

SECTION 603 - CULVERTS AND STORM DRAINS

603.01 Description. This work includes constructing or reconstructing culverts and storm drains referred as "culvert", according to the contract. *

603.02 Materials. Materials shall conform to the following:

Bed Course Material for Pipe	703.16(B)
Structure Backfill Material	703.20
Trench Backfill Material	703.21
Joint Mortar	705.02
Flexible Watertight Gaskets	705.03
Reinforced Concrete Pipe	706.02
Reinforced Concrete Low-Head Pressure Pipe	706.17
Concrete Cylinder Pipe	706.18
Corrugated Metal Pipe and Pipe Arch	707.02
Bituminous Coated Corrugated Metal Pipe and Pipe Arch	707.03
Corrugated Metal Pipe Coupling Bands	707.05
Structural Aluminum Plate for Pipe	707.06
Structural Steel Plate for Pipe, Pipe Arch and Arch	707.08
Spiral Rib Metal Pipe	707.12
Spiral Rib Metal Pipe Coupling Band	707.13
Asphalt Paint	708.05

When the location of manufacturing plants allows, the Engineer may inspect the plants periodically for compliance with specified manufacturing methods. The Engineer may get samples of materials for laboratory testing for compliance with material quality requirements. This may be the basis for acceptance of manufacturing lots as to quality.

The condition of materials will be subject to inspection for acceptance before or during incorporation of materials into the work.

603.02

If shown in the contract, the Contractor shall have the option of *
furnishing and installing corrugated metal pipe, spiral rib metal pipe, or
reinforced concrete pipe for culvert. The Contractor shall not mix the type
of pipe within the inlet and outlet points of installation. |

If the contract specifies siphon pipes, the Contractor shall have the *
option of furnishing and installing reinforced concrete low-head pressure pipe
or concrete cylinder pipe.

603.03 Construction Requirements. The Contractor shall provide, as may be
necessary, for the temporary diversion of water to install the culvert on a
dry bed. |

(A) Excavation. The Contractor shall excavate the trenches according to *
Section 206 - Excavation and Backfill for Conduits and Structures and as
set forth herein.

Trench widths shall be sufficient to allow: *|

(1) proper jointing of the culverts, *|

(2) thorough compaction of the bed course, and *|

(3) backfill material under and around the culvert. *|

If feasible, trench walls shall be vertical. *|

The completed trench bottom shall be firm for its full length and
width.

The Contractor shall remove solid rock met in excavation below *
invert grade. The Contractor shall backfill and compact the trench up to
the culvert invert. The Contractor shall backfill and compact the trench *
to a relative compaction of not less than ninety-five (95) percent in
maximum six (6) inch lifts with bed course material. The test method to
establish maximum densities and relative compaction shall be according to *
Subsection 106.09(A) - Relative Compaction Test. |

For pipes and culverts, except structural plate culverts, the bed
course material under the culvert shall have a thickness of half (1/2)
inch for each foot of fill over the culvert with a minimum thickness of
twelve (12) inches. They need not exceed three-quarters (3/4) of the *
nominal culvert diameter or rise. The width of the bed course shall be
equal to the span or diameter of the culvert plus eighteen (18) inches on
each side. |

For structural plate culverts, the bed course material under the
culvert shall have a thickness of half (1/2) inch for each foot of fill
over the culvert with a minimum thickness of twenty-four (24) inches. *
They need not exceed three-quarters (3/4) of the nominal culvert diameter |

or rise. The width of the bed course shall be equal to the span or diameter of the culvert plus thirty-six (36) inches on each side. For areas of soft, spongy or unsuitable material, the width of the bed course shall be equal to the span or diameter of the culvert plus one diameter on each side.

If the Contractor meets soft, spongy or unsuitable material, the Contractor shall remove such material:

- (1) from a width equal to the span or diameter of the culvert plus one (1) diameter of the culvert,
- (2) one (1) diameter on each side, and
- (3) to a depth specified.

When the contract shows bed course material without thickness specified, the Contractor shall resolve the thickness as specified above for solid rock excavation.

When shown in the contract, the Contractor shall excavate the trench below grade. The Contractor backfill the resulting space with compacted bed course material.

