DIVISION 4
DRAINAGE FEATURES

Section 401. CULVERTS

401.01 Description.

A. **Pipe Culverts.** Construct pipe culverts of the size and class specified, including excavation and backfill. Pipe culverts are divided into six classes as shown in Table 401-1.

When only the size and class of culvert are specified, furnish any of the alternates permitted in Table 401-1.

When a particular type of culvert material is required instead of the classes designated in Table 401-1, the type and size of the culvert will be specified in the contract documents.

A higher strength or greater thickness of culvert may be substituted for the minimum strength or minimum thickness of culvert specified.

B. **Precast Box Culverts.** Design, manufacture, and install a precast concrete box culvert. Provide necessary dewatering; maintain the water flow during construction stages; furnish and install gaskets to seal the culvert joints; and furnish and place geotextile blanket over the exterior of the culvert joint surface.

Construct precast concrete box and appurtenances according to the details shown in the plans, and specified here.

401.02 Materials. Use materials meeting the following.

- Concrete, Grade S2 .................................. 701
- Mortar, Type R-2 .................................... 702
- Granular Material Class II, III, IIIA .................. 902
- Coarse Aggregate 6A .................................. 902
- Open-Graded Aggregate 34R .......................... 902
- Asphaltic Materials .................................. 904
- Culvert Pipe ........................................... 909
- Precast Concrete Box Culvert ........................ 909
- Sealers for Culvert Joints ............................. 909
- Steel Pipe (for jacking in place) ..................... 909
- Drainage Marker Post .................................. 909
- Geosynthetics ......................................... 910
Table 401-1 Pipe Alternates for Culvert Classes

<table>
<thead>
<tr>
<th>Type of Pipe</th>
<th>Class A Culvert 0 to 10</th>
<th>Class B Culvert &gt;10 to 16</th>
<th>Class C Culvert &gt;16 to 23</th>
<th>Class D Culvert &gt;23 to 33 (i)</th>
<th>Class E Culvert 0 to 3 (b)</th>
<th>Class F Drive Culvert (c)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reinforced Concrete Pipe (d)</td>
<td>II</td>
<td>III</td>
<td>IV</td>
<td>V</td>
<td>IV</td>
<td>II</td>
</tr>
<tr>
<td>Nonreinforced Concrete Pipe (e)</td>
<td>1</td>
<td>3</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>1,3 (f)</td>
</tr>
<tr>
<td>Corrugated and Spiral Ribbed Al-Alloy Pipe</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Corrugated and Spiral Ribbed Steel Pipe</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Smooth-Lined Corrugated Plastic Pipe (CPE) (g) (h)</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
</tbody>
</table>

a. Cover, including the pavement structure is defined as the height of fill above the top of the pipe.
b. Class E culvert applies when the culvert is beneath the influence of proposed pavement and the depth of cover is 3 feet or less.
c. Class F culvert applies for driveway culverts (residential and commercial).
d. Roman numerals refer to class of reinforced concrete pipe, AASHTO M 170.
e. Arabic numerals refer to the class of nonreinforced concrete pipe, AASHTO M 86.
f. Nonreinforced concrete pipe Class 1 is allowed for Class F culverts with a depth of cover up to 10 feet. Nonreinforced concrete pipe class 3 is allowed for Class F culverts with a depth of cover greater than 10 feet but less than or equal to 16 feet.
g. CPE must conform to AASHTO M 294, Type S polyethylene pipe.
h. Permitted only for 24-inch diameter pipe and under for CPE pipes. Minimum cover 2 feet (measured from top of pipe to final grade). 30 and 36-inch pipe are approved for selected state projects only and must be installed according to the contract documents.
i. Special design is required for fill heights greater than 33 feet.
Use closed-cell rubber extrusion type gaskets according to ASTM C 990.

Use $\frac{3}{4}$-inch diameter inserts or approved equal.

Use grout for jacked in place steel pipe consisting of a mixture of Portland cement and sand not exceeding 50 percent sand by volume.

**401.03 Construction.**

A. **Design of Precast Concrete Box Culverts.** Design precast box culverts according to the criteria found in Division I, section 17.7 of the AASHTO Standard Specifications for Highway Bridges and ASTM C 1433. The joint design must be suitable for the joint sealing material specified herein and must conform to section 8 of ASTM C 1433.

When the precast concrete box culvert carries Interstate (I), United States (US) or Michigan (M) route traffic, or on and off ramps for these routes, design the culvert to carry AASHTO HS20 Live Loads as prescribed in Table 1 or Interstate Alternate Live Loads as prescribed in Table 2 of ASTM C 1433, whichever produces the maximum circumferential reinforcement area. As an alternative to using the design Tables, the current version of the FHWA approved BOXCAR program may be used to design the culverts.

