

2. The characteristics of the equipment failure or faulty operation evident before repair.
3. The changes made or corrective actions taken.
4. The printed name and signature of the person responsible for making the repairs or changes.

The Engineer will limit signal system shutdowns to the hours traffic restrictions allowed in subsection 643-3.08, Construction Sequencing. During shutdowns, use flag persons to control traffic. Provide local traffic enforcement and maintenance agencies 24 hour notice before shutting down a traffic signal system.

Locate existing conduit runs, buried cables, junction boxes, and underground utilities before starting work that may damage these facilities or interfere with these systems.

Where roadways remain open to traffic and the work includes modifying the existing lighting systems, energize the modified circuit by sunset on the same day the Contractor retires the original circuit.

Relocate or replace signal poles, lighting standards, sign poles, flashing beacon poles, load centers, and controller cabinets whenever reducing clearance from the traveled way to less than 6 feet.

Alignment. During the various phases of construction, shift the signal heads to keep them aligned horizontally and vertically with the approaches according to the following:

1. For overhead signals located 53 feet and more from the stop line, maintain 17.5 feet to 21.5 feet of clearance between the traveled way and the bottom of each signal. For closer signals refer to the MUTCD for maximum clearances.
2. For side mounted signals, maintain nine feet to 11 feet of clearance between the traveled way and the bottom of the signal.
3. Align overhead signals controlling a single lane with the center of the lane.
4. Align overhead signals controlling two or more lanes with the lane lines separating the lanes.
5. When the horizontal angle to the side mounted far right signal exceeds 20°, relocate this signal to an overhead location. Measure the angle 10 feet back from the stop line on the lane line between the two farthest left through lanes.
  - i. With two or more through lanes, center one signal head over each lane.

- ii. With one through lane and protected permitted signal phasing, leave the five section signal over the lane line and center the signal to be relocated over the through lane.
  - iii. Otherwise, install the relocated signal 8 feet to the right of the signal centered over the through lane.
6. For pedestrian signals, maintain 7 to 9 feet between the traveled way and the bottom of each pedestrian signal.
  7. Aim signal heads according to Table 660-2 found in subsection 660-3.08, Signal and Lighting Structures.

When no longer required, salvage original and Department provided equipment according to the Plans and item 6. Salvaging or Reusing Electrical Equipment found in subsection 660-3.01, and remove other materials used in the temporary systems from the project.

Add the following Subsection:

**660-3.11 DIRECTIONAL BORE.** The work specified in this Subsection documents the approved construction methods, procedures and materials for Directional Boring, also commonly called Horizontal Directional Drilling (HDD).

1. General. HDD is a trenchless method for installing a product that serves as a conduit for liquids, gasses, or as a duct for pipe, cable, or wire line products. It is a multi-stage process consisting of site preparation and restoration, equipment setup, and drilling a pilot bore along a predetermined path and then pulling the product back through the drilled space. When necessary, enlargement of the pilot bore hole may be necessary to accommodate a product larger than the pilot bore hole size. This process is referred to as back reaming and is done at the same time the product is being pulled back through the pilot bore hole.

Accomplish alignment of the bore by proper orientation of the drill bit head as it is being pushed into the ground by a hydraulic jack. Determine orientation and tracking of the drill bit by an above ground radio detection device which picks up a radio signal generated from a transmitter located within the drill bit head. Then electronically translate the radio signal into depth and alignment. In order to minimize friction and prevent collapse of the bore hole, introduce a soil stabilizing agent (drilling fluid) into the annular bore space from the trailing end of the drill bit. The rotation of the bit in the soil wetted by the drilling fluid creates a slurry. The slurry acts to stabilize the surrounding soil and prevent collapse of the bore hole as well as provides lubrication.

Select or design drilling fluids for the site specific soil and ground water conditions. Confine free flowing (escaping) slurry or drilling fluids at the ground surface during pull back or drilling. Accomplish this by creating sump areas or

vacuum operations to prevent damage or hazardous conditions in surrounding areas. Remove all residual slurry from the surface and restore the site to preconstruction conditions.

2. Materials.

- a. General. Materials are defined as pipe or conduit that becomes the installed product. Incidental materials that may or may not be used to install the product depending on field requirements are not paid for separately and will be included in the cost of the installed product.
- b. Material Type. The following material standards are to be interpreted as the minimum in place standards. Use materials that are appropriate for the stresses generated by the selected equipment and field conditions. It is not intended to portray that the use of materials with these minimum material standards will retain their required properties if the stress limits are exceeded for which they were designed during installation. Ensure that the appropriate material is used to retain compliance once it is installed.

