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Hunter Water Corporation A.B.N. 46 228 513 446
Standard Technical Specification for:

**REHABILITATION OF SEWERMAINS BY
LINING**

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AMENDMENTS

New Clause	Old Clause	Amendment
AMENDMENTS TO THE NOVEMBER 2002 VERSION		
2.1	2	Updated to current standards
2.2		Hydraulic requirements
2.3		Degree of fit
2.4		Material properties
2.5		Reference documents
4.2	4.2	Updated photograph format
5.1	5	General
5.2	5	Photograph Items
9	9	Hold point added
10.1	10.1	Lining pipe subject to gas attack
10.3	10.3	Witness point & hold point added
10.4		Two witness points added
11.2		Junction sealing detail
11.3		Pressure testing
12		Lateral lining
13		Patch repairs
16	14	Final CCTV inspection photo requirements
AMENDMENTS TO THE AUGUST 2001 VERSION		
All	All	General formatting, rewording and referencing changes to improve clarity but no change to technical requirements

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1. GENERAL

1.1 Scope

This Standard Technical Specification details requirements for the installation of lining systems in existing gravity sewers to restore structural integrity, prevent infiltration or exfiltration, reduce root ingress and/or restore hydraulic capacity of the sewer main.

This Standard Technical Specification covers lining systems installed for the full length between access chambers and lining systems used locally at an isolated defect.

1.2 Interpretation

Unless specifically stated otherwise, rehabilitation of sewer mains includes ALL functions described in this Standard Technical Specification and the provision of any minor materials or services which are not described but are reasonably necessary to produce a fully functional sewer system.

Headings are for the convenience of the reader and shall not be used in the interpretation of this Standard Technical Specification.

Unless the context requires otherwise any expression such as "give notice", "submit", "approval", or "directed" means give notice to, submit to, approval by, or directed by the Superintendent of the Contract or other person nominated by the Principal.

For the purposes of this Standard Technical Specification, the following definitions apply:

"patch repairs": Repair a localised section of pipe between access chambers.

"full linings": Systems inserted into the existing pipeline as a single continuous pipe lining from access chamber to access chamber.

"wound linings": Linings installed by the spiral winding of a profiled strip to form a continuous pipe.

"defect": Any discontinuity, imperfection or inclusion arising from substandard, materials, improper pipe preparation, or faulty manufacture, installation or workmanship which affects the required performance of the lining in terms of structural or hydraulic performance and watertightness.

2. DESIGN OF LINER

2.1 Design Loadings

Design the liner as a flexible pipe capable of supporting all imposed loading. Ignore any contribution from the original pipe. For design calculations assume the deteriorated host pipe and surrounding soil provide the liner with support equivalent to a soil modulus of no more than;

- 2 MPa; or
- 4 MPa if all voids between the liner and the host pipe and external to the host pipe are to be filled with cementitious grout.

Allow for a design life of the installed liner of at least fifty (50) years.

Design the liner to suit each specific location and taking into account ground water pressures, soil pressure, traffic loadings and structural requirements.

For structural purposes, assume there is no long-term bond between the liner and the host pipe.

Assume groundwater pressures comprise hydrostatic pressure from a water table located at the ground surface unless directed otherwise.

Assume vertical earth pressures comprising the maximum height of soil above the pipe, ignoring any reductions due to trench effects.

Calculate live traffic loadings in accordance with Figure 4.1 of AS 2566.1 with the selected intensity consistent with the traffic type and usage.

Design the lining as a flexible pipe in accordance with AS/ANZ 2566.1 to satisfy the critical performance criteria of deflection, strength and buckling. The long-term vertical deflection limit shall be 6%. The value of the limiting value for long-term strain used shall be consistent with the material properties of the lining.

Check all linings for buckling under externally applied groundwater pressures based on the method given in ASTM 1216. The ovality of the existing pipe shall be taken as 2% for linings in cast iron pipes and 5% for all other pipes.

Check short-term effects occurring during installation.

