Section 819. ELECTRICAL AND LIGHTING

819.01. Description. This work consists of providing operating electrical and lighting units; removing, salvaging, or disposing of existing electrical and lighting components; excavating, backfilling, restoring the site; and disposing of waste excavated material. Complete this work in accordance with this section, section 820, and the contract and to the requirements of the NEC, the National Electrical Safety Code, and the Michigan Department of Labor and Economic Growth for those items not identified in the contract.

Provide personnel experienced and qualified to perform the work required. Ensure the on-site presence of a licensed journeyman electrician supervisor for the electrical system installation and during electrical construction. Contact the Michigan Department of Labor and Economic Growth for electric service inspection and pay the applicable fees.

819.02. Materials. Provide material in accordance with the following:

Concrete, Grade S2 701
Granular Material Class II 902
Coarse Aggregate 17A 902
Light Standard and Tower Anchor Bolts 908
Conduit 918
Electrical Grounding System 918
Electrical Wire and Cable 918
Direct Burial Cable 918
Equipment Grounding Conductor 918
Handholes 918
Light Standard Foundation 918
Light Standard 918
Luminaires 918
Wood Poles 918
Tower Lighting Unit 918

A. **Conduit.**

1. **Direct Burial Application.** Provide a smooth surface conduit of one of the following types, for direct burial applications:

   a. Galvanized steel conduit;
   b. Smooth-wall, Schedule 40 rigid (PVC);
   c. Smooth-wall, Schedule 80 rigid (PVC);
   d. Smooth-wall, coilable, Schedule 40 (PE);
   e. Smooth-wall, coilable, Schedule 80 (PE); or

f. Rigid fiberglass.

Provide Schedule 80 conduit for traffic signal work.

2. **Jacking and Boring Application.** Provide Schedule 80 PVC or Schedule 80 polyethylene conduit for jacking and boring operations.

3. **Directional Boring Application.** Provide Schedule 80 coilable polyethylene conduit for directional boring.

4. **Encased Conduit Application.** Provide Schedule 40 conduit for encased conduit and provide Grade S2 concrete made with 17A coarse aggregate in accordance with section 701.

5. **Conduit on Structure Application.** Provide Schedule 80 PVC or rigid fiberglass conduit on structures.

B. **Cable.** Provide the number of stranded copper conductors for overhead and underground cables shown on the plans, or directed by the Engineer.

819.03. Construction.

A. **Conduit.** Build straight conduit runs. If the contract requires sweeps, use the largest radius that will fit the work space available for each sweep.

Provide conduit fittings and use methods of joining conduits, including conduit cement, in accordance with current NEC methods. If the NEC does not clearly describe the method, install the conduits in accordance with the manufacturer's recommendation. Obtain the Engineer's approval of installation methods before beginning work.

Attach end bells on the ends of conduits entering handholes to prevent damage to the cable.

Install continuous coilable conduit between handholes.

Extend conduit, not terminating in structures such as manholes, handholes, or foundations, 2 feet beyond pavement limit unless otherwise required. Plug unoccupied conduit.

Ensure new conduit, inserted into existing manholes or handholes, does not interfere with racking, training of cables, or both. Do not disturb existing cables.

1. **Bends.** Bend conduit to the radii specified in the current NEC requirements. For conduit entering foundations or cable pole envelopes, provide conduit with factory bends.

2. **Excavation.** Excavate the conduit trench to provide an earth cover of at least 30 inches over the finished conduit.

3. **Drainage.** Grade the trench to provide drainage to handholes.

4. **Grades.** Stake conduit grades at no greater than 50-foot intervals, or as directed by the Engineer. Create a grade that slopes at least 4 inches over 100 feet to the lowest manhole or handhole, or from the middle of the conduit run toward both holes.

5. **Backfill.** Place Class II granular material and tamp before placing conduit.

   Backfill trenches outside the roadbed with excavated material, suitable for backfill, as determined by the Engineer. If excavated material is unsuitable, backfill the trenches with Class II granular material in accordance with section 204.

   Backfill trenches within the limits of the roadbed with Class II granular material in accordance with section 204.

6. **Supports.** Provide support for conduit running through holes built over or into existing duct. If ducts are built into an existing handhole, build a 4-inch tapered pocket into the wall. Build new service ducts into existing handholes without interfering with cable racking. Install required inserts.

7. **Clearances.** Do not allow conduit or concrete encasement to contact obstructions. Provide a vertical clearance of 9 inches, except provide at least 12 inches of clearance for conduit running parallel to water lines, gas mains, and other underground structures not part of the electrical system.

   The Engineer and the owner of the obstruction will determine the method of protection if the Contractor cannot provide the required 12-inch clearance.

8. **Clearing.** After installing conduit runs, pull a mandrel 12 inches long, or shorter for conduit runs with bends, and with a diameter ½ inch smaller than the conduit. Attach a swab or cleaning device designed to clear the conduit, to the mandrel. Notify the Engineer before performing clearing work.

