection.

Terminators for the polyvinyl chloride (PVC) conduits should be placed symmetrically about the centerline of the box at the depth shown on the plans.

Terminators that do not have conduits attached must be capped and sealed as shown on the plans.

Install the quantity, size, and location of terminators as shown on the plans.

3.6. **Cover Requirements**.

3.7.3.6. **Type of Cover.** Provide the following types of covers based on the type of ground box:.

3.7.1.3.6.1. **Precast** concrete ground box:**Concrete Ground Box**. Provide a 1one-piece or 2two-piece galvanized steel or cast- iron cover depending on the ground box type. Provide a torsion assisted cover for Type 2 ground box with lids that can open freely a minimum 90º each and lock in place with locking latches or a pin-lock inserted in the hinge. Covers must be grounded in accordance with the requirements of the most current version of the NEC. Provide the cover with drop handles.

3.7.2.3.6.2. **Polymer** concrete ground box:**Concrete Ground Box**. Provide a 1one-piece or 2two-piece cover depending on the ground box type, bolted to the ground box. Cover must have a minimum of 2at least two lifting eyes.

3.8.3.7. **Label**. Permanently mark all ground boxes and covers with the manufacturer's name or logo and model number. Legibly imprint each cover with a permanently marked logo in letters at least 1 in. high as follows: "DANGER—HIGH VOLTAGE TRAFFIC MANAGEMENT",," unless otherwise directed. Glue- in logos are prohibited.

3.9.3.8. **Security**. Equip all ground box covers with a stainless steel penta head or keyed bolting system that will securely hold the cover in place. Provide an appropriate means to secure or lock the cover in place as required byshown on the plans.

3.10.3.9. **Skid Resistance**. All ground box covers must be skid resistant and should have a minimum coefficient of friction of 0.50 on the top surface of the cover. Provide certification that minimum coefficient of friction value is met as part of material documentation.

3.11.3.10. **Strength Requirements**. The following ground box strengths are required based on the following 2two applications.

3.11.1.3.10.1. **Deliberate Roadway Traffic**. Precast concrete ground boxes with steel covers must be used in locations that may experience deliberate, continuous vehicular traffic, such as near the shoulder or an auxiliary lane, or immediately adjacent to the unprotected edge of pavement. Do not place ground boxes in the paved travel lanes or shoulder of highways, frontage roads, streets, bridges, or driveways.

Ground boxes and covers located in these areas must be rated for heavy-duty traffic loading and meet an AASHTO H-20 design loading.

Precast concrete ground boxes and covers located in non-deliberate heavy vehicular traffic must still meet AASHTO H-20 design loading.

3.11.2.3.10.2. **Non-Deliberate Heavy Vehicular Traffic**. Polymer concrete ground boxes and covers may be used in off -roadway applications subject to occasional non-deliberate heavy vehicular traffic, such as driveways, along sidewalks, parking lots, and behind non-mountable curb. Polymer ground boxes and covers located in these areas must meet ANSI/SCTE Tier 22 loading requirements.

4. CONSTRUCTION

Perform work in accordance with the detailsas shown on the plans and the requirements of in accordance with this Item.

Use established industry and utility safety practices when installing or removing ground boxes located near underground utilities. Consult with the appropriate utility company before beginning work.

4.1. **Installation**. Install ground boxes as shown on the plans. Maintain spacing as shown on the plans.

Ground box locations may be revised to fit existing field conditions or to better facilitate the installation of the conduit system with approval ~~by the Engineer~~.

Field-locate ground boxes to avoid steep slopes and low-lying locations with poor drainage.

Construct ground box cover to fit properly on ground box.

When installing ground boxes in surfaced areas, make the tops of the ground boxes flush with the finished surface.

4.1.1. **Gravel at Base of Ground Box**. Install all ground boxes on a bed of crushed rock at the base of the excavation as shown on the plans. Place 12 in. of washed, crushed stone (1.5 in. nominal) ~~which~~that extends 6 in. in all directions from the perimeter of the box. Lightly tamp the gravel immediately ~~prior to~~before the placement of the ground box to reduce settlement. Crushed gravel will not be paid for directly, but will be ~~considered~~ subsidiary to this Item.

4.1.2. **Cable Racking Installation**. Provide and locate cable rack assemblies designed to support up to 25 ft. of slack for each fiber optic cable inside each Type 1 ground box, 100 ft. of slack for each fiber optic cable inside each Type 2 ground box, slack associated with other communication cabling, and any splice enclosure as shown on the plans or as directed. Cable racks may be installed at the factory or in the field. Place the racks in a manner so as not to impede access in and out of the ground box.

Ground metallic cable rack assemblies to grounding system inside ground box in accordance with the ~~most current version of the~~ NEC.

Use fasteners with an ultimate pull out strength of at least ~~2500~~2,500 lb. and ultimate shear strength of at least ~~3000~~3,000 lb. When securing cable racks to ~~side walls~~sidewalls of ground box in the field, seal all penetrations to the ~~side wall~~sidewall to prevent moisture and contaminant penetration. ~~Sufficient~~Enough cable supports must be provided for the particular ~~of~~ conductors or cables coiled or passing through the ground as shown on the plans or directed by the Engineer.

4.1.3. **Buried Installation**. When shown ~~in~~on the plans or identified in the General Notes, bury ground boxes for security measures. When burying ground boxes, provide polymer concrete ground boxes meeting ANSI/SCTE Tier 22 loading requirements.

Provide 12 in. cover between ground surface and top of ground box lid. ~~Prior to~~Before backfilling, provide ~~a~~ 30 ~~-~~lb. felt paper over the entire ground box extending ~~a minimum of~~at least 2 in. from either side to prevent backfill materials from entering ground box.

4.2. **Excavation and Backfill**. Ensure excavation and backfill for ground boxes ~~meets the requirements as set forth by~~are in accordance with Item 400, “Excavation and Backfill for Structures.” For buried ground boxes, compact backfill material ~~in order~~ to prevent depressions in ground surface from occurring over the ground box.

4.3. **Testing**. Ground box and cover must be tested by a laboratory independent of the manufacturer to meet loading requirements. Certificate of such tests must be submitted to the Engineer for approval.

4.4. **Documentation Requirements**. Submit documentation for this Item consisting of the following for Engineer approval ~~prior to~~before installation or as specified below:

- recordrecorded Global Positioning System (GPS) coordinates using North American Datum of 1983 (NAD83 datum) for all ground boxes prior tobefore backfill. Identify location to obtain, with coordinates identified by location on drawing detail.;
- shop drawings.;
- concrete mix design.;
- material specifications for ground box, lid, cable racks, bolts, and skid resistance for cover; and
- testing certification for loading requirements.
- hot, cold, and wet weather plan, and
- backfill material composition.

Shop drawings should clearly detail the following for ground boxes, at a minimum:

- dimensions
- knockouts
- cable racks
- terminators
- adapters
- bolts
- cover
- load rating
- cover lock

- dimensions,
- knockouts,
- cable racks,
- terminators,
- adapters,
- bolts,
- cover,
- load rating, and
- cover lock.

4.5. **Removal**. Remove existing ground boxes and concrete aprons to at least 6 in. below the conduit level. Uncover conduit to a sufficientenough distance so that 90° bends can be removed and conduit reconnected. Clean the conduit in accordance with Item 618, "Conduit.". Replace conduit within 5 ft. of the ground box. Remove old conductors and install new conductors as shown on the plans. Backfill area with material equal in composition and density to the surrounding area. Replace surfacing material with similar material to an equivalent condition.

5. MEASUREMENT

This Item will be measured by each ground box installed or removed.

6. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "ITS Ground Box (Precast Concrete)" of the various types and sizes specified" or "ITS Ground Box (Polymer Concrete)" of the various types and sizes specified, and for "Remove ITS Ground Box"."

6.1. **Furnish and Install**. This price is full compensation for excavating and backfilling; constructing, furnishing, and installing the ITS ground boxes and concrete aprons, when required; and all labor, tools, equipment, materials, transportation, accessories, documentation, testing, and incidentals.

Conduit will be paid for under Item 618, "Conduit" and Special Specification 6016, "Item 619, "Intelligent Transportation System (ITS) Multi-Duct Conduit."

Electrical conductors will be paid for under Item 620, "Electrical Conductors.".

6.2. **Remove**. This price is full compensation for removing and disassembling ground boxes and concrete aprons; excavation, backfilling, and surface placement; removing old conductors; disposal of unsalvageable materials; and materials, equipment, labor, tools, and incidentals. Cleaning of conduit ~~is~~will be subsidiary to this Item. Conduit replaced within 5 ft. of the ground box will be subsidiary to this Item.

Item 624
Ground Boxes

1. DESCRIPTION

1.1. **Installation**. Construct, furnish, and install ground boxes complete with lids.

1.2. **Removal**. Remove existing ground boxes.

2. MATERIALS

Provide new materials that comply with the details shown on the plans, the requirements of this Item, and the pertinent requirements of the following ~~items:~~Items.

- Item 420, "Concrete Substructures"
- Item 421, "Hydraulic Cement Concrete"
- Item 432, "Riprap"
- Item 440, "Reinforcement for Concrete"
- Item 618, "Conduit"
- Item 620, "Electrical Conductors"

Provide fabricated precast polymer concrete ground boxes in accordance with DMS-11070, "Ground Boxes." Provide ~~prequalified~~pre-qualified ground boxes from the Department's MPL. When required by the Engineer, notify the Department in writing of selected materials from the MPL intended for use on each project.

Provide other precast or cast-in-place ground boxes that comply with the details shown on the plans.

3. CONSTRUCTION

Perform work ~~in accordance with the details~~as shown on the plans and ~~the requirements of~~in accordance with this Item.

Use established industry and utility safety practices when installing or removing ground boxes located near underground utilities. Consult with the appropriate utility company before beginning work.

3.1. **Installation**. Fabricate and install ground boxes ~~in accordance with the details, dimensions, and requirements~~as shown on the plans. Install ground box to approved line and grade.

Construct precast and cast-in-place concrete ground boxes in accordance with Item 420~~, "Concrete Substructures,"~~ and Item 440~~, "Reinforcement for Concrete."~~.

Construct concrete aprons as shown on the plans and in accordance with Item 432~~, "Riprap,"~~ and Item 440~~, "Reinforcement for Concrete."~~.

3.2. **Removal**. Remove existing ground boxes and concrete aprons to at least 6 in. below the conduit level. Uncover conduit to a sufficient distance so that 90 ~~degree~~° bends can be removed and conduit reconnected. Clean the conduit in accordance with Item 618~~, "Conduit."~~. Replace conduit within 5 ft. of the ground box. Remove old conductors and install new conductors as shown on the plans. Backfill area with material equal in composition and density to the surrounding area. Replace surfacing material with similar material to an equivalent condition.

4. MEASUREMENT

This Item will be measured by each ground box installed complete in place or each ground box removed.

5. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Ground Box" of the types and sizes specified and for "Remove Ground Box."

5.1. **Installation**. This price is full compensation for excavating ~~and~~, backfilling, and aggregate; constructing, furnishing, and installing ground boxes and concrete aprons; and material, equipment, labor, tools, and incidentals. All wiring connections required inside the ground box will be ~~considered~~ subsidiary to this ~~bid item~~Item. Conduit will be paid for under Item 618~~, "Conduit."~~. Electrical conductors will be paid for under Item 620~~, "Electrical Conductors."~~.

5.2. **Removal**. This price is full compensation for removing and disassembling ground boxes and concrete aprons; excavating, backfilling, and surface placement; removing old conductors; disposal of unsalvageable materials; and materials, equipment, labor, tools, and incidentals. Cleaning of conduit ~~is~~will be subsidiary to this Item. Conduit replaced within 5 ft. of the ground box will be subsidiary to this Item. Additional conduit will be paid for under Item 618~~, "Conduit."~~. Installation of conductors will be paid for under Item 620~~, "Electrical Conductors."~~.

Item 625
Zinc-Coated Steel Wire Strand

1. DESCRIPTION

Furnish and install zinc-coated steel wire strand.

2. MATERIALS

Provide new materials in accordance with ASTM A475, ~~Utilities Grade~~utilities grade or better, Class A coating. These requirements include, but are not limited to, the properties ~~given~~shown in Table 1. Furnish ~~7~~seven wires per strand.

Table 1
Dimensions and Properties

Nominal Diameter of Strand (in.)	Nominal Diameter of Coated Wires (in.)	~~Approx.~~ Approximate Weight per 1,000 ft. (lb.)	Minimum Breaking Strength (lb.)	Minimum Zinc Coating ~~Wt.~~Weight Class A (oz./sq. ft.)
3/16	0.065	80	2,400	0.50
1/4	0.080	121	4,750	0.60
9/32	0.093	164	4,600	0.70
5/16	0.109	225	6,000	0.80
3/8	0.120	273	11,500	0.85
7/16	0.145	399	18,000	0.90
1/2	0.165	517	25,000	0.90

Supply new material. Remove drips, runs, sharp points, voids, and damage from the zinc coating. Samples from each roll of each diameter of strand will be taken. Replace strands failing to meet the requirements of this Item.

3. CONSTRUCTION

Install strands as shown on the plans. Splicing is not permitted.

When the strand is used as a messenger cable or span wire, ground it to the grounding conductor at each pole. Metal poles may be used as the grounding conductor. Ensure a resistance less than 1 ohm from the strand to the ground rod.

4. MEASUREMENT

This Item will be measured by foot of wire strand.

5. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Zinc-Coated Steel Wire Strand" of the sizes specified. This price is full compensation for furnishing, installing, and testing wire strands~~;~~, and materials, equipment, labor, tools, and incidentals.

Item 627
Treated Timber Poles

1. DESCRIPTION

Furnish and install treated timber poles.

2. MATERIALS

Use new treated southern pine timber poles in accordance with ANSI ~~O5~~O 5.1~~, *Specifications*~~ and ~~*Dimensions for Wood Poles,* and the additional requirements of~~ this Item. Use ANSI Class 5 treated timber poles for electrical services and ANSI Class 2 for all other applications, unless otherwise shown on the plans.

Ensure poles are free ~~from~~of pith holes at the tops and butts. Do not use poles that have a trimmed scar with a depth greater than 2 in~~.~~. if the diameter is 10 in. or less, or 1/5 the pole diameter at the scar location~~,~~ if the diameter is more than 10 in. Provide poles that do not deviate from straightness by more than 1 in. for each 10 ft. of length. A pole may ~~only~~ have sweep in one plane and one direction (single sweep), provided a straight line joining the midpoint of the pole at the butt and the midpoint of the pole at the top does not at any intermediate point pass through the external surface of the pole. Timber poles with more than one complete twist of spiral grain are not acceptable.

~~Butt slivering due to felling is permitted if the distance from the outside circumference is at least 1/4 of the butt diameter and the height is not more than 1 ft. Use preservative treatment~~ Furnish treated poles in accordance with AWPA ~~U1, Commodity Specification D. Furnish poles with a~~ to the minimum net retention and penetration of preservative treatment in accordance with Table 1.

Table 1
AWPA Commodity Specification and Use Category for Poles

Product	AWPA Commodity Specification[1]	AWPA Use Category[2]
Poles (southern pine)	D	UC4C

1. For minimum preservative retention requirements, refer to AWPA Use Category System Standard U1, Commodity Specification D, for the preservative provided for the southern pine poles. For preservative penetration and assay zone requirements, refer to AWPA Use Category System Standard T1, Commodity Specification D.
2. Refer to this designated Use Category when locating the minimum required retention for the provided preservative in AWPA Use Category System Standard U1, Commodity Specification D.

Mark all poles by branding in accordance with Table 2.

~~Table 1~~
~~Retention of Preservative Treatment~~

~~Treatment~~	
~~Pentachlorophenol~~	~~0.45 lb./ft.^{3}~~
~~CCA~~	~~0.6 lb./ft.^{3}~~

Table 2
Timber Pole Markings

Marking	Description of Marking
PTC	Supplier's code or trademark (~~for example,~~e.g., Pole Treating Company~~).~~)
F-~~01~~20	Plant location and year of treatment (~~for example,~~e.g., Forestville, ~~2001).~~2020)
SPC	Species and preservative code (~~for example,~~e.g., southern pine, creosote~~).~~)
5-35	Class- length (~~for example,~~e.g., Class 5, 35-ft. pole~~).~~)

Place the bottom of the brand squarely on the face of the pole 10 ft. ~~(plus or minus~~ (±2 in.) from the butt.

Furnish a treatment certification with every shipment of treated timber poles that includes:

- name of treating company,
- location of treating plant,
- applicable product standard (AWPA U1),
- charge number,
- date of treatment,
- contents of charge (poles),
- preservative treatment, and
- actual preservative retention values.

3. CONSTRUCTION

Perform work ~~in accordance with the details~~as shown on the plans and ~~the requirements of~~in accordance with this Item.

Use established industry and utility safety practices while installing poles located near overhead or underground utilities. Consult with the appropriate utility company before beginning work.

Set the pole a minimum depth in accordance with Table 3, unless otherwise shown on the plans.

Table 3
Pole Setting Depth

Pole Length (ft.)	Min Setting Depth (ft.)
25 or less	4.5
26–30	5.0
31–35	5.5
36–40	6.0
41–45	6.5
46–50	7.0

Locate timber poles as shown on the plans or as directed. Drill holes for setting poles a minimum of 1.5 diameters of the pole butt. Set the poles plumb, unless otherwise shown on the plans. Backfill the holes thoroughly by tamping in 6-in. lifts. After tamping to grade, place additional backfill material in a 6-in. high cone around the pole to allow for settling. Use material equal in composition and density to the surrounding area. Repair surface where existing surfacing material is removed, such as asphalt pavement or concrete riprap, with like material to equivalent condition.

4. MEASUREMENT

This Item will be measured by each timber pole installed.

5. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Treated Timber Pole" of the various lengths and classes specified. This price is full compensation for furnishing and installing timber poles; ~~and for~~ all hardware; and materials, equipment, labor, tools, and incidentals.

This payment clause excludes payment for ~~Treated Timber Poles~~treated timber poles when subsidiary to another Item.

Item 628
Electrical Services

1. DESCRIPTION

- **Installation**. Furnish and install electrical services.
- **Relocation**. Relocate existing electrical services.
- **Removal**. Remove existing electrical services.

2. MATERIALS

Provide materials that comply with the details shown on the plans, the requirements of this Item, and the pertinent requirements of the following Items~~:~~.

- Item 441, "Steel Structures"
- Item 445, "Galvanizing"
- Item 449, "Anchor Bolts"
- Item 618, "Conduit"
- Item 620, "Electrical Conductors"
- Item 627, "Treated Timber Poles"
- Item 656, "Foundations for Traffic Control Devices"

For the installation of electrical services, use new materials that meet the requirements of the NEC, UL, ~~CSA,~~the Canadian Standards Association (CSA), and NEMA, and are in accordance with DMS-11080, "Electrical Services."

Provide ~~prequalified~~pre-qualified electrical services ~~prequalified~~ from the Department's MPL. When required ~~by the Engineer~~, notify the Department in writing of selected materials from the MPL intended for use on each project.

3. CONSTRUCTION

Perform work ~~in accordance with the details~~as shown on the plans and ~~the requirements of~~ in accordance with this Item. Use established industry and utility safety practices when installing, relocating, or removing electrical services located near overhead or underground utilities. Consult with the appropriate utility company before beginning work.

3.1. **Installation**. Furnish and install electrical service equipment. Ensure components of the electrical service meet the requirements of the Electrical Detail Standards. ~~Follow~~Install the electrical equipment in accordance with the NEC and in conformance with local utility company requirements ~~when installing the electrical equipment~~. Coordinate the utility companies' work for providing service.

3.2. **Relocation**. Coordinate relocation with the appropriate utility company before beginning work. Remove existing electrical service ~~according to~~in accordance with Section 628.3.3., "Removal~~" under this Item.~~." Reinstall existing electrical service ~~according to~~in accordance with Section 628.3.1., "Installation~~" of this Item.~~." Replace or add circuit breakers as ~~noted~~shown on the plans.

3.3. **Removal**. Coordinate removal with the appropriate utility company before beginning work. Before the removal of the electrical service, disconnect and isolate any existing electrical service equipment in ~~accordance~~conformance with the utility company's requirements.

Remove existing electrical service support ~~a minimum of~~at least 2 ft. below ~~finish~~finished grade unless otherwise shown on the plans. Repair the remaining hole by backfilling with material equal in composition and density to the surrounding area. Replace any surfacing, such as asphalt pavement or concrete riprap, with like material to equivalent condition.

Disconnect and remove conductors ~~and remove them~~ from the conduit. Cut off and cap all protruding conduit 6 in. below finished grade. Abandoned conduit need not be removed unless otherwise shown on the plans.

Reconnect conductors and conduit to be reused when shown on the plans. Make all splices in ground boxes unless otherwise shown on the plans.

Accept ownership and dispose of unsalvageable materials~~, and dispose of them~~ in ~~accordance~~conformance with federal, state, and local regulations.

4. MEASUREMENT

This Item will be measured by each electrical service installed, relocated, or removed.

5. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Electrical Services" of the types specified, "Relocate Electrical Services," or "Remove Electrical Services."

~~5.1. **Installation.** This price is full compensation for paying all fees, permits, and other costs; making arrangements with the utility company for all work and materials provided by the utility company; furnishing, installing, and connecting all components including poles, service supports, foundations, anchor bolts, riprap, enclosures, switches, breakers, service conduit (from the service equipment including the elbow below ground), fittings, service conductors (from the service equipment including the elbow below ground), brackets, bolts, hangers, hardware; and materials, equipment, labor, tools, and incidentals.~~

Costs for utility-owned power line extensions, connection charges, meter charges, consumption charges, and other charges will be paid for by the Department. The Department will reimburse the Contractor the amount billed by the utility, plus an additional 5% of the invoice cost will be paid for labor, equipment, administrative costs, superintendence, and profit.

Applications for a permanent utility service will designate the Department as the service owner unless otherwise shown in the plans.

5.1. **Installation.** This price is full compensation for paying all fees, testing, permits, utility company inspections, connection or meter charges, and other costs; making arrangements with the utility company for all work and materials provided by the utility company; furnishing, installing, and connecting all components, including poles, service supports, foundations, anchor bolts, riprap, enclosures, switches, breakers, service conduit (from the service equipment, including the elbow below ground), fittings, service conductors (from the service equipment, including the elbow below ground), brackets, bolts, hangers, and hardware; and materials, equipment, labor, tools, and incidentals.

5.2. **Relocation**. This price is full compensation for disconnecting and isolating the existing electrical service; relocating the service supports; new service support foundation; backfilling holes; paying all fees, ~~permits~~testing, permits, utility company inspections, connection or meter charges, and other costs; making arrangements with the utility company for all work and materials provided by the utility company; removing, disconnecting, installing, and connecting all components, including poles, service supports, foundations, anchor bolts, riprap, enclosures, switches, breakers, service conduit (from the service equipment, including the elbow below ground), fittings, service conductors (from the service equipment, including the elbow below ground), brackets, bolts, hangers, and hardware; and materials, equipment, labor, tools, and incidentals.

~~Costs for utility-owned power line extensions, connection charges, meter charges, consumption charges, and other charges will be paid for by the Department. The Department will reimburse the Contractor the amount billed by the utility plus an additional 5% of the invoice cost will be paid for labor, equipment, administrative costs, superintendence, and profit.~~

5.3. **Removal**. This price is full compensation for coordinating with the utility company to disconnect and isolate the electrical service; removing the service supports; backfilling holes; and materials, equipment, labor, tools, and incidentals.

Item 636
Signs

1. DESCRIPTION

- **Installation**. Furnish, fabricate, and erect aluminum signs. Sign supports are provided for under other Items.
- **Replacement**. Replace existing signs on existing or replaced sign supports.
- ~~**Refurbishing**. Refurbish existing aluminum signs on existing sign supports.~~

2. MATERIALS

~~2.1. **Sign Blanks**. Furnish sign blank substrates in accordance with DMS-7110, "Aluminum Sign Blanks," and in accordance with the types shown on the plans. Use single-piece sheet aluminum substrates for Type A (small) signs and extruded aluminum substrates for Type G (ground-mounted) or Type O (overhead-mounted) signs.~~

~~2.2. **Sign Face Retroreflectorization**. Retroreflectorize the sign faces with flat surface reflective sheeting. Furnish sheeting that meets DMS-8300, "Sign Face Materials." Use retroreflective sheeting from the same manufacturer for the entire sign face background. Ensure that sign legend, symbols, borders, and background exhibit uniform color, appearance, and retroreflectivity when viewed both day and night.~~

~~2.3. **Sign Messages**. Fabricate sign messages to the sizes, types, and colors shown on the plans. Use sign message material from the same manufacturer for the entire message of a sign. Use screen ink and background reflective sheeting that are from the same manufacturer when fabricating signs.~~

- ~~Ensure that the screened messages have clean, sharp edges and exhibit uniform color and retroreflectivity. Prevent runs, sags, and voids. Furnish screen inks in accordance with DMS-8300, "Sign Face Materials."~~
- ~~Fabricate colored, transparent film legend, and retroreflectorized sheeting legend from materials that meet DMS-8300, "Sign Face Materials."~~
- ~~Fabricate non-reflective black film legend from materials meeting DMS-8300, "Sign Face Materials."~~
- ~~Furnish direct-applied route markers and other attachments within the parent sign face unless otherwise specified on the plans.~~

2.1. **Signs**. Furnish completed signs in accordance with DMS-8301, "Highway Sign Fabrication."

~~2.4.~~2.2. **Hardware**. Use galvanized steel, stainless steel, or dichromate-sealed aluminum for bolts, nuts, washers, lock washers, screws, and other sign assembly hardware. Use plastic or nylon washers ~~to avoid tearing~~when in direct contact with the reflective sheeting. Furnish steel or aluminum products in accordance with DMS-7120, "Sign Hardware."

When dissimilar metals are used, select or insulate metals to prevent corrosion.

2.3. **Sign Identification Decals**. Furnish materials that meet the requirements of DMS-8315, "Sign Identification Decals."

3. CONSTRUCTION

~~3.1. **Fabrication**. Sign fabrication plants that produce permanent highway signs must be approved in accordance with DMS-7390, "Permanent Highway Sign Fabrication Plant Qualification." Furnish signs from prequalified fabrication plants listed in the Department's MPL.~~

~~3.1.1. **Sign Blanks**. Furnish sign blanks to the sizes and shapes shown on the plans and that are free of buckles, warps, burrs, dents, cockles, or other defects. Do not splice individual extruded aluminum panels.~~

~~Complete the fabrication of sign blanks, including the cutting and drilling or punching of holes, before cleaning and degreasing. After cleaning and degreasing, ensure the substrate does not come into contact with grease, oils, or other contaminants before the application of the reflective sheeting.~~

~~3.1.2. **Sheeting Application**. Apply sheeting to sign blanks in conformance with the sheeting manufacturer's recommended procedures.~~

~~When using rotational sensitive white sheeting, fabricate signs by applying the sheeting for cut out legend, symbols, borders, and route marker attachments within the parent sign face with the identification marks or other orientation features in the optimum rotation as identified by the sheeting manufacturer.~~

~~Clean and prepare the outside surface of extruded aluminum flanges in the same manner as the sign panel face.~~

~~Minimize the number of splices in the sheeting. Overlap the lap splices by at least 1/4 in. for encapsulated glass bead sheeting unless otherwise recommended by the reflective sheeting manufacturer. Use butt splices for prismatic reflective sheeting. Provide a 1 ft. minimum dimension for any piece of sheeting. Do not splice sheeting for signs fabricated with transparent screen inks or colored transparent films.~~

~~3.1.3. **Sign Assembly**. Assemble extruded aluminum signs in accordance with the details shown on the plans. Sign face surface variation must not exceed 1/8 in. per foot. Surface misalignment between panels in multi-panel signs must not exceed 1/16 in. at any point.~~

~~3.1.4. **Decals**. Code and apply sign identification decals in accordance with Item 643, "Sign Identification Decals."~~

3.1. **Decals**. The sign fabricator must code the sign identification decals by punching out the appropriate letter or digits for Rows 1–7 as shown in Figure 1 and Table 1.

Rows 8–12 (Installation Date) are only for coding by the Engineer at their discretion.

Affix the decal to lower left corner of the sign back in an upright position.

Figure 1 shows the sign identification decal. The numbers to the far right as shown in Figure 1 are reference row numbers for Table 1 and are not part of the decal. Table 1 describes the information required in each row of the decal.

Texas Department of Transportation												
C	Fabrication Date										T	1
J	F	M	A	M	J	J	A	S	O	N	D	2
	202		203		204		205		206			3
	0	1	2	3	4	5	6	7	8	9		4
Sheeting MFR—Substrate												
A	B	C	D	E	F	G	H	J	K	L	M	5
Film MFR												
A	B	C	D	E	F	G	H	J	K	L	M	6
Sheeting MFR—Legend												
A	B	C	D	E	F	G	H	J	K	L	M	7
Installation Date												
				0	1	2	3					8
	0	1	2	3	4	5	6	7	8	9		9
J	F	M	A	M	J	J	A	S	O	N	D	10
	202		203		204		205		206			11
	0	1	2	3	4	5	6	7	8	9		12
Name of Sign Fabricator Physical Address City, State, Zip Code												13

Figure 1
Decal Design (Row Numbers Explained in Table 1)

Table 1
Decal Description

Row Explanation
1—Sign fabricator
2—Month fabricated
3—First 3 digits of year fabricated
4—Last digit of year fabricated
5—Manufacturer of the sheeting applied to the substrate
6—Film (colored transparent or non-reflective black) manufacturer
7—Manufacturer of the sheeting for the legend
8—Tens digit of date installed[1]
9—Ones digit of date installed[1]
10—Month installed[1]
11—First 3 digits of year installed[1]
12—Last digit of year installed[1]
13—Name of sign fabricator and physical location of sign shop

1. Only for coding by the Engineer at their discretion.

Code the decal by punching out the following:

- "C" if fabricated by a commercial sign fabricator or "T" if fabricated by the Department or the Texas Department of Criminal Justice,
- month fabricated,
- first three digits of the year fabricated,
- fourth digit of the year fabricated, and
- sheeting and film manufacturers. (Codes for these manufacturers are located on the Department's MPL.)

