SECTION 601—PIPE CULVERTS

601.1 DESCRIPTION - This work is construction or reconstruction and cleaning of pipe culverts, and storm drains; including the direct design, manufacturing and testing of reinforced concrete pipes.

601.2 MATERIAL -

(a) Pipes. Comply with the following:

1. Certification. Section 106.03(b)3.

2. Size and Type of Pipe. As indicated.

3. Reinforced Concrete (RC) Pipe.


3.b Plant Acceptance.

3.b.1 General. Do not begin fabrication before the Structural Materials Engineer's inspection and acceptance of the plant. Provide a permanent building offered for the Commission’s acceptance.

Material, equipment, test procedures, methods of fabrication, handling, storage, and transportation are subject to inspection. Through wall lift holes are permitted only if formed during the manufacturing process or cored after the pipe is cured. Punch through methods are prohibited.

Register and certify the plant under either the American Concrete Pipe Association (ACPA) or National Precast Concrete Association (NPCA) plant certification program. Submit an annual endorsed copy to PennDOT’s Structural Materials Engineer for continued qualification.

3.c QC.

3.c.1 General. Establish a level of QC based on uniform production practices. Submit the plant's QC Plan and mix design(s) to the Structural Materials Engineer, MTD, for review and approval. Include with the QC Plan a company organizational chart indicating a separate chain of command from the QC Manager to the Owner/Plant Manager independent of the Production Manager. Resubmit the QC Plan, mix design, and/or organizational chart, when required, due to changes in processes, materials, or personnel.

3.c.2 QC Manager. Provide a QC Manager who has the overall responsibility for the adequacy of production facilities, QC, sampling, and testing, and fabrication of the product, and who will ensure that items are fabricated as designed and specified.

3.d Testing and Inspection.


3.d.2 Inspection. Publication 280. Provide the necessary pipe inspection equipment. Before installation, pipes may have non-through wall cracks of less than 0.003 inch in width. Any pipe having both an unloaded surface crack width of 0.003 inch or greater extending 12 inches or longer, will
be rejected. To determine whether rejection or remediation is required, measure crack widths with leaf gages as described in AASHTO T 280. Use gages having a thickness of 0.003 inch to determine pipe acceptability before installation.

4. Metal Pipes.

4.a Coated Corrugated Galvanized Steel Pipe. AASHTO M 245/M 245M, Type I; AASHTO M 246/M 246M; and AASHTO M 218. Fabricate pipes with coatings as follows:

- Grade Grade 10/10 - 10 mil coating on all surfaces.

5. Half-Circle Pipe. Conforming to the requirements of the type indicated, except modified to meet the half-circle configuration.

6. Thermoplastic Pipes. Provide cell class of material (actual and minimum), minimum pipe stiffness and the dimension ratio, when applicable, if not included in pipe markings.

6.a Group I. 15-foot maximum fill - 1.5-foot minimum fill height

6.a.1 Polyethylene.

- ASTM F 714, Type S, SDR
- ASTM F 714, Type S, SDR=26, cell class 335434C, 21-inch diameter - 48-inch diameter only
- ASTM F 894, Type S, RSC=100, cell class 335434C, 36-inch diameter maximum
- ASTM F 894, Type S, RSC=160, cell class 335434C, 18-inch diameter - 42-inch diameter only

6.a.2 Polyvinyl Chloride.

- ASTM F 794, Type S, PS=46, cell class 12454C or 12364C, 48-inch diameter maximum
- AASHTO M 304, Type S, cell class 12454C, 48-inch diameter maximum
- AASHTO M 304, Type S, cell class 12364C, 18-inch – 48-inch diameter
- ASTM F 679, Type S, T1 or T2, PS=46, cell class 12364C or 12454C, 36-inch diameter maximum
- AASHTO M 278, Type S, cell class 12454B, 12-inch diameter and 15-inch diameter only

6.b Group II. 12-foot maximum fill - 1.5-foot minimum cover. Section 601.2(a)6.a and as follows:
6.b.1 Polyethylene.

