When terminating spans at wood poles, connect messenger cable to a deadend strandvise attached to the pole via a 5/8" diameter shoulder eye bolt or 5/8" diameter shoulder angle bolt with 5/8" eye nut as shown in *Roadway Standard Drawings* No. 1720.01. When terminating spans at metal or other Department-approved poles, connect messenger cable to a deadend strandvise attached to the pole via a pole attachment clamp. Refer to *Metal Pole Standard Drawing* Sheet M6 as shown in the previous paragraph. Do not install more than one messenger cable and strandvise assembly to a single metal or other Department-approved pole attachment clamp. During installation, ensure that messenger cable is centered and directly aligned at the pole clamp's attachment point such that the cable does not exert forces on the sides of the clamp's attachment point.

Maintain electrical continuity at all splices.

(A) Messenger Cable for Signal Heads or Lead-In Cable

For messenger cable attached to joint use poles, install a new grounding system that complies with Article 1720-3 for bonding messenger cable. If a pole ground exists on the joint use pole, bond new pole grounding system to existing pole ground using #6 AWG minimum solid bare copper grounding wire terminated with split bolt connectors or parallel groove clamp at each end. If existing poles do not have a grounding system, install new grounding system that complies with Article 1720-3.

(B) Messenger Cable for Communications Cable

For messenger cable attached to joint use poles, bond messenger cable to existing pole ground at each end and at 1,300-ft intervals. Install bond using #6 AWG minimum solid bare copper grounding wire terminated with split bolt connectors or parallel groove clamp at each end. If existing poles do not have a grounding system, install new grounding system that complies with Article 1720-3.

(C) Messenger Cable for Multiple Cables

On multiple messenger cable arrangements, connect all messenger cable ends with #6 AWG minimum solid bare copper wire and bond with split bolt connectors or parallel groove clamp and terminate to pole ground.

1710-4 MEASUREMENT AND PAYMENT

Messenger Cable (____) will be measured and paid as actual horizontal linear feet of messenger cable furnished, installed and accepted. Measurement will be point to point with no allowance for sag.

No measurement will be made of cable clamps, machine bolts, eye bolts, 3-bolt assemblies, eye nuts, split bolt connectors and pole grounding systems as these will be incidental to furnishing and installing messenger cable.

Payment will be made under:

Pay Item	Pay Unit
Messenger Cable (____)	Linear Foot

SECTION 1715
UNDERGROUND CABLE INSTALLATION

1715-1 DESCRIPTION

Furnish and install temporary lead-in cable or conduit for underground cable installation with tracer wire, miscellaneous fittings, all necessary hardware, marker tape, backfill, graded stone, paving materials and seeding and mulching.

1715-2 MATERIAL

Refer to Divisions 5 and 10.

Item	Section
Conduit	1091-3
Conduit Plug	1091-3(G)
Duct and Conduit Sealer	1091-4
Backfill	1018-2
Graded Stone	545-2 and 545-3

Furnish material, equipment and hardware under this section that is pre-approved on the ITS and Signals QPL.

1715-3 CONSTRUCTION METHODS

(A) General

Ensure conduit is free of moisture and debris before pulling cables.

Following installation of conduit where cable is not immediately installed or conduit is for future use (spare), seal the ends of the conduit with a conduit plug. Secure a pull line to the conduit plug in such a manner that it will not interfere with installation of the conduit plug and provides a watertight seal.

Extend ends of conduit 2" to 4" above concrete surfaces and 4" above crushed stone bases. For metallic conduit, install metallic bushings and bond conduits.

(1) Conduit

(a) Conduit Entering Junction Boxes

Terminate conduits installed for communications cables (fiber optics, twisted pair, ethernet and coaxial) in oversized junction boxes. Do not install other conduits in the oversized junction box unless otherwise specified.

Terminate conduits installed for signal wiring, including lead-in cable, in standard size junction boxes unless otherwise specified.

For all conduits entering junction boxes, seal spare conduits with approved conduit plugs. Seal conduits containing fiber-optic communications cable, signal cable and lead-in cable with duct and conduit sealer.

