Specification

SS 209 – Lining Repairs of Non-Person-Entry Oviform Sewers

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Revision details

Version No.	Clause	Description of revision
1	-	Revision and renaming of EPS 207 issued in March 2009
2	-	General update
3	All sections	Transferred standard content to latest brand template
4	All sections	Minor edits throughout, including updated terminology
	Introduction	Acronyms, definitions, notation, and references revised
	2.1	Changes to chemical resistance test method
	2.2	Updates to WRC SRM references and clarification of ambiguities
	3	Various changes to focus on outcomes over method
	3.3	Included option for installation in live flow, subject to approval
	4	Changes to testing requirements, notably for leakage testing, monitoring of longitudinal shortening, and monitoring of internal dimensions

Introduction

This Specification is for lining repairs of Non-Person-Entry Oviform Sewers for Sydney Water assets.

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Acronyms

Acronym	Definition
AEP	Annual Exceedance Probability
BOD	Biological (or Biochemical) Oxygen Demand
CCTV	Closed Circuit Television
CIPP	Cured-In-Place Pipe
FIFM	Flow Isolation and/or Flow Management
UV	Ultra-Violet

General terms & definitions

Term	Definition
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 or water tightness
Design thickness	The minimum calculated wall thickness of the lining material required to provide a structurally adequate lining for its entire service life
Host pipe	The existing sewer to be rehabilitated by lining
Inherent defect	A defect which commonly occurs with the lining system where it is either not possible or not commercially practicable to take action for its elimination because of the inherent nature of the system
INTACT pipe condition	The existing sewer is in good condition and is capable of carrying the externally imposed earth pressure loading. The liner is designed for hydrostatic loading caused by a water table located above the sewer
Laser profiling	A method used to measure the dimension of the pipe or lined pipe by using laser technology
Lateral	The section of a private sewer immediately upstream of the junction with the Sydney Water sewer
Neat fit	The internal perimeter of the host pipe and the external perimeter of the liner at any section match exactly
Nominal thickness	The proposed finished wall thickness for the lining system when properly installed
Schedule of Technical Data	A schedule of information or similar document, submitted by the lining installer prior to the commencement of works, nominating all relevant properties for each lining system
UV light curing	Ultra-violet light trains used to heat cure CIPP liners

Notation & symbols

Term	Definition	Unit
E_{bL}	Long term ring bending modulus of elasticity of lining material	MPa
t_{min}	Minimum allowable lining material thickness	m
Δ_{all}	Allowable long term deflection of oviform lining over critical length	m
L_{crit}	Oviform liner critical length	m
R	Critical length shape factor	-
O_W	Maximum internal width of existing oviform sewer	m
O_H	Maximum internal height of existing oviform sewer	m

References

Standard	Document Title
AS 1012.9	Methods of testing concrete – Compressive strength tests - Concrete, mortar and grout specimens
AS/NZS 2566.2	Buried Flexible Pipelines – Part 2: Installation
AS 3572	Plastics – Glass Filament Reinforced Plastics (GRP) Methods of Test
AS/NZS ISO 9001	Quality Management Systems

Standard	Document Title
ASTM D543	Standard Practices for Evaluating the Resistance of Plastics to Chemical Reagents
ASTM D638	Standard Test Method for Tensile Properties of Plastics
ASTM D790	Test Methods for Flexural Properties of Reinforced Plastics and Electrical Insulating Material
ASTM D2583	Standard Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor
BS 2782	Methods of Testing Plastics Method 335A: Determination of flexural properties of rigid plastics Method 1003: Determination of tensile properties.
CPDMS0023	Sydney Water Technical Specification – Civil Works
D0000653	Sydney Water Safety in Design Procedure
D0000833	Sydney Water Engineering Competency Standard
D0001870	Sydney Water Specialist Engineering Assessment Procedure
HSP0070	Sydney Water Flow Isolation and/or Flow Management (FIFM) Procedure
ISO 4433-1	Thermoplastics pipes — Resistance to liquid chemicals — Classification
SS 207	Sydney Water Specification for Junction Sealing for Circular Non-Person-Entry Sewer Pipe
WIS 4-34-04	Specification for Renovation of Gravity Sewers by Lining with Cured-in-Place Pipes
WRC SRM	Water Research Centre, Sewerage Risk Management (website)

1. General

1.1 Intent

The intent of this specification is to define requirements for rehabilitation of non-person-entry oviform sewers by lining. This work may be required to protect internal concrete surfaces or mortar from deterioration, restore structural integrity and/or hydraulic capacity, or prevent infiltration of groundwater and exfiltration of sewage.

