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INTELLIGENT TRANSPORTATION SYSTEMS

EDWARDS MILL ROAD

DYNAMIC MESSAGE SIGN

PROJECT SPECIAL PROVISIONS

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1. GENERAL REQUIREMENTS

1.1 DESCRIPTION

A. General

Conform to these Project Special Provisions, Project Plans, and the *2012 Standard Specifications for Roads and Structures* (also referred to hereinafter as the “Standard Specifications”). The current edition of these specifications and publications in effect on the date of advertisement will apply.

In the event of a conflict between these Project Special Provisions and the Standard Specifications, these Project Special Provisions govern.

B. Scope

The scope of this project includes the installation of Department furnished DMS and equipment cabinet and integration.

1. DMS-25 (New Location), Edwards Mill Road north of Reedy Creek Road, install Department furnished DMS and equipment cabinet on a new pedestal mount structure with new conduit and cabling system. Install a new meter base/disconnect combination panel on a new wood pole. Install a new equipment cabinet disconnect on the DMS structure. Install new feeder conductors in the new conduit from the new electrical service to the DMS equipment cabinet. Install a new splice enclosure in the existing oversized junction box and route new 12-fiber drop cable through new conduit to the DMS equipment cabinet. Reuse Department furnished interconnect center and fiber optic transceiver. Splice fibers according to the splice details shown in the plans.

Integrate the DMS with the Triangle Regional Transportation Management Center (TRTMC) Traffic Management System (TMS) and conduct device and system tests as described in these Project Special Provisions. The TRTMC is located at 1636 Gold Star Drive, Raleigh, NC 27607.

Construct the project in a manner that minimizes the downtime of the fiber optic network along Edwards Mill Road.

C. Qualified Products

Furnish new equipment, materials, and hardware unless otherwise required. Inscribe manufacturer’s name, model number, serial number, and any additional information needed for proper identification on each piece of equipment housed in a case or housing.

Furnish factory assembled cables without adapters, unless otherwise approved by the Engineer, for all cables required to interconnect any field or central equipment including but not limited to fiber optic transceivers.

Certain equipment listed in these Project Special Provisions must be pre-approved on the Department’s ITS & Signals Qualified Products List (QPL) by the date of installation. Equipment, material, and hardware not pre-approved when required will not be allowed for use on the project.

The QPL is available on the Department’s website. The QPL website is:

<http://www.ncdot.org/doh/preconstruct/traffic/ITSS/SMS/qpl/>

2. MOBILIZATION

2.1 DESCRIPTION

This work consists of preparatory work and operations, including but not limited to the movement of personnel, equipment, supplies, and incidentals to the project site, for the establishment of offices, buildings, and other facilities necessary for work on the project; the removal and disbandment of those personnel, equipment, supplies, incidentals, or other facilities that were established for the prosecution of work on the project; and for all other work and operations which must be performed for costs incurred prior to beginning work on the various items on the project site.

2.2 MEASUREMENT AND PAYMENT

Mobilization will be measured and paid for at the contract lump sum price for Mobilization.

Partial payments for the item of "Mobilization" will be made with the first and second partial pay estimates paid on the contract, and will be made at the rate of 50% lump sum price for "Mobilization" on each of these partial pay estimates, less than the retainage provided for in Article 109-4 of the Standard Specifications, provided the amount bid for "Mobilization" does not exceed 5 percent of the total amount bid for the contract. Where the amount bid for the item of "Mobilization" exceeds 5 percent of the total amount bid for the contract, 2 ½ percent of the total amount bid will be paid on each of the first two partial pay estimates, and the portion exceeding 5 percent will be paid on the last partial pay estimate. All such payments will be made less the retainage provided for in Article 109-4 of the Standard Specifications.

Payment will be made under:

Pay Item	Pay Unit
Mobilization.....	Lump Sum

3. INSTALL DEPARTMENT FURNISHED DMS AND EQUIPMENT CABINET

3.1 DESCRIPTION

Install Department furnished DMS and equipment cabinet on a new pedestal mount structure with new conduit and cabling system as shown in the Plans and as described in these Project Special Provisions. The Department furnished DMS and equipment cabinet is stored at 200 Roscoe Trail, Raleigh, NC. Once the new structure is installed, transport the Department furnished DMS and equipment cabinet to the site for installation. Notify the Regional ITS Engineer at (919) 233-9331 a minimum of 7 days before performing any work at the DMS location.

Furnish and install all necessary cabling, conduit, and terminal blocks to connect the DMS and the equipment cabinet. Use approved manufacturer's specifications for cable types and sizes. Furnish and install new electrical cables between the DMS and equipment cabinet. Furnish and install new fiber optic cable to interconnect the DMS and the equipment cabinet. Use existing fiber optic interconnect centers in the sign enclosure and equipment cabinet to terminate the fiber optic cable.

A. Conduit

Install the conduit system in accordance with section 1091 of Standard Specification and NEC requirements for an approved watertight raceway.

Make bends in the conduit so as not to damage it or change its internal diameter. Install watertight and continuous conduit with as few couplings as standard lengths permit.

Clean conduit before, during, and after installation. Install conduit in such a manner that temperature changes will not cause elongation or contraction that might damage the system.

Attach the conduit system to and install along the structural components of the DMS structure assemblies with beam clamps or stainless steel strapping. Install strapping according to the strapping manufacturer's recommendations. Do not use welding or drilling to fasten conduit to structural components. Space the fasteners at no more than 4 feet for conduit 1.5 inches and larger or 6 feet for conduit smaller than 1.25 inches. Place fasteners no more than 3 feet from the center of bends, fittings, boxes, switches, and devices.

Flexible conduit will only be allowed when the conduits transition from the horizontal structure segment to the horizontal truss segment and from the horizontal truss segment to the rear entrance of the DMS when installing the DMS communications and feeder cables. The maximum length of flexible conduit allowed at each transition will be 5 feet.

Do not exceed the appropriate fill ratio on all cable installed in conduit as specified in the NEC.

B. Wiring Methods

Do not pull permanent wire through a conduit system until the system is complete and has been cleaned.

Color-code all conductors per the NEC. Use approved marking tape, paint, sleeves or continuous colored conductors for No.8 AWG and larger. Do not mark a white conductor in a cable assemblies any other color.

C. Equipment and Cabinet Mounting

Convert the Department furnished base mounted equipment cabinet to a pole mounted equipment cabinet and install on the new pedestal mount DMS structure. Use an aluminum sheet, type 6061-T6, 5052-H38, 5052-H34, at least 1/8-inch thick to convert the Department furnish DMS equipment cabinet to a pole mounted cabinet. Seal the bottom of the cabinet to the fabricated aluminum plate to form a watertight seal.

Install fasteners as recommended by the manufacturer and space them evenly. Use all mounting holes and attachment points for attaching DMS enclosures and equipment cabinet to the structure.

Provide all mounting plates, mounting bolts, and any other necessary mounting hardware in accordance with these Project Special Provisions and the Plans.

Seal all conduits installed in cabinets at both ends to prevent water and dirt from entering the conduit and cabinet with approved sealing material.

Install ground bushings inside the cabinet on all metal conduits entering the cabinet. Connect these ground bushings to the cabinet ground bus.