3.2. **Storage and Handling**. Ship, handle, and store completed sign blanks and completed signs so that corners, edges, and faces are not damaged. Damage to the sign face that is not visible when viewed at a distance of 50 ft., night or day, will be acceptable. Replace unacceptable signs.

Store all finished signs off the ground and in a vertical position until erected. Store finished sheet aluminum substrate signs in a weatherproof building. Extruded aluminum substrate signs may be stored outside.

Stockpile salvageable materials at the location shown on the plans or as directed. Accept ownership and dispose of unsalvageable materials ~~and dispose of them~~ in ~~accordance~~conformance with federal, state, and local regulations.

3.3. **Cleaning**. Wash completed signs in the fabrication shop ~~with~~using a biodegradable cleaning solution acceptable to the manufacturers of the sheeting, colored transparent film, and screen ink to remove grease, oil, dirt, smears, streaks, finger marks, and other foreign material. Wash again before final inspection after erection.

3.4. **Installation**. Install signs as shown on the plans or as directed.

3.5. **Replacement**. Remove the existing signs from the existing or replaced supports and replace with new signs, including mounting hardware, as shown on the plans. At the Engineer's discretion, existing galvanized mounting hardware can be reused if it was not damaged during removal of existing sign.

~~3.6. **Refurbishing**. Refurbish existing signs by providing and installing new messages and mounting hardware. Install new retroreflectorized legend and supplemental signs as shown on the plans.~~

~~3.7.~~ **Documentation**. Provide ~~the following documentation from the sign fabricator with each shipment of furnished signs:~~

~~3.8.~~3.6. ~~A~~a notarized original of the project-specific Signing Material Statement (Form 2273~~) with the proper attachments~~), from the sign fabricator, along with attached copies of pertinent material certifications for verification of compliance~~, and~~.

- ~~A notarized certification stating that the completed signs were fabricated in accordance with this Item and the plans.~~

4. MEASUREMENT

Signs installed or replaced will be measured by the square foot of the sign face. ~~Signs refurbished will be measured by each sign.~~

This is a plans quantity measurement Item. The quantity to be paid is the quantity shown in the proposal, unless modified by Article 9.2., "Plans Quantity Measurement." Additional measurements or calculations will be made if adjustments of quantities are required.

5. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Aluminum Signs," or "Replacing Existing ~~Aluminum Signs," or "Refurbishing~~ Aluminum Signs," of the type specified.

5.1. **Installation**. This price is full compensation for furnishing and installing new signs and hardware; fabrication of sign panels; treatment of sign panels required before application of the background materials; application of the background materials and messages to the sign panels; furnishing and fabricating frames, wind beams, and stiffeners; furnishing bolts, rivets, screws, fasteners, clamps, brackets, and sign support connections; assembling and erecting the signs; preparing and cleaning the signs; and materials, equipment, labor, tools, and incidentals.

5.2. **Replacement**. This price is full compensation for furnishing and installing new aluminum signs and hardware; reusing existing hardware (when applicable); removal of existing signs; fabrication of sign panels; treatment of sign panels required before application of the background materials; application of the background materials and messages to the sign panels; furnishing and fabricating frames, wind beams, and stiffeners; furnishing bolts, rivets, screws, fasteners, clamps, brackets, and sign support connections; assembling and erecting the signs; preparing and cleaning the signs; salvaging and disposing of unsalvageable materials; and materials, equipment, labor, tools, and incidentals.

~~**Refurbishing**. This price is full compensation for modifying existing sign messages; removing and replacing existing route markers, reflectorized legend, or supplemental signs attached to the parent sign; preparing and cleaning the signs; furnishing sheeting and hardware; salvaging and disposing of unsalvageable materials; and materials, equipment, labor, tools, and incidentals.~~

Item 644
Small Roadside Sign Assemblies

1. DESCRIPTION

1.1. **Installation**. Furnish, fabricate, and erect small roadside sign assemblies or bridge-mounted clearance sign assemblies consisting of the signs, sign supports, foundations (when required), and associated mounting hardware.

1.2. **Relocation**. Relocate existing small roadside sign assemblies or bridge-mounted clearance sign assemblies, and furnish and fabricate material as required.

1.3. **Removal**. Remove existing small roadside sign assemblies or bridge-mounted clearance sign assemblies.

2. MATERIALS

Furnish all materials unless otherwise shown on the plans. Furnish only new materials. Furnish and fabricate materials that comply in accordance with the following Items and details as shown on the plans:

- Item 421, "Hydraulic Cement Concrete"
- Item 440, "Reinforcement for Concrete"
- Item 441, "Steel Structures"
- Item 442, "Metal for Structures"
- Item 445, "Galvanizing"
- Item 636, "Signs"
- ~~Item 643, "Sign Identification Decals"~~
- Item 656, "Foundations for Traffic Control Devices"

Use galvanized steel, stainless steel, dichromate sealed aluminum, or other materials shown on the plans for pipe, bolts, nuts, washers, lock washers, screws, and other sign assembly hardware. When dissimilar metals are used, select or insulate metals to prevent corrosion.

3. CONSTRUCTION

Construct foundations in accordance with Item 656, "Foundations for Traffic Control Devices.". Plumb sign supports. Do not spring or rake posts to secure proper alignment. Use established safety practices when working near underground or overhead utilities. Consult the appropriate utility company before beginning work.

3.1. **Fabrication**. Fabricate sign supports in accordance with Item 441, "Steel Structures.". Ensure all components fit properly.

Verify the length of each post for each sign before fabrication to meet field conditions and sign-mounting heights shown on the plans.

Hot-dip galvanize fabricated parts in accordance with Item 445, "Galvanizing.". Punch or drill any holes in steel parts or members before galvanizing. Repair galvanizing for any steel part or member damaged during assembly, transit, or erection, or for any steel part or member welded, when permitted, after galvanizing. Perform all galvanizing repairs in accordance with Section 445.3.54., "Repairs."

3.2. **Installation**. Locate and install sign supports as shown on the plans, unless directed to shift the sign supports within design guidelines to secure a more desirable location or avoid conflict with utilities and underground appurtenances. Stake sign support locations for verification by the Engineer.

Install stub posts of the type, spacing, orientation, and projection shown on the plans. Remove and replace posts damaged during installation at the Contractor's expense.

Connect the upper post sections to the stub post sections as shown on the plans. Torque connection bolts as shown on the plans.

Attach signs to supports in ~~accordance~~conformance with the plans and pertinent Items.

3.3. **Relocation**. Reuse the existing signs as required unless otherwise shown on the plans. Furnish and install new stub posts in new foundations for relocated sign assemblies. Erect the new supports on the new stub posts~~,~~ and attach the existing signs to the supports in ~~accordance~~conformance with the plans and pertinent Items. Remove existing foundations to be abandoned in accordance with Section 644.3.4., "Removal."

3.4. **Removal**. Remove abandoned concrete foundations to 2 ft. below ~~finish~~finished grade unless otherwise shown on the plans. Cut off and remove steel protruding from the remaining concrete. Backfill the remaining hole with material equal in composition and density to the surrounding area. Replace any surfacing with like material to equivalent condition.

3.5. **Handling and Storage**. Handle and store existing signs or portions of signs removed so they are not damaged. Store all signs to be reused off the ground and in a vertical position until erected. Prevent any damage to the various sign assembly components. Replace any portion of the sign damaged by the Contractor designated for reuse or salvage, including messages removed.

Store all new signs off the ground and in a vertical position until erected. Store new sheet aluminum substrate signs in a weatherproof building. Extruded aluminum substrate signs may be stored outdoors.

Stockpile all removed sign components that will be reused or become the property of the Department at designated locations. Accept ownership of unsalvageable materials~~,~~ and dispose of them in ~~accordance~~conformance with federal, state, and local regulations.

3.6. **Cleaning**. Wash the entire sign after installation ~~with~~using a biodegradable cleaning solution acceptable to the sign face materials manufacturer to remove dirt, grease, oil smears, streaks, finger marks, and other foreign materials.

4. MEASUREMENT

This Item will be measured as each small roadside assembly or bridge~~-~~mounted clearance sign assembly installed, removed, or relocated.

5. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Install Small Roadside Sign Assemblies" of the type specified, "Install Bridge~~-~~Mounted Clearance Sign Assemblies" of the type specified, "Relocate Small Roadside Sign Assemblies" of the type specified, "Relocate Bridge~~-~~Mounted Clearance Sign Assemblies" of the type specified, "Remove Small Roadside Sign Assemblies," or "Remove Bridge~~-~~Mounted Clearance Sign Assemblies."

5.1. **Installation**. This price is full compensation for furnishing, fabricating, galvanizing, and erecting the supports; constructing foundations, including concrete (when required); furnishing complete signs, including sign

connections and all hardware; attaching the signs to the supports; preparing and cleaning the signs; and materials, equipment, labor, tools, and incidentals.

5.2. **Relocation**. This price is full compensation for removing existing sign assemblies and related materials; furnishing and installing new stub posts and new sign supports; constructing foundations, including concrete (when required); ~~and~~ new hardware; reinstallation of signs; preparing and cleaning the signs; salvaging; disposal of unsalvageable materials; removing existing foundations, backfilling, and surface placement; and materials, equipment, labor, tools, and incidentals.

5.3. **Removal**. This price is full compensation for removing existing sign assemblies and related materials; salvaging; disposal of unsalvageable materials; removing existing foundations, backfilling, and surface placement; and materials, equipment, labor, tools, and incidentals.

Item 647
Large Roadside Sign Supports and Assemblies

1. DESCRIPTION

1.1. **Installation**. Furnish, fabricate, and erect steel supports for large roadside signs.

1.2. **Relocation**. Relocate existing large roadside sign assemblies~~,~~ and furnish and fabricate materials as required.

1.3. **Removal**. Remove existing large roadside sign assemblies.

~~1.3.~~1.4. **Replacement**. Replace existing large roadside sign assemblies.

2. MATERIALS

Furnish all materials unless otherwise shown on the plans. Furnish only new materials. Furnish and fabricate materials ~~that comply~~in accordance with the following Items and ~~details~~as shown on the plans~~:~~.

- Item 416, "Drilled Shaft Foundations"
- Item 421, "Hydraulic Cement Concrete"
- Item 440, "Reinforcement for Concrete"
- Item 441, "Steel Structures"
- Item 442, "Metal for Structures"
- Item 445, "Galvanizing"

Use material for perforated fuse plates that does not exceed the ultimate tensile strength shown on the plans.

Use galvanized steel, stainless steel, dichromate sealed aluminum, or other materials shown on the plans for bolts, nuts, washers, lock washers, screws, and other sign~~-~~ assembly hardware. When dissimilar metals are used, select or insulate the metals to prevent corrosion.

3. CONSTRUCTION

Construct foundations for large roadside sign supports and assemblies in accordance with Item 416~~, "Drilled Shaft Foundations,"~~ and ~~the details~~as shown on the plans. Plumb sign supports. Do not spring or rake posts to secure proper alignment. Use established safety practices when working near underground or overhead utilities. Consult with the appropriate utility company before beginning work.

3.1. **Fabrication**. Fabricate in accordance with Item 441~~, "Steel Structures."~~. Ensure all components fit properly.

Verify the length of each post for each sign before fabrication to meet field conditions and sign-mounting heights shown on the plans. Obtain approval for any necessary field fabrication or adjustments.

Hot-dip galvanize fabricated parts in accordance with Item 445~~, "Galvanizing."~~. Punch or drill any holes in steel parts or members before galvanizing. Repair galvanizing for any steel part or member on which the galvanizing has been damaged during assembly, transit, or erection~~:~~, or for any steel part or member welded when permitted, after galvanizing. Make all galvanizing repairs in accordance with Section 445.3.~~5~~4., "Repairs."

3.2. **Installation**. Locate sign supports as shown on the plans, unless directed to shift the sign supports within design guidelines to secure a more desirable location or avoid conflict with utilities and underground appurtenances. Stake the sign support locations for verification by the Engineer.

Install stub posts of the type and at the spacing, orientation, and projection shown on the plans. Secure the stub posts rigidly in position during concrete placement.

~~At the Contractor's option, sign supports may be cast in the concrete foundation as a unit. However, if installation is made with the upper post section attached, do not expose the support to traffic until the sign panel is properly affixed, unless otherwise approved.~~

Connect the upper post sections to the stub post sections as shown on the plans. Ensure a flat washer is positioned on top of the bolt keeper plates between the upper and lower slip base sections, and a flat washer is positioned under the head and nut of each connection bolt. Torque connection bolts as shown on the plans.

Attach signs to supports as shown on the plans and in accordance with ~~the plans and~~ pertinent Items.

3.3. **Relocation**. Reuse the existing supports and shorten ~~or lengthen~~ them as required, unless otherwise shown on the plans. Furnish and install new breakaway stub posts in new foundations for relocated sign assemblies. Erect the supports on the new stub posts and attach the signs to the supports as shown on the plans and in accordance with ~~the plans and~~ pertinent Items.

Unless otherwise shown on the plans, remove abandoned concrete foundations and replace surfacing in accordance with Section 647.3.4., "Removal."

3.4. **Removal**. Remove abandoned concrete foundations, including steel, to 2 ft. below ~~finish~~finished grade, unless otherwise shown on the plans. Cut off and remove steel protruding from the remaining concrete. Backfill the remaining hole with material equal in composition and density to the surrounding area. Replace any surfacing with like material to equivalent condition.

3.5. **Replacement**. Replace sign and sign supports as shown on the plans. Furnish and install new sign steel supports, fuse plates, and sign with hardware. Erect the assembly on top of existing foundation stub and attach signs to the supports in conformance with the plans and pertinent Items.

~~3.5.~~3.6. **Handling and Storage**. Handle and store existing signs or portions of signs removed so they are not damaged. Prevent any damage to the various sign assembly components. Replace any portion of the sign damaged by the Contractor designated for reuse or salvage, including messages removed.

Stockpile all removed sign components that will be reused or become the property of the Department at designated locations. Accept ownership of unsalvageable materials and dispose of them in ~~accordance~~conformance with federal, state, and local regulations.

~~3.6.~~3.7. **Cleaning**. Wash the entire sign after installation ~~with~~using a biodegradable cleaning solution acceptable to the sign face material manufacturers to remove dirt, grease, oil smears, streaks, finger marks, and other foreign materials.

4. MEASUREMENT

Installation will be measured by the pound of large roadside sign support steel. Sign assemblies relocated, removed, or ~~relocated~~replaced will be measured by each large roadside sign assembly.

This is a plans quantity measurement Item. The quantity to be paid is the quantity shown in the proposal, unless modified by Article 9.2., "Plans Quantity Measurement." Additional measurements or calculations will be made if adjustments of quantities are required.

5. PAYMENT

~~This~~The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Install Large Roadside Sign Supports" of the type specified, "Remove Large Roadside Sign Assemblies," ~~or~~ "Relocate Large Roadside Sign Assemblies," or "Replace Large Roadside Sign Assemblies."

New drilled shaft foundations will be paid for in accordance with Item 416~~, "Drilled Shaft Foundations."~~. New signs will be paid for in accordance with Item 636, "Signs."

5.1. **Installation**. This price is full compensation for furnishing, fabricating, galvanizing, and erecting the supports and stub posts; furnishing fuse plate and slip base connections; and materials, equipment, labor, tools, and incidentals.

5.2. **Relocation**. This price is full compensation for furnishing and installing new stub posts~~,~~ and new sign supports (when required); removing existing sign assemblies and related materials; modifying existing sign supports; reinstallation of signs and sign supports; preparing and cleaning the signs; hardware; salvaging and disposing of unsalvageable materials; removing existing foundations, backfilling, and surface placement; and materials, equipment, labor, tools, and incidentals.

5.3. **Removal**. This price is full compensation for removing existing sign assemblies and related materials; salvaging; disposal of unsalvageable materials; removing existing foundations, backfilling, and surface placement; and materials, equipment, labor, tools, and incidentals.

5.4. **Replacement**. This price is full compensation for furnishing, fabricating, galvanizing, and erecting new sign supports; removing existing sign assemblies and related materials; modifying existing sign supports (when required); reinstallation of signs and sign supports (when required); preparing and cleaning the signs; hardware; salvaging and disposing of unsalvageable materials; removing existing foundations, backfilling, and surface placement (when required); and materials, equipment, labor, tools, and incidentals.

Item 650
Overhead Sign Supports

1. DESCRIPTION

- **Installation**. Furnish, fabricate, and erect overhead sign supports.
- **Relocation**. Remove and relocate existing overhead sign supports.
- **Removal**. Remove existing overhead sign supports.

2. MATERIALS

Provide new materials that comply with the details shown on the plans, the requirements of this Item, and the pertinent requirements of the following Items~~:~~.

- Item 416, "Drilled Shaft Foundations"
- Item 420, "Concrete Substructures"
- Item 421, "Hydraulic Cement Concrete"
- Item 441, "Steel Structures"
- Item 442, "Metal for Structures"
- Item 445, "Galvanizing"
- Item 449, "Anchor Bolts"
- Item 618, "Conduit"

Furnish alloy steel or medium-strength mild steel anchor bolts in accordance with Section 449.2.1., "Bolts and Nuts," unless otherwise shown on the plans. Furnish galvanized steel, non-corroding stainless steel, or dichromate-sealed aluminum brackets, clamps, bolts, and other hardware, in accordance with DMS-7120, "Sign Hardware."

Reuse undamaged components when relocating an existing overhead sign structure. Provide new components to replace any damaged during removal or relocation, in accordance with the Items listed in this Article, unless otherwise directed.

3. CONSTRUCTION

3.1. **Alternate Design**. Alternate designs of monotube overhead sign supports are not permitted. The Department will consider alternate designs for cantilevered-truss type overhead sign support columns that meet the requirements of this ~~specification~~Item and the plans.

- Submit design calculations and a list of proposed materials, including anchor bolts, before submitting shop drawings. Additionally, submit relevant plans such as Cantilever Overhead Sign Supports (COSS) plan and elevation sheets, COSS & OSB-SZ table sheets, and any other sheets to support the design calculations. Computer-generated design parameters and calculations are not acceptable unless accompanied by the appropriate supporting documentation.
- Determine the ~~size of~~ pipe diameter and wall thickness to be used for the column from the appropriate ~~Cantilever Overhead Sign Supports (~~COSS~~)~~ or High Level Cantilever Overhead Sign Supports (HCOSS) standard plan tables for the height and span ~~specified~~shown on the plans.
- ~~Determine the maximum design parameters from the COSS or HCOSS standard plan tables for that size of pipe.~~
- pipe diameter and wall thickness. Ensure alternate designs meet or exceed these maximum design parameters.

- Provide top column dimensions compatible with the sign truss mounting details.
- Ensure bottom diameter of the column is compatible with foundation details.
- Limit welds to ~~2~~two longitudinal seam welds per column.
- Provide full penetration longitudinal seam welds within 6 in. of circumferential welds, and 85% minimum penetration seam welds at other column locations.
- Provide longitudinal seam weld and fit-up that will minimize acid entrapment during later galvanizing.

Tapered columns are permitted if the provided calculations demonstrate that the column is adequate at the level of the truss-to-column connection.

3.2. **Shop Drawings**. Electronically submit shop drawings for overhead sign supports in accordance with Item 441~~, "Steel Structures."~~. Include details for anchor bolts, highway and dynamic message sign sizes and positions, walkways, and other required attachments on shop drawings.

Submit only ~~1~~one drawing for ~~2~~two or more supports of identical design and dimensions. ~~Submit shop drawings to the Bridge Division, unless otherwise shown on the plans.~~

3.3. **Fabrication**. Fabricate and weld in accordance with Item 441, ~~"Steel Structures,"~~ AWS D1.1, ~~*Structural Welding Code—Steel;*~~ and ~~the requirements of~~ this Item.

Fabrication plants that produce overhead sign support structures must be approved in accordance with DMS-7380, "Steel Non-Bridge Member Fabrication Plant Qualification." The ~~Construction~~Materials and Tests Division maintains ~~a list~~an MPL of approved overhead sign support structure fabrication plants.

For monotube-type overhead sign supports fabricated with seam-welded pipe, locate the longitudinal seam weld at the neutral axis during the bending process of the post.

For cantilevered-truss type overhead sign support columns with diameters exceeding 30 in., one circumferential weld splice is permitted per column. Locate the splice at ~~the~~a minimum height of 1/2 the column length. Provide mounting channels for the installation of traffic control devices unless otherwise shown on the plans.

Provide 100% ultrasonic testing (UT) in accordance with AWS D1.1 on all circumferential butt joint weld splices of monotube-type posts and cantilevered truss-type columns.

UT acceptance-rejection criteria must be in accordance with AWS D1.1 for cyclically loaded nontubular connections in tension.

For alternate design cantilevered-truss type overhead sign support columns, perform at least 10% UT on longitudinal seam welds using a Department-approved procedure to ensure minimum specified penetration. Perform testing at a minimum of three locations on each column (top, middle, and bottom). The minimum length of each test area will be 10 in. If minimum specified penetration is not achieved in any of the tested areas, test an additional 24 in. beyond the originally selected test area or areas requiring the specified minimum penetration. Test the entire column seam weld if any location within the additional 24-in. test area or areas does not achieve the specified minimum penetration. Repair the deficient areas using a Department-approved repair procedure and retest.

Measure required dimensions of truss-type overhead sign support structures, including camber of overhead sign bridge trusses (in vertical position) and rise of cantilever overhead sign support trusses (in horizontal position).

Shop assemble monotube-type overhead sign supports in the horizontal position to ensure specification compliance for all required dimensions, alignment, geometry, and fit.

Permanently mark sign support base plates with the fabrication plant's insignia ~~or trademark.~~. For monotube ~~-~~type supports, place the mark on the base plate adjacent to the hand hole access compartment.

Conformance to plans and other approved drawings does not relieve the Contractor of responsibility for proper fit of components.

3.4. **Galvanizing**. ~~Punch~~Provide punched, drilled, or ~~drill permitted holes~~mechanically guided thermal cutholes in steel parts or members, when allowed, before galvanizing. Mechanically guided thermal-cut hole quality will be in accordance with Item 445. Hot-dip galvanize all fabricated parts in accordance with Item 445~~, "Galvanizing."~~.

3.5. **Galvanizing Repair**. Repair galvanizing for steel parts or members damaged in assembly, transit, or erection; for permitted field-drilled holes; or for steel parts or members welded after galvanizing in accordance with the pertinent requirements of Section 445.3.~~5~~4., "Repairs."

3.6. **Installation**. Stake sign support locations for verification by the Engineer. Install overhead sign support structures at verified locations.

Use established industry and utility safety practices when erecting sign supports near overhead or underground utilities. Consult with appropriate utility companies before beginning work.

Construct concrete overhead sign support columns, spans, or both~~,~~ as shown on the plans and in accordance with Item 420~~, "Concrete Substructures."~~.

Construct foundations for new overhead sign supports in accordance with Item 416~~, "Drilled Shaft Foundations,"~~ and ~~the details~~as shown on the plans. Orient anchor bolts as shown on the plans. Cap conduit before concrete placement. Ensure the anchor bolt and template assembly is held in position during concrete placement. Use bracing attached to the upper template to ensure conduit is held in place during concrete placement. Remove top template after the concrete achieves initial set.

Erect structures after foundation concrete has attained its design strength as ~~required~~shown on the plans and in accordance with Item 421~~, "Hydraulic Cement Concrete."~~. Coat anchor bolt threads and tighten anchor bolts in accordance with Item 449~~, "Anchor Bolts."~~. Ensure that the structure is plumb. Do not use springing or raking of columns, towers, or anchor bolts to achieve plumb.

Tack weld each anchor bolt nut to its washer in ~~2~~two places and tack weld each washer to the base plate in ~~2~~two places after the overhead sign support has been plumbed and all nuts are tight. Tack weld in accordance with Item 441, ~~"Steel Structures,"~~ AWS D1.1, ~~*Structural Welding Code—Steel;*~~ and ~~the requirements of~~ this Item. Do not weld components to the bolt. Repair galvanizing damage on bolts, nuts, and washers after tack welding in accordance with Section 445.3.~~5~~4., "Repairs." Do not grout between the base plate and foundation.

Ensure sign faces are vertical.

3.7. **Relocation**. Disconnect and isolate electrical power supplies before removing the structure. Remove existing overhead sign support structures as directed. Ensure the structures or attached components suffer no undue stress or damage. Signs, sign walkways, mounting brackets, etc., may be left on the structures, unless otherwise shown on the plans or as directed. Repair or replace damaged components as directed.

Remove abandoned concrete foundations and replace surfacing in accordance with Section 650.3.8., "Removal," unless otherwise shown on the plans.

Move existing overhead sign supports to locations shown on the plans or as directed. Construct foundations for relocated overhead sign supports in accordance with Item 416~~, "Drilled Shaft Foundations,"~~ and ~~the details~~as shown on the plans. Install existing structures on new foundations in accordance with Section 650.3.6., "Installation."

Never reuse or replace lighting materials. Reuse other existing components, with the exception of conductors, unless otherwise directed. Accept ownership and dispose of unsalvageable materials ~~and dispose of~~ in ~~accordance~~conformance with federal, state, and local regulations.

3.8. **Removal**. Disconnect and isolate electrical power supplies before removing the structure. Remove sign panels, walkways, lighting fixtures, lighting brackets, ballast boxes, and other accessories from overhead sign supports. Remove and store items designated for reuse or salvage at locations shown on the plans or as directed. Store sign panels above the ground in a vertical position. Accept ownership and dispose of unsalvageable materials ~~and dispose of~~ in ~~accordance~~conformance with federal, state, and local regulations.

Remove abandoned concrete foundations, including steel, to 2 ft. below finished grade unless otherwise shown on the plans. Cut off and remove steel protruding from the remaining concrete. Backfill with material equal in composition and density to the surrounding area~~,~~ and replace surfacing with like material to an equivalent condition.

4. MEASUREMENT

This Item will be measured ~~as~~by each overhead sign support installed, relocated, or removed.

5. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Install Overhead Sign Supports" of the type and span lengths specified, "Relocate Existing Overhead Sign Supports," and "Remove Overhead Sign Supports." The span lengths will be the design span lengths shown on the plans rounded up to the next 5-ft. increment.

New drilled shaft foundations will be paid for under Item 416~~, "Drilled Shaft Foundations."~~. New concrete columns and spans will be paid for under Item 420~~, "Concrete Substructures."~~. New signs will be paid for under Item 636, "Signs." New sign walkways will be paid for under Item 654, "Sign Walkways."

5.1. **Installation**. This price is full compensation for furnishing, fabricating, galvanizing, assembling, and erecting the overhead sign supports; furnishing and placing anchor bolts, nuts, washers, and templates; furnishing and placing conduit, ground rods, and wiring; and materials, equipment, labor, tools, and incidentals.

5.2. **Relocation**. This price is full compensation for removing overhead sign supports; removing existing foundations; backfilling and surface placement; storing the components to be reused or salvaged; disposal of unsalvageable materials; furnishing, fabricating, and installing required new components, including anchor bolts, nuts, washers, and templates; placing and securing sign supports on new foundations; furnishing and placing conduit, ground rods, and wiring; loading and hauling; and materials, equipment, labor, tools, and incidentals.

5.3. **Removal**. This price is full compensation for removing overhead sign support components; removing the foundations; storing the components to be reused or salvaged; disposal of unsalvageable materials; backfilling and surface placement; loading and hauling; and materials, equipment, labor, tools, and incidentals.

Item 654
Sign Walkways

1. DESCRIPTION

1.1. **Installation**. Furnish, fabricate, and erect sign walkways.

1.2. **Removal**. Remove sign walkways.

2. MATERIALS

Provide materials and construct sign walkways and handrails as shown on the plans and in accordance with ~~the details shown on the plans, the requirements of~~ this Item, and the pertinent requirements of the following Items~~:~~.

- Item 441, "Steel Structures"
- Item 445, "Galvanizing"

3. CONSTRUCTION

3.1. **Standard Designs**. Provide sign walkways as shown on the plans. Electronically submit shop drawings in accordance with Item 441~~, "Steel Structures."~~. Submit shop drawings for sign walkways with shop drawings for overhead sign supports. Electronically submit separate shop drawings for sign walkways when installing sign walkways on existing overhead sign supports. Walkways of identical design and dimensions require only a single shop drawing submission. ~~Electronically submit shop drawings to the Bridge Division unless otherwise shown on the plans.~~

3.2. **Fabrication**. Fabricate and weld sign walkways in accordance with Item 441, ~~"Steel Structures,"~~ the requirements of this Item~~,~~; and AWS D1.1~~, *Structural Welding Code—Steel*~~. Fabrication plants that produce sign walkways must be approved in accordance with DMS-7380, "Steel Non-Bridge Member Fabrication Plant Qualification." The Materials and Tests Division maintains a list of approved sign walkway fabrication plants on the Department's MPL.

