

**ITEM 611 PIPE CULVERTS, SEWERS, DRAINS,  
AND DRAINAGE STRUCTURES**

**611.01 Description.** This work consists of constructing conduits, and constructing and reconstructing drainage structures. This work also includes preparing installation plans, performing inspections, and providing reports and other required documentation.

**611.02 Materials.** Furnish conduit material of the specified conduit type and conduit size or one size larger with the approval of the Engineer. Conduit shown in the plans is designed for hydraulic capacity and the Material Durability Design. Provide conduit materials with Bedding and Structural Backfill materials that meet the structural design requirements of Supplement 1086 for each conduit run. Provide drainage structure materials with Bedding and Structural Backfill materials that will perform structurally for each location. Provide material descriptions and installation procedure details in the Installation Plans. Different conduit and drainage structure materials and the associated Bedding and Backfill may require varying installation procedures. If the conduit material is not specified in the plans, all material for that type of conduit will meet the Material Durability Design.

The Contractor may furnish concrete or plastic pipe of the same type with greater strength than specified. The Contractor may furnish metal pipe with a greater thickness than specified, so long as the pipe has the same corrugation profile and is the same type.

**A. Type A Conduit – Culverts**

Non-reinforced concrete pipe, Class 3 .....	<a href="#">706.01</a>
Reinforced concrete circular pipe .....	<a href="#">706.02</a>
Reinforced concrete pipe, epoxy coated .....	<a href="#">706.03</a>
Reinforced concrete elliptical pipe .....	<a href="#">706.04</a>
Precast reinforced concrete box sections.....	<a href="#">706.05</a>
Precast reinforced concrete 3-sided flat topped culverts .....	<a href="#">706.051</a>
Precast reinforced concrete arch sections.....	<a href="#">706.052</a>
Precast reinforced concrete round sections .....	<a href="#">706.053</a>
Vitrified clay pipe (extra strength only).....	<a href="#">706.08</a>
Corrugated steel conduits .....	<a href="#">707.01</a> or <a href="#">707.02</a>
Structural plate corrugated steel structures.....	<a href="#">707.03</a>
Precoated, galvanized steel culverts.....	<a href="#">707.04</a>
Bituminous coated corrugated steel pipe and pipe arches with paved invert.....	<a href="#">707.05</a> Type B or <a href="#">707.07</a> Type B
Corrugated steel box culverts .....	<a href="#">707.15</a>
Polymer Precoated, Galvanized Steel Conduits with precoated galvanized smooth interior liner.....	<a href="#">707.18</a>
Aluminum coated Steel Conduits with precoated galvanized smooth steel interior liner.....	<a href="#">707.19</a>
Galvanized Coated Steel Conduits with precoated galvanized smooth steel interior liner.....	<a href="#">707.20</a>
Corrugated aluminum alloy pipe .....	<a href="#">707.21</a> or <a href="#">707.22</a>
Aluminum alloy structural plate conduits .....	<a href="#">707.23</a>
Corrugated aluminum box culverts.....	<a href="#">707.25</a>

Corrugated polyethylene smooth lined pipe.....	<a href="#">707.33</a>
Polyethylene Plastic Pipe Based on Outside Diameter	
(OD).....	<a href="#">707.34</a>
Polyethylene Profile Wall Pipe.....	<a href="#">707.35</a>
Corrugated Polypropylene Smooth Lined Pipe .....	<a href="#">707.65</a>
Polypropylene Corrugated Triple Wall Pipe .....	<a href="#">707.69</a>
Glass-fiber-reinforced polymer mortar pipe.....	<a href="#">707.75</a>
Steel reinforced thermoplastic ribbed pipe.....	<a href="#">SS 938</a>

**B. Type B Conduit** – Storm or sanitary sewers under pavement

Non-reinforced concrete pipe, Class 3 .....	<a href="#">706.01</a>
Reinforced concrete circular pipe .....	<a href="#">706.02</a>
Reinforced concrete elliptical pipe .....	<a href="#">706.04</a>
Precast reinforced concrete box sections.....	<a href="#">706.05</a>
Vitrified clay pipe (extra strength only).....	<a href="#">706.08</a>
Polymer-precoated corrugated steel spiral rib pipe .....	<a href="#">707.11</a>
Bituminous lined corrugated steel pipe.....	<a href="#">707.13</a> or <a href="#">707.14</a>
Polymer Precoated, Galvanized Steel Conduits	
with precoated galvanized smooth	
interior liner.....	<a href="#">707.18</a>
Aluminum coated Steel Conduits with	
precoated galvanized smooth steel	
interior liner.....	<a href="#">707.19</a>
Galvanized Coated Steel Conduits with	
precoated galvanized smooth steel	
interior liner.....	<a href="#">707.20</a>
Corrugated aluminum spiral rib pipe .....	<a href="#">707.24</a>
Corrugated polyethylene smooth lined pipe.....	<a href="#">707.33</a>
Polyethylene Plastic Pipe Based on Outside Diameter	
(OD).....	<a href="#">707.34</a>
Polyethylene Profile Wall Pipe.....	<a href="#">707.35</a>
Polyvinyl chloride corrugated smooth interior pipe .....	<a href="#">707.42</a>
Polyvinyl chloride profile wall pipe.....	<a href="#">707.43</a>
Polyvinyl chloride solid wall pipe .....	<a href="#">707.45</a>
Polyvinyl chloride drain waste and vent pipe.....	<a href="#">707.46</a>
Polyvinyl chloride ABS composite pipe .....	<a href="#">707.47</a>
Polyvinyl chloride large-diameter solid wall pipe.....	<a href="#">707.48</a>
ABS drain waste and vent pipe.....	<a href="#">707.51</a>
Corrugated Polypropylene Smooth Lined pipe .....	<a href="#">707.65</a>
Polypropylene triple wall pipe.....	<a href="#">707.69</a>
Glass-fiber-reinforced polymer mortar pipe.....	<a href="#">707.75</a>
Steel reinforced thermoplastic ribbed pipe.....	<a href="#">SS 938</a>
Ductile iron pipe (sanitary).....	<a href="#">748.01</a>
Polyvinyl chloride pipe (sanitary).....	<a href="#">748.02</a>

**C. Type C Conduit** – Storm or sanitary sewers not under pavement

Non-reinforced concrete circular pipe .....	<a href="#">706.01</a>
Reinforced concrete pipe.....	<a href="#">706.02</a>
Reinforced concrete elliptical pipe .....	<a href="#">706.04</a>
Precast reinforced concrete box sections.....	<a href="#">706.05</a>
Vitrified clay pipe (extra strength only).....	<a href="#">706.08</a>
Polymer-precoated corrugated steel spiral rib pipe .....	<a href="#">707.11</a>
Bituminous lined corrugated steel pipe.....	<a href="#">707.13</a> or <a href="#">707.14</a>
Polymer Precoated, Galvanized Steel Conduits with precoated galvanized smooth interior liner.....	<a href="#">707.18</a>
Aluminum coated Steel Conduits with precoated galvanized smooth steel interior liner.....	<a href="#">707.19</a>
Galvanized Coated Steel Conduits with precoated galvanized smooth steel interior liner.....	<a href="#">707.20</a>
Corrugated aluminum spiral rib pipe .....	<a href="#">707.24</a>
Corrugated polyethylene smooth lined pipe.....	<a href="#">707.33</a>
Polyethylene Plastic Pipe Based on Outside Diameter (OD).....	<a href="#">707.34</a>
Polyethylene Profile Wall Pipe.....	<a href="#">707.35</a>
Polyvinyl chloride corrugated smooth interior pipe .....	<a href="#">707.42</a>
Polyvinyl chloride profile wall pipe.....	<a href="#">707.43</a>
Polyvinyl chloride solid wall pipe .....	<a href="#">707.45</a>
Polyvinyl chloride drain waste and vent pipe.....	<a href="#">707.46</a>
Polyvinyl chloride ABS composite pipe .....	<a href="#">707.47</a>
Polyvinyl chloride large-diameter solid wall pipe.....	<a href="#">707.48</a>
ABS drain waste and vent pipe.....	<a href="#">707.51</a>
Corrugated Polypropylene Smooth Lined pipe .....	<a href="#">707.65</a>
Polypropylene triple wall pipe.....	<a href="#">707.69</a>
Glass-fiber-reinforced polymer mortar pipe.....	<a href="#">707.75</a>
Steel reinforced thermoplastic ribbed pipe.....	<a href="#">SS 938</a>
Ductile iron pipe (sanitary).....	<a href="#">748.01</a>
Polyvinyl chloride pipe (sanitary).....	<a href="#">748.02</a>