9. **Encased Conduit.** Encase conduit runs in Grade S2 concrete. Space adjacent conduits, at least 1 inch apart and fill the space with concrete. Provide a conduit encasement with at least 3 inches of concrete around the conduit. If steel reinforcement is required, separate the reinforcing bars from the conduits with 2 inches of

concrete. Provide at least 3 inches of concrete cover between the reinforcing bars and the surface of the encasement. Stagger conduit joints vertically.

Use concrete, plastic, or bituminized fiber as separators, spacers, blocks, or supports that will remain in the finished concrete encasement. If installing 20-foot lengths of conduit, place spacers no greater than 7 feet apart. If installing 10-foot lengths of conduit, place spacers no greater than 5 feet apart.

Prevent the conduit bank from floating after concrete placement by anchoring the bank to stakes at intervals no greater than 10 feet apart in firm soil and no greater than 5 feet apart in loose soil.

Ensure the concrete fully encases the conduit.

a. **Tier by Tier Method.** Grade the trench and place a foundation of concrete at least 3 inches thick in the bottom of the trench. If steel reinforcement is required, place the concrete at least 5 inches thick with reinforcing bars in place. Lay the bottom tier of conduits, separated by spacers. Fill the space between conduits with concrete and cover the conduits to the height of the next conduit tier. Construct succeeding tiers as specified for the first tier. Ensure continuous placement of successive tiers of conduit with interruptions no greater than 45 minutes.

b. **Build-Up or Monolithic Methods.** Grade the trench and place masonry supports at intervals from 3 feet to 5 feet apart, or a foundation of concrete at least 3 inches thick in the bottom of the trench. If steel reinforcement is required, place the concrete at least 5 inches thick with the reinforcing bars in place. Place the conduit using plastic or concrete separators, to erect a rigid, self-supporting structure of conduit. Place the concrete to fill the spaces between the conduits completely, without damaging or displacing them.

   Ensure the Engineer inspects conduit before encasing in concrete.

   Place a coupling on the ends of conduit and install a removable plug. Sheet and brace the trenches as required. Support pipes or other structures exposed in the trenches as required to prevent damage.

10. **Directional Bore.** Bore by augering or jacking a steerable rod and pulling back a cone reamer that expands the soil or a wing cutter that cuts a hole to the required diameter. Use a reamer or wing cutter

with a diameter no greater than 2 inches larger than the conduit, as shown on the plans.

The Contractor may use a drilling fluid of water and bentonite in directional drilling. The Contractor may use a polymer for lubrication in the drilling fluid.

Place directional bore or drill equipment and supplies so they do not interfere with traffic or with the use of adjacent property. Locate equipment and supplies a minimum distance from the edge of pavement as directed by the Engineer. Place access pits in the location of handholes, at the boring termination points, as shown on the plans or directed by the Engineer.

11. **Jacking and Boring.**

    a. **Compaction Auger (packer, expander).** Auger a rotating stem under the roadway then pull back a series of graduated cones that displace the soil to obtain the required diameter.

    b. **Hydraulic Push Rods or Stem (pipe puller, packer).** Push rods or stems under the roadway with a hydraulic ram and pull a series of graduated cones that displace the soil to obtain the required diameter.

    c. **Other Methods.** The Engineer may approve other jacking and boring methods before construction. Do not jet, or use water or air ahead of the casing.

    The Contractor may use air rams longitudinally in the right-of-way, but may use under roadways only if approved by the Engineer.

    Before jacking and boring, excavate a starter alignment trench to the elevation of the proposed conduit. Excavate a length of level trench at least 15 feet long for trenches up to 4 feet deep, and increase the trench length 5 feet for each additional 1 foot of depth.

    Use guide rails, sills, or other positive alignment devices to start the crossing. Restrain drive rods against horizontal and vertical movement.

    If using heads to develop an opening with a diameter greater than 2 inches, develop openings by increasing the head size in 1-inch increments.

    If the highway is super-elevated, start the bore from the lower side of the pavement.

The Engineer will determine if conditions warrant the use of sheeting and bracing. Use sheeting and bracing for boring as directed by the Engineer if access pits are located within the 1:1 slope from the edge of paved surfaces or back of curbs.

Place access pits in the location of handholes, at the boring termination points, as shown on the plans or directed by the Engineer.

Provide the bore and jack record sheet or log if requested by the Engineer.

Control ground water entering the excavation from seepage layers and lenses or pockets of saturated material from inside the excavation using drainage, bailing, pumping, or other methods. Do not remove or disturb adjacent soil while draining the ground water.

If ordinary methods of drainage prove unsatisfactory, as determined by the Engineer, drain excavations as required.

12. **Record Drawings.** Within five days after completing conduit work, or installing working cables, provide a record drawing to the Engineer. Show deviations from the original plans. Measure the lengths from the inside walls of the handholes and the center of post foundations and cable poles.

B. **Electrical Wire and Cable.** The Contractor may energize electrical wire and cables with a voltage no greater than 250 Volts alternating current (VAC).