Conformance to the plans and other approved drawings does not relieve the Contractor of the responsibility for proper fit of components.

3.3. **Galvanizing**. Hot-dip galvanize all fabricated parts in accordance with Item 445~~, "Galvanizing."~~. Punch or drill permitted holes in steel parts or members before galvanizing. Repair galvanizing for any steel part or member damaged in assembly, transit, or erection, or for any steel part or member welded when permitted after galvanizing. Make all galvanizing repairs in accordance with Item 445~~, "Galvanizing."~~.

3.4. **Delivery and Installation**. Deliver each sign walkway as a complete unit or with sub-assemblies marked for field assembly. Install all fittings and hardware~~,~~ or package all parts together with their associated major components during shipment. Erect the sign walkway ~~in accordance with the details~~as shown on the plans.

3.5. **Removal**. Remove sign walkways without damaging materials, and salvage them when indicated on the plans. Stockpile salvaged materials at the location shown on the plans and as directed. Accept ownership of unsalvageable materials, and dispose of them in ~~accordance~~conformance with federal, state, and local regulations.

4. MEASUREMENT

This Item will be measured by the foot installed or each sign walkway removed.

This is a plans quantity measurement Item. The quantity to be paid ~~for~~ is the quantity shown in the proposal, unless modified by Article 9.2., "Plans Quantity Measurement." Additional measurements or calculations will be made if adjustments of quantities are required.

5. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Sign Walkways" of the types and widths specified or for "Remove Sign Walkways."

5.1. **Installation**. This price is full compensation for furnishing, fabricating, galvanizing, assembling, and erecting sign walkways; furnishing and placing required handrails, including connections, latches, plates, bolts, nuts, and washers; and materials, equipment, labor, tools, and incidentals.

5.2. **Removal**. This price is full compensation for removing various components; stockpiling; disposal of unsalvageable materials; and materials, equipment, labor, tools, and incidentals.

Item 656
Foundations for Traffic Control Devices

1. DESCRIPTION

Construct concrete foundations for small roadside signs, traffic signal ~~controllers~~controller cabinets, pedestal poles, roadside flashing beacon assemblies, electrical services, and other small traffic control devices.

2. MATERIALS

Ensure materials and construction methods conform to the requirements of this Item and the pertinent requirements of the following Items~~:~~.

- Item 400, “Excavation and Backfill for Structures”
- Item 416, “Drilled Shaft Foundations”
- Item 420, “Concrete Substructures”
- Item 421, “Hydraulic Cement Concrete”
- Item 432, “Riprap”
- Item 440, “Reinforcement for Concrete”
- Item 441, “Steel Structures”
- Item 442, “Metal for Structures”
- Item 445, “Galvanizing”
- Item 447, “Structural Bolting”
- Item 449, “Anchor Bolts”
- Item 618, “Conduit”

Use Class A concrete for non-reinforced drilled shafts. Use Class C concrete for reinforced drilled shafts. Use Class B concrete or polymer concrete composed of borosilicate glass fiber, catalyzed polyester resin, and aggregate for traffic signal controller cabinet foundations. Use drilled shaft or galvanized steel screw-in type foundations for roadside flashing beacon assemblies.

Use reinforcing steel when required.

3. CONSTRUCTION

Stake and install foundations as shown on the plans. The Engineer may shift the foundation locations within design guidelines where necessary to secure a more desirable location or avoid conflict with utilities. Use established industry and utility safety practices when working near underground or overhead utilities. Consult the appropriate utility before beginning work.

Hold anchor bolts in place ~~with~~using templates during concrete placement. Hold embedded items such as conduit or other hardware in place during concrete placement ~~with~~using templates or other approved means. Cap conduits before placing concrete. Ream conduit to remove burrs and sharp edges. Install bell ends or bushings on the conduit.

Carefully align foundation, posts, and anchor bolts. Do not spring or rake posts or anchor bolts.

Remove the top template after concrete has achieved initial set. Keep forms and other bracing intact until the concrete has cured at least ~~one~~1 curing day.

Allow concrete for pedestal poles and roadside flashing beacon assemblies to cure at least 7 days before placing bases and poles on the foundation, unless otherwise permitted in writing.

Allow concrete for traffic signal controller cabinet foundations and small roadside signs to cure at least 4 days before placing cabinets and posts on the foundation, unless otherwise permitted.

Provide an ordinary surface finish to the concrete foundation extending above ground in accordance with Section 420.4.13., "Ordinary Surface Finish."

Place concrete riprap around the foundation ~~in accordance with~~as shown on the plans.

Backfill disturbed surface with material equal in composition and density to the surrounding area. Replace surfacing material with similar material to an equivalent condition.

4. MEASUREMENT AND PAYMENT

The work performed, materials furnished, equipment, labor, tools, and incidentals will not be measured or paid for directly, but will be subsidiary to pertinent Items.

Item 658
Delineator and Object Marker Assemblies

1. DESCRIPTION

- **Installation**. Install delineator or object ~~maker~~marker assembly.
- **Removal**. Remove delineator or object marker assembly.
- **Replacement**. Remove existing delineator or object marker assembly and replace with new delineator or object marker assembly.

2. MATERIALS

Furnish only new materials ~~in accordance with details~~as shown on the plans unless otherwise directed. The Engineer will sample in accordance with Tex-725-I or Tex-737-I.

2.1. **Delineator and Object Marker Assemblies**. Fabricate in accordance with the following~~:~~.

- DMS-8600, "Delineators, Object Markers, and Barrier Reflectors~~.~~""
- DMS-4400, "Flexible Delineator and Object Marker Posts (Embedded and Surface-Mount Types~~).~~")"

2.2. **Wing Channel Post**. Furnish material of the size shown on the plans. Supply a notarized original of ~~the~~ Form ~~D~~ D~~-~~9-USA-1 (Department Form 1818) with supporting mill test report certifying that the base metal is in accordance with the following~~:~~.

- ASTM A1011, SS Grade 50~~.~~
- ASTM A499~~.~~

Galvanize material in accordance with Item 445, "Galvanizing."

3. CONSTRUCTION

~~3.1.~~ **Installation**. Locate delineators ~~and~~, object markers ~~as shown on the plans or as directed.~~

~~3.2.~~3.1. ~~Locate~~, and barrier reflectors as shown on the plans or as directed~~,~~ and install in ~~accordance~~conformance with ~~manufacturers~~the manufacturer's recommendations.

Install winged channel post and flexible delineator posts to allow the reflector units and reflectorized panels to be installed at the specified height and orientation. Align post as shown or as directed.

Drive post plumb using a driving cap to prevent visible cross-section dimension distortion. Drill or drive a pilot hole when post cannot be driven without visibly distorting the cross-section dimension. Backfill pilot holes thoroughly by tamping in 6-in. lifts to grade.

~~Install surface-mount and other types of delineators and object markers in accordance with details shown on the plans.~~

Repair damaged galvanizing in accordance with Section 445.3.~~5~~4., "Repairs." Install reflector units on wing channel posts after the posts have been erected.

~~3.3.~~3.2. **Removal**. Remove post assemblies without damaging materials, and salvage when indicated on the plans. Remove post to a minimum of 6 in. below ~~finish~~finished grade. Stockpile salvaged materials at the location

shown on the plans or as directed. Accept ownership of unsalvageable materials and dispose of them in ~~accordance~~conformance with federal, state, and local requirements.

3.3. **Replacement**. Remove existing delineator or object marker assembly in accordance with Section 658.3.2., "Removal," and replace with new delineator or object marker assembly in accordance with Section 658.3.1., "Installation."

4. MEASUREMENT

Installation will be measured by each delineator or object marker assembly installed~~. When removal is specified on the plans to be a pay item, it will be measured by each delineator or object marker assembly~~, removed~~.~~, or replaced.

This is a plans quantity measurement Item. The quantity to be paid ~~for~~ is the quantity shown in the proposal, unless modified by Article 9.2., "Plans Quantity Measurement." Additional measurements or calculations will be made if adjustments of quantities are required.

5. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Install Delineator Assemblies~~" or~~," "Install Object Marker Assemblies," "Install High Speed/High Impact Assemblies," "Replace Delineator Assemblies," or "Replace Object Marker Assemblies" of the types and colors specified, and for "Remove Delineator or Object Marker Assemblies."

5.1. **Installation**. This price is full compensation for furnishing and fabricating when required~~, and~~, installing and mounting the delineator or object marker assemblies, including posts, adhesive or pads for surface mount assemblies, back plates, reflector units, fastening plates, brackets, bolts, nuts, and washers; and materials, equipment, labor, tools, and incidentals.

5.2. **Removal**. This price is full compensation for removal and disposal of delineator and object marker assemblies and for materials, equipment, labor, tools, and incidentals.

~~5.1.~~5.3. **Replacement**. This price is full compensation for removal and disposal of existing delineator and object marker assemblies; furnishing, installing, and mounting new delineator or object marker assemblies, including posts, adhesive or pads for surface mount assemblies, back plates, reflector units, fastening plates, brackets, bolts, nuts, and washers; and materials, equipment, labor, tools, and incidentals.

~~5.2. **Removal**. Unless otherwise shown on the plans, removal will not be paid for directly but is subsidiary to bid items of the Contract.~~

~~When removal is shown on the plans as a bid item, this price is full compensation for removal and disposal of delineator and object marker assemblies and for materials, equipment, labor, tools, and incidentals.~~

Item 662
Work Zone Pavement Markings

1. DESCRIPTION

Furnish, place, and maintain work zone pavement markings.

2. MATERIALS

Provide thermoplastic, paint and beads, raised pavement markers (RPMs), prefabricated pavement markings, temporary flexible reflective roadway marker tabs, or other approved materials for work zone pavement markings.

Supply materials ~~meeting:~~in accordance with the following.

- DMS-4200, "Pavement Markers (Reflectorized~~),"~~)"
- DMS-4300, "Traffic Buttons~~,~~""
- DMS-8200, "Traffic Paint~~,~~""
- DMS-8220, "Hot Applied Thermoplastic~~,~~""
- DMS-8240, "Permanent Prefabricated Pavement Markings~~,~~""
- DMS-8241, "Temporary (Removable) Prefabricated Pavement Markings~~,~~""
- DMS-8242, "Temporary Flexible, Reflective Roadway Marker Tabs~~," and~~"
- DMS-8290, "Glass Traffic Beads~~."~~"

2.1. **Nonremovable Markings**. Use hot-applied thermoplastic, paint and beads, or permanent prefabricated pavement markings for nonremovable markings. ~~Paint and beads or other materials are not allowed~~Furnish Type II glass beads in accordance with DMS-8290 for ~~nonremovable~~thermoplastic and paint and bead pavement markings ~~unless shown on the plans~~.

2.2. **Removable and Short-Term Markings**. Use RPMs, traffic buttons, removable prefabricated pavement markings, temporary flexible reflective roadway marker tabs, or other approved materials for removable and short-term markings. Do not use hot-applied thermoplastic, multipolymer pavement markings, or traffic paint for removable markings. Use removable prefabricated pavement markings on the final pavement surface when the plans specify removable markings.

3. CONSTRUCTION

Apply pavement markings in accordance with the following Items.

- Item 666, "Retroreflectorized Pavement Markings"
- Item 668, "Prefabricated Pavement Markings"
- Item 672, "Raised Pavement Markers"

3.1. **Placement**. Install longitudinal markings on pavement surfaces before opening to traffic. Maintain lane alignment traffic control devices and operations until markings are installed. Install markings in proper alignment in accordance with the TMUTCD and as shown on the plans. Short-term markings will be allowed when standard markings (removable or nonremovable) cannot be placed before opening to traffic, if shown on the plans or directed.

When short-term markings are allowed for opening to traffic, place standard longitudinal markings no later than 14 calendar days after the placement of the surface. When inclement weather prohibits placement of markings, the 14-day period may be extended until weather permits proper application.

Place standard longitudinal markings no sooner than 3 calendar days after the placement of a surface treatment, unless otherwise shown on the plans.

Apply thermoplastic markings to a minimum thickness of 0.060 in. (60 mils). When paint and beads are allowed, apply to a minimum dry thickness of 0.012 in. (12 mils).

Place short-term markings in proper alignment with the location of the final pavement markings. Remove and replace short-term markings not in alignment at the Contractor's expense.

For removable placements, use of RPMs to simulate longitudinal markings is at the Contractor's option. Use side-by-side RPMs to simulate longitudinal lines wider than 4 in. Do not use RPMs for words, symbols, shapes, or diagonal or transverse lines.

3.2. **Marking Removal**. Remove markings that conflict with succeeding markings in accordance with Item 677, "Eliminating Existing Pavement Markings and Markers." Remove short-term markings that interfere or conflict with final marking placement immediately before placing final pavement markings, unless otherwise directed. Remove the remainder of the short-term markings before final acceptance.

Remove all temporary markings with minimal damage to the roadway to the satisfaction of the Engineer.

3.3. **Performance Requirements**. Ensure all markings are in accordance with Tex-828-B and are visible from a distance at least ~~300~~320 ft. (eight skiplines) in daylight conditions and at least 160 ft. (four skiplines) in nighttime conditions when illuminated by automobile low-beam headlights. Determine visibility distances using an automobile traveling on the roadway under dry conditions.

Maintain the markings for 30 calendar days after installation. The end of the 30-day maintenance period does not relieve the Contractor from the performance deficiencies requiring corrective action identified during the 30-day period. Remove and replace markings at the Contractor's expense if they fail to meet the requirements of this Item during the 30-day period. The 30-calendar day performance requirement will begin again after replacement of the markings.

Ensure daytime and nighttime reflected color of the markings are distinctly white or yellow. Ensure markings exhibit uniform retroreflective characteristics.

4. MEASUREMENT

This Item will be measured by the foot or each word, shape, symbol, or temporary flexible reflective roadway marker tab. Each stripe will be measured separately. RPMs used to simulate a marking will be measured by the foot of marking or each RPM.

This is a plans quantity measurement Item. The quantity to be paid is the quantity shown in the proposal, unless modified by Article 9.2., "Plans Quantity Measurement." Additional measurements or calculations will be made if adjustments of quantities are required.

5. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Work Zone Pavement Markings" of the type and color specified and the shape, width, and size specified as applicable. This price is full compensation for furnishing, placing, maintaining, and removing work zone pavement markings and for materials, equipment, labor, tools, and incidentals.

Elimination of nonremovable markings will be paid for under Item 677~~, "Eliminating Existing Pavement Markings and Markers."~~. Removal of short-term and removable markings will not be paid for directly, but will be subsidiary to this Item.

Type II work zone pavement markings (paint and beads) used as a sealer for Type I pavement markings (thermoplastic) will be paid for under this Item.

Item 666
Retroreflectorized Pavement Markings

1. DESCRIPTION

Furnish and place retroreflectorized~~,~~ or non-retroreflectorized (shadow) ~~and profile~~ pavement markings.

2. MATERIALS

2.1. **Type I Marking Materials~~.~~ (Thermoplastic).** Furnish in accordance with DMS-8220, "Hot Applied Thermoplastic."

~~Furnish pavement marking material used for Type I profile markings and shadow markings that have been approved by the Construction Division, and in accordance with DMS-8220, "Hot Applied Thermoplastic."~~

2.2. **Type II Marking Materials~~.~~ (Traffic Paint).** Furnish in accordance with DMS-8200, "Traffic Paint."

2.3. **Type III Marking Materials (Multipolymer).** Furnish in accordance with DMS-8230, "Multipolymer Pavement Markings."

~~2.3.~~2.4. **Glass Traffic Beads**. ~~Furnish~~For Type I, Type II, and Type III pavement markings, furnish drop-on glass beads in accordance with ~~DMS-8290~~DMS-8290, "Glass Traffic Beads~~" or as approved. Furnish a double-drop of Type II and Type III drop-on glass beads where each type bead is applied separately in equal portions (by weight), unless otherwise approved. Apply the Type III beads before applying the Type II beads,~~" to meet the specified retroreflective performance requirements for all permanent, longitudinal pavement markings.

~~2.4.~~2.5. **Labeling**. ~~Use~~To sample material, use clearly marked containers that indicate ~~color, mass,~~ material type, color, mass, manufacturer, and batch number.

3. EQUIPMENT

3.1. **General Requirements**. Use pavement marking equipment that:

- is maintained in satisfactory condition~~,~~;
- meets or exceeds the requirements of the National Board of Fire Underwriters and the Texas Railroad Commission for this application~~,~~;
- applies beads by an automatic bead dispenser attached to the pavement marking equipment ~~in~~ such ~~a manner~~ that the beads are dispensed uniformly and almost instantly upon the marking as the marking is being applied to the road surface. The bead dispenser must have an automatic cut-off control, synchronized with the cut-off of the pavement marking equipment~~,~~;
- has an automatic cut-off device with manual operating capabilities to provide clean~~,~~ marking with square ~~marking~~ ends~~,~~;
- ~~is capable of producing~~can produce the types and shapes of profiles specified~~,~~; and
- can provide continuous mixing and agitation of the pavement marking material. The use of pans, aprons, or similar appliances ~~which~~that the die overruns will not be permitted for longitudinal striping applications exceeding a project length of 2,000 ft., unless otherwise approved.

When placing multipolymer pavement markings (MPM), use equipment designed for pavement preparation and the application of selected type of MPM material.

Provide a ~~hand-held~~handheld thermometer capable of measuring the temperature ~~of the~~between 300°F and 450°F to measure the temperature of marking material in the field, when applying Type I material.

~~When pavement markings are required to meet minimum retroreflectivity requirements on the plans:~~

3.1.1. **Measuring Retroreflectivity**. Use a mobile retroreflectometer approved by the ~~Construction~~Materials and Tests Division and certified by the Texas~~ ~~A&M Transportation Institute (TTI) Mobile Retroreflectometer Certification Program.

Use a portable retroreflectometer that:

- uses 30-meter geometry and meets the requirements described in ASTM E1710;
- has either an internal ~~global positioning system~~Global Positioning System (GPS) or the ability to be linked with an external GPS with a minimum location accuracy ~~rating~~ of 16.5 ft~~. 5 in.~~, in accordance with the ~~circular error probability~~Circular Error Probability (CEP) method (CEP is the radius of the circle with its origin at a known position that encompasses 50% of the readings returned from the GPS instrument); and
- can record and ~~print~~export the GPS location and retroreflectivity reading for each ~~location where readings are taken~~measurement.

3.2. **Material Placement Requirements**. Use equipment that can place:

- ~~at least 40~~a minimum length of 30,000 ft. ~~of 4~~for 6-in. solid or broken non-profile markings per working day at the specified thickness, unless otherwise approved;
- ~~at least~~a minimum length of 15,000 ft. of solid or broken profile pavement markings per working day at the specified thickness;
- linear non-profile markings up to 8 in. wide in a single pass;
- non-profile pavement markings other than solid or broken lines at an approved production rate;
- a centerline and no-passing barrier-line configuration (consisting of ~~1~~one broken line and ~~2~~two solid lines ~~at the same time~~simultaneously) to the alignment, spacing, and thickness for non-profile pavement markings shown on the plans;
- solid and broken lines simultaneously;
- white line from both sides;
- lines with clean edges, reasonably square ends, uniform ~~cross-section~~width with a tolerance of ±1/8 in~~. per 4 in. width, .~~, and uniform thickness~~, and reasonably square ends~~;
- skip lines between 10 and 10~~ 1/2~~.5 ft., a stripe-to-gap ratio of 10 to 30, and a stripe-gap cycle between 39~~ 1/2~~.5 ft. and 40~~ 1/2~~.5 ft., automatically; and
- beads uniformly and almost instantly on the marking as the marking is ~~being~~ applied~~;~~.
- ~~beads uniformly during the application of all lines (each line must have an equivalent bead yield rate and embedment); and~~
- ~~double drop bead applications using both Type II and Type III beads from separate independent bead applicators, unless otherwise approved by the Engineer.~~

For Type I markings, equipment must be capable of providing uniform heating of striping materials to temperatures exceeding 390°F (199°C). Ensure that the material is not heated to a temperature above the maximum temperature recommended by the manufacturer.

For Type I markings, equipment must be capable of maintaining the thermoplastic striping material in a plastic state in all mixing and conveying parts, including the line dispensing device, until applied.

4. CONSTRUCTION

Place markings before opening to traffic unless short-term or work zone markings are allowed.

4.1. **General**. Obtain approval for the sequence of work and estimated daily production. Minimize interference to roadway operations when placing markings on roadways open to traffic. Use traffic control as shown on the plans or as approved. Protect all markings placed under open-traffic conditions from traffic damage and disfigurement. Replace markings when more than 5% of the markings are damaged or disfigured.

Establish guides to mark the lateral location of pavement markings as shown on the plans or as directed, and have guide locations verified. Use material for guides that will not leave a permanent mark on the roadway.

Apply markings on pavement that is completely dry and pavement that passes the following tests:

- **Type I Marking Application**—. Place a sample of Type I marking material on a piece of tarpaper placed on the pavement. Allow the material to cool to ambient temperature, and then inspect the underside of the tarpaper in contact with the pavement. Pavement will be considered dry if there is no condensation on the tarpaper.
- **Type II and Type III Marking Application**—. Place a 1-sq. ft. piece of clear plastic on the pavement, and weightweigh down the edges. The pavement is considered dry if, when inspected after 15 min., no condensation has occurred on the underside of the plastic.

Apply markings:

- using personnel skilled and experienced in installation of pavement markings;
- that meet the requirements of Tex-828-B,Tex-828-B;
- that meet minimum retroreflectivity requirements when specified on the plans (applies to Type I markings only),;
- using widths and colors shown on the plans,;
- at locations shown on the plans,;
- in proper alignment with the guides without deviating from the alignment more than 1 in. per 200 ft. of roadway or more than 2 in. maximum,;
- without abrupt deviations,;
- free of blisters and with no more than 5% by area of holes or voids, (percent by area);
- with uniform cross-section, density, and thickness,;
- with clean and reasonably square ends,; and
- that are retroreflectorized with drop-on glass beads, and.
- ~~using personnel skilled and experienced with installation of pavement markings.~~

Remove all applied markings that are not in alignment or sequence as statedshown on the plans, or in accordance with the specifications, at the Contractor's expense, in accordance with Item 677, "Eliminating Existing Pavement Markings and Markers," except for measurement and payment.

4.2. **Spot Striping**. Perform spot striping on a callout basis with a minimum callout quantity as shown on the plans.

4.2.4.3. **Surface Preparation**. Prepare surfaces in accordance with this Section unless otherwise shown on the plans.

4.2.1.4.3.1. **Surface Cleaning for Pavement Marking Applications on New Asphalt Surfaces with No Existing Pavement Markings and for Retracing of Existing Pavement Markings on All Surfaces**. AirUse air blast or broom to clean the pavement surface for new asphalt surfaces (less than 3 years old) and for retracing of all surfaces to remove loose material, unless otherwise shown on the plans. A sealer for Type I markings is not required unless otherwise shown on the plans. If cleaning is needed beyond what is specified, Engineer can use force account to compensate for the extra effort. This is mainly applied when the pavement is covered with thick layer of dirt or mud or there is grass growing on the pavement.

4.2.2.4.3.2. **Surface Cleaning for ~~Old Asphalt and~~ All Concrete Surfaces and Asphalt Surfaces Only When Specified in the Plans (Excludes New Asphalt Surfaces with No Existing Pavement Markings and Retracing)**. Clean ~~old asphalt surfaces (more than 3 years old) and all concrete~~ surfaces in accordance with Item 678, "Pavement Surface Preparation for Markings," to remove curing membrane, dirt, grease, existing loose and flaking ~~existing~~ construction markings, and other forms of contamination.

4.2.3.4.3.3. **Sealer for Type I Markings**. Apply a pavement sealer ~~to~~when shown on the plans. Pavement sealers are recommended for old asphalt surfaces (more than 3 ~~years~~yr. old) and ~~to~~for all concrete surfaces before placing Type I markings on locations that do not have existing markings~~, unless otherwise approved.~~. The pavement sealer may be either a Type II marking or an acrylic or epoxy sealer as recommended by the Type I marking manufacturer, unless otherwise shown on the plans. Follow the manufacturer's directions for application of acrylic or epoxy sealers. Clean the surface of sealer that becomes dirty after placement by washing or in accordance with Section 666.4.~~2~~3.1., "Surface Cleaning for Pavement Marking Applications on New Asphalt Surfaces with No Existing Pavement Markings and for Retracing of Existing Pavement Markings on All Surfaces," as directed. Place the sealer in the same configuration and color (unless clear) as the Type I markings unless otherwise shown on the plans.

4.3.4.4. **Application**. Apply markings during ~~good~~favorable weather unless otherwise directed. If markings are placed at Contractor option when inclement weather is impending and the markings are damaged by subsequent precipitation, the Contractor is responsible for all required replacement costs.

4.3.1.4.4.1. **Type I Markings**. Place ~~the~~all Type I ~~marking~~markings after the sealer cures. Apply within the temperature limits recommended by the material manufacturer. Flush the spray head if spray application operations cease for 5 min. or longer, by spraying marking material into a pan or similar container until the material being applied is at the recommended temperature.

Apply on clean, dry ~~pavements~~pavement passing the moisture test ~~described~~ in accordance with Section 666.4.1., "General," and with a surface temperature above 50°F when measured in accordance with Tex-~~-~~829-~~-~~B.

The Engineer will measure thickness of markings in accordance with Tex-854-B.

4.3.1.1.4.4.1.1. **Non-Profile Pavement Markings**. Apply Type I non-profile markings with a minimum thickness of:

- 0.100 in. (100 mils) for new markings and retracing water-based markings on surface treatments involving Item 316, "Seal Coat,"
- 0.060 in. (60 mils) for retracing on thermoplastic pavement markings, or
- 0.090 in. (90 mils) for all other Type I markings.

~~The maximum thickness for Type I non-profile markings is 0.180 in. (180 mils). Measure thickness for markings in accordance with Tex-854-B using the tape method.~~

4.3.1.2. ~~**Profile Pavement Markings**. Apply Type I profile markings with a minimum thickness of:~~

- ~~0.060 in. (60 mil) for edgeline markings, or~~

4.3.1.3.4.4.1.2. 0.090 in. (90 ~~mil) for gore and centerline/no-passing barrier line markings.~~ mils) for the longitudinal stripe portion.

In addition, at a longitudinal spacing ~~indicated~~shown on the plans, the markings must be profiled in a vertical manner such that the profile is transverse to the longitudinal marking direction. The profile must not be less than 0.30 in. (300 ~~mil~~ mils) nor greater than 0.~~50~~41 in. (~~500 mil~~410 mils) in height when measured ~~above~~from the normal top surface plane of the ~~roadway.~~base marking to the top of the raised profile marking. The transverse width of the profile must not be less than ~~3~~5.25 in.~~.~~. and the longitudinal width not less than ~~1~~2 in., when measured at the top surface plane of the profile bar. The profile may be either a ~~1~~one or ~~2~~two transverse bar profile. When the ~~2~~ two transverse bar profile is used, the spacing between the bases of

the profile bars must not exceed 0.50 in. The above dimensions for transverse ~~bar width is~~bars are for ~~each 4~~ 6 in. ~~of line width.~~wide longitudinal marking.

The raised profile markings must be uniform in size, appearance, and spacing. When profile markings are applied in a two-step process, the raised profile markings must be applied first and then the stripe applied over them. The raised profile markings in a two-step process may be circular in shape. The circular profile markings must be uniform in diameter and the diameter must not be less than 5.25 in. The height of the apex must not be less than 0.30 in. (300 mils) nor greater than 0.41 in. (410 mils) when measured from the normal top surface of the base marking to the top of the raised profile marking.

4.4.1.3. **Type I All-Weather Pavement Markings**. Apply Type I all-weather markings to at least 100-mil film thickness.

~~4.3.2.~~4.4.2. **Type II Markings**. Apply on surfaces with a minimum surface temperature of 50°F. ~~Apply at least 20~~ when measured in accordance with Tex-829-B. Apply at least 30 gal. per mile on concrete and asphalt surfaces and at least ~~22~~33 gal. per mile on surface treatments for a solid ~~4~~6-in. line. Adjust application rates proportionally for other widths. When Type II markings are used as a sealer for Type I markings, apply at least ~~15~~22-1/2 gal. per mile using Type II drop-on beads.

Apply Type II all-weather markings to at least 25-mil wet film thickness.

4.4.3. **Type III Markings**. Apply in conformance with the manufacturer's recommendations.

~~4.3.3.~~4.4.4. **Bead Coverage~~.~~ and Embedment**. Provide a uniform distribution of beads across the surface of the stripe ~~for Type I and Type II markings,~~ with 40~~% to~~ 60% bead embedment.

4.4.5. **Durability**. Provide markings that do not lose more than 5% of the striping material in any 1-ft. section of stripe during their performance period in accordance with Section 666.4.8., "Performance Period." Measure the durability in accordance with ASTM D913.

4.5. **Retroreflectivity Requirements**. ~~When~~ Retroreflectivity requirements are not required for Contracts with less than 20,000 total ft. of longitudinal pavement markings, callout work, black shadow markings, or work zone pavement markings. Retroreflectivity requirements are for dry conditions unless otherwise specified ~~on the plans,~~ .