**D. Type D Conduit** – Drive pipes and bikeways

Non-reinforced concrete pipe, Class 3 .....	<a href="#">706.01</a>
Reinforced concrete circular pipe .....	<a href="#">706.02</a>
Reinforced concrete elliptical pipe .....	<a href="#">706.04</a>
Vitrified clay pipe (extra strength only).....	<a href="#">706.08</a>
Corrugated steel conduits .....	<a href="#">707.01</a> or <a href="#">707.02</a>
Structural plate corrugated steel structures.....	<a href="#">707.03</a>
Corrugated aluminum alloy pipe .....	<a href="#">707.21</a> or <a href="#">707.22</a>
Aluminum alloy structural plate conduits .....	<a href="#">707.23</a>
Corrugated polyethylene smooth lined pipe.....	<a href="#">707.33</a>
Polyvinyl chloride corrugated smooth interior pipe .....	<a href="#">707.42</a>

Polyvinyl chloride profile wall pipe.....	<a href="#">707.43</a>
Polyvinyl chloride solid wall pipe .....	<a href="#">707.45</a>
Polyvinyl chloride large-diameter solid wall pipe .....	<a href="#">707.48</a>
Polypropylene corrugated single wall pipe .....	<a href="#">707.62</a>

**E. Type E Conduit** – Miscellaneous small drain connections and headers

Non-reinforced concrete pipe .....	<a href="#">706.01</a>
Reinforced concrete circular pipe .....	<a href="#">706.02</a>
Reinforced concrete elliptical pipe .....	<a href="#">706.04</a>
Concrete drain tile, extra quality.....	<a href="#">706.07</a>
Vitrified clay pipe (extra strength only) .....	<a href="#">706.08</a>
Clay drain tile, extra quality .....	<a href="#">706.09</a>
Corrugated steel conduit.....	<a href="#">707.01</a> or <a href="#">707.02</a>
Corrugated aluminum alloy pipe .....	<a href="#">707.21</a> or <a href="#">707.22</a>
Corrugated polyethylene drainage pipe.....	<a href="#">707.32</a>
Corrugated polyethylene smooth lined pipe .....	<a href="#">707.33</a>
Smooth-wall polyvinyl chloride underdrain pipe (non-perforated).....	<a href="#">707.41</a>
Polyvinyl chloride corrugated smooth interior pipe .....	<a href="#">707.42</a>
Polyvinyl chloride profile wall pipe.....	<a href="#">707.43</a>
Polyvinyl chloride solid wall pipe .....	<a href="#">707.45</a>
Polyvinyl chloride drain waste and vent pipe.....	<a href="#">707.46</a>
Polyvinyl chloride ABS composite pipe .....	<a href="#">707.47</a>
Polyvinyl chloride large-diameter solid wall pipe .....	<a href="#">707.48</a>
ABS drain waste and vent pipe.....	<a href="#">707.51</a>

**F. Type F Conduit** – Conduit on steep slopes; underdrain outlets

Corrugated steel conduits (steep slope conduit) .....	<a href="#">707.05</a> Type C or <a href="#">707.07</a>
Corrugated aluminum alloy pipe (steep slope conduit) .....	<a href="#">707.21</a> or <a href="#">707.22</a>
Corrugated polyethylene smooth lined pipe (underdrain outlets) .....	<a href="#">707.33</a>
Smooth-wall polyvinyl chloride underdrain pipe (non-perforated underdrain outlets).....	<a href="#">707.41</a>
Polyvinyl chloride corrugated smooth interior pipe (underdrain outlets) .....	<a href="#">707.42</a>
Polyvinyl chloride solid wall pipe (underdrain outlets).....	<a href="#">707.45</a>

**G. For constructing or reconstructing drainage structures, furnish materials conforming to:**

Concrete, Class QC1 .....	<a href="#">511</a> , <a href="#">499</a>
Brick and masonry units.....	<a href="#">704</a>
Precast reinforced concrete manhole, catch basin, and inlet sections .....	<a href="#">706.13</a>
Precast reinforced concrete outlet.....	<a href="#">706.15</a>
Prefomed expansion joint filler .....	<a href="#">705.03</a>

Epoxy coated reinforcing steel .....	<a href="#">709.00</a>
Cast frames, grates, and covers.....	<a href="#">711.12</a> , <a href="#">711.13</a> , or <a href="#">711.14</a>
Welded frames and grates .....	<a href="#">711.01</a> and <a href="#">513.17</a>
Steps .....	<a href="#">711.13</a> , <a href="#">711.30</a> , or <a href="#">711.31</a>
Resilient and flexible gasket joints .....	<a href="#">706.11</a>
Curing materials.....	<a href="#">705.05</a> , <a href="#">705.07</a>
Curing membrane for inlets.....	<a href="#">705.07</a> , Type 1 or 1-D
Mortar.....	<a href="#">602</a>
Nonshrink mortar.....	<a href="#">705.22</a>

**H.** For bedding and backfill, furnish materials conforming to:

Bedding .....	<a href="#">613</a> , <a href="#">703.11</a>
Structural Backfill .....	<a href="#">613</a> , <a href="#">703.11</a>
Final Backfill:	
Granular Structural Backfill .....	<a href="#">703.11</a>
Natural Soils .....	<a href="#">703.16.A</a> <sup>[1]</sup>
Granular Embankment Materials .....	<a href="#">703.16.B</a> <sup>[1]</sup>
Granular Embankment Material	
Types A, B, C and D.....	<a href="#">703.16.C</a> <sup>[1]</sup>
Coarse aggregate .....	<a href="#">Table 703.01-1</a>
Fine aggregate .....	<a href="#">703.02.A</a> , <a href="#">703.03</a> , or <a href="#">703.05.A</a>
<a href="#">304</a> .....	<a href="#">703.17.A</a>
<a href="#">410</a> , <a href="#">411</a> , and <a href="#">617</a> .....	<a href="#">703.18.A</a> <sup>[1]</sup>
Low Strength Mortar Backfill (LSM).....	<a href="#">613</a>

[1] Use any type of material defined as suitable materials for embankment construction except for steel slag, PCS and RAP.

**I.** For concrete collars and encasement, furnish materials conforming to:

Concrete, Class QC 1 .....	<a href="#">511</a> , <a href="#">499</a>
Reinforcing steel .....	<a href="#">509.02</a>

**J.** For field paving of conduit inverts, furnish materials conforming to:

Concrete, Class QC 5, QC Misc .....	<a href="#">511</a> , <a href="#">499</a>
Coarse aggregate, size No. 7, 8, or 78.....	<a href="#">703.02</a>
Galvanized welded wire fabric .....	<a href="#">709.08</a>

For material in items not specified above, furnish materials conforming to:

Mortar.....	<a href="#">602</a>
Nonshrink mortar.....	<a href="#">705.22</a>
Concrete Sealers.....	<a href="#">705.23</a>
Bituminous pipe joint filler .....	<a href="#">706.10</a>
Resilient and flexible gasket joints for:	
Concrete pipe.....	<a href="#">706.11</a>
Vitrified clay pipe.....	<a href="#">706.12</a>
Preformed flexible joint sealant.....	<a href="#">706.14</a>
Type 2 membrane waterproofing.....	<a href="#">711.25</a>
Type 3 membrane waterproofing.....	<a href="#">711.29</a>
Geotextile Fabric.....	<a href="#">712.09</a> , Type A

Joint wrap ..... [ASTM C 877](#), Type III  
Buried liner waterproofing membrane ..... [711.22](#)

For Class QC1 concrete, provide batch plant tickets according to [499.07](#).