(1) Corrugated Metal, Reinforced Concrete, Reinforced Concrete Low-Head Pressure, Concrete Cylinder Culverts and Spiral Rib Metal Culvert. If the Contractor places corrugated metal, reinforced concrete, reinforced concrete low-head pressure, concrete cylinder or spiral rib metal pipes for culverts in embankment fill, the Contractor shall excavate after the Contractor has completed the embankment. The Contractor shall embank on each side of the culvert for a distance of:

(a) not less than five (5) times the outside diameter or

(b) span to an elevation:

1. half (1/2) the outside diameter of the culvert or
2. half (1/2) the rise above the top of the culvert or
3. to the required elevation shown in the contract,

whichever is less.

This work shall conform to Section 203 - Excavation and Embankment. The Contractor shall then excavate the trench through the constructed embankment.

If portions of an installed culvert projects above the existing ground, the Engineer will consider the entire culvert placed in embankment fill.

(2) **Structural Plate Culverts.** If the Contractor places structural plate culvert in embankment, the Contractor shall construct embankment after the Contractor assembles the culvert according to Sections 203 - Excavation and Embankment and 206 - Excavation and Backfill for Conduits and Structures. The embankment shall have a width on both sides of the culvert equal to at least one (1) diameter or span of the culvert. The Contractor shall place backfill material around the culvert and above the top of the culvert as specified.

(B) **Bedding.** The culvert bedding shall conform to the classes specified. When the contract does not specify bedding class, the requirements for Class C Bedding shall apply.

(1) **Class A Bedding.** Class A bedding includes a continuous cradle conforming to the details shown in the contract.

(2) **Class B Bedding.** Class B bedding includes bedding the culvert in bed course material to a depth of not less than fifteen (15) percent of its total vertical height. The thickness of the bed course material under the culvert shall have a minimum thickness of twelve (12) inches. The Contractor shall shape the bed course material to fit the culvert. The Contractor shall shape the recesses in the trench bottom to ease the bell or collar when the Contractor uses such culvert.

(3) **Class C Bedding.** Class C bedding includes bedding the culvert to a depth of not less than ten (10) percent of its total vertical height. The Contractor shall shape the foundation material to fit the culvert. The Contractor shall shape the recesses in the trench bottom to ease the bell or collar when the Contractor uses such culvert.

(C) **Laying Culvert.** The Contractor shall remove and replace the culverts that the Contractor break, bend, or damage by its operations at no cost to the State.

(1) **Corrugated Metal, Reinforced Concrete, Reinforced Concrete Low-Head Pressure, Concrete Cylinder Culvert, and Spiral Rib Metal Culvert.** The culvert laying shall begin at the downstream end of the culvert line. The lower end of the culvert shall be in contact with the shaped bedding throughout its full length. The Contractor shall place the bell or groove ends of rigid culverts and outside circumferential laps of flexible culverts facing upstream. The Contractor shall place the flexible culverts with longitudinal laps or seams at the sides.

The Contractor shall lay the paved or partially lined culverts so that the longitudinal centerline of the paved segment coincides with the flow line. The Contractor shall place the elliptical and elliptically reinforced culverts with the vertical axis within five

(5) degrees of a vertical plane through the longitudinal axis of the culvert. The Contractor shall place the elongated circular corrugated culverts with the major axis vertical. *|
*|

In multiple culvert installation, the clearance between culverts shall be half (1/2) the diameter with a maximum of four (4) feet and a minimum of one (1) foot. |

(2) **Structural Plate Culverts.** The Contractor shall assemble structural plate culverts according to the manufacturer's instructions and as ordered. *|
*|
*|

The Contractor shall tighten the bolts with calibrated wrenches to a torque of one hundred fifty (150) to two hundred (200) foot-pounds. The Contractor shall replace bolts that the Contractor: *|
*|

(a) cannot tighten to the minimum torque or *|

(b) damages when tightening. *|

The Contractor may use manual or power torque wrenches for tightening bolts. The Contractor shall design the torque wrenches to release automatically at the pre-set torque. Nuts shall be in the tightening motion when the Contractor measures the torque. After the Contractor tightens the bolts initially, the Contractor shall immediately tighten the bolts to the prescribed torque. *|
*|
*|

The Contractor shall provide an accurate manual torque wrench at the work site for the Engineer's use in checking the bolts' tightness. The Contractor shall provide the Engineer with safe access to the bolts.

