Make the following Section part of the Standard Specifications:

SECTION 694 – CURED-IN-PLACE PIPE (CIPP)

694.01 Description. This section describes providing for the reconstruction of pipelines and conduits by the installation of a resin-impregnated flexible tube which is tightly formed to the original conduit. The resin is cured using either hot water under hydrostatic pressure or steam pressure within the tube. The CIPP will be continuous and tight fitting.

This section references standards from the American Society for Testing and Materials, such as:

(A)	Rehabilitation of Existing Pipelines and Conduits by the Inversion and curing of a Resin-Impregnated Tube	ASTM F1216
(B)	Rehabilitation of Existing Pipelines and Conduits by Pulled-in-Place Installation of Cured-in-Place Thermosetting Resin Pipe	ASTM F1743
(C)	Cured-in-Place Thermosetting Resin Sewer Pipe	ASTM D5813
(D)	Test Methods for Flexural Properties of Un-reinforced and Reinforced Plastics and Electrical Insulating Materials	ASTM D790
(E)	Tensile, Compressive, and Flexural Creep and Creep-Rupture or Plastics	ASTM D2990

In case of conflicting requirements between this section and these referenced documents, this section will govern.

694.02 Materials.

(A) Tube. The sewn tube shall consist of one or more layers of absorbent non-woven felt fabric and meet the requirements of ASTM F1216, Section 5.1 or ASTM F1743, Section 5.2.1. The tube shall be constructed to withstand installation pressures, have sufficient strength to bridge missing pipe and stretch to fit irregular pipe sections.

The wet out tube shall have a relatively uniform thickness that when compressed at installation pressures will equal or exceed the calculated minimum design thickness.

The tube shall be manufactured to a size that when installed will tightly fit the internal circumference and length of the original pipe. Allowance should be made for circumferential stretching during inversion.

Do not use overlapped layers of felt in longitudinal seams that cause lumps in the final product.

The outside layer of the tube shall be coated with an impermeable, flexible membrane that will contain the resin and all the resin impregnation (wet out) procedure to be monitored.

The tube shall be homogenous across the entire wall thickness containing no intermediate or encapsulated elastomeric layers. No material shall be included in the tube that may cause delamination in the cured CIPP. No dry or unsaturated layers shall be evident. The wall color of the interior pipe surface of CIPP after installation shall be a relatively light reflective color so that a clear detailed examination with closed circuit television inspection equipment may be made.

Seams in the tube shall be stronger than the non-seamed felt material.

The tube shall be marked for distance at regular intervals along its entire length, not to exceed 5 feet. Such markings shall include the manufacturer's name or identifying symbol. The tubes must be manufactured in the USA.

(B) Resin. The resin system shall be corrosion resistant polyester, vinyl ester, or epoxy system including all required catalysts, initiators or hardeners that when cured within the tube create a composite that satisfies the requirements of ASTM F1216 and ASTM F1743, the physical properties herein, and those which are to be utilized in the design of the CIPP for this project. The resin shall produce a CIPP that will comply with the structural and chemical resistance requirements of this section.

694.03 Construction.

(A) Construction Requirements. Design the CIPP in accordance with ASTM F1216, Appendix X1. The CIPP design shall assume no bonding to the original wall.

The Contractor must have performed long-term testing for flexural creep of the CIPP material installed by his Company. Such testing results

are to be used to determine the long-term, time dependent flexural modulus to be utilized in the product design. This is a performance test of the materials (Tube and Resin). A percentage of the instantaneous flexural modulus value (as measured by ASTM D 790 testing) will be used in design calculations for external buckling. Retention valves exceeding 50% of the short-term test results shall not be applied unless substantiated by qualified third-party test data to the Owner's satisfaction. The materials utilized for the contracted project shall be of a quality equal to or better than the material used in the long-term test with respect to the initial flexural modulus used in the CIPP design.

Bond the layers of the CIPP uniformly. It shall not be possible to separate any two layers with a probe or point of a knife blade so that the layers separate cleanly or the probe or knife blade moves freely between layers. If the layers separate during field sample testing, new samples will be required to be obtained from the installed pipe. Any reoccurrence may cause rejection of work.