3.2 CONSTRUCTION

A. General

Perform the work required by this section in accordance with the Standard Specifications for Roads and Structures. Install the Department furnished DMS and equipment cabinet as shown in the Plans. Convert the Department furnished base mounted equipment cabinet to a pole mounted equipment cabinet and install on the new DMS structure.

B. Wiring Methods

Do not pull permanent wire through a conduit system until the system is complete and has been cleaned.

Color-code all conductors per the NEC. Use approved marking tape, paint, sleeves or continuous colored conductors for No.8 AWG and larger. Do not mark a white conductor in a cable assemblies any other color.

C. Equipment and Cabinet Mounting

Install fasteners as recommended by the manufacturer and space them evenly. Use all mounting holes and attachment points for attaching DMS enclosure and controller cabinet to the structure.

Provide all mounting plates, mounting bolts, and any other necessary mounting hardware in accordance with these Project Special Provisions and the Plans.

Seal all conduits to prevent water and dirt from entering the conduits with approved sealing material.

Install ground bushings on all metal conduits. Connect these ground bushings to the cabinet ground bus.

3.3 MEASUREMENT AND PAYMENT

Install Department Furnished DMS and Equipment Cabinet will be measured and paid as the actual number of Department Furnished DMSs and Equipment Cabinets installed. Installation of the Department Furnished DMS and Equipment Cabinet including transporting from 200 Roscoe Trail (Raleigh, NC), all mounting hardware, converting from base mounted to pole mounted equipment cabinet, conduits, risers, conduit bodies, stainless steel straps, new electrical cables between the DMS and equipment cabinet, new fiber optic cable to interconnect the DMS and the equipment cabinet, field wiring, cabling, connectors, tools, materials, all related testing, cost of labor, cost of transportation, incidentals and all other equipment necessary to install and make the Department furnished DMS and equipment cabinet operational will be considered incidental to Install Department Furnished DMS and Equipment Cabinet.

Payment will be made under:

Pay Item	Pay Unit
Install Department Furnished DMS and Equipment Cabinet	Each

4. CONDUIT

4.1 DESCRIPTION

Install underground and above ground conduit at locations shown in the Plans. Install conduit for underground installation with tracer wire at locations shown in the Plans. Comply with Sections 1098-5 and 1715 of the Standard Specifications.

4.2 MATERIAL

Furnish underground PVC, HDPE, and tracer wire as shown in the Plans. All vertical conduits (entrance to electrical service and equipment disconnect and pole mounted cabinet) must be rigid galvanized steel. Furnish rigid hot dipped galvanized steel conduit as shown in the Plans.

4.3 CONSTRUCTION METHODS

Comply with Section 1715-3 of the Standard Specifications. Use adapters and rigid galvanized steel sweeping elbows to transition from PVC conduit to rigid conduit. When installing fiber optic cable in conduit, furnish tracer wire in accordance with Section 1715-3 of the Standard Specifications.

4.4 MEASUREMENT AND PAYMENT

Unpaved trenching (qty) (size) will be measured horizontal linear feet of trenching for underground conduit installation of each type furnished, installed, and accepted. Measurement will be along the approximate centerline of the conduit system. Payment will be in linear feet.

Directional Drill (qty) (size) will be measured horizontal linear feet of directional drill for underground conduit installation furnished, installed and accepted. Measurement will be the approximate centerline of the conduit system. Payment will be in linear feet.

No measurement will be made of vertical segments, metallic conduit, conduit adapters, conduit bodies, sweeping elbows, conduit couplings, stainless steel banding straps, sealing devices, backfill, graded stone, paved materials, miscellaneous fittings, pull lines, seeding and mulching as these will be considered incidental to conduit installation.

Rigid Galvanized Conduit (qty) (size) will be measured in linear feet linear feet of rigid galvanized furnished, installed, and accepted. Measurement will be along the approximate centerline of the conduit system.

No measurement will be made of conduit adapters, conduit bodies, sweeping elbows, conduit couplings, stainless steel banding straps, sealing devices, backfill, graded stone, paved materials, miscellaneous fittings, pull lines, seeding and mulching as these will be considered incidental to conduit installation.

Tracer Wire will be measured along the horizontal linear feet of tracer wire furnished, installed, and accepted. Measurement will be made along the approximate centerline of the conduit system. Payment will be in linear feet. No payment will be made for excess tracer wire in junction boxes and/or cabinets.

Payment will be made under:

Pay Item	Pay Unit
Unpaved Trenching (2) (2").....	Linear Foot
Directional Drill (1) (2")	Linear Foot
Directional Drill (2) (2")	Linear Foot
Rigid Galvanized Conduit (2) (2")	Linear Foot
Tracer Wire	Linear Foot

5. JUNCTION BOXES

5.1 DESCRIPTION

Furnish and install junction boxes (pull boxes) with covers, graded stone, grounding systems, and all necessary hardware. Comply with Section 1716 of the Standard Specifications.

5.2 MATERIAL

Material, equipment, and hardware furnished under this section shall be pre-approved on the Department's QPL.

Refer to Article 1098-5 Junction Boxes and Section 545 Incidental Stone Base.

5.3 CONSTRUCTION METHODS

Comply with Article 1411-3 Electrical Junction Boxes, except as follows:

Install junction boxes flush with finished grade. Do not install sealant compound between junction boxes and covers.

Install junction boxes where underground splicing of cable is necessary and where transitioning from below ground to above ground installation or vice-versa.

5.4 MEASUREMENT AND PAYMENT

Junction Box () will be measured and paid in actual number of junction boxes of each size and type furnished, installed, and accepted.

No measurement will be made of covers, graded stone, and grounding systems as these will be considered incidental to furnishing and installing junction boxes.

Payment will be made under:

Pay Item	Pay Unit
Junction Box (Oversized)	Each
Junction Box (Standard Size).....	Each

6. ELECTRICAL SERVICE

6.1 DESCRIPTION

Install new electrical service equipment as shown in the Plans. Comply with the National Electrical Code (NEC), the National Electrical Safety Code (NESC), the Standard Specifications, the Project Special Provisions, and all local ordinances. All work involving electrical service shall be coordinated with the appropriate utility company and the Engineer.

6.2 MATERIAL

A. Meter Base/Disconnect Combination Panel

Furnish and install a new meter base/disconnect combination panel at the location shown in the Plans. Provide a meter base/disconnect combination panel that has a minimum of eight (8) spaces in the disconnect. Furnish a meter base/disconnect combination panel with lightning arresters and double pole 50 amp circuit breakers. Furnish the new meter base/disconnect combination panels with a minimum of 10,000 RMS symmetrical amperes short circuit current rating in a lockable NEMA 3R enclosure. Ensure meter base/ disconnect combination panel is listed as meeting UL Standard UL-67 and marked as being suitable for use as service equipment. Fabricate enclosure from galvanized steel and electrostatically apply dry powder paint finish, light gray in color, to yield a minimum thickness of 2.4 mils. All exterior surfaces must be powder coated steel. Provide ground bus and neutral bus with a minimum of four terminals and a minimum wire capacity range of number 8 through number 2 AWG.