Hold Point

Submit copies of design calculations prior to installation of the liner. These calculations shall verify that proposed nominal wall thickness of the liner is greater than or equal to the design thickness.

2.2 Hydraulic Requirements

For pipes of 500mm or less diameter, size the lining system to have an internal diameter of at least 90% of the internal diameter of the existing pipe.

For pipes of more than 500mm diameter, size the lining system to have an internal diameter of at least 95% of the internal diameter of the existing pipe.

Any reduction in the sewer's cross-sectional area shall be compensated by the reduced roughness of the liner. The build up of slime and any defects, which may affect hydraulic performance, shall be considered when determining the flow resistance of the liner.

2.3 Degree of Fit

Design the lining to neatly fit the internal wall and length of the pipe being lined with suitable allowance for longitudinal and circumferential stretching of the lining during installation.

2.4 Material Properties

Design the liner with the following characteristics for the service life of the lining;

- resistant to external exposure to soil bacteria and any chemical attack that may be due to residues remaining on the pipe wall or materials in the surrounding ground;
- chemically and biologically resistant to internal exposure to sewage, sewage related gases and mild concentrations of industrial effluent including small quantities of carbon monoxide, carbon dioxide, methane, hydrogen sulphide, traces of mercaptans, gasoline, vegetable oil, kerosene, tap water, saturation with moisture, detergent, soap, and dilute concentrations of sulphuric, nitric and phosphoric acid. Submit technical data confirming the chemical resistance of the lining material;
- not subject to excessive shrinkage, thermal contraction, recovery or reversion affecting the shape or dimensions following installation; and
- resistant to abrasion caused by the migration of silt, sand and debris along the pipe and sufficiently robust not to be damaged by pipe cleaning equipment that may be required to remove any future blockages in the pipe.

As and when requested submit materials properties information such as chemical resistance data, results of accelerated aging tests, bond tests, full-scale trials or hydrostatic testing demonstrating the suitability of the liner and any sealing systems used.

2.5 Reference Documents

Comply with the following Codes, Standards and Manuals except where their requirements relate to specific types of liner other than the type to be used.

AS 2566.1 1998	Buried Flexible Pipelines
WRC Manual	Sewage Rehabilitation Manual
ASTM F1216	Standard Practice for Rehabilitation of Existing Pipelines & Conduits by the Inversion & Curing of a Resin Impregnated Tube
ASTM F1741	Standard Practice for Installation of Machine Spiral-Wound PVC Liner Pipe for Rehabilitation of Existing Sewers and Conduit.
WIS 4-34-04	Renovation of gravity sewers by lining with cured-in-place pipes
WIS 4-35-01	Specification for thermoplastics structured wall pipes, joints and couplers with a smooth bore for gravity sewers for the size range 150-900

3. MATERIALS

3.1 General

Wherever relevant, only use materials and manufacturers listed at;

<http://www.hunterwater.com.au/standardssuppliers.asp>

Comply with all recommendations of the manufacturers regarding the storage and handling of the materials. Undertake all handling, transport and storage such that no damage occurs to the materials including coatings and linings.

3.2 On-site Stockpiles

Only store sufficient materials on site as are necessary to allow timely and efficient progress of the work. Locate stockpiles of excavated or imported material where they cause no interference to the public, drainage routes or vehicular or pedestrian traffic. Clear lines of sight for drivers must not be obstructed. Do not stack materials against structures, fences, trees or other property improvements.

4. PHOTOGRAPHIC RECORDS

4.1 General

Prepare a detailed photographic record of all areas that will be affected by the work under the contract including stockpile areas, storage areas and access tracks. Detail is to include, but not be limited to, buildings, roads, pavements, reserves, kerb and gutter, drains, pits etc. Special attention is to be given to all improvements within 5 metres of the pipeline routes, especially gutters and driveways.

Provide a record of damage and defects to improvements in the vicinity of the works prior to all work under the contract. This record will be used in the resolution of disputes between property owners and the Contractor or Principal and accordingly should be comprehensive in its coverage of the areas affected by construction activities.