Furnish documentation from the fabricator showing the adequacy of the culvert design. This documentation must be sealed by a Professional Engineer licensed in the State of Michigan.

B. **Shop Drawings for Precast Concrete Box Culverts.** Submit shop drawings to the Engineer for review and approval according to subsection 104.02 including the precast box culvert section and construction details of the joints and connections. Shop drawings must show inserts and connection details for attachment of the head walls, wing walls, aprons and curtain walls, as detailed in the plans. Shop drawings for precast head walls, wing walls, aprons and curtain walls may be submitted as an alternative to cast-in-place sections shown on the plans.
Submit shop drawings to the Engineer for review at least 15 working days prior to fabrication. Do not begin fabrication until receipt of written approval of the shop drawings from the reviewing Engineer.

Call attention to all deviations from the contract documents. If deviations have not been clearly identified, they will not be considered as part of the shop drawing approval.

C. Excavation and Culvert Bedding. Excavate according to subsection 206.03.A. Construct pipe culvert bedding using granular material Class IIIA placed in layers not more than 10 inches thick and compact each layer to not less than 95 percent of maximum unit weight for the entire length of the culvert. Where rock or hardpan is encountered, excavate the trench to a minimum of 6 inches below the proposed bottom of the pipe; backfill with granular material Class IIIA and compact.

Construct culvert bedding for the proposed box culvert structure to the limits and depth shown on the plans. Use materials for the culvert bedding consisting of a minimum depth of 9 inches of coarse aggregate 6A (at least 80 percent crushed) covered with 3 inches of open-graded aggregate 34R. Before placing the 34R aggregate, compact the 6A aggregate using a minimum of three passes with a vibrating plate compactor. Compact the 34R aggregate using a minimum of one pass with a vibrating plate compactor.

D. Repair of Damaged Coated Surfaces. Repair galvanized coated culvert surfaces, damaged in transporting, handling, or installing the pipe, according to subsection 716.03.E. Repair other culvert surfaces as directed by the Engineer. The cost of repair to coated culvert surfaces will be borne by the Contractor.

E. Laying and Jointing Pipe. Lay all culverts true to the lines and grades given, bells or grooves upgrade, ends fully and closely jointed, and with full, firm bearing throughout its length. Select all pipe sections/joint assemblies for use in culverts from the Qualified Products List. Provide a field assembly diagram to the Engineer. For pipe with diameters greater than 24 inches, wrap pipe joints with geotextile blanket. Provide geotextile blanket with a minimum width of 36 inches and center it on the joint.

Culvert sections showing signs of settlement or poor alignment, as determined by the Engineer, must be taken up and relaid. Remove, replace and mandrel test, if required, any culvert damaged by the Contractor’s operations.
The cost of this corrective action will be borne by the Contractor.

1. **Corrugated Plastic Pipe.** Provide homing marks on smooth lined corrugated plastic pipe (CPE) to show correct alignment of the pipe sections and joint material during field installation.

   After the required compaction of the trench backfill has been achieved, the Engineer will select at least fifty percent of the installed length of each size of CPE to be tested for deformation. The Contractor is responsible for all labor and equipment required to complete this testing. Use a nine point mandrel with an effective diameter equal to 95 percent of the nominal pipe diameter. Provide the Engineer with a proving-ring to verify mandrel size. Conduct the mandrel testing between 5 and 10 working days before pavement surfacing or completion of final grade, unless otherwise approved by the Engineer.

   Remove and either reinstall or replace, at no additional cost to the Department, pipe with diameter reduced by 5 percent or more. Only pipe which is not damaged may be reinstalled. Do not reinstall such pipe without prior approval of the Engineer.

   All expenses and delays due to the replacement of deformed or damaged pipe will be the Contractor’s responsibility.

2. **Concrete Pipe.** Install reinforced concrete elliptical pipe with the longer axis placed horizontally unless otherwise specified.

   Install Type HE elliptical pipe with the longer axis placed within ±5 degrees of horizontal.

   Install Type VE elliptical pipe with the longer axis placed within ±5 degrees of vertical.

   Install circular concrete pipe with elliptical reinforcement with the lift holes on top of the pipe. Install so the manufacturer’s marks designating the top and bottom of the pipe is not more than 5 degrees from the vertical plane through the longitudinal axis of the pipe. After the pipe is installed, seal the lift holes with concrete plugs and waterproof.