If a precast reinforced concrete box culvert ([706.05](#)) is specified, the Engineer may allow the Contractor to substitute either a precast reinforced concrete 3-sided flat topped culvert, a precast reinforced concrete arch culvert, or a precast reinforced concrete round section ([706.051](#), [706.052](#), or [706.053](#)). If a [706.051](#), [706.052](#), or [706.053](#) is specified, the Engineer may allow the Contractor to substitute one for the other. Refer to [611.04](#) for submittal requirements.

If bituminous coated corrugated steel pipe or pipe arch with paved invert ([707.05](#) or [707.07](#)) is specified, the Contractor may furnish conduit with a coating conforming to [707.04](#).

**611.03 Definitions.** The following terms, when used in this specification, are defined as follows:

**Backfill.** Material used to fill the trench or excavation, further defined as Structural Backfill and Final Backfill, not including the bedding material.

**Bed.** The bottom of the trench or excavation.

**Bedding Material.** Material placed above the bed and below the conduit or drainage structure.

**Conduit.** Includes pipe, culverts, sewers, and drains. Conduits are classified as Type A, B C, D, E, and F.

**Conduit Rise.** The distance of the greatest vertical opening of the conduit. For round conduits, the conduit rise equals the conduit diameter.

**Corrugated Metal Conduit.** Includes all conduit made from corrugated steel or corrugated aluminum. Either material may also have coatings. This includes all of the following types of materials: [707.01](#), [707.02](#), [707.03](#), [707.04](#), [707.05](#), [707.07](#), [707.11](#), [707.12](#), [707.13](#), [707.14](#), [707.15](#), [707.17](#), [707.21](#), [707.22](#), [707.23](#), [707.24](#), and [707.25](#).

**Cut.** A situation where the top of the conduit is below the existing ground surface or where a proposed embankment is constructed at least 2 feet (0.6 m) above the top of the conduit before installation.

**Deflection.** Uniform or symmetrical flattening or ovalization of the pipe's cross-section.

**Design Service Life.** The average usable life of a conduit or structure.

**Drainage Structures.** Manholes, catch basins, inlets, inspection wells, junction chambers, and precast reinforced concrete outlets.

**Fill.** A situation where the top of the conduit is above the existing ground surface in an area where an embankment will be constructed.

**Final Backfill.** Material used to fill the trench or excavation above the Structural Backfill.

**Flexible Conduit.** Plastic, corrugated metal, ductile iron ([748.01](#)), or steel casing pipe ([748.06](#)).

**Infiltration.** Water or other material that enters the conduit or drainage structure through the joints or conduit connections in excess of the limits for soil tightness or for the type of joint specified.

**Lay Length.** The length of a standard section of pipe as normally supplied by the manufacturer.

**Material Durability Design.** Empirical design method used to ensure a 75-year average service life due to conduit material degradation caused by water chemistry and suspended material abrasion.

**Plastic Conduit.** Corrugated polyethylene, polyvinyl chloride, or ABS conduit. This includes all of the following types of materials: [707.32](#), [707.33](#), [707.41](#), [707.42](#), [707.43](#), 707.44, [707.45](#), [707.46](#), [707.47](#), [707.51](#), [707.62](#), [707.65](#), [707.69](#), [SS 938](#), and [748.02](#).

**Racking.** Non-symmetrical deflection or ovalization of a pipe's cross-section.

**Rigid Conduit.** Concrete pipe, vitrified clay pipe, or clay drain tile. This includes all of the following types of materials: [706.01](#), [706.02](#), [706.03](#), [706.04](#), [706.05](#), [706.051](#), [706.052](#), [706.053](#), [706.08](#), and [706.09](#).

**Run of Conduit.** The conduit placed between drainage structures, between a drainage structure and an open outlet, between an open inlet and a drainage structure, or between the open inlet and open outlet.

**Span.** Span is the conduit opening measured along the centerline of the roadway. Multiple cell openings are considered one span if the clear distance between the openings is less than half of the smaller contiguous opening.

**Spring Line.** A line along the length of the pipe at its maximum span. For circular pipes the spring line is located at mid-height of the pipe (rise divided by two).

**Structural Backfill.** Material adjacent to the conduit used to fill the trench from the top of Bedding Material to 12-inches above the top of conduit or greater as required by the manufacturer. For drainage structures, material used to fill the trench from the top of Bedding Material to subgrade in pavement or topsoil in vegetated areas.

#### **611.04 Submittals**

**A. Shop Drawings.** Prepare and submit shop drawings for C&MS items [706.051](#), [706.052](#), [706.053](#). Submit calculations for C&MS items [706.051](#), [706.052](#), [706.053](#) and all conduit materials as required below. Have competent individuals prepare and check the shop drawings and required calculations. Provide a cover sheet containing the preparer(s) and checker(s): First Name, Last Name, Initials and Content Responsibility. Preparer(s) and checker(s) shall initial each sheet for their content responsibility. The preparer(s) and checker(s) shall not be the same individual. Have an Ohio Registered Engineer review, approve, sign, seal and date the shop drawing cover sheet or submittal letter and hydraulic calculations according to [ORC 4733](#) and [OAC 4733-35](#).

1. Submit load rating report in accordance to the most current version of [ODOT's Bridge Design Manual](#) along with one copy of the shop drawings and one copy of the calculations to the Office of Structural Engineering for all structures with a 10 foot or larger span. Submit an additional copy of the shop drawings and calculations to the Engineer.

2. If Reinforced Concrete Circular Pipe, [706.02](#), requires a "Special Design" with a specified D-load requirement other than Tables [706.02-1](#) through [706.02-4](#), submit special structural design calculations. Design the pipe to meet the D-load requirements. Include the following information in the submittal: all structural design and loading information, all material specifications, all dimensions, and the installation plan.

3. Submittals for Precast reinforced concrete 3-sided flat topped culverts, precast reinforced concrete arch sections, or precast reinforced concrete round sections, ([706.051](#), [706.052](#), or [706.053](#)) shall include structural analysis methods, structural design criteria and calculations, structure details, and shop drawings. Include details for a precast slab bottom if required.

4. To substitute a precast reinforced concrete 3-sided flat topped culvert ([706.051](#)), a reinforced concrete arch section ([706.052](#)), or a precast reinforced concrete round section ([706.053](#)) for one another, the submittal shall include hydraulic calculations. The proposed culvert shall meet or exceed

the same hydraulic requirements as the specified culvert and minimum cover requirements. If the specified culvert is on pedestal walls, include the shop drawings for the pedestal wall design in the submittal because 3-sided flat topped culverts, arch culverts, and round sections require different pedestal wall designs.

5. To substitute either a precast reinforced concrete 3-sided flat topped culvert, a precast reinforced concrete arch section, or a precast reinforced concrete round section ([706.051](#), [706.052](#), or [706.053](#)) placed on a precast or cast-in-place slab bottom for a precast reinforced concrete box culvert ([706.05](#)), the submittal shall include hydraulic calculations. The proposed culvert shall meet or exceed the same hydraulic requirements as the specified box culvert and minimum cover requirements. The Department may allow the bottom slab to be cast-in-place but will not issue a time extension for any delays resulting from the use of a cast-in-place bottom slab.

Department approval of shop drawings and calculations is not required.

**B. Installation Plan.** Submit a written installation plan to the Engineer for installing all conduit and drainage structures for review and acceptance.

Submit the installation plan at least 15 days before any conduit or drainage structure work begins.

Do not perform work without an accepted installation plan.

Include the following required information for each conduit run:

1. Completed [CA-P-1A](#) Conduit Installation Plan Form dated 07-16-21.

2. Trench and excavation cross-sections with dimensions.

3. Bedding and Backfill material types with compaction density or compacted depth.

4. Plan and allowed buried height of cover.

5. Other installation details as necessary.

6. Provide written confirmation from the conduit manufacturer that the conduit material with the Bedding and Backfill types and compaction as described in the [CA-P-1A](#) Installation Plan Form will perform structurally for the location. This confirmation by the conduit manufacturer will not relieve the Contractor of the responsibility for obtaining the required results.

