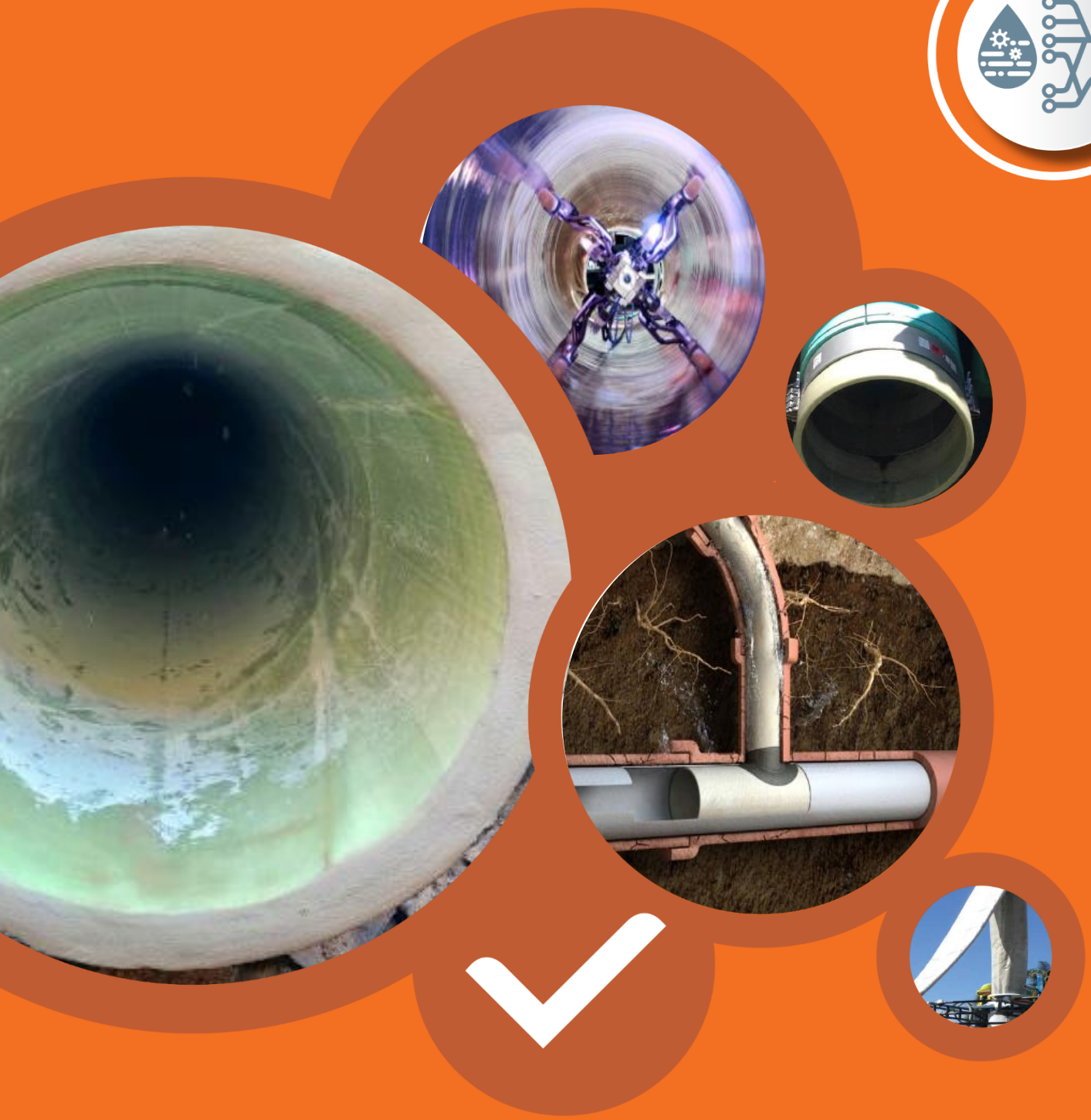

GRAVITY SEWER PIPE REHABILITAION

CURED IN PLACE PIPE (CIPP) – PERFORMANCE SPECIFICATION GUIDELINE

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Watercare

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More information

If you have further queries, please contact the Asset Lifecycle team at standards@water.co.nz

