Amend **Section 603 - Culverts and Storm Drains** to read as follows:

"SECTION 603 - CULVERTS AND STORM DRAINS

603.01 Description. This section is for 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
High Density Polyethylene Pipe	706.10
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
Cullet Materials for Utility Structures	717.03
Cullet Materials for Drainage Systems	717.04

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.

If specified in the contract, the Contractor shall have the option of furnishing and installing corrugated metal pipe, spiral rib metal pipe, reinforced concrete pipe, or high density polyethylene pipe for culvert. Do 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. 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.

Remove solid rock met in excavation below invert grade. Backfill and compact the trench up to the culvert invert. Backfill and compact the trench to a relative compaction of not less than 95% in maximum 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 0.5 inch for each foot of fill over the culvert with a minimum thickness of 12 inches. They need not exceed 0.75 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 18 inches on each side.

For structural plate culverts, the bed course material under the culvert shall have a thickness of 0.5 inch for each foot of fill over the culvert with a minimum thickness of 24 inches. They need not exceed 0.75 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 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.

When meeting soft, spongy, or unsuitable material, remove such material from a width equal to the span or diameter of the culvert plus one foot on each side and to a depth specified.

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

When shown in the contract, excavate the trench below grade. Backfill the resulting space with compacted bed course material.

(1) **Corrugated Metal, Reinforced Concrete, Reinforced Concrete Low-Head Pressure, Concrete Cylinder, Spiral Rib Metal, and High Density Polyethylene Culvert.** When placing Corrugated Metal, Reinforced Concrete, Reinforced Concrete Low-Head Pressure, and Concrete Cylinder, Spiral Rib Metal Culvert, and High Density Polyethylene pipes for culverts in embankment fill, excavate after completing the embankment. Embank on each side of the culvert for a distance of:

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

(b) span to an elevation:

1. 0.5 the outside diameter of the culvert or

2. 0.5 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. 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. When placing structural plate culvert in embankment, construct embankment after assembling 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 diameter or span of the culvert. 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 15% of its total vertical height. The thickness of the bed course material under the culvert shall have a minimum thickness of 12 inches. Shape the bed course material to fit the culvert. Shape the recesses in the trench bottom to ease the bell or collar when using such culvert.

(3) Class C Bedding. Class C bedding includes bedding the culvert to a depth of not less than 10% of its total vertical height. Shape the foundation material to fit the culvert. Shape the recesses in the trench bottom to ease the bell or collar when using such culvert.

(C) Laying Culvert. Remove and replace the culverts that the Contractor breaks, bends, or damages by its operations at no cost to the State.

(1) Corrugated Metal, Reinforced Concrete, Reinforced Concrete Low-Head Pressure, Concrete Cylinder, Spiral Rib Metal, and High Density Polyethylene 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. Place the bell or groove ends of rigid culverts and outside circumferential laps of flexible culverts facing upstream. Place the flexible culverts with longitudinal laps or seams at the sides.

Lay the paved or partially lined culverts so that the longitudinal centerline of the paved segment coincides with the flow line. Place the elliptical and elliptically reinforced culverts with the vertical axis within 5° of a vertical plane through the longitudinal axis of the culvert. Place the elongated circular corrugated culverts with the major axis vertical.

In multiple culvert installation, the clearance between culverts shall be 0.5 the diameter with a maximum of four feet and a minimum of one foot.

(2) Structural Plate Culverts. Assemble the structural plate culverts according to the manufacturer's instructions and as specified by the Engineer.

Tighten the bolts with calibrated wrenches to a torque of 150 to 200 foot-pounds. 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. Design the torque wrenches to release automatically at the pre-set torque. Nuts shall be in the tightening motion when measuring the torque. After tightening the bolts initially, immediately tighten the bolts to the prescribed torque.

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

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

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

If the contract shows asphalt painting, give:

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

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

Apply the asphalt paint by brushing or spraying. The total thickness of the coatings shall not be less than 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.

Make joints with joint mortar or flexible watertight gaskets.

When using mortar to join culvert sections 30 inch or less in diameter, apply mortar to the ends of each section of culvert before joining. 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 30 inch in diameter, apply the mortar to the joint's inside only. Mortar the joints only after installing the culvert sections and after placing sufficient backfill to assure that the culvert does not move. Finish the joint's inside smooth with the inside culvert surface.

When using collared joints, center the collar carefully over the joint. Pack the entire space between the collar and culvert tightly with mortar.

When using portland cement mixtures, protect the completed joints against rapid drying by suitable covering material.