Include the following required information for each drainage structure:

1. Completed [CA-P-3A](#) Drainage Structure Installation Plan Form dated 07-16-21.

2. Trench and excavation cross-sections with dimensions.

3. Bedding and Backfill material types with compaction density or compacted depth.

4. Other installation details as necessary.

Submit any deviations from the installation plan prior to commencing with the Work. Resubmit all installation plan revisions and applicable special structural design calculations to the Engineer within 14 days of the change with the conduit manufacturer's written confirmation as described above. Do not perform conduit or drainage structure Work without an updated, manufacturer signed and accepted installation plan.

For structural plate and metal pipe arch conduit with a span of 57 inches (1440 mm) or larger, ensure the manufacturer provides match-marked ends on the conduit. Include a layout drawing in the installation plan.

For metal conduit with two structural plate thicknesses specified, identify the location of the thicker plates. For precast concrete 3-sided flat and arch topped structures ([706.051](#) and [706.052](#)) provide a 3 inch (75 mm) deep keyway centered on the leg and at least 6 inches (150 mm) wider than



the thickness of the leg at the bottom. For precast concrete round sections ([706.053](#)) provide an 8 inch (200 mm) deep keyway for spans up to 24 feet (7.3 m) and a 10 inch (254 mm) deep keyway for spans greater than 24 feet, (7.3 m). Center the keyway on the precast arch base. The width of the keyway must be 8 inches (200 mm) greater than the thickness of the precast arch base. For non-vertical leg arches set on pedestal walls, a one sided keyway is acceptable if the required pedestal wall design thickness is not sufficient for a full keyway.

**C. Construction Inspection Forms.** Perform work so that it can be verified by the Contractor's representative performing the inspection. Notify the Engineer in writing at least 14 days prior to beginning the work. Submit construction inspection forms to the Engineer for each run of conduit and each drainage structure. Use construction inspection form [CA-P-1](#) for conduit and use construction inspection form [CA-P-3](#) for drainage structures. Inspection form [CA-P-3](#) is not required for precast reinforced concrete outlet structures [706.15](#). Ensure that all deviations from the installation plan are noted on the construction inspection form. Ensure that the information on the construction inspection form is complete and accurate and that the form is signed by a representative of the Contractor certifying that the information on the form is accurate. The Contractor's representative must make the following statement on the form:

"I certify that the information on this form is accurate and all deviations from the current installation plan have been noted."

Submit each day's construction inspection forms before the start of the next work day. If the Engineer gives notice that the information on the form is incomplete or not accurate, do not continue related work until complete and accurate forms are submitted and accepted by the Engineer.

Construction inspection forms [CA-P-1](#) and [CA-P-3](#) require trench and bedding measurement checks to be taken every 50 feet with a minimum of two per run. Record measurements to the nearest 0.1 foot (30 mm). If these measurements are not taken, do not continue related work until the Contractor submits a plan in writing to the Engineer for approval that explains how these measurements will be determined.

**D. Performance Report.** Provide a performance report for each performance inspection. Include the following in each performance report:

1. Project number and County-Route-Section.
2. Date of performance inspection.
3. Type and size of conduit.
4. Time of video recording.
5. Location (e.g. station and offset) and viewing direction.
6. Summary of all defects including type, measurement, and location.
7. For remote inspections using a mandrel, indicate in the performance report, the size of the mandrel and how it was calculated. Document all locations where the mandrel was unable to advance through the conduit.
8. For remote inspections using a crawler mounted camera with laser profiler, include:
  - a. Three dimensional model of the conduit based on the laser profile measurements.
  - b. Digital profile of conduit extracted from the inspection video.
  - c. Calculations of the ovality, capacity and delta of the conduit
  - d. Explanation as to why data was unattainable for any section of the conduit.

## 9. Conduit Evaluation

Submit a performance report to the Engineer within 14 days of completing the performance inspection of the conduit run or drainage structure. Submit the performance report in a digital format that allows the Department to make additional copies.

**611.05 Excavation.** Excavate as described in the installation plan. Record any deviations from the installation plan on the construction inspection forms and revise the installation plan.

Excavate trenches along the centerline of the conduit. When installing conduit in a fill situation, construct the embankment to the elevation of the spring line for the conduit or higher before excavating the trench.

Provide a firm bed for the full width and length of the trench for conduits and drainage structures. Remove any unsuitable material exposed in the bed for the width of the trench and a depth of at least 6 inches (150 mm). Replace the unsuitable material with structural backfill, Type 1 or 2. Remove any rock or shale exposed in the bed to a depth of at least 6 inches (150 mm). Replace the rock or shale with **Structural Backfill**, Type 1 or 2. The Department will pay for this work according to [109.05](#), unless otherwise noted in the Contract Documents. If the Engineer changes the flow line by more than one foot (0.3 m), the Department will pay according to [109.05](#), unless otherwise noted in the Contract Documents.

**611.06 Bedding and Backfill.** Place and compact bedding and backfill as described in the installation plan. Record any deviations from the installation plan on the construction inspection forms and revise the installation plan.

Place geotextile fabric, Type A above coarse aggregate backfill for the full width of the trench. For installations where groundwater is probable, wrap coarse aggregate bedding and backfill with geotextile fabric to the elevation or above the elevation of the the groundwater. Shape the bedding with recesses to receive the bell of bell-and-spigot conduit. Loosen the bedding in the middle third to seat the conduit. If using LSM for bedding, also use LSM for backfill to at least 6 inches (150 mm) over the top of the conduit. Install bedding and backfill for Type F conduits for underdrain outlets according to [605.03.C](#). Conduit Manufacturers may approve materials listed in [611.02](#) for Final Backfill for use as Bedding and Structural Backfill for Type F conduits on slopes 3:1 or greater. Conduit Manufacturers may approve materials listed in [611.02](#) for Final Backfill for use as Structural Backfill for conduit Types D and E and drainage structures not located in pavement. Identify the use of Final Backfill materials proposed for Bedding and Structural Backfill in the Installation Plan and cross-section details.

Vibrate, tamp or compact each Bedding and Backfill lift. Perform compaction density testing of Bedding and Backfill according to [Supplement 1015](#). If Structural Backfill Type 3 or open graded material is used, place the aggregate in lifts not to exceed 12-inches. Measure the Structural Backfill Type 3 compacted lift to ensure consolidation is 85 percent or more of the original lift thickness.

Final Backfill shall meet or exceed the requirements of [203](#).

**611.07 Laying Conduit.** Maintain flows and drainage at all times until the new facilities are completed and in service. Any planned temporary diversion of flows and drainage is the responsibility of the Contractor. Maintain temporary diversion at no additional cost to the Department.

Visually inspect all conduit before it is placed in the trench. Replace all conduit that is damaged as determined by the Engineer. Before installation, measure and record on the [CA-P-1](#) the widest inside dimension of each lay length of conduit. This measurement is to be taken three times along each run of conduit. For corrugated metal conduit measure to the inside peak of the corrugations.

Lay the conduit in the center of the trench at the invert elevation shown on the plans. Any deviation must be approved by the Engineer. If the Engineer does not approve the deviation, stop all related work until the conduit is relaid. Ensure that the conduit is in contact with the bedding for its full length and maintain the line and grade of the conduit. The Contractor's representative doing the inspection will visually inspect all conduit before placing any backfill. Rejoin, re-lay, or replace conduits that have settled, or that are damaged.

Lay all conduits as described in the installation plan and according to the following requirements. The installation plan cannot change the following requirements. Meeting these requirements does not relieve the Contractor of the responsibility for obtaining the required results. Record any deviations from the installation plan on the construction inspection forms and revise the installation plan.