~~4.3.4.~~4.5.1. **Type I Markings**. All Type I markings, including profile markings, must meet the following minimum retroreflectivity values for all longitudinal edgeline ~~markings~~, centerline ~~or~~, no-passing barrier line, and lane ~~lines when measured any time after 3 days, but not later than 10 days after application:~~line markings.

- **White** ~~markings:~~**Markings (ASTM E1710)**. 250 millicandelas per square meter per lux (mcd/m^2/lx~~)~~).
- **Yellow** ~~markings:~~**Markings (ASTM E1710)**. 175 mcd/m^2/lx.

Collect retroreflectivity measurement for markings applied on pavement surface other than seal coat after 10 days but not later than 30 days from the time of application. For markings applied on seal coat, measure retroreflectivity after 3 days but not later than 10 days from the time of application.

4.5.2. **Type I High-Performance Markings**. Type I high-performance markings must meet the following minimum retroreflectivity values for all longitudinal edgeline, centerline, no-passing barrier line, and lane line markings when measured any time after 30 days but not later than 60 days from the time of application.

- **White Markings (ASTM E1710)**. 400 mcd/m^2/lx.
- **Yellow Markings (ASTM E1710)**. 250 mcd/m^2/lx.

4.5.3. **Type I All-Weather Markings**. Type I all-weather markings must meet the following minimum retroreflectivity values for all longitudinal edgeline, centerline, no-passing barrier line, and lane line markings when measured any time after 30 days but not later than 60 days from the time of application.

- **White Markings Dry (ASTM E1710)**. 400 mcd/m^2/lx.

- **Yellow Markings Dry (ASTM E1710)**. 250 mcd/m²/lx.
- **White Markings Wet Continuous (ASTM E2832)**. 150 mcd/m²/lx.
- **Yellow Markings Wet Continuous (ASTM E2832)**. 125 mcd/m²/lx.

4.5.4. **Type II Markings**. Type II markings must meet the following minimum retroreflectivity values for all longitudinal edgeline, centerline, no-passing barrier line, and lane line, markings.

- **White Markings**. 175 mcd/m²/lx.
- **Yellow Markings**. 125 mcd/m²/lx.

Collect retroreflectivity measurement for markings applied on pavement surface other than seal coat after 10 days but not later than 30 days from the time of application. For markings applied on seal coat, measure retroreflectivity after 3 days but not later than 10 days from the time of application.

4.5.5. **Type II All-Weather Markings**. Meet the following minimum retroreflectivity values for all longitudinal edgeline, centerline, no-passing barrier line, and lane line markings.

- **White Markings Dry (ASTM E1710)**. 250 mcd/m²/lx.
- **Yellow Markings Dry (ASTM E1710)**. 150 mcd/m²/lx.
- **White Markings Wet Continuous (ASTM E2832)**. 100 mcd/m²/lx.
- **Yellow Markings Wet Continuous (ASTM E2832)**. 75 mcd/m²/lx.

Collect retroreflectivity measurement for markings applied on pavement surface other than seal coat after 10 days but not later than 30 days from the time of application. For markings applied on seal coat, measure the retroreflectivity after 3 days but not later than 10 days from the time of application.

4.5.6. **Type III Markings**. Type III markings must meet the following minimum retroreflectivity values for all longitudinal edgeline, centerline, no-passing barrier line, and lane line markings when measured any time after 30 days but not later than 60 days from the time of application.

- **White Markings**. 400 mcd/m²/lx.
- **Yellow Markings**. 250 mcd/m²/lx.

4.5.7. **Type III All-Weather Markings**. Type III all-weather markings must meet the following minimum retroreflectivity values for all longitudinal edgeline, centerline, no-passing barrier line, and lane line markings when measured any time after 30 days but not later than 60 days from the time of application.

- **White Markings Dry (ASTM 1710)**. 400 mcd/m²/lx.
- **Yellow Markings Dry (ASTM 1710)**. 250 mcd/m²/lx.
- **White Markings Wet Continuous (ASTM 2832)**. 150 mcd/m²/lx.
- **Yellow Markings Wet Continuous (ASTM 2832)**. 125 mcd/m²/lx.

~~4.4.~~4.6. **Retroreflectivity Measurements**. Use a mobile retroreflectometer ~~for projects requiring minimum retroreflectivity requirements~~ to measure the retroreflectivity of markings for Contracts ~~totaling~~with more than ~~200~~50,000 total ft. of longitudinal pavement markings, unless otherwise shown on the plans. ~~For Contracts with less than 200,000 ft. of pavement markings or~~For Contracts ~~with callout work,~~ between 20,000 and 50,000 total ft. of longitudinal pavement markings, mobile or portable retroreflectometers may be used at the Contractor's discretion. Coordinate with and obtain authorization from the Engineer before starting any retroreflectivity data collection.

Use a portable retroreflectometer for measuring the wet continuous retroreflectivity in accordance with ASTM E2832. Notify the Department when wet retroreflectivity measurements are to be taken. The Department will observe the wet retroreflectivity readings.

~~4.4.1.~~4.6.1. **Mobile Retroreflectometer Measurements**. Provide mobile ~~measurements~~measurement averages for every 0.1 ~~miles~~mi. unless otherwise specified or approved. Take measurements on each section of roadway for each series of markings (~~i.~~e.g., edgeline, center skip line, and each line of a double line~~, etc.)~~) and for

each direction of traffic flow. Measure each line in both directions for centerlines on two-way roadways (i.e., measure both double solid lines in both directions and measure all center skip lines in both directions). Furnish measurements in ~~compliance~~accordance with ~~Special Specification~~Item 667, "Mobile Retroreflectivity Data Collection for Pavement Markings," unless otherwise approved. The Engineer may require ~~an occasional~~a field comparison check ~~with~~using a calibrated portable retroreflectometer ~~meeting the requirements listed above~~ for verification and to ensure accuracy. Use all equipment in ~~accordance~~conformance with the manufacturer's recommendations and directions. Inform the Engineer and TTI at least 24 hr. before taking any measurements.

A marking meets the retroreflectivity requirements if:

- ~~■~~ the combined average retroreflectivity measurement for a ~~one-mile~~1-mi. segment meets the minimum retroreflectivity values specified~~,~~ and
- ■ no more than 30% of the retroreflectivity measurement values are below the minimum retroreflectivity requirements value within ~~the one-mile~~that 1-mi. segment~~.~~; or
- ■ ~~The Engineer may accept failing one-mile segments if~~the combined average retroreflectivity measurement for a 1-mi. segment does not meet the minimum retroreflectivity values specified, but no more than 20% of the retroreflectivity measurements within that ~~mile~~1-mi. segment are below the minimum retroreflectivity requirement ~~value~~.

The ~~one-mile~~1-mi. segment will start from the beginning of the data collection and end after a ~~mile~~mile's worth of measurements have been taken~~, each~~. Each subsequent mile of measurements will be a new segment. Centerlines with ~~2~~two stripes (either solid or broken) will result in 2 ~~miles~~mi. of data for each mile segment. Each centerline stripe must be tested for compliance as a stand-alone stripe.

Restripe at the ~~Contractor's~~Contractor's expense ~~with a minimum of 0.060 in. (60 mils) of Type I marking~~ if the ~~marking fails~~markings fail retroreflectivity requirements. Take retroreflectivity measurements ~~every 0.1 miles a minimum of 10 days after this second~~of all restriped markings following the time interval allowed based on the type of marking and the pavement surface for the latest application ~~within that mile segment for that series of markings~~.

For all Type I markings, if the restripe application does not meet minimum retroreflectivity requirements or the initial stripe combined with the restripe exceeds 0.180 in. (180 mils), the Engineer may require:

- ■ removal of all existing markings,
- ■ a new application as initially specified, and ~~If the markings do~~
- ■ a repeat of the application process until minimum retroreflectivity requirements are met.

For all Type III markings, if the first application does not meet minimum retroreflectivity ~~after 10 days of this second application~~requirements, the Engineer may require removal of all existing markings, a new application as initially specified, and a repeat of the application process until minimum retroreflectivity requirements are met.

~~4.4.2.~~4.6.2. **Portable Retroreflectometer Measurements**. ~~Take a minimum of~~For non-all-weather markings, provide portable measurement averages for every 1.0 mi. unless otherwise specified or approved. Using a portable reflectometer, take at least 20 measurements for each 1-mi. section of roadway for each series of markings (~~i.~~e.g., edgeline, center skip line, and each line of a double line~~, etc.)~~) and direction of traffic flow ~~when using a portable reflectometer~~. Measure each line in both directions for centerlines on two-way roadways (i.e., measure both double solid lines in both directions and measure all center skip lines in both directions). The spacing between each measurement must be at least 100 ft. The Engineer may decrease the mileage frequency for measurements if the previous measurements provide satisfactory results. The Engineer may ~~require~~resume the original number of measurements if concerns arise.

~~Restripe once~~For all-weather markings, take at ~~the Contractor's expense with a minimum of 0.060 in. (60 mils) of Type I marking material if the average of these~~ least three measurements ~~fails. Take a minimum of 10 more measurements after 10 days of this second application within that mile segment~~ for ~~that~~each

series of markings. Restripe again at the Contractor's expense with a minimum of 0.060 in. (60 mils) of Type I (e.g., edgeline, center skip line, and each line of a double line) and direction of traffic flow and average the three measurements for each marking. The spacing between each measurement must be at least 100 ft. If the average of the three measurements taken on an individual marking material if the average of these measurements fallfalls below the minimum acceptable retroreflectivity requirements. If the markings do not meet minimumvalue, take at least six additional measurements on that individual marking and average them. These six additional measurements must also be spaced at least 100 ft. apart. If the average of these six measurements falls below the minimum acceptable retroreflectivity after this third applicationvalue, the Engineer may require removal of all existingmarking does not meet the performance requirements.

Restripe at the Contractor's expense if the averages of these measurements fail. Retake portable retroreflectometer measurements of all restriped markings, following the time interval allowed based on the type of marking and the pavement surface for the latest applicationa new application as initially specified, and a repeat of the application process until minimum retroreflectivity requirements are met.

4.5.4.7. **Traffic Control**. Provide traffic control, as required, when taking portable retroreflectivity measurements after marking application. OnFor the minimum traffic control requirements on low-volume roadways (as definedshown on the plans), refer to the figure, "Temporary Road Closure" in Part 6 of the *Texas Manual on Uniform Traffic Control Devices* for the minimum traffic control requirementsTMUTCD. For all other roadways, the minimum traffic control requirements will be as shown on the Traffic Control Plan (TCP) standard sheets TCP (3-1) and TCP (3-2). The lead vehicle will not be required on divided highways. The TCP and traffic control devices must meet the requirements listed in Item 502, "Barricades, Signs, and Traffic Handling." Time restrictions that apply during striping application will also apply during the retroreflectivity inspections, except when using the mobile retroreflectometer, unless otherwise shown on the plans or approved.

4.6.4.8. **Performance Period**. All longitudinal markings must meet the minimum retroreflectivity requirements ofwithin the timeframe specified. All markings must meet all other performance requirements in accordance with this specificationItem for at least 30 calendar days after installation. Unless otherwise directed, remove pavement markings that fail to meet requirements, and replace them at the Contractor's expense. Replace failing markings within 30 days of notification. All replacement markings must also meet all requirements ofin accordance with this Item for a minimum ofat least 30 calendar days after installation.

4. MEASUREMENT

This Item will be measured by the foot; by each word, symbol, or shape; or by any other unit shown on the plans. Each stripe will be measured separately.

This is a plans quantity measurement itemItem. The quantity to be paid is the quantity shown in the proposal, unless modified by Article 9.2., "Plans Quantity Measurement." Additional measurements or calculations will be made if adjustments of quantities are required.

Acrylic or epoxy sealer, or Type II markings when used as a sealer for Type I markings, will be measured by the foot; by each word, symbol, or shape; or by any other unit shown on the plans.

Profile pavement markings will be measured as a marking consisting of both the pavement marking stripe and the raised profile, regardless of the installation method used.

5. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Pavement Sealer" of the size specified,; "Pavement Sealer (Call Out)" of the size specified; "Retroreflectorized Pavement Markings" of the type and, color specified and the, shape, width, size, and thickness specified as applicable, "; "Non-Retroreflectorized Shadow Pavement Markings with Retroreflective Requirements" of the types, colors, sizes, widthstype,

width, size, and ~~thicknesses~~thickness specified; "Type I High Performance Pavement Markings" of the color, width, size, and thickness specified; "All-Weather Pavement Markings" of the type, color, shape, width, and thickness specified; "Pavement Marking (Call Out)" of the type, color, width, size, and thickness specified; or "Retroreflectorized Profile Pavement Markings" of the ~~various types, colors, shapes, sizes, and widths~~color, shape, size, and width specified.

This price is full compensation for application of pavement markings, materials, equipment, labor, tools, and incidentals.

Surface ~~preparation of new~~cleaning for all concrete surfaces and asphalt ~~concrete pavements more than 3 years old, where no stripe exists,~~surfaces only when shown on the plans (excludes new asphalt surfaces with no existing pavement markings and retracing) will be paid for under Item 678~~, "Pavement~~. Surface ~~Preparation for Markings." Surface preparation of all other asphalt and old concrete pavement~~cleaning for pavement marking applications on new asphalt surfaces with no existing pavement markings and for retracing of existing pavement markings on all surfaces will not be paid for directly, but will be subsidiary to this Item. If cleaning is needed beyond regular brooming and blowing compressed air, the Engineer may use force account to compensate for the extra effort. This is mainly applied when the pavement is covered with a thick layer of dirt or mud or grass is growing on the pavement.

Surface preparation of any surface where pavement markings are being retraced, except for sealing, will not be paid for directly, but ~~is~~will be subsidiary to this Item.

~~Work zone pavement markings (Type II, paint and beads) used as a sealer for Type I markings (thermoplastic) will be paid for under Item 662, "Work Zone Pavement Markings."~~

If the Engineer requires that markings be placed in inclement weather, repair or replacement of markings damaged by the inclement weather will be paid for in addition to the original plans quantity.

~~Special Specification 6438~~Item 667

Mobile Retroreflectivity Data Collection for Pavement Markings

1. DESCRIPTION

Furnish mobile retroreflectivity data collection (MRDC) for pavement markings on roadways as shown on the plans or as designated by the Engineer. Conduct MRDC on dry pavement only. Provider is defined as the Contractor or ~~Subcontractor who~~subcontractor that collects the MRDC data.

2. EQUIPMENT AND PERSONNEL

2.1. **Mobile Retroreflectometer**. Provide a self-propelled, mobile retroreflectometer certified by the Texas A&M Transportation Institute (TTI) Mobile Retroreflectometer Certification Program.

2.2. **Portable Retroreflectometer**. Provide a portable retroreflectometer that uses 30-meter geometry meeting the requirements described in ASTM ~~E 1710~~E1710. Maintain, service, and calibrate all portable retroreflectometers ~~according to~~in conformance with the manufacturer's instructions.

2.3. **Operating Personnel for ~~Mobile~~ Retroreflectometer**. Provide all personnel required to operate the mobile retroreflectometer and portable retroreflectometer. Ensure MRDC system operator has a current certification from the TTI Mobile Retroreflectometer Certification Program to conduct MRDC ~~with~~using the certified mobile retroreflectometer ~~provided~~.

2.4. **Additional Personnel**. Provide any other personnel necessary to compile, evaluate, and submit the data obtained from MRDC.

2.5. **Safety Equipment**. Supply and operate all required safety equipment to perform this service.

3. MRDC DOCUMENTATION AND TESTING

Document all MRDC by county and roadway or as directed by the Engineer. Submit all data to the Department and to the TTI Mobile Retroreflectometer Certification Program no later than ~~three~~3 working days after the day the data ~~is~~are collected. Submit all raw unmodified data collected in addition to all other data ~~submitted~~. Provide data files in Microsoft Excel ~~format~~ or ~~a format~~another approved ~~by the Engineer~~format. Provide measurement notification and field tests as specified. Verification and referee testing may be conducted at the Department's discretion.

3.1. **Preliminary Documentation Sample**. Submit a sample data file, video, and map of MRDC data in the required format at least 10 working days before beginning any work. The format must meet specification and be approved ~~by the Engineer~~ before any work may begin.

3.2. **Initial Documentation Review and Approval**. The Department will review documentation submitted for the first day of MRDC, and if it does not meet specification requirements, will not allow further MRDC until deficiencies are corrected. The Department will inform the Provider no later than ~~three~~ 3 working days after submittal if the first day of MRDC does not meet specification requirements. Time charges will continue unless otherwise directed by the Engineer.

3.3. **Data ~~File. Provide~~Files**. In addition to the raw unmodified data as output from the mobile retroreflectometer, provide data files with the following information:

- date;
- ~~district~~District name or number;
- county name;
- ~~Project CSJ~~project control-section-job (CSJ) number;
- name of mobile retroreflectometer operator;
- route number with reference markers or other reference information provided by the Engineer to ~~indicate~~specify the location of beginning and end points for data collection ~~points~~ on that roadway;
- cardinal direction;
- line type (e.g., single solid, single broken, or double solid~~, etc.);~~);
- line color;
- file name corresponding to video;
- data for each centerline listed separately;
- average reading taken for each 0.1-mi. interval (or interval ~~designated~~specified by the Engineer);
- accurate Global Positioning System (GPS) coordinates (within 20 ft.) for each interval;
- color-coding for each interval ~~indicating~~specifying passing or failing, unless otherwise directed by the Engineer (passing and failing thresholds provided by the Engineer);
- graphical representation of the MRDC (y-axis showing retroreflectivity and x-axis showing intervals) corresponding with each data file;
- distance in miles driven while measuring the retroreflectivity of pavement markings;
- event codes (pre-approved ~~by the Engineer) indicating~~) specifying problems with measurement;
- portable retroreflectometer field check average reading and corresponding mobile average reading for that interval when applicable; and
- upper validation threshold (may be included separately with the raw data but must be clearly identified with the data collected using that threshold).

3.4. **Map**. Provide a map in an approved electronic format ~~approved by the Engineer~~ with each MRDC submission that includes the following information:

- date;
- ~~district~~ District name and number;
- county name;
- color-coded 1-mi. intervals (or interval length ~~designated~~specified by the Engineer) for passing and failing retroreflectivity values, or retroreflectivity threshold values provided by the Engineer; and
- percentage of passing and failing intervals, if required by the Engineer.

3.5. **Video**. Provide a high-quality DVD or electronic video file with the following information:

- date and corresponding data file name on the label;
- ~~district~~ District name or number;
- county name;
- route number with reference markers or other ~~designated~~specified reference information to indicate the location of beginning and end points for data collection ~~points~~ on that roadway; and
- retroreflectivity values presented on the same screen with the following information:
  - date;
  - location;
  - starting and ending mileage;
  - total miles; and
  - ~~retroreflectivity readings; and~~
  - upper validation thresholds (may be included separately with the raw data but must be clearly identified with the data collected using that threshold).

3.6. **Field Comparison Checks ~~with~~Using a Portable Retroreflectometer**. ~~Take~~At the beginning of each set of mobile measurement, collect at least one portable measurement to assess the accuracy of the calibrated MRDC. If requested by the Engineer, take a set of field comparison readings ~~with the~~using a portable retroreflectometer ~~at least once every 4 hr. while conducting MRDC or at~~to validate the ~~frequency designated~~data collected by ~~the~~MRDC. The Engineer~~. Take a minimum~~ will select the location and the markings to be evaluated. The number of ~~20~~ readings~~, spread out~~ should be at least 16 for each marking over the designated measurement interval ~~measured~~. List the average portable retroreflectometer reading next to the mobile average reading for that interval with the reported MRDC data. Request approval ~~from the Engineer~~ to take field comparison readings on a separate roadway~~,~~ when measuring a roadway where portable retroreflectometer readings are difficult to take. Take the off-location field comparison readings at no additional cost. No more than one request will be made for each project unless the average of the portable measurements exceeds ±15% range of MRDC data.

Submit the printout and exported portable retroreflectometer ~~printout of~~data for all the readings taken for the field comparison check with the corresponding MRDC data submitted. The mobile average reading must be within ±15% of the portable average reading. The Engineer may require new MRDC for some or all of the pavement markings measured ~~in a 4-hr.~~during the time interval before a field comparison check not meeting the ±15% range. Provide the new MRDC at no extra cost to the Department.

The Engineer may take readings ~~with~~using a Department portable retroreflectometer to ensure accuracy at any time. The Department's Materials and Tests Division (MTD) will take comparison readings and serve as the referee if there is a significant difference between the Engineer's portable readings and the ~~Provider's~~Provider's mobile and handheld readings. For best results, take field comparison readings on a ~~fairly~~relatively flat and straight roadway when possible.

~~3.6.~~3.7. **Periodic Field Checks at Pre-Measured Locations**. When requested by the Engineer, measure ~~with~~using the mobile unit and report to the Engineer immediately after measurement the average retroreflectivity values for a ~~designated~~specified pre-measured test location. The Engineer will have taken measurements at the test location within 10 days of the test. The test location will not include pavement markings less than 30 days old. If the measured averages do not fall within ±15% of the pre-measured averages, further calibration and comparison measurements may be required before any further MRDC. Submit the MRDC results ~~of~~for the test location to be compared to the Engineer's field check ~~with the MRDC report for that day.~~ measurements.

~~3.7.~~3.8. **Measurement Notification**. Provide notification ~~via~~by email to Mobileretro@tamu.edu with a carbon copy to the Engineer ~~a minimum of~~at least 24 hr. before ~~mobile retroreflectivity data collection~~MRDC to allow for scheduling mobile verification testing ~~when needed~~.

~~3.8.~~3.9. **Verification Testing**. The Engineer or a third party may perform retroreflectivity verification testing within ~~seven~~7 days of the Provider's retroreflectivity readings. The Provider-submitted retroreflectivity data will be compared to the verification test data to determine acceptability of the Provider's mobile retroreflectometer data. Comparison of the data will result in one of the following two scenarios ~~below:~~.

- **Provider's Data ~~is~~ Validated~~—if~~**. If the difference between Provider's and Engineer-third party data is 20% or less, then the Provider's data is validated. The Provider's data will be used for acceptance.
- **Provider's Data ~~is not~~Not Validated~~—if~~**. If the difference between Provider's and Engineer-third party data is more than 20%, then the Provider's data is not validated. The Engineer-third party data will be used for acceptance and the Provider will be required to take corrective action before additional Provider data collection and may require re-certification of the mobile retroreflectometer~~.~~ and MRDC system operator. If the Engineer determines that the Provider's data might be correct, then~~,~~ referee testing may be requested by the Engineer.

~~3.9.~~3.10. **Referee Testing**. MTD will perform referee testing using portable retroreflectometers to determine ~~if~~whether the markings need to be restriped to meet the required retroreflectivity level. The referee test results will be final. Referee testing will be conducted on the verification test sections using the method for portable retroreflectometers ~~specified~~ in accordance with Item 666, "~~Reflectorized~~Retroreflectorized Pavement Markings."

4. FINAL REPORT

Submit a final report in the format specified by the Engineer to the Department's Traffic Engineering representative within one 1 calendar week after the service is complete. The final report must contain a list of all problems encountered (pre-approved event codes) and the locations where problems occurred during MRDC.

5. MEASUREMENT

When mobile retroreflectivity data collection MRDC for pavement markings is specified shown on the plans to be a pay item, measurement will be by the lane mile driven while measuring the retroreflectivity of pavement markings.

6. PAYMENT

Unless otherwise specified shown on the plans, the work performed, materials furnished, equipment, labor, tools, and incidentals will not be paid for directly, but will be considered subsidiary to bid items of the Contract.

When mobile retroreflectivity data collection MRDC for pavement markings is specified shown on the plans to be a pay item, the work performed in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Mobile Retroreflectivity Data Collection." This price is full compensation for providing summaries of readings to the Engineer equipment, equipment calibration and prequalification, equipment, labor, and tools, ; submitting the raw data and summaries of readings to the Engineer; and incidentals.

Item 668
Prefabricated Pavement Markings and Rumble Strips

1. DESCRIPTION

Furnish and place retroreflectorized or non-reflectorized (contrast) prefabricated pavement markings and rumble strips.

2. MATERIALS

Furnish Type B and Type C prefabricated pavement marking materials in accordance with ~~DMS-8240~~DMS-8240, "Permanent Prefabricated Pavement Markings."

Type B prefabricated pavement markings have a backside pre-coated with a pressure-sensitive adhesive to affix the marking to the roadway surface. Type C prefabricated pavement markings are heat-applied and may require additional beads applied during application.

Furnish prefabricated pavement marking materials used for contrast markings in accordance with ~~DMS-8240, "Permanent Prefabricated Pavement Markings," with the exception~~DMS-8240, except that the color requirement for the black contrast portion does not have to meet the color requirements specified for white or yellow markings. Store all materials in a weatherproof enclosure and prevent damage during storage.

Provide prefabricated rumble strips from manufacturers listed on the Department's MPL.

3. CONSTRUCTION

3.1. **General**. Obtain approval for the sequence of work and estimated daily production. Remove all waste generated from the jobsite before the end of each working day.

Establish guides to mark the lateral location of pavement markings as shown on the plans or as directed~~,~~ and have guide locations verified. Use guide material that will not leave a permanent mark on the roadway.

Place ~~pavement markings~~material in alignment with the guides without deviating from the alignment more than 1 in. per 200 ft. of roadway or more than 2 in. maximum and with no abrupt deviations.

3.2. **Placement Limitations**. ~~Do not place Type B pavement marking materials between September 30 and March 1 unless otherwise directed.~~

3.2.1. **Moisture**. Apply material to pavement that is completely dry. Pavement will be considered dry if, on a sunny day after 15 min., no condensation occurs on the underside of a 1-sq. ft. piece of clear plastic that has been placed on the pavement and weighted on the edges.

3.2.2. **Temperature**. Follow pavement and ambient air temperature requirements recommended by the material manufacturer. Do not place material when the pavement temperature is below 60°F or above 120°F if the material manufacturer does not establish temperature requirements.

3.3. **Dimensions**. Place ~~markings~~material in ~~accordance~~conformance with the color, length, width, shape, and configuration shown on the plans. Locate alignment as shown on the plans or as directed.

3.4. **Methods**. Place all materials in ~~accordance~~conformance with the material manufacturer's instructions, as well as the surface condition, moisture, and temperature requirements ~~of~~in accordance with this Item, unless otherwise directed.

3.5. **Surface Preparation**. Prepare surface ~~by~~using any approved cleaning method that effectively removes contaminants, loose materials, and conditions deleterious to proper adhesion. Abrasive or water-blast cleaning is not required unless otherwise shown on the plans. Blast clean, when required, in accordance with Item 678, "Pavement Surface Preparation for Markings." Prepare surfaces further after cleaning by sealing or priming as recommended by the pavement- marking material manufacturer or as directed. Use adhesive, when required, of the type and quality recommended by the pavement- marking material manufacturer. Do not clean concrete pavement surfaces by grinding.

3.6. **Performance Requirements**.

3.6.1. **Durability**. Provide materials that do not lose more than 5% of the material in any 1-ft. section. Measure the durability in accordance with ASTM D913.

~~3.6.1.~~3.6.2. **Adhesion**. Ensure ~~markings do~~the material does not lift, shift, smear, spread, flow, or tear by traffic action.

~~3.6.2.~~3.6.3. **Appearance**. Ensure ~~markings present~~the material presents a neat, uniform appearance that is free of excessive adhesive, ragged edges, and irregular lines or contours.

~~3.6.3.~~3.6.4. **Visibility**. Ensure Type B and Type C markings have uniform and distinctive retroreflectance when inspected in accordance with Tex-~~-~~828-~~-~~B.

3.7. **Performance Period**. All ~~markings~~material must meet the requirements of this Item for at least 30 calendar days after installation. Remove and replace all ~~pavement markings~~material that ~~fail~~fails to meet requirements at the Contractor's expense, unless otherwise directed. Replace failing ~~markings~~material within 30 days of notification. All replacement ~~markings~~material must also meet all requirements of this Item for ~~a minimum of~~at least 30 calendar days after installation.

4. MEASUREMENT

This Item will be measured by the foot, with longitudinal markings measured longitudinally and transverse markings measured transversely, or by each word, shape, or symbol.

Rumble strips will be measured transversely across the roadway on which the rumble strip is installed. Measurement will include all strips of material placed across the roadway surface.

This is a plans quantity measurement Item. The quantity to be paid is the quantity shown in the proposal, unless modified by Article 9.2., "Plans Quantity Measurement." Additional measurements or calculations will be made if adjustments of quantities are required.

5. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Prefabricated Pavement Markings" of the type ~~and~~, color ~~specified and the~~, shape, width, and size specified as applicable, or "Prefabricated Rumble Strips" of the type, color, and width specified as applicable. This price is full compensation for cleaning the pavement by any means other than required abrasive or water-blast cleaning or milling; furnishing and placing materials; and equipment, labor, tools, and incidentals.

Abrasive or water-blast cleaning and milling, when shown on the plans, will be paid for under Item 678~~, "Pavement Surface Preparation for Markings."~~.

Item 672
Raised Pavement Markers

1. DESCRIPTION

Furnish and install raised pavement markers (RPMs).

2. MATERIALS

2.1. **Markers**. Furnish RPMs in accordance with the following ~~Department Material Specifications:~~.