When using preformed plastic sealing compounds, clean and dry the joint surfaces. Apply an accepted primer coat to surface. Allow the primer coat to dry completely. 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, remove the outside wrapper. 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 cut pieces. Do 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 Diameter Inch**	**Cross Sectional Area Square Inch**	**Minimum Delivery 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 Diameter Inch**	**Cross Sectional Area Square Inch**	**Minimum Delivery 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

Install rubber ring gaskets to form a flexible watertight seal. Clean and dry the surfaces to receive lubricants, cements, or adhesives. Affix the gaskets and jointing materials to the culvert not more than 24 hours before the installation. Protect the gaskets and jointing materials from the sun, dust, and other deleterious substances. Inspect the gaskets and jointing materials before installation of the culvert. Remove and replace loose or improperly affixed gaskets and jointing materials. If, the Contractor can see through the exterior joint recess when pulling the joint up to one inch of closure, remove the culvert and remake the joint.

Join the flexible culverts firmly to coupling bands. 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. 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. When using corrugated metal culvert and the contract specifies elongation, elongate

the vertical diameter 5% from a full circular cross section before placing 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.

When elongating the culverts in the field, the method of elongation shall conform to the details in the contract.

When using rods and turnbuckles, wires, or struts to maintain culvert elongation, do not remove them before the completion of the embankment. Remove them before the installing headwalls or other structures at the ends of culverts.

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. When using circular structural plate culvert and the contract specifies elongation, elongate the vertical diameter according to the contract.

Carry elongation uniformly from end to end of culverts when not using headwalls. When using 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 means of timber struts and sills placed according to details shown in the contract.

When using factory-elongated plates, elongate the plates to provide an increase of 5% in the vertical diameter of the culvert after assembly.

When elongating the culverts in the field, increase the vertical diameters according to the following:

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

When shown in the contract or specified by the Engineer, strut the factory elongated culverts for support.

Upon completion of the embankment or when specified by the Engineer, 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 specified by the Engineer, place timber struts and sills for the full length of the culvert ahead of backfilling under certain load conditions. 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 installing the culvert, backfilling shall be according to Section 206 - Excavation and Backfill for Conduits and Structures. The Contractor may use Section 313 – Controlled Low Strength Material (CLSM) instead of Subsection 206.02(C) – Trench Backfill Material as backfill material subject to the Engineer's acceptance. Do not use CLSM as trench backfill when installing aluminum and aluminum coated pipe culverts. When using CLSM, the Engineer will consider CLSM as the required backfill.

Trench backfill material placed below a horizontal plane 12 inches above the top of the pipe or culvert shall conform to Subsection 703.21(A) – Trench Backfill Material A or Section 313 – Controlled Low Strength Material (CLSM).

When using CLSM for trench backfill, the Contractor may reduce the width of the excavation shown on the plans so that the clear distance between the outside of the pipe and the side of the excavation on each side of the pipe is a minimum of 6 inches for pipes less than or equal to

42 inches in diameter or span or 12 inches for pipes more than 42 inches in diameter or span.

Except for structural plate culvert, 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 or with CLSM according to Section 313 – Controlled Low Strength Material (CLSM).

Place CLSM only for that portion of the trench backfill below the original ground, the grading plane, or top of embankment placed before excavating for the culvert pipe. Where necessary, compact the earth plugs at each end of the pipe before placing backfill so that the CLSM is completely contained in the pipe trench.

When using CLSM, the Engineer will not require compaction of the backfill.

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

When operating earth moving equipment over culverts, the Engineer will require a compacted cushion of earth at least:

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

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

Remove and replace broken culverts or damaged by its operation, with acceptable culverts at no cost to the State.

(J) Joining Pressure Pipe. Clean and dry the joints of the pipes before assembly. Affix the rubber gaskets and jointing material to the pipe not more than 24 hours before the installation. Protect the joints from the sun, dust and other deleterious agents.

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

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

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

Fill the pressure pipe with water at a hydrostatic head of 10 feet above the highest point of the pipeline. Maintain the pressure head for not less than 24 hours. 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. Repeat the test until after eliminating leaks or other defects.

603.04 Method of Measurement. The Engineer will measure the bed course material per cubic yard.

The Engineer will measure culverts per linear foot complete 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.

The Engineer will not measure the concrete collar.

603.05 Basis of Payment. The Engineer will pay for the accepted bed course material at the contract unit price per cubic yard. The price includes full compensation for furnishing, placing, and compacting the bed course material; and furnishing labor, material, tools, equipment, and incidental necessary to complete the work.

The Engineer will pay for the accepted culvert at the contract unit price per linear foot complete in place. The price includes full compensation for diverting the water temporarily; removing solid rock; backfilling and compacting the trench; furnishing, laying, and joining the reinforced concrete pipe, including the concrete collar; furnishing labor, material, tools, equipment, and incidental necessary to complete the work.

The Engineer will make payment under:

Pay Item	**Pay Unit**
Bed Course Material for Culvert	Cubic Yard
_____ - Inch Reinforced Concrete Pipe, Class _____	Linear Foot
Clean Existing Culverts	Force Account

The Engineer will pay for the accepted excavation including excavation below flow line grade, bedding, and backfill for culverts and storm drains under Section 206 – Excavation and Backfill for Conduits and Structures."

END OF SECTION