DOCUMENT CONTROL

Document owner	Principal Asset Lifecycle Engineer (Standards)
Review	Head of Sustainability and Innovation

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Version	Description of revision	Prepared by	Approved by	Date
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Definitions

ASTM	American Society for Testing and Materials
ASTT	Australasian Society for Trenchless Technology
CCTV	Closed Circuit Television – which includes cameras and displays to record and inspect pipelines.
CIPP	Cured in place pipe
Contractor	Main contractor engaged by Watercare, responsible for delivering the works
Curing	The process of resin polymerisation, which may be initiated or accelerated using heat or ultraviolet light.
Defect	Any discontinuity, imperfection or inclusion arising from substandard materials, improper pipe preparation, or faulty manufacture, installation or workmanship which affects the hydraulic or structural performance of the lining
DN	Nominal Diameter
Full length liner	Lining a complete section of sewer between two access points.
ISO	International Organisation for Standardisation
Lateral Junction repair (LJR)	Repair made with CIPP technology to a damaged lateral connection, either stand alone or in conjunction with a full or part liner
Liner	A flexible tube or folded sheet, consisting of a combination of carrier material, liquid resin system, and any other reinforcements
NDSRs	No-dig spot repairs
Project Specification	Project specific requirements specific by the design engineer which form part of the minimum requirements to be met during construction
Specialist Contractor	Contractor carrying out the physical installation of the liner in accordance with the project specifications and manufacturer's recommendations.
UV	Ultraviolet
Watercare	Watercare's representative responsible for managing the project.

Table of Contents

1. Scope

This Performance Specification includes the minimum requirements for the rehabilitation of pipelines using Cured In Place Pipe (CIPP).

This document shall be read in conjunction with *ESF-600-STD-206: Gravity sewer pipe rehabilitation – General requirements for the installation of lining systems*.

1.1 Overview

The lining system shall comprise of an acceptable liner and resin combination (refer Section 4.1). An appropriate curing method shall be specified to suit to the lining material.

***Table 1**: Application of cured in place pipe*

Reference	Description
Liner material	• Absorbent polymeric / synthetic fibres (felt) • Glass fibres • Multiaxial glass fibre • Carbon fibres • Combination of the above fibres
Curing type	Heat (water or steam), Photoinitiated reaction (e.g. by UV light), or ambient cure
Roughness coefficient	The liner must be smooth and have an average roughness coefficient factor of 0.013 or lower.
Liner Classification	Class A – Fully structural Class B – Semi-structural Class C – Semi-structural
Applications	Wastewater: non-pressure
Pipe sizes	Pipes sized 100mm to 1200mm diameter[(a)]
Installation	Manhole to manhole (can follow slightly curved alignments to minimise wrinkles)[(b)]
Material quality control	• ASTM F1216 • ASTM F2019 • ASTM F1743 • ISO 11296.4
Design life	50 years

(a) Note: Sewers with larger sizes and various shapes can also be considered, provided the designers, contractors and installers demonstrate a proven track record for the planning, design and construction of these liners.

(b) The feasibility of following curved alignments shall be confirmed with the specialist lining contractor, to ensure that the required curing can take place.

2. Relevant Standards

***Table 2**: Standards applicable to cured in placed pipe liners*

Standard	Relevance
AS/NZS ISO 11295: Plastics piping systems used for the rehabilitation of pipelines - Classification and overview of strategic, tactical and operational activities	Planning and general
AS/NZS ISO 11296.1: Plastics piping systems for renovation of underground non-pressure drainage and sewerage networks, Part 1: General	General
ISO 11296.4: Plastics piping systems for renovation of underground non-pressure drainage and sewerage networks - Part 4: Lining with cured in place pipes.	Design, materials and testing, installation
ASTT – DS-D001 Specification: Design for Structural Renovation of Pipelines by Internal Lining, Part 1 – Circular Non-pressure Pipelines	Design

