DIVISION 700

DRAINAGE, TRAFFIC, AND ROADSIDE CONSTRUCTION

SECTION 701 — CULVERT PIPE, ENTRANCE PIPE, STORM SEWER PIPE, AND EQUIVALENTS

701.01 DESCRIPTION. Furnish and install culvert pipe, entrance pipe, and storm sewer pipe. Use units conforming to the dimensions, fabrication, material, and strength requirements for the type (culvert, entrance, or storm sewer), diameter, cover height, and pH level the Contract specifies. This work may include removing pipe, and relaying pipe.

701.02 MATERIALS.

701.02.01 Pipe. Use reinforced concrete pipe, corrugated metal pipe, polyvinyl chloride (PVC) pipe, high density polyethylene (HDPE) pipe, or corrugated polypropylene (PP) pipe conforming to Section 810.

701.02.02 Structural Plate Pipe. Conform to Section 809 for the following:

1) Corrugated Aluminum Alloy Circular Pipe with Longitudinal Seam with Aluminum or Steel Bolts.
2) Corrugated Aluminum Alloy Circular Pipe Arch with Longitudinal Seams with Aluminum or Steel Bolts.
3) Corrugated Steel Pipe Arch with Longitudinal Seams with Steel Bolts.
4) Corrugated Steel Pipe with Longitudinal Seams with Steel Bolts.

701.02.03 Joint Materials.

A) Mortar Joints. Conform to Section 801 for cement and Section 804 for mortar sand.
B) Asphalt Mastic Joint Sealing Compound. Conform to Subsection 807.03.04.
C) Rubber Gaskets. Conform to Subsection 807.03.04.
D) Butyl Rubber Sealants. Conform to Subsection 807.03.04.
E) Elastomeric Seals. Conform to ASTM F477.
F) Couplings for Thermoplastic Pipe. Conform to Section 810.
G) Cleated and Non-Cleated, Integral Welded Bell Coupler with Gaskets. Conform to Section 810.
H) Coupling Bands. Conform to Section 810.04.04

701.02.04 Bedding Materials. Use No. 8 aggregate, No. 9-M aggregate, or a fine aggregate conforming to Subsection 804.08 for bedding material. Do not use a DGA or gravel base material for bedding material.

701.02.05 Backfill Materials.

A) Granular Backfill.

1) For Reinforced Concrete Pipe. Use size No. 2, 23, 3, 357, 4, 467, 5, 57, 67, 68, 78, 8, or 9M aggregate or material conforming to AASHTO M 145 Al or A3 material with a maximum plasticity index of 10 (see table below). Limit rock fragments to a 3-inch maximum size.
2) For Corrugated Metal Pipe. Use size No. 2, 23, 3, 357, 4, 467, 5, 57, 67, 68, 78, 8, or 9M aggregate or material conforming to AASHTO M 145 Al or A3 material with a maximum plasticity index of 10 (see table below). Limit rock fragments to a size that does not exceed the corrugation width.
3) For Thermoplastic Pipe. Use size No. 5, 57, 67, 68, 78, 8, or 9M aggregate or material conforming to AASHTO M 145 Al or A3 material (see table below).

Limit rock fragments to a 1.5-inch maximum size. For corrugated pipe, limit rock fragments to a size that does not exceed the corrugation width or 1.5 inches, whichever is least.

4) For Structural Plate Pipe. Use Structure Granular Backfill conforming to Section 805.

A1 and A3 Characteristics[1]			
		A1	A3
Sieve Analysis:	Percent passing No. 10	—	—
	Percent passing No. 40	50 max	51 min
	Percent passing No. 200	25 max	10 max
Plasticity index of material passing No. 40		6 max	—

[1] *For a complete description see AASHTO M 145*

B) Flowable Fill. Conform to Subsection 601.03.03 B).

701.02.06 Embankment. Conform to Subsection 206.

701.02.07 Geotextile Fabric Material. Use fabric with a minimum width of 36 inches conforming to Section 843, fabric for subsurface drainage and separation.

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701.02.08 Asphalt Material for Coating. Conform to Section 806.

701.03 CONSTRUCTION.

701.03.01 Pipe Foundations. Take soundings for the pipe foundation design at the inlet and outlet, and along the grade line of each culvert on 20 foot intervals. Take the soundings to a depth of 1/2 inch per foot of embankment height (measured from the crown of the pipe to the maximum fill height) or 24 inches, whichever is greater.

Where rock foundations (ledge rock, gravel, hardpan or other unyielding material) are encountered or known to exist within the limits specified, prepare the foundation according to the Standard Drawings.

Where unstable (soft) foundations are encountered at the established grade line, remove the material that the Engineer determines is unstable and replace with a material conforming to Subsection 701.02.04. The Department will determine the depth of the over excavation by a soils investigation for the specific structure. Wrap the replacement material in geotextile fabric when backfilling.

701.03.02 Trench Conditions. Install all pipe in excavated trenches. Where an embankment condition exists, excavate the trench only after constructing the embankment according to Section 206 to an elevation equal to, or greater than, the minimum cover height of the pipe.

701.03.03 Pipe Bedding.

A) Reinforced Concrete Pipe. Construct bedding according to the Standard Drawings and this section.

1) Type 1 Installation. When working on a rock foundation, place bedding to a depth of 6 inches or equal to Bc/12, the pipe diameter in inches divided by 12, whichever is greater. For all other foundations, place a minimum of 4 inches of bedding. Shape the bedding to conform to the invert shape

throughout the entire width and length of the proposed structure. Compact the bedding, but leave the center third of the pipe diameter (Bc/3) uncompacted. Place and compact additional bedding material in lifts 6 inches or less to an elevation of 0.30 the culvert diameter.

2) Type 4 Installation. When working on a rock foundation, place bedding to a depth of 6 inches or equal to Bc/12, the pipe diameter in inches divided by 12, whichever is greater. For all other foundations, place a minimum of 4 inches of bedding.

B) Corrugated Metal, Thermoplastic, and Structural Plate Pipe. Place and compact bedding to provide 4 inches of bedding below the outside invert of the pipe after shaping. Shape the bedding to conform to the invert shape throughout the entire width and length of the proposed structure. Place and compact additional bedding material in lifts 6 inches or less to an elevation of 0.30 the culvert diameter.

701.03.04 Pipe Hauling, Handling, and Installation. Furnish a copy of the manufacturer's handling and installation procedures to the Engineer before beginning work. Ensure that pipe structures do not sustain damage during loading, unloading, placement on the bedding, compaction of the backfill, by movement of excessively heavy equipment over the fill, or by any other forces that may cause damage. Repair or replace damaged structures as the Engineer directs. Remove and replace any structure that is not constructed to true alignment or shows undue settlement after installation, or is otherwise damaged, without additional compensation.

A) Reinforced Concrete Pipe. Install the pipe beginning at the outlet end of the culvert, with the bell or groove end laid upgrade. Extend successive spigot or tongue ends fully into each adjoining bell or groove. When the pipe includes markings to designate the top and bottom, lay the pipe so the mark is less than 5 degrees from the vertical plane throughout the longitudinal axis of the pipe. Cover all lift holes after installing the pipe by the following:

1) Coat an area 8 inches or wider than the holes on the outside of the pipe with an asphalt coating material;
2) Place a piece of sheet metal 4 inches or wider than the holes and shaped to conform to the outer pipe diameter over each hole; and
3) Apply an additional coating of asphalt material over the entire area of previously applied metal. When desired, use precast lift hole plugs instead of the asphalt and sheet metal.

B) Corrugated Metal Pipe.

1) Asphalt Coating. Apply according to AASHTO M-190.
2) Transporting and Handling. Transport and handle coated pipe using equipment and methods that prevent damage to the coating. When storing pipe on the project, keep it supported above the ground using wooden timbers or pallets. Repair minor damage to exterior and interior coating with asphalt coating material according to AASHTO M 243 or as the Engineer directs before installing the pipe. Repair significant damage and coating deficiencies at the pipe fabrication site as the Engineer directs. Significant damages include spalled coating on the interior of the pipe, uncoated areas due to manufacturing error, and insufficient coating thickness on the interior or exterior of the pipe.

At all times during construction, use every precaution to prevent damage to the protective coating. Do not allow any metal tools or heavy objects to unnecessarily come in contact with the finished coating. Repair any damage

to the protective coating from any cause during installation and before final acceptance as the Engineer directs.

3) Installing. Assemble according to the manufacturer's instructions. Install in the bed starting at the downstream end. When using corrugated metal pipe with paving material, install the pipe with paving material along the bottom centerline or flowline. Construct struts and vertical elongation of corrugated metal pipe as specified in the Plans. Remove the struts only after completing the embankment over the structure.

C) Thermoplastic Pipe. Handle thermoplastic pipe according to the manufacturer's recommendations. Provide a manufacturer's technical representative to assist in the installation of the pipe when the Engineer requests.

D) Structural Plate Pipe. Install the pipe according to the manufacturer's specifications and installation procedures. When the Engineer requests, provide a manufacturer's technical representative to assist in pipe construction. Do not place backfill until all plates in a ring are complete and all bolts in the structure are tightened.

701.03.05 Joints. Provide soil tight joints. Wrap all pipe joints with a geotextile fabric. The Department will require remediation for pipe sections that do not meet the requirements of the specifications in accordance with the joint separation table in Section 701.05.

A) Reinforced Concrete Pipe. Use only one type of jointing materials system throughout each single structure. Construct joints for reinforced concrete pipe with one of the following options.

1) Mortar Joints. Use a mixture containing one part cement and 2 parts sand. Use enough water, not exceeding 5 1/2 gallons per sack of cement, to product a stiff, workable mortar. Thoroughly clean and wet the ends of the pipe before joining them. Place the mortar in the lower half of the bell or groove section that has been laid, and apply mortar to the upper half of the spigot or tongue of the pipe that is being laid. Insert the spigot or tongue in the bell or groove of the pipe already laid, pull the joint tight, and ensure that the inner surfaces of the abutting sections are flush and even. After laying a section of the pipe and before laying the succeeding section, thoroughly plaster the lower portion of the bell or groove of the preceding section on the inside with mortar to such a depth to ensure a smooth joint between the abutting sections. Fill the remainder of the joint flush with mortar. Finish the inside of the joint and wipe smooth around the full circumference. After the initial set, protect the mortar from air and sun with a burlap cover, or permanently backfill.
2) Asphalt Mastic Joints. Immediately before installation, apply the asphalt mastic joint sealing compound to the ends of the pipe section in the same manner as mortar joints except precoat all joining surfaces. Precoat with the manufacturer's recommended primer or an approved emulsified asphalt. Complete installation as per manufacturer's recommendations.
3) Rubber Gaskets. In addition to the requirements of Subsection 701.02, use a pipe section conforming to AASHTO M 315. Use the gasket manufacturer's recommended cement and lubricant. Snugly fit the rubber gasket in the beveled surface of the tongue and groove ends of the sections to form a flexible seal under all conditions of service. Complete installation as per manufacturer's recommendations.
4) Butyl Rubber Sealants. In addition to the requirements of Subsection 701.02, use pipe with a joint design conforming to AASHTO M 198.

When a joint is located 12 feet or less from the outlet on a 3:1 or steeper slope, provide a tied joint according to the Standard Drawings.

B) Corrugated Metal Pipe. Construct joints using a band with annular corrugations and a bolt, bar and strap connection. Use a minimum nominal band width of 12 inches for all pipe diameters 54 inches and smaller. Use a two-piece band with a minimum nominal width of 20 inches for all pipe diameters greater than 54 inches. Manufacture the band from the same base materials as the pipe. The pipe bands may be up to two gauges lighter than the pipe it is joining, with a minimum gauge thickness of 16. The Department may allow dimple band connections for field cut pipe. Install the connecting bands according to the manufacturer's written recommendations.

C) Thermoplastic Pipe. Use an integral bell and spigot type with elastomeric seal joints. When a joint is located 12 feet or less from the outlet on a 3:1 or steeper slope, use a cleated integral bell locking joint or a standard coupling aided by two #14 by 2-inch galvanized sheet metal screws inserted through the coupling into the corrugation crest 2 inches apart circumferentially at the bell and spigot coupler's quarter points.

701.03.06 Initial Backfill. Locate a suitable backfill source for each project. For backfill containing soils, have an AASHTO accredited lab classify the material, run a standard proctor, and certify that the material conforms to the specified granular material. Keep the material certification on file and available to the Engineer upon request.

Place the backfill material in a trench condition as the Contract specifies. Use 6-inch lifts and ensure the backfill is compacted to not less than 95 percent of the maximum density as determined according to KM 64-511.

When the top of the pipe is within one pipe diameter of the subgrade, backfill with flowable fill to an elevation of one foot above the pipe from the outside edge of shoulder or back of curb to outside edge of shoulder or back of curb as applicable. When installing under existing pavement, backfill with flowable fill to the subgrade elevation. When granular backfill is used, the surrounding conditions are not similar in gradation, and the pipe is located within the area bounded by the centerline and a distance 25 feet outside the edge of shoulder or back of curb, as applicable, wrap the bedding and granular backfill in geotextile fabric. The Department will not require geotextile fabric for entrance pipe. When geotextile fabric is required according to this section or the Engineer's direction, install according to Section 214.

When the Contract specifies, perform quality control testing to verify compaction according to KM 64-512. The Department may verify the density results at any time of the duration of the project.

A) Reinforced Concrete Pipe.

1) Type 1 Installation. When the top of the pipe is not within one pipe diameter of the subgrade, backfill with granular backfill, additional bedding material, or flowable fill from the top of the bedding to an elevation equal to 1/2 the pipe diameter, and either granular backfill, flowable fill, or embankment material in 6-inch lifts to an elevation of one-foot above the pipe.
2) Type 4 Installation. Backfill from the top of the bedding with granular backfill, flowable fill, or embankment material in 6-inch lifts to an elevation of one-foot above the pipe. The Department will allow Type 4 installations for median drains and pipe installations located 35 feet or more from the edge of shoulder, back of curb, or any paved surface.

B) Corrugated Metal, Thermoplastic, and Structural Plate Pipe. When the top of the pipe is not within one pipe diameter of the subgrade, backfill with either

granular backfill or flowable fill to an elevation at least one foot above the top of the pipe.

701.03.07 Construction Loads. Do not allow construction equipment or traffic to travel over the top of the structure material until the fill is compacted to a minimum depth of 48 inches over the top of the structure. The Engineer may require temporary cover where the final grade is less than 48 inches. The Engineer may raise but will not lower the minimum cover based on the pipe manufacturer's recommendations.

701.03.08 Inspection of Pipe. The engineer will visually inspect all pipe.

The Department will require camera/video inspection on projects that have more than 250 linear feet of storm sewer and/or culvert pipe and on routes with an ADT of greater than 1,000 vehicles. Conduct camera/video inspections in accordance with KM 64-114 on 100 percent of the pipes that are located under the road and 50 percent of the pipes that are not under the road. Storm sewer runs and outfall pipes not under the roadway take precedence over rural entrance pipes. Camera/video and laser deflection inspection must be completed by a prequalified contractor that has been certified according to KM 64-114. Contractors performing this item of work must be prequalified with the Department in the work type J51 (Video Pipe Inspection and Cleaning). Testing performed by a company failing to meet these requirements will result in non-payment of the pipeline video inspection and non-certification of the pipe tested.

Deflection testing using the laser deflection method shall be limited to pipe up to 48 inches in diameter. Deflection testing using physical measurements is limited to pipes where adequate access is available and to pipes 48 inches and larger in diameter. Mandrel or physical measuring will be used for pipes larger than 48 inches in diameter. Deflection testing is not required for concrete pipe. The pipe to be tested will be selected in complete runs (junction-junction or headwall-headwall). Provide a pipe inspection summarization report in accordance with KM 64-114.

Unless the Engineer directs otherwise, schedule the inspections no sooner than 30 days after completing the installation and completion of earthwork to within 1 foot of the finished subgrade. When final surfacing conflicts with the 30-day minimum, conduct the inspections prior to placement of the final surface. The contractor must ensure that all pipes are free, clear of any debris, and as dry as possible so that a complete inspection can be performed.

Notify the Engineer a minimum of 24 hours in advance of inspection and notify the engineer immediately if distresses or locations of improper installation are discovered. When camera testing shows distresses or improper installation in the installed pipe, the Engineer may require additional sections to be tested. Provide the video and report to the Engineer when testing is complete in accordance with KM 64-114.

Pipes that exhibit distress or signs of improper installation may necessitate repair or removal as the Engineer directs. These signs include, but are not limited to: deflection, cracking, joint separation, sagging or other interior damage. If flexible pipes exceed the deflection and installation thresholds indicated in the Flexible Pipe Deduction Table in Section 701.05, provide the Department with an evaluation of each location conducted by a Professional Engineer addressing the severity of the deflection, structural integrity, environmental conditions, design service life, and an evaluation of the factor of safety using Section 12, "Buried Structures and Tunnel Liners," of the AASHTO LRFD Bridge Design Specifications. Based on the evaluation, the Department may allow the pipe to remain in place at a reduced unit price as shown in the Flexible Pipe Deduction Table in Section 701.05. Provide 10 business days for the Department to review the evaluation. When the pipe shows deflection of 10 percent or greater, remove and replace the pipe. When laser deflection results are called into question, the Department may require direct measurements and/or mandrel testing. If rigid pipes exceed the cracking and installation thresholds

indicated in the Rigid Pipe Remediation Table in Section 701.05, provide the Department with an evaluation of each location conducted by a Professional Engineer addressing the severity of the cracking, structural integrity, environmental conditions, design service life, and an evaluation of the factor of safety using Section 12, "Buried Structures and Tunnel Liners," of the AASHTO LRFD Bridge Design Specifications. Based on the evaluation, the Department may allow the pipe to remain in place if the cracking is remediated according to an approved remediation plan submitted in writing to the Engineer by the Contractor as shown in the Rigid Pipe Remediation Table in Section 701.05. Provide 10 business days for the Department to review the evaluation. When the pipe shows cracking of .1 inches or greater, remediate or replace the pipe as directed by the Engineer. When the camera/video cracking results are called into question, the Department may require direct measurements.

The Cabinet may elect to conduct Quality Assurance verifications of any pipe inspections. These verification inspections will be performed by the Kentucky Transportation Center. The Division of Construction shall be contacted by the Engineer when verification testing is needed.

701.03.09 End Structures. Construct anchors, concrete headwalls, and other end structures specified in the Plans according to Section 610, Section 710, and the Standard Drawings.

701.03.10 Extensions to Existing Culvert Pipe and Entrance Pipe. Construct pipe extensions for culvert pipe, entrance pipe, and equivalent pipe arches according to this section and the Contract. Remove the necessary portions of the existing structure to provide a neat junction with the extension. Do not damage the portion that is to remain in service. Remove all silt and debris that has accumulated in the remaining portion of the structure for a distance back equal to twice the pipe diameter or as the Engineer directs.

701.03.11 Removing Pipe, Removing and Relaying Pipe. Remove all pipe designated for removal in the Contract. Safely store all reusable pipe. Restore or replace in kind, any pipe designated for reuse that incurs damage or destruction through faulty handling. Relay all removed pipe the Contract designates to be relayed. Where pipe is not to be relayed, fill the area to the existing ground line according to subsection 207.03.

The Department will retain ownership of reusable pipe that is not to be re-laid in areas on the project. Unless the Engineer directs otherwise, deliver all reusable pipe not relayed on the project to the designated maintenance facility in the county where the project is located. Take ownership of and remove from the project all pipe that is not designated for reuse or salvage.

701.04 MEASUREMENT.

701.04.01 Culvert Pipe. The Department will measure the quantity in linear feet from end-to-end along the bottom or pipe invert of the installed structure. The Department will include bends, elbows, crosses, tees, reducers, laterals, wyes, and other shapes in the pipe lengths measured. The Department will not measure joint materials and bedding materials for payment and will consider them incidental to this item of work. The Department will not measure replacement of damaged pipe for payment and will consider it incidental to this item of work. The Department will not measure for payment the providing of a manufacturer's technical representative to assist in the construction of the pipe and will consider it incidental to this item of work.

701.04.02 Culvert Pipe Equivalent. Culvert Pipe Equivalent includes elliptical culvert pipe and culvert pipe arches. The Department will measure the quantity in linear feet according to Subsection 701.04.01.

701.04.03 Entrance Pipe. The Department will measure the quantity in linear feet according to Subsection 701.04.01.

701.04.04 Entrance Pipe Equivalent. Entrance Pipe Equivalent includes elliptical entrance pipe and pipe arches. The Department will measure the quantity in linear feet according to Subsection 701.04.01.

701.04.05 Storm Sewer Pipe. The Department will measure the quantity in linear feet according to Subsection 701.04.01.

701.04.06 Storm Sewer Pipe Equivalent. Storm Sewer Pipe Equivalent includes elliptical storm sewer pipe and storm sewer pipe arches. The Department will measure the quantity in linear feet according to Subsection 701.04.01.

701.04.07 Pipeline Video Inspection. The Department will measure the quantity in linear feet along the pipe invert of the structure inspected. When inspection above the quantity specified in the Contract is performed due to a disagreement or suspicion of additional distresses and the Department is found in error, the Department will measure the quantity as Extra Work according to Subsection 104.03. However, if additional distresses or non-conformance is found, the Department will not measure the additional inspection for payment.

701.04.08 Geotextile Fabric. The Department will measure the quantity in square yards.

701.04.09 Flowable Fill. The Department will not measure the quantity for payment and will consider it incidental to the pipe bid item. When the Engineer determines that it is necessary and to the Department's benefit to excavate beyond the typical excavation limits shown in the Standard Drawings, the Department will measure the quantity of flowable fill required for backfill outside the typical excavation limits as Extra Work.

701.04.10 Embankment-In-Place. The Department will measure the quantity where there is unstable foundation material in excess of 3 times the width of outside diameter of the pipe or the width of the outside diameter plus 4 feet, whichever is less, in cubic yards according to Subsection 206.04.

701.04.11 Roadway Excavation. The Department will measure the quantity for removal of unstable foundation material in excess of 3 times the width of outside diameter of the pipe or the width of the outside diameter plus 4 feet, whichever is less, in cubic yards according to Subsection 204.04.

When using Special Design, the Department will measure the quantity by the length of the trench the Contract specifies or as the Engineer directs. The Department will not measure backfilling the trench with bedding material for payment and will consider it incidental to this item of work.

The Department will not measure any other excavation and will consider it incidental to Culvert Pipe, Entrance Pipe, and Storm Sewer Pipe.

701.04.12 Pipe Undercut. The Department will measure the quantity for removal of unstable foundation material or bedded rock in cubic yards up to a maximum of 3 times the width of the outside diameter of the pipe or the width of the outside diameter of the pipe plus 3 feet, whichever is less, and to a depth of up to 2 feet. The Department will measure the quantity at a depth of greater than 2 feet as Extra Work according to Subsection 109.04.

701.04.13 Structure Excavation Unclassified. When the Engineer changes the pipe's plan length or location and causes the required excavation to increase more than 10 percent above the original average excavation per yard, the Department will measure the quantity in cubic yards according to Subsection 603.04. When the Department requires a substantial increase in excavation, submit verification to the Engineer before starting excavation. The Engineer will then measure the quantity of excess volume. The Department will not

consider the excavation of unstable material from the foundation when determining the percentage of material increase.

701.04.14 Removing Pipe. The Department will measure the quantity in linear feet of net laying length per section. The Department will measure bends, elbows, crosses, tees, reducers, laterals, wyes, and other shapes in linear feet along the central axis of the unit. The Department will not measure furnishing and placing any borrow material necessary to refill the area to the original ground line for payment and will consider it incidental to this item of work. When the Department retains ownership, the delivery of the pipe to the designated maintenance facility will not be measured for payment and is considered incidental to this item of work.

Unless design quantities are included in the Contract, the Department will not measure pipe within the typical section for payment and will consider it incidental to roadway excavation.

701.04.15 Removing and Relaying Pipe. The Department will measure the quantity according to Subsection 701.04.01. The Department will not measure sections that are damaged or broken for payment and will consider them incidental to this item of work. The Department will not measure furnishing and placing any borrow material necessary to refill the area to the original ground line for payment and will consider them incidental to this item of work. When the Department retains ownership, the delivery of the pipe to the designated maintenance facility will not be measured for payment and is considered incidental to this item of work.

701.04.16 Deduction for Pipe Deflection. The Department will determine the quantity of deflected pipe using the pipe inspection summarization report in accordance with KM 64-114. The Department will make deductions for pipe sections that do not meet the requirements of the specifications in accordance with the tables in Section 701.05. The section length is determined by the length of the pipe between joints where the failure occurred.

701.05 PAYMENT. The Department will make payment for the completed and accepted quantities under the following:

Code	Pay Item	Pay Unit
00460-00482	Culvert Pipe, Size	Linear Foot
00490-00512	Culvert Pipe Equivalent, Size	Linear Foot
00439-00445	Entrance Pipe, Size	Linear Foot
00450-00454	Entrance Pipe Equivalent, Size	Linear Foot
00520-00542	Storm Sewer Pipe, Size	Linear Foot
00551-00572	Storm Sewer Pipe Equivalent, Size	Linear Foot
02600	Fabric-Geotextile Type IV for Pipe	Square Yard[2]
02230	Embankment-In-Place	See Subsection 206.05
02200	Roadway Excavation	See Subsection 204.05
02219	Pipe Undercut	Cubic Yard[1]
02203	Structure Excavation, Unclassified	See Subsection 603.05
01310	Remove Pipe	Linear Foot
01312	Remove and Relay Pipe	Linear Foot
23131ER701	Pipeline Video Inspection	Linear Foot
10065NS	Pipe Deflection Deduction	Dollars

[1] The unit price is $20.00 per cubic yard for pipe undercut 2 feet in depth or less. The Department will pay for pipe undercut exceeding a depth of 2 feet, as specified in Subsection 109.04.

[2]The unit price is $2.00 per square yard for Fabric-Geotextile Type IV for Pipe

RIGID PIPE REMEDIATION TABLE	
Crack Width (inches)	Payment
≤ 0.1	100% of the Unit Bid Price
Greater than 0.1	Remediate or Replace (1)

(1) Provide the Department in writing a method for repairing the observed cracking. Do not begin work until the method has been approved.

FLEXIBLE PIPE DEDUCTION TABLE(1)	
Amount of Deflection (%)	Payment
0.0 to 7.5	100% of the Unit Bid Price
7.6 to 9.9	50% of the Unit Bid Price (2)
10 or greater	Remove and Replace (3)

(1) Assume 0.5 inch thick paved.
(2) Provide Structural Analysis for HDPE and metal pipe. Based on the structural analysis, pipe may be allowed to remain in place at the reduced unit price.
(3) The Department may allow the pipe to remain in place with no pay to the Contractor in instances where it is in the best interest to the public and where the structural analysis demonstrates that the pipe should function adequately.

JOINT SEPARATION REMEDIATION TABLE FOR PIPE	
Joint Separation Width (inches)	Payment
≤ 0.5	100% of the Unit Bid Price
Greater than 0.5	Remediate or Replace (1)

(1) Provide the Department in writing a method for repairing the observed joint separation. Do not begin work until the method has been approved.

The Department will consider payment as full compensation for all work required under this section.

SECTION 702 — SLOTTED DRAIN PIPE

702.01 DESCRIPTION. Furnish and place slotted drain pipe of the specified size and wall thickness, at the locations specified in the Plans or designated by the Engineer.

702.02 MATERIALS.

702.02.01 Slotted Drain Pipe. Conform to Subsection 810.04.05.

702.02.02 Coupling Bands. Provide coupling bands recommended by the manufacturer.

702.03 CONSTRUCTION. Conform to Section 701.03 and the Standard Drawings for excavation of the pipe trench, pipe placing, and backfill.

Do not begin installing the slotted drain pipe until paving of the traffic lanes adjacent to the pipe has been completed at the location where the pipe is to be installed.

Before backfilling, plug the upgrade end of the slotted drain pipe with a metal cap or by other methods the Engineer approves.

During the backfilling operations and paving operations adjacent to the slot, cover the slot to prevent infiltration of material into the pipe, and do not damage the slotted drain pipe. Remove foreign material that enters the pipe, and repair any damage to the slotted drain pipe to the satisfaction of the Engineer, at no expense to the Department.

702.04 MEASUREMENT.

702.04.01 Slotted Drain Pipe. The Department will measure the quantity in linear feet. The Department will not measure structure excavation, backfill, plugging, removal of foreign material, or coupling bands for payment and will consider them incidental to this item of work.

702.05 PAYMENT. The Department will make payment for the completed and accepted quantities under the following:

Code	Pay Item	Pay Unit
00980-00985	Slotted Drain Pipe, Size	Linear Foot

The Department will consider payment as full compensation for all work required under this section.

SECTION 703 — SLOPE PROTECTION AND CHANNEL LINING

703.01 DESCRIPTION. Furnish and place the specified material for a protective covering for slopes or linings in channels and ditches, according to the Contract or as the Engineer directs. Slope protection includes the following types: Reinforced Concrete Slope Wall, Cyclopean Stone Riprap, and Crushed Aggregate Slope Protection. Channel lining includes the following types: Class IA (mattress units), Class II, Class III, and Class IV (prepared from rock excavation).

703.02 MATERIALS.

703.02.01 Concrete. Conform to Subsection 601.02 and 601.03.

703.02.02 Steel Reinforcement. Conform to Section 811.

703.02.03 Coarse Aggregate. Conform to Section 805.

703.02.04 Fine Aggregate. Conform to Section 804, natural sand.

703.02.05 Joint Material. Conform to Section 807, preformed joint filler.

703.02.06 Drain Pipe. Conform to Section 810.

703.02.07 Mattress Units for Channel Lining Class IA. Conform to Section 813.

703.02.08 Anchor Bars for Channel Lining, Class IA. Use Grade 40 or better steel reinforcing bars conforming to the dimensions shown on the Standard Drawings. The Engineer will base acceptance of the anchor bars on visual inspection.