3. **Metal Pipe.** Do not use wedge lock dimple bands for corrugated metal pipe.
401.03

Do not use dissimilar types of base metal (steel or aluminum alloy) or dissimilar types of coatings on steel (zinc or aluminum) in a single line of pipe. However, use of zinc coated steel end sections with aluminum coated steel pipe is acceptable. Use coupling bands of the same base metal and coating metal as the pipe.

4. **Box Culverts.** Fill the space between the box culvert joints during placement of box sections with closed-cell rubber extrusion type gaskets according to AASHTO M 198. Use gasket size and installation methods recommended by the manufacturer and approved by the Engineer.

Treat every precast concrete box culvert exterior joint, after placement, with cold applied culvert joint sealer and cover with a 36 inch wide strip of geotextile blanket centered on the joint.

5. **Extending Culverts.** Cast a concrete collar with a minimum thickness of 3 inches extending 6 inches each side of the joint when extending a pipe culvert. Wrap the connecting joint with a 36-inch wide geotextile strip centered on the joint. An angle bolt dimple band is allowed instead of a concrete collar on the first connection when extending an existing corrugated metal pipe with a corrugated metal pipe if the existing culvert is in good condition and circular in cross section. The Engineer will approve other methods of connecting to the existing pipe before construction. Provide joints according to MTM 723 for all remaining joints of the extension.

F. **Backfilling.**

1. **Pipe Culvert.** Backfill all culverts within the limits of the roadbed with granular backfill material Class II, III, or IIIA. Place in layers not more than 10 inches thick and compact each layer to not less than 95 percent of maximum unit weight. Backfill culverts or portions of culverts outside the limits of the roadbed with material approved by the Engineer that can be compacted to not less than 95 percent of maximum unit weight, contains no organic material and has a maximum unit weight of at least 95 pounds per cubic foot. Maintain a minimum of 3 feet of cover, unless trimming for final grades.

Use granular material Class IIIA to a minimum of one foot above the pipe and as detailed on the plans as backfill material for smooth lined corrugated plastic pipe (CPE). Class II backfill may be used above this elevation. Place the backfill in layers not more than 10
inches or one-half the pipe diameter, whichever is less. Place the backfill equally on opposite sides of the pipe at the same time.

Maintain the line and grade of the culvert during the backfilling operation by staking or other methods if necessary.

2. **Box Culvert.** Use Granular Material Class II placed according to subsection 206.03 as backfill for precast concrete box culverts. Place and compact backfill on opposite sides of the culvert at the same time.

   The Contractor is responsible for all construction traffic on the culvert. Submit to the Engineer the manufacturer’s minimum fill depth required for construction traffic over the culvert. Do not exceed the specified design loads with construction traffic.

   Replace damaged units at no additional cost to the Department.

G. **Headwalls and End Sections.** Protect the ends of the culvert by headwalls or end sections constructed according to details on the plans. Construct headwalls according to section 706.

   Use precast concrete end sections on concrete culverts. When footings are required for precast end sections, use either precast or cast-in-place footings. Form or place them at the locations and to the elevations shown on the plans.

   Construct the wing walls and aprons for precast concrete box culverts with a positive connection to the adjoining precast section using 3/4-inch diameter threaded bars or as shown on the plans. Form the inside edges between the wing walls and sidewalls and between the top slab and face of the headwall with radii as shown on the plans. Lay the box culvert sections in stages to coincide with maintaining traffic, dewatering, temporary pumping and part width construction sequence and as approved by the Engineer. Precast wing walls, headwalls, and aprons are acceptable alternatives for cast-in-place wing walls, headwalls, and aprons.

   Use metal end sections on corrugated metal pipe culverts. Attach metal end sections to the ends of corrugated metal pipe by means of standard metal bands or other connecting devices as detailed on the plans or as approved by the Engineer. Furnish and install toe plates on the metal end sections when called for on the plans.
Provide either precast concrete or metal end sections for use with corrugated plastic pipe. Do not use plastic end sections. Fasten end sections securely to the pipe as recommended by the pipe manufacturer or as directed by the Engineer. Use of a metal end section that is one size larger in diameter than the corrugated plastic pipe is acceptable. Slip the end section over the end of the pipe and securely fasten, making sure that the portion of the plastic pipe left exposed is less than 3 inches. If a concrete end section is used, wrap the joint with a strip of geotextile blanket 36 inches wide and centered on the joint.

Furnish and install end section grates for culvert end sections on designated culvert end sections. Fabricate end section grates from any grade of weldable hot-rolled steel bars, plain or deformed, of the diameter and configuration specified on the plans. Fasten grates securely to the concrete end sections as called for on the plans.

Place salvaged end sections according to the specifications for placing new end sections.