The CIPP material shall conform to the following structural properties:

Table 694.03-1 – MINIMUM CIPP PHYSICAL PROPERTIES

Property	**Test Method**	**Cured Polyester Composite**	
		Minimum per ASTM F1216 (psi)	**Enhanced Resin (psi)**
Modulus of Elasticity	ASTM D790	250,000	400,000
Flexural Stress	ASTM D790	4,500	4,500

The required structural CIPP wall thickness shall be based as a minimum, on the physical properties listed in Table 694.03-1 Minimum CIPP Physical Properties and in accordance with the design equations in the Appendix X1 Design Considerations of ASTM F1216 and the following parameters:

Table 694.03-2 – DESIGN PARAMETERS

Design Safety Factor	2.0
Retention Factor for Long-Term Flexural Modulus	1% - 75%
Ovality *	%
Enhancement Factor, K	7
Groundwater Depth (above invert of existing pipe)	Ft.
Soil Depth (above crown of existing pipe)	Ft.

*Ovality % = 100 x (Mean diameter – Minimum diameter) / Mean Diameter.
2% ovality is typically assumed when the host pipe measurements have not been field verified.

Any layers of the tube that are not saturated with resin prior to insertion in the existing pipe shall not be included in the structural CIPP wall thickness computation.

(B) Testing Requirements.

(1) Chemical Resistance. The CIPP shall meet the chemical resistance requirements of ASTM F1216, Appendix X2. CIPP samples for testing shall be of tube and resin system similar to that proposed for actual construction. It is required that CIPP samples with and without plastic coating meet these chemical-testing requirements.

(2) Hydraulic Capacity. Overall, the hydraulic cross-section shall be maintained as large as possible. The CIPP shall have a minimum of the full flow capacity of the original pipe before rehabilitation. Calculated capacities may be derived using a commonly accepted roughness coefficient for the existing pipe material taking into consideration its age and condition.

(3) CIPP Field Samples. When requested by the Engineer, submit test results from field installation in the USA of the same resin system and tube materials as proposed for the actual installation. These test results must verify that the CIPP physical properties specified in Subsection 694.03 – Structural Requirements have been achieved in previous field applications. Samples for this project shall be made and tested as described in Subsection 694.05 – Construction Requirements.

(C) Construction Requirements

(1) Inspection of Pipelines. Inspection of pipelines shall be performed by experienced personnel trained in locating breaks, obstacles and service connections using closed circuit television (CCTV) inspection techniques. The pipeline interior shall be carefully inspected to determine the location of any conditions that may prevent proper installation of CIPP. These shall be noted and corrected. A videotape and suitable written log for each line section shall be produced for later reference by the Engineer.

(2) Line Obstructions. Clear the line of obstructions such as solids and roots that will prevent the insertion of CIPP.

(3) CIPP Samples. Test the physical properties in accordance with ASTM F1216 or ASTM F1743, Section 8, using either method proposed. The flexural properties must meet or exceed the values listed in Table 1 of the applicable ASTM.

(4) Wall Thickness Determination. Wall thickness of samples shall be determined in accordance with paragraph 8.1.6 of ASTM F1743. The minimum wall thickness at any point shall not be less than 87 1/2 percent of the minimum design wall thickness as calculated in Subsection 694.03 – Structural Requirements.

(5) Visual Inspection. Visual inspection of the CIPP shall be in accordance with ASTM F1743, Section 8.6.

(6) Surface Preparation. Clean the interior face of the pipe of loose materials, mud, or other foreign matter that could prevent or reduce CIPP bond. Avoid loosening, cracking, or shattering the ground during excavation and cleaning. Remove any surface material which is so loosened or damaged to a sufficient depth to provide a base that is suitable to receive the CIPP. Remove material that loosens as the CIPP is applied. Divert water flow and remove standing water so that the CIPP placement will not be detrimentally affected by standing water.

Upon completion of the installation of work and testing, restore the project area affected by the operations to a condition at last equal to that existing prior to the work.

694.04 Measurement. Cured-in-Place (CIPP) will be paid per linear feet.

694.05 Payment. The Engineer will pay for the accepted cured-in-place pipe per linear foot. Payment will be full compensation for the work prescribed in this section and the contract documents.

The Engineer will pay for the following pay item:

Pay Item	Pay Unit
Cleaning of Drainlines	Force Account

Cured-in-Place Pipe Linear Feet”

END OF SECTION 694