- ASTM F 894, Type S, RSC=100, cell class 335434C, 42-inch diameter

6.c **Group III.** 8-foot maximum fill - 2-foot minimum cover. Section 601.2(a)6.a and as follows:

6.c.1 Polyethylene.

- AASHTO M 294M, Type S and D, cell class 335400C, 30-inch diameter maximum; and 2004 AASHTO LRFD Bridge Design Specifications (with 2001 interims) Chapter 12

6.c.2 Polyvinyl Chloride.

- AASHTO M 304, cell class 12364C, 12-inch diameter and 15-inch diameter

6.d **Group IV.** 7-foot maximum fill - 2.5-foot minimum cover.

6.d.1 Polyethylene.

- AASHTO M 294M, Type D and S, cell class 335400C, 36-inch, 42-inch and 48-inch diameters; and 2004 AASHTO LRFD Bridge Design Specifications (with 2001 interims) Chapter 12

- AASHTO MP7, Type S, cell class 324400C, 54-inch and 60-inch diameters; and 2004 AASHTO LRFD Bridge Design Specifications (with 2001 interims) Chapter 12

6.e **Group V.** 7-foot maximum fill - 2.5-foot minimum cover

6.e.1 Polyethylene.

- AASHTO M 294M, Type C, cell class 335400C, 24-inch diameter maximum

6.f **Group VI.** 15-foot maximum fill - 2-foot minimum cover.

6.f.1 Polyethylene.

- AASHTO M 294M, Type D and S, cell class 335400C; and 2004 AASHTO LRFD Bridge Design Specifications (with 2001 interims) Chapter 12

6.f.2 Polypropylene.

- AASHTO M 330, Types D and S, 12-inch to 60-inch diameter; and 2012 AASHTO LRFD Bridge Design Specifications Chapter 12 with interims

(b) **Other Material.**

- Premolded Expansion Joint Filler—Section 705.1

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• Mortar—Section 705.7(a)
• Caulking Compound—Section 705.8(a)
• Preformed Pipe Joint Gaskets—Section 705.5(b)
• Cement Concrete for Miscellaneous Drainage—Section 704
• Reinforcement Steel—Section 709
• Coarse Aggregate—Type C or better Section 703.2
• Concrete Curing Compound—Section 711.2
• Curing and Protecting Covers—Section 711.1
• Bituminous Paint—Federal Specification TT-V-51F. Certify as specified in Section 106.03(b)3.
• Zinc Chromate Primer—Federal Specification TT-P-645. Certify as specified in Section 106.03(b)3.
• Flowable Backfill—Section 220.1(a)
• Geotextile, Class 4, Type A—Section 735

**c) Grout.** Mix one part cement and two parts fine aggregate with the minimum amount of water necessary to obtain grout of the required consistency containing 3% to 7% entrained air. Air entraining cement may be used in place of the plain cement and air entraining admixture. Use materials meeting the following requirements:

- Cement—Section 701
- Fine Aggregate—Type A or C, Section 703.1
- Water—Section 720.1
- Admixtures—Section 711.3

**601.3 CONSTRUCTION**—As shown on the PennDOT Standard Drawings and as follows:

**a) General.** Provide 6-inch minimum cover from the bottom of the base course to the top of pipe barrel. Construct the embankment to 4 feet above the top of pipe elevation or to subgrade, whichever is less, before excavating for the pipe. Do not haul over pipe with less than 4 feet of cover over the top of the pipe barrel. Maintain a minimum slope of 0.35% unless otherwise specified.

If running water is encountered and cannot be diverted, provide an acceptable temporary pipe or other structure before placing embankment, or as otherwise directed.

In advance of installation, submit to the Representative a detailed list of lifting equipment and hardware, including their rated capacity from the manufacturers for each size of pipe being installed. In addition, perform a visual review of the lifting equipment and hardware each day before installation for signs of damage or wear. Replace damaged or worn lifting equipment and hardware before use.
(b) **Trench and Bedding.** Excavate trench and construct bedding as shown on the PennDOT Standard Drawings. Compact the bottom of the trench before placement of bedding material. If flowable backfill material is used, provide support for pipe as specified in Section 220.3(b)2.