(b) Conduit Entering Cabinet Foundations

For all conduits entering the cabinet through the cabinet foundation, seal spare conduits with approved conduit plugs. Seal conduits containing fiber-optic communications cable, signal cable and lead-in cable with duct and conduit sealer.

(2) Tracer Wire

Install tracer wire in all conduits containing fiber-optic cable. Pull tracer wire simultaneously in a continuous length with the fiber-optic cable. Where multiple pulls of fiber-optic cable are required and conduit is placed in the same trench, only one tracer wire is required. Where multiple pulls of fiber-optic cable are required and conduits may separate into individual trenches, install a tracer wire in each conduit run. Provide waterproof butt splices where tracer wire is spliced. Splicing will be allowed only in cabinets and junction boxes. Label all tracer wires entering the equipment cabinet.

(3) Plan of Record Drawings

Upon completion of the conduit system for communications, furnish the Engineer with a plan of record drawing detailing the locations of the conduit system.

(B) Trenching

In certain cases the Contractor may use an alternate material and method of installation between trenching and plowing based on existing field conduits and preferences. Obtain approval before proceeding.

(1) General

Install PVC, HDPE or rigid metallic conduit for all underground runs. Install rigid metallic conduit for all underground runs located inside railroad right-of-way. Clean existing underground conduit to be incorporated into a new system. Bond all metallic conduit.

If more than one conduit is required between the same points, install conduit in one common trench. Install non-detectable marker tape.

Install longitudinal runs of conduit a minimum of one foot from back of curb or 6 ft from edge of pavement in the absence of curb. If ditches are present, install conduit a minimum of 4 ft from the bottom of the ditch line.

Maintain a minimum trench depth of 30" (or 12" in areas blocked by rock or impenetrable obstructions) below finished grade or 6" below roadway subbase, whichever is deeper. Upon completion, restore surface to like-original condition within 7 calendar days of occurrence of damage. Remove all rock and debris from backfill material. Remove excess material from site and compact area according to Article 300-7. Backfill with excavated material and compact to 95% of original density.

Backfill trench at locations along the trench path where non-movable objects, such as rocks and boulders, cannot be avoided. The purpose of the backfill is to provide a gradual change in elevation of the trench, so that excessive bending and stress will not be transferred to conduits once underground conduit system is installed.

After installation of conduits and upon completion of tamping and backfilling, perform a mandrel test on each conduit to ensure no conduit has been damaged. Furnish a non-metallic mandrel having a diameter of approximately 50% of the inside diameter of the conduit in which it is to be pulled through. If damage has occurred, replace the entire length of conduit. Ensure pull line is re-installed.

(2) Unpaved Trenching

Install conduit in all unpaved areas for all cable including permanent traffic signal installations.

As shown in plans or as directed by the Engineer, direct bury lead-in cable for temporary traffic signal installations.

Rake smooth the top 1 1/2" and seed with same type of grass as surrounding area. Finish unpaved areas flush with surrounding natural ground.

(3) Paved Trenching

On concrete surfaces, replace the entire joint of concrete unless otherwise specified. On all other surfaces, neatly cut and replace the width of trench with like material.

Finish paved areas with materials matching damaged areas. For conduit installed under roadways, cut neatly and replace the width of paved area damaged by trenching. For conduit installed under sidewalks and walkways, remove entire section of slab from joint to joint and replace. Place graded stone material to temporarily maintain traffic where repairs cannot be performed immediately. Comply with Article 545-4.

(C) Plowing (HDPE Conduit Only)

Direct plow HDPE ducts simultaneously using chute plow method. Direct plow ducts at a minimum depth so the top of the highest duct is 30" deep unless otherwise approved.

Provide sufficient personnel to feed chute, operate prime mover and equipment carrying reels (if separate equipment is used), observe chute feeding, observe plowing and observe reel payout. Use chute with adequate dimensions to allow for passage of duct without damage. During plow operation, continuously check chute opening and path to be sure there are no obstructions and monitor payout reels to be sure reels are turning at a steady rate.

With prior approval, install a junction box at locations where splicing or coupling of the underground polyethylene conduits is necessary. Otherwise, splicing or joining of underground polyethylene conduit is prohibited.

