

## 520 Pipe Culverts

### 520.1 Description

- (1) This section describes providing culvert pipe, cattle pass, and apron endwalls; providing and removing temporary culvert pipe; and cleaning existing culvert pipes.

### 520.2 Materials

#### 520.2.1 Culvert Pipe

- (1) Furnish culvert pipe fabricated in a plant listed on the [APL](#) consistent with the diameter the bid item indicates. Furnish materials for the various classes of pipe as follows:

**TABLE 520-1 ALLOWABLE MATERIALS FOR CULVERT PIPE**

CLASS	ALLOWABLE MATERIALS
III	Class III reinforced concrete, corrugated steel pipe of the thickness the contract designates
III-A	Class II and Class III reinforced concrete, corrugated steel of the thickness the contract designates, corrugated polyethylene, corrugated polypropylene
III-A Non-metal	Class II and Class III reinforced concrete, corrugated polyethylene, corrugated polypropylene
III-B	Class III reinforced concrete, corrugated steel of the thickness the contract designates, corrugated polypropylene
III-B Non-metal	Class III reinforced concrete, corrugated polypropylene
IV	Class IV reinforced concrete, corrugated steel pipe of the thickness the contract designates
V	Class V reinforced concrete, corrugated steel pipe of the thickness the contract designates

- (2) Conform to the following:

Corrugated steel pipe .....	<a href="#">521.2</a>
Reinforced concrete pipe .....	<a href="#">522.2</a>
Corrugated polyethylene pipe .....	<a href="#">530.2</a>
Corrugated polypropylene pipe .....	<a href="#">530.2</a>

- (3) Under the Culvert Pipe Temporary bid items, use either new or used culvert pipe in a condition suitable for the purpose intended.

#### 520.2.2 Pipe Cattle Pass

- (1) Under the Pipe Cattle Pass bid item, if the plans do not designate a specific material, the contractor may use either corrugated steel or reinforced concrete. Conform to the following:

Corrugated steel pipe cattle pass .....	<a href="#">521.2</a>
Reinforced concrete pipe cattle pass .....	<a href="#">522.2</a>

#### 520.2.3 Apron Endwalls for Culvert Pipe

- (1) Under the Apron Endwalls for Culvert Pipe bid items, use steel apron endwalls for corrugated steel, corrugated polyethylene, and corrugated polypropylene pipe culvert installations, and use concrete apron endwalls with concrete pipe culvert installations. Conform to the following:

Steel apron endwalls .....	<a href="#">521.2</a>
Concrete apron endwalls .....	<a href="#">522.2</a>

#### 520.2.4 Concrete Pipe Collars and Cattle Pass Walkways

- (1) For concrete collars and cattle pass walkways, furnish grade A concrete conforming to [501](#) as modified in [716](#). Provide QMP for class III ancillary concrete as specified in [716](#).

#### 520.2.5 Backfill

##### 520.2.5.1 General

- (1) Submit daily quantities for material requiring department testing to the engineer as follows:
- For foundation backfill.
  - For trench backfill not obtained from the excavation.
- (2) Determine quantities at the point of placement by collecting truck tickets as the material is placed or by another engineer-approved method. Submit tickets as specified in [109.1.4.2](#).
- (3) Ensure there is adequate moisture in backfill during placing, shaping, and compacting to prevent segregation and achieve adequate compaction.

## 520.2.5.2 Foundation Backfill

### 520.2.5.2.1 General

- (1) Furnish virgin materials consisting of sand-sized particles or sand-sized particles mixed with gravel, crushed gravel, or crushed stone. Do not use materials classified under [301.2.4.3](#) as crushed concrete, reclaimed asphalt, reprocessed material, or blended material. The contractor may use material from the work site.
- (2) Ensure that material provided has a liquid limit less than or equal to 25 and a plasticity index less than or equal to 6.

