

STATE**OF****TENNESSEE**

(Rev. 10-7-19)

January 1, 2021

SPECIAL PROVISION**REGARDING****SLIP LINING OF ROADWAY CULVERTS****Description**

This work consists of furnishing, installing, grouting and providing all labor, material and equipment necessary to rehabilitate existing roadway culvert pipe by the slip lining method.

The required hydraulic capacity of the host pipe shall be determined and then improved or maintained by the use of slip lining products. The slip lining process will require the complete grouting of the annular void between the hosts and insert pipe unless approved otherwise. If the Engineer's hydraulic and geometric evaluation indicates that downsizing of the existing line is acceptable, a variety of materials listed below may be used for insertion.

When necessary, hydraulic advantages may be gained by improvements to inlet details on inlet controlled culverts. (See TDOT Drainage Manual 6.04.3.2 Improved Inlets). Where improved inlets create low pressure on the culvert pipes, pipe liner joints shall be watertight, and testable to the limits of the required pressure.

See Table 607G-1 for Slip lining Pipe Dimension.

Materials

Provide materials for pipe liner that are acceptable for slip lining pipe and include one of the following;

- a. Corrugated High Density Polyethylene Pipe (HDPE),
- b. Profile Walled PVC,
- c. Corrugated Polypropylene Pipe (PP),
- d. Solid Wall High Density Polyethylene Pipe (SWHDPE),
- e. Steel Reinforced Polyethylene Pipe (SRPE),
- f. Machine Spiral Wound PVC or HDPE Pipe,
- g. Glass Fiber Reinforced Plastic Pipe, or
- h. Smooth Wall Carbon Steel Plate Pipe.

Submit manufacturer's detailed product data with complete information on pipe liner materials (pipes, joints, gaskets, fittings, entrance bells), physical properties, dimensions, installation minimum/maximum allowable parameters such as maximum recommended external grout

pressure, axial compressive stress, minimum bending radius or maximum joint angular deflection.

Pipe liner materials other than those stated above may be submitted for consideration and approval by the Engineer based on meeting the design requirements as stated.

Secure written product approval from the Manufacturer before commencing any work.

A. Corrugated High Density Polyethylene Pipe (HDPE)

1. Pipe

The pipe liner shall consist of a HDPE profile wall pipe that conforms to the requirements of AASHTO M 294 for Corrugated Polyethylene Pipe Type “S” or “D”.

2. Joints

Join HDPE profile wall pipe liner by thermal fusion (extrusion welding) per manufacturer specifications, or provide a positive mechanical joint that meets the requirements of ASTM D 3212, consist of an integrally formed bell and spigot connection with a rubber gasket meeting ASTM F477, or a connection meeting equivalent performance standards such that joints shall meet the requirements of ASTM D3212.

If mechanically restrained joints are required to line the host pipe, the pipe joints shall be restrained to allow the pipe to be pulled or pushed into the host pipe without joint separation.

B. Profile Wall Poly Vinyl Chloride (PVC)

1. Pipe

Pipe liner shall consist of PVC corrugated pipe with a smooth interior that conforms to the requirements of AASHTO M304, Poly (Vinyl Chloride) (PVC) Profile Wall Drain Pipe and Fittings Based on Controlled Inside Diameter or ASTM F 949.

Use pipe made of PVC compound with a cell classification of 1245B per ASTM D 1784.

2. Joints

Join the PVC pipe liner with a PVC coupling that uses elastomeric sealing gaskets. The assembled joint shall meet the performance requirements of ASTM D 3212.

The joint shall be able to be pulled or pushed into the host pipe without joint separation. Ensure that elastomeric seals meet the requirements of ASTM F 477.

C. Corrugated Polypropylene Pipe (PP)

1. Pipe

Polypropylene pipe and fittings shall meet the requirements contained in AASHTO M330 type “S” or “D” wall, and or ASTM F2736/ASTM F2764.

Extruded Pipe and Fittings shall be made of virgin polypropylene compounds as described in AASHTO M330 and or ASTM F2736/ASTM F2764.

Polypropylene compounds shall be comprised of the base polypropylene resin and all additives, colorants, UV inhibitors, and stabilizers.

The pipe and fittings shall be free of foreign inclusions and visible defects such as cracks, holes, foreign inclusions or other injurious defects.

2. Joints

Joints shall be water-tight over the range of head pressure expected for the pipe. Joints shall consist of an integrally formed bell and spigot connection with a rubber gasket meeting ASTM F477 or a connection meeting equivalent performance standards such that joints shall meet the requirements of ASTM D3212.

The ends of the pipe shall be square and clean so as not to adversely affect joining or connecting.