- A.** If the welded seam in a metal conduit is longitudinal, place the seam at the spring line.
- B.** For all metal conduit, use only lifting devices that do not require a hole through the material.
- C.** Lay metal conduit so that match marks align.
- D.** For all metal conduit that is cut at a drainage structure or headwall, treat the cut end with the same coating as the conduit. Do not treat any cuts within the run.
- E.** Where two structural plate thicknesses are specified, place the thicker plates according to the installation plan.
- F.** Set precast reinforced concrete 3-sided flat topped culvert sections ([706.051](#)) in the keyway. Place the units in a 1/2 inch (13 mm) bed of mortar. If proper line and grade of the structure cannot be maintained on the bed of mortar, set the sections on 5 × 5 inch (125 × 125 mm) masonite or steel shims. Fill the entire keyway joint with mortar.
- G.** Set precast reinforced concrete arch sections ([706.052](#)) in the keyway. Place the units on 5 × 5 inch (125 × 125 mm) masonite or steel shims to provide a minimum 1/2 inch (13 mm) gap between the footing and the bottom of the leg. Fill the entire keyway joint with mortar.
- H.** Set the precast reinforced concrete round sections ([706.053](#)) in the keyway. Place the units on masonite or steel shims to provide a minimum 1.5 inch (38 mm) gap between the footing and the bottom of the precast arch base. Fill the entire keyway joint with mortar. Provide 5000 psi. (34.5 MPa) mortar. For arches that gain structural continuity by a cast-in-place closure at the project site, provide concrete with the same compressive strength as the precast arch.
- I.** For precast reinforced concrete culverts ([706.05](#), [706.051](#), [706.052](#), and [706.053](#)) fill the lifting devices with mortar. Cover the exterior of the lifting devices with joint-wrap material if they are outside the limits of the membrane waterproofing. Use joint-wrap with a minimum width of 9 inches (225 mm). Use only lifting devices that do not require a hole through the structure.
- J.** The inlet of all rigid conduit used in a Type A application (open inlet) must have a bell. If field cutting is necessary to furnish a bell at the inlet, locate the cut end at an interior joint by removing part of a section within the run. Join the conduit as described below and encase the joint with a concrete collar to ensure a stable connection.
- K.** The top and bottom of reinforced concrete pipe that has elliptical or quadrant mat reinforcing will be clearly marked on the pipe. Handle and place this pipe so that the markings remain in a vertical plane through the center of the pipe.
- L.** Handle and place reinforced concrete pipe with auxiliary reinforcements (stirrups) with the centerline of the auxiliary reinforcement system (stirrups) in a vertical plane through the center of the pipe.

**M.** Fill all lifting holes in rigid conduit with concrete according to the manufacturer's recommendations or using a method approved by the Engineer.

**N.** Immediately after placing conduit, construct the end treatments at both the outlet and inlet ends. Show this activity as part of the conduit construction on the progress schedule. These end treatments include headwalls, concrete riprap, rock channel protection, sod or other erosion control items.

**O.** When conduit is installed under pavement, perform the following immediately after the completion of backfill placement and compaction: remove and dispose of all surplus material according to [105.17](#), clear the site, and replace all pavement necessary to restore traffic. Show this activity as part of the conduit construction on the progress schedule.

**P.** Lay all conduit from outlet end to inlet unless approved by the Engineer.

**611.08 Joining Conduit.** Ensure the joints are clean and free from dirt or debris. Join the conduit sections as described below. Visually inspect all conduit, joints, and gaskets before placing any backfill. Rejoin, re-lay, or replace any conduit that does not meet the requirements.

The Engineer may allow joint materials other than those listed below, provided the Contractor demonstrates the proposed material will result in durable, sealed joints.

Join conduit as described in the installation plan and according to the requirements below. Provide a concrete masonry collar per [SCD D.M.-1.1](#) when joining conduits of different materials. For conduit material not listed below, join conduit as recommended by the manufacturer. Record any deviations from the installation plan on the construction inspection forms and revise the installation plan.

**A. Corrugated Metal Conduit.** Join corrugated metal conduit, Types A, B, C, D, and F, using either coupling bands or bell and spigot joints. Join the conduit according to the following requirements.

1. Coupling bands. Furnish coupling bands conforming to [707.01](#) or [707.02](#), and having the same coating as the conduit being joined. Use either coupling bands with gaskets or wrap the joints with geotextile fabric, Type A.

2. Bell and spigot joints. If using bell and spigot joints, place a gasket in the first corrugation of the spigot end and thoroughly lubricate the gasket and the bell end of the receiving conduit before assembly. Drive the spigot securely into the bell.

3. For **corrugated** metal conduits with smooth steel interior liner, furnish a joint conforming to [707.18](#), [707.19](#) and [707.20](#).

**B. Rigid Conduit.** Join rigid conduit, Types A, B, C, D, and F, according to the following requirements.

1. For all concrete pipe ([706.01](#), [706.02](#), [706.04](#)) that is not epoxy coated and vitrified clay pipe ([706.08](#)), seal the joints using one of the following methods:

a. Fill the joint with bituminous pipe joint filler, providing a smooth transition on the inside and a complete seal on the outside.

b. Use preformed flexible joint sealant to seal the joint. Before installing the joint sealant, prime both surfaces of the joint with asphalt based primer according to the joint sealant manufacturer's recommendations.

c. Use resilient and flexible gasket joints. If the conduit is a sanitary sewer pipe, test the joint for infiltration and exfiltration according to [ASTM C 969](#) or [ASTM C 1103](#). If any joint does not meet the test requirements, make corrections until the joint meets the test requirements.

2. For epoxy coated concrete pipe ([706.03](#)), seal the joint using fibrated coal tar joint compound applied according to the conduit manufacturer's recommendations.

3. For precast reinforced concrete box culverts, precast reinforced concrete 3-sided flat topped culverts, precast reinforced concrete arch sections, and precast reinforced concrete round sections ([706.05](#), [706.051](#), [706.052](#), and [706.053](#)), place the sections according to the installation plan. Clean the joint gap of all debris and apply one of the following:

a. For joints in precast reinforced concrete box culverts ([706.05](#)), fill the top exterior joint gap and the bottom and side interior joint gap with mortar. Next, for any exterior joint not covered by membrane waterproofing, cover the exterior joint with a 9 inch (225 mm) wide strip of joint wrap in accordance with the manufacturer's recommendation. Center the joint wrap on the joint.

b. For precast reinforced concrete 3-sided flat topped culverts ([706.051](#)), fill the top keyway joint with nonshrink mortar. If the side or leg joints are tongue and groove types, fill the joints as described above for concrete box culverts. If the side or leg joints are keyway types, fill with nonshrink mortar. Prepare, place, and cure the nonshrink mortar according to the nonshrink mortar manufacturer's recommendations. Wet all surfaces of the keyway joint, but do not allow free standing water in the joint. Next, cover the exterior joint with a 12 inch (300 mm) wide strip of joint wrap. Center the joint wrap on the joint. Use a continuous length of joint wrap sufficient to extend from the bottom of the vertical face on one side to the bottom vertical face on the other side. Apply membrane waterproofing to the precast sections after they are installed.

c. For precast reinforced concrete arch sections and precast reinforced concrete round sections ([706.052](#) and [706.053](#)), install a 7/8 x 1 3/8 inch (24 x 34 mm) preformed flexible joint sealant ([706.14](#)) along the outside joint chamfer. Use a continuous length of joint sealant sufficient to extend from the bottom of the vertical face on one side to the bottom vertical face on the other side. Before installing the joint sealant, prime the joint chamfer with a primer according to the joint sealant manufacturer's recommendations. For [706.052](#) and [706.053](#), cover all exterior joints with a 12 inch (300 mm) wide strip of joint wrap centered on the joint. Use a continuous length of joint wrap sufficient to extend from the bottom of the vertical face on one side of the structure to the bottom vertical face on the other side. Next, apply all waterproofing as shown on the plans. Apply membrane waterproofing to the precast sections after they are installed.

4. For precast reinforced concrete box culverts, precast reinforced concrete 3-sided flat topped culverts, precast reinforced concrete arch sections, and precast reinforced concrete round sections ([706.05](#), [706.051](#), [706.052](#), and [706.053](#)), apply an approved epoxy-urethane sealer per the plans to all top surfaces not covered by membrane waterproofing. Extend sealer 1 foot (0.3 m) below the backfill on all sides of the culvert sections including the joint.