- **Reflectorized Pavement Markers**. ~~DMS-4200~~DMS-4200, "Pavement Markers (Reflectorized)," ~~types~~Types I-A, I-C, I-R, II-A-A, II-C-C, and II-C- R~~.~~
- **Traffic Buttons**. ~~DMS-4300~~DMS-4300, "Traffic Buttons," ~~types I-A, I-C, I-R, II-A-A, II-C- R,~~ W, Y, and B. Round or oval unless otherwise ~~specified~~shown on the plans~~.~~
- **Plowable Reflectorized Pavement Markers**. ~~DMS-4210~~DMS-4210, "Snowplowable Pavement Markers," ~~types~~ Types I-A, I-C, I-R, II-A-A, II-C-C, and II-C- R~~.~~

The following are descriptions for each type of RPM~~:~~.

- **Type I-A**. The approach face must ~~retro-reflect~~retroreflect amber light. The body, other than the ~~retro-reflective~~retroreflective face, must be yellow.
- **Type I-C**. The approach face must ~~retro-reflect~~retroreflect white light. The body, other than the ~~retro-reflective~~retroreflective face, must be white or silver-white.
- **Type I-R**. The trailing face must ~~retro-reflect~~retroreflect red light. The body, other than the ~~retro-reflective~~retroreflective face, must be white or silver-white, except for I-R plowable markers, which may be black.
- **Type II-A-A**. The ~~2 retro-reflective~~two retroreflective faces (approach and trailing) must ~~retro-reflect~~retroreflect amber light. The body, other than the ~~retro-reflective~~retroreflective faces, must be yellow.
- **Type II-C-R**. ~~Contain 2 retro-reflective~~Contains two retroreflective faces with an approach face that must ~~retro-reflect~~retroreflect white light and a trailing face that must ~~retro-reflect~~retroreflect red light. The body, other than the ~~retro-reflective~~retroreflective faces, must be white or silver-white.
- **Type II-C-C**. Contain two retroreflective faces (approach and trailing) that retroreflect white light. The body, other than the retroreflective face, must be white or silver-white.
- **Type W**. Must have a white body and no reflective faces.
- **Type Y**. Must have a yellow body and no reflective faces.
- **Type B**. Must have a black body and no reflective faces.

2.2. **Adhesives**. Furnish adhesives ~~that conform to~~in accordance with the following ~~requirements:~~.

- DMS-~~-~~6100, "Epoxies and Adhesives," Type II—Traffic Marker Adhesives~~.~~
- DMS-6130, "Bituminous Adhesive for Pavement Markers~~.~~""

The Contractor may propose alternate adhesive materials for consideration and approval.

2.3. **Sampling**. The Engineer will sample in accordance with ~~Tex-729-I~~Tex-729-I.

3. CONSTRUCTION

Remove existing RPMs in accordance with Item 677, "Eliminating Existing Pavement Markings and Markers," except for measurement and payment. Furnish RPMs for each class from the same manufacturer. Prepare all surfaces in accordance with Item 678, "Pavement Surface Preparation for Markings," when shown on the plans. Ensure the bond surfaces are free of dirt, curing compound, grease, oil, moisture, loose or unsound pavement markings, and any other material that would adversely affect the adhesive bond.

Establish pavement marking guides to mark the lateral location of RPMs as shown on the plans and as directed. Do not make permanent marks on the roadway for the guides.

Place RPMs in proper alignment with the guides. Acceptable placement deviations are shown on the plans.

~~Remove~~If necessary, remove and replace RPMs placed out of alignment or sequence, as shown on the plans or ~~stated~~ in accordance with this ~~specification~~Item, at the Contractor's expense~~,~~ in accordance with Item 677~~, "Eliminating Existing Pavement Markings and Markers"~~ (except for measurement and payment).

Use the following adhesive materials for placement of reflectorized pavement markers~~,~~ and traffic buttons, unless otherwise shown on the plans:

- standard or flexible bituminous adhesive for applications on bituminous pavements, and
- epoxy adhesive or flexible bituminous adhesive for applications on hydraulic cement concrete pavements.

Use epoxy adhesive for plowable reflectorized pavement markers.

Apply enough adhesives to:

- ensure that 100% of the bonding area of RPMs is in contact with the adhesive, and
- ensure that RPMs, except for plowable markers, are seated on a continuous layer of adhesive and not in contact with the pavement surface.

Apply adhesives in ~~accordance~~conformance with manufacturer's recommendations unless otherwise required by this Article. Apply bituminous adhesive only when pavement temperature and RPM temperature are 40°F or higher. Do not heat bituminous adhesive above 400°F. Machine agitate bituminous adhesive continuously before application to ensure even heat distribution.

Machine-mix epoxy adhesive. Apply epoxy adhesive only when pavement temperature is 50°F or higher.

Furnish RPMs free of rust, scale, dirt, oil, grease, moisture, and contaminants that might adversely affect the adhesive bond.

Place RPMs immediately after the adhesive is applied and ensure proper bonding. Do not use adhesives or any other material that impairs the functional ~~retro-reflectivity~~retroreflectivity of the RPMs.

~~Provide a 30-day performance period that begins the day following written acceptance for each separate location. The date of written acceptance will be the last calendar day of each month for the RPMs installed that month for the completed separate project locations. This written acceptance does not constitute final acceptance.~~

All RPMs must meet performance requirements for at least 30 calendar days after installation.

Replace all missing, broken, or non-reflective RPMs. Visual evaluations will be used for these determinations. Upon request, the Engineer will allow a Contractor representative to accompany the Engineer on these evaluations.

The Engineer may exclude RPMs from the replacement provisions of the performance, provided the Engineer determines the failure is a result of causes other than defective material or inadequate installation procedures. Examples of outside causes are extreme wear at intersections, damage by snow or ice removal, and pavement failure.

Replace all missing or non-reflective RPMs identified during the performance period within 30 days after notification. The end of the performance period does not relieve the Contractor from the performance deficiencies requiring corrective action identified during the performance period.

4. MEASUREMENT

This Item will be measured by each RPM.

This is a plans quantity measurement Item. The quantity to be paid is the quantity shown in the proposal, unless modified by Article 9.2., "Plans Quantity Measurement." Additional measurements or calculations will be made if adjustments of quantities are required.

5. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Reflectorized Pavement Marker," "Traffic Button," or "Plowable Reflectorized Pavement Marker" of the types specified. This price is full compensation for removing existing markers; furnishing and installing RPMs; and materials, equipment, labor, tools, and incidentals.

No additional payment will be made for replacement of RPMs failing to meet the performance requirements.

Item 677
Eliminating Existing Pavement Markings and Markers

1. DESCRIPTION

Eliminate existing pavement markings and raised pavement markers (RPMs).

2. MATERIALS

Furnish surface treatment materials in accordance with the following Items~~:~~.

- Item 300, "Asphalts, Oils, and Emulsions"
- Item 302, "Aggregates for Surface Treatments"
- Item 315, "Fog Seal"
- Item 316, "Seal Coat"

Use approved patching materials for repairing damaged surfaces.

Use a commercial abrasive blasting medium capable of producing the specified surface cleanliness. Use potable water when water is required.

3. EQUIPMENT

Furnish and maintain equipment in good working condition. Use moisture and oil traps in air compression equipment to remove all contaminants from the blasting air and prevent the deposition of moisture, oil, or other contaminants on the roadway surface.

4. CONSTRUCTION

Eliminate existing pavement markings and markers on both concrete and asphaltic surfaces ~~in~~ such ~~a manner~~ that color and texture contrast of the removed area and surrounding pavement surface will be held to a minimum. Remove all markings and markers with minimal damage to the roadway to the satisfaction of the Engineer. Repair damage to asphaltic surfaces~~,~~ such as spalling~~,~~ and shelling~~, etc.,~~ greater than 1/~~4~~ 8 in. deep resulting from the removal of pavement markings and markers. Dispose of markers in ~~accordance~~conformance with federal, state, and local regulations. Use any of the following methods unless otherwise shown on the plans~~:~~. Refer to the *Pavement Marking Handbook* for additional information on removal types and best practices.

4.1. **Surface Treatment Method**. Apply surface treatment material at the rates shown on the plans, or as directed. Place a surface treatment ~~a minimum of~~at least 2~~-~~ ft. wide to cover the existing marking. Place a surface treatment, thin overlay, or microsurfacing ~~a minimum of~~at least one lane in width in areas where directional changes of traffic are involved or other areas as directed.

4.2. **Burn Method**. Use an approved burning method. For thermoplastic pavement markings or prefabricated pavement markings, heat may be applied to remove the bulk of the marking material before blast cleaning. When using heat, avoid spalling pavement surfaces. Ensure the burning heads are not left in one place too long to prevent pavement damage. Sweeping or light blast cleaning may be used to remove minor residue.

4.3. **Blasting Method**. Use a blasting method such as high-pressure water blasting, abrasive blasting, water abrasive blasting, shot blasting, slurry blasting, water-injected abrasive blasting, or brush blasting as

approved. ~~Remove~~Use high-pressure water blasting for removal of pavement markings for lane shifts on concrete surfaces ~~by a blasting method.~~.

4.4. **Mechanical Method**. Use any mechanical method except grinding. ~~Flail~~Do not use flail milling ~~is acceptable in the removal of~~on grooved concrete or porous asphalt.

~~4.4.~~4.5. **Corrective Actions**. Whenever removed markings on asphalt ~~and concrete~~ surfaces continue to simulate pavement markings to an extent determined by the Engineer to cause driver confusion, apply a fog seal or slurry at least 2 ft. wide over the area where pavement markings were removed as approved.

5. MEASUREMENT

This Item will be measured by each word, symbol, or shape eliminated; by the foot of marking eliminated; or by any other unit shown on the plans.

This is a plans quantity measurement Item. The quantity to be paid is the quantity shown in the proposal, unless modified by Article 9.2., "Plans Quantity Measurement." Additional measurements or calculations will be made if adjustments of quantities are required.

6. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Eliminating Existing Pavement Markings and Markers" of the type and width as applicable. This price is full compensation for the elimination method used and materials, equipment, tools, labor, and incidentals. Removal of RPMs will not be paid for directly, but will be subsidiary to ~~the~~ pertinent ~~bid items~~Items.

Item 678
Pavement Surface Preparation for Markings

1. DESCRIPTION

Prepare pavement surface areas before placement of pavement markings and raised pavement markers (RPMs). Item 677, "Eliminating Existing Pavement Markings and Markers," governs removal of existing markings.

2. MATERIALS

~~Use~~When abrasive blasting is used, use a commercial abrasive blasting medium capable of producing the specified surface cleanliness. Use potable water~~,~~ when water is required.

3. EQUIPMENT

Furnish and maintain equipment in good working condition. Use moisture and oil traps in air compression equipment to remove all contaminants from the blasting air and prevent the deposition of moisture, oil, or other contaminants on the roadway surface.

4. CONSTRUCTION

Prepare enough pavement surface for the pavement markings or RPMs shown on the plans. Remove all contamination and loose material. Avoid damaging the pavement surface. Remove loose and flaking material when existing pavement markings are present. Approved pavement surface preparation methods are sweeping, air blasting, flail milling, and ~~blast cleaning~~blasting methods in accordance with Section 677.4.3., "Blasting Method," unless otherwise ~~specified~~shown on the plans.

Air blast concrete pavement surfaces, in addition to the above, after the removal of contamination or existing material and just before placing the stripe. Perform air blasting ~~with~~using a compressor capable of generating compressed air at a minimum of 150 cu. ft. per minute and 100 psi using 5/16~~-~~ in. or larger hosing.

Contaminants up to 0.5 sq. in. may remain if they are not removed by the following test, performed just before application of markings~~:~~.

- **Step 1**. Air blast the surface to be tested, to simulate blasting during application of markings.
- **Step 2**. Firmly press a 10-in. long, 2-in. wide strip of monofilament tape onto the surface, leaving approximately 2 in. free.
- **Step 3**. Grasp the free end and remove the tape with a sharp pull.

5. MEASUREMENT

This Item will be measured by the foot for each width specified; by each word, shape, or symbol; or by any other unit except lump sum.

This is a plans quantity measurement Item. The quantity to be paid is the quantity shown in the proposal, unless modified by Article 9.2., "Plans Quantity Measurement." Additional measurements or calculations will be made if adjustments of quantities are required.

6. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Pavement Surface Preparation for Markings" of the type and width as applicable. This price is full compensation for the cleaning method used, materials, equipment, labor, tools, and incidentals.

Item 680
Highway Traffic Signals

1. DESCRIPTION

- **Installation**. Install highway traffic signals.
- **Upgrade.** Modify or change existing traffic signals as shown on the plans.
- **Removal**. Remove, store, and salvage traffic signals.

2. MATERIALS

Ensure electrical materials and construction methods conform to the ~~current~~ NEC and additional local utility requirements.

Furnish new materials~~.~~ as shown on the plans. Ensure all materials and construction methods ~~conform to the details~~are as shown on the plans~~, the requirements of~~ and in accordance with this Item~~, and the pertinent requirements of~~ and the following Items~~:~~.

- Item 450, "Railing"
- Item 610, "Roadway Illumination Assemblies"
- Item 618, "Conduit"
- Item 620, "Electrical Conductors"
- Item 621, "Tray Cable"
- Item 625, "Zinc-Coated Steel Wire Strand"
- Item ~~627, "Treated Timber Poles"~~628, "Electrical Services"
- Item 636, "Signs"
- Item 656, "Foundations for Traffic Control Devices"
- Item 682, "Vehicle and Pedestrian Signal Heads"
- Item 684, "Traffic Signal Cables"
- Item 686, "Traffic Signal Pole Assemblies"
- Item 687, "Pedestrian Pole Assemblies"
- Item 688, "Pedestrian and Vehicle Detectors"

Provide controller assemblies ~~that meet the requirements of~~in accordance with DMS-11170, "Fully Actuated, Solid-State Traffic Signal Controller Assembly," and ~~the details shown on the plans.~~as shown on the plans. When shown on the plans, anti-gaffitti coating will be in accordance with DMS-8111, "Anti-Graffiti Coatings."

Provide devices in accordance with DMS-11171, "Malfunction Management Unit (MMU)," and as shown on the plans.

Provide controllers in accordance with DMS-11172, "Preemption Controller," and as shown on the plans.

Provide controllers in accordance with DMS-11173, "Traffic Controller," and as shown on the plans.

Provide prequalified controller assemblies from the Department's MPL.

Provide flasher assemblies ~~that meet the requirements of~~in accordance with DMS-11160, "Flasher Controller Assembly," and ~~the details~~as shown on the plans.

Provide prequalified flasher assemblies from the Department's MPL.

Sampling and testing of traffic signal controller assemblies and internal devices will be ~~done~~ in accordance with Tex-1170-T.

3. CONSTRUCTION

3.1. **Installation**. Install traffic signal controller foundations in accordance with Item 656~~, "Foundations for Traffic Control Devices."~~.

3.1.1. **Electrical Requirements**.

3.1.1.1. **Electrical Services**. ~~Make arrangements~~Arrange for electrical services and install and supply materials not provided by the utility company as shown on the plans. Install ~~120-volt~~120V, single-phase, 60-Hz AC electrical service unless otherwise shown on the plans.

3.1.1.2. **Conduit**. Install conduit and fittings of the sizes and types shown on the plans. Conduit of larger diameter size than that shown on the plans may be used with no additional compensation, providing the same diameter size is used for the entire length of the conduit run. Extend conduit in concrete foundations 2~~ to~~ –3 in. above the concrete. Seal the ends of each conduit with ~~silicone caulking, or other~~ approved sealant, after all cables and conductors are installed.

3.1.1.3. **Wiring**. Furnish stranded ~~No. 12 AWG~~ XHHW conductors~~.~~ as shown on the plans. If a size is not shown on the plans, use a minimum No. 14 AWG. Install ~~above-ground~~aboveground cables and conductors in rigid metal conduit, except for span wire suspended cables and conductors, drip loops, and electrical wiring inside signal poles, unless otherwise shown on the plans. Make power entrances to ground-mounted controllers through underground conduit. Wire each signal installation to operate as shown on the plans.

Attach ends of wires to properly sized self-insulated solderless terminals. Attach terminals to the wires ~~with~~using a ratchet-type compression crimping tool properly sized to the wire. Place pre-numbered identification tags of plastic or tape around each wire adjacent to wire ends in the controller and signal pole terminal blocks.

Do not strip traffic signal cable until it has passed into the location that requires termination.

Splices will not be permitted except as shown on the plans, unless each individual splice is approved in writing. Make all allowed splices watertight.

Ensure both neutral buses are located with one on the left and one on the right bonded together. Relocate neutral bus if not oriented in the cabinet in this manner.

Ensure gauge of wire size used to connect electrical equipment inside the cabinet is sized appropriately for amperage load for the specific device, circuit breaker, or duplex receptacle in accordance with the NEC.

Install Category 6 Ethernet communication cables in accordance with Special Specification, "Networking Intelligent Transportation System (ITS) Communication Cable," and connect networked equipment inside the controller cabinet assembly to field Ethernet switch following the color scheme and assignment information as follows.

- **White**. Ethernet switch (1-ft. patch cord).
- **Blue**. Traffic signal controller.
- **Green**. Malfunction monitor unit (MMU).
- **Red**. Battery backup unit (BBU).
- **Yellow**. Accessible pedestrian system.
- **Black**. Detection (e.g., radar and video).
- **Purple**. Pan, tilt, and zoom (PTZ) camera.
- **Orange**. Other.

- **Gray**. Other.
- **Pink**. Broadband radio.

A standard bundle of cables provided by the cabinet vendor is identified in DMS-11170. Additional CAT 6 Ethernet cables, provided as necessary, must follow the color scheme and assignment above to connect additional networked equipment.

Railroad connection between traffic cabinet and bungalow must be a minimum No. 14 AWG 15-conductor and follow the color code chart shown in Table 1.

Table 1
Railroad Preemption Color Code and Functional Connection

Conductor	Color Code	Railroad Interface Field Terminal Connections	Conductor Identification
1	Black	HLTH-	Health Status DC-
2	White	–	Spare
3	Red	HLTH+	Health Status DC+
4	Green	–	Spare
5	Orange	XR IN	Simultaneous DC-
6	Blue	TCR IN	Advance DC-
7	White/black stripe	–	Spare
8	Red/black stripe	GD/ISLD IN	Gate Down/Island
9	Green/black stripe	APP OUT	Advance Pedestrian Preemption
10	Orange/black stripe	XR OUT	Simultaneous
11	Blue/black stripe	TCR OUT	Advance Primary
12	Black/white stripe	–	Spare
13	Red/white stripe	GD/ISLD OUT	Gate Down/Island DC-
14	Green/white stripe	APP IN	Advance Pedestrian Preemption DC -
15	Blue/white stripe	SUPR	Advance Secondary

3.1.1.4. **Grounding and Bonding**. Ground and bond conductors in accordance with the NEC. Ensure the resistance from the grounded point of any equipment to the nearest ground rod is less than 1 ohm.

Install a continuous bare or green insulated stranded copper wire (equipment ground) throughout the electrical system that is the same size as the neutral conductor~~, but~~. If a size is not shown on the plans, use a minimum No. 8 AWG. Connect the equipment ground to all metal conduit, signal poles, controller housing, electrical service ground, ground rods, and all other metal enclosures and raceways. Inside the controller cabinet assembly, jumper between neutral bus and ground bus is not required. Remove jumper if provided by cabinet manufacturer.

Provide stranded copper wire bonding jumpers that are ~~a~~ minimum No. 8 AWG.

3.1.2. **Controller Assemblies**. Construct controller assembly foundations in accordance with Item 656~~, "Foundations for Traffic Control Devices."~~. Immediately before mounting the controller assembly on the foundation, apply a bead of ~~silicone caulk~~exterior rated penetrating sealant to ~~seal~~ the cabinet base~~.~~ or cabinet riser. Seal any space between conduit entering the controller assembly and the foundation with ~~silicone caulk~~exterior rated penetrating sealant.

~~Deliver the keys for the controller cabinets to the Engineer when the Contract is complete.~~

Stake cabinet foundation forms and underground conduit entering the foundation before installation and secure Department approval before pouring foundation. Cabinet location may vary from that shown on the plans to accommodate field conditions as approved. For controller cabinet assemblies installed on a slope, ensure the cabinet primary door faces and opens to the low side of the slope. If safety rail is required as shown on the plans, it must be in accordance with Item 450. Furnish anchor bolts to mount the cabinet or cabinet riser to the foundation. Manufacturer to determine the appropriate size and type of anchor bolt by

cabinet type and foundation size. Provide appropriate mounting plates and any other necessary hardware to mount the cabinet on a foundation.

Coordinate with the Department on delivery of cabinet keys. Place the instruction manual and wiring diagrams for all equipment in the controller cabinet~~,~~ inside the controller cabinet.

~~3.1.3. **Timber Poles**. Furnish ANSI Class 2 timber poles other than for electrical services in accordance with details shown on the plans.~~

~~3.1.4.~~3.1.3. **Preservation of Sod, Shrubbery, and Trees**. Replace sod, shrubbery, and trees damaged during the Contract.

~~3.1.5.~~3.1.4. **Removal and Replacement of Curbs and Walks**. Obtain approval before cutting into or removing walks or curbs not shown on the plans to be removed or replaced. Restore any curbs or walks removed equivalent to original condition after work is completed, to the satisfaction of the Engineer.

~~3.1.6.~~3.1.5. **Intersection Illumination**. Install luminaires on signal poles as shown on the plans.

~~3.1.7.~~3.1.6. **Signal Timing Plan**. The traffic signal timing plan will be provided by the Department or local entity.

~~3.1.8.~~3.1.7. **Test Period**. Operate completed traffic signal installations continuously for at least 30 days in a satisfactory manner. Designate in writing a sufficiently skilled individual responsible for maintenance and operation of the traffic signals who is available 24 hr. per day, and able to be onsite within 24 hr. of notification by the Engineer, unless otherwise shown on the plans. If any Contractor-furnished equipment fails during the 30-day test period, repair or replace that equipment. This repair or replacement, except lamp replacement, will start a new 30-day test period.

Replace materials that are damaged or have failed before acceptance. Replace failed or damaged existing signal system components when caused by the Contractor. The Department will relieve the Contractor of maintenance responsibilities upon passing a 30-day performance test of the signal system and acceptance of the Contract.

3.2. **Upgrade**. Remove the existing items and install new items as shown on the plans or as directed. For newly installed items, refer to Section 680.3.1., "Installation." Ensure items designated for salvage are removed in a manner to avoid undue stress or damage. When the removed item leaves an opening, cover the opening with similar material to an equivalent condition. When the removed item leaves an unused signal cable, remove the cable. When the removed item leaves unused conductors within a signal cable still in use, trim back and tape off to ensure no electrical shorts by unused conductors. Store items designated for reuse or salvage at locations shown on the plans or as directed.

~~3.2.~~3.3. **Removal**. Remove existing electrical services, pedestal poles, strain poles, mast arm pole assemblies, luminaires, signal heads, vehicle detector equipment, controllers, cables, and other accessories. Remove materials so damage does not occur. Remove and store items designated for reuse or salvage at locations shown on the plans or as directed.

Remove abandoned concrete foundations, including steel, to a point 2 ft. below final grade. Backfill holes with material equal in composition and density to the surrounding area. Replace surfacing material with similar material to an equivalent condition.

Accept ownership and dispose of unsalvageable materials in ~~accordance~~conformance with federal, state, and local regulations.

4. MEASUREMENT

This Item will be measured ~~as~~by each traffic signal installed, upgraded, or removed. A traffic signal is a signalized intersection controlled by a single traffic signal controller.

5. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Installation of ~~Highway~~ Traffic Signals" of the type (~~isolated, system,~~traiffic signal or flashing beacon) specified, or "Removing Traffic Signals."

5.1. **Installation**. This price is full compensation for furnishing, installing, and testing the completed installation~~,~~ of the traffic signal controller and associated equipment with network cabling, controller assembly, foundations, luminaires, ~~signs mounted on signal equipment,~~ damping plates, ~~timber poles,~~ mounting hardware, and ~~steel wire strand~~Department-provided items; preservation and replacement of damaged sod, shrubbery, and trees; removal and replacement of curbs and walks; and materials, equipment, labor, tools, and incidentals. The Department will pay for electrical energy consumed by the traffic signal.

New drilled shaft foundations for traffic signal poles will be paid for under Item 416, "Drilled Shaft Foundations." New safety rail will be paid for under Item 450. New sidewalks or pedestrian ramps will be paid for under Item 531, "Sidewalks." New conduit will be paid for under Item 618~~, "Conduit."~~. New electrical conductors will be paid for under Item 620~~, "Electrical Conductors."~~. New ground boxes will be paid for under Item 624, "Ground Boxes." New span wire will be paid for under Item 625. Wire lashing or cable ties required to secure aerial cables to the messenger wire will be subsidiary. New electrical services will be paid for under Item 628~~, "Electrical Services."~~. New signs will be paid for under Item 636. New internally illuminated signs will be paid for under Special Specification. New vehicle and pedestrian signal heads will be paid for under Item 682~~, "Vehicle and Pedestrian Signal Heads."~~. New traffic signal cables will be paid for under Item 684~~, "Traffic Signal Cables."~~. New traffic signal pole assemblies will be paid for under Item 686~~, "Traffic Signal Pole Assemblies (Steel)."~~. New traffic signal detectors will be paid for under Item 688~~, "Pedestrian Detectors and Vehicle Loop Detectors."~~ or Special Specification.

~~**Removal.**~~ If the design of the intersection control spans more than one intersection, such as a restricted crossing U-turn (RCUT), and requires more than one traffic signal cabinet, this Item will be measured by each traffic signal cabinet installed.

5.2. **Upgrade**. This price is full compensation for removing the various traffic signal components; removing the controller foundations; disposal of unsalvageable materials; hauling; and materials, equipment, labor, tools, and incidentals, as shown on the plans or as directed. This price is full compensation for furnishing, installing, and testing the completed installation, controller and associated equipment, controller foundations, luminaires, damping plates, and mounting hardware; preservation and replacement of damaged sod, shrubbery, and trees; removal and replacement of curbs and walks; and materials, equipment, labor, tools, and incidentals. The Department will pay for electrical energy consumed by the traffic signal.

New drilled shaft foundations for traffic signal poles will be paid for under Item 416. New sidewalks or pedestrian ramps will be paid for under Item 531. New conduit will be paid for under Item 618. New electrical conductors will be paid for under Item 620. New ground boxes will be paid for under Item 624. New span wire will be paid for under Item 625. Wire lashing or cable ties required to secure aerial cables to the messenger wire will be subsidiary. New electrical services will be paid for under Item 628. New signs will be paid for under Item 636. New internally illuminated signs will be paid for under Special Specification. New vehicle and pedestrian signal heads will be paid for under Item 682. New traffic signal cables will be paid for under Item 684. New traffic signal pole assemblies will be paid for under Item 686. New traffic signal detectors will be paid for under Item 688 or Special Specification.

5.3. **Removal.** This price is full compensation for removing the various traffic signal components; removing the controller foundations; disposal of unsalvageable materials; hauling; and materials, equipment, labor, tools, and incidentals.

Item 681
Temporary Traffic Signals

1. DESCRIPTION

Furnish, install, operate, maintain, reconfigure, and remove temporary traffic signals.

2. MATERIALS

Furnish new or used materials as shown on the plans and in accordance with the details shown on the plans, the requirements of this Item, and the pertinent requirements of the following Items, (except for measurement"Measurement" and payment:"Payment").

- Item 416, "Drilled Shaft Foundations,""
- Item 610, "Roadway Illumination Assemblies,""
- Item 617, "Temporary Roadway Illumination"
- Item 618, "Conduit,""
- Item 620, "Electrical Conductors,""
- Item 621, "Tray Cable,""
- Item 622Special Specification, "Duct Cable,""
- Item 624, "Ground Boxes,""
- Item 625, "Zinc-Coated Steel Wire Strand,""
- Item 627, "Treated Timber Poles,""
- Item 628, "Electrical Services,""
- Item 636, "Signs,""
- Item 656, "Foundations for Traffic Control Devices,""
- Item 680, "Highway Traffic Signals,""
- Item 682, "Vehicle and Pedestrian Signal Heads,""
- Item 684, "Traffic Signal Cables,""
- Item 686, "Traffic Signal Pole Assemblies (Steel),")"
- Item 687, "Pedestal Pole Assemblies," and"
- Item 688, "Pedestrian Detectors and Vehicle Loop Detectors"

Obtain signal equipment at locations shown on the plans if the equipment is furnished by the Department. All materials determined to be in good working condition by the Engineer can be reused on temporary traffic signals. Do not use previously installed materials for permanent traffic signal installations.

3. CONSTRUCTION

Install traffic signal assemblies in accordance with Item 680, "Highway Traffic Signals," (except for measurement"Measurement" and payment)"Payment") as shown on the plans. Install electrical services in accordance with Item 628, "Electrical Services," (except for measurement"Measurement" and payment)"Payment") as shown on the plans. If the Department requires access to the signal by an advanced traffic management systems network, the Department will provide the equipment for installation by the Contractor.

3.1. **Operation and Maintenance**. **(O&M).** Maintain and operate the temporary traffic signals for the duration of the Contract. The traffic signal timing plan will be provided by the Department or local entity. Set signal timing as shown on the plans or as directed. If the Department requires access to the signal by an advanced traffic

management systems network, the Department will complete the required configuration of the software and hardware after the Contractor has installed the Department-provided equipment.

Designate in writing a sufficiently skilled individual responsible for ~~maintenance and operation~~O&M of the temporary traffic signals who is available ~~to respond within a reasonable time,~~ 24 hr. ~~each~~per day and in transit to the project location within 2 hr. of notification by the Engineer, unless otherwise shown on the plans.