H. Drainage Marker Posts. Place drainage marker posts at headwalls and culvert end sections for culverts 36-inches in diameter or less and at all outlet endings.

I. Pipe Culverts Jacked in Place. Furnish all equipment and labor required to jack into place a pipe culvert of the size and type detailed on the plans. Jack the culvert into place to the line and grade shown on the plans or established by the Engineer.

When jacking pipe under railroad tracks, submit sheeting and bracing plans for the jacking pits, through the Engineer, for approval by the railroad company. Do not begin excavation of the jacking pit until the approval has been received.

Excavate the approach trench large enough to accommodate all jacks and blocking and at least one section of pipe. Lay two rails or sills in the bottom of the trench to keep the pipe at the established line and grade.

Minimize excavation ahead of the pipe to prevent caving of the earth. Attaching a steel cutting edge or shield to the front section of pipe to form and cut the required opening for the pipe is acceptable.

Fill voids between the excavation and the pipe using materials and placing methods approved by the Engineer.
J. **Steel Pipe Jacked in Place.** Jack steel pipe in place to serve as a carrier pipe or a casing for a carrier pipe. Jack steel pipes in place according to subsection 401.03.I.

K. **Steel Casing Pipe.** Install steel casing pipe in a trench as detailed on the plans. Provide steel casing pipes placed for future use with a temporary bulkhead at each end to prevent infiltration into the pipe.

L. **Corrugated Steel Culvert.** Do not use dissimilar type of base metal (steel or aluminum alloy) or dissimilar types of coatings on steel (zinc or aluminum) in a single line of pipe.

M. **Disposal of Surplus Material.** Dispose of surplus material according to subsection 205.03.P.

N. **Cleanout.** Maintain all culverts installed on the project. All culverts installed on the project must be free of silt, debris, and other foreign matter above the existing flow line of the drainage course at the time of final acceptance.

O. **Video Inspection.** Video inspect culverts as detailed for sewers in subsection 402.03.K. Video inspection is not required for driveway culverts; culvert extensions less than 50 feet; new culverts less than 50 feet; extension of catch basin leads less than 20 feet or culverts greater than 36 inches in diameter.

P. **Dewatering and Maintaining Stream Flow During Construction.** Perform all dewatering or pumping and temporary drainage for maintaining stream flow during construction to avoid damage to adjacent property or structures and without interfering with the rights of the public, owners of adjacent properties, vehicular traffic or the work of other contractors. Dewater and temporarily pump so that the soil under and next to existing structures is not disturbed.

Direct all water from dewatering operations or from maintaining stream flow to a filter bag before discharging to an existing drainage facility. Do not overload or obstruct existing drainage facilities.

**401.04 Measurement and Payment.**

<table>
<thead>
<tr>
<th>Contract Item (Pay Item)</th>
<th>Pay Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Culv, Cl___, ___ inch</td>
<td>Foot</td>
</tr>
<tr>
<td>Culv, Cl___, (material), ___ inch</td>
<td>Foot</td>
</tr>
<tr>
<td>Culv, Precast Conc Box, (span) foot (rise)</td>
<td>Foot</td>
</tr>
<tr>
<td>Culv, Reinf Conc Ellip, Cl___, (rise) inch</td>
<td>Foot</td>
</tr>
</tbody>
</table>

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401.04
Culv, CSP Arch, Cl, (span) inch by (rise) inch .......... Foot
Culv Bedding ................................ Cubic Yard
Culv Bedding, Box Culv, .................................. Cubic Yard
Culv, Slp End Sect, (slope), __ inch, Longit ............. Each
Culv, Slp End Sect, (slope), __ inch, Transv ............. Each
Culv, Slp End Sect, Arch Pipe, (slope),
(span) inch by (rise) inch, Longit ............. Each
Culv, Slp End Sect, Arch Pipe, (slope),
(span) inch by (rise) inch, Transv ............. Each
Culv, Slp End Sect, Ellip Pipe, (slope),
(rise) inch by (span) inch, Longit ............. Each
Culv, Slp End Sect, Ellip Pipe, (slope),
(rise) inch by (span) inch, Transv ............. Each
Culv End Sect, (material), __ inch ..................... Each
Culv End Sect, __ inch .................................. Each
Culv End Sect, Footing .................................. Each
Culv End Sect, Grate .................................... Pound
Culv, Cl, __ inch, Jacked in Place .................... Foot
Steel Casing Pipe, __ inch, Jacked in Place ............ Foot
Steel Casing Pipe, __ inch, Trench Det ................. Foot
Dr Marker Post .................................. Each
Culv End Sect, Salv, 30 inch or less ................. Each
Culv End Sect, Salv, over 30 inch ..................... Each

A. **Pipe Culvert.**

1. **Culvert** of the diameter, class and/or material specified will be measured by length in feet excluding the length of end section as detailed on the plans. Payment for culverts includes excavating the material down to grade or to the culvert bedding bottom elevation, dewatering and maintaining the stream flow during construction stages, disposing of excess material, furnishing and placing the culvert and geotextile strip, mandrel testing when required, and furnishing, placing, and compacting the backfill. The cost of providing temporary cover and restraining the pipe to maintain line and grade is included in the item of work.

