Section 4147. Pipe and Manhole Rehabilitation Materials

4147.01 PIPE REHABILITATION.

A. Polyethylene and Polyolefin Manufactured Pipe for Sliplining.

1. Pipe.
- **a.** Comply with ASTM D 3035, minimum pipe stiffness of 46 psi (320 kPa).
- **b.** Polyethylene complying with ASTM D 1248, Type III, Class C, Category 5, Grade P 34 or ASTM D 3350 Cell Classification PE 335434C.
- **c.** Maximum outside diameter as specified in the contract documents.

2. Joints.
- **a.** Joined into continuous length on job site.
- **b.** Fuse butt joints according to the pipe manufacturer's recommendations with approved equipment and complying with ASTM D 2657.

B. Polyvinyl Chloride Pipe Corrugated Pipe 12 Inch to 36 Inch (300 mm to 900 mm) for Sliplining.

1. Pipe.
- **a.** Comply with ASTM F 949, minimum pipe stiffness, 46 psi (320 kPa).
- **b.** PVC plastic complying with ASTM D 1784, Cell Classification 12454.

2. Joints.
Gasketed joints complying with ASTM F 477 and ASTM D 3212.

C. Polyvinyl Chloride Pipe Closed Profile Pipe 21 Inch to 48 Inch (525 mm to 1200 mm) for Sliplining.

1. Pipe.
- **a.** Comply with ASTM F 1803, minimum pipe stiffness, 46 psi (320 kPa).
- **b.** PVC plastic complying with ASTM D 1784, Cell Classification 12364.

2. Joints.
Gasketed joints complying with ASTM F 477 and ASTM D 3212.

D. Centrifugally Cast Fiberglass Reinforced Polymer Mortar Pipe (CCFRPM) 18 Inch to 48 Inch (450 mm to 1200 mm) for Sliplining.

1. Pipe.
Comply with ASTM D 3262.

2. Joints.
Gasketed joints complying with ASTM D 4161.

E. Resin-Impregnated Tube for Cured-in-place Pipe (CIPP) Lining.

1. Pipe Lining.

a. Comply with ASTM F 1216.

b. Use one or more layers of flexible needled felt or equivalent non-woven material.

c. Stretch material to fit irregular pipe and negotiate bends.

d. Outside layer plastic coated with a translucent flexible material. No delamination of plastic coating.

e. Fabricated to a size that when installed tightly fits length without joints.

f. Designed as per Equation X-1, ASTM F 1216.

2. Resin and Catalyst.

a. Unsaturated, styrene-based, thermoset resin and catalyst system or an epoxy resin and hardener that is compatible with the inversion process.

b. Cure in the presence of water with temperature greater than 150ºF (66ºC) and less than 180ºF (82ºC).

c. Initial structural properties complying with ASTM F 1216. Comply with Table 4147.01-1.

Table 4147.01-1: CIPP Lining Properties

CIPP Properties	ASTM Test Method	Minimum Value
Flexural Strength	D 790	4500 psi (31 MPa)
Flexural Modulus of Elasticity	D 790	250,000 psi (1725 MPa)

3. CIPP Lining Dimensions.

a. Use nominal internal diameter and length such that CIPP forms to internal circumference and length of original pipe.

b. Field verify diameter and length.

c. Use one continuous length without joints.

F. Deformed/Reformed High Density Polyethylene Pipe Lining (DRP-HDPE).

1. Pipe Lining.

a. Manufactured in deformed shape from HDPE pipe compound complying with ASTM D 1248, Class C, Category 5 and Grade P 34.

b. Comply with long term hydrostatic strength rating of 1600 psi (11 MPa) or more according to ASTM D 2837.

c. Environmental stress crack resistance (ESCR) less than 2,000 hours in 100% solution, Igepal CO-630 at 100ºC before failure according to ASTM D 1693, Condition C.

d. Comply with Table 4147.01-2 for minimum DRP lining structural standards.

Table 4147.01-2: DRP-HDPE Lining Properties

FIPP Properties	ASTM Test Method	Minimum Value
Flexural Strength	D 790	3300 psi (22.75 MPa)
Flexural Modulus of Elasticity	D 790	136,000 psi (938 MPa)
Tensile Strength	D 638	3200 psi (22.1 MPa)

2. DRP Lining Dimensions.

- **a.** Nominal internal diameter and length of existing pipe as specified in the contract documents.
- **b.** Field verify diameter and length.
- **c.** Outside diameter fabricated to fit tightly.
- **d.** Use one continuous length without joints between manholes.
- **e.** Minimum wall thickness complying with SDR as specified in the contract documents.

G. Folded/Formed Polyvinyl Chloride Pipe Lining.

1. Pipe Lining.

- **a.** Manufacture in deformed shape complying with ASTM D 1784, Cell Classification 12454 B. Compounds with different cell classifications because one or more properties are superior to those specified are acceptable.
- **b.** Performance requirements complying with ASTM D 3034.
- **c.** Comply with Table 4147.01-3 for FPP lining structural properties.