Permanently tag wires and cables, in manholes, handholes, and cabinets at the points of entrance, exit, splicing, and termination. Label wires and cables to indicate the source and use of each. Tag wires and cables in manholes and handholes with a stamped brass tag.

Provide wires and cables with an additional length of at least 10 feet in each manhole and handhole.

Seal cable ends where the plans show coiling of cable.

Cut and remove cables within handholes and manholes for abandoned underground cables as shown on the plans.

Permanently label detector wiring harnesses at the connector with the source and use.

Do not splice signal cables or interconnect cables for traffic signals unless indicated in the plans.

C. **Direct Burial Cable.** Provide and install single conductor, direct burial cable.

1. **Approval.** Unless otherwise specified in the contract, the Department is the agency responsible for maintaining direct burial cable facilities. Provide certified test reports to the maintaining agency upon request.

2. **Installation.** Install direct burial cable as shown on the plans and in accordance with the manufacturer's recommendations. Do not drag cable on the ground. Do not splice cable underground. Install cable in continuous runs between manholes, handholes, or foundations.

3. **Location.** Install direct burial cable parallel to the edge of pavement, along the shoulder edge, clear of guardrail locations. Place cable in a straight line between visible reference points such as handholes or light standards.

4. **Excavation.** After compacting the subbase in the shoulder area to at least the elevation of the top of the base course, cut a trench at least 10 inches deep along the shoulder edge for placement of the direct burial cable.

   Remove rocks or other sharp objects from the trench. Lay the cable in the trench.

   Install marking tape from 6 inches to 18 inches above underground conduit or cable. Do not install marking tape above jacked and bored conduit. The Department will provide the marking tape.

   Provide 3 feet of cover over direct burial cable installed outside the shoulder.

5. **Cable Installed In Conduit.** If installing direct burial cable in conduit, use clean conduit, free of rough spots.

   Avoid damage to insulation and cable jackets during installation.

   When required, use lubricating compounds approved by the cable manufacturer. Use UL listed, non-injurious lubricants, on conduits, conductors, insulations, or jackets.

   Provide slack in each run of cable.

   Group multiple wires, trained through a box, manhole or handhole, by circuit. Bundle them using cable ties, and support them to reduce pressure or strain on cable insulation. Bend wire and cable in accordance with the manufacturer's recommended bending radius, during installation and in permanent placement.

Use a cable pulling apparatus with no sharp edges or protrusions.

6. **Testing.** Test direct burial cable for continuity, shorts, and grounds after installation and backfill. Replace cables that fail field tests with new cable at no additional cost to the Department.

D. **Equipment Ground Conductor.** Provide and install equipment grounding conductors (bare or THHN) to provide a continuous grounding of equipment throughout the electrical system. Install equipment grounding conductors and connect to light standard shafts, span wire, and ground rods to construct a continuous connection from the control cabinet to the light standards.

If installing conductors directly in earth with no conduit protection, the Contractor may use a bare conductor. Install the conductor 4 inches above the electric cable.

If installing the conductors in conduit, insulate the conductor and color code with green. Avoid damaging the conductor during installation.

Extend equipment ground conductor runs individually to the ground bus of the lighting controller.

E. **Handholes.** Provide and install, remove, salvage, reconstruct, abandon or adjust handholes, including covers and fittings as shown on the plans.

If the plans show existing cables maintained in new handholes, break and remove conduit and concrete encasements to the walls of the new handhole. Extend existing cables, train, rack, and support on the walls of the handhole.

1. **Remove or Abandon.** Remove handholes completely or abandon in accordance with section 204.

2. **Adjust.** Adjust handholes in accordance with section 403.

3. **Reconstruct.** Reconstruct handholes in accordance with section 403. Use existing frames and covers, unless otherwise directed by the Engineer.

4. **Installation.** Ensure handholes are flush with the pavement surface and 1 inch above grade outside paved areas. Install the frame and cover flush with the top of the handhole.

   Use cast-in-place or precast reinforced concrete handholes.

   Make the inner surface of reinforced handholes smooth. Sandblast castings. Cast handholes free of pouring faults, blow holes, cracks, and other imperfections. Cast handholes sound, true to form and

thickness, clean, and finished. Coat the castings with coal tar pitch varnish.

Provide and install cable racks and hooks.

Plug unused conduit entrances and conduit openings for future use by others with removable plastic plugs or other plugs approved by the Engineer.

Remove rubbish, construction debris, and water from handholes. Grout conduits from outside the handholes to inside the handholes.

5. **Excavation.** Excavate to the diameter and depth for installing handholes at locations shown on the plans.

6. **Drainage.** Cast drain holes at the bottom of the handhole. Ensure drainage of handholes installed over underground conduits and on bridge decks.

7. **Backfill.** Install the handhole on Class II Granular Material. The Engineer will determine if excavated material meets the backfill requirement. Use Class II granular material if the Engineer determines excavated material does not meet the backfill requirement.