Standard	Relevance
ASTM F1216: Standard Practice for Rehabilitation of Existing Pipelines and Conduits by the Inversion and Curing of a Resin-Impregnated Tube	Design, materials and testing, installation (partially and fully deteriorated pipes)
ASTM F2019: Standard Practice for Rehabilitation of Existing Pipelines and Conduits by pulled in Place Installation of Glass Reinforced Plastic Cured-in-Place (GRP-CIPP) Using the UV-Light Curing Method	Design, materials and testing, installation (partially and fully deteriorated pipes)
ASTM F1743: Standard Practice for Rehabilitation of Existing Pipelines and Conduits by Pulled-in-Place Installation of Cured-in-Place Thermosetting Resin Pipe (CIPP)	Material and installation
ASTM D5813: Standard Specification for Cured-In-Place Thermosetting Resin Sewer Piping Systems	Installation (CIPP Liner)
ASTM F2561: Standard Practice for Rehabilitation of a Sewer Service Lateral and Its Connection to the Main Using a One-Piece Main and Lateral Cured-in-Place Liner	Installation (Laterals)
WIS 4-34-06: Specification for localised sewer repairs using cured-in-place systems with or without re-rounding.	Installation (Repairs)
ASTM D790: Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.	Materials testing
ASTM D2990: Standard Test Methods for Tensile, Compressive, and Flexural Creep and Creep-rupture of Plastics	Materials testing

Note: The latest revisions of the standards listed above shall be referred to when carrying out any of the associated works

3. Design

For all general design requirements refer to *ESF-600-STD-206: Gravity sewer pipe rehabilitation – General requirements for the installation of lining systems*.

The CIPP liner shall be designed using one of the following standards:

- **ASTT – DS-D001 Specification:** Design for Structural Renovation of Pipelines by Internal Lining, Part 1 – Circular Non-pressure Pipelines
- **ASTM F1216:** Standard practice for rehabilitation of existing pipelines and conduits by inversion and curing of a resin-impregnated tube – Appendix X1
- **ASTM F2019:** Standard Practice for Rehabilitation of Existing Pipelines and Conduits by pulled in Place Installation of Glass Reinforced Plastic Cured-in-Place (GRP-CIPP) Using the UV-Light Curing Method – Appendix X1

The long term (50 year extrapolated) Creep Reduction Factor shall be set at 50% of the initial flexural modulus as determined by ASTM D790 test method. This value shall be used unless the Contractor submits long term test data (ASTM D2990) to substantiate a higher retention factor.

4. Material requirements

4.1 Material properties

The Contractor shall submit test data to substantiate that the values for material properties nominated in the design calculations can be achieved by the materials supplied for the pipeline installation.

Where material properties under load vary with time, material properties of the lining at the end of the 50-year design life shall be used in design calculations. The exception to this is design of the lining for loads applied only during installation, which may be based on short-term material properties.

The material properties of the lining material used in the rehabilitation of the pipeline shall be consistent with the design properties. These properties shall have the same values as those nominated by the Designer.

4.1.1 Tube

The tube shall consist of one or more layers of absorbent material such as non-woven felt fabric, glass fibre, carbon fibre, multiaxial glass fibre, or a combination of these materials, meeting the requirements of ASTM F1216, ASTM F1743, or ASTM F2019 and ASTM D5813.

The tube shall have sufficient strength to withstand curing pressures and temperatures.

4.1.2 Resin system

The resin system shall conform to ASTM D5813 Section 8.2.2.

The resin shall be a corrosion resistant polyester, vinyl ester or epoxy resin and catalyst system that when properly cured within the composite liner assembly, meets the requirements of ASTM F1216, ASTM F1743, or ASTM F2019, and those which are to be utilized in the design of the CIPP, for this project

4.2 Chemical, temperature and abrasion resistance

Refer to *ESF-600-STD-206: Gravity sewer pipe rehabilitation – General requirements for the installation of lining systems*, Section 4.3 for general requirements.

The contactor shall provide evidence that the materials proposed, meet the requirements set out in either:

- ASTM F1216-22: Section X2. Chemical resistance tests; or
- ISO 11296-4: Section 8.7 – Additional characteristics.