Table 4147.01-3: FPP Lining Properties

FIPP Properties	ASTM Test Method	Minimum Value
Tensile Modulus of Elasticity	D 638	350,000 psi (2415 MPa)
Tensile Strength	D 638	6000 psi (41.4 MPa)

2. FPP Lining Dimensions.

- **a.** Nominal internal diameter and length of existing pipe as specified in the contact documents.
- **b.** Field verify diameter and length prior to manufacturing.
- **c.** Use one continuous length without joints between manholes.
- **d.** Outside diameter fabricated to fit tightly.
- **e.** Minimum wall thickness complying with the specified SDR as specified in the contract documents and complying with ASTM F 1216.

H. Pipe Repair Couplings for Spot Repairs by Pipe Replacement.

1. Style.
Full circle, fully lined, bolted.

2. Length.
12 inches (300 mm), minimum.

3. Materials and Manufacturer.
- **a.** Shells, armors, side bars, lugs, Turner lifting bars, bolts, and nuts complying with ASTM A 240, Type 304 stainless steel.
- **b.** MIG welds, fully passivated.
- **c.** Rubber gasket complying with ASTM D 2000, AA415 with full coverage and grid pattern.
- **d.** Stainless steel armor bonded to gasket to bridge lug area.

4. Nuts and Bolts.
1/2 inch or 5/8 inch (12.5 mm or 15.9 mm), Teflon coated threads.

I. Sewer Main Pipe (For Spot Repairs).

1. Apply Section 2504.

2. Use materials for pipe replacement as specified in the contract documents or approved by the Engineer.

4147.02 MANHOLE REHABILITATION.

A. Rubber Chimney Seal.
Apply Article 4149.02, J, for external and internal rubber chimney seals.

B. Urethane Chimney Seal.

1. Use only when specified in the contract documents.

2. Comply with Table 4147.02-1 for the physical properties:

Table 4147.02-1: Physical Properties

Property	ASTM Test Method	Acceptable Value
Elongation	D 412	800%, minimum
Tensile Strength	D 412	1150 psi (8 MPa), minimum
Adhesive Strength	D 903	175 lb/in (3 kg/mm), minimum
Pressure Resistance	C 1244/C 1244M	2 minutes

C. In-Situ Manhole Replacement, Cast-in-place Concrete.

1. Forming System.
Provide an internal forming system capable of forming a new and structurally independent manhole wall within the existing manhole, with the specified thickness and conforming to the general shape of the existing manhole.

2. Concrete.
Type I/II Portland cement with 5/8 inch (16 mm) minus coarse aggregate with fiber reinforcement and water reducer, 4000 psi (28 MPa) minimum 28 day compressive strength or as approved by the Engineer.

3. Plastic Liner.
When specified, provide a PVC or PE plastic liner resistant to degradation by sulfuric acid. Use a liner capable of being attached to the exterior of the forming system during erection of the forms. Use a plastic liner with a ribbed or studded exterior surface suitable for anchoring to the newly formed interior wall.

4. Casting.
Provide new casting. Apply Article 4149.02, I.

D. Centrifugally Cast Cementitious Mortar Liner with Epoxy Seal.

1. Cementitious Lining.
a. Use a high-strength, high-build, corrosion-resistant mortar, based on Portland cement fortified with micro silica. Mixed mortar is to have a paste-like consistency that may be sprayed, cast, pumped, or gravity-flowed into any area 1/2 inch (13 mm) and larger.
b. Comply with Table 4147.02-2 for physical properties:

Table 4147.02-2: Physical Properties

Property	Value
Unit Weight	125 pcf (2000 kg/m^3)
Set Time at 70° F (21° C) ASTM C 403/C 403M Initial Set / Final Set	240 minutes / 440 minutes
Modulus of Elasticity ASTM C 469 24 hours / 28 days	180,000 psi / 1,150,000 psi (1240 MPa / 7930 MPa)
Flexural Strength ASTM C 293 24 hours / 28 days	650 psi / 800 psi (4.5 MPa / 5.5 MPa)
Compressive Strength ASTM C 109/C 109 M 24 hours / 28 days	3000 psi / 10,000 psi (21 MPa / 70 MPa)

Tensile Strength ASTM C 307	600 psi (4 MPa)
Shear Bond ASTM C 882/C 882M	>1000 psi (7 MPa)
Shrinkage ASTM C 157/C 157M	None
Chloride Permeability ASTM C 1202	<550 Coulombs

c. Use a lining containing a liquid admixture for the prevention of micro-biologically induced corrosion.

2. Corrosion-Resistant Epoxy Lining.

a. Use a two-component 100% solids epoxy formulated for use in sewer systems.

b. Comply with Table 4147.02-3 for physical properties:

Table 4147.02-3: Physical Properties

Property	Value
Dry Time	4-6 hours at 75° F (24º C)
Compressive Strength ASTM D 695	16,800 psi (116 MPa)
Flexural Strength ASTM D 790	13,900 psi (96 MPa)
Tensile Strength ASTM D 638	12,400 psi (86 MPa)
Hardness ASTM D 2240	68-72 Shore D
Heat Distortion ASTM D 648	220°F (104º C)
Ultimate Elongation ASTM D 638	4.5 %
Adhesive Shear ASTM C 882/C 882M	1000 psi (7 MPa)

3. Casting.

Provide new casting. Apply Article 4149.02, I.