703.02.09 Geotextile Fabric. Use fabric conforming to Section 843, for slope protection.

703.03 CONSTRUCTION.

703.03.01 Slope Protection.

A) General. Do not allow slopes on which protection is placed to be steeper than the natural angle of repose. Shape the slopes to the slope and contour indicated or as the Engineer directs. Use slope templates in determining the slope. Bring depressions to the required slope line with fill material moistened and compacted as the Engineer directs.

Unless solid rock is encountered, begin all slope protection, except crushed aggregate slope protection, in a trench 2 feet below the natural ground. Where solid rock is encountered, stop the lower terminus of the slope protection at the solid rock line unless the Engineer directs otherwise.

Unless solid rock is encountered, underlay cyclopean stone riprap, crushed aggregate slope protection and all classes of channel lining with geotextile fabric.

B) Reinforced Concrete Slope Wall. Use 6-inch slope walls on slopes 1/4 to one or flatter.

Construct porous aggregate underdrains at the location of all construction joints at the intervals shown on the Standard Drawings. Ensure that the porous aggregate underdrains consist of a 12-inch by 12-inch trench excavated in the earth or solid rock and filled with coarse aggregate or natural sand. Place weep holes along the toe of the reinforced concrete slope walls at a maximum of 10-foot intervals. Construct weep holes by using 4-inch diameter pipe or suitably formed 4-inch diameter holes through the walls.

Construct slope walls using Class A concrete according to Subsection 601.03. Construct slope walls using the size, position, width of sheets, length of laps, and diameter of the mesh shown on the Standard Drawings. Construct the finished slope walls with an even, smooth surface that will not show a variation from a true plane of more than 1/2-inch in 4 feet. Build warped or curved surfaces to the same degree of accuracy as plane surfaces. Cure concrete according to Subsection 601.03. After completing the slope protection, backfill excavated areas that are not filled by slope protection to the surface of the original groundline.

C) Cyclopean Stone Riprap Slope Protection. Construct cyclopean stone riprap to a minimum thickness of 2 feet measured perpendicular to the slope. The Department will allow dumping stone in place and relocating it in a manner to produce a surface of approximate regularity not varying more than 6 inches from a true plane.

D) Crushed Aggregate Slope Protection. Unless otherwise shown, place the aggregate to a depth of one foot measured perpendicular to the slope flush with the embankment slopes under the bridge; extend it from the face of the abutments or end bents across the berm and down the slope to the toe of the slope; and extend it laterally to 18 inches beyond the outer edges of the superstructure.

The Department will allow dumping the crushed aggregate in place and relocating it in a manner to produce a uniform surface varying no more than 1 1/2 inches in 4 feet from a true plane. The Department will not require hand placing except as necessary to correct irregularities exceeding the specified tolerances.

703.03.02 Channel Lining. Before placing any channel lining materials, excavate and shape the area to receive the channel lining, so that the completed channel lining will be uniform and will conform to the designated lines, grades, and cross section.

A) Channel Lining, Classes II and III. Construct Channel Lining Classes II and III to the dimensions specified in the Plans, Standard Drawings, or as the Engineer directs. The Department will allow dumping the stone in place and relocating it in a manner to produce a surface of approximate regularity, varying no more than 3 inches from a true plane. The Department will not require hand placing except as necessary to correct any surface irregularities exceeding the specified tolerance.

B) Channel Lining, Class IV. Unless solid rock is encountered, begin the channel lining in a trench 2 feet below the natural ground or 2 feet below the channel flowline when the flowline is not lined. Where solid rock is encountered, stop the lower terminus of the slope protection at the solid rock line. Construct Channel Lining, Class IV to the minimum thickness specified in the Plans. The Department will allow dumping the stone in place and relocating it in a manner to produce a surface of approximate regularity not varying more than 6 inches from a true plane.

C) Channel Lining, Class IA. Construct according to the Standard Drawings. Set empty mattress units to the required line and grade. Use lacing wire to join the units together.

After the mattress units are set to line and grade, stretch them to remove any kinks from the mesh and to hold alignment.

Fill the mattress units with stone. Place by hand or machine to ensure good alignment. Avoid bulging of the mesh by minimizing voids between the stones. After filling a unit, close its top so that it meets the sides and ends of each mattress unit. Then, secure the top to the sides, ends, and the diaphragms with lacing wire as shown on the Standard Drawings.

When placing the mattress unit on a grade, begin placing the stone at the bottom of the slope and progress upgrade. Overfill mattress units approximately one inch to allow for settlement.

When space limitations prevent the installation of a complete mattress on the slope, cut the unit to fit in the manner the Plans specify. Drive anchor bars in place at the locations shown on the Standard Drawings when the grade is 5 percent or greater.

703.04 MEASUREMENT.

703.04.01 Reinforced Concrete Slope Walls. The Department will measure the quantity in square yards of surface area including the area of the front face of concrete placed within the trench below natural ground. The Department will not measure steel reinforcement or any excavation required for the construction of slope protection for payment, and will consider them incidental to this item of work.

703.04.02 Cyclopean Stone Riprap. The Department will measure the quantity in tons. The Department will not measure excavation required for the construction of slope protection for payment and will consider it incidental to this item of work.

703.04.03 Crushed Aggregate Slope Protection. The Department will measure the quantity according to Subsection 703.04.02.

703.04.04 Channel Lining, Class IA. The Department will measure the quantity in tons. The Department will not measure excavation below the upper surface of any channel lining for payment and will consider it incidental to the work. The Department will not measure anchor bars, wire mesh, lacing wire, or other material necessary to acceptably complete the wire mattress units for payment, and will consider them incidental to this item of work.

703.04.05 Channel Lining Class II. The Department will measure the quantity in tons. The Department will not measure excavation below the upper surface of any channel lining for payment and will consider it incidental to this item of work.

703.04.06 Channel Lining Class III. The Department will measure the quantity according to Subsection 703.04.05.

703.04.07 Channel Lining Class IV. The Department will measure the quantity according to Subsection 204.04.

703.04.08 Geotextile Fabric. The Department will measure the quantity according to Subsection 214.04.

703.05 PAYMENT. The Department will make payment for the completed and accepted quantities under the following:

Code	Pay Item	Pay Unit
08014, 08016	Reinforced Concrete Slope Wall, Size	Square Yard
08019	Cyclopean Stone Riprap	Ton
08020	Crushed Aggregate Slope Protection	Ton
02482	Channel Lining, Class IA	Ton
02483	Channel Lining, Class II	Ton
02484	Channel Lining, Class III	Ton
02488	Channel Lining, Class IV	See Subsection 204.05

The Department will consider payment as full compensation for all work required under this section.

SECTION 704 — UNDERDRAINS

704.01 DESCRIPTION. Construct underdrains of perforated pipe, non-perforated pipe, and porous aggregate. When required, construct headwalls according to Section 710, and the Standard Drawings.

704.02 MATERIALS AND EQUIPMENT.

704.02.01 Underdrain Pipe.

A) All Underdrain Pipe Except Edge Drain Outlet Pipe. Conform to Section 810 for the following:

1) Circular Reinforced Concrete Pipe.
2) Corrugated Steel Pipe, Type III.
3) Corrugated Aluminum Alloy Pipe, Type III.
4) High Density Polyethylene (HDPE) Pipe (Thermoplastic).

B) Edge Drain Outlet Pipe. Conform to Section 810 for the following:

1) Corrugated Steel Pipe, Type III.
2) Corrugated Aluminum Alloy Pipe, Type III.
3) High Density Polyethylene Pipe (HDPE), Type S (Thermoplastic).
4) Polyvinyl Chloride (PVC) Pipe (Thermoplastic) as follows:

   a) Smooth. Conform to ASTM D 1785 for Schedule 40, or ASTM D 2241 for SDR 17.
   b) Ribbed. Conform to ASTM F 794 for series 46.
   c) Corrugated. Conform to ASTM F 949.

704.02.02 Coarse Aggregate. Conform to Subsection 805.08.

704.02.03 Natural Sand. Conform to Section 804.

704.02.04 Geotextile Fabric. Use fabric for subsurface drainage and separation conforming to Section 843 for wrapping coarse aggregate. Use circular-knit geotextile conforming to ASTM D 6707 for perforated pipe socks.

704.02.05 Pipeline Inspection Camera. Provide a pipeline inspection camera for edge drains having the following:

1) Capable of recording the station, milepost, distance into the drain or other indicators of location on the video.
2) A device for measuring the distance the camera has been pushed from the end of the outlet.
3) The ability to record the distance superimposed on the video.
4) An outside diameter no greater than 3 inches.
5) Color capability with a minimum horizontal resolution of 400 lines according to the manufacturer's specifications.
6) Capable of being pushed in the 4-inch outlet pipes and mainline pipes for a minimum of 280 feet, 250 feet of mainline plus outlet pipe.
7) Capable of being pushed or tractored for 1,000 feet in 8-inch or larger pipes serving as a collector system for edge drains without headwalls.
8) A video output jack for connecting a video recording device.
9) Capable of being connected to controls, including the video recording device, for the pipeline inspection equipment in the inspection vehicle.

704.02.06 Video Recording Device. Provide a video recording device capable of connecting to the video output jack on the pipeline inspection system for recording the inspection.

704.02.07 Inspection Vehicle. Provide an inspection vehicle that will accommodate the operation of the inspection camera and video recording device, and 2 passengers. Provide a pipe inspection operator to operate the vehicle and observe the inspection. The Engineer may accompany the pipe inspection operator in the vehicle at any time.

704.02.08 Flowable Fill. Conform to Subsection 601.03.03 B).

704.02.09 Headwalls. Conform to Subsection 710.02.

704.02.10 Concrete. Conform to Subsection 601.02.

704.03 CONSTRUCTION.

704.03.01 Porous Aggregate Underdrain. Excavate the trench to the lines, grades, and section according to the Contract. Finish the bottom of the trench so that it is smooth and firm. Tamp if necessary.

After preparing the trench, place the aggregate in the trench, in loose layers not exceeding 6 inches in depth, and firmly tamp each layer in place. Use either crushed or uncrushed coarse aggregate, including pea gravel, or natural sand. Continue backfilling the trench with aggregate until the backfill reaches the compacted depth specified in the Plans. When using coarse aggregate, completely wrap the aggregate in geotextile fabric according to Subsection 214.03. Backfill above the aggregate with soil that the Engineer approves and tamp in place in layers not exceeding 6 inches loose thickness.

704.03.02 Perforated and Non-Perforated Pipe Underdrains.

A) All Pipe Underdrains Except Pavement Edge Drains. Excavate the trench to a depth below the outside bottom of the plan underdrain elevation to allow for the placement of sufficient bedding to eliminate any irregularities in the trench bottom, and to a width of at least one foot wider than the external diameter of the pipe.

Place perforated pipe with the perforations in the invert. Join perforated sections with coupling fittings or bands. Place and compact granular backfill of Size No. 78, 8, or 9M coarse aggregate or natural sand around the pipe ensuring that the pipe is true to line and grade and the haunches are fully supported. Where perforated pipe installations outlet into open ditches provide a minimum of 8 feet of non-perforated pipe from the outlet.

For non-perforated pipe installations, place the pipe with the bell end upgrade and with open joints not exceeding 3/8 inch. Join the last 2 outlet sections.

Close the upgrade ends of all underdrain pipe installations with plugs to prevent entry of debris. Equip the outlet end of underdrain pipe with a screen.

After placing the pipe, place coarse aggregate or natural sand to a height of at least one foot above the top of the pipe. When using natural sand for backfill, wrap the perforated pipe in circular-knit geotextile fabric; when using coarse aggregate for backfill, completely wrap the aggregate in geotextile fabric, according to Subsection 214.03. Fill any remaining portion of the trench with either granular or impervious material according to the Contract or as the Engineer directs. Do not allow the minimum height of fill to be more than 2 feet above the top of the pipe, except the Engineer will allow one foot of fill from the top of the pipe to the top of subgrade in cases where 2 feet would not allow proper installation for drainage. Thoroughly compact the fill material in layers not exceeding 6 inches loose measurement. During placement of the aggregate and granular or impervious material do not damage or displace the pipe.

Encase any pipe that has less than one foot of cover at the outlet end in 6-inch thick concrete of any class or flowable fill. Proportion the concrete or flowable fill according to Subsection 601.03.

B) Pavement Edge Drains. Construct using 4-inch diameter pipe according to Subsection 704.03.02 A), or as shown on the plans, except for the following:

1) Backfilling.

   a. Fabric Wrapped Trench and Crushed Aggregate. When backfilling, place geotextile fabric in the trench and shape to the sides and bottom of the trench without stretching the fabric. Ensure that the geotextile fabric does not pull down into the trench when placing the backfill material. Do not damage the geotextile fabric when placing the filter aggregate. Partially wrap the aggregate according to Subsection 214.03. Fold the fabric over the backfilled trench and secure.
   b. Geotextile Pipe, Sock and Sand. Backfill the pipe with a natural sand conforming to Section 804. Do not use geotextile pipe, sock and sand if the pavement section is constructed with a drainage blanket.
   c. Edge Drain Outlet Pipe. Encase any outlet pipe with a minimum of 6 inches of concrete or flowable fill over the top of the outlet pipe. In paved sections bring the concrete or flowable fill up to the bottom of pavement. Proportion the concrete or flowable fill according to Subsection 601.03.

2) Headwalls for Outlets. When the Contract requires outlet headwalls, the Engineer will require adjustments to the headwalls when necessary to fit existing drainage conditions. Place precast headwalls according to Subsection 710.03.01 B). Install the headwall with a slope of 1/2 inch in one foot. When practical, place the toe of the headwall a minimum of 6 inches (one foot desirable) above the bottom of the ditch. Place crushed aggregate size No. 2 a minimum depth of 4 inches around the headwall as specified in the Contract.
3) Cored Hole Drainage Box or Cross Drain Headwall Connector. Make the connection according to Section 705. Make the cored hole drainage box connection a minimum of one foot above the bottom of the box. Attach a rodent screen to all edge drain outlet structures according to the Standard Drawings.
4) Construction Near Guardrail. When guardrail is attached to a structure, adjust the placement of the outlet pipe so that guardrail posts will not be driven within one foot of the outlet pipe. When the guardrail is not attached to a structure, adjust the placement of the outlet pipe or the guardrail so that guardrail posts will not be driven within one foot of the outlet pipe. Mark the location of the outlet with paint or other means the Engineer approves. Conduct a mandrel test after driving the guardrail posts by pushing a piece of flexible 2-inch gas pipe through the outlet pipes. Replace all damaged outlets.
5) Field Data. Visually observe the condition of each headwall. Observe the extent of debris blocking the headwall. Provide a description of the debris, the condition of the rodent screen, a description of the ditch line drainage, and the percent grade of the headwall. Take photographs of significant distresses and provide copies of the photographs to the Engineer. Describe the location of these significant distresses and the headwall type for each headwall. Record all observations and data and submit them to the Engineer on standard forms approved by the Engineer.
6) Inspection of Edge Drain Systems. Inspect installed pavement edge drain system immediately before placing the final surface. Use a pipeline inspection camera to determine if the edge drain system is functioning properly. Beginning at the rodent screen, push the camera through the outlet pipe system and into the mainline edge drain system. Push the camera into the

mainline edge drain until there is resistance against further movement, the end of the pipe segment is reached, or for approximately 250 feet, and record this distance. Use the camera as a mandrel for determining locations of compressed pipes when desired. Document observed distresses, including blockages, rips, separations, backfill in the crushed pipe, crushed pipe, improper couplings, improper connections, and all other distresses. Make all photographic observations on video and provide a copy to the Engineer. Record all observations and data and submit to the Engineer, on standard forms approved by the Engineer. Provide the CCTV inspection on a standard video file or other format the Engineer approves.

7) Certification of Edge Drain Systems. Provide certification that the installed pavement edge drain system is functioning properly before formal acceptance of the project.
8) Trenching Material. When the Engineer approves, excavated trench material may be used to dress the existing shoulder adjacent to the trench.
9) Corrective Work. The Department may require corrective work when the video or Inspection report indicates there are pipe distresses.

704.04 MEASUREMENT.

704.04.01 Porous Underdrain. The Department will measure the quantity in linear feet along the centerline of the underdrain. The Department will not measure excavation for the trench less than or equal to 4 feet in depth or the geotextile fabric used to wrap coarse aggregate for payment and will consider them incidental to this item of work.

704.04.02 Perforated and Non-Perforated Pipe. The Department will measure the quantity of each size of Perforated and Non-Perforated Pipe in linear feet along the centerline of the pipe. The Department will not measure saw cutting the existing shoulder, materials for bedding and backfill encasement with concrete or flowable fill, or excavation of the trench up to 4 feet in depth for payment, and will consider them incidental to this item of work.

704.04.03 Perforated Pipe Headwalls. The Department will measure the quantity according to Subsection 710.04.

704.04.04 Structure Excavation, Common. The Department will measure the quantity of excavation for the trench in excess of 4 feet in depth in cubic yards. The Department will measure the maximum trench width as that specified in the Plans or Standard Drawings.

704.04.05 Crushed Aggregate Size No. 2. The Department will measure the quantity used for edge drain headwall outlet erosion control by the ton. The Department will not measure removal of excess material for payment and will consider it incidental to this item of work.

704.04.06 Inspect and Certify Edge Drain System. The Department will measure Inspect and Certify Edge Drains System by the lump sum. The Department will not measure corrective work due to the construction operation for payment and will consider it incidental to this item of work.

704.04.07 Perforated and Non-perforated Pipe for Edge Drains. The Department will measure the quantity of each size of Perforated and Non-Perforated Pipe for Edgedrains in linear feet along the centerline of the pipe. The Department will not measure materials for bedding and backfill, encasement with concrete or flowable fill, geotextile fabric used for wrapping perforated pipe or for wrapping coarse aggregate backfill, or excavation of the trench up to 4 feet in depth for payment, and will consider them incidental to this item of work.

704.05 PAYMENT. The Department will make payment for the completed and accepted quantities under the following:

Code	Pay Item	Pay Unit
02679	Porous Underdrain	Linear Foot
01000-01004	Perforated Pipe, Size	Linear Foot
-----	Perforated Pipe Edge Drain, Size	Linear Foot
01010-01014	Non-Perforated Pipe, Size	Linear Foot
01020-01035	Perforated Pipe Headwalls, Type, Size	See Subsection 710.05
08001	Structure Excavation Common	See Subsection 603.05
00078	Crushed Aggregate Size No. 2	Ton
01015	Inspect and Certify Edge Drain System	Lump Sum

The Department will consider payment as full compensation for all work required under this section.

SECTION 705 — CORED HOLE DRAINAGE BOX CONNECTOR

705.01 DESCRIPTION. Core drill a hole in the side or sides of existing small drainage structures, and connect the outlet end of 4, 6, or 8-inch underdrain pipe, instead of constructing concrete headwalls on the underdrain pipe.

705.02 MATERIALS.

705.02.01 Non-Shrink Grout. Conform to Subsection 601.03.03 B).

705.02.02 Asphalt Mastic Joint Sealing Compound. Conform to Section 807.

705.02.03 Pipe. Conform to Subsection 704.02. Furnish the same type and size as the underdrain pipe.

705.02.04 Styrofoam Backer Rod. Obtain the Engineer's approval.

705.03 CONSTRUCTION. Cut holes by core drilling into existing small drainage structures at the locations specified in the Contract or where the Engineer directs, without damaging the existing structure. Cut holes of a diameter equal to the outside diameter of the pipe with a tolerance of plus 1/2 inch. Place 2 styrofoam backer rods on the pipe near each wall face, and seal the opening around the pipe with mastic material or a non-shrink grout. Use wyes, tees, and ells in the pipe system to reduce the number of holes to be drilled. Patch all damage to the existing wall in the coring operation with non-shrink grout. Apply non-shrink grout according to Subsection 601.03.

705.04 MEASUREMENT. The Department will measure the quantity by each individual unit. The Department will not measure pipe, wyes, tees, ells, styrofoam backer rods, or repair of damage to existing wall for payment and will consider them incidental to this item of work.

705.05 PAYMENT. The Department will make payment for the completed and accepted quantities under the following:

Code	Pay Item	Pay Unit
01740-01742	Cored Hole Drainage Box Connector, Size	Each

The Department will consider payment as full compensation for all work required under this section.

SECTION 706 — ENCASEMENT PIPE

706.01 DESCRIPTION. Provide an encasement pipe, open cut or a bored and jacked pipe under a roadway or other sensitive area.

706.02 MATERIALS.

706.02.01 Welded and Seamless Steel Pipe. Conform to the following table for the minimum wall thickness for steel pipe

MINIMUM WALL THICKNESS FOR STEEL PIPE	
Nominal Diameter (Inches)	Wall Thickness (Inches)
18 or less	0.375
24	0.500
30	0.500
36	0.532
42	0.625

706.03 CONSTRUCTION.

706.03.01 Open Cut. Install the pipe according to the manufacturer's specifications and installation procedures. When the Engineer requests, provide a manufacturer's technical representative to assist in pipe installation.

706.03.02 Bore and Jack. Construct access pits on both sides of the area to be tunneled, one for the boring equipment and one on the receiving end.

Use a boring and jacking machine that is capable of keeping the advanced bore hole within the required alignment. Maintain the alignment of the guide rails to the proper line and grade, immediately correcting any possible displacement, until completing the boring and jacking operation.

Use a smooth casing pipe of sufficient strength and diameter to provide a tight fit against the earth sides of the bore hole and of sufficient size to allow installation of the carrier pipe and any required positive anchorage. Weld the joints with a continuous circumferential weld.

Frequently check the line and grade and adjust the alignment as practical. When a physical obstruction or other situation requires the abandonment of a partially completed bore hole and the starting of a new hole, backfill as the Engineer directs.

706.04 MEASUREMENT.

706.04.01 Open Cut Encasement Pipe. The Department will measure the completed length of encasement pipe through the flowline from end to end in linear feet. The Department will not measure the backfill and will consider it incidental to this item of work.

706.04.02 Bored and Jacked Encasement Pipe. The Department will measure the completed length of encasement pipe through the flowline from end to end in linear feet. When abandoning a bore hole due to an unforeseen physical obstruction or situation, the Department will measure the work according to a negotiated supplemental agreement. When abandoning a bore hole due to mechanical malfunction, improper alignment, or other problems due to construction operations, the Department will not measure the backfill and relocation for payment and will consider it incidental to this item of work.

706.05 PAYMENT. The Department will make payment for the completed and accepted quantities under the following:

Code	Pay Item	Pay Unit
01059-01087	Steel Encasement Pipe,Bore and Jack,Size,Thickness	Linear Foot
-----	Steel Encasement Pipe,Open Cut,Size,Thickness	Linear Foot

The Department will consider payment as full compensation for all work required under this section.

SECTION 707 — TUNNELS BY USE OF STEEL LINER PLATES

707.01 DESCRIPTION. Tunnel using conventional tunneling methods and install tunnel liner plates.

707.02 MATERIALS.

707.02.01 Liner Plates. Conform to Section 819.

707.02.02 Grout. Conform to Subsection 601.02.

707.03 CONSTRUCTION. Excavate tunnels by full face, heading and bench, multiple drift procedures, or other Engineer approved methods. Complete all work under the supervision of a superintendent familiar with tunneling and the use of tunnel liner plates.

Begin tunneling at either end unless otherwise directed. When necessary to reach the entrance grade, construct an access pit of sufficient size to accommodate the tunnel excavation, spoil removal, access rails, liner plates, and other items necessary for the tunnel operation. Sheet or shore the access pit to accommodate all requirements for safety and stability. Excavate for the tunnel in close conformance to the outside shape of the liner plates.

Replace any liner plates damaged during handling and placing. Handle coated plates in a manner that prevents damage to the coating. Assemble the liner plates according to the manufacturer's recommendations at such time so there will not be more than 2 feet of tunnel mucking ahead of the bolting up of plates. At the end of each work day, construct a bulkhead inside the assembled liner plate at the construction face unless the Engineer specifically grants permission to omit the bulkhead.

Install grout blocks at each end after completing bolting of liner plates. Proportion grout according to Subsection 601.03. Force grout into voids through the grouting holes in the plates with such pressure that all voids occurring between the liner plates and excavation will be filled.

Grout and install liner plates simultaneously.

707.04 MEASUREMENT. The Department will measure tunnels of each size in linear feet along the invert.

707.05 PAYMENT. The Department will make payment for the completed and accepted quantities under the following:

Code	Pay Item	Pay Unit
----	Tunnel, Size	Linear Foot

The Department will consider payment as full compensation for all work required under this section.

SECTION 708 — FILLING AND CAPPING, SAFELOADING, AND PLUGGING ABONDONED UNDERGROUND STRUCTURES

708.01 DESCRIPTION. Fill and cap designated wells, inlets, catch basins, and manholes. Safeload designated small drainage structures and underground containers. Plug designated pipe and wells. This work does not include the removal of hazardous material.

708.02 MATERIALS.

708.02.01 Concrete. Conform to Subsection 601.02 and 601.03.

708.02.02 Steel Reinforcement. Conform to Section 811.

708.02.03 Coarse Aggregate. Conform to Section 805, No. 8 or 9M.

708.02.04 Flowable Fill. Conform to Subsection 601.02 and 601.03.

708.02.05 Cement. Conform to Section 801.

708.02.06 Sand. Conform to Section 804.

708.02.07 Water. Conform to Section 803.

708.02.08 Fly Ash. Conform to Section 844.

708.03 CONSTRUCTION.

708.03.01 Filling and Capping Wells, Catch Basins, Inlets, and Manholes (Diameters 24 inches or less). Fill all wells (except water wells), catch basins, inlets, and manholes having an average diameter of 24 inches or less, with coarse aggregate to within 18 inches of their surface elevation. Place, then rod or tamp aggregate without creating large voids or unfilled pockets. After placing the aggregate, fill the remaining 18 inches with concrete. Use Class A concrete according to Subsection 601.03. Tamp, rod, or vibrate the concrete in place. The Department will not require curing the concrete. When it is not practical to completely fill a deep well, the Engineer may allow plugging according to Subsection 708.03.03 and then filling and capping the well or structure.

708.03.02 Filling and Capping Wells, Catch Basins, Inlets, and Manholes (Diameters over 24 inches). Fill all wells (except water wells), catch basins, and manholes having an average diameter exceeding 24 inches with select compatible soil or other approved material to within 8 inches of their surface elevation. Place and compact the soil or other approved material in layers not exceeding one foot in thickness. Compact by hand or mechanical tamping. Cap the remaining 8 inches with an 8-inch reinforced concrete slab either precast or cast-in-place. Use Class A concrete according to Subsection 601.03. Reinforce the slab with No. 4 reinforcing bars placed at 6-inch centers in both directions and located 2 inches from the bottom surface of the slab. Cure slabs according to Subsection 601.03.

708.03.03 Plugging Water Wells. Plug water wells according to 401 KAR 6:310. Employ a Kentucky certified water well driller as required by KRS 223.400 through 223.460 to perform the work. Furnish copies of the driller's log sheets to the Engineer after completing the plugging work.

708.03.04 Safeloading Small Drainage Structures. When safeloading, either completely fill the designated areas with grout in such a manner to make them safe from collapse or fill the designated area with flowable fill. Mix flowable fill according to Subsection 601.03. Furnish grout consisting of one part cement or cement with fly ash to 6 parts mortar sand or concrete sand, by volume, and water. Mix to a workable consistency. Add an amount of fly ash that does not exceed 20 percent of the cement quantity.

Clean septic tanks before safeloading. Remove appreciable deposits of debris from other structures prior to safeloading. Plug the ends of existing culverts with bulkheads containing small openings at the tops through which the grout or flowable fill may be pumped at a minimum pressure of 15 psi. Completely fill all structures that require safeloading with grout or flowable fill.

708.03.05 Plugging Pipe. Shape or place plywood, 3/4 inch or greater in thickness, or use other approved material to snugly fit the interior of the pipe to be plugged. When bracing is necessary, adequately secure it in the designated location to ensure that the placement of concrete will not move or distort it. Place the forming material within the pipe a distance of no less than 5 feet, measured along the flowline, from the end of the pipe to be plugged. Then completely fill the portion to be plugged with concrete. Use Class A concrete according to Subsection 601.03. Tamp, rod, or vibrate the concrete in a manner to form a dense mass and to exclude voids. Keep the plastic concrete within the pipe using adequately braced forms. The Department will not require curing the concrete.

708.04 MEASUREMENT.

708.04.01 Filling and Capping (Diameters 24 inches or less). The Department will measure the quantity of wells (except water wells) by each individual unit. The Department will not measure plugging wells (except water wells) for payment and will consider plugging wells other than water wells incidental to this item of work.

708.04.02 Plug Water Wells. The Department will measure the quantity by each individual unit.

708.04.03 Capping (Diameters over 24 inches). The Department will measure the quantity in square yards of the finished reinforced concrete cap.

708.04.04 Embankment-in-Place (Diameters over 24 inches). The Department will measure the quantity according to Subsection 206.04. The Department will measure material used in lieu of select compatible soil as embankment-in-place.

708.04.05 Roadway Excavation (Diameters over 24 inches). The Department will measure the quantity according to Subsection 204.04. The Department will measure material used in lieu of select compatible soil as roadway excavation.