Furnish NEMA Type 3R combinational panel rated 125 amp minimum that meets the requirements of the local utility. Provide meter base with sockets' ampere rating based on sockets being wired with a minimum of 167 degrees F insulated wire. Furnish 4 terminal, 600 volt, single phase, 3-wire meter bases that comply with the following:

- Line, Load, and Neutral Terminals accept 4/0 AWG and smaller Copper/Aluminum wire
- With or without horn bypass
- Made of galvanized steel
- Listed as meeting UL Standard US-414
- Overhead service entrance specified.

At the main service disconnect, furnish and install UL-approved lightning arresters that meet the following requirements:

Type of design	Silicon Oxide Varistor
Voltage	120/240 Single phase, 3 wires
Maximum current	100,000 amps
Maximum energy	3000 joules per pole
Maximum number of surges	Unlimited
Response time one milliamp test	5 nanoseconds
Response time to clamp 10,000 amps	10 nanoseconds
Response time to clamp 50,000 amps	25 nanoseconds
Leak current at double the rated voltage	None
Ground Wire	Separate

B. Equipment Cabinet Disconnect

Furnish and install a new 50 amp electrical disconnect with one (1) double pole 50 amp circuit breaker at the locations shown in the Plans. Provide equipment cabinet disconnects that have a minimum of eight (8) spaces and a minimum of 10,000 RMS symmetrical amperes short circuit current rating in a lockable NEMA 3R enclosure. Ensure disconnects are listed as meeting UL Standard UL-489 and marked as being suitable for use as service disconnects. Fabricate enclosure from galvanized steel and electrostatically apply dry powder paint finish, light gray in color, to yield a minimum thickness of 2.4 mils. All exterior surfaces must be powder coated steel. Provide ground bus and neutral bus with a minimum of four terminals and a minimum wire capacity range of number 8 through number 2 AWG.

C. 3-Wire Copper Service Conductors

Furnish 3-wire stranded copper service conductors with THWN rating for supplying power to the new meter base/disconnect combination panel. Provide conductors with black, red, and white insulation that are intended for power circuits at 600 Volts or less and comply with the following:

- Listed as meeting UL Standard UL-83
- Meets ASTM B-3 and B-8 or B-787 standards.

See the Plans for wire sizes.

D. 4-Wire Copper Feeder Conductors

Furnish 4-wire stranded copper feeder conductors with THWN rating for supplying power to DMS field equipment cabinets. Provide conductors with black, red, white, and green insulation that are intended for power circuits at 600 Volts or less and comply with the following:

- Listed as meeting UL Standard UL-83

- Meets ASTM B-3 and B-8 or B-787 standards.

See the Plans for wire sizes and quantities.

E. Grounding System

Furnish 5/8"x10' copper clad steel grounding electrodes (ground rods), #4 AWG solid bare copper conductors, and exothermic welding kits for grounding system installations. Comply with the NEC, Standard Specifications, these Project Special Provisions, and the Plans.

6.3 CONSTRUCTION METHODS

Permanently label cables at all access points using nylon tags labeled with permanent ink. Ensure each cable has a unique identifier. Label cables immediately upon installation. Use component name and labeling scheme approved by the Engineer.

A. Meter Base/Combination Disconnect Panel

Install meter base/disconnect combination panels with lightning arresters as called for in the Plans. Route the feeder conductors from the meter base/disconnect to the DMS equipment cabinet in conduit. Provide rigid galvanized conduit for above ground and PVC or HDPE for below ground installations.

B. Equipment Cabinet Disconnect

Install equipment cabinet disconnects as called for in the Plans. Install circuit breakers as shown in the Plans. Install THWN stranded copper feeder conductors as shown in the Plans between the electrical service disconnect and the DMS equipment cabinet disconnect. Route the conductors from the equipment cabinet disconnect to the DMS equipment cabinet in rigid galvanized steel conduit. Bond the electrical service disconnects in accordance with the NEC. Ensure that the grounding system complies with the grounding requirements of these Project Special Provisions, the Standard Specifications and the Plans.

A. 3-Wire Copper Service Conductors

Furnish and install 3-wire THWN stranded copper service entrance conductors in rigid galvanized riser with weather head from the meter base/disconnect combination panel extending three (3) feet from the top to the riser with weather head. Install a waterproof hub on top of the meter base/disconnect combo panel for riser entrance/exit. Size the conductors as specified in the Plans. Comply with the Standard Specifications and Standard Drawings and all applicable electrical codes.

B. 4-Wire Copper Feeder Conductors

At locations shown in the Plans, install 4-wire THWN stranded copper feeder conductors to supply 240/120 VAC to the DMS field equipment cabinet. Size the conductors as specified in the Plans. Comply with the Standard Specifications and Standard Drawings and all applicable electrical codes.

C. Grounding System

Install ground rods as indicated in the Plans. Connect the #4 AWG grounding conductor to ground rods using an exothermic welding process. Test the system to ensure a ground resistance of

20-ohms or less is achieved. Drive additional ground rods as necessary or as directed by the Engineer to achieve the proper ground resistance.

6.4 MEASUREMENT AND PAYMENT

Meter base/disconnect combination panel will be measured and paid as the actual number of complete and functional meter base/disconnect combination panel service locations furnished, installed and accepted. Breakers, exposed vertical conduit runs to the cabinet, risers, hardware, fittings, and conduit bodies to connect the electrical service to the cabinet will be considered incidental to meter base/disconnect combination panels. All other required feeder conductors will be paid for separately.

Equipment cabinet disconnect will be measured and paid as the actual number of complete and functional equipment cabinet disconnects furnished, installed and accepted. Breakers, exposed vertical conduit runs to the cabinet, ground wire and any remaining hardware and conduit to connect the equipment cabinet disconnect to the cabinet will be considered incidental to the equipment cabinet disconnect.

3-Wire copper service conductors will be incidental to furnishing and installing the meter base/disconnect combination panel.

4-Wire copper feeder conductors will be measured and paid as the actual linear feet of 4-wire THWN stranded copper feeder conductors furnished, installed and accepted. Payment is for all four conductors. Measurement will be for the actual linear footage of combined conductors after all terminations are complete. No separate payment will be made for each individual conductor. No separate payment will be made for different wire sizes. No payment will be made for excess wire in the cabinets.

5/8" X 10' grounding electrode (ground rod) will be measured and paid as the actual number of 5/8" copper clad steel ground rods furnished, installed and accepted. No separate payment will be made for exothermic welding kit as they will be considered incidental to the installation of the ground rod.

#4 solid bare grounding conductor will be measured and paid as the actual linear feet of #4 AWG solid bare copper grounding conductor furnished, installed and accepted. Measurement will be along the approximate centerline from the base of the electrical service disconnect to the last grounding electrode.

Payment will be made under:

Pay Item	Pay Unit
Meter Base/ Disconnect Combination Panel	Each
Equipment Cabinet Disconnect.....	Each
4-Wire Copper Feeder Conductors	Linear Foot
5/8"X10' Grounding Electrode.....	Each
#4 Solid Bare Copper Grounding Conductor.....	Linear Foot

7. WOOD POLES

7.1 DESCRIPTION

Furnish and install wood poles with grounding systems and all necessary hardware in accordance with Section 1720 of the Standard Specifications.

7.2 MATERIAL

Furnish 40' Class 3 or better wood poles for mounting electrical service equipment as shown in the Plans.