(D) Directional Drilling

(1) Pre-Approvals and Minimum Depth Requirements

Obtain approval before beginning drilling operations.

At all points where HDPE conduit will traverse under roadways, driveways, sidewalks or Controlled Access Areas including entrance/exit ramps, maintain a minimum depth of 4 ft or 8 times the back reamer's diameter, whichever is deeper. For an installation that runs parallel to a controlled access area or entrance/exit ramps maintain a minimum depth of 30" below finished grade. Maintain a minimum clearance of 30" below finished grade when crossing ditch lines. For the following structures, the minimum clearance requirements are:

TABLE 1715-1
MINIMUM CLEARANCE REQUIREMENTS FOR STRUCTURES

Man-made Structure	Minimum Clearance Requirement
Bridge Foundation	5 ft horizontal and 4 ft vertical (clearances greater than minimum horizontal should continue to use the 4V:5H ratio, i.e., 10 ft horizontal should be no deeper than 8 ft)
Drainage Pipes 60" or Less	1 ft above or below [while maintaining a minimum depth of 30" below grade]
Drainage Pipes Greater than 60"	1 ft above or 4 ft below [while maintaining a minimum depth of 30" below grade]
Box Culverts	1 ft above or 4 ft below [while maintaining a minimum depth of 30" below grade]
Slope Protection	2 ft below
Slope Protection Foundation Footing	5 ft below

Guarantee the drill rig operator and digital walkover locating system operator are factory-trained to operate the make and model of equipment provided and have at least one year experience operating the make and model of drill rig. Submit documentation of the operators' training and experience for review at least 2 weeks before start of directional drilling operations.

Provide a means of collecting and containing drilling fluid/slurry that returns to the surface such as a slurry pit. Provide measures to prevent drilling fluids from entering drainage ditches and storm sewer systems. Prevent drilling fluid/slurry from accumulating on or flowing onto pedestrian walkways, driveways and streets. Immediately remove all drilling fluids/slurry that are accidentally spilled.

(2) Directional Drill Operations

Provide grounding for the drill rig in accordance with the manufacturer's recommendations.

Place excavated material near the top of the working pit and dispose of properly. Backfill pits and trenches to facilitate drilling operations immediately after drilling is completed.

Use drill head suitable for type of material being drilled and sized no more than 2" larger than the outer diameter of the conduit. Direct drill to obtain proper depth and desired destination. Pressure grout with an approved bentonite/polymer slurry mixture to fill all voids. Do not jet alone or wet bore with water.

During drilling operation, locate drill head every 10 ft along drill path and before traversing underground utilities or structures. Use digital walkover locating system to track drill head during directional drilling operation. Ensure locating system is capable of determining pitch, roll, heading, depth and horizontal position of the drill head at any point.

Once drill head has reached final location, remove head and install back reamer of appropriate size (no more than 2" larger than outer diameter of conduits) to simultaneously facilitate back reaming of drill hole and installation of conduit. Back reamer is sized larger than actual conduits to ensure conduits are not adversely subjected to deviations caused by the original drill operation and are as straight as practical in their final position.

The intent of these Specifications is to limit the diameter of the actual drill shaft/hole so that it is no more than 2" larger than the conduit outer diameter. The 2" larger diameter may be accomplished during the original bore or during the back reaming/conduit installation process.

Once installation of conduit has started, continue installation without interruption so as to prevent conduit from becoming firmly set. Apply bentonite/polymer slurry mixture during conduit installation.

Upon completion of conduit installation, perform a mandrel test on conduit system to ensure conduit has not been damaged. Furnish non-metallic mandrel with a diameter of approximately 50% of the inside diameter of the conduit in which it is to be pulled through. If damage has occurred, replace the entire length of conduit and ensure that pull line is re-installed.

(3) Drilling Fluids

Use lubrication for subsequent removal of material and immediate installation of the conduit. The use of water and other fluids in connection with directional drilling operations will be permitted only to the extent necessary to lubricate cuttings. Do not jet alone or wet bore with water. Use drilling fluid/slurry consisting of at least 10% high-grade bentonite/polymer slurry to consolidate excavated material and seal drill hole walls.