708.04.06 Safeloading. The Department will measure safeloading structures in cubic yards.

708.04.07 Plugging Pipe. The Department will measure the quantity by each individual unit per end plugged.

708.05 PAYMENT. The Department will make payment for the completed and accepted quantities under the following:

Code	Pay Item	Pay Unit
01710, 01717, 01786	Fill and Cap (Item), (24 inches or less)	Each
02473, 02479	Cap (Item), (over 24 inches)	Square Yard
02220	Roadway Excavation	See Subsection 204.05
02230	Embankment-in-Place	See Subsection 206.05
02475	Plug Water Well	Each
02690	Safeloading	Cubic Yard
01314	Plug Pipe	Each

The Department will consider payment as full compensation for all work required under this section.

SECTION 709 — FLUME INLETS AND PAVED DITCHES

709.01 DESCRIPTION. Construct reinforced concrete flume inlets and paved ditches.

709.02 MATERIALS.

709.02.01 Concrete. Conform to Subsection 601.02 and 601.03.

709.02.02 Steel Reinforcement. Conform to Section 602.

709.03 CONSTRUCTION. Construct according to the Plans and Standard Drawings. Excavate the subgrade to the required depth below the finished grade. Remove all soft and yielding material, replace it with suitable material, compact the subgrade, and finish it to a firm and smooth surface.

Place Class A concrete with steel reinforcement, finish, and cure according to Subsection 601.03.

When adjacent to a concrete pavement or shoulder, tie flume inlets to the concrete pavement or shoulder by means of deformed steel tie bars. Furnish and install strips of recessed type longitudinal metal joint, punched to accommodate tie bars, at the designated locations adjacent to the forms at the pavement edge. Bend tie bars to right angles at the midpoints and install them in the pavement with one end of each tie bar placed in the grooves of the metal joint so the bar can be straightened after removing the pavement forms.

When constructing flume inlets prior to installing guardrail posts, provide a blockout in the inlet using a 6-inch radius. After setting the posts, fill the holes between the posts and flume inlets with concrete.

Construct paved ditches at the locations and to the widths the Engineer directs. The location and width specified in the Plans are for purposes of estimating only.

Construct anchors according to the Standard Drawings. Construct end anchors at the inlet and outlet ends. When required construct intermediate anchors on 20-foot centers. Form and cast against earth the exposed ends of end anchors for paved ditches and the other ends of end anchors and all intermediate anchors.

Moisten the subgrade prior to placing the concrete.

Place sod in areas the Standard Drawings designate.

709.04 MEASUREMENT.

709.04.01 Flume Inlets. The Department will measure the quantity as each individual unit. The Department will not measure steel tie bars, longitudinal metal joints, or blockouts for payment and will consider them incidental to this item of work.

709.04.02 Paved Ditches. The Department will measure this quantity in square yards of actual surface area. The Department will not measure intermediate anchors for payment and will consider it incidental to this item of work.

709.04.03 Roadway Excavation. The Department will measure this quantity according to Subsection 204.04.

709.04.04 Sod. The Department will measure this quantity according to Subsection 212.04.

709.05 PAYMENT. The Department will make payment for the completed and accepted quantities under the following:

Code	Pay Item	Pay Unit
01689-01691	Flume Inlet, Type	Each
02155-02158	Paved Ditch, Type	Square Yard
02220	Roadway Excavation	See Subsection 204.05
05990	Sodding	See Subsection 212.05

The Department will consider payment as full compensation for all work required under this section.

SECTION 710 — SMALL DRAINAGE STRUCTURES

710.01 DESCRIPTION. Construct, reconstruct, or adjust inlets, outlets, manholes, junction boxes, catch basins, edge drain outlet headwalls, and other small drainage structures.

710.02 MATERIALS.

710.02.01 Concrete. Conform to Subsection 601.02.

710.02.02 Steel Reinforcement. Conform to Subsection 811.

710.02.03 Manhole Pipe. Conform to Section 810.

710.02.04 Brick Unit Masonry. Conform to Section 824.

710.02.05 Preformed Joint Filler. Conform to Section 807.

710.02.06 Dense Graded Aggregate. Conform to Section 805.

710.02.07 Pipe. Conform to Section 810.

710.02.08 Mortar. Conform to Section 601.02.

710.02.09 Structural Steel. Conform to Section 812.

710.02.10 Miscellaneous Metals. Conform to Section 813.

710.02.11 Steel Manhole Risers. Conform to Section 813.

710.02.12 Manhole Covers and Lids. Conform to Section 813.

710.02.13 Precast Manhole Sections. Conform to Section 824.

710.02.14 Manhole Steps. Provide manhole steps that are on the Department's List of Approved Materials.

710.02.15 Plastic Adjusting Rings. Provide plastic or rubber adjusting rings that are on the Department's List of Approved Materials.

710.03 CONSTRUCTION

710.03.01 Newly Constructed Small Drainage Structures.

A) General. Construct all small drainage structures according to the Contract or as the Engineer establishes. The Engineer may approve similar units that conform to the typical features depicted in the Standard Drawings. Construct small drainage structures using Class A concrete according to Subsection 601.03.

Attach all cast iron grates and lids and all structural steel grates to the frames, or to the concrete in the event there is no frame, with a chain of sufficient length to permit removal for clean out and maintenance purposes. Obtain the Engineer's approval, in writing, of shop drawings for the security device, when different from what the Plans specify.

When extending pipe through the walls of small drainage structures, use pipe that is the same size and type, and conforms to the same requirements as the existing pipe with which it is to be connected. Use extensions of sufficient length to provide for connections and construction to prevent leakage of the pipe and

structure wall joint.

When excavation for small drainage structures extends under pavement, curb, gutter, or sidewalk, backfill the excavation with dense graded aggregate or gravel base. For backfill under aprons around drop box inlets or similar structures, use dense graded aggregate or gravel base when required by the Standard Drawings. Use dense graded aggregate or gravel base backfill as the Engineer directs, and compact it in layers not exceeding 6 inches loose thickness.

When structures abut rigid pavement, place 1/2 inch preformed joint filler between the rigid pavement and the structure for the full depth of the pavement.

Construct concentric or eccentric concrete pipe cones for manholes according to the Standard Drawings. Use precast concrete, precast concrete pipe sections, and cast-in-place concrete, for manhole construction according to the Standard Drawings. Use precast concrete, precast concrete pipe sections, cast-in-place, brick, or plastic adjusting rings or for adjustment of existing manholes according to the Standard Specifications.

The Department will allow the use of square outside cast-in-place bases in lieu of round bases.

Form and construct a U-shaped channel in the base of circular pipe manholes with Class A concrete for a smooth continuation of the pipe. Do not allow the channel height to be less than 3/4 of the diameter of the smaller pipe that is intercepted.

Construct the tops of box inlets specified in the Standard Drawings to the same cross slope as any existing or proposed shoulder, sidewalks, medians, or islands that will abut the box inlets.

Install steps according to the Standard Drawings in all manholes 4 feet or greater in depth.

Do not paint frames, grates, and lids made of structural steel or cast iron for any of the structures.

B) Precast Structures Except Manholes. If furnishing precast structures, conform to the following requirements.

Only furnish products manufactured by a precast producer listed in the Department's List of Approved Materials. If the producer does not have an approved drawing for the product, submit an electronic copy of shop drawings to the Engineer for review and approval. Ensure that the shop drawings show details of any variation from the Department's Standard Drawings and include any special installation instructions necessary. Submit specifications for any special materials for joint construction with the shop drawings, and submit samples of joint materials when requested.

Before beginning fabrication, furnish a copy of the approved shop drawings to the Engineer.

Use concrete that equals or exceeds the requirements for Class A concrete. Conform to Section 605 for the fabrication of the structures, the requirements for a mix design, and a Certified Concrete Technician.

Set the precast structures on a foundation of at least 4 inches of dense graded aggregate compacted using mechanical tampers. Backfill box inlets with cantilevered portions to the elevation of the bottom of the cantilevered element, and place 4 inches of compacted dense graded aggregate before placing the cantilevered element.

Make positive seals between the pipe and the precast structure, and between individual precast segments of the structure, in the field. Obtain any special materials required for joint construction from the structure fabricator at no additional expense to the Department.

The Department will sample and test all materials used in manufacture of the precast elements, including cement, aggregates, water, admixtures, steel reinforcement, and galvanized metal items according to the Department's standard procedures for these items. Do not begin fabrication until the Department has approved these materials.

Repair or replace structures damaged during handling, transporting, erecting, or backfilling, or any structure that cannot be placed satisfactorily, as the Engineer directs or approves.

710.03.02 Reconstructed Small Drainage Structures. Reconstruct existing units to the required line and elevation according to the Standard Drawings. Recondition structures where work is in excess of the limits required for adjusting small drainage structures. Attach all cast iron grates and lids and all structural steel grates to the frames, or to the concrete in the event there is no frame, with a chain of sufficient length to permit removal for clean out and maintenance purposes.

710.03.03 Adjusted Small Drainage Structures. Adjust existing frames and covers or gratings to the proper elevation. Accomplish this by removing or adding cast-in-place concrete masonry, precast reinforced concrete masonry, brick masonry, or an adjusting ring, for a vertical distance not to exceed one foot above or below the existing masonry, and replacing existing castings firmly and permanently in place. For plastic or rubber adjusting rings, install and seal according to the manufacturer's recommendations.

When the Contract specifies, use the Adjusting Ring Method as described in this section, for adjusting manhole castings to grade. When applicable, use the Adjusting Ring Method in lieu of the methods outlined in the preceding paragraph. Raise a casting by inserting an additional casting into the existing frame as follows:

1) Use an adjusting casting of an approved type. Hold it rigidly to the existing frame using set screws in the bearing leg of the ring, or spot weld the adjusting ring to the existing frame in 4 equally spaced locations.
2) Adjust existing manhole covers to the proper elevation by inserting variable height adjustable casting that the Engineer approves into the existing frame. Use an adjustable casting capable of diameter adjustment as well as vertical height adjustment.

   When the difference between the existing elevation and the proposed elevation is less than the outer thickness of the cover or grate plus 1/2 inch, insert a casting that provides for receiving a new casting that is 2 inches less in diameter in any horizontal measurement than the existing casting. Furnish a new cover or grate similar in design to the existing cover or grate, except for the diameter or other horizontal dimensions.
3) Use a steel expanding manhole riser that is of the correct height and is designed to receive the existing manhole cover.

Attach all cast iron grates and lids and all structural steel grates to the frames, or to the concrete in the event there is no frame, with a chain of sufficient length to permit removal for clean out and maintenance purposes.

710.04 MEASUREMENT.

710.04.01 Newly Constructed Small Drainage Structures Except Type 12 Drop Box Inlets. The Department will measure the quantity by each individual unit. The Department will not measure any increase in the height of a structure to one foot from the Plan height for payment and will consider it incidental to this item of work. The Department will measure for payment a change in height that exceeds one foot. The Department will measure the quantity of reinforcing steel and concrete placed in excess of the plan height plus one foot according to Subsections 602.04 and 601.04, respectively. The Department will not measure excavation or materials for backfill for payment and will consider them incidental to this item of work. The Department will not measure extra work or materials required for use of precast units and will consider them incidental to this item of work.

710.04.02 Type 12 Drop Box Inlets. The Department will measure the quantity by each individual unit according to Subsection 710.04.01, except the Department will measure the units in linear feet.

710.04.03 Reconstructed Small Drainage Structures. The Department will measure the quantity by each individual unit.

710.04.04 Adjusted Small Drainage Structures. The Department will measure the quantity by each individual unit.

710.05 PAYMENT. The Department will make payment for the completed and accepted quantities under the following:

Code	Pay Item	Pay Unit
01432-01799	Newly Constructed Small Drainage Structure (except Type 12 Drop Box Inlets), Type, Size	Each
01709, 01719, 01792, 01791	Adjusting Small Drainage Structure, Type, Size[1]	Each
01633, 01708, 01720, 01789	Reconstructing Small Drainage Structure, Type, Size	Each
01547	Drop Box Inlet, Type 12	Linear Foot

[1] *When small drainage structures that require adjusting exist on a project and there is not a bid item for adjusting small drainage structures, the Department will make payment according to Subsection 104.03.*

The Department will consider payment as full compensation for all work required under this section.

SECTION 711 — PREFABRICATED VERTICAL WICK DRAINS

711.01 DESCRIPTION. Furnish and place prefabricated vertical wick drains at the locations shown on the Plans.

711.02 MATERIALS. Conform to the Contract requirements.

711.03 CONSTRUCTION. Stake the proposed location of the drains before installation. Do not vary the locations by more than 6 inches from those shown on the Plans. Maintain staked locations during construction. Install trial drains at locations within the work area. Demonstrate that all equipment and materials produce a satisfactory installation. Obtain approval from the Engineer that materials and installation procedures are satisfactory. Perform corrective action if trial drains are not accepted.

Install the prefabricated wick drains with a protective mandrel or sleeve. Provide an anchor plate or similar arrangement at the bottom to prevent soil from entering the bottom of the mandrel during installation of the drain and to anchor the drain tip at the required depth. Advance the mandrel or sleeve by continuously pushing or vibrating into the soil and retract after each installation. The maximum cross sectional area of the mandrel or sleeve is 14 square inches, including the attached anchor. Pre-auger when mandrel or sleeve cannot be continuously pushed or vibrated and when the Engineer deems necessary. Use augers with a maximum outside diameter of 8 inches. Install the prefabricated wick drains vertically from the top of the working platform to the elevation shown on the plans. Ensure that plumbness of the drain does not deviate from the vertical more than 2 1/2 inches in 10 feet. Provide the Engineer a means to verify plumbness of the equipment and the depth of the drain.

Splice, no less than 6 inches, or connect the drain material according to the manufacturer's recommendations to ensure continuity of flow. Limit splices to one per drain. Cut the drain flush with the upper surface of the working platform. Install the drains in a sequence that prevents travel over previously installed drains.

Repair or replace drains that are more than 6 inches from the plan locations, improperly installed, or damaged during construction at no cost to the Department. Remove any auger cuttings or debris from the top of the working platform before continuing with fabric and fill placement over drains.

711.04 MEASUREMENT. The Department will measure prefabricated vertical wick drains in linear feet. The Department will not measure trial drains or pre-augering for payment and will consider it incidental Prefabricated Vertical Wick Drains.

711.05 PAYMENT. The Department will make payment for the completed and accepted quantities under the following:

Code	Pay Item	Pay Unit
02774	Prefabricated Wick Drain	Linear Foot

The Department will consider payment as full compensation for all work required under this section.

SECTION 712 — PAVEMENT MARKERS

712.01 DESCRIPTION. Furnish and install raised pavement markers.

712.02 MATERIALS.

712.02.01 Markers. Use Type IV or Type V raised markers conforming to Section 840 or Inlaid Markers, as designated in the Contract.

712.02.02 Adhesives. Conform to the manufacturer's recommendations.

712.03 CONSTRUCTION. Before installing the markers, furnish the manufacturer's current recommendations for adhesives and installation procedures to the Engineer.

Use one brand and design throughout the project for each type of marker required.

The Contract or Standard Drawings will specify either mono-directional or bi-directional markers, and the marker color.

Remove all excess adhesive from in front of the reflective faces.

If any adhesive or foreign matter cannot be removed from the reflective faces, or if any marker fails to properly adhere to the pavement surface, remove and replace the marker.

712.03.01 Type IV Markers. Before installing new markers, remove all portions of the existing Type IV marker, and all traces of adhesive, rust, and dirt from the casting, to the satisfaction of the Engineer. Abrasive blast or use other methods approved by the Engineer. Ensure that the casting surface is dry and free from dirt and other deleterious material before placing the marker in the casting.

Place adhesive on the marker or casting in sufficient quantity to ensure complete coverage of the contact area with no voids present and with a slight excess after the marker is pressed in place.

Firmly seat the marker in the casting with a minimum load of 100 pounds.

Ensure that the pavement surface temperature is at or above 45 ºF at the time of application. Conform to a higher temperature if recommended by the adhesive manufacturer.

712.03.02 Type V Markers. Install Type V Markers in slots cut into the pavement according to the manufacturer's recommendations. Do not cut the slots until the pavement has cured sufficiently to prevent tearing or raveling.

Prepare the pavement surfaces, and install the markers according to the manufacturer's recommendations and the following requirements. Remove all dirt, grease, oil, loose or unsound layers, and any other material from the marker area which would reduce the bond of the adhesive. Maintain pavement surfaces in a clean condition until placing markers. Ensure that the adhesive bed area is equal to the bottom area of the marker, and apply adhesive in sufficient quantity to force excess out around the entire perimeter of the marker. Use materials, equipment, and construction procedures that ensure proper adhesion of the markers to the pavement surface.

712.03.03 Inlaid Pavement Markers. Install Inlaid Pavement Markers in recessed grooves cut into the final course of asphalt pavement according to the manufacturer's recommendations. Do not cut the grooves until the pavement has cured sufficiently to prevent tearing or raveling. Cut installation grooves using diamond blades on saws that accurately control groove dimensions. Remove all dirt, grease, oil, loose or unsound layers, and any other material from the marker area which would reduce the bond of the adhesive. Maintain pavement surfaces in a clean condition until placing marker.

Prepare the pavement surfaces, and install the markers in the recessed grove according to the standard drawing or sepia. Use an approved snowplowable epoxy adhesive. Ensure that the adhesive bed area is equal to the bottom area of the marker, and apply adhesive in sufficient quantity to force excess out around the entire perimeter of the marker. Use materials, equipment, and construction procedures that ensure proper adhesion of the

markers to the pavement surface according to the manufacturer's recommendations. Remove all excess adhesive from in front of the reflective faces. If any adhesive or foreign matter cannot be removed from the reflective faces, or if any marker fails to properly adhere to the pavement surface, remove and replace the marker at no additional cost to the Department.

712.03.04 Location and Spacing. Install markers as specified on the current Standard Drawings or sepias. Install Inlaid Pavement Markers in the pattern for high reflectivity with two (2) Inlaid Pavement Markers per groove. Do not install markers in bridge decks.

Under no circumstances install a marker on top of a pavement joint or crack and maintain the minimum 1 inch offset to the stripe. Offset markers a minimum of 2 inches from any longitudinal pavement joint or crack and at least one inch from the painted stripe, ensuring that the finished line of markers is straight with minimal lateral deviation. Preference should be given to maintaining the 2-inch offset between marker and joint as opposed to keeping the line of markers straight. If conflicts between marker placement in relation to pavement joint and striping cannot be resolved, markers may be eliminated with the Engineer's approval.

Place Type V markers as much in line with existing pavement striping as possible. For facilities with double yellow centerlines, place markers between the 2 lines provided the minimum 2-inch gap requirement between the marker and the longitudinal pavement joint or crack is not violated. For instances when the double yellow centerline may bound the longitudinal pavement joint or crack, use judgment to determine which side of the painted stripe would be suitable for marker installation. Place markers installed along an edgeline or channelizing line so that the near edge of the casting is no more than one inch from the near edge of the line maintaining a minimum of 2 inches from any longitudinal paving joint or crack. Place markers installed along a lane line or dashed yellow centerline between and in line with the dashes. Do not place markers over the lines except where the lines deviate visibly from their correct alignment, and then only when the Engineer approves the location.

712.04 MEASUREMENT. The Department will measure the quantity by each individual unit. For Inlaid Pavement Marker, one (1) installation will consist of grooving the pavement, removing asphalt cuttings and debris, preheating pavement to remove moisture, adhesives, and installation of two (2) markers with all lenses.

712.05 PAYMENT. The Department will make payment for the completed and accepted quantities under the following:

Code	Pay Item	Pay Unit
06580-06584	Pavement Marker, Type IV (mono- or bi-directional, color)	Each
06589-06593	Pavement Marker, Type V (mono- or bi-directional, color)	Each
24489EC	Inlaid Pavement Marker	Each

The Department will consider payment as full compensation for all work required under the section.

SECTION 713 — PERMANENT PAVEMENT STRIPING

713.01 DESCRIPTION. Furnish and apply waterborne striping paint to provide lane lines, edgelines, and gore markings as specified in the Contract.

713.02 MATERIALS AND EQUIPMENT.

713.02.01 Paint. Conform to Section 842 and Section 846.

713.02.02 Drop On Glass Beads. Use beads that will ensure the pavement marking material will meet retroreflectivity requirements. The Department will evaluate the beads as part of the marking system through retroreflectivity readings.

713.02.03 Application Equipment. Use a self-propelled striper capable of heating the paint to provide uniform flow. Ensure that the striper has a guide boom or optical pointer to attain smooth and straight lines. Ensure that the equipment maintains proper application pressures for paint and beads at all times. Provide equipment capable of applying a single line or parallel lines of the specified width and in any combination of a skip line and a solid line in one pass.

Provide equipment with a paint cutoff device to provide clean, square marking ends of the paint lines.

Equip the paint pots or tanks with an agitator that will keep the paint thoroughly mixed.

Provide equipment with bead dispensers, minimum of one for each paint spray gun, placed such that the beads are applied to the paint almost instantly as the paint is being placed on the roadway surface. Design and align the bead dispensers so that beads are applied under air pressure uniformly to the entire surface of the paint lines. Equip the bead dispensers with cutoff controls synchronized with the cutoff controls for the paint spray guns.

713.03 CONSTRUCTION. Provide yellow centerline markings, which are defined as those separating traffic moving in opposite directions. Provide white lane line markings, which are defined as those separating traffic moving in the same direction. Ensure that these markings are skip lines and solid lines as required by Part 3 of the MUTCD. Ensure that edge lines are solid lines, and determine the color from Part 3 of the MUTCD.

On interstates and parkways, and other routes approved by the State Highway Engineer, install pavement striping that is 6 inches in width. On other routes, install pavement striping that is 4 inches in width. When centerline markings consist of a double yellow line (either a one-direction or two-direction no passing zone marking), the spacing between the two lines shall be the same as the width of one line marking. Ensure that all lines have clean edges with a width tolerance of plus 1/2 inch. The Engineer may waive the tolerances when deviations are caused by undulation in the pavement surface.

Construct skip lines with a stripe-to-gap ratio of a 10-foot paint stripe to a 30-foot gap. Ensure that the length of the stripe is between 10 and 10 1/2 feet. Ensure that the stripe-gap cycle is between 40 and 40 1/2 feet. Offset longitudinal lines at least 2 inches from longitudinal pavement construction joints. Offset longitudinal lane lines on multi-lane highways 2 inches towards the median.

On resurfacing, pavement restoration, and pavement rehabilitation projects, reinstall the recorded existing pavement markings as modified by the Engineer. On new construction, place the markings as the Contract specifies or as the Engineer directs.

Do not apply pavement marking materials to the reflector of a plowable pavement marker. Interrupt the application of the pavement marking line at each pavement marker where marking material would otherwise be applied to the marker's prismatic reflector. Provide a maximum gap in the marked line of 18 inches at each marker. Remove pavement marking material applied to a prismatic reflector surface, or replace the reflector that same workday. If material must be removed from the reflector, restore the reflector's brightness to its prior condition.

713.03.01 Records. On resurfacing, pavement restoration, and pavement rehabilitation projects, prepare and keep a written record of the locations of existing pavement markings, and furnish a copy to the Engineer at least 15 days before removing or obliterating the markings.

713.03.02 Pavement Surface Preparation. Clean grease, oil, mud, dust, dirt, grass, loose gravel, or other deleterious material from the surface where pavement markings are to be applied. On new concrete pavement surfaces, remove the curing compound from the pavement surface before applying the pavement marking material. Use only Engineer approved cleaning methods.

713.03.03 Paint Application. Apply permanent striping to new pavements when the final surface course has been placed and subsequent paving operations will not adversely impact the permanent striping. When subsequent paving operations will adversely impact the permanent striping, apply temporary striping according to Section 112.03.11 and apply the permanent striping as soon as conditions permit. Apply striping before sunset on new pavement that is to be driven over by the public.

Comply with the following application rates.

Material	Paint Application Rate	Glass Bead Application Rate
4 inch waterborne paint	Min. of 16.5 gallons/mile	Min. of 6 pounds/gallon
4 inch durable waterborne paint	Min. 24 gal/mile	Min. of 6 pounds/gallon
6 in waterborne paint	Min. of 24.8 gallons/mile	Min. of 6 pounds/gallon
6 inch durable waterborne paint	Min. of 36 gallons/mile	Min. of 6 pounds/gallon

713.03.04 Marking Removal. Remove all markings made in error or not conforming to the traffic operation in use. Do not paint with asphalt binder or other material to obliterate the markings. Remove pavement striping, temporary or permanent, from asphalt or concrete pavement using ultra-high pressure water. Marking removal totaling 1,000 linear feet or less may be removed by an abrasive method to the satisfaction of the Engineer. Vacuum all marking material and removal debris concurrently with the marking removal operation.

Do not damage the pavement in any way and protect all joint seals. If damage is observed, stop the removal process until the operation can provide an acceptable marking removal. Repair any damage to the pavement as a result of the marking removal. Removal of marking will not be measured for payment.

Waterblast to remove temporary or permanent striping completely as the Engineer directs.

713.03.05 Proving Period. A proving period will follow the application of the permanent pavement striping. During this period, the Engineer will make such observations as are necessary to determine if the markings are acceptable. The proving period begins when the facility is opened to traffic.

A) Requirements. The minimum retroreflectivity requirements at the end of the proving period, as measured with a Department approved 30 meter geometry handheld or mobile retroreflectometer, are as follows:

White: 300 mcd/lux/square meter
Yellow: 225 mcd/lux/square meter

The Department will take these measurements between 30 and 60 days after the start of the proving period, with acceptance based on KM 202 or KM 203 as

applicable. If the Department determines that the markings are acceptable, the installation of the markings will be considered complete.

B) Failure. For any one-mile section and each gore area during the proving period, the Department will consider the section defective when the retroreflectivity falls below the minimum required. The Department will consider each edge line, centerline, lane line and gore area marking separately.

C) Corrective Work. If a line is found to be defective, repair or remove and replace the line. Perform pavement marking replacement according to the requirements specified in this subsection for the initial application. The corrective work will be subject to a proving period as listed above.

713.03.06 Acceptance of Non-Specification Markings. If weather conditions allow, perform corrective work to bring striping retroreflectivity into conformance. If corrective work has been performed and the work meets all requirements except for minimum retroreflectivity, the Department may accept the work according to Subsection 105.04. When the Engineer determines that the markings may be left in place, the Department will accept them at a reduction in the Contract unit bid price according to the Acceptance Pay Schedule. Additionally, the Engineer may remove the striping crew for the remainder of the project according to Subsection 108.06 Part A).

The Engineer may also apply this section when corrective work cannot be performed due to weather.

ACCEPTANCE PAY SCHEDULE FOR PERMANENT STRIPING

Pay Value	White mcd/lux/square meter	Yellow mcd/lux/square meter
1.00	≥300	≥225
0.50	251-299	176-224
0.25	226-250	151-175
0.00	200-225	125-150
Remove and Replace	< 200	< 125

713.04 MEASUREMENT.

713.04.01 Pavement Striping. The Department will measure the quantity in linear feet. When a bid item is not included for gore markings, the Department will measure the quantity by converting the actual length and width of line installed to an equivalent length of the normal width line on that section of roadway. The Department will measure temporary striping according to 112.04.07 when subsequent paving operations will adversely impact the permanent striping.

713.05 PAYMENT. The Department will make payment for the completed and accepted quantities under the following:

Code	Pay Item	Pay Unit
06514-06517	Pavement Striping - Permanent Paint, Width	Linear Foot
24189ER	Durable Waterborne Marking – 6 IN W	Linear Foot
24190ER	Durable Waterborne Marking – 6 IN Y	Linear Foot
24191ER	Durable Waterborne Marking – 12 IN W	Linear Foot

The Department will consider payment as full compensation for all work required under this section.

SECTION 714 — DURABLE PAVEMENT STRIPING

714.01 DESCRIPTION. Furnish and install durable marking materials, thermoplastic or Type I tape, to provide lane lines, edgelines, and gore markings as specified in the Contract.

714.02 MATERIALS AND EQUIPMENT.

714.02.01 Thermoplastic. Conform to Section 837.

714.02.02 Type I Tape. Conform to Section 836.

714.02.03 Binder. Furnish a binder that the manufacturer of the pavement marking material recommends and the Engineer approves. Provide a binder that forms a continuous film that dries rapidly and adheres to the pavement. Provide a material that does not discolor or cause any noticeable change in the appearance of the pavement outside of the finished pavement marking. Submit the material and method of application to the Engineer and obtain written approval from the Engineer and the manufacturer of the pavement marking material before applying.

714.02.04 Drop On Glass Beads. Use beads that will ensure the pavement marking material will meet retroreflectivity requirements. The Department will evaluate the beads as part of the marking system through retroreflectivity readings.

714.02.05 Thermoplastic Application Equipment. Provide equipment with an extrusion die that simultaneously deposits and shapes lines at a minimum thickness of 90 mils on the pavement surface. Do not use spray and ribbon gun applicators.

Ensure the application equipment conforms to the following:

1) Capable of providing continuous and uniform heat to maintain the material between 400 and 440 °F throughout the mixing, conveying, and dispensing.
2) The kettle is capable of continuous agitation during mixing and heated storage and is equipped with an automatic thermostat control device and material thermometer.
3) Motorized and capable of applying a uniform line at a rate of 3 mph.
4) Equipped with a cutoff device that provides clean, square stripe ends.
5) Equipped with an automatic bead dispenser.

714.03 CONSTRUCTION. Provide yellow centerline markings, which are defined as those separating traffic moving in opposite directions. Provide white lane line markings, which are defined as those separating traffic moving in the same direction. Ensure that these markings are skip lines and solid lines as required by Part 3 of the MUTCD. Ensure that edge lines are solid lines, and determine the color from Part 3 of the MUTCD.