(c) **Laying Pipe.** Lay pipe as shown on the PennDOT Standard Drawings before constructing base course or pavement. Lay pipe with bells or grooves up grade in shaped recesses when required, spigot end fully entered into the hubs. Begin placement of the pipe at the outlet end with a full length of pipe and continue towards the inlet end, unless otherwise directed. Fill lift holes with a manufactured lift hole plug that is soil tight.

Control the pipe alignment and grade with suitable string lines, with an electronic laser beam system, or by other acceptable methods.

Camber the grade line to offset anticipated settlement due to the height of embankment and bedding used, if directed.

On straight-line pipe placements, join pipe sections within 1/4-inch per foot of inside diameter or 1 inch, whichever is less. Join pipes placed on a radius to within these tolerances as measured at a point halfway up the pipe, springline, along the interior of the curve. For pipe runs placed on curves with a radius less than 765 yards (greater than 2 degrees 30 minutes) use shorter lengths of precast pipe to minimize the joint gap.

If pipes are protected by endwalls or connected with drainage structures, place exposed pipe end within cast-in-place wall or cut off flush with precast structure face and finish with mortar, as directed. Provide satisfactory connections to existing drainage structures.

Coat all aluminum surfaces that will be embedded into concrete with one coat of zinc chromate primer, or a coat of bituminous paint. Allow coating to dry completely before placement of concrete.

(d) **Joints.** Lay pipe, except interlocking style and pipe joined with bands, with pipe caulk or preformed pipe joint gaskets as follows:

1. **Pipe Joint Caulk.** Before placing succeeding pipe sections, place the caulk on the inside of the bell end of the pipe, such that a sufficient layer of material is placed around the entire circumference of the pipe. After the joint is assembled, remove excess caulk on the inside of the pipe, such that the flow of water is not obstructed and seal the outside of the circumference of the joint.

2. **Preformed Pipe Joint Gaskets.** Before placing succeeding pipe sections, place preformed pipe joint gaskets according to manufacturer’s recommendation.

(e) **Elongation of Metal Pipes.** When indicated, elongate metal pipe vertically 5%, using acceptable shop methods. Elongate coated pipe by acceptable shop methods only. Satisfactorily repair coating damaged by elongation procedures.

(f) **Backfilling Trench.** After the pipe is laid, backfill the trench as shown on the PennDOT Standard Drawings. Place material in 4-inch layers. However, 8-inch layers will be permitted if vibratory compaction equipment is used. Compact each layer of backfill to the density shown on the PennDOT Standard Drawings to a height of 4 feet above the top of the pipe, for the full trench width. Use mechanical tampers or other acceptable compaction equipment that will not damage the pipe. Use of excavator-mounted hydraulic plate compactors are permitted only outside of the toe of slope. Do not use excavator mounted hydraulic plate compactors under roadway, sidewalk, shoulder, and side slope areas. Compact backfill material to the density shown on the PennDOT Standard Drawing as determined by Standard Proctor Density (SPD). Test as specified in Section 206.3(b)1. Test the coarse aggregate backfill for reinforced concrete pipe before placing remaining backfill. If flowable backfill material is used, backfill the trench as shown in the Flowable Backfill Detail on the PennDOT Standard Drawings, and as specified in Section 220.3.
(g) Shored or Trench Box Installation. Construct shored or trench box installation where indicated and as specified in Section 107.08.

Construct shored or trench box installation as required for reinforced concrete pipe.

Construct shored or trench box installations for thermoplastic or metal pipe as follows:

- Leave trench sheeting in place to prevent loss of foundation support and backfill materials unless otherwise directed by the Bridge Engineering Manager. When the top of trench sheeting is to be cut off, make the cut 18-inch or more above the crown of the pipe. Leave rangers, whalers and braces in place as required to support the cut off sheeting and trench wall in the vicinity of the pipe zone. Leave timber sheeting in place. Treat timber sheeting against biological degradation and decay if placed above the ground water table.