2. **Culv, Jacked in Place** of the size and type specified, will be measured by length, determined by multiplying the number of units actually jacked by the commercial laying length. Payment includes all items necessary to complete the work including the pit, sheeting, bracing, jacking equipment, drainage, safety devices, and all other items associated with the operation.
B. **Box Culvert.** Payment for **Culv, Precast Conc Box**, includes all work required to design, manufacture, and install the precast elements. This contract item includes cold applied culvert joint sealer, closed-cell rubber extrusion type gaskets, geotextile pipe wrap for box culvert joints, inserts for the size of bars specified, dewatering and maintaining the stream flow during construction stages. Excavation and backfill will be paid for separately.

If precast wing walls, headwalls, aprons, or curtain walls are used in lieu of cast-in-place wing walls, headwalls, aprons, and curtain walls, they will be paid for as the corresponding pay items for the cast-in-place wing walls, headwalls, aprons, and curtain walls as detailed in the contract documents.

C. **Culv Bedding** and **Culv Bedding, Box Culv** will be measured by volume compacted in place to the depth, length, and width as shown on the plans or directed by the Engineer to provide a stable foundation for the culvert. Payment for **Culv Bedding, Box Culv**, includes all labor, equipment, and material necessary to place and compact the coarse aggregate 6A and open-graded aggregate 34R. Payment for **Culvert Bedding** includes the cost of excavating and disposing of the unsuitable material and furnishing, placing, and compacting the bedding material. When rock excavation is required, it will be paid for separately according to subsection 205.04.

D. **Culvert End Sections.**

1. **Culv, Slp End Sect** of the size and shape specified includes furnishing and placing the end section, including the longitudinal and cross tubes.

2. **Culv End Sect, (material)** of the size and type required includes furnishing and placing the end section. Riprap required will be paid for according to subsection 813.04.

3. Metal end sections will be paid for as **Culv End Sect, Metal** of the size required. The length of culvert represented by the “c” dimension, which is detailed on the plans, is included in the length of **Culv End Sect, Metal**. Payment includes the cost of furnishing and placing the end section and a toe plate, if specified on the plans.

4. Footings required for precast concrete end sections will be paid for as **Culv End Sect, Footing.** Payment for the work includes all excava-
401.04

tion, forming, furnishing and placing the steel reinforcement, and
furnishing, placing, finishing, and curing the concrete for the footing
according to the plans.

5. When corrugated plastic pipe is furnished, the end section will be
paid for as **Culv End Sect** of the diameter specified for the culvert,
even when the Contractor furnishes a metal end section larger than
the nominal diameter of the pipe. The cost of fastening the end
section to the pipe is included in the payment for the end section.

6. Payment for **Culv End Sect, Salv** of the diameter specified, includes
removing the existing end section, salvaging and storing, and re-
installing as required. **Culv End Sect Grates** will be measured by
weight in pounds as indicated on the plans for the size of grate
specified.

7. End sections which become damaged during salvaging or replacing
shall be replaced with the same size of end section as the original
and all costs of replacement will be borne by the Contractor.

E. Headwalls will be measured and paid as steel reinforcement and
concrete, Grade S2, according to subsection 706.04. If precast wing
walls, headwalls, and aprons are used in lieu of cast-in-place wing
walls, headwalls, and aprons, they will be paid for as the corresponding
pay items for the cast-in-place wing walls, headwalls, and aprons as
detailed in the contract documents.

F. Whenever steel pipe is jacked in place to act as a casing at the
option of the Contractor, it will not be paid for separately and any
required grouting between the carrier and casing pipes will be included
in payment for the carrier pipe.

G. Payment for **Steel Casing Pipe** of the size and trench detail shown
will include all excavation and backfill necessary to complete the item.
Payment for pipe inserted into the casing will be paid for at the unit
price for pipe installed in trench. Payment will include casing chocks,
inserting the pipe, and grouting as required to install the carrier pipe.

H. **Video Taping Sewer and Culvert Pipe** will be measured and paid for
according to Subsection 402.04.