4.2 Format

Present the photographs as “jpeg” digital files with a thumbnail summary sheet.

The date must be displayed on the photograph.

For each photograph identify the site by house number and provide comments on any pre-existing defects, particularly where they are not obviously visible in the photographs.

Hold Point

Submit photographic records before commencing work on site other than establishment.

4.3 Updating of Records

Add to the photographic record as work proceeds if additional areas will be affected by the work under the contract and the condition has not been previously recorded or if site conditions change.

5. INITIAL CCTV INSPECTION

5.1 General

Undertake a closed circuit television inspection of the full length of the pipeline prior to commencement of the rehabilitation work to provide an up to date assessment of the condition of the pipeline. Notify the Superintendent if a latent condition exists or the proposed method of work is no longer viable.

Submit a colour video recording of the inspection made in accordance with Standard Technical Specification for Closed Circuit Television Inspection of Sewers as attached.

5.2 Photographs

Submit colour photographs of the internal condition of the pipeline where the following defects are identified:

- collapsed, deformed or broken pipe;
- all junctions or connections;
- displaced joints where internal diameter has decrease preventing nominated internal diameter being obtained;
- significant infiltration (runners or gushers);
- all obstructions; or
- whenever an inspection is abandoned.

Where significant continuous defects exist, take electronic photographs to represent typical defects over the particular length that will prevent the sewermain from being lined.

Take all photographs when the camera is stationary.

6. MANAGEMENT OF SEWER FLOWS

Manage the flow of sewage in the length of pipeline being replaced. Any equipment inserted in the sewermain or property service lines to plug or restrict the flow is to be permanently marked with the Contractor's name and a unique identifier.

Manage flows within the sewermain to be lined as required to prevent surcharging. Flow from property service lines need not be pumped if there is sufficient storage capacity in the lines for the duration of the isolation. Responsibility for the prevention of surcharging in property service lines shall remain with the Contractor.

Hold Point

Submit details of any bypass system capacity prior to installing the system.

Monitor the lines that have been plugged and/or otherwise affected by the work and take all steps necessary to ensure surcharging does not occur. If the bypass system equipment fails bring the sewer pipeline back into normal operation as quickly as possible.

Give written notice two days in advance if shut down of upstream pumping stations is required.

Ensure that the line and access chambers are clear of material before removing the plugs and ceasing any bypass pumping. Remove the plugs at the earliest possible time.

7. SURCHARGE

Take all care to prevent surcharging during all stages of the work but if surcharging occurs immediately notify the Superintendent and thoroughly clean up the affected area to the Superintendent's satisfaction. Undertake any actions required by the New South Wales Department of Environment and Conservation as a consequence of the spill.

8. CLEARING FOR ACCESS

Remove obstructions as necessary to provide access for the execution of the works. Do not destroy, remove or clear vegetation or surface improvements to an extent greater than necessary for the execution of works.

Obtain the approval of the Council for the removal of any trees. Take any steps necessary to prevent damage to trees that are not to be removed.

Dispose of all rubbish and surplus material within 24 hours of clearing.

9. PREPARATION OF THE PIPELINE

Immediately prior to installing the liner clean both the pipeline and junctions up to at least 100mm past the first joint of each junction. Remove all roots, encrustation, scale, debris, protruding junctions or other obstructions which reduce internal diameter by jetting, grinding or other appropriate means. Ensure the structural integrity of the sewer main is not reduced during preparation for lining.

Grind displaced joints that reduce the internal diameter of the lined pipeline to less than the minimum final internal diameter as stated in Clause 2.2 or which exceed half the wall thickness of the original pipe. Where complete removal of a step in a displaced joint by grinding would result in perforation or fracture of the original pipe, grinding shall be used to reduce the size of the step, the extent of the constriction and the severity of the local defect formed in the finished lining. Grinding shall be tapered at a maximum slope of 1 in 4.

Undertake a closed circuit television inspection to confirm that the pipe and junctions are suitably clean to receive the liner and junction sealing system where required.