Install pavement striping at the width specified in the Contract. Ensure that all lines have clean edges with a width tolerance of plus 1/2 inch. The Engineer may waive the tolerances when deviations are caused by undulation in the pavement surface.

Construct skip lines with a stripe-to-gap ratio of a 10-foot stripe to a 30-foot gap. Ensure that the length of the stripe is between 10 and 10.5 feet. Ensure that the stripe-gap cycle is between 40 and 40.5 feet.

Use Type I Tape for markings on bridge decks, JPC pavement and JPC intersections. Do not use thermoplastic materials on JPC pavement and JPC intersections.

714.03.01 Layout. Install all pavement markings according to Part 3 of the MUTCD and the following requirements.

Make the width of lane lines and edgelines as specified in the Plans or as the Engineer directs. Make lines for gore area markings twice the normal width line for that section of roadway.

Unless striping plans are included in the proposal or otherwise directed by the Engineer, install gore area markings as shown in Figures 3B-8 and 3B-9 of the MUTCD. Do not use the optional markings shown (transverse lines in the neutral area and dotted extension of the right edgeline).

Due to the possibility that water may be retained on the roadway by the thermoplastic edgelines, place a one foot gap every 20 feet in all thermoplastic edgelines. Do not install gaps for taped edgelines.

Offset longitudinal lines at least 2 inches from longitudinal pavement construction joints. Offset longitudinal lane lines on multi-lane highways 2 inches towards the median.

On resurfacing, pavement restoration, and pavement rehabilitation projects, prepare and keep a written record of the locations of existing pavement markings, and furnish a copy to the Engineer at least 15 days before removing or obliterating the markings. The Engineer will notify you of any changes to the existing markings.

Before applying the pavement marking material, pre-mark the pavement surface and obtain the Engineer's approval of the proposed location, alignment, and control guides.

714.03.02 Surface Preparation.

1) Remove existing pavement markings and clean grease, oil, mud, dust, dirt, grass, loose gravel, or other deleterious material from the surface where pavement markings are to be applied, as directed by, and by methods acceptable to, the Engineer.
2) Remove the existing pavement markings until a minimum of 90 percent of the pavement surface is uniformly exposed throughout. Ensure that the pavement surface is in proper condition for successful bonding of the pavement markings and provides a neat appearance. Do not leave any loose or flaking existing pavement markings.
3) When removing the existing pavement markings, ensure that the finished pavement surface is not damaged or left in a condition that may mislead or misdirect the motorist. Repair any damage to the pavement, pavement joint materials, or the pavement surface caused by the removal of the existing pavement markings in a manner acceptable to the Engineer. After completing these operations, use compressed air to blow clean the pavement surface of residue and debris resulting from the removal of existing pavement markings.
4) When removal of existing pavement markings and objectionable materials obscures existing pavement markings of a lane occupied by public traffic, immediately remove the residue, including dust, from the surface being treated. Obtain the Engineer's approval of the removal methods.
5) Place the final pavement markings on the same day that the existing pavement markings are removed.
6) On concrete surfaces and as the Engineer directs on older asphalt pavements, apply binder to the area where placing pavement marking material.
7) On new concrete pavement surfaces, remove the curing compound from the pavement surface before applying the binder and the pavement marking material.

714.03.03 Application.

A) Type I Tape. Apply according to the manufacturer's recommendations. When applied to concrete, cut the tape at all joints.

B) Thermoplastic. Rather than installing thermoplastic pavement markings on fresh asphalt, the Department will allow temporary striping with paint. Temporary striping is incidental to the permanent marking. The Department will not require removal of the interim pavement marking paint, as referenced in 714.03.02, before applying the thermoplastic pavement markings when completed within 30 calendar days of placement of the interim pavement markings.

Install the thermoplastic material at a minimum thickness of 90 mils on the pavement surface in a melted state at a temperature from 400 and 440 °F.

Apply additional glass beads by drop-on or pressure spray methods in sufficient quantities to obtain the retroreflectivity requirements specified in Subsection 714.03.06.

Verify the adhesion of the thermoplastic to asphalt pavements by performing bond checks, at least 4 per mile of line, as follows. Approximately 60 to 120 seconds after applying a thermoplastic line to the roadway surface, cut and lift approximately a 6-inch section of thermoplastic. The thermoplastic is successfully bonding to the pavement surface if a layer of asphalt clings to the removed thermoplastic stripe and the pavement surface under the removed stripe is shiny and black.

Provide finished markings that are continuous and uniform in shape, having clear and sharp dimensions. Ensure that all lines have well-defined edges.

714.03.04 Restrictions. Do not apply the pavement marking material when air and pavement temperatures are below 50 °F.

Do not apply the pavement marking material when the surface of the pavement contains evidence of moisture in amounts significant enough to prevent the pavement marking material from bonding to the pavement. Significant amounts of moisture can be caused by heavy dew or very humid nights as well as from rainfall.

If encountering significant amounts of moisture while applying the thermoplastic, the Contractor, at his own risk, may attempt to apply thermoplastic subject to the following restrictions. Heat the thermoplastic material to the upper temperature limit specified by the manufacturer, and apply a test line on the pavement. Perform a bond check according to Subsection 714.03.03. If the thermoplastic successfully bonds to the pavement continue to apply thermoplastic lines, provided there is evidence that the moisture is escaping through the surface of the line, as indicated by very small pin holes. If there is excessive moisture, as indicated by larger sized holes or bubbles on the surface of the line, do not apply thermoplastic until the moisture can be effectively dealt with. Perform a sufficient number of bond checks to ensure that the thermoplastic is bonding to the pavement.

714.03.05 Project Conflicts. When other construction projects are in progress within the limits of the designated work areas, install no pavement markings that will be removed or damaged by immediate subsequent construction. The Engineer will give notification of all conflicting construction projects. Schedule the installation of pavement markings after completion of the conflicting construction. When scheduling is impossible or creates an undue hardship, the Engineer will delete the intersection from this project.

714.03.06 Proving Period for Durable Markings. A 180 day proving period will follow the application of the durable markings. During this period, the Engineer will make such observations as are necessary to determine if the markings are acceptable. The proving period begins when the facility is opened to traffic.

A) Requirements.

1) Type I Tape. During the proving period, ensure that the pavement marking material shows no signs of failure due to blistering, excessive cracking, bleeding, staining, discoloration, oil content of the pavement materials, deterioration due to contact with grease deposits, oil, diesel fuel, or gasoline drippings, chipping, spalling, poor adhesion to the pavement, loss of retroreflectivity, vehicular damage, and normal wear. Type I Tape is manufactured off site and warranted by the manufacturer to meet certain retroreflective requirements. As long as the material is adequately bonded to the surface and shows no sign of failure due to the other items listed in Subsection 714.03.06 A) 1), retroreflectivity readings will not be required. In the absence of readings, the Department will accept tape based on a nighttime visual observation.

2) Thermoplastic. During the proving period, ensure that the thermoplastic pavement marking material shows no signs of failure due to blistering, excessive cracking, bleeding, staining, discoloration, oil content of the pavement materials, smearing or spreading under heat, deterioration due to contact with grease deposits, oil, diesel fuel, or gasoline drippings, chipping, spalling, poor adhesion to the pavement materials, loss of retroreflectivity, vehicular damage and normal wear.

The minimum retroreflectivity requirements at the end of the proving period, as measured with a Department approved 30 meter geometry handheld or mobile retroreflectometer, are as follows:

White:	300 mcd/lux/square meter
Yellow:	225 mcd/lux/square meter

The Department will take these measurements between 150 and 210 days after the start of the proving period, with acceptance based on KM 202 or KM 203 as applicable. If the Department determines that the markings are acceptable, the installation of the markings will be considered complete.

B) Failure. During the proving period, the Department will consider markings defective when the retroreflectivity falls below the minimum required or the material fails to meet the other requirements of A) above. Additionally, when more than 10 percent of any one-mile section or individual gore area is defective, the Department will consider the entire section defective. The Department will consider each edge line, centerline, lane line and gore area marking separately.

C) Corrective Work. If a line is found to be defective, repair or remove and replace the line. Perform pavement marking replacement according to the requirements specified in this subsection for the initial application. The corrective work will be subject to a proving period as listed above.

714.03.07 Marking Removal. Remove all markings made in error or not conforming to the traffic operation in use. Do not paint with asphalt binder or other material to obliterate the markings. Remove pavement striping, temporary or permanent, from asphalt or concrete pavement using ultra-high pressure water. Marking removal totaling 1,000 linear feet or less may be removed by an abrasive method to the satisfaction of the Engineer. Vacuum all marking material and removal debris concurrently with the marking removal operation.

Do not damage the pavement in any way and protect all joint seals. If damage is observed, stop the removal process until the operation can provide an acceptable marking removal. Repair any damage to the pavement as a result of the marking removal. Removal of marking will not be measured for payment.

714.03.08 Acceptance of Non-Specification Thermoplastic Markings. When reasonably acceptable work has been produced but retroreflectivity requirements are not met, the Department may accept the work according to Subsection 105.04. When the Engineer determines that the markings may be left in place, the Department will accept them at a reduction in the Contract unit bid price according to Acceptance Pay Schedule for Thermoplastic.

714.04 MEASUREMENT. When a bid item is not included for gore markings, the Department will measure the quantity by converting the actual length and width of line installed to an equivalent length of the normal width line on that section of roadway.

714.04.01 Thermoplastic Pavement Markings. The Department will measure for payment by the units listed in the Quantity Summary. The Department will not measure sampling, testing, surface preparation, pre-marking, interim marking, and binder application for payment and will consider them incidental to the thermoplastic bid items. The Department will not measure corrective work for payment.

714.04.02 Durable Pavement Markings, Type I. The Department will measure for payment by the units listed in the Quantity Summary. The Department will not measure sampling, testing, surface preparation, pre-marking, and binder application for payment and will consider them incidental to the pavement marking bid items. Corrective work will not be measured for payment.

714.04.03 Pavement Striping Removal. When listed as a bid item, the Department will measure for payment by the units listed in the Quantity Summary. The Department will not measure for payment the removal of existing pavement markings that have not been authorized by the Engineer. When the Contract does not list a bid item, the Department will consider existing pavement marking removal incidental to the other pavement marking bid items. The Department will not measure for payment any corrective work required due to the removal work.

714.05 PAYMENT. The Department will make payment upon completion of the work. If after the proving period the markings do not meet minimum retroreflectivity requirements, the Department will adjust the payment or require corrective work according to the following:

ACCEPTANCE PAY SCHEDULE FOR THERMOPLASTIC		
Pay Value	White mcd/lux/square meter	Yellow mcd/lux/square meter
1.00	≥300	≥225
0.50	251-299	176-224
0.25	226-250	151-175
0.00	200-225	125-150
Remove and Replace	< 200	< 125

Code	Pay Item	Pay Unit
06540-06547	Pavement Striping - Thermoplastic, width, color	Linear Foot
06554-06561	Pavement Striping - Durable Type I Tape, width, color	Linear Foot

The Department will consider payment as full compensation for all work required under this section.

SECTION 715 — PANEL TRAFFIC SIGNS

715.01 DESCRIPTION. Furnish and install extruded panel traffic signs. Traffic signs include ground mounted, overhead structure mounted, or bridge mounted signs.

715.02 MATERIALS.

715.02.01 Panel Signs. Conform to Section 833.

715.02.02 Concrete. Conform to Subsection 601.02 and 601.03.

715.02.03 Steel Reinforcement. Conform to Section 602.

715.02.04 Structural Steel. Conform to Section 812.

715.02.05 Miscellaneous Metals. Conform to Section 813.

715.02.06 Retroreflective Materials. Conform to Section 830.

715.02.07 "Pop" Fasteners. Use corrosion resistant protruding head "pop" rivets with a minimum diameter of 1/8 inch. Obtain the Engineer's approval before use.

715.03 CONSTRUCTION. The Department may inspect fabrication and erection work. The Department will perform a day and night inspection after the installation is complete.

If a manufacturer provides a warranty on any materials covered under these specifications, furnish the same warranty to the State. Perform the work according to the requirements specified in the following publications:

- MASH
- MUTCD
- AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals, 2013 – 6th Edition with current interims
- Federal Standard 595, Standard Highway Sign Colors
- Standard Highway Signs

Use Class A concrete according to Subsection 601.03.

715.03.01 Location. Use the Plans as general guidance for the extent and general arrangement of signs. Consider sign locations specified in the Plans as approximate only. Determine the exact location for each sign and obtain the Engineer's approval. When it is necessary to relocate any sign more than 25 feet from the station listed, obtain the Division of Traffic's approval. Center overhead signs over the lane or lanes to which they apply. Allow for differences in elevation across the full shoulder width, as specified in the Plans, in maintaining the required 18-foot minimum vertical clearance to the bottom of the lowest parts of the signs or supports for overhead signs. Submit all proposed revisions in writing to the Engineer for written approval.

715.03.02 Messages. Sign messages specified in the Plans are the final messages. Due to construction phasing, the Engineer may make changes in some messages. If the Engineer changes a message before the sign installation store the final message copy on the project. Conform message spacing to the applicable requirements of the previously cited publications for guide signs, and the manufacturer's recommendations for sign sizes indicated, as the Engineer approves. Center message copy over the lane or lanes to which they apply.

715.03.03 Attachment. Attach letters, symbols, numbers, and borders to sign faces with "pop" fasteners ("pop" rivets).

715.03.04 Shields. For panel sign mounted route markers, use a retroreflectorized white cut-out for the US shield and KY round shape, omitting the black background of the standard rectangular shapes. Do not use borders on the cut-out shapes. Use the dimensions shown in the Standard Highway Signs Manual. Space route markers evenly across the panel sign face. Provide Route Markers for panel signs that meet the specification requirements for Type IX Class I of ASTM D 4956, and that consist of reflective sheeting having an integral air cavity between the front surface and the optical elements, mounted on fully covering aluminum base copy stock not otherwise embossed or crimped, but having a minimum thickness of 0.080 inches.

715.03.05 Covering. Cover sign faces only when absolutely necessary and keep covered only as long as necessary. Use only porous cloth or geotextile fabric for sign covers. Replace any signs damaged as a result of being covered at no expense to the Department.

715.03.06 Shop Drawings. Submit detailed shop drawings in electronic format to the Engineer for written approval before fabricating signs. Before installation, obtain the Engineer's written approval of drawings, descriptions, manufacturer's cuts, etc. covering all materials to be used. Submit mill test reports for I-beams, wide flange beams, aluminum or steel panels, and each different gauge of aluminum or steel sheeting used to the Engineer for approval before installation.

715.03.07 Fabrication. Hot dip galvanize all steel components after completing fabrication. Regalvanize or paint all abraded or damaged surfaces with 2 coats of commercially available zinc rich paint.

Ensure that sign structures are free from kinks, twists, or bends and are uniform in appearance. Assemble completed sections in the shop and check them for straightness, alignment, and dimensions. Correct any irregularities.

Consider sign post lengths as approximate only. Conform to the applicable requirements contained in AWS for welded fabrication.

715.03.08 Footings, Bases, and Pedestals. Provide protection for traffic during construction of concrete bases for overhead sign structures.

Exercise caution during any excavation to prevent damaging existing utilities whether specified or not specified in the Plans. Repair or replace any utilities that are disturbed or damaged during construction at no additional expense to the Department. Provide the Engineer the opportunity to inspect repairs to damaged utilities before covering the repairs.

Construct footings and bases according to Subsection 601.03. The Department will allow construction of footings against undisturbed earth without forms, unless otherwise directed. Slope top surfaces of bases and pedestals to provide for drainage. Provide an ordinary surface finish for all exposed concrete. Construct a rustication groove in all pedestals. Cure concrete according to Subsection 601.03.17.

Remove beam sign supports concurrently with the relocation of affected signs to new supports. Grade, to the existing slope, any areas disturbed by removing existing signs or constructing new signs, and reseed as the Engineer directs.

715.03.09 Sign Beams and Supports. Use beams of sufficient length to extend from the top of the sign to the required base embedment. Use either Type A (standard fixed beam installation) or Type C (omni-directional break-a-way beam installation) or Type D Breakaway Supports as specified in the Plans. Embed Type "A" and Type "B" beams in concrete to a depth equal to the dimension "a" as indicated for each sign. Provide a concrete footing for Type "C" beams according to the design on the Type "C" beam sheets.

Wait 7 calendar days after placing concrete before mounting beams and supports to the bases or pedestals. Where aluminum is in contact with concrete, thoroughly coat the contacting surface with alumilastic compound or an approved equal in order to completely insulate the aluminum from the concrete. Where bond between the aluminum and concrete is desired, coat the aluminum with commercially available zinc chromate paint, and allow it to dry before installation.

A) Type A Beam. Furnish A 36 steel beams galvanized according to ASTM A 123.

B) Type B Beam. Specifications for Type B uni-directional break-a-way beams are listed on the detail sheet for Type "B" beams. Specifications for Type B beams are listed on the break-away detail sheet.

C) Type C Beam. Specifications for Type C omni-directional break-a-way beams are listed on the details sheets for Type "C" beams.

715.03.10 Bridge Mounting for Signs. Do not install brackets for support of bridge mounted signs within 6 inches of open joints in concrete handrail plinths. The Department will allow moving of supports to clear handrail posts. Place sign brackets on 4-foot maximum centers with a 2-foot maximum sign overhang.

When necessary, remove existing handrails to drill anchor bolt holes. Reinstall handrails after drilling. Locate bolt holes drilled in prestressed concrete beams to not interfere with steel strands. Drill holes for concrete beams with a rotary type core drill. Do not use impact type drills. Install bolts with expansion plugs and lock washers in the holes and fill the void between the plug and face of the concrete with non-shrinking grout.

715.03.11 Mounting Signs. Install new concrete bases, support beams, etc. before dismantling any existing sign. When existing signs are to be out of service for more than one work shift, install temporary signing of the proper color, shape, and with copy of similar configuration to existing signs at the same approximate station as the out of service sign. Install sign panels on sign structures, beams, or bridge mounted brackets as specified in the Plans. Delay installation as long as possible to avoid any damage to the sign. Replace all damaged signs.

715.04 MEASUREMENT.

715.04.01 Concrete. The Department will measure according to Subsection 601.04.

715.04.02 Steel Reinforcement. The Department will measure according to Subsection 602.04.

715.04.03 Sign Supports. The Department will measure the quantity by each individual unit.

The Department will not measure clearing and grubbing, excavation, electrical conduit and ground rods located in support bases, and temporary panel signing for payment and will consider them incidental to this item of work.

715.04.04 Beams. The Department will measure the quantity in pounds.

715.04.05 Bridge Mounted Sign Fixtures. The Department will measure the quantity by each individual unit. A unit is as all material necessary for mounting a bridge mounted sign of given size.

715.04.06 Sign Panels. The Department will measure the quantity in square feet for each size and type.

715.05 PAYMENT. The Department will make payment for the completed and accepted quantities under the following:

Code	Pay Item	Pay Unit
06490	Class A Concrete for Signs	See Subsection 601.05
06491	Steel Reinforcement for Signs	See Subsection 602.05
06416-06426, 06436, 06438, 06443, 06445	Sign Supports, Size and Type	Each
06400, 06440, 06441	GMSS Galvanized Steel, Type	Pound
06402	GMSS Aluminum	Pound
06448	Sign Bridge Attachment Bracket	Each
06405-06409	Sign Panels, Type and Size	Square Foot

The Department will consider payment as full compensation for all work required under this section.

SECTION 716 — ROADWAY LIGHTING SYSTEMS

716.01 DESCRIPTION. Furnish, install, and connect lighting systems according to the Contract.

716.02 MATERIALS. Conform to Section 834. For materials that are not on the Department's List of Approved Materials, submit documentation for material approval in electronic format to the Division of Traffic Operations. Documentation included descriptive literature, drawings, and any requested design data or changes. Notify the Engineer when submitting any information to the Division of Traffic Operations. Do not begin work until shop drawings or construction changes are approved. Do not make substitutions for approved materials without written permission from the Engineer.

716.02.01 Paint. Conform to Section 821.

716.03 CONSTRUCTION. Perform the work according to:

1) The Contract
2) Kentucky Department of Highways, Standard Drawings
3) National Fire Protection Association (NFPA) 70
4) National Electrical Code
5) Institute of Electrical and Electronic Engineers (IEEE), National Electrical Safety Code
6) AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals, 2013-6th Edition with current interims,
7) AASHTO Roadside Design Guide
8) AASHTO Roadway Lighting Design Guide, 2005 edition
9) Standards of the utility company servicing the installation

The Plans indicate the extent and general arrangement of the lighting circuits and materials to be used. Advise the Engineer in writing and obtain written approval from the Engineer for any modifications before beginning work. Stake pole locations/elevations and obtain the Engineer's approval before beginning the work.

716.03.01 Utility Requirements. Contact all utility companies and the district utility agent before any holes are dug or set to insure proper clearance and shielding from existing or proposed utility lines. Before ordering materials, confirm the type and location of the service available from the utility company.

After completing the installation and before the electrical service is connected, obtain the service from the utility company (in contractor's name) and a certificate of compliance from the Kentucky Department of Housing, Buildings and Construction, Electrical Inspection Division. .

716.03.02 Standard Installation. Locate poles to avoid trees, drainage, structures, etc. Regardless of the station & offset noted, locate all poles/bases behind guardrail a minimum of 4 feet from the front face of the guardrail to the front face of the pole base. All poles shall be placed at exact stations and offsets as stated on Plans to provide proper illumination and to comply with Federal Aviation Administration (FAA) and Kentucky Airport Zoning Commission (KAZC) requirements. If any pole needs to be relocated from stations/offsets indicated, the Division of Traffic Operations shall be contacted. When submitting brochures for suggested high pressure sodium luminaires, include iso lux curves, IES type distribution, lamp lumens, and typical ballast factor for each type of luminaire. When submitting brochures for suggested light emitting diode luminaires, include all documents specified in Section 834 for each type of luminaire. Submit the photometric data in a digital IES format to the Division of Traffic Operations by email. Include with the

submittal a point of contact and phone number to answer technical questions about the luminaire.

A) Conventional Installation. Install each conventional pole as noted on plans and have luminaires with light patterns as indicated. Pole/arm shall be perpendicular to the roadway surface or as otherwise stated on the plans. Pole heights, arm lengths, and setbacks are denoted as stated on "Luminaire Designation Example" on Luminaire/Fuse Connector Detail sheet. Orient the transformer base door on the side that is opposite the side facing oncoming traffic. Base door shall be secured. If transformer doors are lockable, the contractor shall coordinate with the Division of Traffic Operations to obtain a proper key to open/secure the door. If poles are installed on a barrier wall, the pole doors shall be oriented facing the barrier wall on the same side as the junction box and be secured. The Department will allow steel plates or washers between the nuts and the transformer base or pole for stabilization and shims to plumb the pole for gaps up to 1/4 inch. Aluminum spacer plates shall be installed between pole and top of the transformer base to prevent openings. Install and secure pole cap with provided set screws. All excess holes in the pole or transformer base shall be filled in to prevent water/bugs from entering the structure.

1) Breakaway Installation and Requirements. For breakaway supports, conform to Section 12 of the Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals 2013 Edition. Grade surface appropriately to meet the 4-inch breakaway support stub height. This stub height includes the pole base, conduits, nuts, and the anchors bolts. All breakaway devices shall be able to be electrically disconnected from all electrical components.

2) Concrete Base Installation. Ensure that concrete bases for lighting up to 50 feet high, have a minimum depth of 6 feet and a minimum diameter of 2 feet. Precast concrete bases are not acceptable. Construct a level base, with no more than a 3/8-inch gap existing between the concrete base and the transformer base when the pole is plumbed. The concrete base shall be round and have a 1 inch chamfer on the top. The concrete base shall not have any voids between installed conduits and anchor bolts. The reinforcement and anchor bolts shall be adequately supported in the proper positions so no movement occurs during concrete placement. Exposed portions of the foundation shall be formed to create a smooth finished surface. All forming shall be removed upon completion of foundation construction. Subsurface conditions consisting of very soft clay or very loose saturated sand could result in soil parameters weaker than those assumed. The Engineer shall consult with the Geotechnical Branch of the Division of Structural Design if such conditions are encountered. The bottom of the drilled hole shall be firm and thoroughly cleaned so no loose or compressible materials are present at the time of the concrete placement. If the drilled hole contains standing water, the concrete shall be placed using a tremie to displace water. Continuous concrete flow will be required to insure full displacement of any water.

3) Rebar Installation. Six equally spaced No. 5 bars shall be used for the vertical rebar. The vertical bars shall be at least 3 inches from the edge of the concrete on the sides, top, and bottom. The horizontal rebar shall be No. 3 bars on a 12 inch pitch from the top of the vertical rebar to the bottom of the rebar. Spiral reinforcement may be substituted for ties. The ties shall be spaced 12 inches apart starting from the bottom of the verticals bars. If spiral reinforcement is used, one and one-half closed

coils shall be provided at the ends of each spiral unit.

4) Pole Installation. Top nuts shall be tightened to one-sixth turn beyond snug-tight on the pole and the transformer base connection. Snug-tight is defined as the condition where the nut is in full contact with the base plate. It is assumed that the full effort of a workman on a 12 inch wrench results in a snug-tight condition. Fasten each transformer base to the base flange of the pole with four loose washers, four lock washers, and connecting bolts/nuts. The top anchor bolt cover with screws shall be installed per the manufacturer's recommendations. Each bolt shall have at least one flat washer, one lock washer, one nut, or what is recommended by the manufacturer. The clearance between the bottom of the leveling nuts and the top of the concrete foundation shall not exceed one bolt diameter. There shall be at least two threads of the anchor bolt beyond the top nut. Welding of anchor bolts to the reinforcing cage is unacceptable. Templates shall be used. Secure a one-piece anchor base to the lower end of the pole.

a. Barrier wall anchor bolt installation. All threads, caps, nuts, etc. shall be wrapped prior to any application of wall finishing compounds. The wrapping shall be removed after the wall is finished and prior to the electrical inspection.

b. Procedure to fix anchor bolts. Drill existing bolt from concrete. Drill a 19 inch embedment depth and use the 500 Hilti anchoring system (or approved equal) for the following situations: (1) any installation using a 30 foot pole or shorter or (2) any installation using an 8 foot arm or shorter. For other installations, up to a 40 foot pole or 15 foot arm, drill a 20 inch embedment depth and use the 200 Hilti anchoring system (or approved equal).

5) Required Time to Apply Loads on Concrete Structures. Conform to Subsection 601.03.15.

B) High Mast Installation. . Install each high mast pole as noted on Plans. Install each high mast pole on a separate circuit. Use luminaires with light patterns as indicated. Orient luminaires as shown in Plans. Orient the axis of the winch drum so that it is on the side that is not facing on-coming traffic.

1) **Breakaway Installation and Requirements.** Highmast poles shall not be installed on break away supports.

2) **Concrete Base Installation.** Drilled shaft depth shall be based on the soil conditions encountered during drilling and slope condition at the site. Refer to the below design chart. The concrete base shall be round, level, and have a 3/4 inch chamfer on the top. The concrete base shall not have any voids between installed conduits and anchor bolts. The bottom of the drilled hole shall be firm and thoroughly cleaned so no loose or compressible materials are present at the time of the concrete placement. If the drilled hole contains standing water, the concrete shall be placed using a tremie to displace water. Continuous concrete flow will be required to insure full displacement of any water. Exposed portions of the foundation shall be formed to create a smooth finished surface. All forming shall be removed upon completion of foundation construction.

Drilled Shaft Depth Data							
Level Ground		3:1 Ground Slope		2:1 Ground Slope		1.5:1 Ground Slope [(2)]	
Soil	Rock	Soil	Rock	Soil	Rock	Soil	Rock
17 ft	7 ft	19 ft	7 ft	20 ft	7 ft	(1)	7 ft

Steel Requirements			
Vertical Bars		Ties or Spiral	
Size	Total	Size	Spacing or Pitch
#10	16	#4	12 inch

(1): Shaft length is 22 feet for cohesive soil only. For cohesionless soil, contact the Geotechnical Branch.
(2): Do not construct high mast drilled shafts on ground slopes steeper than 1.5:1 without the approval of the Division of Traffic.

3) **Rock Installation**. If rock is encountered during drilling operations and confirmed by the Engineer to be of sound quality, the shaft is only required to be further advanced into the rock by the length of rock socket shown in the table. The total length of the shaft need not be longer than that of soil alone. Both longitudinal rebar length and number of ties or spiral length shall be adjusted accordingly. If a shorter depth is desired for the drilled shaft, the contractor shall provide, for the Engineer's review and approval, a detailed column design with individual site specific soil and rock analysis performed and approved by a Professional Engineer licensed in the Commonwealth of Kentucky.

4) **Rebar Installation.** Spiral reinforcement may be substituted for ties. If spiral reinforcement is used, one and one-half closed coils shall be provided at the ends of each spiral unit. Subsurface conditions consisting of very soft clay or very loose saturated sand could result in soil parameters weaker than those assumed. Engineer shall consult with the Geotechnical Branch of the Division of Structural Design if such conditions are encountered. The reinforcement and anchor bolts shall be adequately supported in the proper positions so no movement occurs during concrete placement. Welding of anchor

bolts to the reinforcing cage is unacceptable, templates shall be used.

5) **Splicing of Reinforcement.** Conform to Subsection 602.03.06. Splicing of vertical reinforcement shall be Class C or as recommended by the Division of Traffic Operations. When a drilled shaft is lengthened in the field, the splice location shall be made at the bottom of the reinforcement cage.