Note: The chemical resistance requirements listed in the standards above are applicable for general domestic wastewater applications. Where liners are subject to more harsh industrial environments, a suitably resistant lining material shall be selected.

5. Construction

For all general construction requirements refer to *ESF-600-STD-206: Gravity sewer pipe rehabilitation – General requirements for the installation of lining systems*.

5.1 Installation

5.1.1 Liner installation

The liner installation shall be in accordance with the following standards and shall be installed as per the liner manufacturer's specification:

- **ASTM F1216**: Standard Practice for Rehabilitation of Existing Pipelines and Conduits by the Inversion and Curing of a Resin-Impregnated Tube.
- **ASTM F2019**: Standard Practice for Rehabilitation of Existing Pipelines and Conduits by pulled in Place Installation of Glass Reinforced Plastic Cured-in-Place (GRP-CIPP) Using the UV-Light Curing Method – Appendix X1
- **ASTM F1743**: Standard Practice for Rehabilitation of Existing Pipelines and Conduits by Pulled-in-Place Installation of Cured-in-Place Thermosetting Resing Pipe (CIPP)
- **ISO 11296.4**: Plastics piping systems for renovation of underground non-pressure drainage and sewerage networks - Part 4: Lining with cured in place pipes – Section 9.

The liner shall fit neatly inside the host pipe, with the liner generally being in contact with the host pipe. The liner shall not reduce the internal diameter of the pipe by more than 10% or as specified to achieve the required hydraulic capacity.

There shall be no defects or discontinuities that could adversely affect the hydraulic performance or long-term life of the lining system (including all joints and transitions).

5.1.2 Curing of Liner

If heat curing is required (hot water or steam), the Contractor shall ensure that the entire length of the liner is heated at the required temperature and for the required cure cycle.

Under no circumstances shall a higher than specified temperature be used for the purpose of achieving a "faster" cure.

Where a UV cured system is specified, the Contractor shall ensure that the light train is run centrally to provide uniform curing throughout its perimeter.

Before curing, remote temperature and pressure sensors shall be placed in the conduit, to monitor these values during the cure cycle.

Note: Where lining is required around bends, it shall be confirmed that the wrinkles and resulting compressed thickness of material can be fully cured before starting to install the liner.

5.1.3 Lateral connections

Refer to *ESF-600-STD-206: Gravity sewer pipe rehabilitation – General requirements for the installation of lining systems*.

5.1.4 Defects

Liners shall be assessed for defects as per the relevant requirements of Section 5.2.10 of *ESF-600-STD-206: Gravity sewer pipe rehabilitation – General requirements for the installation of lining systems*.

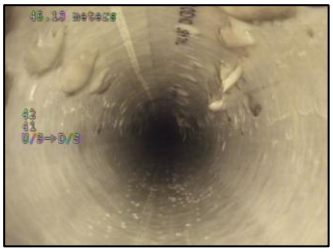
The following defects are considered unacceptable:

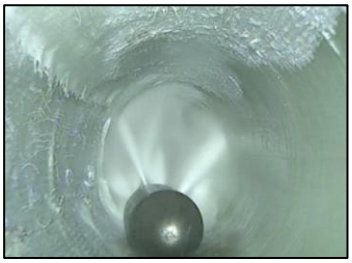
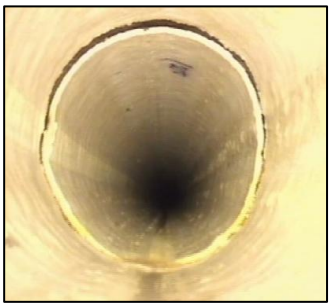
- Irregular wall structure reducing the hydraulic capacity more than 10% or compromising the structural integrity of the liner (Liner installed over debris, liner installed over unacceptable protrusions or deformations in the host pipe resulting in delamination)
- Under-strength finished liner materials – short term flexural strength or modulus is less than the respective design value declared in the *Project Specification*
- Inadequate curing (e.g. Insufficient impregnation of resin within the carrier material or insufficient curing)
- Excessive wrinkles (transverse or longitudinal – refer example below)
- Tensile failure (e.g. circumferential failure)
- Leakage observed through the liner wall
- Damaged laterals
- Poor quality cut outs or misalignment of cut outs with connections.
- Pinholes
- Inadequate seals at manholes (between liner and chamber) or laterals.
- Liner thickness less than specified design value.