Backfilling shall begin after the Engineer has checked and approved the torque on the bolts.

If the contract shows headwalls, the Contractor shall cut off the ends of culverts neatly flush with the outside face of the headwall. *|
*|

If the contract shows asphalt painting, the Contractor shall give: *|
*|

(a) the bottom plates two (2) coatings of asphalt paint before erection and *|
*|

(b) the side and top plates two (2) coatings before acceptance. *|
*|

The Contractor shall apply the asphalt paint by brushing or *|
spraying. The total thickness of the coatings shall not be less *|
than twelve (12) mils, measured from the crest of the corrugation.

(D) Joining Culverts. Rigid culverts may be of bell and spigot or tongue *|
and groove design. The method of joining culvert sections shall be such *|
that the Contractor enters the ends fully and the inner surfaces are *|
flush and even.

The Contractor shall make joints with joint mortar or flexible *|
watertight gaskets.

When using mortar to join culvert sections thirty (30) inch or less *|
in diameter, the Contractor shall apply mortar to the ends of each *|
section of culvert before joining. The Contractor shall make mortar *|
joints with an excess of mortar to form a bead around the outside of the *|
culvert and finish smooth on the inside. |

When using mortar to joint culvert sections greater than thirty (30) *|
inch in diameter, the Contractor shall apply the mortar to the joint's *|
inside only. The Contractor shall mortar the joints only after the *|
Contractor installs the culvert sections and after the Contractor places *|
sufficient backfill to assure that the culvert shall not move. The *|
Contractor shall finish the joint's inside smooth with the inside culvert *|
surface.

If the Contractor uses collared joints, the Contractor shall center *|
the collar carefully over the joint. The Contractor shall pack the entire *|
space between the collar and culvert tightly with mortar. *

If the Contractor uses portland cement mixtures, the Contractor *|
shall protect the completed joints against rapid drying by suitable *|
covering material.

If the Contractor uses preformed plastic sealing compounds, the *|
Contractor shall clean and dry the joint surfaces. The Contractor shall *|
apply an accepted primer coat to surface. The Contractor shall allow the *|
primer coat to dry completely. The Contractor shall apply the flat side *|
of the preformed plastic sealing adhesive strips to the dry primed *|
surface. The outside wrapper remains for protection. *

In the ditch before jointing, the Contractor shall remove the *|
outside wrapper. The Contractor shall install the jointing by a pushing *|
or pulling force applied in a straight line to bring the opposing joint *|
surface tightly closed. The jointing pressure shall result in squeezing *|
the plastic gasket to a solid pack. The Engineer will allow only whole *|
pieces and one (1) cut pieces. The Contractor shall not use the short, *|
fragmented pieces to complete the circumference. *

Table 603-I and Table 603-II lists the gasket sizes for dry and wet *|
trench (double head application) conditions. *

TABLE 603-I (DRY TRENCH CONDITION) EXTRUDED ROPE SIZE			
Pipe Size Inch	Rope Diam. Inch	Cross Sec. Area Square Inch	Min. Deliv. Length Foot-inch
18 and below	1	0.80	2 - 5
24 - 42	1-1/2	1.75	3 - 5
48 - 66	1-3/4	2.50	3 - 5
72 - 96	2	3.25	3 - 5

TABLE 603-II (WET TRENCH CONDITION) EXTRUDED ROPE SIZE (DOUBLE HEAD APPLICATION)			
Pipe Size Inch	Rope Diam. Inch	Cross Sec. Area Square Inch	Min. Deliv. Length Foot-inch
30 and below	1	0.80	2 - 5
36 - 48	1-1/2	1.75	3 - 5
54 - 72	1-3/4	2.50	3 - 5
78 - 96	2	3.25	3 - 5

The Contractor shall install rubber ring gaskets to form a flexible watertight seal. The Contractor shall clean and dry the surfaces to receive lubricants, cements, or adhesives. The Contractor shall affix the gaskets and jointing materials to the culvert not more than twenty-four (24) hours before the installation. The Contractor shall protect the gaskets and jointing materials from the sun, dust and other deleterious substances. The Contractor shall inspect the gaskets and jointing materials before installation of the culvert. The Contractor shall remove and replace loose or improperly affixed gaskets and jointing materials according to the contract. If, the Contractor can see through the exterior joint recess when the Contractor pulls the joint up to one (1) inch of closure, the Contractor shall remove the culvert and remake the joint according to the contract.