D. Solid Wall High Density Polyethylene Pipe (HDPE)

1. Pipe

High density polyethylene pipe and fittings shall meet the requirements in the AASHTO LRFD Bridge Design Specifications, Section 12, as a solid wall HDPE pipe meeting the requirements of Specification AASHTO M 326.

The pipe shall be homogeneous throughout and free from visible cracks, holes, foreign inclusions or other injurious defects. The pipe shall be as uniform as commercially practical in color, opacity, density and other physical properties. Pipe shall be solid wall with a smooth interior and exterior with no corrugations or ferrous elements.

Pipe and pipe fittings shall be manufactured from high density compounds in accordance with ASTM D3350, cell classification 345464C or (345474C) with a designation of PE 3408or (PE 4710) and a minimum Standard Dimension Ratio (SDR) of 32.5.

Each pipe segment shall be marked on the outside with a coded number which identifies the manufacturer, SDR, size, materials, machine, date and shift on which the pipe was extruded.

Pipe[s] shall be specifically applicable for installation and use in the project environment.

2. Joints

Joints shall be water-tight and soil tight meeting AASHTO M 326 over the range of head pressure expected for the pipe.

Joints shall be butt-fused in accordance with ASTM F2620 and the manufacturer's recommendations or shall be capable of being joined into a continuous length by an

interlocking method such that joints meet the requirements of ASTM D3212. Screw-type or threaded joints will not be allowed unless a positive lock is included in the joint system or the perimeter of the joint is extrusion welded at the bearing assembly prior to insertion. Internal beads resulting from butt fusion shall be limited to a 0.25 inch (6 mm) projection perpendicular to the inside wall of the pipe. Trim beads larger than a 0.25 inch (6 mm) 360 degrees around the interior of the pipe. External beads resulting from butt fusion need not be trimmed unless the bead projection will negatively impact pipe installation or migration of annulus grout.

E. Steel Reinforced Polyethylene Pipe (SRPE)

1. Pipe

The pipe profile is manufactured using a high quality stress-rated thermoplastic meeting the requirements of ASTM F2562 “Standard Specification for Steel Reinforced Thermoplastic Ribbed Pipe and Fittings for Non-Pressure Drainage and Sewerage” or AASHTO Designation MP-20, Bridge Construction Section 26 & Design Section 12.

Virgin high density polyethylene stress-rated resins are used to manufacture the pipe and complimentary fabricated fittings. Resins shall conform to the minimum requirements of cell classification 345464C as defined and described in the latest version of ASTM D3350 “Standard Specification for Polyethylene Plastics Pipe and Fittings Materials”.

2. Joints

Low Head (LH) Joints (30” – 72”) shall be gasketed, stress-rated high density polyethylene bell and spigot joints (meeting the requirements set forth in the above Material Properties paragraph) that have been laboratory tested to 3 psi when tested in accordance with ASTM D3212 “Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.

High Performance (HP) Joints (30” – 72”) shall be gasketed, bell and spigot joints where both the bell and spigot are reinforced with steel that is fully encased in stress-rated high density polyethylene (meeting the requirements set forth in the above Material Properties paragraph) and that have been laboratory tested to 15 psi when tested in accordance with ASTM D3212 “Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals”.

Welded Coupler (WC) Joints (36” – 120”) shall utilize plain ended pipe welded together with a polyethylene coupler by way of electro fusion welding or extrusion welding technology. The welded connections provide a true, infield watertight system. The field installed welded coupler joints shall remain watertight and can achieve zero leakage rates on appropriate applications. The welded coupler joints have been laboratory tested to 30 psi in accordance with ASTM D3212 Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals”.

F. Machine Spiral Wound PVC or HDPE Pipe**1. Profile Strip**

Provide extruded PVC profile strip in accordance with the requirements of ASTM F1697 except as noted below.

Provide extruded HDPE profile strip in accordance with the requirements of ASTM F1741 “standard Practice for Installation “OD” Machine Spiral wound PVC Pipe Liner for Rehabilitation of Existing Sewers and conduit” modified for SPR PE (HDPE) pipe liner.

Pipe made from similar grade HDPE as new sewer and drainage pipe, meeting cell classification of 335420C (or E) in accordance with ASTM D 3350.

Continuous welding process seals subsequent strip of profile creating a seamless pipe line of high stiffness, consistent material properties.

Structural stand-alone liner – does not rely upon the grout for strength but only to transfer the load.

All profile strips shall be specifically applicable for installation and use in the project.