Material, equipment, and hardware furnished under this section shall be pre-approved on the Department's QPL. Refer to Subarticles 1082-3(F) Treated Timber and Lumber – Poles and 1082-4(G) Preservative Treatment – Poles.

7.3 Construction Methods

Mark final pole locations and receive approval from the Engineer before installing poles. Comply with all requirements of Section 1720-3 of the Standard Specifications.

7.4 Measurement And Payment

Wood Pole will be measured and paid as the actual number of 40' wood poles furnished, installed, and accepted.

No measurement will be made for installing grounding systems as these will be incidental to furnishing and installing wood poles.

Payment will be made under:

Pay Item

Wood Pole.....Each

8. RISER ASSEMBLIES

8.1 DESCRIPTION

Furnish and install riser assemblies with clamp-on, aluminum weatherheads, galvanized pole attachment fittings, and all necessary hardware in accordance with Section 1722 of the Standard Specifications.

8.2 MATERIAL

Material, equipment, and hardware furnished under this section shall be pre-approved on the Department's QPL. Provide rigid metallic conduit for risers. Refer to Subarticle 1098-4(B)(1) Rigid Metallic Conduit.

8.3 Construction Methods

Install risers with required weatherheads on poles using pole attachment fittings. Comply with all requirements of Section 1722-3 of the Standard Specifications.

8.4 Measurement And Payment

___ " Riser with _____ will be measured and paid as the actual number of risers of each type and size furnished, installed, and accepted. No measurement will be made of weatherheads or pole attachment fittings as these will be considered incidental to furnishing and installing risers.

Payment will be made under:

Pay Item

1 ½" Riser with WeatherheadEach

9. FIBER OPTIC COMMUNICATIONS AND EQUIPMENT

9.1 DESCRIPTION

Furnish and install 12-fiber, fiber optic drop cable at DMS-25 to provide a communications link over the existing fiber optic communications network. Install Department furnished interconnect center and fiber optic transceiver. Install a new splice enclosure in an existing oversized junction box.

9.2 MATERIAL

Material, equipment, and hardware furnished under this section shall be pre-approved on the Department's QPL.

A. Drop Cable

Furnish new 12-fiber, single-mode, drop-cable and fusion splice to the mainline fiber optic communication's system along Edwards Mill Road at DMS-25. Comply with Section 1098-10 of the Standard Specifications.

B. Splice Enclosure

Furnish and install a new fiber optic splice enclosure inside an existing oversized junction box at DMS-25 as shown in the Plans. Comply with Section 1098-11 of the Standard Specifications.

9.3 Construction Methods

A. Drop Cable

Furnish and install fiber optic drop cable, including slack, to reach from termination point to termination point. At the locations shown in the Plans, splice new fiber optic drop cable to the existing fiber optic truck line in new underground splice enclosures. Route the new fiber optic drop cable from the splice enclosures to the equipment cabinet in new conduit as shown in the Plans.

Install Department furnished interconnect center and fiber optic transceiver. Comply with Section 1730 of the Standard Specifications.

B. Splice Enclosure

Furnish and install a splice enclosure in the existing oversized junction box at the location shown in the plans.

C. Testing

After splicing is complete, perform bi-directional OTDR tests on each re-spliced fiber. Comply with Section 1731 of the Standard Specifications.

9.4 Measurement And Payment

Drop Cable (12-fiber) will be measured and paid as linear feet of 12 fiber drop cable furnished, installed and accepted. Sag and vertical segments will not be paid for as these distances are considered incidental to the installation of drop cable assemblies.

No measurement will be made for terminating, splicing, and testing fiber optic drop cables as these will be considered incidental to the installation of drop cables. There will be no measurement for installing the Department furnished interconnect center and fiber optic transceiver in the Department furnished DMS equipment cabinet.

Splice Enclosure will be measured and paid as the actual number of splice enclosures furnished and installed.

Payment will be made under:

Pay Item

Drop Cable (12-Fiber).....	Linear Foot
Splice Enclosure	Each

10. INTEGRATION

10.1 DESCRIPTION

Center to Field communication will be accomplished over existing fiber optic communications cable. Ensure the Department furnished DMS system is integrated into the DMS Control Software at the TRTMC.

10.2 CONSTRUCTION METHOD

At the TRTMC, modify the existing Traffic Management System to integrate the DMS. Use the DMS Control Software to configure the DMS into the DMS database. Modify the GUI, if necessary, to position device icons on the regional map view. Coordinate all integration activities with the Engineer.

10.3 MEASUREMENT AND PAYMENT

No separate measurement will be made for the work performed for the successful integration of the Department furnished DMS at the field and at the TRTMC as this is paid for elsewhere in these Project Special Provisions.

11. DMS TESTING REQUIREMENTS

11.1 OPERATIONAL FIELD TEST

Conduct an Operational Field Test of the DMS system installed on the project to exercise the normal operational functions of the equipment. The Operational Field Test will consist of the following tests as a minimum:

A. Physical Examination

Verify bend radius of cables is not excessive or could potentially cause damage. Verify that there are no exposed live terminals.

B. Continuity Tests

Check the wiring to assure it conforms to the requirements of these Project Special Provisions.

C. Functional Tests

Perform the following functional tests:

- Start-up and operate the DMS locally using a laptop computer.
- Exercise the DMS by displaying static messages, flashing messages, and alternating static and flashing message sequences.
- Automatic poll the DMS by the Central Control Software and verify the data received by Central Control Software from DMS.
- Execute status request on the DMS controller.
- Set controller clock using the Central Control Software.
- Execute system shutdown using the Central Control Software and local user interface.

If the DMS system does not pass these tests, document the corrections that are needed, and notify the Engineer.

11.2 Measurement and Payment

No separate measurement will be made for the work performed under this section as this is paid for elsewhere in these Project Special Provisions.

12. DMS ASSEMBLIES

12.1 DESCRIPTION

This section includes all design, fabrication, furnishing, and erection of the DMS assemblies, maintenance platforms, and ladder attachment for access to the DMS inspection doors, and attachment of the DMS enclosures to the structures in accordance with the requirements of these Project Special Provisions and the Plans. Fabricate the supporting DMS assemblies from tubular steel. Furnish one pedestal type DMS assembly as shown in the Plans at DMS-25. Cantilevered and Monotube (horizontal truss) DMS structures will not be allowed.

Provide pedestal structure with a minimum of 25 feet clearance from the high point of the road to the bottom of the DMS enclosure.

Design the DMS assemblies (including footings), maintenance platforms, and access ladders and submit shop drawings to the Engineer for acceptance. A Professional Engineer that is registered in the state of North Carolina will prepare such computations and drawings. These must bear his signature, seal, and date of acceptance.

The provisions of Section 900 of the Standard Specifications apply to all work covered by this section.

12.2 MATERIAL

Use materials that meet the following requirements of the Standard Specifications:

Structural Steel	Section 1072
Overhead Sign Structures	Section 1096
Signing Materials	Section 1092
Organic-Zinc Repair Paint	Article 1080-9
Reinforcing Steel	Sub-article 1070
Direct Tension Indicators	Sections 440 and 1072

12.3 CONSTRUCTION METHODS

A. General

Fabricate the new DMS assemblies, maintenance platforms, and access ladders in accordance with the details shown in the approved shop drawings and the requirements of these Project Special Provisions.