6) **Pole Installation**. Top and bottom nuts shall be tightened to one-sixth turn beyond snug-tight. Snug-tight is defined as the condition where the nut is in full contact with the base plate. It is assumed that the full effort of a workman on a 12 inch wrench results in a snug-tight condition. Each bolt shall have at least one flat washer, one lock washer, two nuts, or what is recommended by the manufacturer. The flat washer shall be installed between the bottom nut and base plate. The lock washer shall be installed between the top nut and the base plate. The clearance between the bottom of the leveling nuts and the top of the concrete foundation shall not exceed one bolt diameter. There shall be at least two threads of the anchor bolt beyond the top nut.

7) **Require Time to Apply Loads on Concrete Structures.** Conform to Subsection 601.03.15

8) **High Mast Inspection.** Each lowering device shall be inspected by a representative of the manufacturer of the lowering device prior to final acceptance of the project by the Department. The Contractor shall submit a letter from the manufacturer that this inspection has been performed and that the lowering device has been installed according to the manufacturer's requirements. The letter shall be on the company's letterhead and signed by the representatives from the company that performed the inspection.

716.03.03 Trenching.

A) High Mast Ducted Cables. Trench/open cut and lay conduit for ducted cables to a depth at least 24 inches below grade. If conduit and/or ducted cable is in the same trench/open cut, the Engineer will only pay for one trench/open cut, not multiple. Do not cut any pavement without obtaining the Engineer's prior approval or as noted on the plans. The bending radii for the ducted cable shall be installed according to manufacturer's recommendation. Ducted cable shall not be cramped in junction boxes, poles, cabinets, or in the ground.

B) Non-High Mast Cables. Lay conduit not subjected to traffic to a depth at least 18 inches below grade. On transverse crossings under roadway surfaces and shoulders, place the conduit (as specified in Contract) at a depth of no less than 24 inches below grade. If depths greater than 24 inches are necessary for either situation listed previously, obtain the Engineer's approval and maintain the required conduit depths coming into the junction boxes. No payment for additional junction boxes for greater depths will be allowed. Make all pavement crossings by placing conduit in the subgrade before paving or by boring and jacking under

existing pavements. When it is necessary to bore under roadways and ramps, obtain the Engineer's approval of the boring procedure. Do not cut any pavement without obtaining the Engineer's prior approval or as noted on the plans. If conduit and/or ducted cable is in the same trench/open cut, the Engineer will only pay for one trench/open cut, not multiple.

C) Procedure. The pavement shall be open cut to a depth of 39 1/2 inches below grade (assuming a 2 inch conduit). The depth will have to be adjusted if conduit is larger in diameter. This includes a minimum of 6 inches width at the bottom of the open cut. Open cut top portion 10 1/2 inches below grade and 12 inches wide. The top portion of the open cut shall be cut 3 inches larger on both sides of the original open cut. The conduit in the open cut shall be a minimum of 3 inches from the bottom of the open cut and should be encased in concrete. After placement of the conduit the open cut shall be filled with class A concrete. The top portion of the open cut shall have either No. 5 bars at 12 inches on center each way or No. 4 bars 8 inches on center each way installed about three-fourths of the way down. There shall be 1 1/2 inch asphalt surface compacted on the top of the open cut if needed.

716.03.04 Conduit Installation. Provide schedule 80 PVC or Duct (as stated in Subsection 834.06.01) conduit encasements for conductors except as specified in the Contract. Provide rigid steel conduit encasement for all conductors under any road crossing, any areas above ground, and for any conduit leading to the electrical service except as specified in the Contract or stated below. Provide schedule 40 PVC for encasement inside concrete barrier walls, except for conduits coming in from under the roadway which shall be rigid steel. Ream all conduit ends to remove burrs and sharp edges. Ensure that conduit bends have a radius of not less than 12 times the nominal diameter of the conduit. Cap spare conduits on both ends with test/pipe plugs. Conduit locations are schematic only.

A) Junction Boxes. Provide conduits in junction box type A that are installed 9 inches (18 inch trench) or 3 inches (24 inch trench) in the side and from the bottom of the box. Provide conduits in junction box type C that are installed 12 inches (18 inch trench) or 6 inches (24 inch trench) in the side and from the bottom of the box. The top of the conduits shall be at least 8 inches from the bottom of the junction box lid. Install conduit inside the junction box with 90 degree conduit elbow. Provide conduits and spares that are accessible inside Junction boxes.

B) Junction Boxes for High Mast Ducted Cable. Install conduit horizontally through the junction box. Provide conduits in junction box Type A that are installed 3 inches from the bottom and at least 4 inches from the side of the junction box. Provide conduits in junction box type C that are installed 12 inches (18 inch trench) or 6 inches from the bottom and at least 4 inches from the side of the junction box. The conduit for the ducted cable and spare shall be accessible inside junction boxes.

C) Installation in Pole Bases. In conventional lighting bases, there shall be at least two 1 1/4 inch rigid steel conduit and 3/4 inch schedule 80 PVC conduit for the grounding. In high mast bases, there shall be two 3 inch schedule 80 PVC conduit and one shall be a spare. The conduit shall be installed at least 6 inches from the bottom of the high mast pole door frame. If ducted cable is ran to the pole bases, the duct shall be connected with Bonduit (or approved equal) to the same size rigid steel

conduit entering the pole base. Alternately if ducted cable is used, the contractor can install rigid steel conduit two times the size of the duct and run the duct inside this conduit. The sweep for the conduit shall be increased to adhere to the bending radius recommended by the manufacturer of the duct. In bases, an arrow shall be etched on the top of the base to show the location/direction of the spare conduit.

D) Installation in Cabinets. For a base mounted cabinet, there shall be one 3 inch schedule 80 PVC conduit for each circuit for high mast and specified Schedule 80 PVC conduits for conventional installations. For pole mounted cabinets, there shall be appropriate rigid steel conduits installed to meet the National Electric Code and any notes on the plans. In cabinet bases (base mounted only), an arrow shall be etched on the top of the base to show the location/direction of the spare conduit.

E) Barrier Wall Installation. The Department will allow slip joints for joining schedule 80 PVC conduit to junction boxes in barrier wall. The slip shall be schedule 80. Appropriate sized mouse with attached pull string shall be blown through the conduits to verify that it is clear of any obstructions. The pull string shall be tied off at each end of the conduits. Use a sealing lock nut and a rigid end bell PVC conduit bushing on the inside for all conduit penetrations, except for under the roadway conduit which shall be rigid steel.

F) High Mast Ducted Cables. Run ducted cables inside 3inch rigid steel conduits, or other Engineer approved methods, when crossing roadways. Run only one ducted cable through each 3inch rigid steel conduit.

G) Coupling Installation. When a standard coupling cannot be used, use an approved threaded union coupling.

H) Bonding/Bushing Requirements. Bond together conduits, junction boxes, metal poles, and control boxes throughout the lighting system to all ground rods by using grounding bushings/lugs.

I) PVC/Ducted Cable Bushing. There shall be a schedule 80 PVC end bell bushing installed on all ends of PVC conduit. A spear type bushing can be used in a barrier wall when approved by the Engineer.

J) Painting. Paint damaged portions of galvanized surfaces and untreated threads resulting from field cuts with an Engineer approved rust prohibitive paint.

K) Bore and Jack. Construction methods shall be in accordance with Subsections 706.03.02, paragraphs 1, 2 and 4. If bore and jack, all conduits under the roadway will be paid for each individual length of conduit bored.

L) Existing Base Conduit Installation. Install conduit by sawing a slot, chipping out, or drilling a hole. After the installation of the conduit, any spaces between conduit and original base shall be filled with grout. If any cabinet wiring must be disconnected for this operation, wires shall be neatly labeled with permanent non-fading labels and reconnected after installing the conduit.

M) Service Ground Conduit Installation. Install schedule 80 PVC conduit that is separate from the pole or cabinet grounding system ground.

716.03.05 Underground Warning Tape. Install underground utility warning tape immediately above the circuit cables that are in duct or conduits. Bury the tape at a depth of 6 to 10 inches.

716.03.06 Backfilling and Disturbed Areas. Before starting backfilling operations, allow the Engineer to inspect the conduit installation. Place and compact the backfill materials in lifts of 9 inches or less. If in rock areas, backfill the trench with dense gravel/sand to 12 inches above the placed conduit and then fill with compacted backfill materials as stated above. After all work is completed, clean work sites and all disturbed areas. Dispose of all waste and debris off the right of way at sites obtained by the Contractor at no additional cost to the Department. Sow all disturbed earthen areas with Seed Mix Type I.

716.03.07 Wiring Installation. Where installing more than one circuit within the same conduit, affix permanent circuit identification numbers to the wires wherever the wiring emerges, including junction boxes, poles, transformer bases, and control cabinets. Run all cable or wire splice-free from the controller to each pole the cable or wire is feeding. All wiring shall be color coded according to the National Electric Code (NEC), current edition. Removal of wire strands will not be allowed when connecting to splices, luminaires, circuit breakers, and any other electrical device.

For conventional ground wire installations, all poles shall have a #12 awg green ground wire run from bottom of pole to the luminaire for grounding. All poles shall have a green wire, the same size as the circuit wire, run from pole to pole for grounding. Grounding wires shall be connected to grounding lugs on conduits or on the pole/transformer base.

716.03.08 Splicing.

A) A) Approval. Permission to splice is determined by the Division of Traffic Operations and the locations shall be shown on the layout sheet. If splicing is needed but not shown on the layout sheet, receive prior approval from the Division of Traffic Operations through the Engineer. When approved, splice only in junction boxes, in transformer bases, or in the pole when no transformer base is provided. Ensure the splices are of the correct size for the wire being used. Any splice kits shall be incidental to the wire and cable being installed. If splicing is allowed by the Division of Traffic Operations, all splicing methods shall be approved by the Division of Traffic Operations. All splice locations shall be noted on the as-built plans.

B) One Way Splicing Procedures. Conform to Subsection 834.13.02. Cover all butt splices with a vinyl mastic pad. The pad shall be placed so that it is in the center of the butt splice and extended at least 2 inches past the wire where insulation was removed. After installation of the pad, 3M #33 electrical tape (or approved equal) shall be installed over the entire pad and be extended 1 inch beyond the pad. The tape shall be as tight as possible so that the pad can compress on to the wire splice for water protection. All wire and butts shall be dried off before the installation of the pad and tape.

C) Two or Multiple Way Splicing. Conform to Subsection 834.13.01.

716.03.09 Fused Connector Kits. Install inside transformer bases, barrier wall junction boxes, above ground junction boxes, below ground junction boxes, or as noted on the plans. Ensure fuse connectors are of the correct size for the wire being used. Install fuses or lugs as required by the plans. Insulate and waterproof the terminals according to

the manufacturer's recommendation. Removal of wire strands will not be allowed.

716.03.10 Electrical Junction Box. Where required, junction box shall be oriented such that the dimensions comply with the National Electrical Code. Any additional junction boxes shall be approved by the Engineer. No junction boxes shall be installed in the roadway pavement.

A) In-Ground Installation. Place junction boxes in locations to avoid standing water and ditch lines. If near ditch lines, the junction box shall be installed at the top of the slope of the ditch line. All junction boxes shall be level with the final grade. All junction boxes shall have bolts and washers installed to secure the junction box.

B) Filter Fabric. Before the installation of the #57 aggregate and junction box, the contractor shall install geotextile filter fabric type IV in the bottom of hole. The fabric shall extend to just below the top lip of the junction box and shall be continuously adhered to the exterior of the box with adhesive. In locations where conduits enter the box, the fabric shall be "x cut" only as much as necessary to allow passage of each individual conduit through the fabric. The fabric shall be adhered to the conduit with adhesive.

C) Aggregate. Install 12 inches of #57 aggregate below the bottom of the junction box. For type A junction boxes with extension, the aggregate shall be at least 27 inches from final grade. For type C junction boxes, the aggregate shall be at least 30 inches from final grade.

D) Barrier Wall Installation. Protect cover of junction box from damage/disfigurement from masonry coating application and other sources by taping or wrapping during construction. Remove protection prior to final electrical inspection and repair any damage or disfigurement to the satisfaction of the Engineer and at no cost to the Department. Liberally coat the threads of the cover fasteners with anti-seize compound during construction and before final closure.

E) Above Ground Installation. Cable clamps shall be provided for cables entering and exiting the box. Liberally coat the threads of the cover fasteners with anti-seize compound during construction and before final closure.

716.03.11 Grounding Installation. Ground all conduits, poles, pedestals, junction boxes, controller cabinets, and services according to the plans. All ground rods shall be at least 24 inches from the edge of the pole base, wood pole, or cabinet base. No ground rods can be installed directly into any concrete bases. All ground rods shall be securely connected with ground lugs. All ground rods shall have the full length installed in the ground, and none can be cut off. Separate all ground rods by a minimum of 6 feet. Ensure the top of the ground rod is a minimum of 3 inches below finished grade. All ground rods shall be left uncovered so that the inspector can insure that they are installed according to the Plans. Barrier wall and above ground junction boxes shall have a grounding lug installed on the back wall of the junction box. The lug should be centered and be sized to receive all the wire sizes that are indicated on the plan sheet. All services shall have at least 2 ground rods installed and shall not use the ground rods of poles or cabinets. All cabinets shall have separate ground rods and shall not use the ground rods of poles, services, and other cabinets. All high mast bases shall have three equally spaced 3/4 inch by 10 foot ground rods installed. Conventional bases shall have one 5/8 inch by 8 foot ground rod installed. All cabinets shall have one 5/8 inch by 8 foot ground rod installed.

716.03.12 Marker Installation. When specified in the Contract, mark the position of buried circuits with concrete slab markers. Install cable markers immediately above the cable. Place the markers with the top exposed approximately one inch above ground. Mark each cable run at approximately 300 foot increments between junction boxes and/or light poles, with additional markers at each change of direction. If there is a change of direction, a marker shall be placed at each end of the change. Depending on the length of change, the Engineer may require a marker in the middle of the change of direction. Install concrete slab markers at the end of the conduits crossing a roadway if a junction box is not present. Any additional markers or relocated markers shall be approved by the Engineer before placement.

716.03.13 Temporary/Maintain Lighting. The Contractor shall furnish and install all materials necessary to temporarily light the proposed roadway to design standards in Subsection 716.03. The Contractor shall submit his proposed design of temporary lighting to the Division of Traffic Operations for approval at least 30 days before installation.

Maintain all lighting elements impacted within or outside the project limits until new lighting elements are installed and a functional inspection has been performed on the new lighting elements. The Contractor shall submit a proposed design for maintaining lighting to the Division of Traffic Operations for approval at least 30 days before installation.

716.03.14 Remove Lighting. Remove all lighting equipment that is identified by the Engineer as no longer necessary including, but not limited to, the following: pole bases, poles, brackets, markers, structures, junction boxes, cabinets, services, luminaires, and wood poles. Pole bases shall be removed a minimum of one foot below finished grade by chipping off or other method that is approved by the Engineer. Dispose of all removed concrete off right-of-way. Wood poles shall be removed a minimum of one foot below finished grade. Backfill holes with material approved by the Engineer. Conduit may be abandoned in the ground. Any conduit/junction boxes above ground shall be removed if it is part of the current installation. Contractor may have to remove other conduit if specified in the contract. All materials shall be removed from the project as directed by the Engineer. Transformers not owned by a utility shall be tested for PCB's and disposed of in accordance with state regulations.

716.03.15 Painting. Clean non-galvanized or damaged surfaces of exposed junction boxes, pull boxes, control panels, poles, and similar equipment and apply one coat of an inhibiting paint and two coats of aluminum paint. For items fabricated from galvanized or nonferrous alloys, which are inherently rust resistant, paint only on damaged surfaces with an application of inorganic zinc rich primer or aluminum paint, as applicable.

716.03.16 Control Cabinet Installation. Coordinate with the Kentucky Department of Housing, Buildings and Construction, Electrical Inspection Division, to ensure the cabinet and all components within are approved as an assembly. The assembly shall be certified by the manufacturer or by a Professional Engineer licensed in the Commonwealth of Kentucky.

A) Concrete Base. Install a concrete pad that is approximately 4.5 feet by 5.5 feet by 2.5 feet. The base shall be of sufficient size to allow a minimum of 36 inches in front of the cabinet and 12 inch minimum clearance around the sides and back of the cabinet. The concrete base shall be class A and placed on a bed of power tamped dense grade rock. The dense grade rock shall extend at least 8 inches past the overall dimension of the base. The concrete base shall be at least 18 inches above the final grade. The top of the base shall be sloped at 1/8 inch per foot to prevent standing water. The outside edge of the base shall have a 1 inch chamfer. There shall be 4 layers of rebar in a horizontal grid with 8 inch vertical spacing between layers. Grid shall be fabricated with #4 rebar at 12 inch spacing between

bars. All layers of rebar need to be tied together. The rebar shall be at least 3 inches clear of the edge of concrete on the short side horizontal and top/bottom of the base. The long side of the base shall be at least 4 inches clear of the edge of the concrete.

B) Base Mounted. Install 18 inch base adaptor on the concrete with concrete anchors on each corner. The control cabinet shall be installed on the adaptor with at least 4 aluminum bolts (one on each corner). The cabinet/adaptor shall be installed so that there is a minimum of 36 inches of space on the front side of cabinet and a minimum clearance of 12 inches on the sides and back. There shall at least four cabinet mounting anchors securely installed, and they shall not be extended more than 1 inch above the top of the concrete pad. There shall be a continuous bead of caulk installed around the bottom of all base-mounted cabinets.

C) Pole Mounted. Install the cabinet securely to the pole with two aluminum brackets that attach at the top and the bottom of the cabinet. The brackets shall be made so that the weight of the cabinet can be supported. There shall be a bolt that is installed completely through the pole and that is attached to the aluminum brackets on both sides of the wood pole. The connection of the bolt shall include flat washers, lock washers, and nuts on both sides of the bracket.

D) Service Location. Install meter, utility disconnect (if needed), and main disconnect at appropriate height on the pole so that the main disconnect can be cut off easily. If the service location is more than 50 feet from the cabinet or across a roadway from the cabinet, there shall be a secondary disconnect installed at the cabinet location. This secondary disconnect shall be installed on a 2 inch square post structure and shall be incorporated in to the concrete base of the base mounted cabinet. The secondary disconnect can also be installed on the closest pole near the cabinet. If a pole mounted cabinet is installed, drop the utility service to the top of the pole and install service equipment on same pole as cabinet. If pole mounted cabinet pole is further away from utility and another pole needs to be added, the main service meter/disconnect shall be installed on the nearest pole to the utility drop and underground conduit shall be installed to get to the main pole location. Conduit shall be sized for the wiring from the secondary service location to the main cabinet location.

716.03.17 Navigation and Aviation Obstruction Lights. Navigation fixtures shall have a service position, at most, one foot from the catwalk platform railing or the bridge wall structure. Stems for green navigation lights shall be the length necessary for the navigation light to hang below the lowest bridge member in the navigation span so as to be visible from an approaching vessel.

Aviation lights shall be placed so they are visible from the height above the structure that it is an obstruction.

The solar electric modules shall be securely attached to the bridge structure. All conduit attachments to this cabinet shall be made in the base or side of the cabinet to minimize moisture penetration. Where conduit crosses an expansion or open joint, use LFMC with conduit outlet bodies on each end to compensate for movement in any direction between the two conduit ends which it connects. Conduits shall be affixed to the bridge members by using stainless steel clamps or straps with stainless steel nuts, bolts and locking washers. All conduit shall be secured every 4 feet.

If wireless monitoring is required, install a wireless router shall be installed in the lighting control cabinet. The Contractor shall deliver the router to the Division of Traffic Operations for provisioning on the KYTC APN. The Department will provision the router within 4 weeks of receipt and return via mail to the Contractor. The Department will pay the monthly data plan charges. The Department will allow temporary access to the router until the close of the contract for configuring of the monitoring system.

716.03.18 Wood Pole Installation. The pole shall be embedded in the dirt/rock at least 6 feet for a 35 to 40 foot pole and 6.5 feet for a 45 foot pole. If a messenger wire is attached to the pole, there shall be at least one anchor installed for each span force on the pole in the opposite direction of the force.

716.03.19 Drawings. Before final inspection of the system, provide a complete set of reproducible as-built drawings that show the arrangement and locations of all equipment and circuits. Include ducts, conduits, junction boxes, spare conduits, cabinets, and pavement crossing with distances to permanent markers, such as structures and curb lines. Keep a daily record of all conduit placed in trenches, showing the distance from the pavement edge, the depth, and the length of runs, and indicate these on the as-built drawings.

716.03.20 Acceptance and Inspection Requirements. Conform to Subsection 105.12. After the work has been completed, conduct an operational test demonstrating that the system operates in accordance with the Plans in the presence of the Engineer. The Department will also conduct its own tests with its own equipment before final acceptance.

Traffic Operations will conduct an inspection of the installation prior to calling the job complete. The inspection will include, but not limited to, the following:

1. Wires or Ducted Cables shall test free of shorts and unauthorized grounds and shall have an insulating resistance of at least one hundred megaohms when tested with a 500 volt direct current potential in a reasonably dry atmosphere between conductors and ground.
2. Ground rods shall have a resistance to ground not to exceed 25 ohms. If the resistance to ground is greater than 25 ohms, two or more ground rods connected in parallel shall be installed.

716.04 MEASUREMENT.

716.04.01 Pole. The Department will measure the quantity as each individual unit furnished and installed. The Department will not measure anchor bolts, washers, nuts, anchor bolt covers, ground lugs, and any associated hardware for payment and will consider them incidental to this item of work.

716.04.02 High Mast Pole. The Department will measure the quantity as each individual unit furnished and installed. The Department will not measure the lowering device, anchor bolts, head frame assembly, cables, winch unit, power cables, wiring, connectors, circuit breakers, grounding lugs, ground wire, ground rods, conduits, test plugs,, adjustment and calibration of the unit to provide the desired operation, and any associated hardware for payment and will consider them incidental to this item of work.

716.04.03 Bracket The Department will measure the quantity as each individual unit furnished and installed. The Department will not measure any associated hardware needed for attaching the bracket to the pole for payment and will consider them incidental to this item of work.

716.04.04 Pole Base. The Department will measure the quantity as each individual unit furnished and installed. The Department will not measure excavation, concrete, conduits, fittings, ground rods, ground wires, ground lugs, reinforcing steel, restoring disturbed areas to the satisfaction of the Engineer, and any associated hardware for payment and will consider them incidental to this item of work. All conduits used for grounding, spares, and conductors (not ducted cable) that are installed in the pole base (including 24 inches of conduit past the edge of the pole base) are incidental to the bid item for pole base.

716.04.05 Pole Base High Mast. The Department will measure the quantity in cubic yards furnished and installed. The Department will not measure excavation,

concrete, conduits, fittings, ground rods, ground wires, ground lugs, reinforcing steel, restoring disturbed areas to the satisfaction of the Engineer, and any associated hardware for payment and will consider them incidental to this item of work. All conduits used for grounding, spares, and conductors (not ducted cable) that are installed in the pole base (including 24 inches of conduit past the edge of the pole base) are incidental to the bid item for pole base.

716.04.06 Pole Base in Median Wall The Department will measure the quantity as each individual unit furnished and installed. The Department will not measure conduits, fittings, junction boxes, additional reinforcing steel, ground rods, ground wire, ground lugs, and aluminum cover plates (if specified) for payment, and will consider them incidental to this item of work.

716.04.07 Transformer Base. The Department will measure the quantity as each individual unit furnished and installed. The Department will not measure transformer door, ground lug, anchoring bolts, nuts, washers, and any associated hardware for payment and will consider them incidental to this item of work. The filling of any unused holes will also be considered incidental to this item of work.

716.04.08 Pole with Secondary Control Equipment. The Department will measure the quantity as each individual unit furnished and installed. The Department will not measure mounting the cabinet to the pole, backfilling, restoration, any necessary hardware to anchor pole, electrical inspection fees, and required building fees involving utility secondary, and primary service for payment and will consider them incidental to this item of work. The Department will also not measure furnishing and installing electrical service conductors, specified conduits, meter base, transformer, service panel, fused cutout, fuses, lighting arrestors, photoelectrical control, circuit breaker, contactor, manual switch, ground rods, ground lugs, and ground wires for payment and will consider them incidental to this item of work. The filling of unused holes will also be considered incidental to this item of work.

716.04.09 Lighting Control Equipment. The Department will measure the quantity as each individual unit furnished and installed. The Department will not measure the concrete base, excavation, backfilling, restoration, any necessary anchors, electrical inspection fees, and required building fees involving utility secondary/primary service for payment and will consider them incidental to this item of work. The Department will also not measure furnishing and installing electrical service conductors, specified conduits, meter base, transformer, service panel, fused cutout, fuses, lighting arrestors, photoelectrical control, circuit breakers, contactor, manual switch, ground rods, ground lugs, and ground wires for payment and will consider them incidental to this item of work. The Department will not measure the filling of any unused holes with and will consider them incidental to this item of work. All conduits used for grounding, spares, service/pole, and conductors (not ducted cable) that are installed in the cabinet base (including 24 inches of conduit past the edge of the cabinet based and on cabinet/service pole) are incidental to bid item for lighting control equipment.

716.04.10 Luminaire. The Department will measure the quantity as each individual unit furnished and installed. The Department will not measure lamps, starters, ballasts, drivers, surge protection, dimming modules, photo-control receptacle, specified shielding (if required), and any adjustments necessary to provide the desired lighting pattern for payment and will consider them incidental to this item of work.

716.04.11 Fuse Connector Kits. The Department will measure the quantity as each individual unit furnished and installed. The Department will not measure fuses/lugs for payment and will consider them incidental to this item of work.

716.04.12 Conduit. The Department will measure the quantity in linear feet

furnished and installed. The Department will not measure installation in ground or on structures, conduit fittings, test plugs, expansion joints with bonding straps, grounding lugs, drill anchors, clamps, and any additional hardware required for payment and will consider them incidental to this item of work.

716.04.13 Markers. The Department will measure the quantity as each individual unit furnished and installed.

716.04.14 Electrical Junction Box Type Various. The Department will measure the quantity as each individual unit furnished and installed. The Department will not measure additional junction boxes for greater depths than those identified in Plans, #57 aggregate, backfilling, restoration of disturbed areas to the satisfaction of the Engineer, geotextile filter fabric, concrete, hot dipped galvanized cover, stainless steel screws, rubber gasket, and any associated hardware for payment , and will consider them incidental to this item of work.

716.04.15 Trenching and Backfilling. The Department will measure the quantity in linear feet. The Department will not measure excavation, backfilling, underground utility warning tape (if required), and the restoration of disturbed areas to original condition for payment and will consider them incidental to this item of work.

716.04.16 Wire or Cable. The Department will measure the quantity in linear feet furnished and installed. The Department will not measure installation within conduit, splice boots, and any other hardware required for installing cable for payment and will consider them incidental to this item of work.

716.04.17 Ducted Cable. The Department will measure the quantity in linear feet furnished and installed. The Department will not measure installation within trench or conduit and any other necessary hardware for payment and will consider them incidental to this item of work.

716.04.18 Temporary Lighting. The Department will measure the quantity by lump sum. The Department will not measure poles, luminaires, wire, conduit, trenching and backfilling, control equipment, all relocations and removal, design (if required), and any other necessary hardware to make a complete installation for payment and will consider them incidental to this item of work.

716.04.19 Maintain Lighting. The Department will measure the quantity by lump sum. The Department will not measure maintenance of lighting elements and design (if required) for payment and will consider them incidental to this item of work.

716.04.20 Remove Lighting. The Department will measure the quantity by lump sum. The Department will not measure backfilling and the disposal or transportation of equipment and materials associated with any structural or electrical component of the lighting system including, but not limited to pole bases, poles, junction boxes, cabinets, and wood poles for payment and will consider them incidental to this item of work.

716.04.21 Bore and Jack Conduit. The Department will measure the quantity in linear feet. This item shall include all work necessary for boring and installing conduit under an existing roadway.

716.04.22 Lighting-navigation/aviation monitoring system. The Department will measure the quantity as lump sum unit. The Department will not measure furnishing and installing all necessary equipment including hardware and software, radio transmitters and receivers, modems, current transformers, cabinets, wiring,

conduit and all other equipment to complete a fully functioning monitoring system for the navigation/aviation lighting. The routers and antenna will be incidental to this bid item.

716.04.23 Solar battery backup. The Department will measure the quantity as each individual unit. The Department will not measure furnishing and installing solar array, controller, battery, cabinet, mounting hardware, conduit, wiring and all other necessary equipment to provide backup power to the navigation/aviation lights.

716.04.24 Navigation/Aviation light (various types). The Department will measure the quantity as each individual unit furnished and installed as specified in the plans. The fixture shall have two separately connected lamps as indicated in the detail sheets. All required equipment such as but not limited to mounting hardware, stems, latches, pull chains, housings, lenses, lamps, spare lamps, etc. To install the fixture as indicated in the plans shall be considered incidental to the navigation/aviation light.

716.04.25 Solar powered navigation/aviation lighting system. The Department will measure the quantity as each unit. The Department will not measure furnishing and installing specified upstream and downstream led lighting units, solar arrays, control equipment, batteries, cabinets, cabinet platforms, mounting hardware, conduit, wiring and all other necessary equipment to complete a fully functioning solar powered navigation/aviation lighting system that complies with united states coast guard and all other regulatory requirements. The department will not measure maintaining of the existing navigation/aviation.