2. Joints

Joints shall meet the requirements of ASTM D3212, and gaskets meeting the requirements of ASTM F477. The joint shall consist of a single, mechanical interlock between profile strips supplemented with sealant and is created continuously as the profile is wound into the pipe. Once wound into place within the host pipe, joints shall be considered completed and the pipe shall not be intentionally or otherwise expanded or permitted to translate in any direction at the joint. Joints shall be water-tight over the range of head pressure expected for the pipe.

The completed pipe liner shall be provided such that the outside diameter of the pipe is not increased, nor the internal diameter of the pipe is decreased at the joint.

G. Glass Fiber-Reinforced Plastic Pipe**1. Pipe**

Provide centrifugally cast fiberglass reinforcement plastic mortar pipe (CCFRMP) in accordance with ASTM D3262, cell classification Type 1, Liner 2, Grade 3. All pipes shall be specifically applicable for installation and use in the project environment.

Minimum pipe stiffness shall be 36 psi (248) kPa when tested in accordance with ASTM D2412.

The glass fibers shall be a commercial grade of E-type glass fibers with the amount, location and orientation of the chopped glass-fiber reinforcement specifically designed for each application.

Sand shall be minimum 98 percent silica kiln-dried and graded.

The polyester wall resin shall be an isophthalic, orthophthalic or other approved resin with a minimum tensile elongation of 2 percent.

Fiberglass liner shall be shown by tests to be resistant to long-term corrosion. Testing shall be performed in accordance with ASTM D3681 using 1.0N sulfuric acid for sanitary sewage.

Each pipe segment shall be marked on the inside and outside to identify the manufacturer's number, diameter, stiffness, ASTM designation and lot number.

2. Joints

Provide pipe with joints designed so that neither the outside diameter of the pipe is increased, nor the internal diameter of the pipe is decreased at the joint. Joints shall be water-tight over the range of head pressure expected for the pipe. Joints shall meet the performance requirements of ASTM D4161. Field connect pipe[s] with low-profile, fiberglass bell-spigot joints or flush fiberglass bell-spigot joints, when the fit requires. Utilize elastomeric sealing gaskets as the sole means to maintain joint water-tightness. Gaskets shall meet the requirements of ASTM F477. Joints at tie-ins, when needed, may utilize gasket-sealed closure couplings.

H. Smooth Wall Carbon Steel Plate Pipe

1. Pipe

The pipe liner shall consist of arc welded straight seam pipe with .20 minimum copper content for improved corrosion resistance, for use in culvert rehabilitation and pipe linings. The pipe liner may be round, elliptical, arch shaped, or other special sections as specified. All round and non-round pipe liner sections of a smooth wall carbon steel plate pipe must conform to the following requirements:

- a. All pipe must be domestic with melted and manufactured in USA (MMU), made from new unused steel plates, and shall be straight seam pipe. Longitudinal seams welded after rolling must be welded by the automatic double submerged arc weld (DSAW) method. Joints or midwelds welded after rolling must be welded by automatic or semiautomatic DSAW, flux cored arc weld (FCAW) or gas metal arc weld (GMAW) methods, and splices and repair welds done before rolling must be welded by automatic, semiautomatic or manual DSAW, FCAW, GMAW methods.
- b. Each heat number of steel used for the pipe liner must be tested for chemical composition and tensile requirements that meet the following:

Carbon:	0.26 max
Manganese:	1.65 max, *See Note
Phosphorous:	0.035 max

Sulfur: 0.035 max
 Copper: 0.20 max
 Tensile Strength: 60,000 PSI min
 Yield Strength: 36,000 PSI min

*For each 0.01 percent reduction of carbon below the maximum concentration shown above, a 0.05 percent increase of manganese is allowed up to a maximum concentration of 2 percent manganese.

- c. Pipe liner wall thicknesses should be no less than .500 (½”) wall, or as determined by ASHTO HL-93 load bearing analysis. The minimum specified wall thickness to be used for round pipe liner made to this specification shall be .500 nominal wall, and the wall thickness at any point shall not be more than 12.5% under the specified nominal wall thickness.
- d. The minimum specified wall thickness to be used for elliptical, arch, and other non-round pipe liner sections shall be .500, and the wall thickness at any point shall not be thinner than .015 under the specified wall thickness.

2. Joints

Welded steel pipe liner joints must be full penetration welds in accordance with AWS D1.1, allowing for Bevel X Plain End joint configuration.

Table 607G-1: SLIPLINING PIPE DIMENSION

Pipe Materials (Size Dimension)	Nominal Pipe Size (in.)		
	12 - 36	42 - 60	66 - 120
Corrugated HDPE (Inner)	X		
Profile Wall PVC (Inner)	X		
Corrugated PP (Inner)	X	X	
Solid Wall HDPE (Outer)	X	X	
SRPE (Inner)	X	X	X
Spiral Wound PVC	X	X	X
Spiral Wound HDPE		X	X
Glass Fiber Reinforced (Inner)		X	X
Smooth Wall Carbon Steel Plate Pipe	X	X	X

I. Grout for Annular Space

Provide grout for the annular space in accordance with this Specification and with the manufacturer's published recommendations.