### 520.2.5.2.2 Gradation

- (1) Furnish foundation backfill with a gradation conforming to the following:

- For the entire sample, conform to the following gradation limits:

SIEVE	PERCENT PASSING BY WEIGHT
1 1/4-inch	100
No. 4	25 - 100

- For the portion of the sample passing the No. 4 sieve, conform to the following gradation limits:

SIEVE	PERCENT PASSING BY WEIGHT
No. 4	100
No. 40	—
No. 100	0 - 30
No. 200	0 - 15.0

- (2) The contractor may substitute material with a gradation conforming to the following:

3/4-inch dense-graded base course ..... [305.2.2.1](#)

1 1/4-inch dense-graded base course ..... [305.2.2.1](#)

### 520.2.5.2.3 Sampling and Testing

- (1) The department will sample and test material according to the following:

Sampling<sup>[1]</sup> ..... [AASHTO T2](#)

Percent passing the 200 sieve ..... [AASHTO T11](#)

Gradation<sup>[1]</sup> ..... [AASHTO T27](#)

Liquid limit ..... [AASHTO T89](#)

Plasticity index and plastic limit ..... [AASHTO T90](#)

<sup>[1]</sup> As modified in [CMM 860](#).

- (2) Submit contractor test results for gradation, liquid limit, and plasticity index testing to the engineer for approval before placing backfill. The engineer may waive contractor testing for known sources.

### 520.2.5.3 Trench Backfill

- (1) Furnish trench backfill consisting of material from the typical roadway section. Use material from the excavation that is free of large lumps, clods, rocks and other perishable and deleterious matter. If the engineer determines that material from the excavation is not suitable, backfill the trench with an engineer-approved material.

### 520.2.6 Joint Connections

#### **520.2.6 Revise joint connections to add seals and clarify information.**

- (1) Furnish seals for joint connections conforming to:

Concrete pipe joints using rubber gaskets ..... [ASTM C443](#)

Polyethylene and polypropylene pipe joints using rubber gaskets ..... [ASTM D3212](#)

Concrete pipe joints using preformed flexible joint sealants ..... [ASTM C990](#)

External sealing bands for concrete pipe ..... [ASTM C877](#)

Bituminous mastic joint sealer ..... [608.2](#)

- (2) Unless the contract specifies otherwise, provide pipe with joints and seals designed a minimum of soil tight except pipe joints with rubber gaskets shall be designed watertight. Minimum installed joint performance shall be per [520.3.3\(8\)](#).

- (3) Provide joint seals as follows:

- Provide pipe manufacturer recommended preformed flexible joint sealants or rubber gaskets for concrete pipe compatible with the joint design.

- For concrete pipe not designed to accommodate flexible joint sealants or rubber gaskets, seal the joints with pipe manufacturer recommended bituminous mastic and an external sealing band or a circumferential wrap of geotextile applied per [520.3.3\(4\)](#). Provide a manufacturer certification stating that the joint design can not accommodate preformed flexible joint sealants or rubber gaskets.
- Provide manufacturer recommended rubber gasket seals for all polyethylene and polypropylene pipe joints.

### **520.3 Construction**

#### **520.3.1 General**

- (1) Unless the engineer authorizes otherwise in writing, do not order or deliver pipe culverts for the project until the engineer furnishes a corrected list of sizes and lengths.
- (2) Provide temporary drainage facilities necessary to protect the work and adjacent property. Maintain temporary drainage in effective operating condition, as the engineer approves, until the permanent culvert pipe installations are operational. Remove and dispose of temporary culverts after the permanent culvert pipe installations are operational.
- (3) Place foundation and trench backfill in a way that does not damage the pipe.
- (4) Construct concrete cattle pass walkways using concrete conforming to [520.2.4](#) where and as the plans show.
- (5) Construct concrete collars using concrete conforming to [520.2.4](#) where and as the plans show. Also use collars for connections to existing pipe, existing endwalls, or dissimilar pipe materials where the engineer agrees a manufactured joint, coupling, or restraint cannot be used.