No welding, cutting, or drilling in any manner will be permitted in the field, unless approved by the Engineer.

Drill bolt holes and slots to finished size. Holes may also be punched to finished size, provided the diameter of the punched holes are at least twice the thickness of the metal being punched. Flame cutting of bolt holes and slots is not permitted.

Erect DMS in accordance with the requirements indicated on the Plans and in these Project Special Provisions. Field drill two holes per connection in the Z bars for attaching the DMS to the structure. Use two bolts at each connection. Provide two (2) U-bolts at each U-bolt connection such as 1) each truss chord to sign hanger, or 2) each truss chord to platform support. Provide two (2) U-

bolts at each U-bolts connection where ends of truss chords are supported. Minimum diameter of all U-bolts is to be ½ inch.

Use two coats of a zinc-rich paint to touch up minor scars on all galvanized materials. See Standard Specifications for Roads and Structures Section 1076-7.

For high strength bolted connections, provide direct tension indicator washer.

B. Shop Drawing

Submit to the Engineer for approval a complete design for the DMS assemblies (including footings), maintenance platforms, access ladders, DMS assembly hardware, brackets for supporting the DMS and maintenance platforms. Base the design on the line drawings and correct wind speed in accordance with the latest edition of AASHTO "Standard Specifications for Structural Supports for Highway Signs, Luminaries and Traffic Signals."

The manufacturer of the DMS assembly must ensure that design of the assembly is compatible with the DMSs for mounting and attachment.

Submit six copies of complete detailed shop drawings and one copy of the design computations for the DMS assembly to the Engineer for approval prior to fabrication. Show in the shop drawings complete design and fabrication details including foundations, provisions for attaching the DMS, maintenance platform and access ladders to supporting structures, applicable material specifications, and any other information necessary for procuring and replacing any part of the complete DMS assembly.

Allow a minimum of 40 working days for shop drawing approval after the Engineer receives them. If revised drawings are necessary, allow appropriate additional time for review and approval of final shop drawings.

Approval of shop drawings by the Engineer will not relieve the Contractor of his responsibility for the correctness of drawings, or for the fit of all shop and field connections and anchors.

C. Design and Fabrication

1. Dynamic Message Sign Assembly

- Design must be in accordance with the Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals, 4th Edition, 2001, and the latest Interim Specifications.
- The wind pressure map that is developed from the 3-second gust speeds, as provided in Article 3.8, shall be used.
- The natural wind gust speed in North Carolina shall be assumed to be 5 meters per second or 11.6 mph for inland areas, and 7 meters per second or 15.7 mph for coastal areas. The coastal area shall be defined as any area within 2 miles from the waterfront facing the ocean or sound and all area where the design basic wind speed is above 120 mph, as shown in Figure 3-2.
- The fatigue importance category used in the design, for each type of structure, as provided for in Article 11.6, Fatigue Importance Factors, shall be Category II unless otherwise shown on the contract plans.

- Wind drag coefficient for Dynamic Message Sign enclosures shall be 1.7.

The following Specification interpretations or criteria shall be used in the design of overhead sign assemblies:

- For design of supporting upright posts or columns, the effective length factor for columns “K”, as provided for in Appendix B, Section B.5, shall be taken as the following, unless otherwise approved by the Engineer:
 - Case 1 For a single upright post of span type overhead sign structure, the effective column length factor, “K”, shall be taken as 2.0.
 - Case 2 For twin post truss-type upright post with the post connected to one chord of a horizontal truss, the effective column length factor for that column shall be taken as 2.0.
 - Case 3 For twin post truss-type upright post with the post connected to two truss chords of a horizontal tri-chord or box truss, the effective column length factor for that column shall be taken as 1.65.
- For twin post truss-type upright post, the unbraced length shall be from the chord to post connection to the top of base plate.
- For twin post truss-type upright post that is subject to axial compression, bending moment, shear, and torsion the post shall satisfy Standard Specifications for Structural Supports for Highway Signs, Luminaries and Traffic Signals Equations 5-17, 5-18 and 5-19. To reduce the effects of secondary bending, in lieu of Equation 5-18, the following equation may be used:

$$\frac{f_a}{F_a} + \frac{f_b}{\left(1 - \frac{0.6f_a}{F_e}\right)F_b} + \left(\frac{f_v}{F_v}\right)^2 \leq 1.0$$

Where

fa = Computed axial compression stress at base of post

- The base plate thickness for all uprights and poles shall be a minimum of 2” but not less than that determined by the following criteria and design.
 - Case 1 Circular or rectangular solid base plates with the upright pole welded to the top surface of base plate with full penetration butt weld, and where no stiffeners are provided. A base plate with a small center hole, which is less than 1/5 of the upright diameter, and located concentrically with the upright pole, may be considered as a solid base plate.

The magnitude of bending moment in the base plate, induced by the anchoring force of each anchor bolt shall be calculated using equation $M = (P \times D_1) / 2$.

Case 2 Circular or rectangular base plate with the upright pole socketed into and attached to the base plate with two lines of fillet weld, and where no stiffeners are provided, or any base plate with a center hole that is larger in diameter than 1/5 of the upright diameter.

The magnitude of bending moment induced by the anchoring force of each anchor bolt shall be calculated using equation $M = P \times D_2$.

- M , bending moment at the critical section of the base plate induced by one anchor bolt
 - P , anchoring force of each anchor bolt
 - D_1 , horizontal distance between the center of the anchor bolt and the outer face of the upright, or the difference between the radius of the bolt circle and the outside radius of the upright
 - D_2 , horizontal distance between the face of the upright and the face of the anchor bolt nut
- The critical section shall be located at the face of the anchor bolt and perpendicular to the radius of the bolt circle. The overlapped part of two adjacent critical sections shall be considered ineffective.
 - The thickness of base plate of Case 1 shall not be less than that calculated based on formula for Case 2.
 - Uprights, foundations, and trusses shall be designed in accordance with the DMS Foundation Special Provision for the effects of torsion. Torsion shall be considered from dead load eccentricity of these attachments, as well as for attachments such as maintenance platforms, supporting brackets, etc., that add to the torsion in the assembly. Truss vertical and horizontal truss diagonals in particular and any other assembly members shall be appropriately sized for these loads.
 - Uprights, foundations, and trusses shall be designed for the proposed sign wind area and future wind areas. The design shall consider the effect of torsion induced by the eccentric force location of the center of wind force above (or below) the center of the supporting truss. Truss vertical and horizontal truss diagonals in particular and any other assembly members shall be appropriately sized for these loads.

Fabricate the supporting structures using tubular members of either aluminum or steel, using only one type of material throughout the project.

Horizontal components of the supporting structures for overhead DMS must be of a truss design to support the DMS. Truss centerline must coincide with centerline of the DMS design area shown on the structure line drawing. Provide permanent camber in addition to dead load camber in accordance with the "Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals." Indicate on the shop drawings the amount of camber provided and the method employed in the fabrication of the support to obtain the camber.

For all U-bolt connections of hanger beams to overhead assembly truss chords, provide all U-bolts with a flat washer, a lock washer and double nuts at each end of the U-bolts. All double nuts that are on any U-bolt shall be the same thickness and weight. When assembled, the double nuts shall be brought tight against each other by the use of two wrenches.

Fabricate attachment assemblies for the mounting DMS in a manner that allows easy removal of the sign.