The grout shall be nonstructural or structural based upon the type of slip liner system provided. If the pipe liner provided cannot meet the stated requirements for factor of safety against buckling or crushing, then a structural grout must be used regardless of the pipe lining system used in order to fulfill the factor of safety requirements as stated herein.

Utilize material specifications for solidification of the annular void between host and the inserted liner with low density flowable fill or cellular grout. The cellular grout with a density between 40 and 80 lbs. per cubic foot may be used. Reduced density flowable fill grout with a density between 80 and 120 lbs. per cubic foot may be used.

Grout shall be mixed in small quantities as needed, and shall not be re-tempered or used after it has begun to set, unless otherwise specified or directed. The grout shall consist of one part portland cement and two parts sand by volume mixed with sufficient water to form a grout of proper consistency. When non-shrinking or non-shrinking fast-setting grout is specified, it shall be formulated by the incorporation of an admixture, or a pre-mixed grout may be used. The formulation and the admixture or the premixed grout used will be subject to the approval of the Engineer, and shall be mixed and used in accordance with the recommendations of the manufacturer.

For pipe 12"-36" when justified by structural design factors the use of grout is not required.

Equipment

Provide all necessary equipment for satisfactory completion of the work including restoration of the site.

Pipe Stockpiling and Handling

Pipe and fittings shall be stockpiled in a safe manner at each contractor staging area or pit location. The stockpiling shall be arranged to cause a minimum of interference to pedestrian and stored outside the safety clear zone of vehicular traffic.

When handling slip lining pipe, take all precautions necessary to avoid damaging the pipe. Pipe with cuts greater than 10% of the wall thickness shall be rejected or replaced at no cost to the Department.

Pipe storage areas shall be approved by the Engineer.

Construction Requirements

The existing culvert pipe shall be cleaned by whatever means necessary to remove all obstructions which may be encountered that would prevent insertion of the slip liner into the host pipe as approved by the Engineer. All drainage structures and ditches shall remain open at all times.

As Directed by the Engineer, reestablish the flow-line of eroded inverts with grout meeting the requirements of Subsection 918.21 of the specifications. Premixed grout may be used subject to approval of the Engineer.

A detailed plan on holding the liner pipe on the invert of the host pipe shall be submitted to the Engineer for approval.

Where required, a bullnose device shall be pulled through the existing culvert to facilitate the slip lining installation. The bullnose device shall be of appropriate diameter to return the culvert to its approximate shape.

The annular void shall be completely grout filled without deflecting the insertion pipe greater than 1.5 percent.

Provide end seals at the open points of each run of pipe to be grouted

Penetration of the host pipe shall be permitted for host pipe constructed with Corrugated Metal Pipe (CMP) to facilitate grouting of the annular void. Multiple fill pipes will be required.

The annular void shall be grouted solid by injecting grout from one end of the pipe run and allowing it to flow toward the other end. Venting of the annular void shall be performed to assure uniform filling of the void space during the grouting process. An open ended, high point tap or equivalent vent must be provided and monitored at the bulkhead opposite to the point of grouting.

After installation of the pipe liner is complete, seal the inlet end of the pipe with a water tight seal between the pipe liner and the existing pipe. The seal shall be one recommended by the pipe manufacturer and approved by the Engineer.

All incidental work, such as brush removal, flow-line adjustments, etc., shall be accomplished by the contractor.

Upon acceptance of the installation work and testing, clean-up and restore the project area affected by operations as approved by the Engineer.

Method of Measurement

The Department will measure the pipe liner to Slip Line the existing pipe by the linear feet installed and accepted.

The Department will measure the Cement by each per 94 lb bag. If pre-mixed grout is used, the amount of cement in each bag, or other units of pre-mixed grout, must be determined and expressed in equivalent 94 pound bag units for payment purposes.

Basis of Payment

The Department will pay for accepted quantities at the contract prices as follows:

Item		Pay Unit
607-65.20	Site Preparation	Each
607-65.XX	(Desc) Pipe To Slip Line (Desc)	Linear Feet
719-03	Cement	Bag

Such payment is full compensation for furnishing and installing pipe liner, clearing, reestablishing pipe flow lines, site restoration, and all other labor, materials and any incidentals necessary to complete the work.

All cost incurred in grouting eroded inverts of existing culvert pipes shall be included in the contract bid price for cement (per 94 pound bag).