#### **520.3.2 Excavating and Constructing Foundations for Pipe Culverts**

##### **520.3.2.1 Public Highway Culvert**

- (1) If placing pipe culverts under a public highway in open trenches, either place in an excavation in the existing ground, or in previously placed embankment compacted as specified for embankment in [207](#). Place and compact embankment to at least one foot above the top of the culvert before excavating the trench. Avoid placing embankment to an elevation exceeding 2 feet above the top of the culvert before placing the culvert.
- (2) Perform trenching, shoring, and excavating according to 29 CFR part 1926, OSHA subpart P. Use shoring if utilities and other restraints make sloping or benching of the excavation impracticable.  
[http://www.dol.gov/dol/cfr/title\\_29/](http://www.dol.gov/dol/cfr/title_29/)
- (3) Make trenches wide enough to provide free working space on each side of the pipe, but not exceeding 1/2 the nominal pipe diameter and never less than 6 inches. The required working space depends upon the size of the pipe and the character of the material in the excavation; however, always provide sufficient space between the pipe and the sides of the trench to allow for preparing the foundation, laying the pipe, and placing and compacting the backfill. If the height of the proposed embankment or earth cover above the top of the pipe exceeds 6 feet, excavate the trench below the top of the pipe as vertical as possible.
- (4) For steel or concrete pipe, make the trench wide enough to allow for preparing the foundation, laying the pipe, and placing and compacting backfill, except that the trench width must not exceed the pipe's outside diameter by more than 36 inches. For polyethylene and polypropylene pipe, conform to [ASTM D2321](#) and ensure that the trench is as wide or wider than the pipe outside diameter plus 16 inches or the pipe outside diameter times 1.25 plus 12 inches whichever is wider.
- (5) Excavate the trench to at least 6 inches below the elevation established for the bottom of the pipe. Backfill to this depth with foundation backfill. Mechanically compact foundation backfill before laying the pipe. After laying the pipe, place and mechanically compact foundation backfill to an elevation of 12 inches above the pipe to provide full and continuous support. Do not place lifts more than 6 inches thick as measured after compaction. Compact the entire layer before placing the next layer. Do not compact by flooding if using foundation backfill with a dense-graded base gradation.
- (6) Excavate and backfill pipe arches as specified above, except backfill and trim to a height that fully and continuously supports the pipe arch.
- (7) If the engineer determines existing material for at least 6 inches below the bottom of the pipe conforms to [520.2.5.1](#); the contractor need not excavate, backfill, or shape the bed under the pipe.
- (8) If rock, hardpan, or fragmented material exists, excavate the trench below the pipe to a depth equal to 1/2 inch per foot of proposed embankment above the top of the pipe, but not less than 6 inches. Construct the foundation and backfill to 12 inches above the pipe with foundation backfill.
- (9) Excavate recesses to receive bells if necessary.

- (10) Notify the engineer if the proper bearing cannot be obtained 6 inches below the bottom of the pipe. Excavate unsuitable material as the engineer directs and backfill with foundation backfill.

#### **520.3.2.2 Rock Excavation for Culvert Pipe**

##### **520.3.2.2 Revise to add information for rock excavation.**

- (1) Classify rock excavation for culvert pipe as specified for rock excavation in [205.2.3](#), except include rock boulders with a volume of 1/2 cubic yard or more.

#### **520.3.2.3 Private Entrance and Temporary Culverts**

- (1) Shape the earth foundation for the pipe culverts for private entrances, and temporary installations to fit the pipe exterior for a height of at least 10 percent of the pipe's overall diameter.
- (2) If rock, hard pan, boulders, or fragmented material exist, bed the pipe on an earth, or granular bedding, compacted and shaped similarly to the above, for no less than 6 inches below the pipe.