Provide backup power for each location at all times, when shown on the plans.

3.2. **Reconfiguration**. Reconfigure temporary traffic signals as shown on the plans and in accordance with ~~the plans, and within the requirements of~~ this Item, as directed. Reconfiguration is any change made to an installed intersection, including relocation of poles, controller, signal heads, or luminaires.

3.3. **Removal**. Remove all equipment installed for temporary traffic signals as shown on the plans or as directed in writing.

Completely remove poles or other supports used for temporary traffic signals. When approved, concrete foundations may remain 2 ft. or more below finished grade. Backfill the remaining hole with material equal in composition and density to the surrounding area. Replace any surfacing, such as asphalt pavement or concrete riprap, with like material to equivalent condition.

Retain all removed temporary signal components, except for those furnished by the Department, unless otherwise shown on the plans.

4. MEASUREMENT

This Item will be measured by each temporary signalized intersection. A signalized intersection is a group of signals operated by a single controller.

5. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Temporary Traffic Signals." This price is full compensation for~~-~~:

- picking up and returning materials furnished by the Department;
- installation, ~~operation, maintenance~~O&M, reconfiguration, and removal of the temporary traffic signal consisting of traffic signal pole assemblies, vehicle and pedestrian signal heads, vehicle ~~loop~~ detectors, pedestrian detectors, traffic signals, portable signals, flasher controllers, and associated equipment, signs, luminaires, ground boxes, conduit, traffic signal cables, conductors, wire strand, and electrical services;
- installation and removal of foundations; and
- materials, equipment, labor, tools, and incidentals.

Electrical energy consumed by the Contractor on an existing Department electrical service will be paid for by the Department.

~~Costs for utility-owned power line extensions, connection charges, meter charges, consumption charges, and other charges~~ Applications for a temporary utility service will ~~be paid for by the Department.~~designate the Contractor as the service owner unless otherwise shown on the plans. The Department will reimburse the Contractor the amount billed by the utility for utility-owned service line extensions and consumption charges, plus an additional 5% of the invoice cost will be paid for labor, equipment, administrative costs, superintendence, and profit.

Item 682
Vehicle and Pedestrian Signal Heads

1. DESCRIPTION

1.1. ~~Furnish~~**Installation**. Fabricate, furnish, and install vehicle and pedestrian signal heads.

1.2. **Removal**. Remove existing vehicle and pedestrian signal heads.

2. MATERIALS

~~Furnish only~~Provide new materials~~.~~ as shown on the plans and in accordance with this Item.

2.1. **Definitions**.

2.1.1. **Back Plate**. A thin strip of material extending outward from all sides of a signal head.

2.1.2. **Light-Emitting Diode (LED) Optical Unit**. The LED lens and associated supporting parts in a signal section.

2.1.3. **Louver**. A device mounted to the visor restricting signal face visibility.

2.1.4. **Signal Section**. One housing case, housing door, visor, and optical unit.

2.1.5. **Signal Face**. One section or an assembly of ~~2~~two or more sections facing one direction.

2.1.6. **Signal Head**. A unidirectional face or a multidirectional assembly of faces, including back plates and louvers when required, attached at a common location on a support.

2.2. **General**. Provide vehicle signal heads in accordance with DMS-11121, "Twelve-Inch LED Traffic Signal Lamp Unit." Provide prequalified vehicle signal heads from the Department's MPL.

Provide pedestrian signal heads in accordance with DMS-11131, "Pedestrian LED Countdown Signal Modules." Provide prequalified pedestrian signal heads from the Department's MPL.

Supply either aluminum or polycarbonate signal head components of the same material and manufacturer for any one project.

Use galvanized steel, stainless steel, or dichromate sealed aluminum bolts, nuts, washers, lock washers, screws, and other assembly hardware. When dissimilar metals are used, ensure the metals are selected or insulated to prevent corrosion.

Use closed-cell silicone or closed-cell neoprene gaskets.

3. CONSTRUCTION

3.1. **Assembly**. Assemble individual signal sections in multi-section faces in ~~accordance~~conformance with the manufacturer's recommendations to form a rigid signal face. Assemble and mount signal heads ~~as shown on the plans. Install~~, louvers, and back plates as shown on the plans to the mounting hardware or in ~~accordance~~conformance with the manufacturer's recommendations. Close any openings in an assembled signal head with a plug of the same material and color as the head.

~~Remove only the existing lens, reflector, and incandescent lamp when installing a retrofit replacement LED traffic signal or pedestrian signal lamp unit into an existing signal housing; fit the new unit securely in the housing door; and connect the new housing unit to the existing electrical wiring or terminal block by means of simple connectors.~~

3.2. **Wiring**. Wire each optical unit to the terminal block located in that signal section ~~by means of~~using solderless wire connectors or binding screws and spade lugs. Wire all sections of a multi-section signal face to the section terminal blocks in which the traffic signal cable is terminated. Maintain the color coding on leads from the individual optical units throughout the signal head, except for the traffic signal cable. Use solderless wire connectors or binding screws and spade lugs for connections to terminal blocks. Use binding screws and spade lugs for field wiring. The traffic signal cable will not be stripped until it has passed into the location that requires termination.

3.3. **Installation**. Install the signal head assemblies, as shown on the plans or as directed, to the required signal mast arm or pole. A drip loop is required when passing between signal hardware, as shown on the plans or as directed.

3.4. **Removal**. Remove the existing item as shown on the plans or as directed. Ensure the items designated for salvage are removed in a manner to avoid undue stress or damage. When the removed item leaves an opening, cover the opening with similar material to an equivalent condition. When the removed item leaves an unused signal cable, remove the cable. When the removed item leaves unused conductors within a signal cable still in use, trim back and tape off to ensure no electrical shorts by unused conductors.

4. MEASUREMENT

This Item will be measured by each vehicle signal section, pedestrian signal section, back plate, ~~or~~ louver, or head assembly installed or removed.

5. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for the installation or removal of the "Pedestrian Signal Section," "Vehicle Signal Section," "Back Plate," ~~or~~ "Louver," or "Head Assembly," of the types and sizes specified.

5.1. **Installation**. This price is full compensation for furnishing, fabricating, assembling, and installing the signal sections, back plates and louvers, and lenses and optics; mounting attachments; and materials, equipment, labor, tools, and incidentals.

5.2. **Removal**. This price is full compensation for removing, salvaging, disassembling, and stockpiling vehicle or pedestrian signal head components removed as shown on the plans or as directed.

Item 684
Traffic Signal Cables

1. DESCRIPTION

1.1. ~~Furnish~~**Installation**. Fabricate, furnish, and install traffic signal cables.

1.2. **Removal**. Remove existing traffic signal cables.

2. MATERIALS

Provide polyethylene-jacketed multi-conductor cables ~~in accordance with details~~as shown on the plans. Individual conductors must be copper with polyethylene insulation rated for ~~600 volts~~600V. Furnish new materials. Provide traffic signal cables in accordance with DMS-11110, "Traffic Signal Cable."

2.1. **Type A Cables**. Use Type A cables ~~meeting the requirements of~~in accordance with IMSA 20-1 for underground conduit installation or aerial cable supported by a messenger~~.~~ wire. Messenger wire is defined under Item 625, "Zinc-Coated Steel Wire Strand."

2.2. **Type B Cables**. Use Type B cables ~~meeting the requirements of~~ in accordance with IMSA 20-3 as the integral messenger ~~cable~~wire for aerial installations.

~~2.3.~~ **Type C Cables**. Use Type C cables ~~meeting the requirements of~~in accordance with IMSA 50-2 for loop detector lead-in installations consisting of ~~2~~two conductor shielded ~~cable.~~

~~2.4. **Types A and B Cable Materials**. Provide the following materials for Type A and B cables:~~

- ~~Use the size and number of conductors shown on the plans. Unless otherwise shown on the plans, use conductors consisting of 7 copper strands.~~
- ~~Ensure color coding of conductors and sequence for cables are in compliance with Table 1. Base color is the insulation color. Tracer color is the colored stripe that is part of or firmly adhered to the insulation surface for the full length of the conductor.~~
- ~~Ensure 2-conductor cable is of the round twisted type with fillers used where necessary to form a round cable.~~
- ~~For cables with more than 2 conductors, ensure individual conductors are laid up symmetrically in layers with fillers used when necessary, to produce a uniform assembly of conductors with a firm, compact cylindrical core.~~
- ~~Ensure fillers are a non-metallic, moisture-resistant, non-wicking material.~~
- ~~Supply conductor assemblies covered with a wrapping of a moisture-resistant tape applied to overlap at least 10% of the tape width.~~
- ~~Ensure the taped conductor assembly is covered with a tightly fitting black polyethylene jacket that is smooth and free from holes, splits, blisters, and any other imperfections.~~
- ~~Supply cables that clearly show the name of the manufacturer and the IMSA specification number applied at approximate 2-ft. intervals to the outer surface of the jacket by indent printing.~~

~~Table 1~~
~~Conductor Color and Sequence for Cables~~

~~Conductor No.~~	~~Base Color~~	~~Tracer Color~~
~~1~~	~~Black~~	
~~2~~	~~White~~	
~~3~~	~~Red~~	
~~4~~	~~Green~~	
~~5~~	~~Orange~~	
~~6~~	~~Blue~~	
~~7~~	~~White~~	~~Black~~
~~8~~	~~Red~~	~~Black~~
~~9~~	~~Green~~	~~Black~~
~~10~~	~~Orange~~	~~Black~~
~~11~~	~~Blue~~	~~Black~~
~~12~~	~~Black~~	~~White~~
~~13~~	~~Red~~	~~White~~
~~14~~	~~Green~~	~~White~~
~~15~~	~~Blue~~	~~White~~
~~16~~	~~Black~~	~~Red~~
~~17~~	~~White~~	~~Red~~
~~18~~	~~Orange~~	~~Red~~
~~19~~	~~Blue~~	~~Red~~
~~20~~	~~Red~~	~~Green~~
~~21~~	~~Orange~~	~~Green~~

~~2.5. **Additional Requirements for Type B Cable Materials.** Additional material requirements particular to Type B cable are as follows:~~

- ~~Ensure cables consisting of 5 or more conductors have a 0.25-in. nominal diameter messenger. For the messenger, use Class A galvanized Extra High Strength Steel Strand with 3 or 7 wires.~~
- ~~A solid strand messenger with 0.134-in. diameter may be used for cables with less than 5 conductors.~~
- ~~To provide corrosion protection, ensure the messenger strand is coated and the interstices are flooded with a rubber asphalt compound or equivalent.~~
- ~~Ensure the integral messenger and conductors are enclosed in the jacket forming a cross-section similar to a figure 8.~~

~~2.6. **Type C Cable Materials.** Use the following materials for Type C cables:~~

- ~~Unless otherwise shown on the plans, use No. 14 AWG insulated conductors with concentric stranding with black insulation on 1 of the 2 conductors and clear insulation on the other conductor. Ensure conductors have a minimum of 2 twists per foot within the cable.~~
- ~~Use cables that have 100% shield coverage using aluminum bonded to a Mylar film. Ensure the drain wire is stranded tinned copper, 2 AWG sizes less than the conductor, and in continuous contact with the aluminum side of the shield material.~~
- ~~Ensure the jacket is black polyethylene.~~

~~2.7.~~2.3. ~~Use cables that legibly show the name of the manufacturer and the IMSA specification number applied at approximate 2-ft. intervals on a tape under the outer jacket~~.

~~2.8.~~2.4. **Sampling**. The Engineer may take samples from each roll of each size of cable for establishing conformity to IMSA. The samples will be at least 3 ft. long. Replace any cable failing to meet IMSA requirements.

3. CONSTRUCTION

3.1. **Installation**. For each cable run in underground conduit, coil an extra 5 ft. of cable in each ground box. For aerial installations over span wire, coil 5 ft. of cable neatly at the top of the nearest span wire pole for

pole-mounted cabinets. Coil an extra 5 ft. of cable for each vehicle signal head assembly as shown on the plans or as directed.

Splices are not permitted in Type A and Type B cables unless shown on the plans~~,~~ or approved in writing. Ensure splices are watertight.

Make splices between Type C cable and loop detector wires only in the ground box near the loop the cable is servicing. Use non-corrosive solder for splices. Ground the drain wire of Type C cable to earth ~~ground~~ only at the controller or detector cabinet. Ensure the resistance from the drain wire to the ground rod is less than 1 ohm.

Test the cables after installation and before any connection to the cables. Cables testing less than 50 ~~megohms~~ megohm insulation resistance at ~~500 volts~~500V will be rejected.

3.2. **Removal**. Remove the existing cable as shown on the plans or as directed. When the removed item leaves an opening, cover the opening with similar material to an equivalent condition.

4. MEASUREMENT

This Item will be measured by the foot of traffic signal cables installed or removed.

This is a plans quantity measurement Item. The quantity to be paid is the quantity shown in the proposal, unless modified by Article 9.2., "Plans Quantity Measurement." Additional measurements or calculations will be made if adjustments of quantities are required.

5. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for installation or removal of the "Traffic Signal Cables" of the types and sizes specified.

5.1. **Installation**. This price is full compensation for furnishing and installing materials, and for equipment, labor, tools, and incidentals, except as shown below.

Cables inside traffic signal pole and pedestal pole assemblies will be paid for under this Item.

Cables used for inside signal heads and controllers or coils in ground boxes, on pole bases, and on span wires will not be paid for directly, but will be subsidiary to pertinent Items. The wire lashing or cable tie used to secure aerial cables to messenger wires will be subsidiary to Item 680, "Highway Traffic Signals," or Item 690, "Maintenance of Traffic Signals and Illumination."

5.2. **Removal**. This price is full compensation for removing traffic signal cables as shown on the plans or as directed.

Item 685
Roadside Flashing Beacon Assemblies

1. DESCRIPTION

- **Installation**. Furnish, fabricate, and erect roadside flashing beacon assemblies.
- **Relocation**. Remove and relocate existing roadside flashing beacon assemblies.
- **Removal**. Remove existing roadside flashing beacon assemblies.

2. MATERIALS

Furnish new materials in accordance with the following Items and ~~details~~as shown on the plans~~:~~.

- Item 441, "Steel Structures"
- Item 442, "Metal for Structures"
- Item 445, "Galvanizing"
- Item 449, "Anchor Bolts"
- Item 656, "Foundations for Traffic Control Devices"
- Item 687, "Pedestal Pole Assemblies"

Provide prequalified flasher controller assemblies from the Department's MPL in accordance with DMS-11160, "Flasher Controller Assembly."

Provide prequalified pedestal pole bases from the Department's MPL in accordance with DMS-11140, "Pedestal Pole Base."

When shown on the plans, provide prequalified solar~~-~~powered flasher controller assemblies from the Department's MPL in accordance with DMS-11150, "Solar Power Flasher Controller Assembly."

3. CONSTRUCTION

Install foundations for installation and relocation in accordance with Item 656~~, "Foundations for Traffic Control Devices."~~.

3.1. **Fabrication**. Provide poles and bases in accordance with Item 687~~, "Pedestal Pole Assemblies."~~. Provide mild steel anchor bolts in accordance with Item 449~~, "Anchor Bolts."~~. Use galvanized bolts, nuts, and washers.

3.2. **Galvanizing**. Galvanize all fabricated parts in accordance with Item 445~~, "Galvanizing."~~. Repair galvanizing for any steel part or member damaged in assembly, transit, or erection, or any steel part or member welded after galvanizing, in accordance with Section 445.3.~~5~~4., "Repairs."

3.3. **Installation**. Install roadside flashing beacon assemblies at the locations shown on the plans or as directed. Stake the assembly locations for verification by the Engineer unless otherwise shown on the plans.

Install pole, breakaway base, connectors, wiring, signal beacons, sign, and foundation as shown on the plans, or as directed. Install the flasher controller assembly on the electrical service pole. Install watertight breakaway electrical fuse holders in all ~~line~~lines and neutral conductors at the breakaway base.

Use established industry and utility safety practices to erect assemblies near overhead or underground utilities. Consult with the appropriate utility company before beginning such work.

Install solar panels, batteries, and battery box (when required) as shown on the plans or as directed.

3.4. **Relocation**. Disconnect and isolate the electrical power supply before removal of the assembly. Remove existing assembly as directed. Salvage existing components, such as sign, beacons, pole, and base, unless otherwise directed. Repair or replace lost or damaged components as directed.

Relocate existing assembly to the location shown on the plans or as directed. Install existing assembly at new foundations in accordance with Section 685.3.3., "Installation." Remove existing foundations in accordance with Section 685.3.5., "Removal." Accept ownership and dispose of unsalvageable materials ~~and dispose of~~ in ~~accordance~~conformance with federal, state, and local regulations.

3.5. **Removal**. Disconnect and isolate existing electrical power supplies before removal of the assembly. Remove existing sign panel, beacons, pole, and base from existing assembly. Store items to be reused or salvaged without damaging. Store sign panels above the ground in a vertical position at locations shown on the plans or as directed. Accept ownership and dispose of unsalvageable materials ~~and dispose of~~ in ~~accordance~~conformance with federal, state, and local regulations.

Remove abandoned foundations, including steel, to 2 ft. below the finished grade unless otherwise shown on the plans. Backfill with material equal in composition and density to the surrounding area, and replace any surfacing, such as asphalt pavement or concrete riprap, with like material to equivalent condition.

4. MEASUREMENT

This Item will be measured by each installed, relocated, or removed roadside flashing beacon assembly.

5. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Install Roadside Flashing Beacon Assemblies," "Install Roadside Flashing Beacon Assemblies (Solar Powered)," "Relocate Roadside Flashing Beacon Assemblies," "Relocate Roadside Flashing Beacon Assemblies (Solar Powered)," "Remove Roadside Flashing Beacon Assemblies," or "Remove Roadside Flashing Beacon Assemblies (Solar Powered)." The Department will pay for electrical energy consumed by the roadside flashing beacon.

New conduit will be paid for under Item 618, "Conduit," except for conduit in the foundation and within 6 in. of the foundation. New electrical conductors will be paid for under Item 620, "Electrical Conductors." New tray cable will be paid for under Item 621, "Tray Cable." New duct cable will be paid for under Item 622, "Duct Cable." New ground boxes will be paid for under Item 624, "Ground Boxes." New electrical services will be paid for under Item 628, "Electrical Services." New signs will be paid for under Item 636, "Signs." New signal heads will be paid for under Item 682, "Vehicle and Pedestrian Signal Heads." New traffic signal cable will be paid for under Item 684, "Traffic Signal Cables."

5.1. **Installation**. This price is full compensation for furnishing, fabricating, galvanizing, assembling, and erecting the roadside flashing beacon assemblies, including poles and bases; solar power flashing controller assemblies, including batteries and battery box ~~(when required);~~ foundations; conduit in the foundation and within 6 in. of the foundation; furnishing and placing anchor bolts, nuts, washers, and templates; controller; and materials, equipment, labor, tools, and incidentals.

5.2. **Relocation**. This price is full compensation for removing the roadside flashing beacon assemblies; removing battery box (when required); removing existing foundations; installing new foundations; installing new conduit in the foundation and within 6 in. of the foundation; furnishing, fabricating, and installing any new components as required and replacing the assembly on its new foundations with all manipulations and electrical work; controller; batteries; battery box; salvaging; disposal of unsalvageable materials; loading and hauling; and materials, equipment, labor, tools, and incidentals.

5.3. **Removal**. This price is full compensation for removing the various roadside flashing beacon ~~assemblies~~assembly components; removing the foundations; storing the components to be reused or salvaged; disposal of unsalvageable materials; backfilling and surface placement; loading and hauling; and materials, equipment, tools, labor, and incidentals.

Item 686

Traffic Signal Pole Assemblies ~~(Steel)~~

1. DESCRIPTION

1.1. **Installation**. Fabricate, furnish, and install steel traffic signal pole assemblies.

1.2. **Relocation**. Remove and relocate existing steel traffic signal pole assemblies.

1.3. **Removal**. Remove existing steel traffic signal pole assemblies.

2. MATERIALS

Provide new materials ~~that comply with the details~~as shown on the plans~~, the requirements of~~ and in accordance with this Item~~,~~ and the ~~pertinent requirements of~~ the following Items~~:~~.

- Item 416, "Drilled Shaft Foundations"
- Item 421, "Hydraulic Cement Concrete"
- Item 441, "Steel Structures"
- Item 442, "Metal for Structures"
- Item 445, "Galvanizing"
- Item 449, "Anchor Bolts"

Furnish alloy steel or medium-strength mild steel anchor bolts in accordance with Section 449.2.1., "Bolts and Nuts," unless otherwise shown on the plans.

3. CONSTRUCTION

3.1. **Standard Design**. Fabricate ~~poles~~pole assemblies in accordance with this Item to the designs shown on the plans. Alternate designs are not acceptable. Deviations that affect the basic structural behavior of the pole are considered ~~to be~~ alternate designs. For deviations that do not affect the basic structural behavior of the pole, electronically submit shop drawings in accordance with Item 441~~, "Steel Structures,"~~ to the Bridge Division for approval.

3.2. **Fabrication**. Fabricate and weld in accordance with Item 441, ~~"Steel Structures,"~~ AWS D1.1~~, *Structural Welding Code—Steel,*~~ and ~~the requirements of~~ this Item. Fabrication tolerances are ~~given~~shown in Table 1.

Table 1
Fabrication Tolerances

Part	Dimension	Tolerance (in.)
Pole and mast arm shaft	Length	±1
	Thickness	+0.12, –0.02
	Difference between flats or diameter	±3/16
	Straightness	1/8 in 10 ft.
	Attachment locations	±1
Base and mast arm mounting plates	Overall	±3/16
	Thickness	+1/4, –0
	Deviations from ~~flat~~flat[1]	3/16 in 24 in.
	Spacing between holes	±1/8
	Bolt hole size	±1/16
Anchor bolts	Length	±1/2
	Threaded ~~Length~~length	±1/2
	Galvanized ~~Length~~length	–1/4
Assembled shafts	Angular ~~Orientation~~orientation	1/16 in 12 in.~~1~~2
	Centering	±3/16
	Twist	3° in 50 ft.

1. For long mast arm assembly (LMA) structures, refer to plan sheets for mast arm mounting plate tolerance.

~~1.~~2. 1/8 in 12 in. between mounting plates and between mounting plates and base plates.

Fabrication plants that produce steel traffic signal pole assemblies must be approved in accordance with DMS-7380, "Steel Non-Bridge Member Fabrication Plant Qualification." The Department maintains an MPL of approved traffic signal pole assembly fabrication plants.

Provide properly fitting components. Provide round or octagonal shafts for poles and mast arms tapered as shown on the plans. Fabricate mast arms straight in the unloaded condition unless otherwise shown on the plans. The Department will accept bolted slip joints overlapping by at least 1.5 diameters in mast arms 40 ft. and longer.

Provide circumferential welds only at the ends of the shafts. Provide no more than ~~2~~two longitudinal seam welds in shaft sections. ~~Grind or smooth the exterior of longitudinal seam welds to the same appearance as other shaft surfaces. Ensure~~Provide 100% penetration within 6 in. of circumferential base welds and 60% minimum penetration at other locations along the longitudinal seam welds. ~~Use a welding technique~~Provide longitudinal seam weld and fit-up that ~~minimizes~~will minimize acid entrapment during later galvanizing. ~~Hot-dip galvanize all fabricated parts in accordance with Item 445, "Galvanizing."~~

~~Treat welds with Ultrasonic Impact Treatment when shown on the plans after galvanization and with the dead load (actual or simulated) applied. Repair damaged galvanizing in accordance with Section 445.3.5., "Repairs."~~

For LMA structures, perform at least 10% ultrasonic testing (UT) of longitudinal seam welds on the arm and pole shafts. Use a Department-approved UT procedure to ensure 60% minimum penetration where specified. Perform testing at a minimum of three locations on each shaft (at both ends and middle). The minimum length of each test area must be 10 in. If minimum penetration is not achieved in any of the tested areas, test an additional 24 in. beyond the originally selected test areas requiring 60% penetration. Test the entire arm or pole shaft seam weld if any locations within the additional 24-in. test areas do not achieve 60% penetration. Repair the deficient areas using a Department-approved repair procedure and retest. Hot-dip galvanize all fabricated parts in accordance with Item 445. Provide punched, drilled, or mechanically guided thermal-cut holes in steel parts or members, when allowed, before galvanizing. Mechanically guided thermal-cut hole quality will be in accordance with Item 445.

Connect the luminaire arm to the pole ~~with~~using simplex fittings. Ensure the fittings have no defects affecting strength or appearance.

Permanently mark, at a visible location when erected, pole base plates and mast arm mounting plates with the design wind speed.

Permanently mark, at a visible location when erected, pole base plates and fixed mast arm mounting plates with the fabrication plant's insignia ~~or trademark.~~ Place the mark on the pole base plate adjacent to the hand-hole access compartment.

Deliver each traffic signal pole assembly with fittings and hardware either installed or packaged with its associated components. ~~Ship all components with a weatherproof tag identifying the manufacturer, Contract number, date, and destination of shipment.~~

3.3. **Installation**. Locate traffic signal pole assemblies as shown on the plans, unless otherwise directed, to secure a more desirable location or avoid conflict with utilities. Stake the traffic signal pole assembly locations for verification by the Engineer.

Use established industry and utility safety practices when working near overhead or underground utilities. Consult with the appropriate utility before beginning work.

Construct foundations for new traffic signal pole assemblies in accordance with Item 416~~, "Drilled Shaft Foundations," and the details~~ and as shown on the plans. Orient anchor bolts as shown on the plans.

Erect structures after foundation concrete has attained its design strength as ~~required~~shown on the plans and in accordance with Item 421~~, "Hydraulic Cement Concrete."~~. Coat anchor bolt threads and tighten anchor bolts in accordance with Item 449~~, "Anchor Bolts."~~.

After the traffic signal pole assembly is plumb and all nuts are tight, tack weld each anchor bolt nut in ~~2~~two places to its washer. Tack weld each washer to the base plate in ~~2~~two places. Never weld components to the bolt. Tack weld in accordance with Item 441~~, "Steel Structures."~~. After tack welding, repair galvanizing damage on bolts, nuts, and washers in accordance with Section 445.3.~~5~~4., "Repairs."

Do not grout between the base plate and the foundation.

3.4. **Relocation**. Disconnect and isolate traffic signal cables before removing the pole. Remove existing traffic signal pole assemblies as directed. Ensure the poles or attached components suffer no undue stress or damage. Signs, signal heads, mounting brackets, and luminaires~~, etc.,~~ may be left on the poles. Repair or replace damaged components as directed.

Remove abandoned concrete foundations, including steel, to a point 2 ft. below final grade unless otherwise shown on the plans. Cut off and remove steel protruding from the remaining concrete. Backfill the hole with materials equal in composition and density to the surrounding area. Replace surfacing material with similar material to an equivalent condition.

Move existing pole assemblies to locations shown on the plans~~,~~ or as directed. Construct foundations for relocated traffic signal pole assemblies in accordance with Item 416~~, "Drilled Shaft Foundations,"~~ and ~~the details~~as shown on the plans. Install existing pole assemblies on new foundations in accordance with Section 686.3.3., "Installation."

Accept ownership and dispose of unsalvageable materials ~~and dispose of~~ in ~~accordance~~conformance with federal, state, and local regulations.

3.5. **Removal**. Disconnect and isolate traffic signal cables before removing the pole. Remove existing traffic signal pole assemblies as shown on the plans or as directed. Ensure the poles or attached components that are salvaged suffer no undue stress or damage.

Remove abandoned concrete foundations, including steel, to a point 2 ft. below final grade unless otherwise shown on the plans or as directed. Cut off and remove steel protruding from the remaining concrete. Backfill the hole with materials equal in composition and density to the surrounding area. Replace surfacing material with similar material to an equivalent condition.

4. MEASUREMENT

This Item will be measured by each traffic signal pole assembly installed ~~or~~, relocated, or removed.

5. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Install Traffic Signal Pole Assemblies ~~(Steel)""~~ of the types and sizes specified ~~or~~, "Relocate Traffic Signal Pole Assemblies ~~(Steel)""~~ of the types specified, or "Remove Traffic Signal Pole Assemblies" of the types specified.

New drilled shaft foundations will be paid for under Item 416~~, "Drilled Shaft Foundations."~~.

5.1. **Installation**. This price is full compensation for furnishing, fabricating, galvanizing, assembling, and erecting the pole upon a foundation; furnishing and erecting required mast arms and luminaire arms; furnishing and placing anchor bolts, nuts, washers, and templates; and materials, equipment, labor, tools, and incidentals.

5.2. **Relocation**. This price is full compensation for removing traffic signal pole assemblies; removing existing foundations; backfilling and surface placement; storing the components to be reused or salvaged; furnishing, fabricating, and installing required new components including anchor bolts, nuts, washers, and templates; placing and securing traffic signal pole assemblies on new foundations; furnishing and placing conduit, ground rods, and wiring; ~~disposal~~disposing of unsalvageable materials; loading and hauling; and materials, equipment, labor, tools, and incidentals.

~~5.2.~~5.3. **Removal**. This price is full compensation for removing, salvaging, disassembling, and stockpiling signal pole assemblies; salvaging and relocating existing conduit; removing existing foundations; backfilling and surface placement; splicing existing conductors; disposing of unsalvageable materials; and materials, equipment, labor, tools, and incidentals.