2. DMS Maintenance Platform (Walkway)

Provide a maintenance platform, a minimum of three feet wide with open skid-resistant surface and safety railing on the DMS assemblies for access to the DMS inspection door. Provide platforms with fixed safety railings along both sides from the beginning of the platform to the inspection door.

Ensure the design, fabrication and installation of the access platforms on new DMS structures complies with the following:

1. The top of the platform grading surface is vertically aligned with the bottom of the DMS door. Ensure the platform extends from the DMS enclosure to the access ladder.
2. The DMS door will open 90-degrees from its closed position without any obstruction from the platform or safety handrails.
3. The platform is rigidly and directly connected to the walkway brackets and there is no uneven surface between sections.
4. Install a 4" x 4" safety angle parallel to and along both sides of the platform and extend it the entire length of the platform. Design the safety angle to withstand loading equivalent to the platform.
5. Ensure the platform design allows full access to the DMS enclosure inspection door with no interference or obstructions.

3. DMS Access Ladder

Provide a fixed ladder, of the same material as the pedestal structures, leading to the access platform. Equip the ladder with a security cover (ladder guard) and lock to prohibit access by unauthorized persons. Start the first ladder rung no more than 18 inches above finished ground and end it at the access platform. Design the rungs on 12-inch center to center typical spacing. Attach the security cover approximately 6 feet above the finished ground. Design the ladder and security cover as a permanent part of the DMS assembly and include complete design details in the DMS assembly shop drawings. Fabricate the ladder and cover to meet all OSHA requirements and applicable state and local codes, including but not limited to providing a ladder cage. Attached the bottom of the ladder to a concrete pad a minimum of 4 inches deep, 24 inches wide, and 36 inches long.

12.4 MEASUREMENT AND PAYMENT

DMS-25 Structure will be measured and paid as the actual number of DMS-25 structures furnished, installed, and accepted. Payment includes all design, fabrication, construction, transportation, and attachment of the dynamic message sign assemblies (including Z-bars and U-

bolts), supporting structure, hardware, access platform, direct tension indicators, preparing and furnishing shop drawings, additional documentation, incidentals, and all other equipment and features necessary to furnish the system described above.

DMS Access Ladder will be measured and paid as the actual number of DMS access ladders furnished, installed and accepted. Payment includes design, fabrication, transportation, 4(d) x 24(w) x 36(l) concrete pad, and attachment to the DMS assembly as described above.

DMS Walkway will be measured and paid as the actual number of DMS maintenance walkways furnished, installed and accepted. Payment includes design, fabrication, transportation, and attachment to the DMS assembly as described above.

Payment will be made under:

Pay Item

DMS-25 Structure.....	Each
DMS Access Ladder	Each
DMS Walkway.....	Each

13. FOUNDATIONS AND ANCHOR ROD ASSEMBLIES FOR METAL POLES

SP9 R05REV

13.1 Description

Foundations for metal poles include foundations for signals, cameras, overhead and dynamic message signs (DMS) and high mount and low level light standards supported by metal poles or upright trusses. Foundations consist of footings with pedestals and drilled piers with or without grade beams or wings. Anchor rod assemblies consist of anchor rods (also called anchor bolts) with nuts and washers on the exposed ends of rods and nuts and a plate or washers on the other ends of rods embedded in the foundation.

Construct concrete foundations with the required resistances and dimensions and install anchor rod assemblies in accordance with the contract and accepted submittals. Construct drilled piers consisting of cast-in-place reinforced concrete cylindrical sections in excavated holes. Provide temporary casings or polymer slurry as needed to stabilize drilled pier excavations. Use a prequalified Drilled Pier Contractor to construct drilled piers for metal poles. Define "excavation" and "hole" as a drilled pier excavation and "pier" as a drilled pier.

This provision does not apply to materials and anchor rod assemblies for standard foundations for low level light standards. See Section 1405 of the *2012 Standard Specifications* and Standard Drawing No. 1405.01 of the *2012 Roadway Standard Drawings* for materials and anchor rod assemblies for standard foundations. For construction of standard foundations for low level light standards, standard foundations are considered footings in this provision.

This provision does not apply to foundations for signal pedestals; see Section 1743 of the *2012 Standard Specifications* and Standard Drawing No. 1743.01 of the *2012 Roadway Standard Drawings*.

13.2 Materials

Refer to the *2012 Standard Specifications*.

Item	Section
Conduit	1091-3
Grout, Nonshrink	1003
Polymer Slurry	411-2(B)
Portland Cement Concrete	1000
Reinforcing Steel	1070
Rollers and Chairs	411-2(C)
Temporary Casings	411-2(A)

Provide Type 3 material certifications in accordance with Article 106-3 of the *2012 Standard Specifications* for conduit, rollers, chairs and anchor rod assemblies. Store steel materials on blocking at least 12" above the ground and protect it at all times from damage; and when placing in the work make sure it is free from dirt, dust, loose mill scale, loose rust, paint, oil or other foreign materials. Load, transport, unload and store foundation and anchor rod assembly materials so materials are kept clean and free of damage. Damaged or deformed materials will be rejected.

Use conduit type in accordance with the contract. Use Class A concrete for footings and pedestals, Class Drilled Pier concrete for drilled piers and Class AA concrete for grade beams and wings including portions of drilled piers above bottom of wings elevations. Corrugated temporary casings may be accepted at the discretion of the Engineer. A list of approved polymer slurry products is available from:

www.ncdot.org/doh/preconstruct/highway/geotech/leftmenu/Polymer.html

Provide anchor rod assemblies in accordance with the contract consisting of the following:

- (A) Straight anchor rods,
- (B) Heavy hex top and leveling nuts and flat washers on exposed ends of rods, and
- (C) Nuts and either flat plates or washers on the other ends of anchor rods embedded in foundations.

Do not use lock washers. Use steel anchor rods, nuts and washers that meet ASTM F1554 for Grade 55 rods and Grade A nuts. Use steel plates and washers embedded in concrete with a nominal thickness of at least 1/4". Galvanize anchor rods and exposed nuts and washers in accordance with

Article 1076-4 of the *2012 Standard Specifications*. It is not necessary to galvanize nuts, plates and washers embedded in concrete.

13.3 Construction Methods

Install the required size and number of conduits in foundations in accordance with the plans and accepted submittals. Construct top of piers, footings, pedestals, grade beams and wings flat, level and within 1" of elevations shown in the plans or approved by the Engineer. Provide an Ordinary Surface finish in accordance with Subarticle 825-6(B) of the *2012 Standard Specifications* for portions of foundations exposed above finished grade. Do not remove anchor bolt templates or pedestal or grade beam forms or erect metal poles or upright trusses onto foundations until concrete attains a compressive strength of at least 3,000 psi.

(A) Drilled Piers

Before starting drilled pier construction, hold a predrill meeting to discuss the installation, monitoring and inspection of the drilled piers. Schedule this meeting after the Drilled Pier Contractor has mobilized to the site. The Resident or Division Traffic Engineer, Contractor and Drilled Pier Contractor Superintendent will attend this predrill meeting.

Do not excavate holes, install piles or allow equipment wheel loads or vibrations within 20 ft of completed piers until 16 hours after Drilled Pier concrete reaches initial set.