1.2 Scope

This specification defines requirements for design, manufacture, installation, workmanship and testing of lining systems to be used for rehabilitation of non-person-entry oviform gravity sewers.

The scope of this specification is limited to non-person-entry linings to be installed in INTACT oviform sewers that do not rely on any bond with the existing sewer for their structural capacity.

This specification is not applicable to linings that act solely as a protective coating or those installed using spray techniques.

1.3 General requirement

The liner must seal the sewer effectively to prevent infiltration of ground water into the sewer and exfiltration of sewage into the surrounding ground.

Details must be provided for sealing of entries to the un-bonded interface between the liner and the sewer conduit at entry and exit points in access chambers, laterals, junctions and branches.

The difficulty of the liner achieving a good fit at the invert of oviform sewers due to the relatively small bending radius required must be considered, and allowance made as necessary. The capability of the proposed liner to achieve a neat fit to the host sewer as defined in Clause 2.4 must be confirmed.

2. Product

2.1 Material

The minimum required service life of the installed lining material is fifty (50) years.

The material must be demonstrated to have adequate resistance to various chemicals that may present in the sewer, which include:

a) 20% Sulphuric acid

b) 5% Sodium hydroxide

c) 5% Ammonium hydroxide

d) 1% Nitric acid

e) 1% Ferric chloride

f) 1% Sodium hypochlorite

g) 0.1% Soap

h) 0.1% Detergent (linear alkyl benzyl sulfonate)

i) Bacteriological (BOD @ 700 ppm or greater)

The method of testing must be in accordance with ASTM D543, ISO 4433-1, or other recognised international standards as agreed with Sydney Water. Where agreed with Sydney Water, the requirement for chemical resistance testing may be waived for materials with a proven history of satisfactory performance in sewer environments.

The lining must also be resistant to external exposure to soil bacteria and any chemical attack that may be due to residues remaining on the conduit wall or materials in the surrounding ground.

If requested by Sydney Water, technical data confirming the chemical resistance of the lining material must be provided.

The lining must be comprised of materials that will not be subject to excessive shrinkage, thermal contraction, recovery or reversion affecting the shape or dimensions of the lining following installation. The lining must not be subjected to excessive residual stresses resulting from any part of the manufacturing and installation process. The lining must be capable of resisting all design loads in combination with any residual stresses.

The lining material must have satisfactory abrasion resistance to the migration of silt, sand and debris along the conduit. It must be sufficiently robust not to be damaged by conduit cleaning equipment, which may be required to remove any future blockage following installation of the lining. Evidence must be provided that the liner will not be damaged as a result of normal cleaning and jetting processes (defined as 14MPa jetting pressure at 5L/s flow rate) throughout its design life.

2.2 Design

2.2.1 Condition of existing pipe

The condition of existing sewers to be lined at the end of the service life of the lining has been classified for design purposes as INTACT. Assessment and determination of condition classifications for existing sewers must only be undertaken by suitably competent and experienced personnel.

Prior to lining, the condition of the existing sewer must be assessed to confirm the INTACT condition classification. Where the condition is not considered INTACT, Sydney Water must be notified and provided with evidence. In such cases, lining works must not be undertaken unless directed by Sydney Water.

The original construction method for the sewer must be determined based on historic documentation (e.g. work-as-constructed drawings) to identify any potential for limited external support to the sewer. Where the existing sewer was originally constructed in a tunnel, or any other situation where external support to the existing sewer may be inadequate to accommodate lining, restrictions apply to the liner product and installation methodology, and additional investigations must be carried out to ensure the long-term integrity of the sewer. Refer to Clause 2.5 for details.

2.2.2 Material

Where material properties under load vary with time, material properties of the lining at the end of the fifty (50) year service life must 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 used in the design must be consistent with the composition of the lining material. These must be the same values as those nominated in the Schedule of Technical Data. The designer is responsible for determining appropriate values for material properties for design purposes. Characteristic values must be used with a confidence level of not less than 95%.

If requested by Sydney Water, test data must be submitted in accordance with Clause 4 to substantiate the values for material properties nominated in the Schedule of Technical Data.