The Contractor shall join the flexible culverts firmly to coupling bands. The Contractor shall submit a joint detail and joining method to the Engineer for acceptance before installing flexible culvert.

The Engineer will inspect the culvert before the Contractor places backfill. The Contractor shall take up and re-lay or replace culverts out of alignment and unduly settled at no cost to the State.

(E) Elongation of Corrugated Metal Culverts. If the Contractor uses corrugated metal culvert and the contract specifies elongation, the Contractor shall elongate the vertical diameter five (5) percent from a full circular cross section before the Contractor places fills.

The Contractor may so elongation at the fabricating shop or in the field.

The Contractor may elongate the culverts at the fabricating shop by the following methods:

(1) Fabricating the plates so that the Contractor gets elongation after assembly;

(2) Mechanical pressure sufficient to introduce a permanent elongation in the culvert;

(3) Elongating the assembled culvert and retaining the elongation by rods and turnbuckles, wires, or struts.

If the Contractor elongates the culverts in the field, the method of elongation shall conform to the details in the contract.

If the Contractor uses rods and turnbuckles, wires, or struts to maintain culvert elongation, the Contractor shall not remove them before the completion of the embankment. The Contractor shall remove them before the installing headwalls or other structures at the ends of culverts.

The Contractor shall remove the rods and turnbuckles, wires, or struts used for elongation at no cost to the State. If they are to be left in place for a longer period, the Engineer will remove them at no cost to the Contractor.

(F) Elongation of Structural Plate Culverts. If the Contractor uses circular structural plate culvert and the contract specifies elongation, the Contractor shall elongate the vertical diameter according to the contract.

The Contractor shall carry elongation uniformly from end to end of culverts when the Contractor does not use headwalls. When the Contractor uses headwalls with circular culverts, the Contractor may reduce the percent of elongation gradually under the side slopes of the embankment so that the ends of the culvert at the headwalls are circular.

The Contractor shall get elongation by using factory elongated plates or by elongating circular culvert by timber struts and sills placed according to details shown in the contract.

If the Contractor uses factory elongated plates, the Contractor shall elongate the plates to provide an increase of five (5) percent in the vertical diameter of the culvert after assembly.

If the Contractor elongates the culverts in the field, the Contractor shall increase the vertical diameters according to the following:

Culverts using No. 1 or 3 gage top and side plates	1 percent
Culverts using No. 5 or 7 gage top and side plates	2 percent
Culverts using No. 8, 10, 12 gage top and side plates	3 percent

When shown in the contract or ordered, the Contractor shall strut the factory elongated culverts for support.

Upon completion of the embankment or when ordered, the Contractor shall remove the strutting at no cost to the State. If the strutting remains left in place for a longer period, the Engineer will remove the struts at no cost to the Contractor.

(G) Strutting for Support. When shown in the contract or ordered, the Contractor shall place timber struts and sills for the full length of the culvert ahead of backfilling under certain load conditions. The Contractor shall place the strutting to retain the original cross section of the culvert.

(H) Repairing Damaged Zinc-Coated Surfaces. Repairs to damaged zinc-coated surfaces shall be according to Subsection 501.03(G)(2) - Repairing of Damaged Zinc-Coated Surfaces.

(I) Backfilling. After the Contractor installs the culvert, backfilling shall be according to Section 206 - Excavation and Backfill for Conduits and Structures.

Trench backfill material placed below a horizontal plane twelve (12) inches above the top of the pipe or culvert shall conform to Subsection 703.21(A) - Trench Backfill Material A.

Except for structural plate culvert, the Contractor shall backfill the remainder of the trench with structural backfill material according to Section 703.20(B) - Structure Backfill Material B or with trench backfill material according to Section 703.21(B) - Trench Backfill Material B.

For structural plate culvert, the remainder of the backfill shall conform to Section 203.02(B) - Embankment Construction.