Material Standards for HDD Installation		
Material Type	Non-Presssure	Pressure
Polyethylene (PE)	ASTM D 2447	ASTM 2513 ASTM D 2447
High Density Polyethylene (HDPE)	ASTM D 2447 ASTM D 3350 ASTM F714	ASTM D 2447 ASTM D 3350 ASTM F714 ASTM 2513
Polyvinyl-Chloride (PVC)	ASTM F 789	N/A
Steel	ASTM A139 Grade B <sup>(1)</sup>	AWWA C200 API 2B <sup>(2)</sup>
<sup>(1)</sup> No hydrostatic test required		
<sup>(2)</sup> Dimensional tolerances only		

3. Site Conditions.

- a. Carry out excavation for entry, exit, recovery pits, slurry sump pits, or any other excavation as specified in the specifications. Sump pits are required to contain drilling fluids if vacuum devices are not operated throughout the drilling operation, unless approved by the Engineer.
- b. Within 48 hours of completing installation of the boring product, clean the work site of all excess slurry or spoils. Take responsibility for the removal and final disposition of excess slurry or spoils. Ensure that the work site is restored to pre-construction conditions or as identified on the plans.

4. Damage Restoration. Take responsibility for restoration for any damage caused by heaving, settlement, separation of pavement, escaping drilling fluid (frac-out), or the directional drilling operation, at no cost to the Department.
5. Remediation Plans. When required by the Engineer, provide detailed plans which show how damage to any roadway facility will be remedied. When remediation plans are required, they must be approved by the Engineer before any work proceeds.
6. Quality Control. Take control of the operation at all times. Have a representative who is thoroughly knowledgeable of the equipment, boring and Department procedures, present at the job site during the entire installation and available to address immediate concerns and emergency operations. Notify the Engineer 48 hours in advance of starting work. Do not begin installation until the Engineer is present at the job site and agrees that proper preparations have been made.
7. Failed Bore Path. If conditions warrant removal of any materials installed in a failed bore path, as determined by the Engineer, it will be at no cost to the Department. Promptly fill all voids by injecting all taken out of service casings/pipes that have any annular space with excavatable flowable fill.
8. Locating and Tracking. Use a locating and tracking system capable of ensuring that the proposed installation is installed as intended.
9. Bore Hole Diameter. Minimize potential damage from soil displacement/settlement by limiting the ratio of the bore hole to the product size. The size of the back reamer bit or pilot bit, if no back reaming is required, will be limited relative to the casing diameter to be installed as follows:

Maximum Pilot or Back-Reamer Bit Diameter When Rotated 360 Degrees	
Nominal Inside Pipe Diameter - Inches	Bit Diameter - Inches
2	4
3	6
4	8
6	10
8	12
10	14
12 and greater	Maximum Product OD plus 6

10. Drilling Fluids. Use a mixture of bentonite clay or other approved stabilizing agent mixed with potable water with a minimum pH of 6.0 to create the drilling fluid for lubrication and soil stabilization. Vary the fluid viscosity to best fit the soil conditions encountered. Do not use any other chemicals or polymer surfactants in the drilling fluid without written consent from the Engineer. Certify to the Engineer in writing that any chemicals to be added are environmentally safe and not harmful or corrosive to the facility. Identify the source of water for

mixing the drilling fluid. Approvals and permits are required for obtaining water from such sources as streams, rivers, ponds or fire hydrants. Any water source used other than a potable water may require a pH test.

11. **Equipment Requirements.** Ensure that appropriate equipment is provided to facilitate the installation as follows:

HDD Equipment				
System Description	Pipe <sup>(1)</sup> Diameter Inches	Bore Length Feet	Torque Ft-Lbs	Thrust/Pullback Lbs
Maxi-HDD	18 and greater	>1,000	>10,000	>70,000
Midi-HDD	Up to 16	Up to 1,000	1,900 to 9,999	20,001 to 69,999
Mini-HDD	Up to 6	Up to 600	Up to 1,899	Up to 20,000
<sup>(1)</sup> For the above, multiple pipe or conduit installations must not exceed the total outside pipe diameters stated above.				

Match equipment to the size of pipe being installed. Obtain the Engineer's approval for installations differing from the above chart. Ensure that the drill rod can meet the bend radius required for the proposed installation.

12. **Thrust/Pullback Requirements.** Unless approved by the Engineer, limit use of HDD equipment to installing the following product sizes and lengths based on the following casing size, force and length relationships.

HDD Bore Equipment Thrust/Pullback Capacity						
Lbs	5,000 to 7,000	7,001 to 12,000	12,001 to 16,000	16,001 to 25,000	25,001 to 40,000	>40,000
Casing Size <sup>(1)</sup> Inches	Maximum Pullback Distance In Feet					
4 or <	400 or <					
6 or <		600 or <				
8 or <			800 or <			
10 or <				1,000 or <		
12 or <					2,000 or <	
>12						Engineer's Discretion
<sup>(1)</sup> for the above, where a single pull of multiple conduits is to be attempted, the applicable product size must be determined by the diameter of a circle that will circumscribe the individual conduits as a group.						