F. **Light Standard Foundation.**

1. **General.** Install light standard foundations as shown on the standard plans.

2. **Remove.** Remove foundations in accordance with section 204 and restore the site as directed by the Engineer.

3. **Installation.** Drill foundation holes with an auger of the same diameter as the foundation. If the diameter of the auger cannot accommodate the planned foundation size, excavate the hole.

   Do not use construction rubble, broken sidewalk, or other deleterious material in place of concrete in the foundation. The Engineer will not accept cracked or otherwise deformed foundations.

   Obtain the Engineer's approval before placing foundations. Secure steel reinforcement, raceway conduits, and anchor bolts to each other in the augured hole to prevent displacement during concrete placement. Position anchor bolts accurately. Maintain the vertical alignment of anchor bolt projections on top of the foundation. Space the anchor bolts on the bolt circle and parallel to the curb. Place the lower portion of the foundation without forms, if the soil is stable and

the hole remains open. For unstable soil conditions, subject to cave-in, use forms for the entire depth of the hole for the foundation.

Form the upper 12 inches of the foundation and provide a smooth finish and a horizontal top surface.

Cure the foundations 7 days before installing bases and standards.

Backfill with Class II granular material. The Engineer will determine if excavated material meets the backfill requirement. If the Engineer determines excavated material does not meet the backfill requirement, use Class II granular material.

G. **Light Standard.** Install light standards, consisting of the light standard shaft and light standard arm, on new foundations, bridges, retaining walls, concrete barrier walls, frangible transformer bases, or other structures. Use new or salvaged materials.

1. **Submittals.** Submit Test Data Certifications for fabricated light standard and frangible transformer bases.

   Before installation, submit a complete set of light standard installation shop drawings, including fabrication drawings, to the Engineer for approval.

   Provide final approved shop drawings to the Engineer. Include contract and project numbers on the drawings.

2. **Shipping.** Provide clean shafts, free of scratches, dents, or similar disfiguring marks.

   Provide round standards with a uniform finish. Provide protection for the standards during shipping, handling, storage, and erection.

   Repair galvanized coating on light standard components, damaged in transportation, handling, or erection, in accordance with subsection 716.03.E, and at no additional cost to the Department.

3. **Testing.** At the Engineer's option, conduct testing as follows:

   a. Apply a 250-pound vertical load within 3 inches of the luminaire end of the bracket arm.
   b. The standard must sustain the 250-pound load without collapsing or rupturing portions of the standard assembly.
   c. The test load may permanently deform the bracket arm, provided no part collapses, ruptures, tears apart, or fails, causing the weight to fall to the ground.

d. Replace bracket arms deformed by the test load. The Engineer will measure replacement bracket arms for payment provided the original bracket arms meet or exceed all test parameters.

4. **Light Standard Frangible Base.** Provide and install, or remove, light standard frangible bases.

a. **Light Standard Frangible Base – Remove.** Remove the frangible base from the foundation. Take ownership of the removed frangible base.

b. **Construction.** Install frangible transformer bases on concrete foundations. Finish the top surface of the concrete foundation level to within ¼ inch over 10 feet of level. The Engineer will not allow the use of steel shaft foundations. Mount the frangible base directly on the concrete foundation and secure to the anchor bolts in accordance with manufacturer's specifications. Use lock washers. Do not use leveling nuts. Mount the frangible transformer base to the concrete foundation so the tabs project at least ½ the anchor bolt diameter beyond the nut. Complete the anchor bolt installation and tightening in accordance with subsection 810.03.N.

Tighten bolts connecting the pole to the frangible base in accordance with subsection 707.03.D.7. Use lock washers. Do not use bolt or nut covers.

Use a beveled washer to compensate for slopes greater than ¼ inch over 10 inches level on surfaces in contact with the bolt head and nut in accordance with subsection 810.03.N.

c. **Inspection.** Notify the Engineer, in writing, to request final inspection of light standard frangible bases. The Engineer will schedule and complete the inspection within 21 calendar days from receipt of the written request. The Engineer will arrange for the inspection in accordance with subsection 707.03.D.7.c, subsection 810.03.N, and subsection 819.03.

d. **Reporting.** The Structural Fabrication Engineer will notify the Engineer within the 21 calendar day inspection period about the acceptance or rejection of items. The Structural Fabrication Engineer will provide written inspection reports to the Engineer within the 21 calendar day inspection period.

Correct rejected items in accordance with subsection 707.03.D.7.c, subsection 810.03.N, and subsection 819.03 at no additional cost to the Department.

5. **Light Standard Arm.** Provide and install, or remove, light standard arms, including bracket arm assemblies.

   a. **Light Standard Arm — Install.** Install light standard arms, provided by the Engineer, on the required light standard shafts.

   b. **Light Standard Arm — Install Salvaged.** Install light standard arms, salvaged in accordance with subsection 819.03.G.5.d, on the required light standard shafts.

   c. **Light Standard Arm — Remove.** Remove light standard arms from the shaft. Take ownership of removed light standard arms.

   d. **Light Standard Arm — Remove and Salvage.** Remove and salvage light standard arms from the shaft. Transport light standard arms and hardware to a storage location, if required, as shown on the plans or otherwise directed by the Engineer.