#### **520.3.3 Laying Pipe**

##### **520.3.3 Expand joint seal information and performance requirement.**

- (1) Do not place any pipe culvert until the engineer approves the foundation. Additionally, do not place pipe culverts in cuts until completing the rough grading.
- (2) Unless the plans show otherwise, if laying 2 or more pipes next to each other, separate them by a distance equal to at least 1/2 the pipe diameter, with a minimum distance of 18 inches. For pipes with attached apron endwalls, separate them by a distance that provides a minimum of 6 inches between the apron endwalls. For cast-in-place concrete or other alternate endwall installations, space pipes as the plans show.
- (3) Lay concrete pipe with bells or grooves up grade and with spigot or tongue ends fully inserted in the bells or grooves.
- (4) For concrete pipe joints sealed with rubber gaskets or preformed flexible joint sealants conform to [608.3.4](#) with materials conforming to [520.2.6](#). For concrete pipe joints sealed with a trowelable bituminous mastic joint sealer also install an external sealing band or a circumferential wrap of Geotextile Type DF, Schedule A conforming to [645.2.2.4](#). Geotextile length shall be adequate for coverage of pipe circumference plus a twenty-four (24) inch minimum overlap. Geotextile width shall cover a minimum of eighteen (18) inches on each side of joint. Secure geotextile wrap in place with metal or plastic straps or as approved by the engineer. Wipe joints clean on the inside after sealing.
- (5) Provide joint ties on upstream and downstream ends of circular and horizontal elliptical concrete culvert and concrete cattle pass installations. Tie the last 3 pipe joints or, if using apron endwalls, the endwall joint and the next 2 pipe joints. Ties are not required on culverts with masonry endwalls unless the plans show them.
- (6) For polyethylene or polypropylene pipe, use full pipe sections except as needed to meet the plan specified length. Place full pipe sections at infall or outfall ends unless the engineer allows otherwise. If a partial pipe section must be used at an infall or outfall end, restrain as the manufacturer recommends, or absent a recommendation, use one or more of the following:
  - A manufacturer supplied external mechanical coupling.
  - A manufactured coupling with a mastic impregnated geotextile wrap and mechanical fastening bands.
  - A concrete collar meeting [520.2.4](#).
- (7) Lay riveted or spot-welded corrugated steel pipe so that flow is over the lap of the sheets, except for beveled end sections where the contractor may reverse the lap at the outlet end. Make field joints by joining the metal pipe sections together with a band bolted firmly in place. If elongation of the vertical diameter is specified, provide an appropriately modified prefabricated section.
- (8) Ensure the minimum performance of all installed joints is soil tight unless otherwise specified in the contract. A joint is considered soil tight if it resists infiltration of particles larger than those retained on the No. 200 sieve.
- (9) Lay pipes true to the designated line, grade, and required camber. Fit and match them to form a smooth and uniform invert. Carefully fit the sections of pipe together to keep the size of joint openings to a minimum.
- (10) Clean sockets carefully before lowering pipes into trenches. Lower the pipes in a way that avoids unnecessary handling in the trench.

### **520.3.4 Backfilling Trenches**

#### **520.3.4.1 Public Highway Culverts**

- (1) Place trench backfill from 1 foot above the top of the pipe to the top of the subgrade in layers no more than 8 inches thick after compaction. Mechanically compact the entire length of each layer to the same degree as the material next to the trench before placing the next layer.
- (2) Immediately after backfilling, cushion pipe for at least the trench width with compacted earth. Provide 2 feet or more cover, including backfill depth, above the pipe to prevent damage under construction loads. Maintain this cushion during subsequent operations. Do not walk, travel across, or work near completed pipe until minimum cover is established.
- (3) Place the remaining portion of the embankment, if any, above the top of the trench as specified for the adjacent embankment.

#### **520.3.4.2 Private Entrance and Temporary Culverts**

- (1) Carefully backfill private entrance and temporary culverts in layers no more than 8 inches deep after compaction, then ram and tamp material to completely fill spaces under and next to the pipe.

#### **520.3.5 Placing Apron Endwalls**

- (1) Excavate the foundation for the apron endwall to the required width and grade. For metal aprons with toe plates, excavate a trench to allow placing the toe plate against the inner face of the trench if the apron is in its final position. After securing the apron to the pipe, backfill and firmly compact the trench.
- (2) Place the concrete apron endwall with its tongue or groove fully entered in the groove or tongue of the pipe.
- (3) Use the same backfill for aprons as required for culvert pipes unless the engineer directs otherwise.

#### **520.3.6 Cleaning Culvert Pipes**

- (1) Clean the existing culvert pipes of dirt and vegetation. Use suitable materials removed from the culvert pipes in other areas requiring fill material within the project limits as the engineer directs. Dispose of surplus and unsuitable material as specified in [205.3.12](#).

#### **520.3.7 Deflection Testing**

- (1) The department accepts polyethylene and polypropylene pipe based on testing with a department-approved mandrel. Test pipe as the engineer directs after installation but before paving or finish grading.
- (2) Provide a mandrel with a diameter equal to 92.5 percent of the pipe's nominal diameter and having cable attachment points on each end of the core. Ensure that the mandrel has nine fins or legs permanently marked to designate the pipe size and the allowable percent deflection.
- (3) Test 100 percent of the installed length of pipe 24 inches or greater in diameter. Ensure that the mandrel passes through the entire section in one pass when pulled by hand without using excessive force. If the designated length of pipe fails, the engineer may require additional testing.
- (4) For pipe less than 24 inches in diameter, the engineer will designate at least 10 percent of the installed length of pipe for testing. The mandrel must pass through the entire section in one pass when pulled by hand without using excessive force. If the designated length of pipe fails, engineer may require additional testing.
- (5) Relay or replace pipe that does not pass deflection testing. Retest relayed or replaced pipe.