Item 687
Pedestal Pole Assemblies

1. DESCRIPTION

- **Installation**. Furnish and install pedestal pole assemblies for vehicle and pedestrian signals.
- **Relocation**. Remove and relocate existing pedestal pole assemblies.
- **Removal**. Remove existing pedestal pole assemblies.

2. MATERIALS

Furnish new materials in accordance with the following Items and ~~with details~~as shown on the plans~~:~~.

- Item 445, "Galvanizing"
- Item 449, "Anchor Bolts"
- Item 656, "Foundations for Traffic Control Devices"

2.1. **Pedestal Pole Base**. Provide prequalified pedestal pole bases with locking collar from the Department's MPL in accordance with DMS-11140, "Pedestal Pole Base."

2.2. **Pedestal Pole**. Provide 4-in. diameter ~~schedule~~ Schedule 40 steel pipe or tubing, aluminum pipe (~~alloy~~Alloy 6061~~-~~T6), or rigid metal conduit~~.~~, unless otherwise shown on the plans. Do not use aluminum conduit. Galvanize pedestal pole assemblies in accordance with Item 445, ~~"Galvanizing,"~~ unless otherwise shown on the plans.

2.3. **Pedestrian Push Button Pole Assembly**. Provide diameter as shown on the plans, ~~schedule~~Schedule 40 steel pipe or tubing, aluminum pipe (~~alloy~~Alloy 6061-T6), or rigid metal conduit. Do not use aluminum conduit. Galvanize pedestrian push button post in accordance with Item 445, ~~"Galvanizing,"~~ unless otherwise shown on the plans.

3. CONSTRUCTION

Install foundations in accordance with Item 656~~, "Foundations for Traffic Control Devices."~~.

3.1. **Pedestal Pole Base**. Ground the base with connectors to the 1/2-13 NC female threaded hole. Fabricate the base for 4four L-~~-~~bend anchor bolts arranged in a square pattern with a 12-3/4 in. bolt circle. Provide mild steel anchor bolts in accordance with Item 449~~, "Anchor Bolts,"~~ for each base. Provide three 1/16-in. thick and three 1/8-in. thick U-shaped galvanizing steel shims for each base. Size shims to fit around the anchor bolts.

3.2. **Installation**. Install pedestal pole assemblies and pedestrian push button post assemblies as shown on the plans, or as directed. Pedestal pole assemblies include foundation, pole shaft, base, anchor bolts, anchor bolt nuts, anchor bolt template, shims, and miscellaneous components. Watertight breakaway electrical disconnects are required for pedestal pole assemblies used in conjunction with vehicle and pedestrian heads and components. Pedestrian push button post assemblies include foundation, pole, and post cap.

Use established industry and utility safety practices to erect assemblies near overhead or underground utilities. Consult with the appropriate utility company before beginning such work.

Repair damaged galvanizing in accordance with Section 445.3.~~5~~4., "Repairs."

3.3. **Relocation**. Disconnect and isolate the electrical power supply before removal of the assembly. Remove existing assembly as directed. Salvage existing components, such as signs, heads, buttons, pole, and base, unless otherwise directed. Repair or replace lost or damaged components as directed.

Install foundations in accordance with Item 656~~, "Foundations for Traffic Control Devices."~~.

Relocate existing assembly to the location shown on the plans or as directed. Install existing assembly at new foundations in accordance with Section 687.3.2., "Installation." Remove existing foundations in accordance with Section 687.3.4., "Removal." Accept ownership of unsalvageable materials, as determined by the Engineer, and dispose of them in ~~accordance~~conformance with federal, state, and local regulations.

Repair galvanizing for any damaged steel part or any steel part welded after galvanizing in accordance with Item 445~~, "Galvanizing."~~.

3.4. **Removal**. Disconnect and isolate electrical power supplies before removal of the assembly. Remove existing sign panel, beacons, pole, and base from existing assembly. Store items to be reused or salvaged without damaging them. Store sign panels above the ground in a vertical position at locations shown on the plans or as directed. Accept ownership and dispose of unsalvageable materials ~~and dispose of~~ in ~~accordance~~conformance with federal, state, and local regulations.

Disconnect and remove conductors from abandoned circuits. Remove abandoned conduit and ducts to a point 6 in. below final grade. Destroy existing transformer bases to prevent reuse. Remove abandoned foundations to 2 ft. below the finished grade unless otherwise shown on the plans. Cut off and remove steel protruding from the remaining concrete. Backfill the remaining hole with material equal in composition and density to the surrounding area. Replace any surfacing with like material to equivalent condition.

3.5. **Painted Finish**. When required, paint pedestal pole and pedestrian push button post assemblies ~~in accordance with details~~as shown on the plans.

4. MEASUREMENT

This Item will be measured by each pedestal pole assembly or each pedestrian push button post assembly installed, relocated, or removed.

5. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Install Pedestal Pole Assembly," "Install Pedestrian Push Button Post Assembly," "Relocate Pedestal Pole Assembly," "Relocate Pedestrian Push Button Post Assembly," "Remove Pedestal Pole Assembly~~"~~," or "Remove Pedestrian Push Button Post Assembly."

New signal heads will be paid for under Item 682, "Vehicle and Pedestrian Signal Heads." New pedestrian detector buttons will be paid for under Item 688, "Pedestrian and Vehicle Detectors."

5.1. **Installation**. This price is full compensation for furnishing and installing the shaft; base, shims, anchor bolts, and foundation; and materials, equipment, labor, tools, and incidentals.

5.2. **Relocation**. This price is full compensation for removing the pedestal pole or pedestrian push button assemblies; removing existing foundations; installing new foundations; furnishing, fabricating, and installing any new components as required and replacing the assembly on its new foundations with all manipulations and electrical work; controller; salvaging; disposal of unsalvageable material; loading and hauling; and equipment, material, labor, tools, and incidentals.

5.3. **Removal**. This price is full compensation for removing the various pedestal pole ~~assemblies~~assembly components; removing the foundations; storing the components to be reused or salvaged; disposal of

unsalvageable material; backfilling and surface placement; loading and hauling; and equipment, materials, tools, labor, and incidentals.

Item 688

Pedestrian ~~Detectors~~ and Vehicle ~~Loop~~ Detectors

1. DESCRIPTION

1.1. ~~Furnish~~**Installation**. Fabricate, furnish, and install traffic signal detectors.

1.2. **Removal**. Remove existing traffic signal detectors.

2. MATERIALS

Provide new materials ~~that comply with the details~~as shown on the plans~~, the requirements of~~ and in accordance with this Item~~,~~ and the pertinent requirments of the following Items~~:~~.

- Item 618, "Conduit"
- Item 624, "Ground Boxes"
- Item 682, "Vehicle and Pedestrian Signal Heads"
- Item 684, "Traffic Signal Cables"

2.1. **Pedestrian ~~Detectors~~Detector**. Supply housing or an adapter (i.e., saddle) that conforms to the pole shape, fitting flush to ensure a rigid installation. Supply adapters of the same material and construction as the housing. Supply push~~-~~button switches that have single-pole, single-throw contacts and screw-type terminals and have a design life of at least 1 million operations.

Ensure the internal components provide a push~~-~~button with normal open contacts, and include all electrical and mechanical parts required for operation. Ensure the push~~-~~button assembly is weather-tight and tamperproof, is designed to prevent an electrical shock under any weather condition, and has provisions for grounding in accordance with the NEC.

2.1.1. **Standard Pedestrian ~~Detectors~~Detector**. Provide a ~~2~~two-piece cast aluminum housing unit consisting of a base housing and a removable cover. Provide threaded holes for 0.5-in. conduit in the housing for any necessary conduit attachment.

Ensure the manufacturer's name or trademark is located on the housing.

2.1.2. **Accessible Pedestrian Signals (APS)**. Provide accessible pedestrian detectors in accordance with DMS-11132, "Accessible Pedestrian Signals ~~(APS)."~~."

2.2. **Vehicle Loop Detectors**. Use stranded copper No. 14 AWG XHHW cross-linked-thermosetting-polyethylene-insulated conductor rated for ~~600 volts AC~~600V alternating current for vehicle detector loop wire unless otherwise shown on the plans. Ensure each length of wire shows the name or trademark of the manufacturer, insulation voltage rating, wire gauge, and insulation type at approximate 2-ft. intervals on the insulation surface.

When shown on the plans, use flexible vinyl or polyethylene tubing with 0.184~~–~~in. minimum inside diameter, 0.031~~–~~in. minimum wall thickness, 0.26~~–~~in. maximum outside diameter, and a smooth bore. Use tubing that does not adhere to the loop wire in any way and is capable of resisting deterioration from oils, solvents, and temperatures up to 212°F. Use tubing that is abrasion-resistant and remains flexible from ~~–~~22~~°F to –~~212°F. Use orange or red tubing unless otherwise shown on the plans.

Use sealant for the vehicle detector loops in accordance with DMS-6340, "Vehicle Loop Wire Sealant."

3. CONSTRUCTION

3.1. **Pedestrian ~~Detectors~~Detector**.

3.1.1. **Push~~-~~ Button Unit**. ~~Meet the requirements of the TMUTCD when installing~~Install push~~-~~ buttons~~.~~ in accordance with the TMUTCD. Wire the push~~-~~ button ~~according to~~in conformance with manufacturer's installation instructions. Close unused housing openings with a weather~~-~~tight closure painted to match the housing. Verify that each button is communicating and fully functional.

Do not use terminal connections or splice wire leads except at approved locations. All allowed splices must be watertight.

Attach wires to terminal posts ~~with~~using solderless terminals unless otherwise advised by manufacturer's recommendations. Attach terminals to the wires ~~with~~using a ratchet-type compression crimping tool properly sized to the wire.

Mount a pedestrian push button sign near each push button as shown on the plans.

For installations where APS buttons are placed less than 10 ft. apart from one another, program the appropriate speech walk message (include the name of the appropriate street in the message) for these buttons. When ~~2~~two APS buttons are installed on the same pole, ensure that the APS buttons are insulated to eliminate vibrations from traveling to the other button.

3.1.2. **Controller Unit**. If a controller unit is required by the plans, integrate the pedestrian controller unit into the traffic signal controller cabinet assembly.

3.2. **Vehicle Loop ~~Detectors~~Detector**. Provide the loop location, configuration, wire color, and number of turns as shown on the plans. Loops may be adjusted by the Engineer to fit field conditions.

3.2.1. **Saw-Cuts**. Cut the pavement ~~with~~using a concrete saw to form neat lines. Do not exceed 1~~-~~in. depth on concrete bridge slab saw-cuts. Cut all other saw-cuts deep enough to provide a minimum of 1~~-~~in. depth of sealant over the wire. Make a separate saw-cut from each loop to the edge of the pavement unless otherwise shown on the plans. Ensure the cut is clean and dry when the wire and sealant are placed.

3.2.2. **Conduit**. Place conduit between the pavement and ground box as shown on the plans.

3.2.3. **Loop Wire Color**. Use the following color code unless otherwise shown on the plans. Use white for the first loop on the right, followed by black, orange, green, brown, and blue. Use the same color for all loops in the same lane. Loops installed in multi-lanes will have the same color code in the order in which the loops are installed. When facing the same direction ~~that~~of traffic ~~flows~~flow, the color code will read from right to left for all lanes carrying traffic in that direction. If traffic moves in ~~2~~two directions, the color code will be repeated for the other direction of traffic.

3.2.4. **Loop Wire Installation**. When shown on the plans, place the loop wire in a flexible vinyl or polyethylene tubing in accordance with Article 688.2., "Materials." The loop wire color requirements do not apply to wires in tubing.

Twist the wire from the loop to the ground box a minimum of ~~5~~five turns per foot. When only one pair of wires is in a saw-cut, it need not be twisted while in the saw-cut. Do not splice loop wire in the loop or in the run to the ground box.

Hold the loop wire in place every 2 ft. with strips of rubber, neoprene flexible tubing, or polyethylene foam sealant approximately 1 in. long. Leave these strips in place and fill the slot with loop sealant.

Splice the loop lead-in cable and loop detector wires only in the ground box near the loop it is serving. Use non-corrosive solder for splices and ensure the splice is watertight. Ground the drain wire of the loop lead-in cable to earth ground only at the controller or detector cabinet. Ensure the resistance from the drain wire to the ground rod is less than 1 ohm.

3.3. **Installation**. Install the detectors as shown on the plans or as directed.

3.4. **Removal**. Remove the existing item as shown on the plans or as directed. Ensure the items designated for salvage are removed in a manner to avoid undue stress or damage. When the removed item leaves an opening, cover the opening with similar material to an equivalent condition. When the removed item leaves an unused signal cable, remove the cable. When the removed item leaves unused conductors within a signal cable still in use, trim back and tape off to ensure no electrical shorts by unused conductors.

4. MEASUREMENT

~~This Item~~Vehicle loop detector will be measured by the foot of saw-cut containing loop wire ~~and each pedestrian~~installed or removed.

Pedestrian push~~-~~ button detector and controller unit will be measured by the each installed or removed.

This is a plans quantity measurement Item. The quantity to be paid is the quantity shown in the proposal, unless modified by Article 9.2., "Plans Quantity Measurement." Additional measurements or calculations will be made if adjustments of quantities are required.

5. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for the installation or removal of the "Vehicle ~~Loop~~ Detectors" of the type specified, "Vehicle Detector Controller Unit" of the type specified, "Pedestrian Detector Push~~-button~~ Button Units" of the type specified, or "Pedestrian Detector Controller Unit." ~~This price is full compensation for furnishing, installing, and testing the detectors, detector controller units, including detector configuration devices or software (when applicable); saw-cutting, excavation, backfill, sealant, and sealant placement; pavement repair associated with saw-cutting; and materials, equipment, labor, tools, and incidentals, except as follows.~~

5.1. ~~The conduit~~**Installation**. This price is full compensation for furnishing, installing, detector hardware and software configuration, detector testing, detector controller units, saw-cutting, excavation, backfill, sealant, sealant placement, pavement repair associated with saw-cutting, materials, equipment, labor, and incidentals. Conduit and loop wire from the edge of pavement to the ground box used for the vehicle loop detectors will not be measured or paid for directly, but will be subsidiary to this Item. New ground boxes will be paid for under Item 624, and the new loop lead-in cable will be paid for under Item 684.

5.2. ~~New ground boxes will be paid for under Item 624, "Ground Boxes." New loop lead-in cable will be paid for under Item 684, "Traffic Signal Cables."~~**Removal**. This price is full compensation for removing, salvaging, disassembling, and stockpiling detector components removed as shown on the plans or as directed. Repairs to the pavement or signal poles required from the removal will be subsidiary to this Item.

Item 690
Maintenance of Traffic Signals and Illumination

1. DESCRIPTION

Furnish, install, modify, repair, replace, reroute, or remove components of a traffic signal~~.~~ or illumination system.

2. LICENSES AND CERTIFICATIONS

Provide personnel with electrical licensing and electrical certification in accordance with Item 7, "Legal Relations and Responsibilities," and all applicable Special Provisions to Item 7.

~~2.~~3. MATERIALS

The Department will only furnish luminaires, luminaire poles, anchor bolts, transformer bases, traffic signal poles, mast arms, and controllers that become part of the final installation, unless otherwise ~~noted~~shown on the plans. Submit a materials list to the Engineer for all poles, mast arms, and controllers needed. Pick up materials at the locations and times shown on the plans. Designate in writing the ~~persons~~personnel authorized to pick up the materials.

Furnish all materials required to repair breaks or shorts in electrical conductors and cables including, but not limited to, all concrete, ground boxes, wire mesh, conduit, conductors, and pipe casing. Ensure materials furnished by the Contractor meet all Department standards and specification requirements.

When performing maintenance on luminaires, verify whether fixtures are covered under the manufacturer's warranty. If warranty applies, coordinate with the Department and follow any necessary procedures to have the manufacturer replace or repair fixtures.

Assume responsibility for all materials furnished by the Department. Use materials furnished by the Department for this Contract only. Return unused or removed materials deemed salvageable by the Engineer to the Department upon completion of the work and before final payment at location shown on the plans or as directed. Dispose of materials deemed unsalvageable by the Engineer~~,~~ in ~~accordance~~conformance with federal, state, and local regulations. When materials are required to be furnished by the Contractor, meet the "Materials" Article ~~requirements~~ of the pertinent Item.

~~3.~~4. EQUIPMENT

~~Use~~Furnish all equipment ~~that includes~~, tools, and machinery necessary for the proper prosecution of the work including, but ~~is~~ not limited to:

- an aerial device capable of reaching overhead work,
- trenching machine,
- boring machine,
- concrete saw, ~~and~~
- digger-boom truck~~.~~,
- underground conductor detectors, and
- underground fault detectors and splicing tools.

Use only equipment, tools, and machinery in good repair and operating condition. ~~Repair~~Immediately repair or replace any equipment that, in the opinion of the Engineer, may affect the quality of work or safety.

~~4.~~5. WORK METHODS

Conform to the latest edition of the NEC as adopted by TDLR, local utility requirements, the requirements of this Item, and the pertinent requirements of the following Items~~:~~.

- Item 104, "Removing Concrete"
- Item 400, "Excavation and Backfill for Structures"
- Item 416, "Drilled Shaft Foundations~~,~~"
- Item 421, "Hydraulic Cement Concrete~~,~~"
- Item 431, "Pneumatically Placed Concrete"
- Item 432, "Riprap"
- Item 440, "Reinforcement for Concrete"
- Item 445, "Galvanizing"
- Item 449, "Anchor Bolts"
- Item 450, "Railing"
- Item 476, "Jacking, Boring, or Tunneling Pipe or Box~~,~~"
- Item 610, "Roadway Illumination Assemblies~~,~~"
- Item 613, "High Mast Illumination Poles"
- Item 614, "High Mast Illumination Assemblies"
- Item 616, "Performance Testing of Lighting Systems"
- Item 618, "Conduit~~,~~"
- Item 620, "Electrical Conductors~~,~~"
- Item ~~622~~ 621, "Tray Cable"
- Special Specification, "Duct Cable~~,~~"
- Item 624, "Ground Boxes~~,~~"
- Item 625, "Zinc-Coated Steel Wire Strand~~,~~"
- Item 627, "Treated Timber Poles~~,~~"
- Item 628, "Electrical Services~~,~~"
- Item 636, "Signs~~,~~"
- Item 656, "Foundations for Traffic Control Devices~~,~~"
- Item 680, "Highway Traffic Signals~~,~~"
- Item 682, "Vehicle and Pedestrian Signal Heads~~,~~"
- Item 684, "Traffic Signal Cables~~,~~"
- Item 685, "Roadside Flashing Beacon Assemblies~~,~~"
- Item 686, "Traffic Signal Pole Assemblies ~~(Steel),~~"
- Item 687, "~~Pedestrian~~Pedestal Pole Assemblies~~," and~~"
- Item 688, "Pedestrian ~~Detectors~~ and Vehicle ~~Loop~~ Detectors~~."~~

~~Perform the following work as directed:~~

Perform the following work as directed. Maintain existing roadway illumination systems as directed. Perform a monthly inspection to determine whether any maintenance of the illumination system is needed and provide a detailed report to the Engineer. Provide proper maintenance or repairs within 48 hr. of notification. If the work requires time to procure materials, the Contractor must provide a purchase order with estimated delivery date and a schedule to complete the work. Submit completed maintenance log as directed. Coordinate electric power issues with local utility company.

The term "duct cable" as used herein consists of a complete assembly of conductors enclosed in a high-density polyethylene duct.

Perform maintenance, installation, removal, or replacement activities located near any overhead or underground utilities using established industry and utility safety practices. Consult with the appropriate utility company before beginning such work.

Maintain, install, repair, or replace the following items as shown on the plans, in accordance with the NEC, and as directed.

4.1.5.1. **Conduit**. Install, replace, remove, or modify conduits in accordance with Item 618, ~~"Conduit";~~ as shown on the plans~~;~~, or as directed. Use 90° "sweep" type elbow on conduits entering a ground box or foundation.

4.2.5.2. **Foundations**. Install, replace, or remove concrete or screw-in foundations for traffic signal pole, pedestal pole, luminaire pole, and ground mount controller cabinets in accordance with Item 416~~, "Drilled Shaft Foundations";~~ and ~~in accordance with~~ Item 656, ~~"Foundations for Traffic Control Devices";~~ as shown on the plans~~;~~, or as directed. Remove foundations in accordance with Item 610 and Item 104. Backfill in accordance with Item 400.

4.3.5.3. **Concrete**. Install concrete in accordance with Item 421~~, "Hydraulic Cement Concrete."~~.

5.4. **Ground ~~Boxes~~Box**. Install~~, repair, replace, remove, or modify~~ ground boxes as shown on the plans and in accordance with Item 624~~, "Ground Boxes"; as shown on the plans; or as directed.~~. When shown on the plans, provide a Class A concrete apron in accordance with Item 421. Place ground box to line and grade as approved. All wiring connections required inside the ground box will be subsidiary to this bid item.

Remove ground box and fill hole with approved fill to at least 6 in. below conduit level. Remove conductors and cables from conduit back to the point of termination. Uncover enough conduit that 90° bends can be removed and conduit reconnected. Clean conduit in accordance with Item 618 and pull and terminate new conductors and cables. Conduit replaced within 5 ft. of the ground box will be subsidiary to this Item. Cleaning of conduit and pulling of conductors will be paid for under "Install or Replace Conductor" or "Install or Replace Cable." Backfill in accordance with Item 400. If more than 5 ft. of conduit or duct cable needs to be replaced, the additional will be paid for under "Replace Underground Conduit" or "Replace Duct Cable."

If applicable, ground box removal includes removing the existing riprap apron.

4.4.5.5. **Vehicle and Pedestrian Detectors**. Install, repair, replace, remove, or modify pedestrian push buttons and vehicle loop detectors in accordance with Item 688, ~~"Pedestrian Detectors and Vehicle Loop Detectors";~~ as shown on the plans~~;~~, or as directed.

4.5.5.6. **Electrical Service**. Install, repair, replace, remove, or modify an electrical service assembly in accordance with Item 628, ~~"Electrical Services";~~ as shown on the plans~~;~~, or as directed. Mount any or all of the following on an electrical service support assembly~~: conduit, weather head, load center, meter base, lightning protection, wiring, and associated hardware~~.

- Conduit
- Weather head
- Load center
- Meter base
- Lightning protection
- Wiring
- Associated hardware

4.6.5.7. **Signal Pole**. Install, repair, replace, remove, or modify signal poles in ~~accordance~~conformance with pertinent Items, as shown on the plans, or as directed. Comply with Item 627~~, "Treated Timber Poles,"~~ for timber signal

poles with guy wires and anchors and Item 686~~, "Traffic Signal Pole Assemblies (Steel),"~~ for steel poles with concrete foundations. Remove timber poles and anchors completely, to 24 in. below ground level, or as directed. Remove concrete foundations to ~~24 in~~2 ft. below ground level, or as directed.

Install, repair, replace, remove, or modify pedestrian signal pole assemblies in accordance with Item 687, ~~"Pedestrian Pole Assemblies";~~ as shown on the plans~~;~~, or as directed. Install, repair, replace, remove, or modify roadside flashing beacons in accordance with Item 685, ~~"Roadside Flashing Beacon Assemblies";~~ as shown on the plans~~;~~, or as directed.

5.8. **Luminaire Poles**. Install, repair, replace, remove, or modify luminaire poles in accordance with Item 610, as shown on the plans, or as directed. Remove concrete foundations to 2 ft. below ground level, or as directed.

~~4.7.~~5.9. **Down Guy**. Install, replace, remove, or modify down guy with guard or down guy with anchor and guard.

~~4.8.~~5.10. **Steel Wire Strand**. Install, replace, or remove steel wire strand in accordance with Item 625, ~~"Zinc-Coated Steel Wire Strand";~~ as shown on the plans~~;~~, or as directed. Attach ~~span~~strain wire on timber poles using a 5/8-in. straight thimble-eye bolt. Attach ~~span~~steel strain wire on metal poles using at least ~~2~~two turns of wire around the pole. Place and properly tighten the ~~3~~three-bolt clamp as near as possible to the pole.

~~4.9.~~5.11. **Luminaire Head and Mast Arm**. Install, replace, remove, or modify luminaire heads, arms, bulbs, photocells, and hardware in accordance with Item 610, as shown on ~~timber~~the plans, or ~~steel signal poles.~~as directed. Install material ~~using~~in conformance with manufacturer's specifications. Fuse luminaires individually in the signal pole hand-hole. ~~Install a separate cable from the breaker load panel to each luminaire.~~

~~4.10.~~5.12. **Signal Head Assembly**. Install, repair, replace, remove, or modify pedestrian signal heads or vehicle signal head assemblies in accordance with Item 682, ~~"Vehicle and Pedestrian Signal Heads";~~ as shown on the plans~~;~~, or as directed. Mount signal heads ~~by~~with a ~~span~~strain wire hanger clamp, bracket arm assembly, or mast arm bracket assembly. Signal head assemblies consist of 1~~ to ~~12 signal sections. Install signal heads as shown on the plans, or as directed.

Assemble the signal heads with backplates, louvers, and brackets as needed. Mount all signal heads at the same elevation. Install signal head perpendicular to the travel lane it controls. Plumb all signal heads vertically and horizontally.

~~4.11.~~5.13. **Traffic Signal Controller Cabinet, Ground Mount**. Install, repair, replace, remove, or modify ground-mounted cabinet. Plumb and tighten the cabinet. Apply silicone sealant around the base of the cabinet. Coil all cabling that enters the cabinet neatly on the cabinet floor. Mark and terminate each cable as shown on the plans, or as directed.

~~4.12.~~5.14. **Traffic Signal Controller Cabinet, Pole Mount**. Install, repair, replace, remove, or modify pole-mounted cabinet. Plumb and tighten the cabinet. Coil all cabling that enters the cabinet neatly on the cabinet floor. Mark and terminate each cable as shown on the plans, or as directed.

~~4.13.~~5.15. **Flashing Beacon Controller Cabinet**. Install, repair, replace, remove, or modify flasher cabinet. Plumb and tighten the cabinet. Coil all cabling that enters the cabinet neatly on the cabinet floor. Mark and terminate each cable as shown on the plans, or as directed.

~~4.14.~~5.16. **Cables**. Install, repair, replace, remove, reroute, or modify signal, loop lead-in, electrical, communication, or illumination cables in conduits or along messenger ~~cables~~wires in accordance with Item 620, ~~"Electrical Conductors"; in accordance with~~Item 621, and Item 684~~, "Traffic Signal Cables";~~ as shown on the plans; or as directed.

Attach aerial cable at 1-ft. intervals using approved cable ties or wire wrap along a messenger ~~span cable~~strain wire. Install a drip loop with at least ~~2~~two turns at each pole, signal head, and weather head.

Label each cable brought into the controller cabinet. Coil 5 ft. of cable neatly on the traffic signal controller cabinet floor ~~for each cable~~or in the closest ground box for each cable for ground mounted cabinets. Coil 5 ft. of cable neatly at the top of the nearest strain wire pole for pole mounted cabinets.

Install solderless pressure connectors ~~that meet the requirements of~~in accordance with the NEC for all wires attached to terminal posts. Use a ratchet-type full-circle crimper for insulated terminals to provide a solderless pressure connector.

~~4.15.~~5.17. **Sealing**. Install, repair, replace, remove, or modify sealant in detector saw slots, at the open end of all conduits terminated at the roadway edge, and in ground boxes. Apply sealant as shown on the plans or as directed.

~~4.16.~~5.18. **Salvage Operations**. Remove traffic signal when no replacement is required. Return unused or removed material deemed salvageable by the Engineer to the Department. Dispose of all other material.

~~4.17.~~5.19. **Signal-Related Signs**. Install, repair, replace, remove, or modify small post-mounted or overhead signs.

~~4.18.~~5.20. **Curbs, Ramps, and Sidewalks**. Install, repair, replace, remove, or modify curbs, ramps, and sidewalks. Secure permission to install traffic signal items before cutting into or removing curbs, ramps, and sidewalks. Replace all curbs, ramps, and sidewalks as shown on the plans. Install pedestrian access ramps as shown on the plans.

~~4.19.~~5.21. **Protection of Utilities**. Locate and protect all public lines and utility customer service lines in the work area. Notify the utility company and locate and mark, uncover, or otherwise protect all such lines in the construction area. Obtain information ~~on~~pertinent to the location and grade of water, sewer, gas, telephone, electric lines, and other utilities in the work area from the utility company. This information does not relieve the Contractor of responsibility for protecting utilities.

Reimburse the utility line owner for expenses or costs (including fines that may be levied against the utility company) that may result from unauthorized or accidental damage to any utility lines in work area.

~~4.20.~~5.22. **Preservation of Sod, Shrubbery, and Trees**. Preserve all sod, shrubbery, and trees at the site during the Contract. Obtain permission to remove any sod, shrubbery, or tree branches. Preserve and restore sod and shrubbery into their original position. Replace damaged sod or shrubbery at the Contractor's expense.

~~4.21.~~5.23. **Polyvinyl Chloride (PVC) Weatherproof Enclosures**. Install, remove, or replace 12 × 12 × 6-in. PVC weatherproof enclosure at locations shown on the plans or as directed. ~~Only use~~Use enclosure only for reconnecting or terminating traffic signal cables at the top of a timber or steel strain pole ~~which~~that has been replaced or reinstalled due to accidental knock down.