      Replace parts of light standard arms, damaged during disassembly, handling, or storage operations, at no additional cost to the Department.

   e. **Light Standard Arm.** Provide and install light standard arms on the required light standard shafts.

6. **Light Standard Shaft.** Provide and install, or remove light standard shafts. The light standard shaft includes the shaft, anchor base, associated hardware, and No. 8 pole wire extending from the fusing at the base of the pole to the luminaire. Install two wires for each luminaire.

   a. **Light Standard Shaft — Install.** Install light standard shafts, provided by the Engineer, on the required light standard foundations.

   b. **Light Standard Shaft — Install Salvaged.** Install light standard shafts, salvaged in accordance with subsection 819.03.G.6.d, on the required light standard foundations.

      Replace parts of light standard shafts damaged during reassembly, at no additional cost to the Department.

   c. **Light Standard Shaft — Remove.** Remove light standard shafts from the foundations. Take ownership of removed light standard shafts.

   d. **Light Standard Shaft — Remove and Salvage.** Remove and salvage light standard shafts from the foundations. Transport

light standards and hardware to a storage location, if required, as shown on the plans or otherwise directed by the Engineer.

Replace parts of light standard shafts, damaged during disassembly, handling, or storage operations, at no additional cost to the Department.

e. **Light Standard Shaft — Single, Double, or No Arm.** Provide and install light standard shafts of the length required for single, double, or no arm light standards on the light standard foundations shown on the plans. If the plans show no arm light standard shafts, include the tenon at the top of the pole with the light standard shaft.

7. **Installation Details.** Install the light standards to a vertical position for the upper one-third of the shaft with the bracket arm and luminaire attached. Erect bracket arms at right angles to the edge of pavement. Install light standards so the handhole faces away from oncoming traffic. On barrier wall and bridge installations, install the handhole facing, and accessible from, the roadway.

Splice wire at access points, including handholes or access holes located on the shaft of the light standards. Loop direct burial wire up into the standards and make connections at the handholes.

Bond joints, insulate, and tape in accordance with the manufacturer's specifications for the type and cable voltage class. Use lug connectors or solder with non-corrosive flux for bonding joints. Use UL-approved plastic tape. Provide moisture-proof joints, insulated for the required voltage. Submit, to the Engineer for approval, samples of pre-insulated, solderless connectors, or mechanical connectors requiring special tools.

The Contractor may install luminaires with the light standards.

If installing luminaires with light standards, repair interior and exterior damage to the luminaires before operation, at no additional cost to the Department.

Ground the light standards in accordance with the current NEC requirements unless the local agency requirements exceed NEC grounding practices.

H. **Luminaires.** Provide and install, or remove and salvage luminaires. Use new or salvaged luminaires, as shown on the plans.

1. **General.** Provide luminaires of the type, size and lighting distribution pattern shown on the plans.

Individually package luminaires for shipment.

Paint the hood and refractor supporting member of cobra head luminaires gray.

2. **Submittals.** Provide the Engineer with a drawing showing a general diagram of the luminaire unit and the assembly and installation method.

   Provide a General Certification for luminaires.

3. **Luminaire.** Install luminaires of the size, type, and lighting distribution shown on the plans.

   a. **Luminaire — Install Salvaged.** Install luminaires, salvaged in accordance with subsection 819.03.H.3.c, on the light standard shaft and arm shown on the plans.

   b. **Luminaire — Remove.** Remove luminaires from the shaft and arm. Take ownership of the removed luminaires.

   c. **Luminaire — Remove and Salvage.** Remove and salvage luminaires from the shaft and arm. Transport the luminaires and hardware to a storage location, if required, as shown on the plans or otherwise directed by the Engineer.

      Replace parts of the luminaires damaged during disassembly, handling, or storage operations, at no additional cost to the Department.

4. **Installation.** Clean the luminaire reflector and glassware after installation in accordance with the manufacturer's recommendations.

I. **Tower Lighting Unit.** Construct tower lighting unit foundations in accordance with subsection 810.03.J and subsection 810.03.K. Provide and install tower lighting units with steel shafts and base plates, head frame assemblies, luminaire mounting rings, luminaires with ballasts and lamps, lowering devices, fused safety switches, lightning arresters, rodent screens, and related items to mount operating tower lighting units on foundations.

1. **Submittals.** Before fabrication, submit three copies of complete tower lighting unit shop drawings, including welding details, to the Engineer for approval. Include contract and job numbers.

   Provide three sets of the approved drawings to the Engineer.

   Submit a Test Data Certification covering the material used by the fabricator in the fabrication of the lighting installation. The Engineer may request check tests on certified material.