2.2.3 Design loads

Each lining must be designed to resist hydrostatic pressures from a water table located at the surface or, for linings under permanent waterways, at the height of the permanent water level, unless nominated otherwise by Sydney Water. Where such hydrostatic pressures are unrealistic and overly conservative (e.g. for very deep trunk sewers), a geotechnical investigation may be undertaken to determine the actual suitable long term ground water level for design purposes (subject to approval by Sydney Water).

Where located in an area subject to flooding, the capacity of the lining to resist hydrostatic pressures from a water level at the 1% AEP flood level must also be checked. For this calculation, use of the long-term material properties of the lining is conservative and appropriate short term properties may be used instead.

2.2.4 Design criteria

The lining must be designed to satisfy the performance criteria of strength, deflection and minimum liner thickness.

For the purpose of structural design, it must be assumed that in the long term there will be no bond between the original pipe and the lining.

The lining must be checked for strength and deflection based on the procedure set out in the WRC Sewerage Risk Management website (under Sewer Renovation > Structural Design > Type II Design > SRM Type II Design). The designer must ensure that this method is applicable to the specific geometry of the existing oviform sewer to be lined, based on the guidance provided in the WRC SRM website. Where this method is not applicable, the design procedure must be agreed with Sydney Water.

Calculations must be carried out to ensure long-term bending stresses and strains are less than the maximum permissible values for the lining. The liner critical length (L_{crit}) is defined as the greater of O_w or

2/3*O_H. The maximum allowable deflection of the liner (Δ_{all}) must not exceed 3% of L_{crit}. The critical length shape factor (R) is 0.5. For GRP liners, a safety factor of 2 must be applied to the permissible long-term bending stress values provided in the WRC Sewerage Risk Management website (under Sewer Renovation > Renovation Materials > Material Properties).

Alternative recognised international design methodologies may be accepted subject to agreement with Sydney Water.

2.2.5 Design calculations

Design calculations must be provided in a design report in accordance with the requirements of the Sydney Water Technical Specification – Civil (CPDMS0023).

Review of design calculations by Sydney Water must not be construed as verification or acceptance of the calculations. Responsibility for the design remains with the designer.

If requested, a copy of the calculations for short term design checks required by Clause 2.2.6 must also be provided.

All work on the preparation of the design calculations, including verification and independent verification where required, must comply with the Sydney Water Engineering Competency Standard (D0000833).

2.2.6 Short term design checks

Short term design checks must be carried out for the lining material, either in its final or one of its intermediate states, to ensure the lining is stable and will not be overstressed during the installation and/or curing of the particular system.

Short term materials properties may be used to verify the suitability of installation and curing methods.

2.2.7 Minimum liner thickness

Notwithstanding of the design lining thickness determined in Clauses 2.2.4 and 2.2.6 above, the minimum allowable liner thickness (t_{min}) must be as indicated below.

Lining material with long term flexural modulus (E_{bL}) > 3000 MPa, t_{min} = 5mm

Lining material with long term flexural modulus (E_{bL}) ≤ 3000 MPa, t_{min} = 10mm

2.3 Hydraulic requirements

The lining system must not reduce the existing cross-sectional area of the oviform sewer by more than 5%.

There must be no reduction in overall hydraulic capacity following lining of the sewer when calculated in accordance with the method set out in the Water Research Centre Sewerage Risk Management website (under Sewer Renovation > Renovation Materials > Other Issues). The lining material must be such that any reduction in the sewer's cross-sectional area is offset by reduced surface roughness.

Account must be taken of the build-up of slime and any defects, which may affect hydraulic performance.

2.4 Degree of fit

The lining must be designed and fabricated in a manner that, when installed, will neatly fit the internal wall and length of the conduit being lined. Where lining technology requires, suitable allowance must be provided for longitudinal and circumferential stretching of the lining during installation.

Laser profiling must be conducted in accordance with Clause 4.5 to determine appropriate liner dimensions and ensure an acceptable degree of fit.

A lining will be considered to neatly fit if the mean difference between the inside of the host pipe and outside of the lining (annulus) is less than or equal to 1 mm.

Where the annulus is greater than 1mm, the annulus must be grouted in accordance with Clause 3.6.

2.5 Retention of structural condition of existing sewer

No activity during preparation of the sewer section and installation of the liner may adversely affect existing structural integrity of the sewer.