**C. Plastic Conduit.** Join plastic conduit, Types A, B, C, D, and F, using either coupling bands, bell and spigot joints, or bell-bell couplers. Join the conduit according to the following requirements.

1. Coupling bands. Furnish coupling bands of the same size as the conduit and that engage at least two full corrugations on each conduit section. Furnish gasketed coupling bands of the same material as the plastic conduit.

2. Bell and spigot joints. If using bell and spigot joints, drive the spigot securely into the bell. For gasketed joints, ensure that the gasket is properly seated after joining.

3. Bell-bell couplers. If using bell-bell couplers, drive the conduit securely into the coupler.

**D. Type E Conduit.** Join Type E conduits with open joints by butting the ends and wrapping with a minimum 4 inch (100 mm) wide tarred paper or tarred burlap. Place soil around this material to hold it in place during backfilling.

**611.09 Exterior Coatings and Membrane Waterproofing.** Apply exterior coatings and membrane waterproofing as specified below. Protect the exterior coatings and membrane waterproofing from damage during placing of the bedding, backfill, and embankment.

**A.** For 611.08.B.3. concrete conduit, clean the surfaces before placing the membrane waterproofing. Apply membrane waterproofing as specified. Apply the membrane waterproofing to all surfaces that will be in contact with the backfill (top and sides) according to the membrane waterproofing manufacturer's recommendation.

**B.** For structural plate metal structures and corrugated metal box culverts ([707.03](#), [707.15](#), [707.23](#), and [707.25](#)), apply waterproofing by one of the following methods.

1. Coat the exterior of the conduit above the limits of the bedding and within the limits of backfill. Ensure that all plate seams and bolts are thoroughly sealed. Furnish coating material and apply it according to [AASHTO M 243](#). Allow asphalt mastic material to dry 48 hours and tar base material to dry 28 hours before placing the conduit backfill. Rib stiffeners do not need to be coated.

2. Construct buried liner waterproofing membrane protection in the fill according to the manufacturer's recommendations. The buried liner waterproofing membrane protection must be a continuous sheet placed over the conduit and extend at least 10 feet (3.3m) outside of the paved shoulder and for the width of the trench. Seams constructed in the field are not acceptable.

**611.10 Drainage Structure Construction.** Install drainage structures as shown on the plans and standard construction drawings. Maintain flows at all times until the new facilities are completed and in service.

Visually inspect all precast drainage structures before they are placed. Replace all drainage structures that are damaged as determined by the Engineer.

Install each drainage structure casting to the elevation, station, and offset shown on the plans. Any deviations must be approved by the Engineer. If the Engineer does not approve the deviation, stop all related work until the drainage structure is reinstalled. The offset is to the center of the casting. Place each manhole base so that it is in alignment with the pipe and its invert elevation according to the standard construction drawings. Use flat slab top manholes as shown on the standard construction drawing. Do not remove the flat slab top manhole lifting devices.

Locate or cut conduits so any protrusion inside the structure wall is minimized.

Set iron frames, tops, and covers in mortar with a flush joint.

Prevent earth or debris resulting from construction operations from entering the drainage structure. Remove any debris resulting from construction.

Thoroughly grout the underdrain outlet pipe to the precast reinforced concrete outlet with a flush mortar joint.

Take adequate precautions to prevent concrete or mortar from freezing. Preheat the brick, concrete block, or precast concrete structure throughout the entire mass to a temperature between 50 to 80 °F (10 to 27 °C) before placing mortar if the ambient temperature is 40 °F (4 °C) or less.

**A. Brick and Block Masonry.** For brick and block masonry drainage structure construction thoroughly wet the units before placing in mortar. Lay the units with a flush mortar joint. Cure the

exposed surfaces of all brick and block masonry by covering with wet burlap or by applying a curing membrane according to [705.07](#). Keep burlap wet for at least 48 hours.

**B. Modular Precast Concrete.** For precast concrete modular drainage structures furnish precast bases on a compacted bed with or without a bedding material as described in the installation plan. Ensure that the bed is level and uniformly supports the entire area of the base. Seal all joints between modules as described above for concrete conduit.

All penetrations through precast drainage structures must be either manufactured or cored.

After placing the conduit, grout all openings less than 4 inches (100 mm) between the pipe and structure with mortar. Grout all openings greater than 4 inches (100 mm) between the pipe and structure with non-shrink mortar. Furnish the same curing membrane for barrier inlets as that used on the barrier. Apply the curing membrane according to [622.07](#).

**C. Reconstruction to grade.** When reconstructing an existing manhole, catch basin or inlet to grade, follow the procedure below.

1. Carefully remove and clean the existing castings.
2. Remove the existing walls of manholes down to the spring line of the conduit or below as necessary. Remove existing walls of catch basins and inlets below the window openings, grates, or any points of wall failure.
3. Using the salvaged casting, reconstruct the structure to the new grade, conforming as nearly as practicable to the existing dimension and type of construction.

**D. Adjustment to grade.** When adjusting an existing manhole, catch basin, or inlet to match grade, follow the procedure below.

1. Carefully remove and clean the existing frame, adjust the height of supporting walls, and reset the existing frame in mortar or concrete to the new grade.
2. Carefully remove the existing cover or grate and install a casting or an acceptable adjusting device on file at the Laboratory or an adjusting device approved by the Engineer to the new grade and install according to the adjusting device manufacturer's recommendations.

**611.11 Field Paving of New or Existing Conduit.** Field pave the bottom of the conduit with concrete as shown on the plans. Installation Plans are not required for field paving of existing conduits. Include any field paving details in the Installation Plan for all new conduit.

For new pipe installations, do not pave until at least 4 feet (1.2 m) of fill is placed on top of the conduit or the top of subgrade is reached. If the paving is placed before completion of the entire fill, clean any gaps between the conduit and concrete paving, and then fill with heated bituminous material conforming to [705.04](#).

Reinforce the paving with 2 x 2-W0.9 x W0.9 galvanized welded wire fabric or epoxy coated reinforcing steel meeting the material requirements of [509.02](#). Provide galvanized wire fabric or epoxy coated reinforcing steel with a width 4 inches (100 mm) less than the finished paving. Provide support beneath the mesh where necessary using galvanized support chairs or #4 epoxy coated reinforcing steel. Securely fasten the mesh to the conduit near each edge and at the center of the mesh at points not more than 4 feet (1.2 m) apart along the flow line of the culvert. Securely fasten the epoxy coated reinforcing steel to the conduit at each end and along the length of the steel not more than 4 feet (1.2 m) apart. Repair any damage to the galvanizing or other coating material caused by placement or by tack welding. Use wire brushing and zinc rich paint to make the repairs.

For all aluminum conduits, prior to placing concrete, coat the area to be paved with a zinc chromate primer or an epoxy paint formulated for applying to aluminum. Extend primer or epoxy 4 inches beyond the proposed paving limits. For aluminum structural plate, securely fasten the mesh to the circumferential seam bolts with galvanized tie wire.

Construct paving so that it is 3 inches (75 mm) thick measured from the top of the corrugations of the conduit to a height equal to 1/3 of the **Conduit Rise**. Maintain the position of the mesh while placing concrete. After placing the concrete, strike it off with a template to produce the proper radius, and finish with a float to produce a smooth finish. Cure the concrete according to [451.11](#).

When field paving existing conduits, maintain flows in accordance with [611.07](#).

When standing water is encountered and cofferdams are necessary, construct and pay for cofferdams per Item 503.

**611.12 Performance Inspection.** Notify the Engineer at least five workdays before conducting a performance inspection. Ensure the Engineer is present during all performance inspection activities.