- Do not disturb the installed pipe and its embedment when using movable trench boxes and shields. Do not use movable supports below the top of the pipe backfill pay limit zone unless approved methods for maintaining the integrity and level of compaction of the backfill material are submitted to and approved by the Bridge Engineering Manager. Before moving supports, place and compact embedment to sufficient depths to ensure protection of the pipe. Finish placing and compacting the backfill material as supports are moved.

- If the use of sheeting or other trench wall supports is permitted by the Representative below the pipe backfill pay limit zone, ensure that pipe, bedding and backfill materials are not disturbed by support removal. Fill voids left upon removal of supports and compact all material to required densities.

(h) Jacked Pipe. Jack pipe by means of conventional tunneling or boring methods, when indicated. Before commencement of this work, submit a complete plan and schedule for pipe installation. Include complete details of sheeting, shoring, and bracing for the protection of facilities above the pipe, as well as materials and equipment pertinent to the jacking operation. Do not proceed with pipe installation until the plan and schedule have been accepted.

Do not disturb facilities or cause settlement of the ground above the pipe. Provide free and unobstructed use of facilities above the pipe, without delay or danger to life, equipment, or property.

Install pipe immediately following the heading or tunneling excavation. After completion of the jacking operation, fill voids around the pipe with grout placed under pressure. Properly protect the grout for at least 3 days.

Place joint sealant material on concrete pipe in front of the jacking frame. Replace or repair pipe damaged during the jacking operations, as directed. If steel casing pipe is used, butt-weld the joints as installation progresses. Make joints watertight.

If it is determined that the pipe installation is being conducted in an unsatisfactory manner, stop this work and place a bulkhead at the heading until an alternate procedure is proposed and accepted.

(i) Extension of Existing Pipe. If extensions of pipe culverts or drains are indicated or required, remove the existing endwalls, as directed. Cut the existing pipe to a true edge, as required, to make a satisfactory joint. Join the new pipe to the existing pipe or endwalls, using acceptable collars constructed of Class A Concrete or Bulletin 15 approved connecting bands. Clean the existing pipe, according to Section 601.3(j). Repair or replace existing pipe damaged during construction.

As an alternate to removing the endwall, if permitted, extend the pipe using a concrete collar for pipe extension, as specified in Section 618.

(j) Cleaning Existing Pipes. Clean existing pipe culverts, as indicated and as directed, before the start of roadway paving operations. Clean inlets, bridge scuppers and piping, manholes, endwalls, and other drainage appurtenances connected to the pipes, as directed. Clean in an acceptable manner and repair
damage resulting from the cleaning operation. Remove any material deposited in inlets during paving or construction operations. Waste material removed from pipes and inlets as specified in Section 105.14.

Perform cleaning in such manner as will not contribute to the pollution of existing watercourses, streams, drainage features, and wetlands. Ensure that cleaning methods meet with the approval of the Department of Environmental Protection or any other organizations legally concerned with the control of pollution of watercourses, streams, drainage features and wetlands. Contain erosion control within the existing drainage system.

(k) Reset Pipe. If indicated or as directed, reset outlet sections of existing pipes in the same manner specified for new pipes.

(m) Removal and Replacement. Remove and replace pipe that is not true to alignment, shows settlement after installation, is broken, or is damaged.

(n) Inspection of Pipes. Before final acceptance, inspect all of the following types of installed pipe with total backfill/embankment load applied. Perform inspection on pipes at least 30 days after backfill/embankment is completed. The inspection may be performed before final paving is complete. Provide pipe inspection equipment and inspect all pipes over 30 inches in diameter from inside the pipe. Inspect 18-inch to 30-inch diameter pipes from access points. Provide written documentation of all inspections to the Representative within 72 hours following each inspection.

1. Concrete Pipes. Provide pipe gages, as specified in Section 601.2(a) 3.d.2 and inspect concrete pipes for signs of damage including offset joints, bell/spigot shear failure, joint separation, cracks greater than 0.007 inch in width, spalls, damaged or cracked ends, and visible reinforcement. If signs of damage are identified during inspection, submit a plan for repair or replacement as specified in Section 601.3(p) for approval.