As noted in Clause 2.2.1, particular care must be taken when installing liners in oviform sewers that were originally constructed in tunnels due to limited support and/or highly variable backfill treatment of voids between the sewer crown and the tunnel soffit. The presence of loose fill or unfilled voids above the sewer crown can lead to collapse of the crown due to outward loading during installation (e.g. expansion/inflation of CIPP liners) or post-installation (e.g. hoop deformation of flexible linings under hydrostatic pressure). Similar issues may be observed in other situations where there is limited external support to the existing sewer, and similar care must also be taken when installing liners in these assets. Accordingly, CIPP liners should be avoided for oviform sewers originally constructed in tunnels or other scenarios where there is limited external support.

Where lining is proposed for an oviform sewer originally constructed in a tunnel (or any other situation with limited external support), a Specialist Engineering Assessment must be carried out in accordance with the Sydney Water Specialist Engineering Assessment Procedure (D0001870) to demonstrate that there will be no unacceptable adverse impacts on the existing sewer.

2.6 Manufacture of lining

The manufacture of the lining must be carried out in accordance with a specification purpose written for the particular system (this may be referred to a product specification or material specification). This specification must detail all labour, materials and equipment required to combine the various constituents to produce the lining ready for delivery to site.

The purpose written specification must also include testing and inspection work carried out to verify the dimensions and quality of the manufactured lining. A copy of this specification must be provided upon request by Sydney Water.

Certified English translations must be provided for any international documentation written in a language other than English.

Dimensions of the existing sewer must be measured prior to fabrication, to ensure that proper fit is achieved. This must include measurement of the horizontal and vertical alignment at changes in direction and bends.

All work involved in the measurement, inspection and testing of the lining during manufacture must be covered under a Quality Management System certified to AS/NZS ISO 9001.

3. Execution

3.1 Preparation of conduit

Pipelines must be cleaned to remove all foreign matter (such as debris, silt, sludge, rags, roots, scale, etc.) and to facilitate precise CCTV inspections and installation of the lining system.

CCTV inspection is required prior to installation of liners to establish that the pipe is clean and ready to receive the liner.

The CCTV must ensure full view of any connection, lateral, junction, branch, or private sewer joining in at an acute angle.

3.1.1 Private sewers (location and survey)

Inspection and testing must be carried out before lining to confirm which junctions are live. Where this cannot be confirmed by visual inspection, dyed water must be run into the house service line and the running dyed water must be evident on the pre-installation CCTV inspection.

The location of all live and dead junctions must be recorded.

Before installing the liner, the junction at the property branch line and Sydney Water sewer must be cleared of any roots, debris, silt etc. up as far as the branch of the junction to leave it clean and smooth edged and free of any obstruction.

3.2 Access chambers

This clause only covers requirements associated with the adjustment of access chambers to facilitate lining and the sealing of the lining at the entry or exit points for the main line sewer. Requirements for repair of access chambers including grouting to reduce infiltration are covered elsewhere in other technical specifications.

Where an access chamber has to be altered as part of these works, Sydney Water must be notified of the change, prior to the work.

All access chambers must be reinstated to the satisfaction of Sydney Water, such that installed liners do not form irregularities around the edges of the liners at the access chambers. After installation of liners, the channel in the access chamber must be free from any irregularities or differences in level which may cause accumulation of solids (i.e. debris, silt, rags, etc.) in the sewer or access chamber channel.

Where liners have been installed to one side of the access chamber, the access chamber channel must be rendered to form smooth slope to the liner to prevent accumulation near the liner edge.

The ends of the lining must be sealed once they have been trimmed to match the face of the access chamber. The materials used and the method of sealing must be determined by the project team.

The minimum requirements of the seal are as follows:

- Material requirements in accordance with Clause 2.1
- Compatibility with composition of lining and access chamber
- Provide a permanent watertight seal against infiltration and exfiltration

If requested by Sydney Water, information such as the following must be provided; chemical resistance data, method to ensure adequate curing of all sealing products and materials (particularly where the sealing

is installed under water/live flow), accelerated aging tests, bond tests, full scale trials or hydrostatic testing to demonstrate the suitability of sealing system.

3.3 Delivery and installation of liner

The length to be lined must generally be restricted to a single length between access chambers. Any lining installed over more than one length requires the prior approval of Sydney Water.

Sewers must be cleaned prior to lining, with CCTV inspection immediately prior to lining to confirm cleanliness. This CCTV inspection footage must be provided to Sydney Water on request.