Hold Point

Submit photographs or videotapes of displaced joints which require grinding prior to commencement of any grinding.

10. MANUFACTURE AND INSTALLATION OF LINER

10.1 General

Manufacture the lining in accordance with a purpose written specification or appropriate Australian or overseas standard. Manufacture shall include the completion of offsite testing to confirm the liner quality prior to delivery. Submit a copy of the specification and/or standards.

Take observations and measurements of the existing pipe following cleaning to determine the internal dimensions of the existing pipe necessary for proportioning the lining and to confirm that the lining can be installed within the alignment and defect constraints of the existing pipe.

Install the liner such as to ensure achievement of the lining design requirements.

Where the length of pipeline being rehabilitated is subject to gas attack, ensure a continuous bond without any voids between the host pipe and the new liner to impede further gas attack.

Do not line more than one full length between access chambers in a single operation without approval. Install the lining in a continuous operation.

Seal cut the ends of the lining at access chambers. The sealing system is to be compatible with the lining system, suitable for the in-service conditions given in Clause 2.4, have a life expectancy comparable with lining and provide a watertight seal against infiltration and exfiltration.

10.2 Defects

The finished lining shall be free of all defects that affect hydraulic performance or structural adequacy. This shall include defects arising from substandard materials, faulty or inaccurate manufacture, inadequate pipe preparation, faulty installation or workmanship, or inadequate curing.

Defects, which are unacceptable in all liners, include, but are not limited to the following:

- under strength finished materials
- foreign inclusions
- irregularity in lining caused by inadequate pipe preparation
- leakage through the lining
- inadequate material curing
- inadequate resin impregnation
- excessive resin loss during installation
- dry spots, bubbles, cracks or delaminations
- pinholes
- leakage through welded, glued or mechanical locked joints
- poor quality cut outs
- inadequate seals at access chambers or laterals
- bulges
- longitudinal or circumferential wrinkling
- excessive reduction in cross sectional area
- longitudinal or circumferential shrinkage

The following will be considered as unacceptable defects if they exceed the limits given in brackets below:

- inadequate lining thickness (finished thickness < 90% of nominal lining thickness)
- excessive variation in thickness around the circumference of the lining (variation in minimum or maximum thickness > 20% of mean lining thickness)
- excessive longitudinal or circumferential variation in dimensions after completion of the cut-outs at access chambers or junctions (variation > 1mm in every 2m or 0.05% measured 14 days after installation).
- excessive longitudinal wrinkling of the lining in straight, non defective portions of the host pipe (wrinkling > 2.5% of the nominal diameter of pipe).

10.3 Monitoring of Longitudinal Variation

Monitor and report on longitudinal shortening for linings that are pulled into position and/or reformed using temperature or pressure during installation.

Allow 100mm of liner to protrude into the access chamber at each end of the lined section. Place fixed markers on the liner and access chamber benching and/ or wall to allow repeatable

measurements of longitudinal movement to an accuracy of +/- 1mm. Take measurements as follows:

- at completion of cut outs, or at 24 hours for linings without cut outs;
- fourteen days after installation; and
- more than ninety days after installation.

Witness Point

Submit a record of all measurements for the monitoring of longitudinal shortening. Submit results of the fourteen-day readings as soon as possible after readings are taken.

If the change of liner length is more than 1mm for every 2m of liner length, pressure test the seal at each lateral connection and reseal if necessary.

Hold Point

Obtain approval of the longitudinal monitoring results before cutting the lining to its final length and sealing at the access chamber wall.

10.4 Testing & Measurement

Undertake testing to verify the quality of the lining during all stages from the manufacture to the installation of the lining including testing of short-term tensile and flexural (ring bending stiffness) properties. For single component linings that are not modified by temperature or pressure these tests may be performed during manufacture. For all other linings, samples are to be collected and tested during installation at a rate of 5% of completed lines with a minimum of one line for each pipe diameter. Perform tests in accordance with recognised Australian or overseas standards.