716.05 PAYMENT. The Department will make payment for the completed and accepted quantities under the following:

Code	Pay Item	Pay Unit
04700-04701	Pole(Various) Mtg Ht	Each
04710-04714	Poles (Various) MTG HT HIGH Mast	Each
04720-04730	Bracket (Various)	Each
04740	Pole Base	Each
04742/23161EN	Pole Base –High Mast	Each/Cubic Yard
04741	Pole Base In Med Wall	Each
04750	Transformer Base	Each
04760	Pole W/ Secondary Control Equip	Each
04761	Lighting Control Equipment	Each
04770-04773	HPS Luminaire (Various)	Each
04780	Fuse Connector Kit	Each
04790-04799	Conduit (Various)	Linear Foot
04800	Marker	Each
04810-04811	Electrical Junction Box (Various)	Each
20391NS835	Electrical Junction Box Type A	Each
20392NS835	Electrical Junction Box Type C	Each
04820	Trenching and Backfilling	Linear Foot
04832-04837	Wire-No (Various)	Linear Foot
04860-04864	Cable-No (Various) Ducted	Linear Foot
20410ED	Maintain Lighting	Lump Sum
20454NS835	Temporary Lighting	Lump Sum
04940	Remove Lighting	Lump Sum
21543EN	Bore and Jack Conduit	Linear Foot
23365EC	Lighting- nav monitoring system	lump sum
4775-4777	Navigation light (various)	each
40144	Aviation light	each
24838EC	Solar Powered lighting system	each
24839EC	Solar Battery Backup	each

The Department will consider payment as full compensation for installing and placing the complete roadway lighting systems in satisfactory operation.

SECTION 717 — INTERSECTION MARKINGS

717.01 DESCRIPTION. Furnish and install thermoplastic or Type I tape intersection markings (Stop Bars, Crosswalks, Turn Arrows, etc.) by either a machine applied, screed extrusion process or by applying preformed thermoplastic intersection marking material.

717.02 MATERIALS AND EQUIPMENT.

717.02.01 Preformed Thermoplastic Intersection Marking Material. Select from the Department's List of Approved Materials.

717.02.02 Extruded Thermoplastic Pavement Marking Material. Conform to Section 837.

717.02.03 Binder. Conform to Subsection 714.02.03

717.02.04 Drop On Glass Beads. Use beads that will ensure the pavement marking material will meet retroreflectivity requirements. The Department will evaluate the beads as part of the marking system through retroreflectivity readings.

717.02.05 Extruded Thermoplastic Application Equipment. Provide equipment with a shaping die that simultaneously deposits and shapes lines at a minimum thickness of 90 mils on the pavement surface. Do not use spray and ribbon gun applicators.

Ensure the application equipment conforms to the following:

1) Capable of providing continuous and uniform heat to maintain the material between 400 and 440 °F throughout the mixing, conveying, and dispensing.
2) The kettle is capable of continuous agitation during mixing and heated storage and is equipped with an automatic thermostat control device and material thermometer.
3) Equipped with a cutoff device that provides clean, square stripe ends.
4) Equipped with an automatic bead dispenser.

717.02.06 Type I Tape. Conform to Section 836.

717.03 CONSTRUCTION.

717.03.01 Layout. On resurfacing, pavement restoration, and pavement rehabilitation projects, prepare and keep a written record of the locations of existing pavement markings, and furnish a copy to the Engineer at least 15 days before removing or obliterating the markings. The Engineer will notify you of any changes to the existing markings.

On new construction, the Department will provide more detailed information for each intersection prior to beginning work. This information will consist of plans, a drawing of each intersection, or an inspector to work with each crew to layout the markings in the field.

Before applying the pavement marking material, pre-mark the pavement surface and obtain the Engineer's approval of the proposed location, alignment, and control guides.

717.03.02 Surface Preparation. Clean all grease, oil, mud, dust, dirt, grass, loose gravel, or other deleterious material from the surface where pavement markings are to be applied as directed by, and by methods acceptable to, the Engineer.

On concrete surfaces and as the Engineer directs on older asphalt pavements, apply binder to the area where placing pavement marking material. Ensure that all solvents have evaporated from the binder before applying the marking material. On new concrete pavement surfaces, remove the curing compound from the pavement surface before applying the binder and the pavement marking material.

717.03.03 Application.

A) Thermoplastic. Install extruded thermoplastic at a minimum thickness of 90 mils on the pavement surface in a melted state at a temperature from 400 and 440 °F. Install preformed thermoplastic according to manufacturer's instructions at a minimum thickness of 125 mils. Apply additional glass beads by a drop-on method at a rate that satisfies the retroreflectivity requirements of Subsection 717.03.05.

When installing symbols and legends (turn arrows, the word "ONLY" etc.) by the extrusion process, ensure that the finished markings conform to the standard size and shape in the Manual on Uniform Traffic Control Devices.

Verify the adhesion of the thermoplastic to asphalt pavements by performing bond checks as follows. Approximately 60 to 120 seconds after applying the thermoplastic material cut and lift approximately a 6-inch section. The thermoplastic is successfully bonding to the pavement surface if a layer of asphalt clings to the removed thermoplastic and the pavement surface under the removed section is shiny and black.

Ensure that finished markings are continuous and uniform in shape having clear and sharp edges with uniform bead distribution across the entire width and length of the line, symbol, or legend.

B) Type I Tape. Apply according to the manufacturer's recommendations. Cut all tape at pavement joints when applied to concrete surfaces.

717.03.04 Restrictions. Do not apply the pavement marking material when air and pavement temperatures are below 50 °F.

Do not apply the pavement marking material when the surface of the pavement contains evidence of moisture in amounts significant enough to prevent the pavement marking material from bonding to the pavement. Significant amounts of moisture can be caused by heavy dew or very humid nights as well as from rainfall.

If encountering significant amounts of moisture while applying the thermoplastic, the Contractor, at his own risk, may attempt to apply the thermoplastic material subject to the following restrictions. Heat the thermoplastic material to the upper temperature limit specified by the manufacturer, and apply a test line on the pavement. Perform a bond check according to Subsection 717.03.03. If the thermoplastic successfully bonds to the pavement continue to apply thermoplastic material, provided there is evidence that the moisture is escaping through the surface of the material, as indicated by very small pinholes. If there is excessive moisture, as indicated by larger sized holes or bubbles on the surface of the material, do not apply thermoplastic until the moisture can be effectively dealt with. Perform a sufficient number of bond checks to ensure that the thermoplastic is bonding to the pavement.

717.03.05 Proving Period. A proving period of 180 days will follow the application of the durable markings. During this period, the Engineer will make such observations as are necessary to determine if the markings are acceptable. The proving period begins when the facility is opened to traffic.

A) Requirements.

1) Thermoplastic. During the proving period, ensure that the material shows no signs of failure due to blistering, excessive cracking, bleeding, staining, discoloration, oil content of the pavement materials, smearing or spreading under heat, deterioration due to contact with grease deposits, oil, diesel fuel, or gasoline drippings, chipping, spalling, poor adhesion to the pavement materials, loss of retroreflectivity, vehicular damage and normal wear.

The minimum retroreflectivity requirements at the end of the proving period, as measured with a Department approved 30 meter geometry handheld retroreflectometer, are as follows:

White: 300 mcd/lux/square meter
Yellow: 225 mcd/lux/square meter

The Department will take these measurements between 15 and 45 days after the start of the proving period, with acceptance based on KM 201. If the Department determines that the markings are acceptable, the installation of the markings will be considered complete.

2) Type I Tape. During the proving period, ensure that the pavement marking material shows no signs of failure due to blistering, excessive cracking, bleeding, staining, discoloration, oil content of the pavement materials, drippings, chipping, spalling, poor adhesion to the pavement, loss of retroreflectivity, vehicular damage, and normal wear. Type I Tape is manufactured off site and warranted by the manufacturer to meet certain retroreflective requirements. As long as the material is adequately bonded to the surface and shows no signs of failure due to the other items listed in Subsection 714.03.06 A) 1), retroreflectivity readings will not be required. In the absence of readings, the Department will accept tape based on a nighttime visual observation.

B) Failure. The Department will consider any marking defective when the readings for that marking do not satisfy the retroreflectivity requirements or more than 10 percent of the material fails to meet the other requirements of A) above. The Department will consider each marking separately.

C) Corrective Work. If any marking is found to be defective, repair or remove and replace the marking. Perform pavement marking replacement according to the requirements specified in this subsection for the initial application. The corrective work will be subject to a proving period as listed above.

717.03.06 Marking Removal. Remove all markings made in error or not conforming to the traffic operation in use. Remove markings by water blasting process to the satisfaction of the Engineer. Vacuum all marking material and removal debris concurrently with the removal operation. Do not paint with asphalt binder or other material to obliterate the markings.

A) Waterblast Stripe Removal. Conform to subsection 713.03.04.

717.03.07 Acceptance of Non-Specification Markings. When reasonably acceptable work has been produced but retroreflectivity requirements are not met, the Department may accept the work according to Subsection 105.04. When the Engineer determines that the markings may be left in place, the Department will accept them at a reduction in the Contract unit bid price according to Acceptance Pay Schedule for Thermoplastic. The Department will not consider these procedures a means to continue accepting non-specification markings.

717.04 MEASUREMENT. The Department will measure the intersection markings on a per unit basis for items listed in the Quantity Summary.

The Department will not measure the removal of existing markings, layout, surface preparation, binder, glass beads, or testing for payment and will consider them incidental to the installation of the new marking. The Department will exclude the gaps when measuring dotted lane line extensions.

717.05 PAYMENT. The Department will make payment for the completed and accepted quantities under the following:

ACCEPTANCE PAY SCHEDULE FOR THERMOPLASTIC		
Pay Value	White mcd/lux/square meter	Yellow mcd/lux/square meter
1.00	≥300	≥225
0.50	251-299	176-224
0.25	226-250	151-175
0.00	200-225	125-150
Remove and Replace	< 200	< 125

Code	Pay Item	Pay Unit
06565, 06566	Pavement Marking, Thermoplastic X-Walk, Size	Linear Foot
06567, 06568	Pavement Marking, Thermoplastic Stop Bar, Size	Linear Foot
06569	Pavement Marking, Thermoplastic Cross Hatch	Square Foot
06572	Pavement Marking, Dotted Lane Extension	Linear Foot
06573-06575, 06578	Pavement Marking, Thermoplastic Arrow, Type	Each
06576	Pavement Marking, Thermoplastic "ONLY"	Each
06577	Pavement Marking, Thermoplastic "SCHOOL"	Each
06563	Pave Marking – R/R X Bucks 16 IN	Linear Foot
20782NS714	Pave Marking Thermo – Bike	Each
23251ES717	Pave Mark TY I Tape X-Walk, Size	Linear Foot
23264ES717		
23252ES717	Pave Mark TY I Tape Stop Bar, Size	Linear Foot
23265ES717		
23253ES717	Pave Mark TY I Tape Cross Hatch	Square Foot
23254ES717	Pave Mark TY I Tape Dotted Lane Extension	Linear Foot
23255ES717	Pave Mark TY I Tape Arrow, Type	Each
23268ES717-23270ES717		
23256ES717	Pave Mark TY I Tape- ONLY	Each
23257ES717	Pave Mark TY I Tape- SCHOOL	Each
23266ES717	Pave Mark TY 1 Tape R/R X Bucks-16 IN	Linear Foot
23267ES717	Pave Mark TY 1 Tape-Bike	Each

The Department will consider payment as full compensation for all work required under this section.

SECTION 718 — OBJECT MARKERS

718.01 DESCRIPTION. Furnish and place Object Markers for obstructions within the roadway, adjacent to the roadway, obstructions adjacent to or within the roadway, and for the end of roadway. See Sections 2C.63, 2C.64, and 2C.65 of the MUTCD for a general description.

718.02 MATERIAL. Object markers should conform to Section 2C.63 of the MUTCD.

718.02.01 Retroreflective Sheeting. Provide yellow sheeting conforming to Section 830.

718.02.02 Aluminum Substrate. Conform to Section 833.

718.03 CONSTRUCTION. Prepare the aluminum sheeting and the reflective material applied according to the manufacturer's recommendations.

Mount the object marker on a post and sign support system meeting the requirements in Section 832. The Contractor is responsible for determining the actual length necessary at each location.

Install the object markers at locations and heights directed by MUTCD Sections 2C.63, 2C.64, and 2C.65.

718.04 MEASUREMENT. The Department will measure the quantity of Object Marker Type 1, 2, and 3 by each individual unit. The Department considers a unit to include all materials, including the sign support system and post, necessary to acceptably furnish and install the marker.

718.05 PAYMENT. The Department will make payment for the completed and accepted quantities under the following:

Code	Pay Item	Pay Unit
24640ED	Object Marker, Type 1	Each
02565	Object Marker, Type 2	Each
20191ED	Object Marker, Type 3	Each

The Department will consider payment as full compensation for all work required under this section.

SECTION 719 — GUARDRAIL

719.01 DESCRIPTION. Furnish and install or remove all necessary material for each type of guardrail, end treatment, terminal section, and guardrail bridge end connector. Remove and relocate, or remove and reset, all necessary material for each type of guardrail. Adjust guardrail, including replacement of existing offset blocks, with new modified offset blocks. Furnish additional new hardware as needed to complete the adjustment.

719.02 MATERIALS.

719.02.01 Guardrail Systems. Conform to Section 814.

719.02.02 Concrete. Use Class A concrete conforming to Subsection 601.02 and 601.03.

719.02.03 Reinforcement Steel. Conform to Section 811.

719.02.04 Grout. Conform to Subsection 601.02.

When used in placement on a curve having a radius of 150 feet or less, curve guardrail in shop. Mark the radius of curvature on each of the curved elements. Furnish rail elements that have a nominal length of 13 1/2 feet.

Use the same type of posts, fastenings, and accessories throughout the project.

719.03 CONSTRUCTION. Do not leave uncompleted guardrail, bridge end connectors, terminal sections, or end treatments exposed to the traveling public. Construct guardrail, end treatments, bridge end connectors, and terminal sections behind lane closures or shoulder closures.

Construct guardrail 31 inches to the top of the rail, with a tolerance of plus or minus one inch above the theoretical pavement elevation. Compute these elevations from the proposed pavement edge elevations or from other methods to ensure construction of the guardrail to the true gradient and with no sags.

Paint all damaged galvanizing with 2 coats of zinc dust-zinc oxide paint conforming to Federal Specification TT-P-641.

Provide permanent or temporary guardrail where it presently exists throughout the winter close-down periods of the Contract as the Engineer directs.

Proprietary end treatments shall be installed according to the manufacturer's assembly or installation instructions.

Prior to ordering guardrail materials meet the Engineer on the job site to check the guardrail end treatments at locations designated in the plans to ensure they are appropriate for the actual field conditions. Adjustments will be made as appropriate and final location and end treatment types will be approved by the Engineer. The Engineer will consult with the Division of Highway Design when necessary.

719.03.01 Setting Posts. Install posts according to the Contract without damaging the road or shoulder. Provide extra length posts when the Engineer directs to do so. Do not damage any portion of the driven posts. If damage occurs, discontinue driving. Remove the damaged post and replace with a new post in an excavated hole.

Ram bottoms of dug post holes to provide a stable foundation. Set posts vertically with the rail faces in a straight line, or when on a curve, at a uniform distance from the pavement. Backfill post holes in layers not to exceed 6 inches, and compact until the post is solid, firm, and in true alignment. Cut and set timber post tops to correct grade, and bevel according to the Standard Drawings. Bore holes at proper places to attach the rails. Anchor posts according to the Standard Drawings. Repair all damaged pavement.

Do not drive guardrail posts within one foot of the outlet pipe for pavement edgedrains. Repair all damage to the outlet pipe for pavement edgedrains caused by guardrail installations. If repair is not possible, remove and replace damaged outlet pipe.

If a guardrail post is damaged when installing in rock or rock fill, remove the damaged post. Drill a hole slightly larger than the post 24 inches into the rock or to the desired embedment depth, whichever is less. Backfill around the post with #9 or #57 stone or with flowable fill for pipe backfill (proportioned in accordance with Subsection 601.03.03). Wood guardrail posts that are cut or bored, shall be retreated in accordance with Subsection 814.04.02.

If a guardrail post for a proprietary end treatment is damaged during installation into rock or rock fill, utilize the manufacturer's installation instructions to provide holes for placement of the guardrail posts.

719.03.02 Placing Rail. Construct the guardrail to the alignment and at the locations shown in the Contract. Splice rail element at mid-span by lapping in the direction of traffic. Bolt rail element to each post through the holes provided in the rail. Where the holes are slotted for expansion, erect rail with the bolt in the center of the slot. Install nuts on the backside of all bolts, either through splices or through rail and posts. Draw bolts tightly. Extend the bolt at least 1/4 inch beyond the nut. Do not tighten bolts so tightly through expansion members that they prevent functioning of the members.

Erect rail so it appears smooth, uniform, continuous, and closely parallels the line and grade of the pavement.

Provide the type of end treatments, terminal sections, and guardrail bridge end connectors specified in the Contract. The Department will not allow field cutting, punching, burning, or welding.

719.03.03 Remove Rail. Remove the existing guardrail system, which includes bridge end connectors, terminal sections, or guardrail end treatments including all associated concrete, components, and incidentals. Fill all voids left from pulling guardrail posts with dry sand. Do not damage guardrail.

719.03.04 Relocate the Existing Guardrail System. Relocate the existing rail and posts to the alignment and at the locations shown in the Contract. Spot paint edges of all holes punched in the existing rail and posts that are to be reused. Spot paint all scratches or marred areas in completed installations where the galvanizing has been damaged. Spot paint with 2 coats of zinc dust-zinc oxide paint conforming to Federal Specification TT-P-641.

Do not intermix new pieces of guardrail with pieces of existing rail at any installation. Add new pieces, as needed, on one or both ends of an installation.

The Department will retain ownership of all items in the existing system not suitable for reconstruction, except concrete. Remove and dispose of existing concrete off the right-of-way.

If additional guardrail is needed to replace damaged guardrail, furnish and install new guardrail.

719.03.05 Adjust Existing Guardrail. Adjust existing guardrail to the alignment and at the locations shown in the Contract. Remove existing rail elements and offset blocks from the existing posts. Install new modified offset blocks. Reinstall rail elements. Realign guardrail both vertically and horizontally at the raised elevation.

When new end treatments, terminal sections, or bridge connectors are not specified, connect adjusted rail to the existing installation in a smooth transition. When new end treatments, terminal sections, or bridge connectors are specified, construct at new shoulder elevation or new grade condition.

719.03.06 Temporary Guardrail. Conform to the same construction requirements for temporary guardrail as for permanent guardrail. The Department will show temporary guardrail locations in the Contract. Maintain the temporary guardrail system for the duration of its use. Retain ownership of damaged or surplus components. The Contractor may use undamaged components in permanent installations.

719.03.07 Salvaged Material. The Department will retain ownership of the existing guardrail, guardrail post, and hardware. Stack W-beam rail 45 per bundle (3 wide, 15 high, overlapped). Stack and band metal posts 50 per bundle (5 wide, 10 high, overlapped). Bag nuts, bolts, and washers. Salvage a minimum of 80 percent of the nuts, bolts, and washers. Deliver existing guardrail and components to the Bailey Bridge Lot located at 1224 Wilkinson Blvd in Frankfort, Kentucky. Contact the lot supervisor at (502) 564-8187 to schedule delivery of material a minimum of 10 working days in advance of delivery. Deliver the material between the hours of 8:00AM and 3:30PM eastern time, Monday through Friday. Dispose of all removed concrete off the right-of-way.

719.04 MEASUREMENT.

719.04.01 Guardrail. The Department will measure the quantity in linear feet along the actual length of the rail between the limits for end treatments, terminal sections and bridge end connections, and crash cushions. The Department will measure the quantity of shop curved guardrail in linear feet at 1.3 times the actual length.

719.04.02 Guardrail Terminal Sections. The Department will measure the quantity by each individual unit.

719.04.03 Extra Length Post. The Department will measure the quantity by each individual unit. The Department will still measure guardrail at locations where extra length post are required as this item represents only the added work and material required by the extra length.

719.04.04 Guardrail End Treatment. The Department will measure the quantity by each individual unit that is not a part of the guardrail. Pay limits for proprietary end treatments will in accordance with Standard Drawings.

719.04.05 Crash Cushion. The Department will measure the quantity by each individual unit that is not a part of the guardrail.

719.04.06 Guardrail Bridge End Connector. The Department will measure the quantity by each individual unit, including their end treatment.

719.04.07 Guardrail Connector to Concrete Median Barrier. The Department will measure the quantity, by each individual unit, according to Standard Drawing RBC-100.

719.04.08 Remove Guardrail. The Department will measure the quantity in linear feet. The Department will not measure the delivery and stacking of guardrail, posts, and its hardware for payment and will consider it incidental to this item of work.

719.04.09 Relocate Guardrail System. The Department will measure the quantity in linear feet.

719.04.10 Adjust Guardrail. The Department will measure the quantity in linear feet.

719.04.11 Temporary Guardrail. The Department will measure the quantity in linear feet. The Department will not measure maintenance and removal for payment and will consider it incidental to this item of work.

719.04.12 Nested Guardrail. The Department will measure the quantity in linear feet. The Department will still measure guardrail at locations where nested guardrail is required as this item represents only added work and materials required by the nested guardrail.

719.05 PAYMENT. The Department will make payment for the completed and accepted quantities under the following:

Code	Pay Item	Pay Unit
02351, 02355	Guardrail, Steel W Beam, Single Face	Linear Foot
02353	Guardrail, Steel W Beam Single Face, Install	Linear Foot
02352	Guardrail, Steel W Beam, Double Face	Linear Foot
02360, 02364, 02366	Guardrail Terminal Section, Type	Each
02399	Extra Length Post	Each
02367, 02369, 02371, 02373,	Guardrail End Treatment, Type	Each
02391, 02365, 02885, 02888, 02894, 02920, 02923, 02929	Crash Cushion, Type	Each
02377, 02378, 02382, 02387, 02388	Guardrail Bridge End Connector, Type	Each
02359	Guardrail Connector to Concrete Median Barrier	Each
02381	Remove Guardrail	Linear Foot
02385	Relocate Guardrail System	Linear Foot
02350	Adjust Guardrail	Linear Foot
02397	Temporary Guardrail	Linear Foot
24381EC	G/R Steel W Beam-S Face-(Nested)	Linear Foot
24382EC	G/R Steel W Beam-S Face-7 FT Post (Nested)	Linear Foot

The Department will consider payment as full compensation for all work required under this section.

SECTION 720 — METAL HANDRAILS

720.01 DESCRIPTION. Furnish and install metal handrails.

720.02 MATERIALS.

720.02.01 Handrails. For materials for metal handrails for bridges conform to the requirements specified in the Contract. For other handrails, conform to the following subsections:

Handrail, Type A	810.05.04

720.02.02 Chain Link Fence. When constructed as part of the handrail, conform to Section 817, Type A, using aluminum coated steel fabric and tension wire.

720.02.03 Paint. Conform to Section 821.

720.03 CONSTRUCTION. Fabricate all handrails according to the details specified in the Plans or on Standard Drawings. When erected, ensure that all posts, except on bridges, are vertical and the rails are true to the alignment indicated.

Set bridge railing posts at right angles to the fascia line, perpendicular to grade, and erect tubing parallel to the fascia line. Use washer shims not exceeding 1/8 inch in thickness between the concrete and post base to obtain post or tubing alignment.

Fasten railing to the concrete as specified in the Plans.

Where aluminum is in contact with concrete, thoroughly coat the contacting surfaces with alumilastic compound or approved equal so as to completely insulate the aluminum from the concrete; or where bond between aluminum and concrete is desired, coat the aluminum with commercially available zinc chromate paint, and allow it to dry before installing it.

Paint plain steel handrail according to Subsection 607.03.23.

The Department will not require painting of galvanized handrail, except paint all exposed threads as required for plain handrail.

The Department will not require painting of aluminum handrail.

720.04 MEASUREMENT. The Department will measure the quantity of each type in linear feet along the top of the rail from center to center of end posts. The Department will not measure posts, pipe, channel, pickets, fittings, chain link fence, or painting for payment and will consider them incidental to this item of work.

720.05 PAYMENT. The Department will make payment for the completed and accepted quantities under the following:

Code	Pay Item	Pay Unit
02611-02616, 02619, 02620, 08232, 08255-08257	Handrail, Type	Linear Foot

The Department will consider payment as full compensation for all work required under this section.

SECTION 721 — FENCE

721.01 DESCRIPTION. Furnish and erect fence and gates of the height and type specified in the Plans, supported by steel, concrete, or timber posts along the inside limits of the right-of-way or at other locations shown or otherwise designated and at grades designated during construction.

721.02 MATERIALS.

721.02.01 Woven Wire Fencing. Conform to Section 816.

721.02.02 Chain Link Fencing. Conform to Section 817.

721.02.03 Concrete. Conform to Subsection 601.02 and 601.03.

721.03 CONSTRUCTION. Before starting fencing operations, remove all brush, stumps, logs, and debris that will interfere with the proper construction of the fence. Remove or trim sound standing trees in the fence line as directed.

Construct fence with new materials according to the Standard Drawings and as specified in this section. Install fence as one of the first construction operations. Where it is impractical to install fence initially in its final form or location, obtain written permission from adjacent property owners either to permit construction of a suitable temporary fence or to delay fence erection until such time as the permanent fence may be erected. Where tying fence to a new structure, erect a temporary fence until such time as the structure is complete and the permanent fence can be anchored to the structure in the manner specified in the Plans.

Install fence 18 inches inside the right-of-way line or in other locations specifically indicated.

Install fence facing the property owner except on horizontal curves. On horizontal curves install the fence to pull against all posts. Apply sufficient tension between pull posts to make the fence stock tight. Install pull posts at all breaks in horizontal alignment of the fence, and at sharp breaks in vertical alignment. For tangents and curves up to one degree, space pull posts a maximum of 500 feet on centers; ensure that curves over one degree to 4 degrees have pull posts spaced a maximum of 250 feet on centers; and curves over 4 degrees have pull posts installed each time the angle of deflection increases 5 degrees.

Use any Class concrete according to Subsection 601.03.

721.03.01 Setting Posts. Set all posts at the required depths and intervals designated in the Contract. Set posts plumb and in true alignment on the side where the wire is attached. Dig holes for posts to full depth and with sufficient diameter to allow proper tamping and compaction of the backfill. Use sound earth for the backfill and tamp it in place until the post is firm and rigid in its position. Set wood posts with the butt end down.

When encountering solid rock at grade or below, drill a hole one foot deep and slightly larger than the outside dimensions of the post or brace in the rock, and grout in the post. At line posts where top of rock is 8 inches or less below grade, remove the anchor plate. Backfill all excavation above rock, below grade, in 4 to 6-inch layers and tamp each layer thoroughly in place. Field cut posts and braces to fit maximum depth whenever encountering solid rock.

Set all end, gate, corner, and pull posts, and anchor them in concrete placed to the top of the ground, finished smooth, and sloped to drain.

Brace all end, gate, and corner posts. Brace pull posts in 2 directions. Brace corner posts in the direction of each line of the fence. Anchor the metal braces from the metal posts in concrete that is crowned at the top to shed water. Brace wood or concrete posts with a pole or bar of the same type of material as the post. When using wood posts, notch the braced post and adjacent line posts one inch deep at one foot from the top of the finished post to receive the brace pole. Secure the brace pole to the posts by spiking or other means. Loop galvanized smooth wire having a minimum diameter of 0.148 inch around the braced

post near the ground, and then loop it around the line post at 12 inches below its top continuing between the posts until 4 strands of wire are in place and the ends of the wire are securely fastened together. Then twist the strands of wire together until the brace pole is in compression. Do not allow the compression to be great enough to cause lateral springing in the brace pole.

Allow concrete anchors to cure for at least 5 days before erecting the fence.

721.03.02 Fencing. Tie any intersecting fence to an independent pull post.

Stretch woven wire fabric taut and securely fasten it to each post. Accomplish stretching with a stretcher that will produce equal tension in each line wire. Stretch fabric until the tension is just below the point of producing displacement in the tension crimps. At each end, corner, or gate post, cut and turn each strand of line wire around the post and tie it back to itself with no less than 3 turns.

When it is necessary to splice 2 sections of fence, make the splice by placing together the end stay wires of each section, and twist the end of each line wire around the stay wires and back onto itself with no less than 3 turns; or splice the fence by using Engineer approved splicing sleeves designed for that purpose.

Attach the fence to each wood post with a staple for each line wire and as many additional staples as necessary to firmly secure the wire. Furnish galvanized staples having a nominal diameter of 0.148 inch and a length of no less than one inch in length, for hardwood posts. When using treated softwood posts, furnish staples that are 1 1/2 inches long. Securely attach the woven wire fabric as shown on the Standard Drawings.

Use tension wires and rails in erection of chain link fences as shown on the Standard Drawings. When shown on the Standard Drawings, place, stretch taut, and secure at ends the top or bottom tension wires to all posts in a manner before placing fabric. When a top rail is required, secure the bar at each end before stretching and tying the fabric. Secure ends of the fabric with stretcher bars threaded through the loops of the fabric and secured to the posts by means of clamps with bolts and nuts. Use the number of clamps as indicated.

Place the fabric by securing one end and applying sufficient tension to remove all slack before making attachments elsewhere. Fasten the fabric to the line posts and to the top tension wire or to the top rail, with tie wires or bands as called for in Section 817 or as the Contract designates.

Determine the number of tension bands required per post of chain link fence by taking the height of the fence in feet and subtracting one. Space tie wires for attaching chain link fence to the top tension wire or top rail on 24-inch centers. Space tie wires for attaching chain link fence to intermediate or line posts on 14-inch centers. Space tie wires on chain link gates on 24-inch centers. Install the chain link fence around utility installations facing the highway with the barbed wire arms at a 45 degree angle extending toward the highway. Design and install post caps for all tubular posts so as to exclude moisture from inside the posts, and install socket type brace end connections so as to exclude moisture from inside the rails.