If the Contractor needs earth moving equipment to operate over culverts, the Contractor needs a compacted cushion of earth at least: *

(1) four (4) feet above the top of the culvert and *

(2) extending five (5) diameters on each side of the culvert. *

The Contractor shall remove and replace broken culverts or damaged by its operation, with acceptable culverts at no cost to the State. *

(J) Joining Pressure Pipe. The Contractor shall clean and dry the joints of the pipes before assembly. The Contractor shall affix the rubber gaskets and jointing material to the pipe not more than twenty-four (24) hours before the installation. The Contractor shall protect the joints from the sun, dust and other deleterious agents. *

The Contractor shall align the pipe with the previously installed pipe and pull the joint together. If the Contractor does not seat the rubber gasket properly, the Contractor shall remove the pipe and remake the joint according to the contract. *

The joints shall be watertight. The Contractor shall not backfill, mortar or concrete coat, fill, or pack the joints before the hydrostatic test. After the satisfactory completion of the test, the Contractor shall grout the joints. *

(K) Hydrostatic Test. Before backfilling, the Contractor shall test the pressure pipe as follows: *

The Contractor shall fill the pressure pipe with water at a hydrostatic head of ten (10) feet above the highest point of the pipeline. The Contractor shall maintain the pressure head for not less than twenty-four (24) hours. The Contractor shall correct leaks or other defects that the Contractor observes at no cost to the State. The Engineer will not consider sweating that does not develop into a flow or drip as leakage. The Contractor shall repeat the test until the Contractor eliminates leaks or other defects. *

603.04 Method of Measurement. The Engineer will measure culverts of the different types and sizes, both new and relaid, by the linear foot in place. The Engineer will measure culvert with sloped or skewed ends along its invert. *

The Engineer will include branch connections and elbows in the length measurement for the culvert. *

603.05 Basis of Payment. The Engineer will pay for the accepted quantities of culvert at the contract unit price per linear foot for culvert of the types and sizes specified in the proposal complete in place. *

The Engineer will make payment under:

*|

Pay Item	Pay Unit
Bed Course Material for Culvert	Cubic Yard
___ - Inch Reinforced Concrete Pipe, Class ___	Linear Foot
___ - Inch Corrugated ___ ___, Sheet Thickness, ___ - Inch	Linear Foot
___ - Inch Corrugated ___ End Section, Sheet Thickness, ___ - Inch	Each
___ - Inch Structural ___ Plate ___, No. ___ Gage	Linear Foot
___ - Inch Spiral Rib Metal Pipe, Sheet Thickness, ___ - Inch	Linear Foot
___ - Inch Corrugated ___ Pipe, Sheet Thickness, ___ - Inch or ___ - Inch Reinforced Concrete Pipe, Class ___	Linear Foot
___ - Inch Corrugated Steel ___, Sheet Thickness, ___ - Inch or ___ - Inch Corrugated Aluminum ___, Sheet Thickness, ___ - Inch	Linear Foot
___ - Inch Corrugated Steel Pipe, Sheet Thickness ___ - Inch or ___ - Inch Corrugated Aluminum Pipe, Sheet Thickness, ___ - Inch or ___ - Inch Reinforced Concrete Pipe, Class ___	Linear Foot
___ - Inch Structural Steel Plate ___, No. ___ Gage or ___ - Inch Structural Aluminum Plate ___, No. ___ Gage	Linear Foot
___ - Inch Corrugated Steel End Section, Sheet Thickness, ___ - Inch or ___ - Inch Corrugated Aluminum End Section, Sheet Thickness, ___ - Inch	Linear Foot
___ - Inch Spiral Rib Metal Pipe, Sheet Thickness, ___ - Inch	Linear Foot
___ - Inch Corrugated/Spiral Rib Metal Pipe, Sheet Thickness, ___ - Inch or ___ - Inch Reinforced Concrete Pipe, Class ___	Linear Foot
___ - Inch Spiral Rib Metal Pipe, Sheet Thickness, ___ - Inch or ___ - Inch Reinforced Concrete Pipe, Class ___	Linear Foot

The Engineer will pay for the accepted quantities of excavation *| including excavation below flow line grade, bedding and backfill for culverts and storm drains according to Section 206 - Excavation and Backfill for *| Conduits and Structures.