Witness Point

If specified carry out a Gravity Pipe Leakage Test on each nominated installed liner in accordance with ASTM F1216 prior to cutting of junctions. The test shall cover the full length of the lined sewermain between access chambers. Record and submit the results of all tests.

Witness Point

If specified undertake excavation of a short length of lined pipe, cut away top half of pipe and undertake measurement to check internal and external diameter of lining, lining thicknesses, size of annular gap and presence of defects. Record and submit results of all tests.

11. PROPERTY SERVICE CONNECTIONS

11.1 General

Reinstate inactive vacant lots and live junctions only. Test and confirm which junctions are live before lining by running dyed water into the property service connection such that the running dyed water is evident on the pre-installation CCTV inspection.

Record the location of all live and dead junctions.

Perform initial rough cuts at each junction on the day of lining. Before finishing the cut outs, allow sufficient time for any movement of the installed lining relative to the host pipe including movements caused by shrinkage, thermal contraction, stress recovery, mechanical adjustment in material properties during curing, or any other action.

Use cutting equipment capable of reinstating the opening into the Principal's sewer for both slope and square connections leaving a smooth, bevelled edge free of any protrusions. Make the cut out flush with the inside surface of the branch line sewer with no discontinuity between the lining material at the cut hole and the branch sewer line. Ensure that each hole cut will not inhibit flow into the Principal's sewer from the junction, cause any constrictions or be such that it will catch solid material and cause a chokeage.

11.2 Junction Sealing

11.2.1 General

Seal the cut hole at the connection be either grouting or a special junction sealing system. Use a junction sealing system in all cases where the lateral is rehabilitated using a cured in place lateral lining.

11.2.2 Junction Grouting

Where grout is used, inject the grout between the liner and the original pipe and any cracks in the junction up to the collar of the junction under a minimum pressure of 70kPa.

Deliver the grout using a lateral packer that can also seal the first joint in the lateral connection. Use a polyurethane type grout with minimum solids content of 10%.

11.2.3 Junction Sealing System

Junction sealing system shall be cured in place systems capable of being inserted and cured so they exactly fit the internal dimensions of the host surfaces. They are to comprise a circular tube with a branch that extends at least 100mm past the first joint in the lateral line. The overall length in the sewermain shall be 200mm upstream and downstream past the extremities of the cut out.

The sealing systems shall have the following properties:

- comply with the material properties outlined in Clause 2.4;
- compatibility with the sewermain liner, property service connection and any other surfaces or conditions present so as to ensure a sealed bond with, and no deleterious effects on, these surfaces or conditions;
- provide a watertight seal against infiltration, exfiltration and tree root intrusion;
- ensure smooth transitions free of any protrusions, constrictions or defects that may decrease hydraulic efficiency, cause chokage or otherwise inhibit flows across the sealing system; and
- be sufficiently robust not to be damaged by pipe cleaning equipment that may be required to remove any future blockage or chokage

Bevel edges of the junction cut out to provide smooth corners.

Install junction seals after any lateral lining.

Inspect the junction by CCTV after cleaning and preparation and after completion of the seal.

11.3 Pressure Testing

If specified, hydrostatically test junctions under a pressure of 35kPa. The test shall cover the full length and ends of the seal in both the sewermain and the property service connection. Re-seal and re-test any junction seals with a pressure loss of more than 7kPa over one minute. Record and submit the results of all tests.

12. LATERAL LININGS

Lateral linings shall comprise a combination of resin and felt that is capable of being inserted and cured to stretch and compress around bends and changes in geometry without significant loss in thickness, reduction in strength or excessive wrinkling.

Material properties shall be as given in Clause 2.4.

Lateral linings shall have a minimum thickness of 3mm for linings with a short term flexural modulus of 2200MPa or greater. The minimum thickness shall be increased to provide an equivalent ring bending stiffness for lower values of short term flexural modulus.

Manufacture, impregnation and installation shall be carried out in accordance with a purpose written specification or work procedure that covers aspects such as measurement of lateral geometry, sizing of the lining, proportioning and mixing of components, impregnation, installation equipment and processes, curing, finishing, and testing.