Submit the manufacturer's certification of the tower lighting unit design. Submit three copies of design calculations for the following:

a. Stress sized components of luminaire mounting rings,
b. Head frame assembly lowering devices,
c. Poles at joints, and
d. Sections through handholes and anchor bases.

2. **Shipping.** Repair galvanized poles and related components, damaged in transportation, handling or erection, in accordance with subsection 716.03.E, at no additional cost to the Department.

3. **Installation.** Obtain the Engineer's approval for the pole assembly method before beginning the work.

   After raising the luminaires to the normal operating position, ensure the center of the apparent light source of each luminaire is within 2 feet of the nominal mounting height, as measured from the top of the foundation.

   Provide and erect the pole without field welds.

   Field assemble sectional poles before erecting on the foundations.

   During the final assembly, place the pole on aligned supports and apply force to seat each splice. Use axial or concentric compressive loading applied by hydraulic jacks, turnbuckles, or cable coffing hoists, to obtain the last 3 inches of the lap. To ensure required lapping of the joint, place a temporary circumferential mark outside the lower tube. Mark the lower tube a distance of 1½ times the diameter plus 12 inches from the top. Consider the joint tight, when the bottom of the overlapping section is within 12 inches, measured equally around the pole, of the temporary mark.

   Erect the tower lighting unit so the horizontal offset at the top of the pole is within 4 inches of the true vertical position with respect to the base of the pole, and the offset at the midpoint of the pole is equal to or less than one-quarter of the offset position at the top of the pole. Install a rodent screen at the base of the pole, galvanized in accordance with ASTM A 123.

   The Engineer will direct when and how to determine pole alignment after erection.

4. **Field Test.** After anchoring the tower shaft in place, notify the Engineer to arrange for MDOT personnel to witness the raising and lowering of the luminaire ring. Raise and lower the ring at least three times.

Raise the ring to the working position and visually check to verify horizontal position. Energize the lamps and allow them to burn for at least 15 minutes before lowering. After lowering, inspect the ring for cable tension, levelness, hardware tightness, electrical connections, and power cord adjustments. Adjust the unit to ensure required operation of the lowering device and electrical system.

If the operation of the ring requires more adjustments after the required tests, raise the ring until operational deficiencies are corrected.

The Engineer will document successful completion of this field test before approving of the tower for operation.

J. **Wood Pole.** Provide and install, relocate, or remove wood poles and associated hardware for supporting span wire and bracket arm mounted traffic signals, and guying the pole if required.

Tamp the earth replaced around new or relocated poles. Fill, tamp, and level holes after removing poles. Use hot dip galvanized turnbuckles, tension tie bars, and associated steel hardware in accordance with ASTM A 153.

Set wood poles to the minimum depths specified in Table 819-1:

Table 819-1
Wood Pole Lengths and Depths

Pole Length	Depth
35 ft Class 4 pole	6 ft
40 ft Class 4 pole	6 ft
45 ft Class 4 pole	6½ ft
50 ft Class 4 pole	7 ft
55 ft Class 4 pole	7½ ft
60 ft Class 4 pole	8 ft

819.04. Measurement and Payment.

Pay Item	**Pay Unit**
Conduit, Rem	Foot
Conduit, Encased, (number), __ inch	Foot
Conduit, Directional Bore, (number), __ inch	Foot
Conduit, DB, (number), __ inch	Foot
Conduit, (type), __ inch, Structure	Foot
Conduit, (type), __ inch	Foot
Conduit, Schedule (number), __ inch	Foot
Conduit, Jacked Bored, (number), __ inch	Foot
DB Cable, 600 Volt, 1/C# (size)	Foot
DB Cable, in Conduit, 600 Volt, (number) 1/C# (size)	Foot

DB Cable, in Conduit, 600 Volt, 1/C# (size) ..... Foot
DB Cable, in Conduit, Rem ..... Foot
Cable, Rem ..... Foot
Cable, (type), Rem ..... Foot
Cable Pole, (type), Disman ..... Each
Cable, P.J., 600 Volt, 1, (size) ..... Foot
Cable, Sec, (volt), (number), (size) ..... Foot
Cable, Sec, (type), (number), (size) ..... Foot
Cable, Shielded, (volt), (number), (size), (type) ..... Foot
Cable, St Ltg, (volt), (number), (size), (type) ..... Foot
Cable, Equipment Grounding Wire, 1/C# (size) ..... Foot
Elec Serv, Rem ..... Each
Hh, (type) ..... Each
Hh, (type), (size) ..... Each
Hh, (work) ..... Each
Light Std Fdn ..... Each
Light Std Fdn, Rem ..... Each
Light Std, Frangible Transformer Base ..... Each
Light Std, Frangible Transformer Base, Rem ..... Each
Light Std Arm, (work) ..... Each
Light Std Arm, __ foot ..... Each
Light Std Shaft, (work) ..... Each
Light Std Shaft, Square, __ foot ..... Each
Light Std Shaft, 30 foot or less ..... Each
Light Std Shaft, __ foot to __ foot ..... Each
Light Std Shaft, 30 foot or less, Single Arm ..... Each
Light Std Shaft, __ foot to __ foot, Single Arm ..... Each
Light Std Shaft, 30 foot or less, Double Arm ..... Each
Light Std Shaft, __ foot to __ foot, Double Arm ..... Each
Luminaire ..... Each
Luminaire, (work) ..... Each
Luminaire, (watt) High Pressure Sodium ..... Each
Luminaire, (watt) High Pressure Sodium, Spec ..... Each
Luminaire, (watt) High Pressure Sodium, Rectangular ..... Each
Tower Ltg Unit, __ foot (Number) Luminaire ..... Each
Tower Ltg Unit, Fdn Cased ..... Foot
Tower Ltg Unit, Fdn Uncased ..... Foot
Wood Pole ..... Each
Wood Pole, Cl __, __ foot ..... Each
Wood Pole, Rem ..... Each
Wood Pole, Fit Up, (type) ..... Each
Concrete Pole, Fit Up, (type) ..... Each
Steel Pole, Fit Up, (type) ..... Each