Note: The defects listed above are not intended to be an exhaustive list. Installed liners will be assessed to confirm they meet the functional requirements over the design life of the lining system.

Table 3 shows some examples of defective characteristics.

***Table 3**: Example of unacceptable defects*

Defect	Characteristics	Example
Irregular wall structure	Deformations in wall structure resulting from delamination or protrusions.	

Defect	Characteristics	Example
Inadequate curing	Delamination of liner material	 
Wrinkles	Excessive wrinkling both circumferential and transverse, reducing the pipe diameter by more than 10% and affecting the flow the pipe. Longitudinal wrinkles or fins greater than 10% of the pipe diameter would require further engineering assessment to determine acceptability.	
Tensile Failure	Indicated by the clean circumferential crack and subsequent retraction of the liner	

6. Acceptance Control

Acceptance control of CIPP lining shall be as per the relevant items described in Section 6 of *ESF-600-STD-206: Gravity sewer pipe rehabilitation – General requirements for the installation of lining systems* including the process of assessment of defects, their acceptance and/or repair.

6.1 Testing

6.1.1 Leak testing

Refer to *ESF-600-STD-206: Gravity sewer pipe rehabilitation – General requirements for the installation of lining systems*.

6.2 Sampling

Sampling shall be carried out in accordance with the inspection practices of ASTM F1216, ASTM F1743, or ASTM F2019. The retrieved samples shall be large enough to complete the required number of flexural and tensile tests where the initial structural strength shall exceed the greater of the design / declared values or that shown in Table 4.

Table 4: *Minimum initial structural properties of CIPP*

Property	Test Method	ASTM F1216 & ASTM F1743 Minimum Value	ASTM F2019 Minimum Value
Flexural Strength	ASTM D790	31 MPa	103 MPa
Flexural Modulus	ASTM D790	1724 MPa	5000 MPa

The minimum thickness of the liner shall not be less than 87.5% of the design thickness in accordance with ISO 3126. Mean wall thickness shall also comply with the requirements set out in ISO 3126. The liner thickness may be measured by measuring the protruding liner at the downstream manhole.

Appendix A: Example Inspection and Test Plan

Contractor Name	ABC Limited	**To be completed, submitted, and approved before works can commence**	**Complete Watercare's Health and Safety induction**	*Yes*	*Date*
Project Reference	(Project Name)		**Control of Work documentation submitted (AA, JSA, Work Permits etc.)**	*Yes*	*Date*
Contractor Representative			**Work Method Statement**	*Yes*	*Date*
			Flow management plan	*Yes*	*Date*
			Quality Control Plan	*Yes*	*Date*

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Upstream Structure (e.g. MH 01)	Downstream Structure (e.g. MH 02)	Pipe Cleaned (Yes / No)	Flow Management in place (Yes/No)	CCTV Inspection (Reference Report No.)	Confirm host pipe Size (mm)	Liner Thickness (mm)	Liner Material Certificates	Confirm location of laterals	Pipeline preparation after cleaning (e.g. repairs)	Installed liner - no defects	Grouting around liner anulus (if required)	Liner termination and epoxy around manholes	Post-installation CCTV	Testing and sampling of pipeline	Remediate all defects	Contractor's Representative
MH01	*MH-02*	*Yes*	*Yes - in place (17/04/2024)*	*Yes: Report No. 1234 (18/04/2024)*	*450 mm*	*12 mm*	*Yes*	*Yes*	*Repairs completed (21/04/2024)*	*Yes*	*Not required, only at terminations*	*Yes (25/04/2024)*	*Yes: Report No. 9876 (26/04/2024)*	*Pass – Report No. (30/04/2024)*	*Completed (02/05/2024)*	*Signed and Date*