721.03.03 Gates. Erect gates at locations specified in the Plans or as the Engineer directs. Erect the gate plumb with its hinges firmly attached to the post and to the gate. Allow the gate to swing freely when opened. Install the latch so it works easily and secures the gate when closed.

Furnish water gates of the specified type that conform to the Plans and Standard Drawings.

721.03.04 Finishing. Ensure that the tops of all posts are at a uniform height above the ground or at a uniform distance above the top of the woven wire fabric. After erecting the fence, saw the tops of wood posts uniformly at least 2 inches above the strand of barbed wire. Make the cut at an angle of 60 degrees to the vertical on the side of the post away from the wire.

Ensure that the finished fence is true to line, taut, and solid at all points. Dispose of all surplus excavated material and other debris resulting from construction and leave the fence line with a neat and orderly appearance.

721.04 MEASUREMENT.

721.04.01 Fence. The Department will measure the quantity of each type and height in linear feet along the top of the fence from outside to outside of end posts of fence installed, with deductions for all gates.

The Department will not measure material removal and disposal, drilling, excavating, or backfilling, installation or removal of temporary fences, or for connections to abutments or other structures for payment and will consider it incidental to this item of work.

721.04.02 Gates. The Department will measure the quantity by each individual unit.

The Department will not measure excavation or concrete for water gates for payment and will consider it incidental to this item of work.

721.05 PAYMENT. The Department will make payment for the completed and accepted quantities under the following:

Code	Pay Item	Pay Unit
02259, 02261-02263, 02273-02275, 08709-08716	Fence, Type and Height	Linear Foot
02281, 02282, 02286-02289	Gate, Type	Each
08100-08105, 02555	Concrete	Cubic Yard

The Department will consider payment as full compensation for all work required under this section.

SECTION 722 — REMOVING, RESETTING, OR REPLACING FENCE

722.01 DESCRIPTION. Remove, remove and reset, or remove and replace fences (except masonry fences).

722.02 MATERIALS.

722.02.01 Posts. Use the same type of posts existing in the original fence, and comply with applicable requirements.

722.02.02 Woven Wire Fencing. Conform to Section 816.

722.02.03 Chain Link Fencing. Conform to Section 817.

722.02.04 Concrete. Conform to Section 601.02 and 601.03. Select any class concrete specified in Section 601.03.

722.03 CONSTRUCTION.

722.03.01 Resetting Fence. Reset the fence to the location designated in the Contract, using material from the original fence, and leave all fences in as good condition as before removal. Reset all posts using the same type of construction that was used on the original fence, and furnish any new material necessary to set these posts in the manner used on the original fence. Where any posts are set in concrete, reconstruct the fence in the same manner. Ensure that reconstructed fences are true to line and vertical. Ensure that all wires are taut and well stapled. Remove and restore gates for service at the new location. Repair or replace fence and gates damaged during moving or resetting.

722.03.02 Remove Fence. When listed as a bid item, remove the designated fence and dispose of the materials off the right-of-way.

722.03.03 Removing and Replacing Fence. Remove the fence as described above. Replace the fence according to Section 721.

722.04 MEASUREMENT. The Department will not measure repair or replacement of fence or gates damaged during moving or resetting for payment and will consider it incidental to the work item being performed.

The Department will not measure concrete or new material necessary to set posts in the manner used on the original fence for payment and will consider it incidental to Resetting Fence and Replacing Fence.

722.04.01 Removing and Resetting Fence. The Department will measure the quantity, including gates, in linear feet along the top of the fence and gates from outside to outside of end posts for each continuous run of fence.

722.04.02 Removing Fence. The Department will measure the quantity, including gates, in linear feet along the top of the fence and gates before removal from outside to outside of end posts for each continuous run of fence.

722.04.03 Resetting Fence. The Department will measure the quantity, including gates, in linear feet along the top of the fence and gates from outside to outside of end posts for each continuous run of fence.

722.04.04 Removing and Replacing Fence. The Department will measure the quantity, including gates, in linear feet along the top of the fence and gates from outside to outside of end posts for each continuous run of fence.

722.05 PAYMENT. The Department will make payment for the completed and accepted quantities under the following:

Code	Pay Item	Pay Unit
02267	Remove and Reset Fence	Linear Foot
02265	Remove Fence	Linear Foot
02266	Reset Fence	Linear Foot
02268	Remove and Replace Fence	Linear Foot

The Department will consider payment as full compensation for all work required under this section.

SECTION 723 — SIGNAL SYSTEMS

723.01 DESCRIPTION. Furnish, install, and connect electrical traffic control devices according to the Contract.

723.02 MATERIALS. Conform to Section 835. For materials that are not on the Department's List of Approved Materials, submit documentation for material approval in electronic format to the Division of Traffic Operations. Documentation includes descriptive literature, drawings, and any requested design data or changes. Notify the Engineer when submitting any information to the Division of Traffic Operations. Do not begin work until shop drawings or construction changes are approved. Do not make substitutions for approved materials without written permission from the Engineer.

723.02.01 Paint. Conform to Section 821.

723.02.02 Sand. Use natural sand that conforms to Subsection 804.04.01.

723.02.03 Seeding. Use Seed Mix Type I.

723.03 CONSTRUCTION. Perform the work according to:

1) Contract
2) Kentucky Department of Highways, Standard Drawings
3) National Fire Protection Association (NFPA) 70
4) National Electrical Code
5) Institute of Electrical and Electronic Engineers (IEEE), National Electrical Safety Code
6) AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals, 2013-6th Edition with current interims
7) AASHTO Roadside Design Guide
8) Manual on Uniform Traffic Control Devices for Streets and Highways, current Edition
9) Standards of the utility company serving the installation.

The Plans indicate the extent and general arrangement of the proposed installation and the materials to be used. Advise the Engineer in writing and obtain written approval from Engineer for any modifications before beginning the work. Stake pole locations/elevations and obtain the Engineer's approval before beginning the work.

723.03.01 Utility Requirements. Conform to Subsection 716.03.01.

723.03.02 Steel Strain and Mast Arm Installations.

A) Pole Installation. Regardless of the station and offset noted, locate all poles behind guardrail with a minimum of 4 feet from the front face of the guardrail to the front face of the pole base. The Division of Traffic Operations shall be contacted if any pole needs to be relocated from the stations indicated. Poles shall not be installed on breakaway supports. Poles shall be installed so that each button is no more than 10 inches from the paved sidewalk or shoulder. Orient the handhole door so that it is not facing oncoming traffic. Top and leveling nuts shall be tightened to one-sixth turn beyond snug-tight. Snug-tight is defined as the condition where the nut is in full contact with the base plate. It is assumed that the full effort of a workman on a 12 inch wrench results in a snug-tight condition. The clearance between the bottom of the leveling nuts and the top of the concrete foundation shall not exceed one bolt diameter. There shall be one flat washer installed on the bottom side of the base plate, and there shall be one flat washer and one lock washer installed on the top side of the base plate.

B) Base/Rebar Installation. If pole base is installed within a sidewalk, the top of

the pole base shall be the same grade as the sidewalk. If pole base is not within a sidewalk, install pole base 4 to 6 inches above grade. There shall be at least 3 feet of usable sidewalk if a portion of the base is installed in the sidewalk. To have proper placement of pedestrian buttons, the base will need to extend approximately 10 inches into the sidewalk. For pedestrian buttons to be within 10 inches of the sidewalk, an extra sidewalk pad may be necessary. The concrete base shall be round and have a 1 inch chamfer on the top. The concrete base shall not have any voids between installed conduits and anchor bolts. The reinforcement and anchor bolts shall be adequately supported in the proper positions so no movement occurs during concrete placement. Exposed portions of the foundation shall be formed to create a smooth finished surface. All forming/sonotube shall be removed upon completion of foundation construction. Subsurface conditions consisting of very soft clay or very loose saturated sand could result in soil parameters weaker than those assumed. The Engineer shall consult with the Geotechnical Branch of the Division of Structural Design if such conditions are encountered. The bottom of the drilled hole shall be firm and thoroughly cleaned so no loose or compressible materials are present at the time of the concrete placement. If the drilled hole contains standing water, the concrete shall be placed using a tremie to displace water. Continuous concrete flow will be required to insure full displacement of any water.

Drilled shaft depth shall be based on the soil conditions encountered during drilling and slope condition at the site. Refer to the below design chart.

Maximum Service Forces	Drilled Shaft Data							
	Depth (feet)				Vertical Bars		Ties or Spiral	
Max Service Moment (Ft-kips)	< 2:1 Ground Slope		2:1 Ground Slope[1]					
	Soil	Rock	Soil	Rock	Size	Total	Size	Spacing or Pitch
< 40	10	6	12	6	#8	13	#4	12"
40.0 to 69.9	12	6	15	6	#8	13	#4	12"
70.0 to 99.9	14	6	17	6	#8	13	#4	12"
100.0 to 149.9	16	6	18	6	#8	13	#4	12"
150.0 to 199.9	18	6	21	6	#8	13	#4	12"
200.0 to 299.9	21	7	24	7	#8	13	#4	12"
300.0 to 400.0	23	7	26	7	#8	18	#4	12"

[1] Do not construct drilled shafts on ground slopes steeper than 2:1 without the approval of the Division of Traffic.

For maximum service moment, use the service moment provided by the pole manufacturer or the calculated service moment provided on the Plans, whichever is greater.

C) Splicing of Reinforcement. Conform to Subsection 602.03.06. Splicing of vertical reinforcement shall be Class C or as recommended by the Division of Traffic Operations. When a drilled shaft is lengthened in the field, the splice location shall be made at the bottom of the reinforcement cage.

D) Required Time to Apply Loads on Concrete Structures. Conform to Subsection 601.03.15.

723.03.03 Pedestal Base and Post. Pedestal bases and posts shall be installed so that each button is no more than 10 inches from the paved sidewalk or shoulder. The farthest button shall be within the 10 inches maximum distance from the sidewalk or shoulder. There shall be at least 3 feet of usable sidewalk if a portion of the pedestal base is installed in the sidewalk. To have proper placement of pedestrian buttons, the pedestal base will need to extend approximately 2 inches into the sidewalk. Ensure that concrete bases for poles up to 12 feet tall have a minimum depth of 4 feet and a minimum diameter of 2 feet. If pole is over 12 feet tall, the base shall have a minimum depth and diameter that conforms to Subsection 716.03.02 (A) (2). Rebar shall include six #6 vertical bars that are equally spaced. The vertical bars shall be 3 inches clear of the outside edge and top/bottom of the concrete base. There shall be #3 tie or spiral bars (diameter of 1 foot 6 inches) connected to the vertical bars that are 12 inches on center. The spiral/ties shall not overlap by more than 1 foot 3 inches. Construct a level base with no more than a 3/8 inch gap existing between the concrete base and the transformer base when the pole is plumbed. For breakaway supports, conform to Section 12 of the AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals, 2013-6th Edition with current interims. Grade the surrounding surface appropriately to meet the 4 inch breakaway support stub height. This stub height includes the pole base, conduits, nuts, and the anchors bolts.

A) Splicing of Reinforcement. Conform to Subsection 602.03.06. Splicing of vertical reinforcement shall be Class C or as recommended by the Division of Traffic Operations. When a drilled shaft is lengthened in the field, the splice location shall be made at the bottom of the reinforcement cage.

B) Required Time to Apply Loads on Concrete Structures. Conform to Subsection 601.03.15.

723.03.04 Wood Pole Installations. Poles shall be installed so that each button is no more than 10 inches from the paved sidewalk or shoulder. The farthest button shall be within the 10 inches maximum distance from the sidewalk or shoulder. There shall be at least 3 feet of usable sidewalk if a portion of the pole is installed in the sidewalk. For a 35 to 40 foot pole, the pole shall be embedded in the dirt/rock at least 6 feet. For a 45 foot pole, the pole shall be embedded in the dirt/rock at least 6.5 feet. If a messenger wire is attached to the pole, there shall be at least one anchor installed for each span force on the pole in the opposite direction of the force.

723.03.05 Trenching and Open Cut. Conform to Subsection 716.03.03 (B) and (C).

723.03.06 Conduit Installation. Conform to Subsection 716.03.04.

A) Junction Boxes. Conform to the installation/general notes for conduit in junction boxes type A & C in Subsection 716.03.04 (A). Provide conduits in junction box type B that are installed not more than 4 inches from the bottom of the junction box. Install conduit inside the junction box with a 90 degree conduit elbow. Provide conduits and spares that are accessible inside junction boxes. Conduit from saw slot to the junction shall be 1 inch rigid steel and be installed between 9 inches to 12 inches from the shoulder edge or face of curb. For transition conduit for loops, there shall be a 1 1/2 inch diameter hole from the saw slot to install the 1 inch conduit to the junction box on a 45 degree angle.

B) Installation in Pole Bases. Conform to guidance in Subsection 716.03.04 (C) regarding the installation of conduit in conventional lighting pole bases and the

general installation of conduit. In pedestal bases, there shall be at least two 1 1/4 inch rigid steel conduits and a 3/4 inch schedule 80 PVC conduit for the grounding. In steel strain bases, use conduit per contract, 3/4 inch schedule 80 PVC conduit for grounding system for the pole, and a 1 ¼ inch schedule 80 PVC spare. If the steel strain base location is the location of service, the conduit (3/4 inch schedule 80 PVC) for grounding system for the service can be ran inside or outside the base plate of the steel strain pole. If the steel strain base location is the location of service, the conduit (1 inch rigid steel) for the service wiring can be ran inside or outside the base plate of the steel strain pole. In accordance with the NEC, if service conduit is ran inside the pole, there shall be a rigid flex conduit installed from the concrete base conduit to the meter base to isolate the service wiring from the signal wiring going up the pole. Flex conduit for the service wire shall not block the handhole or the ability to access the grounding system. The main steel strain pole base, near the cabinet, shall have a minimum of four 2 inch schedule 80 PVC conduits from the based mounted cabinet; but to comply with the NEC, the Contractor shall modify the quantity of conduits in order to provide one spare conduit. All conduits shall be installed 6 inches above the concrete. In bases, an arrow shall be etched on the top of the base to show the location/direction of the spare conduit.

C) Installation in Cabinets. The base mounted cabinet near the main pole shall have a minimum of four 2 inch schedule 80 PVC conduit from the base cabinet to the pole; but to comply with the NEC, the Contractor shall modify the quantity of conduits in order to provide one spare conduit. If it is a pole mounted cabinet, all the conduit except for the grounding system shall be rigid steel and sized to meet the NEC. A pole mounted cabinet shall have a minimum two 2 inch rigid steel conduits for signal wires; but to comply with NEC requirements, the Contractor shall modify the size and quantity of conduits and provide one spare conduit. In cabinet bases (base mounted only), an arrow shall be etched on the top of the base to show the location/direction of the spare conduit. The conduits shall be installed between 4 to 6 inches above the concrete pad, and they cannot exceed the 6 inch height.

D) Barrier Wall Installation. Conform to Subsection 716.03.04 (E)

E) Coupling Installation. Conform to Subsection 716.03.04 (G).

F) Bonding/Bushing Requirements. Conform to Subsection 716.03.04 (H).

G) PVC Bushing. Conform to Subsection 716.03.04 (I).

H) Painting. Conform to Subsection 716.03.04 (J).

I) Bore and Jack Conduit. Conform to Subsection 716.03.04 (K).

J) Existing Base Conduit Installation. Conform to Subsection 716.03.04 (L).

723.03.07 Fuse Connector Kits. Conform to Subsection 716.03.09.

723.03.08 Painting. Conform to Subsection 716.03.15.

723.03.09 Electrical Junction Boxes. Conform to Subsection 716.03.10.

723.03.10 Underground Warning Tape. Conform to Subsection 716.03.05.

723.03.11 Backfilling and Disturbed Areas. Conform to Subsection 716.03.06.

723.03.12 Wiring Installation. Affix each wire/cable in the controller cabinet with a permanent identification label 6 inches from the final connecting location. When installing more than one loop lead-in cable within the same conduit, affix permanent identification 6 inches from the top of the conduit per loop schedule. Identification shall be used on cables wherever the wiring emerges, including junction boxes, poles, and pedestals. Affix each splice between loop wire and loop lead-in with a permanent identification label per loop schedule. Use heat shrink tape or vinyl to wrap all wires where they pass through holes. Deburr all holes and provide a grommet at each opening. Provide an extra two feet of loop wire and lead-in past the installed conduit in poles, pedestals, and junction boxes. The Contractor shall install all cable or wire runs splice-free from the controller to each loop wire, signal head, pedestrian head/detector, camera, blankout sign, and audible pedestrian head/detector.

For all wiring, use connection/color code according to the following charts:

5-Conductor	IMSA 19-1
3-Section Heads	
Connection	Color
Red Ball/Arrow	Red
Yellow Ball/Arrow	Orange
Green Ball/Arrow	Green
Neutral	White
Not Used	Black

5-Conductor	IMSA 19-1
4-Section Heads	
Connection	Color
Red Ball	Red
Yellow Ball	Orange
Green Ball	Green
Green Arrow	Black
Neutral	White

7-Conductor	IMSA 19-1
5-Section Heads	
Connection	Color
Red Ball	Red
Yellow Ball	Orange
Yellow Arrow	White/Tracer
Green Ball	Green
Green Arrow	Blue
Neutral	White
Not Used	Black

5-Conductor	IMSA 19-1
Ped Signal and Button	
Connection	Color
Walk	Green
Don't Walk	Red
Button	Black
Button	Orange
Not Used	White

For all wiring of flashing yellow arrow signal heads, use connection/color code according to following charts:

5-Conductor	IMSA 19-1
3-Section Heads	
Connection	Color
Red Arrow	Red
Steady Yellow Arrow	Orange
Flashing Yellow Arrow	Black
Not Used	Green
Neutral	White

5-Conductor	IMSA 19-1
4-Section Heads	
Connection	Color
Red Arrow	Red
Steady Yellow Arrow	Orange
Flashing Yellow Arrow	Black
Green Arrow	Green
Neutral	White

7-Conductor	IMSA 19-1
4-Section Heads	
Connection	Color
Red Arrow	Red
Steady Yellow Arrow	Orange
Flashing Yellow Arrow	White/Tracer
Green Arrow	Green
Neutral	White
Not Used	Blue
Not Used	Black

The Contractor shall connect the connector labeled "2PY 4PY 6PY 8PY" to connector "CMU 13, 16, R, U" behind the output panel. If it is a solid state cabinet, only have two connectors which simply need to be connected together. Phase connection to output file in cabinet for flashing yellow arrow signal heads according to following charts:

Flashing yellow arrow signal wiring on phase 1 & 5 three-section FYA heads Special requirements with the use of 5 conductor			
Connection	Color	Output file connection For FYA on Phase 1	Output file connection For FYA on Phase 5
Red arrow	Red	Phase 1 red	Phase 5 red
Steady yellow arrow	Orange	Phase 1 yellow	Phase 5 yellow
Flashing yellow arrow	Black	Phase 1 green	Phase 5 green
Neutral	White	Neutral	Neutral

Flashing yellow arrow signal wiring on phase 3 & 7 three- section fya heads Special requirements with the use of 5 conductor			
Connection	Color	Output file connection For fya on phase 3	Output file connection For fya on phase 7
Red arrow	Red	Phase 3 red	Phase 7 red
Steady yellow arrow	Orange	Phase 3 yellow	Phase 7 yellow

Flashing yellow arrow	Black	Phase 3 green	Phase 7 green
Neutral	White	Neutral	Neutral

Flashing yellow arrow signal wiring on phase 1 & 5 four-section fya heads Special requirements with the use of 5 conductor			
Connection	Color	Output file connection For fya on phase 1	Output file connection For fya on phase 5
Red arrow	Red	Phase 1 red	Phase 5 red
Steady yellow arrow	Orange	Phase 1 yellow	Phase 5 yellow
Flashing yellow arrow	Black	Phase 1 green	Phase 5 green
Green arrow	Green	Ped yellow phase 2	Ped yellow phase 6
Neutral	White	Neutral	Neutral

Flashing yellow arrow signal wiring on phase 3 & 7 four-section fya heads Special requirements with the use of 5 conductor			
Connection	Color	Output file connection For fya on phase 3	Output file connection For fya on phase 7
Red arrow	Red	Phase 3 red	Phase 7 red
Steady yellow arrow	Orange	Phase 3 yellow	Phase 7 yellow
Flashing yellow arrow	Black	Phase 3 green	Phase 7 green
Green arrow	Green	Ped yellow phase 4	Ped yellow phase 8
Neutral	White	Neutral	Neutral

723.03.13 Loop Installation. Twist unshielded loop wire with three to five turns per foot before placing in saw slots, conduits, junction boxes, or cabinets. Extend loop wires splice-free to poles, pedestals, or junction boxes as shown on the Plans. Splice loop wires to loop lead-in cable in poles, pedestals, or junction boxes as shown on the Plans. Extend loop lead-in cable splice-free from the pole, pedestal, or junction box to the controller. Provide an extra two feet of loop wire and lead-in past the installed conduit in poles, pedestals, and junction boxes. Make splices accessible from the handholes of poles. On projects involving new asphalt pavement, install loops in the base course of asphalt pavement before the final surface is constructed. Coordinate the installation of the loops with the paving contractor and the Engineer.

A) Loop Saw Slot and Fill/Loop Wire Placement. The following is a typical step by step procedure for the installation of a loop.

1. Carefully mark the slot to be cut, perpendicular to the flow of traffic and centered in the lane.
2. Make each saw-cut 3/8 inch wide (3/4 inch wide for preformed loops only) and at a depth such that the top of the backer rod is a minimum of 4 inches below the surface of asphalt pavement.

3. Drill a 1 1/2 inch core hole at each corner and use a chisel to smooth corners to prevent sharp bends in the wire.

4. Clean all foreign and loose matter out of the slots and drilled cores and within 1 foot on all sides of the slots using a high pressure washer.

5. Completely dry the slots and drilled cores and within 1 foot on all sides of the slots.

6. Measure 9 to 12 inches from the edge of the paved surface (shoulder break or face of curb) and drill a 1½ inch hole on a 45º angle to the conduit adjacent to the roadway.

7. Closely inspect all cuts, cores, and slots for jagged edges or protrusions prior to the placement of the wire. All jagged edges and protrusions shall be ground or recut and cleaned again.

8. Place the loop wire splice-free from the termination point (cabinet or junction box) to the loop, continue around the loop for two turns (6 foot by 30 foot loop) or three turns (6 foot by 6 foot loop), and return to the termination point.

9. Push the wire into the saw slot with a blunt object such as a wooden stick. Make sure that the loop wire is pushed fully to the bottom of the saw slot. Screwdrivers shall not be used.

10. Install duct sealant to a minimum depth of 1 inch into the cored 1 1/2 inch hole.

11. Apply loop sealant from the bottom up and fully encapsulate the loop wires in the saw slot. The wire should not be able to move when the sealant has set.

12. Cover the encapsulated loop wire with a continuous layer of backer rod along the entire loop and home run saw slots such that no voids are present between the loop sealant and backer rod.

13. Finish filling the saw cut with non-shrinkable grout per manufacturer's instructions. Alleviate all air pockets and refill low spaces. There shall be no concave portion to the grout in the saw slot. Any excess grout shall be cleaned from the roadway to alleviate tracking.

14. Clean up the site and dispose of all waste off the project.

15. Ensure that the grout has completely cured prior to subjecting the loop to traffic. Curing time varies with temperature and humidity.

723.03.14 Grounding Installation. Conform to Subsection 716.03.11. All poles and cabinets (including beacon and school flasher cabinets) shall be grounded with one 5/8 inch by 8 foot ground rod and shall not use the ground rods of poles, services, and other cabinets.

723.03.15 Splicing. Use and approval of splices shall conform to Subsection 716.03.08.

A) One Way Splicing Procedures. Cover splices with a vinyl mastic pad or approved equal. The mastic pad must cover at least 3 inches past each end of the butt splice and shall extend at least one inch onto the outer insulation of the lead-in wire. All internal wires for signal and loop cables shall be installed inside one mastic pad tape splice with 3M #33 electrical tape (or approved equal). Encase each conductor, including the ground, in a separate splice kit.

B) Two or Multiple Way Splicing. Two or multiple way splicing shall not be used for the splicing of signal cables or loop wires.

723.03.16 Remove Signal Equipment. Remove all traffic signal equipment that is identified by the Engineer as no longer necessary including, but not limited to, the following: pole bases, poles, pedestals, pedestal bases, junction boxes, cabinets, wood poles, cable/wire, and advance warning flashers. Pole bases shall be removed a minimum of one foot below finished grade by chipping off or other method that is approved by the Engineer. Dispose of all removed concrete off right-of-way. Wood poles shall be removed a minimum of one foot below finished grade. Backfill holes with material approved by the Engineer. Conduit may be abandoned in the ground. Contact the District Traffic Engineer to determine if any removed signal equipment needs to be returned to the district and to determine the location/time for such deliveries.

723.03.17 Loop Installation on Pavement Rehabs. This specification applies to loop installation (including preformed loops) on pavement rehabilitation projects. It is expected that the Contractor made a thorough inspection of the site prior to starting work and has thoroughly familiarized himself with existing conditions so that the work can be expeditiously performed. Information provided in the Plans regarding types and quantities of work is not to be taken as an accurate or complete evaluation of the materials and conditions to be encountered during construction.

A) Testing. The Contractor shall test all loops and lead-in cables according to Subsection 723.03.20 before and after milling the roadway. The Contractor may have to separate the loop from the lead-in to perform this test. If the loop/lead-in meets the requirements at the controller cabinet, the loop/lead-in shall not be replaced. If the existing loop does not meet the requirements either before or after milling of the road, the loop shall be replaced. If the loop is replaced before the milling, the Contractor shall verify that the loop meets the requirements before the final surface is laid. If the loop does not meet the requirements, the Contractor shall replace the loop before the resurfacing activities begin and will be incidental to the milling bid item. The Contractor shall be responsible to re-splice the current loop to the lead-in with the proper splice as noted in these specifications.

B) Coordination. Notify the Engineer in writing, two weeks prior to beginning any work. The Engineer will coordinate work with the District Traffic Engineer and the Division of Traffic Operations. The electrical contractor shall coordinate with the Contractor and the Engineer to ensure preformed loops are properly located

and installed prior to placing the concrete pavement and shoulders. Ensure preformed loops are operational prior to opening pavement to traffic.

C) Connection. The Contractor shall schedule all signal loop installation to ensure the new loops are connected to the lead-in and operational within five calendar days of the old loops being damaged and/or disconnected. This requirement includes damage caused by any work activity associated with the project. If the new signal loops are not functioning as intended following 5 calendar days, the Department may assess liquidated damages at a rate of $500 per calendar day per signal location until the loops are operating at pre-construction conditions. All liquidated damages will be applied cumulatively.

D) Maintain and Control Traffic. Conform to contract traffic control plan.

E) Concrete Inlays. The Contractor shall coordinate with the concrete contractor and the Engineer to get preformed loops installed in a timely matter. The Contractor may have to use 1 inch PVC conduit in sections of the concrete inlay for transition from lane to lane so that the preformed loop or preformed loop/lead-in can be connected to the preformed loop. The PVC conduit shall be incidental to the project. To maintain detection, preformed loops may be temporarily attached to the top of pavement as recommended by the manufacturer.

F) Milling. On projects involving milling and texturing of the existing pavement, install loops in the existing pavement before or after performing the milling and texturing. After milling, the remnant contents of the existing saw slot (grout, loop wires, backer rod, and/or loop sealant) may not be flush with the top of the milled portion of the asphalt. In such cases, clear the saw slot of loose remnant contents and refill the saw slot with natural sand. Obtain the Engineer's approval of the stabilized saw slot prior to resurfacing. The Department will not measure for separate payment clearing and stabilizing the saw slot and shall consider this work incidental to Asphalt Pavement Milling and Texturing.

G) Loop Saw Slot and Fill/Loop Wire Placement. Conform to Subsection 723.03.13 (A).

H) Backfilling and Disturbed Areas. Conform to Subsection 723.03.11.

I) Removal. Conform to Subsection 723.03.16.

J) Property/Roadway Damage. The Contractor shall be responsible for all damage to public and/or private property resulting from the work. Upon completion of the work, restore all disturbed highway features and private property in like kind design and materials at no additional cost to the Department.

K) Right-of-Way Limits. Limit work activities to obvious Right-of-Way and work areas secured by the Department through Consent and Release of the adjacent property owners. Contractor shall be responsible for all encroachments onto private lands.

L) Bore and Jack. Conform to Subsection 723.03.06 (I).

723.03.18 Control Cabinet Installation.

A) Base-Mounted. Install a concrete pad that is approximately 78 inches by 36 inches by 28 inches. The base shall be of sufficient size to allow a minimum 26 1/2 inches in front and back of cabinet. The cabinet shall be centered within the 36 inch width of the concrete pad. The concrete base shall be at least 4 inches above the final grade or at same grade as sidewalk. The outside edge of the base shall have a 1 inch chamfer. There shall at least four cabinet mounting anchors securely installed, and they shall be extended no more than 1 inch above the top of the concrete pad. There shall be a continuous bead of caulk installed around the bottom of all base-mounted cabinets.

B) Pole Mounted. Install the cabinet securely to the pole with two brackets that attach at the top and the bottom of the cabinet. These brackets shall be secured to the pole with banding straps.

C) Service Location. Conform to Subsection 716.03.16 (D).