Unless otherwise required, the unit prices for the pay items listed in this subsection include the cost of excavation, granular material, backfill, disposal of waste excavated material, and reestablishing turf in kind.

A. **Conduit.** The Engineer will measure conduit in place, from the inside walls of manholes, and the centers of handholes, post foundations, and cable poles.

The unit prices for **Conduit, Rem; Conduit, (type), __ inch** and **Conduit, DB, (number), __ inch** include the cost of installing or removing the type, number, and size of direct buried conduit shown on the plans, and installing marking tape.

The unit price for **Conduit, (type), __ inch, Structure** includes the cost of providing and installing the conduit components, hardware, and other appurtenances required.

The unit price for **Conduit, Jacked Bored, (number), __ inch** includes the cost of installing rigid metal, or Schedule 80 PVC conduit.

The unit price for **Conduit, Directional Bore, (number), __ inch** includes the cost of installing Schedule 80 polyethene conduit.

The unit price for **Conduit, Encased, (number), __ inch** includes the cost of the following:

1. Installing conduits,
2. Installing sheeting and bracing,
3. Removing boring pits, and
4. Filling voids.

The unit price for **Conduit, Schedule (number), __ inch** includes the cost of installing conduit approved for direct burial applications, as specified in subsection 819.02.A.1, and installing marking tape.

B. **Direct Burial Cable.** The Engineer will measure cables in place for the total length of the required conductors, single, multiple, or both.

The Engineer will measure direct burial cable, at grade, between centers of handholes, light standards, and poles.

The Engineer will not measure the following cable portions:

1. Looping,
2. Sag,
3. Trainers,
4. Splicing,
5. Racking,
6. Slack length, or

7. Length inside equipment.

The Engineer will measure the vertical length of cable from 2½ feet below grade to the pot head or service head at cable poles.

The unit prices for the relevant direct bury cable pay items include the cost of marking tape, bonding, tagging, and making splices, terminations, and connections.

The unit price for **DB Cable, in Conduit, 600 Volt, 1/C# (size)** includes the cost of pulling the cable in the conduit.

The unit price for **DB Cable, In Conduit, Rem** includes the cost of removing cables from the existing conduit.

C. **Cable, Removal.** The unit prices for **Cable, Rem** and **Cable, __, Rem** include the cost of dead ending, circuit cutting, installing guying, work required to leave circuits operable, and disposing of the removed cables, wire, hardware, and other appurtenances.

The unit prices for other items of work include the cost of abandoning cables and conduit.

D. **Cable, Pole Dismantle.** The unit price for **Cable, Pole, __, Disman** includes the cost of dismantling and off-site disposal of the following:

1. Riser pipe,
2. Cross arms,
3. Lightning arrestors,
4. Pot heads,
5. Cutouts,
6. Molding,
7. Weather cap,
8. Concrete encased bend, and
9. Other related materials.

E. **Cable, P.J.; Cable, Section; Cable, Shielded, and Cable, Street Lighting.** The Engineer will measure **Cable, P.J.**, **Cable, Sec**, **Cable Shielded**, and **Cable, St Ltg**, of the type required, including the number and size of conductors, in place from centers of manholes or handholes and between wood poles, and will add 10 feet of cable for every handhole.

The unit prices for **Cable, P.J.**, **Cable, Sec**, **Cable Shielded**, and **Cable, St Ltg**, of the type required, include the cost of the following:

1. Racking in manholes and handholes;
2. Bonding and tagging cables in manhole and handhole identifications;
3. Making splices and connections;

4. Cutting cable and re-splicing for service to traffic signals; and
5. Providing and installing the cable components, hardware, and other appurtenances required.

F. **Cable, Equipment Grounding Wire.** The Engineer will measure **Cable, Equipment Grounding Wire, 1/C# (size)** in a straight line between changes in direction and to the centers of light standards and the control cabinet. The Engineer will measure only one equipment grounding conductor if more than one circuit conductor run is installed in conduit.