2. Metal Pipes. Inspect metal pipes for damage including rust, cracking of coatings, damaged galvanization or lining, joint separation, loose bolts, dents, and areas of buckling. Repair damaged coatings according to AASHTO M 36/M 36M and AASHTO M 245/M 245M. Perform deflection testing using either electronic deflectometers, calibrated television or video cameras, properly sized, 9-leg (minimum) “go, no-go” mandrel, direct measurement by extension rulers or tape measures in pipes that allow safe entry, or other acceptable devices. At a minimum, perform deflection testing if pipe cannot be physically inspected. Develop and submit a remediation or replacement plan as specified in Section 601.3(p) if deflection is greater than 7.5% of a round pipe nominal diameter plus a manufacturing tolerance of 1% or 1/2-inch undersize, whichever is greater. For pipe arch, the deflection limits are a 7.5% decrease in rise and a 7.5% increase in span from the nominal dimension with no allowance for manufacturing tolerance.

3. Thermoplastic Pipes. Inspect thermoplastic pipes for damage including cracking, buckling, and joint separation, and perform deflection testing. If the pipe run is 40 feet or less in length, not under the roadway, and the initial visual inspection does not indicate any deflection or other deficiencies, additional testing will be waived. In all other cases, perform the deflection testing using either electronic deflectometers, calibrated television or video cameras, properly sized "go, no-go” mandrel, direct measurement by extension rulers or tape measures in pipes that allow safe entry, or other acceptable devices. Perform deflection testing at a minimum if pipe cannot be physically inspected. Develop a remediation or replacement plan as specified in Section 601.3(p) if deflection is greater than 5% of the unloaded inside diameter of the pipe, or cracking, buckling, or joint separation is found. Provide the unloaded inside diameter pipe size from the manufacturer for each pipe type and size delivered to the project.

(o) Not used.
(p) Remediation. Remedial action may include but is not limited to removal and replacement or an accepted repair procedure. Submit all pipe remediation plans to the Representative for approval. All pipe remediation plans detailing either removal and replacement or repair must be prepared and sealed by a Professional Engineer registered in the State.

601.4 MEASUREMENT AND PAYMENT—

(a) Pipe Culverts. Liner Foot.
Measured to the point of centerline intersection of "T," "Y," and other branches. The unit price includes the pipe, excavation, the bedding material, coarse aggregate, removal of existing structures, connections, re-grading and backfill. Also includes shoring and trench box when necessary. Furnishing personnel and equipment for dewatering operations, inspection of pipes, and all remedial measures are incidental to the pipe items.
If the pipe item for shore/trench box is indicated or required; the unit price includes placement and removal or keeping in place of shoring, supports, shield systems and trench boxes as specified in Section 601.3(g).

(b) Reset Existing Drainage Pipe Outlets. Linear Foot

(c) Half-Circle Pipe. Linear Foot
Includes excavation, bedding and anchors.

(d) Cement Concrete for Miscellaneous Drainage. Cubic Yard
As indicated, for the class specified, for the item indicated.
Includes reinforcement when required.

(e) Cleaning Existing Pipe Culvert - Linear Foot or Lump Sum.
1. Cleaning Existing Drainage System - Lump Sum. Includes all pipes and inlets within the project limits.

2. Cleaning Existing Pipe Culverts, Diameters up to and including 36-inches – Linear Foot. Measured from inlet end to outlet end through existing inlets, manholes, endwalls and other drainage appurtenances along the pipe centerline.

3. Cleaning Existing Pipe Culverts, Diameters over 36-inches – Linear Foot. Measured from inlet end to outlet end through existing inlets, manholes, endwalls and other drainage appurtenances along the pipe centerline.

(f) Jacked Pipe. Linear Foot
Payment includes excavation.

(g) Flowable Backfill Material. As indicated, for all pipe installations, flowable backfill and geotextile are incidental to linear foot of pipe payment.