### **520.4 Measurement**

#### **520.4.1 Culvert Pipes**

- (1) The department will measure the Culvert Pipe bid items and Pipe Cattle Pass by the linear foot acceptably completed, measured along the invert.
- (2) The department will measure the Apron Endwalls, Cleaning Culvert Pipes, and Concrete Collars bid items as each individual unit acceptably completed. The department will only measure Concrete Collars for Pipe if required under [520.3.1](#)(5) or [608.3.3](#)(10).
- (3) The department will measure Cleaning Culvert Pipes as each individual culvert acceptably completed.

#### **520.4.2 Rock Excavation for Culvert Pipe**

<b>520.4.2 Add measurement information for rock excavation culvert pipe.</b>
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- (1) The department will measure Culvert Pipe Rock Excavation by the cubic yard acceptably completed. The department will measure this work in its original position and complete the volume, excluding boulders, by the method of average end areas.

- (2) The department will measure boulders of 1/2 cubic yard or more as specified for boulders and surface stone greater than one cubic yard in [205.4.1](#).
- (3) The department will measure this work vertically from the top of the rock to the bottom of the rock, or to an elevation 6 inches below the bottom of the pipe, whichever is higher. The department will measure this work horizontally as the outside diameter of the pipe plus 3 feet, 1-1/2 feet on either side, regardless of actual width required under [520.3.2.1](#).

**520.5 Payment**

**520.5.1 General**

**520.5 Add bid item and payment information for culvert pipe rock excavation.**

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
<b>520.0005</b>	<b>Culvert Pipe Rock Excavation</b>	<b>CY</b>
520.1000 - 1199	Apron Endwalls for Culvert Pipe (size)	EACH
520.2000 - 2099	Culvert Pipe Temporary (size)	LF
520.3100 - 3199	Culvert Pipe Class III (size)	LF
520.3300 - 3399	Culvert Pipe Class III-A (size)	LF
520.3400 - 3499	Culvert Pipe Class III-A Non-metal (size)	LF
520.3500 - 3599	Culvert Pipe Class III- B (size)	LF
520.3600 - 3699	Culvert Pipe Class III-B Non-metal (size)	LF
520.4100 - 4199	Culvert Pipe Class IV (size)	LF
520.5100 - 5199	Culvert Pipe Class V (size)	LF
520.8000	Concrete Collars for Pipe	EACH
520.8500	Pipe Cattle Pass	LF
520.8700	Cleaning Culvert Pipes	EACH

- (2) Payment for Culvert Pipe Rock Excavation is full compensation for rock excavation and disposal. If the contract does not contain Culvert Pipe Rock Excavation bid item, the department will pay for the required excavation as specified for extra work in [109.4](#).
- (3) Payment for the Apron Endwalls for Culvert Pipe bid items is full compensation for providing apron endwalls; and for excavating, constructing the foundation, and backfilling. The department will pay separately for cast-in-place concrete and alternate endwall installations under the Concrete Masonry Endwalls bid item as specified in [504.5](#) and other associated bid items.
- (4) Payment for Concrete Collars for Pipe is full compensation for providing concrete pipe collars required under [520.3.1](#)(5) or [608.3.3](#)(10).
- (5) Payment for Cleaning Culvert Pipes is full compensation for cleaning the culvert pipe and disposing of waste.
- (6) Payment for the 520 bid items also includes water for compaction and dust control, except if the contract contains the Water bid item, the department will pay separately for water under [624.5](#).

**520.5.2 Culvert Pipe and Cattle Pass**

- (1) Payment for the Culvert Pipe bid items and Pipe Cattle Pass is full compensation for providing pipe; **for joint seals, wraps, and couplers**; for concrete collars not required under [520.3.1](#)(5) or [608.3.3](#)(10); for excavating and backfilling; for constructing the foundation; for associated dewatering and maintaining drainage; and for concrete cattle pass walkways.
- (2) If material from the typical roadway section is not suitable for trench backfill, the department will pay separately for trench backfill under other contract bid items.
- (3) The department will pay separately for excavating unsuitable material and backfilling as specified in [520.3.2.1](#)(10) as extra work.