The unit price for **Cable, Equipment Grounding Wire, 1/C# (size)** includes the cost of the following:

1. Installing grounding conductor in conduit,
2. Vertical conductors and required slack,
3. Bonding,
4. Tagging, and
5. Making splices and connections.

For traffic signals, the Department considers equipment grounding incidental to electrical work and will not pay for it separately.

G. **Electrical Service, Removal.** The unit price for **Elec Serv, Rem** includes the cost of returning the meter to the local utility company, and disposing of the removed concrete encased conduit, cables, hardware, and other appurtenances.

H. **Handholes (Hh).** The unit prices for handhole pay items include the cost of removing concrete encasement and conduit where new manholes or handholes access an existing conduit run as indicated on the plans, and installing cable racks and hooks.

The Department differentiates between **Hh, (type)** and **Hh, (type), (size)** based on the size, and type of material to construct the handhole.

The unit prices for **Hh, (type)** and **Hh, (type), (size)** include the cost of the frame and cover, ground rods, and treated wood foundations.

The Department will differentiate **Hh, (work)** pay items by the activities required to complete the work. The following pay items are **Hh, (work)** pay items:

1. **Handhole Adjust.** The unit price for **Hh, Adj** includes the cost of using existing frames and covers.

2. **Handhole Abandon.** The Engineer will measure **Hh, Abandon** by planned quantities. The unit price for **Hh, Abandon** includes the

cost of removing the frame and cover, and breaking down the wall structure.

The unit price for **Hh, Access** includes the cost of installing the following:

a. Access handhole openings and covers in existing steel poles,
b. Additional hardware,
c. Reinforcing frames,
d. Stainless steel screws, and
e. Other material required to complete the work.

3. **Handhole Reconstruct, Remove, and Salvage.** The unit price for **Hh, Reconst** includes the cost of using existing frames and covers.

   The unit price for **Hh, Rem** includes the cost of removing the handhole and restoring the site.

   The unit price for **Hh, Salvage** includes the cost of installing salvaged handholes.

I. **Light Standard Foundation.** The unit price for **Light Std Fdn** includes the cost of providing and installing the anchor bolts, conduit, hardware, and other appurtenances required.

The unit price for **Light Std Fdn, Rem** includes the cost of removing and disposing of foundations.

The Engineer will withhold 40 percent of the total contract value for **Light Std, Frangible Transformer Base** and **Light Std Fdn** until completion of inspection and reporting requirements specified in subsection 819.03.G.4.

J. **Light Standard Arm.** The unit price for **Light Std Arm**, of the size required, includes the cost of removing, installing, or salvaging light standard arms.

1. **Light Standard Shaft.** The unit price for light standard shaft pay items include the cost of installing the light standard shaft on the foundation or frangible transformer base, and providing street lighting circuit cable cutting, and splicing.

2. **Luminaire.** The unit price for **Luminaire** includes the cost of the following:

   a. Luminaire,
   b. Lamp,
   c. Wiring,
   d. Other material, and

e. Providing connections for making luminaire operational.

The unit price for **Luminaire (watt), High Pressure Sodium** includes the cost of providing and installing the complete luminaire, including the ballasts, lamps, and associated hardware and wiring.

K. **Tower Lighting.** The unit price for **Tower Ltg Unit, __ foot, __ Luminaire** includes the cost of the following:

1. Erection,
2. Aligning plumb,
3. Anchoring to the foundation,
4. Electrically wiring for operation, and
5. Testing of the unit.

The Engineer will measure **Tower Ltg Unit, Fdn Cased** and **Tower Ltg Unit, Fdn Uncased** vertically from the bottom to the top of the shaft. The unit prices for **Tower Ltg Unit, Fdn Cased** and **Tower Ltg Unit, Fdn Uncased** include the cost of providing and installing the anchor bolts, conduit, casing, hardware, and other appurtenances required.

L. **Wood Pole.** The unit price for **Wood Pole** includes the cost of providing and installing pole markers, additional support, components, hardware, and other appurtenances required, and transferring wires from old to new poles.

The unit price for **Wood Pole, Cl __, __ foot** includes the cost of guying wood poles of the required class.

The Engineer will measure **Wood Pole, Rem** based on plan quantities.

The unit price for **Wood Pole, Rem** includes the cost of removing and storing, if required, poles, concrete, pole bases and hardware.

The unit price for **Wood Pole, Fit Up** includes the cost of arranging wire on poles, and providing and installing the components, wires, hardware, and other appurtenances required.

M. **Concrete Pole, Fit Up.** The unit price for **Concrete Pole, Fit Up** includes the cost of providing and installing the conduit, wires, hardware, and other appurtenances required.

N. **Steel Pole, Fit Up.** The unit price for **Steel Pole, Fit Up** includes the cost of providing and installing the conduit, wires, hardware, and other appurtenances required.