723.03.19 Drawings. Conform to Subsection 716.03.19.

723.03.20 Acceptance and Inspection Requirements. Conform to Subsection 105.12. In coordination with the District Traffic Engineer, energize traffic control device as soon as it is fully functional and ready for inspection. After the work has been completed, conduct an operational test demonstrating that the system operates in accordance with the Plans in the presence of the Engineer. The Department will also conduct its own tests with its own equipment before final acceptance. Ensure that the traffic control device remains operational until the Division of Traffic Operations has provided written acceptance of the electrical work. Traffic Operations will conduct an inspection of the installation prior to calling the job complete. The inspection will include, but not be limited to, the following:

1. Induction loop conductors shall test free of shorts and unauthorized grounds and shall have an insulating resistance of at least one hundred megaohms when tested with a 500 volt direct current potential in a reasonably dry atmosphere between conductors and ground.

2. Ground rods shall have a resistance to ground not to exceed 25 ohms. If the resistance to ground is greater than 25 ohms, two or more ground rods connected in parallel shall be installed.

723.04 MEASUREMENT.

723.04.01 Conduit. The Department will measure the quantity in linear feet furnished and installed. The Department will not measure conduit fittings, ground lugs, test plugs, expansion joints, and clamps for payment and will consider them incidental to this item of work.

723.04.02 Electrical Junction Box Type Various. The Department will measure the quantity as each individual unit furnished and installed. The Department will not measure additional junction boxes for greater depths than those identified in Plans, Aggregate (#57), backfilling, restoration of disturbed areas to the satisfaction of the Engineer, geotextile fabric, concrete, hot dipped galvanized cover, stainless steel screws, rubber gasket, and any associated hardware for payment and will consider them incidental to this item of work.

723.04.03 Trenching and Backfilling. The Department will measure the quantity in linear feet. The Department will not measure excavation, backfilling, underground utility warning tape, and the restoration of disturbed areas to original condition for payment and will consider them incidental to this item of work.

723.04.04 Open Cut Roadway. The Department will measure the quantity in linear feet. The Department will not measure concrete, reinforcing steel, and asphalt for payment and will consider them incidental to this item of work.

723.04.05 Loop Wire. The Department will measure the quantity in linear feet furnished and installed. The Department will not measure splice boots, cable rings, and any other necessary hardware for payment and will consider them incidental to this item of work. Re-splicing shall be incidental to this bid item.

723.04.06 Cable. The Department will measure the quantity in linear feet furnished and installed. The Department will not measure splice boots, cable rings, and any other hardware for payment and will consider them incidental to this item of work.

723.04.07 Pole-Wooden. The Department will measure the quantity as each individual unit furnished and installed. The Department will not measure excavation, backfilling, and restoring disturbed areas for payment and will consider them incidental to this item of work.

723.04.08 Steel Strain Pole. The Department will measure the quantity as each individual unit furnished and installed. The Department will not measure excavation, backfilling, and restoring disturbed areas for payment and will consider them incidental to this item of work.

723.04.09 Mast Arm Pole. The Department will measure the quantity as each individual unit furnished and installed. The Department will not measure anchor bolts, arms, mounting brackets, and any other necessary hardware for payment and will consider them incidental to this item of work.

723.04.10 Signal Pedestal. The Department will measure the quantity as each individual unit furnished and installed. The Department will not measure excavation, concrete, reinforcing steel, conduits, fittings, ground rods, ground wire, ground lugs, backfilling, restoring disturbed areas, and other necessary hardware for payment and will consider them incidental to this item of work. All conduits used for grounding, spare conduits, and conductors that are installed in the pole base (including conduits extending 24 inches past the edge of the pole base) are incidental to this bid item.

723.04.11 Post. The Department will measure the quantity as each individual unit furnished and installed. The Department will not measure excavation, backfilling, and restoring disturbed areas for payment and will consider them incidental to this item of work.

723.04.12 Anchor. The Department will measure the quantity as each individual unit furnished and installed. The Department will not measure down-guy, messenger, clamps, guy guard, or insulators, and possible installation in various soil conditions for payment and will consider them incidental to this item of work.

723.04.13 Messenger. The Department will measure the quantity in linear feet furnished and installed. The Department will not measure strand vises, bolts, washers, and other necessary hardware for payment and will consider them incidental to this item of work.

723.04.14 Install Beacon Controller – 2 Circuit. The Department will measure the quantity as each individual unit furnished and installed. The Department will not measure the controller housing, mounting equipment, S5-1 school zone sign, time clock, NEMA flasher, ground rods, ground wires, ground lugs, metering disconnect hardware, electrical inspection fees, and required building fees involving utility secondary/primary service for payment and will consider them incidental to this item of work.

723.04.15 Loop Saw Slot and Fill. The Department will measure the quantity in linear

feet. The Department will not measure sawing, cleaning, filling induction loop saw slot, loop sealant, backer rod, drilling hole for conduit, and grout for payment and will consider them incidental to this item of work.

723.04.16 Pedestrian Detector. The Department will measure the quantity as each individual unit furnished, installed and connected to pole/pedestal. The Department will not measure installing R10-3e signs, detector housing, and installing mounting hardware for sign for payment and will consider them incidental to this item of work.

723.04.17 Signal. The Department will measure the quantity as each individual unit furnished, installed and connected to signal conductors. The Department will not measure furnishing and installing LED modules, retroreflective tape, back plates, and any other hardware for payment and will consider them incidental to this item of work.

723.04.18 Signal Controller – Type 170. The Department will measure the quantity as each individual unit furnished and installed. The Department will not measure the concrete base, mounting the cabinet, connecting the signal and detectors, excavation, backfilling, restoration, any necessary pole mounting hardware, electric service, electrical inspection fees, and building fees involving secondary/primary service for payment and will consider them incidental to this item of work. The Department will also not measure furnishing and connecting the induction of loop amplifiers, pedestrian isolators, load switches, model 400 modem card, electrical service conductors, conduits, anchors, meter base, fused cutout, fuses, ground rods, ground wires, and ground lugs for payment and will consider them incidental to this item of work. All conduits used for grounding, spares, service/pole, and conductors (not ducted cable) that are installed in the cabinet base (including 24 inches of conduit past the edge of the cabinet base and on cabinet/service pole) are incidental to this item.

723.04.19 Beacon Controller – 2 Circuit. The Department will measure the quantity as each individual unit furnished and installed. The Department will not measure the controller housing, mounting equipment, S5-1 school zone sign, time clock, NEMA flasher, ground rods, ground wires, ground lugs, metering disconnect hardware, electrical inspection fees, and required building fees involving utility secondary/primary service for payment and will consider them incidental to this item of work.

723.04.20 Install Signal Controller – Type 170. The Department will measure the quantity as each individual unit installed. The Department will not measure the concrete base, mounting the cabinet, connecting the signal and detectors, excavation, backfilling, restoration, any necessary pole mounting hardware, electric service, electrical inspection fees, and required building fees involving utility secondary/primary service for payment and will consider them incidental to this item of work. The Department will also not measure connecting the induction loop amplifiers, pedestrian isolators, load switches, model 400 modem card for payment and will consider them incidental to this item of work. The Department will also not measure furnishing and installing electrical service conductors, conduits, anchors, meter base, fused cutout, fuses, ground rods, ground lugs, and ground wires for payment and will consider them incidental to this item of work. All conduits used for grounding, spares, service/pole, and conductors (not ducted cable) that are installed in the cabinet base (including 24 inches of conduit past the edge of the cabinet base and on cabinet/service pole) are incidental to this item.

723.04.21 Install Steel Strain Pole. The Department will measure the quantity as each individual unit installed. The Department will not measure any necessary clamp assemblies for payment and will consider them incidental to this item of work.

723.04.22 Remove Signal Equipment. The Department will measure the quantity by lump sum. The Department will not measure backfilling and the disposal or transportation of equipment and materials associated with any structural or electrical component of the

signal system including, but not limited to pole bases, poles, junction boxes, cabinets, and wood poles for payment and will consider them incidental to this item of work.

723.04.23 Install Span/Pole Mounted Sign. The Department will measure the quantity as each individual unit installed. The Department will not measure the hanger or any other hardware necessary to install the sign for payment and will consider them incidental to this item of work.

723.04.24 Install Pedestrian Head LED. The Department will measure the quantity as each individual unit installed and connected to signal conductors. The Department will not measure the installation of LED modules and any other necessary hardware for payment and will consider them incidental to this item of work.

723.04.25 Install Signal LED. The Department will measure the quantity as each individual unit installed and connected to signal conductors. The Department will not measure the installation of LED modules, retroreflective tape, back plates, and any other necessary hardware for payment and will consider them incidental to this item of work.

723.04.26 Install Coordinating Unit. The Department will measure the quantity as each individual unit installed. The Department will not measure radio, modem, cable(s), antenna(s), router, repeater, and any other necessary hardware for payment and will consider them incidental to this item of work.

723.04.27 Video Camera. The Department will measure the quantity as each individual unit furnished and installed. The Department will not measure video modules, mounting bracket, truss type arm, power cable, coaxial cable, and any other necessary hardware for payment and will consider them incidental to this item of work.

723.04.28 Install Ped Detector Audible. The Department will measure the quantity as each individual unit installed and connected to pole/pedestal. The Department will not measure installing R10-3e sign, detector housing, and installing mounting hardware for payment and will consider them incidental to this item of work.

723.04.29 Audible Pedestrian Detector. The Department will measure the quantity as each individual unit furnished, installed, and connected to pole/pedestal. The Department will not measure furnishing and installing the R10-3e sign, detector housing, and installing mounting hardware for payment and will consider them incidental to this item of work.

723.04.30 Bore and Jack Conduit. The Department will measure the quantity in linear feet. This item shall include all work necessary for boring and installing conduit under an existing roadway.

723.04.31 Install Pedestrian Detector. The Department will measure the quantity as each individual unit installed and connected to pole/pedestal. The Department will not measure installing R 10-3e sign, detector housing, and installing mounting hardware for payment and will consider them incidental to this item of work.

723.04.32 Install Mast Arm Pole. The Department will measure the quantity as each individual unit installed. The Department will not measure installation of arms, signal mounting brackets, anchor bolts, and any other necessary hardware for payment and will consider them incidental to this item of work.

723.04.33 Pedestal Post. The Department will measure the quantity as each individual unit furnished and installed. The Department will not measure excavation, backfilling, restoration, furnishing and installing concrete, reinforcing steel, anchor bolts, conduit, fittings, ground rod, ground wire, ground lugs, or any other necessary hardware for payment and will consider them incidental to this item of work. All conduits used for grounding,

spare conduits, and conductors that are installed in the pole base (including conduits extending 24 inches past the edge of the pole base) are incidental to this bid item.

723.04.34 Span/Pole-Mounted Sign. The Department will measure the quantity as each individual unit furnished and installed. The Department will not measure the hanger, sign, and any other necessary hardware for payment and will consider them incidental to this item of work.

723.04.35 Remove and Reinstall Coordinating Unit. The Department will measure the quantity as each individual unit removed and reinstalled. The Department will not measure removing, storage, reinstalling, and connecting radio, modem, cable(s), antenna(s), router, repeater, and any other necessary hardware for payment and will consider them incidental to this item of work.

723.04.36 Traffic Signal Pole Base. The Department will measure the quantity in cubic yards furnished and installed. The Department will not measure excavation, backfilling, restoration, furnishing and installing reinforcing steel, anchor bolts, conduits, ground rods, ground wires, and ground lugs for payment and will consider them incidental to this item of work. All conduits used for grounding, spare conduits, and conductors that are installed in the pole base (including conduits extending 24 inches past the edge of the pole base) are incidental to this bid item.

723.04.37 Install Signal Pedestal. The Department will measure the quantity as each individual unit installed. The Department will not measure excavation, backfilling, restoration, furnishing and installing concrete, reinforcing steel, conduits, fittings, ground rod, ground wire, ground lugs, and any other necessary hardware for payment and will consider them incidental to this item of work. All conduits used for grounding, spare conduits, and conductors that are installed in the pole base (including conduits extending 24 inches past the edge of the pole base) are incidental to this bid item.

723.04.38 Install Pedestal Post. The Department will measure the quantity as each individual unit installed. The Department will not measure excavation, backfilling, restoration, furnishing and installing concrete, reinforcing steel, conduit, fittings, ground rod, ground wire, ground lugs, and any other necessary hardware for payment and will consider them incidental to this item of work. All conduits used for grounding, spare conduits, and conductors that are installed in the pole base (including conduits extending 24 inches past the edge of the pole base) are incidental to this bid item.

723.04.39 Install Antenna. The Department will measure the quantity as each individual unit installed. The Department will not measure any other materials necessary to complete the installation for payment and will consider them incidental to this item of work.

723.05 PAYMENT. The Department will make payment for the completed and accepted quantities under the following:

Code	Pay Item	Pay Unit
4790-4799	Conduit, Size	Linear Foot
4810,	Electrical Junction Box	Each
04811	Electrical Junction Box Type B	Each
20391NS835	Electrical Junction Box Type A	Each
20392NS835	Electrical Junction Box Type C	Each
4820	Trenching & Backfilling	Linear Foot
4821	Open Cut Roadway	Linear Foot
4830	Loop Wire	Linear Foot
4840-4852	Cable, Type	Linear Foot
4871-4873	Pole-Wooden, Size	Each
4880	Steel Strain Pole	Each
4881	Mast Arm Pole	Each
4882	Signal Pedestal	Each
4883	Post	Each
4884	Anchor	Each
4885-4886	Messenger, Strength	Linear Foot
4895	Loop Saw Slot and Fill	Linear Foot
4900	Pedestrian Detector	Each
4910-4916	Signal	Each
4920	Signal Controller-Type 170	Each
4930	Beacon Controller-2 Circuit	Each
4931	Install Sig Controller-Type 170	Each
4932	Install Steel Strain Pole	Each
4950	Remove Signal Equipment	Each
6472, 20631ND	Install Span/Pole Mounted Sign	Each
20093NS835	Install Pedestrian Head LED	Each
4887, 20188NS835 20189NS835	Install Signal LED, Size	Each
20266ES835	Install Signal LED, Size	Each
20408NS835	Install Signal LED, Size	Each
20390NS835	Install Coordinating Unit	Each
20455NS835	Video Camera	Each
20457NS835	Install Ped Detector Audible	Each
20495NS835	Audible Pedestrian Detector	Each
21543EN	Bore and Jack Conduit	Linear Foot
21743NN	Install Pedestrian Detector	Each
22631NN	Install Mast Arm Pole	Each
23051NN	Pedestal Post	Each
23052NN	Span/Pole-Mounted Sign	Each
23068NN	Remove & Reinstall Coordinating Unit	Each
23157EN	Traffic Signal Pole Base	Cubic Yard
23222EC	Install Signal Pedestal	Each
23235EC	Install Pedestal Post	Each
23982EC	Install Antenna	Each
24526ED	Install Beacon Controller 2 Cir	Each

The Department will consider payment as full compensation for installing and placing the complete traffic control device in satisfactory operation.

SECTION 724 — PLANTING VINES, SHRUBS, AND TREES

724.01 DESCRIPTION. Furnish and plant trees, shrubs, vines, seedlings, and other materials in the areas and in the arrangement specified in the Plans or as the Engineer directs. Dig and prepare beds and planting holes, prune plants, furnish and place backfill, fertilize, mulch, water, brace, and perform all other incidentals required for planting.

Additionally, care for plants during the period required to demonstrate the plants have become established in a healthy growing condition, replace plants found defective as prescribed, and perform all other incidentals necessary to complete the work as specified in the Contract and as provided in this section.

724.02 MATERIALS.

724.02.01 Plants. Conform to the requirements of the American Standard for Nursery Stock as published by the American Nursery and Landscape Association. Provide 30 calendar days notice before obtaining nursery stock vines, shrubs, or trees to allow Department personnel to inspect the stock at the source. The Department will inspect all vines, shrubs, and trees at the work site. Obtain the Engineer's approval of the plants before planting.

724.02.02 Mulch. Conform to Subsection 827.05.

724.03 CONSTRUCTION.

724.03.01 Times Permissible for Planting. Perform the initial planting operation between the dates of November 1 and April 1. Perform initial planting when the temperature is a minimum of 35 °F and the ground is not frozen. Regardless of the calendar date, plants must be dormant when they are dug at the nursery source and when they arrive at the project site.

Perform the replacement planting operation between the dates of November 1 and May 15.

724.03.02 Transportation. Transport all plants from the nursery sources to the project site by covered vehicle.

724.03.03 Layout of Planting. Before digging of planting holes or beds, lay out, by suitable staking, the location of all planting holes and beds, and obtain the Engineer's approval.

When the Contract specifies planting at locations that will not sustain healthy growth, submit a written request to the Engineer for approval to relocate the plants. If the Engineer cannot find a suitable site to relocate the plants, they will be deleted from the Contract.

724.03.04 Backfill for Planting. Backfill with the best available material from the site. When desired, use topsoil from an off-site source. Exclude any soil with significant amounts of rock, shale, or clay material.

724.03.05 Surplus Excavation. Dispose of surplus excavation from the planting holes as the Engineer directs.

724.03.06 Mulching. Use either hardwood wood chips or shredded bark for mulching material, and place it around the plants as quickly as possible after planting. Apply it uniformly over the planting area to a depth of 4 inches and to a distance of one foot outside the periphery of the plant hole or planting bed.

724.03.07 Bracing. Brace evergreens and shade trees. The Department will not require bracing on other plants except when the Engineer directs. When bracing is required, brace according to the Standard Drawings.

724.03.08 Period of Establishment. The Department will require a period of establishment to follow the completion of the initial planting. During this time perform the following maintenance items to ensure that optimum growing conditions for the plant material are maintained during the life of the contract. These maintenance items include but are not limited to the following: weeding beds, mowing perimeter of beds, watering plants, insect and disease control, periodic bracing adjustments.

When the total of the combined plant materials would constitute a major item, the Department will require a 3 growing season period of establishment. When the total of the combined plant materials would not constitute a major item, the Department will require a one growing season period of establishment. The Department will require a one growing season period of establishment for plant material used along channel changes regardless of total. The Department will consider the period from April 30th until September 15th of the same year to be one growing season.

724.03.09 Inspection Schedule. When all planting is complete, notify the Engineer and the Initial Inspection will be made. The Department will make Replacement Inspections by September 15th following each growing season to determine if replacement planting is required. Perform all required replacement planting before April 15. When all replacement planting is complete, notify the Engineer. If no replacement plantings are required at the last Replacement Inspection, the Department will consider the Replacement Inspection to be the Final Inspection.

724.03.10 Replacement Planting. Ensure the plant materials remain in a healthy growing and vigorous condition at all times throughout the life of the period of establishment. The Department will consider plant materials to be unacceptable when any of the following conditions occur:

1) Plants are dead or missing from the planting site.
2) Plants that have experienced injury and show obvious signs of damage from drought, sun scald, insects, or disease.
3) Dieback of central leader and or lateral branches which disfigures the plant rendering it unacceptable.
4) Plants that have been damaged by physical or mechanical injury.

For 24-inch or shorter trees, perform replacement planting when the number of acceptable trees of that species and size falls below 75 percent. Ensure the replacement plantings raise the quantity of acceptable trees of that species and size to at least 85 percent.

For all other plant materials, perform replacement planting when the number of acceptable plants of that species and size falls below 95 percent. Ensure the replacement plantings raise the quantity of acceptable trees of that species and size to 100 percent.

724.03.11 Removal of Stakes, Tags, and Bracing. Remove stakes, tags, and bracing materials after the first Replacement Inspection and no later than 18 months after initial planting. Dispose of removed material off of the right-of-way.

724.03.12 Restoring Disturbed Areas. Restore all disturbed areas.

724.04 MEASUREMENT. The Department will measure the quantity of Plants, Vines, Shrubs, and Trees by each individual unit.

The Department will not measure bracing, mulching, furnishing topsoil, or maintenance for payment and will consider it incidental to the plant.

The Department will not measure replacement planting, including that necessitated by a third party, for payment and will consider it incidental to the plant.

724.05 PAYMENT. The Department will make payment for the completed and accepted quantities according to the Warranty Payment Schedule under the following:

Code	Pay Item	Pay Unit
----	Plants, Vines, and Shrubs; Species and Size	Each
----	Trees, Species and Size	Each

Warranty Payment Schedule
(one growing season)

		Completion Date	Payment
—	Initial Inspection		70%
Sept 15	1st Year Replacement Inspection	April 30	30%

Warranty Payment Schedule
(3 growing seasons)

		Completion Date	Payment
—	Initial Inspection		70%
Sept 15	1st Year Replacement Inspection	April 30	10%
Sept 15	2nd Year Replacement Inspection	April 30	10%
Sept 15	Final Inspection		10%

Any replacement work not done by the scheduled completion date and all work found unacceptable during final inspection shall receive full deduction of its unit bid price from the payment.

The Department will consider payment as full compensation for all work required under this section.

SECTION 725 — CRASH CUSHIONS

725.01 DESCRIPTION. Furnish and install crash cushion systems of the designated types and configurations at the locations shown on the Plans, and furnish replacement items in quantities designated on the Plans. Install each type of crash cushion according to the Standard Drawings and according to the manufacturer's instructions.

725.02 MATERIALS. Conform to the most current specifications and details recommended by the manufacturer of the crash cushion designated for use, except as otherwise specified herein.

725.02.01 Type VI Class B & BT. Furnish approved Type VI Class B & BT crash cushion that conforms to Standard Drawings.

725.02.02 Type VI Class C & CT. Furnish approved Type VI Class C & CT crash cushion that conforms to Standard Drawings.

725.02.03 Type VII Class B. Furnish approved Type VII Class B crash cushion that conforms to Standard Drawings.

725.02.04 Type VII Class C. Furnish approved Type VII Class C crash cushion that conforms to Standard Drawings.

725.02.05 Type VIII. Furnish a TMA that has been successfully crash tested in accordance with NCHRP 350 or be Manual for Assessing Safety Hardware (MASH) certified at the appropriate test level for the project's posted speed limit. For all miscellaneous metal work conform to ASTM A 36 and hot-dip galvanize according to ASTM A 123.

725.02.06 Type IX. Furnish approved Type IX crash cushion that conforms to Standard Drawings. Connect to a wall, pier, or other fixed object. For all miscellaneous metal work conform to ASTM A 36 and hot-dip galvanize according to ASTM A 123.

725.02.07 Type IX-A. Furnish approved Type IX-A crash cushion that **c**onforms to Standard Drawings. Connect to guardrail. For all miscellaneous metal work conform to ASTM A 36 and hot-dip galvanize according to ASTM A 123.

The Department may allow a higher crash cushion class type to be used in lieu of a lower class type of cushion that is specified in the Contract.

725.02.08 Concrete. Furnish AA concrete conforming to Section 601.

725.03 CONSTRUCTION. Submit to the Engineer for approval installation drawings that accurately depict all details necessary for completing the installation. Do not start work until the Engineer approves the drawings. Furnish to the Engineer items such as manufacturer's brochures or specifications that completely outline the crash cushion manufacturer's current recommendations for materials and installation methods before beginning installation. All workmanship and materials are subject to the Engineer's approval.

Furnish and install Type 1 object markers according to the Plans and Standard Drawings.

The Department may specify various components of the system on the plans or in the proposal as replacement elements. Furnish the specified quantity of replacement elements and deliver to the storage area designated in the proposal or by the Engineer.

725.03.01 Type VI Class B & C and VII Class B & C. Install at the locations shown on the Plans or where the Engineer directs. Construct a concrete pad when the

Contract requires or when the Engineer directs. Construct the pad according to Section 501 for rigid pavement or Section 505 for sidewalk, except use Class AA concrete.

725.03.02 Type VI Class BT & CT. Type VI Class BT & CT are temporary crash cushions at the end of temporary concrete barriers. Install at the locations shown on the Plans or where the Engineer directs, and connect to the temporary concrete barrier according to the Plans or Standard Drawings.

Construct a concrete pad when the Contract requires or when the Engineer directs. Construct the pad according to Section 501 for rigid pavement or Section 505 for sidewalk, except use Class AA concrete.

The Plans or the Engineer may require a Crash Cushion Type VI Class BT or CT to be used at more than one location on the project. When required, relocate the crash cushion at the time and in the sequence designated by the plans or by the Engineer.

Maintain and keep operative each Crash Cushion Type VI Class BT or CT until its usefulness has ended. Stock at all times the necessary materials to repair a damaged crash cushion. Repair damaged crash cushion as soon as practical, not to exceed 24 hours, after the damage occurs.

After the usefulness of each Crash Cushion Type VI Class BT or CT has ended, dismantle and store on the right-of-way at a site the Engineer approves. Previous KYTC approved NCHRP Report 350 or Manual for Assessing Safety Hardware (MASH) certified crash cushions can continue to be used in temporary locations only, until the end of their normal service life.

725.03.03 Type VIII. Mount on a truck of the size, and in a manner, recommended by the crash cushion manufacturer. During the course of the work, deploy, operate, and maintain the truck-mounted crash cushion at locations the Engineer directs. Stock enough cells to restore one crash cushion after one impact, and repair all damaged crash cushions as soon as practicable after damage occurs. After its usefulness has ended, remove the crash cushion from the truck and store the crash cushion together with mounting hardware on the right-of-way at a site the Engineer approves. The crash cushion and mounting hardware will become the property of the Department. The Department will not take ownership of the truck.

725.03.04 Type IX, and IX-A. Install at the locations shown on the Plans or where the Engineer directs.

725.04 MEASUREMENT.

725.04.01 Crash Cushion Types VI Class B & C, VII Class B & C, IX, and IX-A. The Department will measure the quantity by each individual unit. When the plans or proposal specifies that the crash cushion is to be used in a temporary manner, the Department will measure as specified for Crash Cushion Type VI Class BT & CT.

The Department will not measure the work necessary to anchor Crash Cushion Types VI Class B & C, VI Class BT & CT and VII Class B & C to existing pavement or bridge decks for payment and will consider it incidental to the crash cushion.

725.04.02 Crash Cushion, Type VI Class BT & CT. The Department will measure the quantity of Crash Cushion Type VI Class BT & CT units furnished, installed, dismantled, and stored on the right-of-way.

The Department will not measure furnishing and installing the W-beam to crash cushion connectors; furnishing and installing rear unit plates and front unit plates; work or materials necessary to repair damaged crash cushions; materials kept in stock or used to repair damaged crash cushions; or dismantling the units and storing them on the right-of-way for payment and the Department will consider them incidental to the crash cushion.

725.04.03 Relocate Crash Cushion. The Department will measure the quantity by each unit and will consider it to include the unit's removal and re-installation at a different location.

725.04.04 Crash Cushion, Type VIII. The Department will measure the quantity by each unit and will consider it to include furnishing, deploying, operating, maintaining, and storing on the right-of-way.

725.04.05 Crash Cushion Replacement Elements. The Department will measure the quantity by the lump sum and will consider it to include all replacement elements the Contract specifies and their delivery to the designated storage area.

725.04.06 Concrete, Class AA (for pads). The Department will measure the quantity used for Crash Cushion Type VII in cubic yards. The Department will not measure excavation or steel reinforcement for payment and will consider it incidental to the Class AA Concrete.

The Department will not measure the quantity for payment when used for Crash Cushion Type VI or VI-T and will consider it incidental to the crash cushion bid item.

725.05 PAYMENT. The Department will make payment for the completed and accepted quantities under the following:

Code	Pay Item	Pay Unit
08900-08908	Crash Cushion, Type	Each
02898	Relocate Crash Cushion	Each
02892	Crash Cushion Replacement Elements	Lump Sum
08104	Concrete, Class AA	Cubic Yard

The Department will consider payment as full compensation for all work required in this provision.

SECTION 726 — RIGHT OF WAY MONUMENTS

726.01 DESCRIPTION. Furnish and install right-of-way monuments at the location and with the type shown on the plans.

726.02 MATERIALS. Furnish Aluminum Alloy monuments specified on the Standard Drawing.

726.03 CONSTRUCTION. Install right-of-way monuments at the earliest opportunity on a project as determined by the Engineer. Install right-of-way monuments under the direct supervision of a Kentucky Licensed Professional Land Surveyor.

Establish right-of-way monuments from existing Primary or Supplemental control monuments with an accuracy of 1:15,000 or greater.

Place right-of-way monument information on a Control Monument Information Sheet (Exhibit 300-08 of the Highway Design Manual) provided by the Department. Place the completed Control Monument Information Sheet in a final survey report. Completely fill out the Control Monument Information Sheet, including the signature and registration number of the Kentucky Licensed Professional Land Surveyor in charge of the monumentation. Submit the Final Survey Report to the KYTC Survey Coordinator in the Division of Highway Design and the Engineer.

Reset all monuments disturbed or destroyed during or prior to construction, with the same accuracy as stated previously. Update the Control Monument Information Sheet with any new data and include in the Final Survey Report. Ensure the Kentucky Licensed Professional Land Surveyor in charge of the re-monumentation signs and places his registration number on the updated Control Monument Information Sheet. Submit the updated Final Survey Report to the KYTC Survey Coordinator in the Division of Highway Design, the Engineer, and the Kentucky Licensed Professional Land Surveyor who set the original monuments.

Right-of-way monuments that cannot be established at the planned location due to inaccessibility should be witnessed by a witness right-of-way monument on both lines and labeled as such (see Standard Drawing).

Use a 6-foot long orange witness post to aid in locating right-of-way monuments. Set the witness post within the public right-of-way and within one foot of the monument location. Label the witness post to denote that the point is KYTC right-of-way (See Standard Drawing).

726.04 MEASUREMENT. The Department will measure the quantity by each individual unit.

726.05 PAYMENT. The Department will make payment for the completed and accepted quantities under the following:

Code	Pay Item	Pay Unit
02429	Right-of-Way Monument, Type 1	Each
02430	Right-of-Way Monument, Type 1A	Each
02431	Witness R/W Monument Type 2	Each
02432	Witness Post	Each

The Department will consider payment as full compensation for all work required in this provision.