For all Type A, B, and C conduits, inspect all lengths greater than 20 feet with slopes of 25 percent or less and all new drainage structures. Performance inspections are not required for all Type D, E and F conduits. A performance inspection is not required for projects that meet all of the following:

All conduit is Type C

Conduit plan quantities are less than 100 feet (30.5 m)

All conduit has less than 16 feet (4.8 m) of maximum fill height

In each phase of construction of a conduit, perform the inspection no sooner than 30 days and no later than 90 days after the completion of the finished grade when not below pavement and after the completion of the rough subgrade when any portion of the conduit is below pavement. The Engineer may permit inspection beyond the 90 day limit. If any corrections are made to the installed pipe after the completion of the finished grade or rough subgrade and prior to the performance inspection, wait 30 days after the correction was made to do the performance inspection. If the contract duration will not permit a 30 day waiting period then the Engineer may adjust the waiting period.

Visually inspect for surface settlements within the trench limits or within 4 feet of a drainage structure. Document all locations of surface settlement in the inspection report.

Furnish a video recording of all conduit and drainage structure inspections. On the recording, identify the date and time of the inspection, a description of the conduit or drainage structure being inspected, the location, and the viewing direction. Record the entire run of conduit being inspected. Provide a source of light that allows all areas of concern to be readily observed on the video recording. Furnish the video recording in a digital, reproducible format on one of the following media types: Portable hard drive, flash drive or as determined appropriate by the Engineer. Provide the video files with a naming format consistent with the Installation Plan references or as determine acceptable by the Engineer.

Ensure that the condition of the conduit will allow an accurate inspection. Perform a manual inspection on drainage structures. Perform either a manual inspection or remote inspection as follows:



Non-circular conduits	Manual inspection
Conduits with a rise of 48 inches (1.2 m) and greater	Manual inspection
Conduits with a rise of 36 inches (900 mm) up to 48 inches (1200 mm)	Manual or Remote inspection
Conduits with a rise of 12 inches or greater up to 36 inches (300 to 900 mm)	Remote inspection

Conduits with a rise less than 12 inches (300 mm) and Type D, E, and F conduits – Remote inspection as directed by the Engineer. The Department will pay for this inspection according to [105.10](#).

**A. Manual Inspection.** Perform a manual inspection by entering the conduit or drainage structure to record video and to make measurements. If the conduit or drainage structure is considered a confined space, provide entry for all project inspection personnel according to [OSHA](#) requirements.

Measure the deflection of the conduit using either a metal tape, fabric tape or equipment accepted by the Engineer and read to the nearest ½ inch (10 mm). Measure crack width using either a crack comparator or a feeler gage capable of measuring 0.01 inch (0.25 mm). Measure joint gaps using a tape or ruler and read to the nearest ½ inch (10 mm). Other measuring devices may be used if approved by the Engineer. Record the measurements and include them in the performance report. Measure the following:

1. For all conduits, measure the location, length, and greatest width of each crack.
2. For flexible conduit, measure the smallest inside diameter three times for each conduit section in the run. Take the first measurement vertically from the crown to invert (12 o'clock to 6 o'clock positions). Take the second measurement by rotating 60 degrees from vertical (2 o'clock to 8 o'clock positions). Take the third measurement by rotating 120 degrees from vertical (4 o'clock to 10 o'clock positions). For all measurements, stretch tape to full extent across inside of pipe. For corrugated metal conduit, the inside diameter is defined as the distance between the inside peaks of the corrugations.
3. For all conduits, measure the widest gap at each joint in the run.
4. For conduit with manufactured seams, measure the location, length, and greatest width of any separation at the seam.
5. For drainage structures, measure the location, length and greatest width of each crack and the widest gap at each conduit entering the drainage structure.

Record the location of any other defect not listed above and describe the defect. For each measurement location in a conduit, record the length from the nearest drainage structure.

**B. Remote Inspection.** Perform a remote inspection by using a crawler mounted camera to record video and using equipment described below to make measurements. Use equipment that meets the requirements of [Supplemental Specifications 902 \(SS902\)](#). Remove all debris from the conduits being inspected according to [107.19](#). Dewater the conduit if the water level hinders the performance of the equipment.

Based on the type of conduit, make measurements using the equipment listed in the following table. Also record the location of any other defect not listed below and describe the defect.

**TABLE 611.12.B**

<b>Conduit Type</b>	<b>Measurement Equipment</b>	<b>Type of Measurement</b>
Rigid conduit and <a href="#">748.06</a> , steel casing pipe	Crawler mounted camera according to <a href="#">SS902.01</a> with crack measuring capabilities according to <a href="#">SS902.02 C</a>	Joint gaps Crack widths
Plastic conduit, <a href="#">707.12</a> , corrugated steel spiral rib conduit, <a href="#">707.24</a> , corrugated aluminum spiral rib conduit, <a href="#">748.01</a> , ductile iron pipe, and Circular corrugated metal conduit not listed below	Crawler mounted camera with laser profiler according to <a href="#">SS902.02</a> A, B, and C or Mandrel according to <a href="#">SS902.03</a> and Crawler mounted camera according to <a href="#">SS902.01</a> with crack measuring capabilities according to <a href="#">SS902.02 C</a>	Joint gaps Crack widths Deflection
The following types of corrugated metal conduit: <a href="#">707.04</a> , precoated, galvanized steel culverts <a href="#">707.05</a> and <a href="#">707.07</a> , bituminous coated corrugated steel pipe with paved invert <a href="#">707.11</a> Polymer-precoated corrugated steel spiral rib pipe <a href="#">707.13</a> and <a href="#">707.14</a> , bituminous lined corrugated steel pipe	Crawler mounted camera with laser profiler according to <a href="#">SS902.02</a> A, B, and C	Joint gaps Crack widths Deflection

**611.13 Conduit Evaluation.** Have an independent [Registered Engineer](#) review the conduit Performance Inspection and provide a written documentation of whether defects listed in [Table 611.13](#) are present or not. Record any other identified defects present in the conduit. Evaluate the defects to ensure structural stability and hydraulic capacity are in conformance with the contract documents and as prescribed by *AASHTO LRFD Bridge Construction Specifications*, Section 26 for metal conduit, Section 27 for concrete conduit, and Section 30 for plastic conduit with modifications according to this specification. Provide written documentation of evaluations performed of all defects and any recommended repairs to the Engineer. The independent [Registered Engineer](#) cannot be an employee of the Contractor or the conduit manufacturer.

When using a laser profiler, the conduit deflection must be calculated from the actual inside diameter at the measured location or calculated by inputting the nominal diameter. When using a mandrel, the mandrel must be sized according to [SS902](#). If the evaluation determines repairs are not necessary and repairs are not required based on the type or size of the defect in [Table 611.13](#), have the independent [Registered Engineer](#) make the following statement in the evaluation:

“I certify that repairs are not required to address the defects identified during the conduit evaluation. The conduit will function in accordance with the contract documents.”

If the evaluation determines repairs are necessary, or if repairs are required based on the type or size of the defect in [Table 611.13](#), have the independent [Registered Engineer](#) prepare, sign, seal, and date plans for the repair. The independent [Registered Engineer](#) must make the following statement on the repair plans:

“I certify that this repair plan was designed to ensure the repaired conduit will function structurally and provide hydraulic capacity in accordance with the contract documents.”