Cleaning and CCTV requirements shall be the same as for reticulation linings.

13. PATCH REPAIRS

Patch repairs shall conform to all relevant requirements for full-length lining in this specification.

Patch repairs extend a distance of 300mm past the upstream and downstream limit of the defect that they are intended to address

The ends of the repair shall be tapered to ensure they do not reduce hydraulic performance or cause a build up of debris or blockage.

14. ACCESS CHAMBERS

Notify the Superintendent if an access chamber is to be altered as part of the work under the Contract.

Reinstate all access chambers such that installed liners do not form irregularities around the edges of the liners at the access chambers. After installation of liners, provide a channel in the access chamber free from any irregularities or differences in level that may cause accumulation of solids (ie. debris, silt, rags, etc).

At each access chamber seal the gap between the outside of the lining and inside of the host pipe to prevent both infiltration into, and migration through, the annular space between the existing pipe and the lining. At the access chamber, the sealing system is to be compatible with lining system, suitable for in-service conditions given in Clause 2.4, and have a life expectancy comparable with the lining.

15. RESTORATION

15.1 General

Restore as near as practicable to their pre-existing condition, all surfaces, services and/or improvements disturbed, destroyed, removed or damaged during the work under the contract. Improvements shall be deemed to include trees and shrubs, mulched areas, gardens, paving, flagging, proprietary finished areas such as 'pebble crete' and the like, retaining walls, fences and all other structures.

When necessary for the restoration of surfaces, stockpile existing topsoil separately and replace it over the areas where it was previously located when completing backfilling operations. Where there is a shortfall of existing topsoil use approved imported topsoil.

15.2 Timing of restoration

Undertake restoration to surfaces, services and improvements progressively as the work proceeds.

Undertake any maintenance of the restoration within two calendar days of the need for such maintenance becoming apparent.

15.3 Turf

Restore areas of established lawns to the full limits of the disturbed area with approved imported turf. Restoration using sods removed prior to construction will only be approved if the sods are of equivalent standard to imported turf. Also use turf to restore areas where there is significant risk of erosion such as on steep or long slopes.

Following backfilling and initial settlement spread and grade topsoil to achieve a smooth surface free from lumps, stones or other debris and blending into the levels and shapes of the adjoining undisturbed ground allowing for the turf. Mix an approved fertiliser of N:P:K ratio of 10:4:6 (equivalent to "Mulitgro") into the topsoil at a rate of 40g/m².

Lay the turf without gaps on the prepared topsoil surface and lightly top dress and compact. Water regularly until regrowth is established.

15.4 Trees

Where Council or private landowners require replacement trees to be planted, provide trees suitable for planting adjacent to the sewer as detailed in Hunter Water Corporation's publication entitled "Tree Roots".

15.5 Maintenance of Restored Surfaces

Maintain all restored surfaces and improvements in a satisfactory condition until expiry of the Defects Liability Period; notwithstanding any deterioration, and the need for maintenance, that may or may not, be due to defects that become apparent or arise from events occurring during that period.

15.6 Certification

Submit certificates issued by the relevant public authorities certifying that all roads, footpaths and surfaces in public places under their control have been satisfactorily restored. Notwithstanding any other provision, the Defects Liability Period shall not be completed until such certification is submitted unless it is agreed that the public authority has unreasonably withheld issue of the certificate. The issue of such certificates shall not relieve the Contractor of any responsibility for any defect.

16. FINAL CCTV INSPECTION

16.1 General

Submit a colour video recording of the full length of the lined pipeline in accordance with Standard Technical Specification STS901.

16.2 Photographs

Submit colour photographs indicating the internal condition of the pipeline where all lateral connections and junctions have been reinstated into the sewermain.

Reference all photographed lateral connections and junctions to the street address of the junction property.

Where significant continuous defects exist, take electronic photographs to represent typical defects over the particular length that has been lined.

Take all photographs when the camera is stationary.

[END OF STS701]