Check for correct drilled pier alignment and location before beginning drilling. Check plumbness of holes frequently during drilling.

Construct drilled piers with the minimum required diameters shown in the plans. Install piers with tip elevations no higher than shown in the plans or approved by the Engineer.

Excavate holes with equipment of the sizes required to construct drilled piers. Depending on the subsurface conditions encountered, drilling through rock and boulders may be required. Do not use blasting for drilled pier excavations.

Contain and dispose of drilling spoils and waste concrete as directed and in accordance with Section 802 of the *2012 Standard Specifications*. Drilling spoils consist of all materials and fluids removed from excavations.

If unstable, caving or sloughing materials are anticipated or encountered, stabilize holes with temporary casings and/or polymer slurry. Do not use telescoping temporary casings. If it becomes necessary to replace a temporary casing during drilling, backfill the excavation, insert a larger casing around the casing to be replaced or stabilize the excavation with polymer slurry before removing the temporary casing.

If temporary casings become stuck or the Contractor proposes leaving casings in place, temporary casings should be installed against undisturbed material. Unless otherwise

approved, do not leave temporary casings in place for mast arm poles and cantilever signs. The Engineer will determine if casings may remain in place. If the Contractor proposes leaving temporary casings in place, do not begin drilling until a casing installation method is approved.

Use polymer slurry and additives to stabilize holes in accordance with the slurry manufacturer's recommendations. Provide mixing water and equipment suitable for polymer slurry. Maintain polymer slurry at all times so slurry meets Table 411-3 of the *2012 Standard Specifications* except for sand content.

Define a "sample set" as slurry samples collected from mid-height and within 2 ft of the bottom of holes. Take sample sets from excavations to test polymer slurry immediately after filling holes with slurry, at least every 4 hours thereafter and immediately before placing concrete. Do not place Drilled Pier concrete until both slurry samples from an excavation meet the required polymer slurry properties. If any slurry test results do not meet the requirements, the Engineer may suspend drilling until both samples from a sample set meet the required slurry properties.

Remove soft and loose material from bottom of holes using augers to the satisfaction of the Engineer. Assemble rebar cages and place cages and Drilled Pier concrete in accordance with Subarticle 411-4(E) of the *2012 Standard Specifications* except for the following:

- (1) Inspections for tip resistance and bottom cleanliness are not required,
- (2) Temporary casings may remain in place if approved, and
- (3) Concrete placement may be paused near the top of pier elevations for anchor rod assembly installation and conduit placement or
- (4) If applicable, concrete placement may be stopped at bottom of grade beam or wings elevations for grade beam or wing construction.

If wet placement of concrete is anticipated or encountered, do not place Drilled Pier concrete until a concrete placement procedure is approved. If applicable, temporary casings and fluids may be removed when concrete placement is paused or stopped in accordance with the exceptions above provided holes are stable. Remove contaminated concrete from exposed Drilled Pier concrete after removing casings and fluids. If holes are unstable, do not remove temporary casings until a procedure for placing anchor rod assemblies and conduit or constructing grade beams or wings is approved.

Use collars to extend drilled piers above finished grade. Remove collars after Drilled Pier concrete sets and round top edges of piers.

If drilled piers are questionable, pile integrity testing (PIT) and further investigation may be required in accordance with Article 411-5 of the *2012 Standard Specifications*. A drilled pier will be considered defective in accordance with Subarticle 411-5(D) of the *2012 Standard Specifications* and drilled pier acceptance is based in part on the criteria in Article 411-6 of the *2012 Standard Specifications* except for the top of pier tolerances in Subarticle 411-6(C) of the *2012 Standard Specifications*.

If a drilled pier is under further investigation, do not grout core holes, backfill around the pier or perform any work on the drilled pier until the Engineer accepts the pier. If the drilled pier is accepted, dewater and grout core holes and backfill around the pier with approved material to finished grade. If the Engineer determines a pier is unacceptable, remediation is required in accordance with Article 411-6 of the *2012 Standard Specifications*. No extension of completion date or time will be allowed for remediation of unacceptable drilled piers or post repair testing.

Permanently embed a plate in or mark top of piers with the pier diameter and depth, size and number of vertical reinforcing bars and the minimum compressive strength of the concrete mix at 28 days.

(B) Footings, Pedestals, Grade Beams and Wings

Excavate as necessary for footings, grade beams and wings in accordance with the plans, accepted submittals and Section 410 of the *2012 Standard Specifications*. If unstable, caving or sloughing materials are anticipated or encountered, shore foundation excavations as needed with an approved method. Notify the Engineer when foundation excavation is complete. Do not place concrete or reinforcing steel until excavation dimensions and foundation material are approved.

Construct cast-in-place reinforced concrete footings, pedestals, grade beams and wings with the dimensions shown in the plans and in accordance with Section 825 of the *2012 Standard Specifications*. Use forms to construct portions of pedestals and grade beams protruding above finished grade. Provide a chamfer with a 3/4" horizontal width for pedestal and grade beam edges exposed above finished grade. Backfill and fill in accordance with Article 410-8 of the *2012 Standard Specifications*. Proper compaction around footings and wings is critical for foundations to resist uplift and torsion forces. Place concrete against undisturbed soil and do not use forms for standard foundations for low level light standards.

(C) Anchor Rod Assemblies

Size anchor rods for design and the required projection above top of foundations. Determine required anchor rod projections from nut, washer and base plate thicknesses, the protrusion of 3 to 5 anchor rod threads above top nuts after tightening and the distance of one nut thickness between top of foundations and bottom of leveling nuts.

Protect anchor rod threads from damage during storage and installation of anchor rod assemblies. Before placing anchor rods in foundations, turn nuts onto and off rods past leveling nut locations. Turn nuts with the effort of one workman using an ordinary wrench without a cheater bar. Report any thread damage to the Engineer that requires extra effort to turn nuts.

Arrange anchor rods symmetrically about center of base plate locations as shown in the plans. Set anchor rod elevations based on required projections above top of foundations.

Securely brace and hold rods in the correct position, orientation and alignment with a steel template. Do not weld to reinforcing steel, temporary casings or anchor rods.

Install top and leveling (bottom) nuts, washers and the base plate for each anchor rod assembly in accordance with the following procedure:

- (1) Turn leveling nuts onto anchor rods to a distance of one nut thickness between the top of foundation and bottom of leveling nuts. Place washers over anchor rods on top of leveling nuts.
- (2) Determine if nuts are level using a flat rigid template on top of washers. If necessary, lower leveling nuts to level the template in all directions or if applicable, lower nuts to tilt the template so the metal pole or upright truss will lean as shown in the plans. If leveling nuts and washers are not in full contact with the template, replace washers with galvanized beveled washers.
- (3) Verify the distance between the foundation and leveling nuts is no more than one nut thickness.
- (4) Place base plate with metal pole or upright truss over anchor rods on top of washers. High mount luminaires may be attached before erecting metal poles but do not attach cables, mast arms or trusses to metal poles or upright trusses at this time.
- (5) Place washers over anchor rods on top of base plate. Lubricate top nut bearing surfaces and exposed anchor rod threads above washers with beeswax, paraffin or other approved lubricant.
- (6) Turn top nuts onto anchor rods. If nuts are not in full contact with washers or washers are not in full contact with the base plate, replace washers with galvanized beveled washers.
- (7) Tighten top nuts to snug-tight with the full effort of one workman using a 12" wrench. Do not tighten any nut all at once. Turn top nuts in increments. Follow a star pattern cycling through each nut at least twice.
- (8) Repeat (7) for leveling nuts.
- (9) Replace washers above and below the base plate with galvanized beveled washers if the slope of any base plate face exceeds 1:20 (5%), any washer is not in firm contact with the base plate or any nut is not in firm contact with a washer. If any washers are replaced, repeat (7) and (8).
- (10) With top and leveling nuts snug-tight, mark each top nut on a corner at the intersection of 2 flats and a corresponding reference mark on the base plate. Mark top nuts and base plate with ink or paint that is not water-soluble. Use the turn-of-nut method for pretensioning. Do not pretension any nut all at once. Turn top nuts in increments for a total of one flat (1/6 revolution) for anchor rod diameters greater than 1 1/2" and 2 flats (1/3 revolution) for anchor rod diameters 1 1/2" or less. Follow a star pattern cycling through each top nut at least twice.
- (11) Ensure nuts, washers and base plate are in firm contact with each other for each anchor rod. Cables, mast arms and trusses may now be attached to metal poles and upright trusses.
- (12) Between 4 and 14 days after pretensioning top nuts, use a torque wrench calibrated within the last 12 months to check nuts in the presence of the Engineer. Completely erect mast arm poles and cantilever signs and attach any hardware before checking

top nuts for these structures. Check that top nuts meet the following torque requirements:

TORQUE REQUIREMENTS

Anchor Rod Diameter, inch	Requirement, ft-lb
7/8	180
1	270
1 1/8	380
1 1/4	420
≥1 1/2	600

If necessary, retighten top nuts in the presence of the Engineer with a calibrated torque wrench to within ± 10 ft-lb of the required torque. Do not overtighten top nuts.

- (13) Do not grout under base plate.

13.4 Measurement and Payment

Foundations and anchor rod assemblies for metal poles and upright trusses will be measured and paid for elsewhere in the contract.

No payment will be made for temporary casings that remain in drilled pier excavations. No payment will be made for PIT. No payment will be made for further investigation of defective piers. Further investigation of piers that are not defective will be paid as extra work in accordance with Article 104-7 of the *2012 Standard Specifications*. No payment will be made for remediation of unacceptable drilled piers or post repair testing.

14. OVERHEAD AND DYNAMIC MESSAGE SIGN FOUNDATIONS

14.1 DESCRIPTION

Sign foundations include foundations for overhead and dynamic message signs (DMS) supported by metal poles or upright trusses. Sign foundations consist of footings with pedestals or drilled piers with or without grade beams or wings, conduit and anchor rod assemblies. Construct sign foundations in accordance with the contract and accepted submittals. Define "cantilever sign" as an overhead cantilever sign support in accordance with Figure 1-1 of the *AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals*.

14.2 MATERIAL

Use sign foundation materials that meet the *Foundations and Anchor Rod Assemblies for Metal Poles* provision.

(A) Assumed Subsurface Conditions

Assume the following soil parameters and groundwater elevation for sign foundations unless these subsurface conditions are not applicable to sign locations:

- (A) Unit weight (γ) = 120 lb/cf,
- (B) Friction angle (ϕ) = 30°,
- (C) Cohesion (c) = 0 lb/sf, and
- (D) Groundwater 7 ft below finished grade.

A subsurface investigation is required if the Engineer determines these assumed subsurface conditions do not apply to a sign location and the sign cannot be moved. Subsurface conditions requiring a subsurface investigation include but are not limited to weathered or hard rock, boulders, very soft or loose soil, muck or shallow groundwater. No extension of completion date or time will be allowed for subsurface investigations.

(B) Subsurface Investigations

Use a prequalified geotechnical consultant to perform one standard penetration test (SPT) boring in accordance with ASTM D1586 at each sign location requiring a subsurface investigation. Rough grade sign locations to within 2 ft of finished grade before beginning drilling. Drill borings to 2 drilled pier diameters below anticipated pier tip elevations or refusal, whichever is higher.

Use the computer software gINT version 8.0 or later manufactured by Bentley Systems, Inc. with the current NCDOT gINT library and data template to produce SPT boring logs. Provide boring logs sealed by a geologist or engineer licensed in the state of North Carolina.

(C) Sign Foundation Designs

Design sign foundations for the wind zone and clearances shown in the plans and the slope of finished grade at each sign location. Use the assumed soil parameters and groundwater elevation above for sign foundation designs unless a subsurface investigation is required. For sign locations requiring a subsurface investigation, design sign foundations for the subsurface conditions at each sign location. Design footings, pedestals, drilled piers, grade beams and wings in accordance with the 4th Edition of the *AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals*. In some instances, conflicts with drainage structures may dictate sign foundation types.

Design footings in accordance with Section 4.4 of the *AASHTO Standard Specifications for Highway Bridges*. Do not use an allowable bearing pressure of more than 3,000 lb/sf for footings.

Design drilled piers for side resistance only in accordance with Section 4.6 of the *AASHTO Standard Specifications for Highway Bridges* except reduce ultimate side resistance by 25% for uplift. Use the computer software LPILE version 5.0 or later manufactured by Ensoft, Inc. to analyze drilled piers. Provide drilled pier designs with a horizontal deflection of less than 1" at top of piers. For

cantilever signs with single drilled pier foundations supporting metal poles, use wings to resist torsion forces. Provide drilled pier designs with a factor of safety of at least 2.0 for torsion.

For drilled pier sign foundations supporting upright trusses, use dual drilled piers connected with a grade beam having a moment of inertia approximately equal to that of either pier. The Broms' method is acceptable to analyze drilled piers with grade beams instead of LPILE. Use a safety factor of at least 3.5 for the Broms' design method in accordance with C13.6.1.1 of the *AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals*.

Submit boring logs, if any, working drawings and design calculations for acceptance in accordance with Article 105-2 of the *2012 Standard Specifications*. Submit working drawings showing plan views, required foundation dimensions and elevations and typical sections with reinforcement, conduit and anchor rod assembly details. Include all boring logs, design calculations and LPILE output for sign foundation design submittals. Have sign foundations designed, detailed and sealed by an engineer licensed in the state of North Carolina.

14.3 CONSTRUCTION METHODS

Construct footings, pedestals, drilled piers, grade beams and wings and install anchor rod assemblies for sign foundations in accordance with the *Foundations and Anchor Rod Assemblies for Metal Poles* provision.

14.4 MEASUREMENT AND PAYMENT

Overhead Footings will be measured and paid in cubic yards. Sign foundations will be measured as the cubic yards of foundation concrete for footings, pedestals, drilled piers, grade beams and wings shown on the accepted submittals. The contract unit price for *Overhead Footings* will be full compensation for providing labor, tools, equipment and foundation materials, stabilizing or shoring excavations and supplying concrete, reinforcing steel, conduit, anchor rod assemblies and any incidentals necessary to construct sign foundations. Subsurface investigations required by the Engineer will be paid as extra work in accordance with Article 104-7 of the *2012 Standard Specifications*.

Payment will be made under:

Pay Item	Pay Unit
Overhead Footings	Cubic Yard