13. **Drilling Operations.**

- a. **Installation Process.** Ensure adequate removal of soil cuttings and stability of the bore hole by monitoring the drilling fluids such as the pumping rate, pressures, viscosity and density during the pilot bore, back reaming and pipe installation. Relief holes can be used as necessary to relieve excess pressure down hole. Obtain the Engineer's approval of the location and all

conditions necessary to construct relief holes to ensure the proper disposition of drilling fluids is maintained and unnecessary inconvenience is minimized to other facility users.

To minimize heaving during pull back, the pull back rate is determined in order to maximize the removal of soil cuttings without building excess down hole pressure. Contain excess drilling fluids at entry and exit points until they are recycled or removed from the site or vacuumed during drilling operations. Ensure that entry and exit pits are of sufficient size to contain the expected return of drilling fluids and soil cuttings.

Ensure that all drilling fluids are disposed of or recycled in a manner acceptable to the appropriate local, state, or federal regulatory agencies. When drilling in suspected contaminated ground, test the drilling fluid for contamination and appropriately dispose of it. Remove any excess material upon completion of the bore. If in the drilling process it becomes evident that the soil is contaminated, contact the Engineer immediately. Do not continue drilling without the Engineer's approval.

The timing of all boring processes is critical. Install a casing into a bore hole within the same day that the pre-bore is completed to ensure necessary support exists.

- b. Boring Failure. If an obstruction is encountered during boring which prevents completion of the installation in accordance with the design location and specification, the pipe may be taken out of service and left in place at the discretion of the Engineer. Immediately fill the product left in place with excavatable flowable fill. Submit a new installation procedure and revised plans to the Engineer for approval before resuming work at another location. If, during construction, damage is observed to the roadway facility, cease all work until resolution to minimize further damage and a plan of action for restoration is obtained and approved by the Engineer.

**660-4.01 METHOD OF MEASUREMENT.** Delete the first paragraph and replace with the following: Item 660(9), Bored Casing. The method of measurement will be based on the length of bored or jacked casing or **conduit bundle** measured in place along the surface of the ground, complete and accepted. No additions or deductions will be made for sweeps in either the vertical or horizontal direction to complete the installation, **nor for multiple casings or conduits installed in a single bore. Outer casing enclosing the conduit may be installed at the contractor's expense.**

**660-5.01 BASIS OF PAYMENT.** Add the following: The amount bid for an item shall include full compensation for:

1. All excavation, bedding, and backfill to install the components shown in the Plans. Dewatering excavations is a subsidiary obligation of completing the excavation work.
2. Removing and repairing existing improvements to complete the work, the repairs of which are not covered by other items in the contract.
3. All work associated with installing loop detectors, including: saw cutting, asphalt removal, aggregate base course, tack coating, and installing new asphalt concrete.

The Engineer will pay for the disposal of all surplus and unusable excavation and for all imported backfill and bedding material at their respective contract unit prices, or as extra work if the contract does not include these items.

The costs of repairing damage to finishes on new equipment are a subsidiary obligation.

The costs of maintaining the existing and temporary electrical system to keep them fully operational are a subsidiary obligation of the 660 items included in the contract.

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Add the following:

Bored Casing.

**Bored casing consists of casing or conduit installed by the directional boring method.** Price and payment to install bored casing will be full compensation for all work specified in this Section, including furnishing and installing pipe or conduit, from plan point of beginning to plan point of ending at plan depth, removal of excavated materials and spoils, removal and disposal of drilling fluids, backfilling, and complete restoration of the site. Bundled casings **or conduit** in a single bore will be paid for as a single bore based on the required drill bit head or back reamer head size. Separate payment shall not be made for individual casings **or conduit** in a bundle.

The installation and attachment of tracking conductors (wire or tape) will be included in the cost of the bore and will not be paid for separately.

No payment will be made for failed bore paths, injection of flowable fill, bored casings taken out of service, **additional or outer casings installed for the convenience of the contractor**, or incomplete installations.

## SECTION 661

### ELECTRICAL LOAD CENTERS

#### Special Provisions

Add the following subsection:

**661-1.02 EQUIPMENT LIST (S) AND DRAWINGS.** Within 14 days following award of the contract, submit 4 collated copies of a portfolio of equipment and material to be installed. The Department will review these for approval. The portfolio(s) shall consist of a table of contents which includes each item's intended use(s) and the following:

1. For materials on the Approved Products List: a description that includes product name, manufacturer, model or part number, and the conditions listed for approval.
2. For materials not on the Approved Products List: catalog cuts that include the manufacturer's name, type of product, size, model number, conformance specifications, and supplemented by other data as may be required, including manufacturer's maintenance and operations manuals, or sample articles.

This information may be included in the portfolio for 660 items.

The Department will not be liable for materials purchased, labor performed, equipment used, or delay to the work before equipment and materials have been reviewed and approved.

**661-2.01 MATERIALS.** Add the following to the paragraph titled Meters: Furnish meter sockets and landing pads rated for 200 ampere services.

**661-5.01 BASIS OF PAYMENT.** Add the following: Payment of fees required by the local authority for an electrical inspection and the costs of correcting the deficiencies noted during the inspection will be considered incidental to the Section 661 items.