Transport waste drilling fluid/slurry from site and dispose of in a method that complies with Federal, State and local laws and regulations.

(4) Conduit Splicing

With prior approval, install a junction box at locations where splicing or coupling of conduit is necessary. Otherwise, splicing or joining of HDPE conduit is prohibited.

(E) Bore and Jack

For bore and jack areas, comply with Articles 1540-4 except as follows:

For bore and jack areas, install metallic conduit at a minimum depth of 30" below finished grade or 6" below roadway subbase, whichever is greater. Provide a 3 ft clearance to conduit from back of curb or from edge of pavement. Terminate ends of conduit into junction boxes.

Comply with the *NCDOT Policies and Procedures for Accommodating Utilities on Highway Rights-of-Way* in effect on the date of advertisement.

1715-4 MEASUREMENT AND PAYMENT

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

Unpaved Trenching (qty)(size) & (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.

Unpaved Trenching for Temporary Lead-in will be measured in horizontal linear feet of trenching for placement of temporary lead-in cable. Measurement will be along the approximate centerline of the trench. Payment will be in linear feet.

Paved Trenching (qty)(size) & (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.

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

Bore and Jack (qty)(size) & (qty)(size) will be measured in horizontal linear feet of bore and jack for underground conduit installation furnished, installed and accepted. Measurement will be along the approximate centerline of the bore from junction box to junction box. Payment will be in linear feet.

No measurement will be made of vertical segments, non-metallic conduit, metallic conduit, conduit sealing material, backfill, graded stone, paving materials, miscellaneous fittings, non-detectable marker tape, pull lines and seeding and mulching as these will be incidental to conduit installation.

Conduit will be paid per linear foot based on quantity and size of conduits. As examples, an installation of a single 1.25" HDPE conduit would be paid as:

Directional Drill (1)(1.25") Linear Foot, and

An installation of two 1.25" and four 2" HDPE conduits would be paid as:

Directional Drill (2)(1.25")&(4)(2") Linear Foot.

Payment will be made under:

Pay Item	Pay Unit
Tracer Wire	Linear Foot
Unpaved Trenching (qty)(size) & (qty)(size)	Linear Foot
Unpaved Trenching for Temporary Lead-in	Linear Foot
Paved Trenching (qty)(size) & (qty)(size)	Linear Foot
Plowing (qty)(size) & (qty)(size)	Linear Foot
Directional Drill (qty)(size) & (qty)(size)	Linear Foot
Bore and Jack (qty)(size) & (qty)(size)	Linear Foot

SECTION 1716
JUNCTION BOXES

1716-1 DESCRIPTION

Furnish and install junction boxes (pull boxes) with covers, graded stone, grounding systems and all necessary hardware.

1716-2 MATERIAL

Refer to Division 10.

Item	Section
Junction Box	1098-5
Graded Stone	545

Furnish material, equipment and hardware under this section that is pre-approved on the ITS and Signals QPL.

1716-3 CONSTRUCTION METHODS

Install standard size junction boxes as shown in the plans and where underground splicing of electrical cables is necessary. Install standard size junction boxes within 3 ft of pole or pole foundation where transitioning from below ground to a riser assembly. Install standard size junction boxes within 5 ft of each end of each lateral run of conduit for electrical cables. When lateral runs for electrical cables are greater than 150 ft, install additional junction boxes to ensure distances between junction boxes does not exceed 150 ft.

Install oversized junction boxes for fiber-optic cables at locations shown in the plans.

Provide real world coordinates for all junction boxes and equipment cabinets installed or used under this project. Provide the coordinates in feet units using the North Carolina State Plane coordinate system (1983 North American Datum also known as NAD ’83). Furnish coordinates that do not deviate more than 1.7 ft in the horizontal plane and 3.3 ft in the vertical plane. Global positioning system (GPS) equipment able to obtain the coordinate data within these tolerances may be used. Submit cut sheets on the GPS unit proposed to collect the data for approval by the Engineer.

Provide both a digital copy and hard copy of all information regarding the location (including, but not limited to, manufacturer, model number, and NCDOT inventory number) in the Microsoft® spreadsheet provided by the Department, shown by example in Figure 1716-1.