**TABLE 611.13**

<p><b>Metal Conduit</b></p>	<p>Evaluate if infiltration is observed.          Evaluate all racking, buckling or denting.          Evaluate all vertical sags or misalignments exceeding 0.1 ft.          Repair or replace vertical sags or misalignments of 0.25 ft and greater.          Evaluate the overall vertical alignment of the conduit recorded in <a href="#">CA-P-1</a>.          Evaluate if the joint gap exceeds the Manufacturer’s tolerance*.          Repair or replace conduit if the joint gap exceeds the Manufacturers tolerance*.          Repair all damage to coatings.          Repair or replace conduit if the Performance Inspection per <a href="#">611.12</a> indicates a deflection &gt; 7.5%.          Replace conduit if the Performance Inspection per <a href="#">611.12</a> indicates a deflection &gt; 12%</p>
<p><b>Rigid Conduit</b></p>	<p>Evaluate if infiltration is observed.          Evaluate if joint gap exceeds the Manufacture’s tolerance*.          Evaluate all vertical sags or misalignments exceeding 0.1 ft.          Repair vertical sags or misalignments of 0.25 ft and greater.          Evaluate the overall vertical alignment of the conduit recorded in <a href="#">CA-P-1</a>.          Repair or replace conduit if the joint gap exceeds the Manufacturers tolerance*.          .          Repair or replace conduit if cracks &gt; 0.10 inch.          Repair or replace conduit if spalls or slabbing are observed.</p>
<p><b>Plastic Conduit</b></p>	<p>Evaluate if infiltration is observed.          Evaluate all racking, bulging or buckling.          Evaluate if joint gap exceeds the Manufacturers tolerance*.          Evaluate all vertical sags or misalignments exceeding 0.1 ft.          Repair vertical sags or misalignments of 0.25 ft and greater.          Evaluate the overall vertical alignment of the conduit recorded in <a href="#">CA-P-1</a>.          Evaluate all cracks.          Repair or replace conduit if the joint gap exceeds the Manufacturer’s tolerance*.          Repair or replace conduit if Performance Inspection per <a href="#">611.12</a> indicates a deflection &gt; 7.5%.          Replace conduit if the Performance Inspection per <a href="#">611.12</a> indicates a deflection &gt; 12%</p>

\* Note: The tolerance is defined as the maximum joint gap listed in the Installation Plan.

Submit the evaluation, repair plans, and revised installation plan to the Engineer at least 7 days before performing the repairs. Provide written confirmation from the conduit manufacturer that the repair methods are appropriate. The Department may review the submittal, but Department acceptance is not required. If the Department does not review the plan, proceed with the repairs 7 days after delivering the submittal to the Engineer. If the Department reviews the submittal and determines it does not conform to the Contract, revise, resubmit, and proceed with the repairs only after the Department accepts the resubmittal.

Perform the repair at no additional cost to the Department. Perform an inspection to evaluate the repaired portion of the conduit and any conduit potentially affected by the repair work 30 days after the repair has been made. Perform the inspections according to [611.12](#) and at no additional cost to the Department. Have an independent [Registered Engineer](#) evaluate the inspection according to [611.13](#) and at no additional cost to the Department.

**611.14 Drainage Structure Evaluation.** Have an independent [Registered Engineer](#) evaluate the drainage structures and provide a written documentation of whether defects listed in [Table 611.14](#) are present or not. Record any other identified defects present in the drainage structure. Evaluate all identified defects to ensure structural stability and hydraulic capacity are in conformance with the contract documents. Provide written documentation of evaluations performed of all defects and any recommended repairs to the Engineer. The independent [Registered Engineer](#) cannot be an employee of the Contractor or drainage structure manufacturer.

**TABLE 611.14**

<b>Defects requiring evaluation</b>
Connection between conduit and drainage structure has free flowing water, infiltration or has not been constructed in accordance with <a href="#">611.10</a> .
Grate is more than 0.1 ft (30 mm) from horizontal or vertical location documented on construction inspection form <a href="#">CA-P-3</a> .
Invert elevation is more than 5 percent of the conduit diameter or 0.1 ft (30 mm) from plan elevation, whichever is greater as documented on construction inspection form <a href="#">CA-P-1</a>
Grates do not properly seat in the frame.
Grates are not placed on the required slope.
Grates or frames are broken or cracked.
Drainage structure does not match the details on the standard construction drawing.
Steps do not line up.
Manhole top does not match plans.
Conduit connections are not fully grouted per <a href="#">611.10</a>
Conduits protrusions are present

If the evaluation determines repairs are not necessary, have the independent [Registered Engineer](#) make the following statement in the evaluation:

“I certify that repairs are not required to address the defects identified during the drainage structure evaluation. The drainage structure will function in accordance with the contract documents.”

If the evaluation determines repairs are necessary have the independent [Registered Engineer](#) prepare, sign, seal, and date plans for the repair. The independent [Registered Engineer](#) must make the following statement on the repair plans:

“I certify that this repair plan was designed to ensure the structure will function structurally and provide hydraulic capacity in accordance with the contract documents.”

Perform the repair at no additional cost to the Department. Perform an inspection to evaluate the repaired portion of the drainage structure and any conduit potentially affected by the repair work 30 days after the repair has been made. Perform the inspections according to [611.12](#) and at no additional cost to the Department. Have an independent [Registered Engineer](#) evaluate the inspection according to [611.14](#) and at no additional cost to the Department.

**611.15 Surface Settlements.** Repair any surface settlement within the trench limits or within 4 feet (1.2 m) of a drainage structure. Have an independent [Registered Engineer](#) evaluate the conduit

according to [611.13](#) or the drainage structure according to [611.14](#). Perform all repair work at no additional cost to the Department.

**611.16 Method of Measurement.** The Department will measure conduit by the number of feet (meters), measured from center-to-center of small drainage structures or between open ends including the length of pipe bends and branches. The Department will not deduct conduit length for catch basins, inlets, or manholes where the distance measured in the direction of flow, including bends, is 6 feet (2 m) or less. Where the location of a drainage structure or an open end is changed with the approval of the Engineer to accommodate full conduit sections, the Department will measure the length placed. Conduits placed on slopes steeper than 3H:1V or with beveled or skewed ends will be measured along the invert.

The Department will measure field paving of existing pipe by the number of feet (meters).

The Department will measure Manholes, Inlets, Catch Basins, Inspection Wells, Junction Chambers, and Precast Reinforced Concrete Outlets, whether new, reconstructed, or adjusted to grade, by the number of each type of structure complete and accepted.

**611.17 Basis of Payment.** Payment for all inspections is included with the contract unit price of the corresponding pay item. When a pay item calls for concrete encasement, the Department will pay for furnishing and placing the concrete encasement and for any additional excavation required under the contract unit price for the encased conduit. When a pay item calls for conduit to be field paved, all work and materials necessary for the item are included in the contract unit price for each conduit.

All required repairs, including any settlement problems, must be made prior to acceptance. Payment for the repair is included with the contract unit price of the corresponding pay item. The Department will not make additional payment for repair work on conduit installed under this specification.

All conduits and drainage structures installed without required submittals per [611.04](#) are considered unacceptable materials per [106.07](#).

The Department will pay for accepted quantities at the contract prices as follows:

Item	Unit	Description
611	Foot (Meter)	___ " (___ mm) Conduit, Type _____
611	Foot (Meter)	___ × ___ Conduit, Type _____
611	Foot (Meter)	___ " (___ mm) Conduit Reconstructed, Type _____
611	Foot (Meter)	Type _____ Precast Reinforced Concrete Three-Sided Flat Topped Culvert, ___' (___ mm) Span × ___' (___ mm) Rise
611	Foot (Meter)	Type ___ Precast Reinforced Concrete Arch Sections, ___' (___ mm) Span × ___' (___ mm) Rise
611	Foot (Meter)	Type ___ Precast Reinforced Concrete Round Sections, ___' (___ mm) Span × ___' (___ mm) Rise
611	Foot (Meter)	___' (___ mm) Rise × ___' (___ mm) Span Conduit, Type A Corrugated Steel Box Culvert, ___' (___ mm) Minimum Cover, ___' (___ mm) Maximum Cover
611	Foot (Meter)	___' (___ mm) Rise × ___' (___ mm) Span Conduit, Type ___ Corrugated Aluminum Box Culvert, ___' (___ mm) Minimum Cover, ___'

		( ___ mm) Maximum Cover
611	Foot (Meter)	___" (___ mm) Conduit, Type ___, with Field Paving of Pipe
611	Foot (Meter)	___" (___ mm) Conduit, Type ___, Field Paving of Existing Pipe
611	Foot (Meter)	Conduit, Type F for underdrain outlets
611	Each	Manholes
611	Each	Inlets
611	Each	Catch Basins
611	Each	Inspection Wells
611	Each	Junction Chambers
611	Each	Manhole, Catch Basin or Inlet Reconstructed to Grade
611	Each	Manhole, Catch Basin, or Inlet Adjusted to Grade
611	Each	Precast Reinforced Concrete Outlet