~~4.22.~~5.24. **Light-Emitting Diode (LED) Lamp Unit**. Install, replace, or remove LED optical unit in accordance with Item 682, ~~"Vehicle and Pedestrian Signal Heads";~~ as shown on the plans~~;~~, or as directed.

~~4.23.~~5.25. **Spread Spectrum Radio Antennas**. Replace, repair, or install spread spectrum radio antenna in accordance with Special Specification, "Spread Spectrum Radios for Traffic Signals"; as shown on the ~~plan~~plans; or as directed.

~~4.24.~~5.26. **Video Imaging Vehicle Detection System (VIVDS)**. Install, repair, replace, remove, or modify VIVDS in accordance with Special Specification, "Video Imaging Vehicle Detection System~~,"",~~, as shown on the plans~~,~~; or as directed.

5.27. **Controller Base**. Replace breakaway controller base in accordance with Standard Sheet TS-CF, as shown on the plans, or as directed.

5.28. **Battery Backup (BBU) System**. Install, replace, or remove BBU system in conformance with vendor specifications, as shown on the plans, or as directed.

5.29. **Vehicle Signal Tunnel Visor (12-in.)**. Remove existing traffic signal visor from the signal head and replace it with a new visor at the locations shown on the plans.

5.30. **Duct Cable**. Install, remove, or replace duct cable in accordance with Special Specification, "Duct Cable."

5.31. **Conduit or Duct Cable Repair and Conductor Splices**. Notify the Engineer when an underground break in duct cable or conduit must be located or if a short in a conductor must be located.

Expose the break or short, install the ground box, repair the conduit or duct cable, perform the electrical splices, and backfill. Backfill in accordance with Item 400. New ground boxes will be paid for under "Install Ground Box."

When a ground box is not needed, expose the break or short, repair conduit or duct cable, remove damaged conductors, and install new conductors. Replace up to 3 ft. of conduit when repairing duct cable, regardless of the number of conduits in trench. Only one repair will be considered for payment per trench. If more than 3 ft. of conduit or duct cable needs to be replaced, the additional will be paid for under "Replace Underground Conduit" or "Replace Duct Cable." Replacement of conductors will be paid for under "Install or Replace Conductor." Backfill in accordance with Item 400.

An electrical splice will include the replacement of up to 3 ft. of conductor, regardless of the number of conductors in the conduit. Only one splice will be considered for payment per conduit. If more than 3 ft. of conductor needs to be replaced, the additional will be paid for under "Install or Replace Conductor."

Above-ground conduit repairs performed in conjunction with a bid item will be subsidiary to the pertinent bid item. Above-ground conduit repairs not performed in conjunction with a bid item will include the replacement of up to 3 ft. of conduit per repair. If more than 3 ft. of conduit must be replaced, the additional will be paid for under "Replace Above-Ground Conduit."

5.32. **Bore Operations**. Place underground wiring under roadways by boring in accordance with Item 476. Bore at least 60 in. below the roadway surface (and at least 36 in. below the ditch flowline) and extend 10 ft. outside the edge of the roadway or as directed. Placement of conduit for the length of the bore will be subsidiary to this bid item. Electrical conductors will be paid for under the bid item "Install or Replace Conductor."

5.33. **Roadway Illumination Assembly**. Install, remove, or replace roadway illumination assemblies, including the base, pole, luminaire arms, luminaire, and required wiring.

5.34. **Underpass Luminaire**. Install, remove, or replace underpass luminaires, including the luminaire, junction box, mounting hardware, and required wiring.

5.35. **Induction Fluorescent Fixture**. Install, remove, or replace induction fluorescent fixture.

5.36. **Luminaire**. Install, remove, or replace luminaire.

5.37. **High Mast Luminaires**. Replace high mast luminaires.

5.38. **Luminaire Arms**. Replace luminaire arms.

5.39. **Maintenance of Roadway Illumination**. Maintain roadway illumination assemblies, including replacement of lamps, fuses, fuse holder, starting aid, photocells, ballasts, and other work required to keep lights operational. Relevel the fixture. Clean the reflector and inside and outside of lens using an approved cleaning solution.

5.40. **Maintenance of High Mast Illumination**. Maintain high mast illumination assemblies, including lowering the ring assembly and the replacement of lamps, fuses, fuse holder, starting aid, photocells, ballasts, and other work required to keep lights operational. Re-aim the lights and clean the lenses and reflectors as directed. Clean the reflector and inside and outside of lens using an approved cleaning solution. Maintain mechanical and electrical equipment as directed.

5.41. **Maintenance of Overhead Sign Lighting**. Maintain overhead sign lighting for large signs mounted over the roadway, including replacing the ballast, lamps, fuses, and lamp sockets to properly restore the lighting to satisfactory operation. Install as shown on the plans or as directed. Clean the reflector and inside and outside of lens using an approved cleaning solution.

5.42. **Maintenance of Underpass Fixtures**. Maintain high-pressure sodium vapor (HPS) underpass fixtures, including the replacement of lamps, fuses, fuse holder, starting aid, photocells, ballasts, and other work required to keep lights operational. Relevel the fixture. Clean the reflector and inside and outside of lens using an approved cleaning solution.

5.43. **Maintenance of Induction Fluorescent Fixtures**. Maintain induction fluorescent fixtures, including the replacement of lamps, fuses, fuse holder, starting aid, photocells, ballasts, and other work required to keep lights operational. Relevel the fixture. Clean the reflector and inside and outside of lens using an approved cleaning solution.

5.44. **Scheduled Preventive Maintenance of Roadway Illumination Assembly**. Inspect and perform the following listed items in accordance with the schedule provided by the Engineer.

- Inspect and maintain all foundation anchor bolts, nuts, and washers.
- Prepare and touch up rust spots using cold galvanizing spray.
- Replace lamp and clean fixtures as directed.
- Replace ballast as directed.
- Level fixture.
- Inspect electrical system.
- Repair shorts or open circuits.

5.45. **Scheduled Preventive Maintenance of High Mast Assembly**. Complete and sign *Luminaire Preventive Maintenance for High Mast Lighting* reports. Fill out forms legibly and completely. List all materials used at each location.

Inspect and perform the following listed items in accordance with the schedule provided by the Engineer.

- Inspect and fill gearbox lubrication reservoir.
- Lubricate grease fittings.
- Adjust brake mechanism to proper torque.
- Inspect cable drum.
- Inspect all wire rope and cables for deterioration or wear.
- Inspect safety lanyard.
- Lower ring and inspect mechanism.
- Inspect all foundation anchor bolts, nuts, and washers.
- Inspect welds around baseplate and ground sleeve for visible cracks.
- Prepare and touch-up rust spots using cold galvanizing spray.
- Replace lamps and clean fixtures as directed.
- Replace ballasts as directed.
- Replace aviation warning (obstruction) lamps as directed.
- Inspect electrical system.
- Repair short or open circuits as directed.
- Raise ring to proper position.

5.46. **Replace Service Pole**. Replace service poles by removing the existing service pole; installing the new pole and related electrical service equipment; installing conduit, including the elbow below ground for underground service feed or the weatherhead for overhead service feed; and connecting and installing electrical service. Install in accordance with Item 628.

5.47. **Replace Transformer Base**. Replace transformer base as shown on the plans or as directed. The removal of the pole, mast arm, and luminaire for replacement of the transformer base only will be subsidiary to the pertinent bid items.

5.48. **Replace Transformer Base Cover**. Replace damaged or missing covers on existing transformer bases.

5.49. **Replace Hand Hole Cover**. Replace damaged or missing covers on existing illumination poles.

5.50. **Install Ground Rod**. The installation of ground rods will include running a properly sized copper grounding conductor to the ground connection.

5.51. **Replace Ballast**. Replace ballast for pole-mounted, underpass, sign, and wall pack fixtures as shown on the plans or as directed.

5.52. **Replace Ballast (High Mast Lighting)**. Replace ballast for high mast fixtures.

5.53. **Install or Replace Fused Disconnect**. Install or replace fused disconnect.

5.54. **Replace Lamp Socket**. Replace lamp socket for pole-mounted, underpass, high mast, and wall pack fixtures.

5.55. **Replace Lamp**. Replace lamps for pole-mounted, underpass, sign, and wall pack fixtures. Clean the reflector and inside and outside of lens using an approved cleaning solution.

5.56. **Replace Lamp (High Mast Lighting)**. Replace lamp for individual high mast fixtures. Clean the reflector and inside and outside of lens using an approved cleaning solution.

5.57. **Replace Wall Pack Luminaires**. Replace wall pack luminaires on structures, rest areas, maintenance warehouses, and other facilities.

5.58. **Replace Lens**. Replace pole-mounted, underpass, sign, wall pack, or high mast luminaire lenses.

5.59. **Replace Wall Pack Guard**. Replace wall pack guard.

5.60. **Replace Fuses**. Replace fuses for pole-mounted, underpass, sign, and wall pack fixtures, and fused disconnects.

5.61. **Replace Fuse Holders**. Replace fuse holder for pole-mounted, underpass, sign, and wall pack fixtures.

5.62. **Replace Breakaway Fuse Holders**. Replace breakaway fuse.

5.63. **Replace Starting Aid**. Replace starting aid for pole-mounted, underpass, sign, and wall pack fixtures.

5.64. **Replace Photocells and Brackets**. Replace photocells and brackets.

5.65. **Replace Control Transformer**. Replace the control transformer.

5.66. **Replace Control Circuit**. Replace the control circuit.

5.67. **Replace Aviation Warning Fixtures**. Replace the aviation warning (obstruction) fixtures.

5.68. **Replace Aviation Warning Lamp**. Replace the aviation warning (obstruction) fixture lamp.

5.69. **Replace Hand-Off-Auto Switch**. Replace three-position hand-off-auto control switch.

5.70. **Replace Contactor**. Replace electromagnetic contactors.

5.71. **Replace Meter Bases**. Replace meter bases in conformance with electrical service provider's requirements.

5.72. **Replace Time Clocks**. Replace time clocks.

5.73. **Replace Breaker Panel**. Replace breaker panel.

5.74. **Install or Replace Circuit Breaker**. Install or replace circuit breakers.

5.75. **Replace Flexible Power Cable or Cord**. Replace flexible power cable or cord.

5.76. **Replace Twist Lock Connectors**. Replace twist lock connectors.

5.77. **Replace Safety Lanyard**. Replace safety lanyard.

5.78. **Raise and Lower Ring (High Mast Lighting)**. Raise and lower ring to perform various maintenance and repair items.

5.79. **Restrap Existing Conduit**. Restrap existing conduit as shown on the plans or as directed.

5.80. **Replace Missing Nuts, Washers, and Other Hardware**. Replace missing nuts, washers, and other miscellaneous hardware.

5.81. **Troubleshoot for Repairs**. Troubleshoot location as directed to identify work needed for repairs.

5.82. **Project Inspections**. Inspect and review the project to determine whether any items need repair and provide the Engineer with a list of these items. Make repairs to those items as approved. All repairs will be paid for under their respective pay items.

5.83. **Install or Replace Safety Switch**. Install or replace safety switch.

5.84. **Replace 5/16-in. Wire Rope**. Replace 5/16-in. wire rope with swaged terminals.

5.85. **Replace 3/8-in. Wire Rope**. Replace 3/8-in. wire rope with swaged terminals.

5.86. **Replace High Mast Winch**. Replace high mast winch.

5.87. **Replace Wire Rope Pulley**. Replace wire rope pulley.

5.88. **Replace Electrical Cable Pulley**. Replace electrical cable pulley.

5.89. **Install or Replace Access Hole Cover**. Replace damaged or missing access covers on existing high mast poles.

5.90. **Replace High Mast Springs**. Replace high mast spring set.

5.91. **Remove and Reinstall High Mast Pole for Repairs**. Remove and reinstall high mast pole from the foundation to perform any repairs to internal components.

5.92. **Remove, Replace, or Install Pedestrian Rail**. Remove, replace, or install pedestrian rail as shown on the plans, or as directed.

5.93. **Remove, Replace, or Install Cabinet Lock**. Remove, replace, or install cabinet lock as shown on the plans, or as directed.

5.94. **Remove, Replace, or Install Anti-Graffiti Coating**. Remove, replace, or install anti-graffiti coating as shown on the plans, or as directed.

5.95. **Remove, Replace, or Install Sunshield**. Remove, replace, or install sunshield as shown on the plans, or as directed.

5.96. **Remove, Replace, or Install Preemption System**. Remove, replace, or install preemption system as shown on the plans, or as directed.

5.97. **Remove, Replace, or Install Network Rack Assembly**. Remove, replace, or install network rack assembly as shown on the plans, or as directed.

5.98. **Remove, Replace, or Install Fiber Housing**. Remove, replace, or install fiber housing as shown on the plans, or as directed.

5.99. **Replace Traffic Signal Controller**. Replace traffic signal controller as shown on the plans, or as directed.

5.100. **Replace Malfunction Management Unit**. Replace malfunction management unit as shown on the plans, or as directed.

5.101. **Complete Preventive Maintenance**. Complete preventive maintenance as shown on the plans, or as directed.

~~5.~~6. MEASUREMENT

Measurement will be as follows~~:~~.

~~5.1.~~6.1. ~~**Removal of**~~ **Conduit**. By the foot of conduit installed, removed, or replaced, including the installation of all hardware necessary to attach and connect the conduit, and any excavation, backfill, and compaction.

- ~~**Installation of**~~ "Install Above-Ground Conduit ~~**by Trenching.**~~"
- "Remove Above-Ground Conduit"
- "Replace Above-Ground Conduit"
- "Install Underground Conduit"
- "Remove Underground Conduit"
- "Replace Underground Conduit"

6.2. **Cable**. By the foot of electrical conductor or cable installed, removed, replaced, or rerouted.

- "Install Cable"
- "Remove Cable"
- "Replace Cable"
- "Reroute Cable"

6.3. **Duct Cable**. By the foot of ~~the trench containing~~duct cable installed, removed, or replaced, including excavation, backfill, and compaction.

- "Install Duct Cable"
- "Remove Duct Cable"

- "Replace Duct Cable"

6.4. **Conduit or Duct Cable Repair and Conductor Splices**.

- **"Install Electrical Splice."** By each electrical splice installed per conduit~~, regardless~~.
- **"Repair Above-Ground Conduit."** By each conduit location repaired, including installation of ~~the size~~all hardware necessary to attach and connect the conduit.
- **"Repair Underground Conduit."** By each conduit location repaired, including excavation, placement of conduit, backfill, and compaction.
- ~~**Installation**~~**"Repair Underground Duct Cable."** By each duct cable location repaired, including excavation, placement of ~~**Conduit by Jacking or Boring**~~duct cable, backfill, and compaction.

6.5. **Road Bore**. By the foot of road bore~~ made. Pits~~, including conduit installed.

6.6. **Install, Remove, or Replace Roadway Illumination Assembly**. By each assembly installed, removed, or replaced. This item includes all wiring and hardware connections above the foundation.

- "Install Roadway Illumination Assembly (LED)"
- "Remove Roadway Illumination Assembly (LED)"
- "Replace Roadway Illumination Assembly (LED)"

6.7. **Install, Remove, or Replace Underpass Luminaire**. By each luminaire installed, removed, or replaced.

- "Install Underpass Luminaire (HPS)"
- "Remove Underpass Luminaire (HPS)"
- "Replace Underpass Luminaire (HPS)"
- "Install Underpass Luminaire (LED)"
- "Remove Underpass Luminaire (LED)"
- "Replace Underpass Luminaire (LED)"

6.8. **Install, Remove, or Replace Induction Fluorescent Fixture**. By each fixture installed, removed, or replaced.

- "Install Induction Fluorescent Fixture"
- "Remove Induction Fluorescent Fixture"
- "Replace Induction Fluorescent Fixture"

6.9. **Install, Remove, or Replace Luminaire**. By each luminaire installed, removed, or replaced.

6.10. **Install, Remove, or Replace High Mast Luminaire**. By each high mast luminaire installed, removed, or replaced.

6.11. **Install, Remove, or Replace Luminaire Pole**. By each pole installed, removed, or replaced.

6.12. **Install, Remove, or Replace Luminaire Arm**. By each luminaire arm installed, removed, or replaced.

6.13. **Maintain Roadway Illumination**. By each luminaire pole maintained.

6.14. **Maintain High Mast Illumination**. By each high mast pole maintained.

6.15. **Maintain Overhead Sign Lighting**. By each sign light maintained.

6.16. **Maintain Underpass Fixture**. By each underpass fixture maintained.

6.17. **Maintain Induction Fluorescent Fixture**. By each induction fluorescent fixture maintained.

6.18. **Scheduled Preventive Maintenance (Roadway Illumination Assembly)**. By each roadway illumination pole. (Replacing lamp and ballast will be subsidiary to this bid item.)

6.19. **Scheduled Preventive Maintenance (High Mast Assembly)**. By each high mast pole regardless of the number of luminaires on the ring. (Replacing lamps and ballast will be subsidiary to this bid item.)

6.20. **Install, Remove, or Replace Electrical Service**. By each electrical service installed, removed, or replaced.

6.21. **Replace Service Pole (Timber, Steel, or Concrete)**. By each service pole replaced.

- "Replace Timber Service Pole"
- "Replace Steel Service Pole"
- "Replace Concrete Service Pole"

6.22. **Install, Remove, or Replace Ground Box**. By each ground box installed.

6.23. **Install Foundation**. By each foundation installed.

6.24. **Remove Foundation**. By each foundation removed.

6.25. **Replace Transformer Base**. By each base replaced.

6.26. **Replace Transformer Base Cover**. By each cover replaced.

6.27. **Replace Hand Hole Cover**. By each cover replaced.

6.28. **Install, Remove, or Replace Ground Rod**. By each ground rod installed, removed, or replaced.

6.29. **Replace Ballast**. By each ballast replaced.

6.30. **Replace Ballast (High Mast Lighting)**. By each high mast ballast replaced.

6.31. **Install or Replace Fused Disconnect**. By each fused disconnect installed or replaced.

~~5.2.~~6.32. **Replace Lamp Socket**. By each lamp socket replaced for ~~jacking or boring are subsidiary to this Item~~pole-mounted, underpass, wall pack, or high mast fixture.

6.33. ~~**Installation of Vehicle Detectors.**~~**Replace Lamp**. By each lamp replaced for pole-mounted, underpass, wall pack, or high mast fixture.

6.34. **Replace Lamp (High Mast Lighting)**. By each lamp replaced.

6.35. **Install, Remove, or Replace Wall Pack Luminaire**. By each wall pack installed, removed, or replaced.

6.36. **Install, Remove, or Replace Lens**. By each lens installed, removed, or replaced.

6.37. **Install, Remove, or Replace Wall Pack Guard**. By each guard installed, removed, or replaced.

6.38. **Replace Fuse**. By each fuse replaced.

6.39. **Replace Fuse Holder**. By each fuse holder replaced.

6.40. **Replace Breakaway Fuse Holder**. By each breakaway fuse holder replaced.

6.41. **Replace Starting Aid**. By each starting aid replaced.

6.42. **Replace Photocell and Bracket**. By each photocell and bracket replaced.

6.43. **Replace Control Transformer**. By each transformer replaced.
- "Replace Control Transformer for High Mast"
- "Replace Control Transformer for Electrical Service"

6.44. **Replace Control Circuit**. By each control circuit replaced.
- "Replace Control Circuit for High Mast"
- "Replace Control Circuit for Electrical Service"

6.45. **Replace Aviation Warning Fixture**. By each obstruction fixture replaced.

6.46. **Replace Aviation Warning Lamp**. By each obstruction lamp replaced.

6.47. **Replace Hand-Off-Auto Switch**. By each hand-off-auto control switch replaced.

6.48. **Replace Contactor**. By each electromagnetic contactor replaced.

6.49. **Replace Meter Base**. By each meter base replaced.

6.50. **Replace Time Clock**. By each time clock replaced.

6.51. **Replace Breaker Panel**. By each breaker panel replaced.

6.52. **Install or Replace Circuit Breaker**. By each circuit breaker installed or replaced.
- "Install Circuit Breaker"
- "Replace Circuit Breaker"

6.53. **Replace Flexible Power Cable or Cord**. By foot of cable or cord replaced.

6.54. **Replace Twist Lock Connector**. By each twist lock connector replaced.

6.55. **Replace Safety Lanyard**. By foot of chain replaced. Associated hardware will be subsidiary to this item.

6.56. **Raise and Lower Ring (High Mast Lighting)**. By each ring raised and lowered (not part of scheduled preventive maintenance).

6.57. **Restrap Existing Conduit**. By each strap installed.

6.58. **Replace Missing Nuts, Washers, and Other Hardware**. By each nut, washer, or miscellaneous hardware replaced.

6.59. **Troubleshoot for Repairs**. By the ~~foot of saw-cut containing detector~~man-hour of troubleshooting.

6.60. **Project Inspections**. By the month.

6.61. **Install or Replace Safety Switch**. By each safety switch installed or replaced.
- "Install Safety Switch"
- "Replace Safety Switch"

6.62. **Replace 5/16-in. Wire Rope**. By each 5/16-in. wire rope with swaged terminals replaced.

6.63. **Replace 3/8-in. Wire Rope**. By each 3/8-in. wire rope with swaged terminals replaced.

6.64. **Replace High Mast Winch**. By each winch replaced.

6.65. **Replace Wire Rope Pulley**. By each wire rope pulley replaced.

6.66. **Replace Electrical Cable Pulley**. By each electrical cable pulley replaced.

6.67. **Install or Replace Access Hole Cover**. By each access cover installed or replaced.

- "Install Access Hole Cover"
- "Replace Access Hole Cover"

6.68. **Replace High Mast Springs**. By each high mast spring set replaced.

~~5.3.~~6.69. **Remove and Reinstall High Mast Pole for Repairs**. By each high mast pole removed and reinstalled.

~~5.4.~~ **Removal, Replacement, or Installation of ~~Ground Boxes~~Cable**. By ~~each box~~the foot of cable removed, replaced, rerouted, or installed in a run, regardless of the ~~type of box. A concrete apron around the box will be considered subsidiary to this Item.~~

~~5.5.~~6.70. ~~**Removal, Replacement, or Installation of Cables**. By the foot of traffic signal cables removed, replaced, or installed, except measurement~~number of conductors per cable. Measurement will not be made for cable inside signal heads and controllers or cable coiled in ground boxes, in pole bases, and on ~~span~~strain wires.

~~5.6.~~6.71. **Installation of Duct Cables**. By the foot of trench containing duct cable.

~~5.7.~~6.72. **Removal, Replacement, or Installation of ~~Cables~~Cable by Messenger ~~Cable~~Strain Wire**. By the foot of aerial cable removed, replaced, or installed, regardless of number of conductors per cable.

~~5.8.~~ **Removal, Replacement, or Installation of ~~Span Cable~~Strain Wire Assembly**. By the foot of ~~span~~strain wire removed, replaced, or installed. ~~A span~~Strain wire quantity is defined as the distance from one pole to the next pole~~.~~

~~5.9.~~6.73. ~~**Replacement or Installation of Electrical Service**. By~~ for each ~~electrical service replaced or installed. The removal of the existing assembly will be considered subsidiary to this Item~~strain wire.

~~5.10.~~6.74. **Removal, Replacement, or Installation of Timber Poles**. By each timber pole removed, replaced, or installed. Attachment of required hardware ~~is~~will be subsidiary to this Item.

~~5.11.~~6.75. **Removal, Replacement, or Installation of Signal Head Assemblies**. By each head removed, replaced, or installed. Assembly and wiring ~~are~~will be subsidiary to this Item.

~~5.12.~~6.76. **Removal, Replacement, or Installation of Signal Related Signs**. By each sign assembly removed, replaced, or installed.

~~5.13.~~6.77. **Removal, Replacement, or Installation of Pedestrian Push Buttons**. By each push button removed, replaced, or installed.

~~5.14.~~6.78. **Removal, Replacement, or Installation of Traffic Signal Pole Foundations**. By the foot~~,~~ of the type of foundation removed, replaced, or installed.

~~5.15.~~6.79. **Installation of Foundations for Ground Mount or Pole Mount Cabinets**. By each foundation installed.

~~5.16.~~6.80. **Removal, Replacement, or Installation of Controller Cabinet, Ground Mount**. By each cabinet removed, replaced, or installed.

~~5.17.~~6.81. **Removal, Replacement, or Installation of Controller Cabinet, Pole Mount**. By each cabinet removed, replaced, or installed.

~~5.18.~~6.82. **Removal, Replacement, or Installation of Flasher Cabinet**. By each cabinet removed, replaced, or installed.

~~5.19.~~6.83. **Installation of Foundations for Roadside Flashing Beacon Assemblies**. By each foundation installed.

~~5.20.~~6.84. **Removal, Replacement, or Installation of Roadside Flashing Beacon Assemblies**. By each assembly removed, replaced, or installed.

~~5.21.~~6.85. **Removal, Replacement, or Installation of Signal Pole Assemblies**. By each assembly~~, according to the type of pole assembly~~ removed, replaced, or installed. Wiring in the pole and hardware ~~is~~will be subsidiary to this Item. The removal of the top of the foundation and steel to at least 2 ft. below grade will be subsidiary to the removal of the pole. Removal of foundation should be paid for only by the foot if a pole is not removed or replaced, or when more than 2 ft. of foundation removal is required when removing or replacing a pole.

~~5.22.~~6.86. **Removal, Replacement, or Installation of Curbs**. By the foot removed, replaced, or installed.

~~5.23.~~6.87. **Removal, Replacement, or Installation of Pedestrian Ramps**. By each ramp removed, replaced, or installed.

~~5.24.~~6.88. **Removal, Replacement, or Installation of Sidewalks**. By the square foot removed, replaced, or installed.

~~5.25.~~6.89. **Removal of Concrete Foundations**. By each foundation removed.

~~5.26. **Removal, Replacement, or Installation of Luminaire Heads**. By each luminaire head removed, replaced, or installed.~~

~~5.27. **Removal, Replacement, or Installation of Luminaire Mast Arms**. By each mast arm removed, replaced, or installed.~~

~~5.28.~~6.90. ~~**Removal, Replacement, or Installation of**~~ **Down Guy with Guard**. By each down guy with guard removed, replaced, or installed.

~~5.29.~~6.91. **Removal, Replacement, or Installation of Down Guy with Guard and Anchor**. By each down guy with guard and anchor removed, replaced, or installed.

~~5.30.~~6.92. **Remove and Salvage Traffic Signals**. By each signalized intersection salvaged. A signalized intersection is a group of traffic signals operated by a single controller.

~~5.31.~~6.93. **Removal, Replacement, or Installation of 12 × 12 × 6-in. PVC Weatherproof Enclosure**. By each PVC weatherproof enclosure removed, replaced, or installed.

~~5.32.~~6.94. **Removal, Replacement, or Installation of LED Lamp Unit**. By each LED lamp unit removed, replaced, or installed.

~~5.33.~~6.95. **Removal, Replacement, or Installation of Spread Spectrum Radio Antennas**. By each radio antenna removed, replaced, or installed.

~~5.34.~~6.96. **Removal, Replacement, or Installation of ~~Video Imaging~~ Vehicle Detection System ~~(VIVDS)~~**. By each ~~camera~~ assembly removed, replaced, or installed. The mounting hardware and detector controller card required to make the system function will be subsidiary to the Item.

6.97. **Removal, Replacement, or Installation of Screw-In Foundation**. By each screw-in foundation removed, replaced, or installed.

6.98. **Replacement of Breakaway Controller Base**. By each breakaway base replaced.

6.99. **Removal, Replacement, or Installation of Battery Backup (BBU) System**. By each BBU system removed, replaced, or installed.

6.100. **Removal, Replacement, or Installation of Detection Cable**. By the linear foot of each cable removed, replaced, or installed. For loop detectors, the saw-cut and grout filler will be subsidiary to the installation.

6.101. **Removal, Replacement, or Installation of Vehicle Signal Tunnel Visor (12-in.)**. By each vehicle signal tunnel visor (12-in.) removed, replaced, or installed.

6.102. **Removal, Replacement, or Installation of Wrapping of Signal Cable**. By the linear foot of wrapped cable removed, replaced, or installed.

6.103. **Removal, Replacement, or Installation of Anti-Graffiti Coating**. By each anti-graffiti coating removed, replaced, or installed.

6.104. **Removal, Replacement, or Installation of Sunshield**. By each sunshield removed, replaced, or installed.

6.105. **Removal, Replacement, or Installation of Preemption System**. By each preemption system removed, replaced, or installed.

6.106. **Removal, Replacement, or Installation of Network Rack Assembly**. By each network rack assembly removed, replaced, or installed.

6.107. **Removal, Replacement, or Installation of Fiber Housing**. By each fiber housing removed, replaced, or installed.

6.108. **Replacement of Traffic Signal Controller**. By each traffic signal controller replaced.

6.109. **Replacement of Malfunction Management Unit**. By each malfunction management unit replaced.

6.110. **Complete Preventive Maintenance**. For each hour to complete preventive maintenance.

~~6.~~7. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit ~~prices~~price bid for the various designations. This price is full compensation for furnishing all materials, equipment, labor, fines, tools, and incidentals. The Department will pay for electrical energy consumed by the traffic signal.

Wiring in the pole; splices; backfill (soil or concrete); sealing of conduit ends and loop detector saw slots; installation of loop wire and PVC for encased loops; protection of utilities; and preservation of sod, shrubbery, and trees will not be measured or paid for directly, but will be subsidiary to pertinent Items.

The required traffic control will be paid for separately as shown on the plans, or as directed.