Flow in private sewers (formerly known as House Service Lines or HSLs) and Sydney Water sewers must be isolated during the lining operation to ensure that no debris enters which may get trapped between the liner and the original pipe. Arrangements must be made to ensure that private sewers are not in use during the lining operation. This requirement may be waived, with prior agreement with Sydney Water, for lining activities that are suitable for carrying out in live flow.

Refer to Sydney Water's FIFM procedure (HSP0070) for requirements associated with planning and implementing flow isolation and/or flow management.

The lining must be installed in a continuous operation. Consideration must be given to site specific characteristics to ensure the suitability of methods and procedures used for the lining works. The installation procedure must be executed to prevent both infiltration into, and migration through the annular space between the existing pipe and the lining.

In case of heat curing, the liner must be heated at the prescribed temperature throughout its length for the required period. Temperature must be monitored along the length of the liner in accordance with the lining manufacturer's recommendations and recorded throughout the curing period.

For UV cured systems the light train must be run at the centroid, to ensure uniform curing throughout its perimeter across the full liner thickness. All other characteristics of the UV curing operation must be strictly in accordance with the lining manufacturer's recommendations and recorded throughout the curing period. Such characteristics may include traverse speed, light intensity, internal pressure, and air quality.

It must be ensured there are no built in or residual stresses in the liner following installation.

Records of curing activities and monitoring must be provided to Sydney Water on request.

The ends of liners within access chambers must be prepared to allow monitoring of longitudinal movements in accordance with Clause 4.4.

A CCTV inspection must be carried out after installation to establish that the lining has been installed in the desired manner and that all live laterals have been reconnected properly. The CCTV inspection must be carried out as per the relevant specifications.

3.4 Reinstatement of connections

Only live junctions are to be reinstated. All cut-outs at junctions (connections) must be sealed in accordance with SS 207, unless agreed otherwise with Sydney Water.

Sufficient time must be allowed for any movement of the installed lining relative to the host pipe before finishing the cut outs. This includes movements caused by shrinkage, thermal contraction, stress recovery, mechanical adjustment in material properties during curing, or any other action.

The cutting equipment must be capable of reinstating the opening into Sydney Water's sewer for slope or square connections. The cutting tool must leave a smooth bevelled edge free of any protrusions. The cut must be flush with the inside surface of the branch sewer line.

There must be no discontinuity between the lining material at the cut hole and the branch sewer line. Each required opening must have initial rough cut on the day of lining and be 100% completed after the lining has reached its final dimensions in terms of length and cross section.

Each hole cut by this equipment, or otherwise reinstated, must not inhibit flow into the Sydney Water sewer from the junction, cause any constrictions, or be such that it will catch solid material and cause a blockage.

3.5 Finish (hydraulic acceptability)

The installed lining must be continuous over its length and must be free of any defect which is likely to affect the satisfactory hydraulic performance of the lined pipe or cause accumulation of solids. Where inherent defects are nominated which are likely to affect hydraulic performance, these defects must satisfy the accepted criteria agreed with Sydney Water.

The finished lining must be free of any leakage from the lined section of pipe to the surrounding ground or from the ground to the inside of the lined pipe.

3.6 Grouting

Where required by Clause 2.4, the annulus between the existing oviform sewer and the liner must be filled with a cementitious based grout. The grouting method must ensure the complete filling of the annulus (without deformation of the liner) to provide uniform support to the liner and is subject to approval by Sydney Water.

Prior to commencement of work, a work method statement must be submitted detailing the proposed grouting procedures and grout composition.

The grout composition must ensure that the following properties are attained:

- the grout must not undergo any shrinkage
- the grout must remain structurally sound over the long-term (minimum 50 year period)
- the grout composition must have no adverse effect on the liner

The liner must not be subjected to any hydrostatic pressure from the grout and/or water table during the grouting phase that cannot be withstood by the liner. Short term design checks must be carried out in accordance with Clause 2.2.6.

Records must be maintained of all grouting operations, which must include (but not be limited to) the location of all grout injection points, volume of grout pumped, grouting pressures, commencement and completion times, and grout composition details. One copy of this record must be submitted to Sydney Water at the completion of each access chamber length.

3.7 Defects

The finished lining must be free of all defects which affect hydraulic performance or structural adequacy. This includes defects arising from substandard materials, faulty or inaccurate manufacture, inadequate pipe preparation, faulty installation or workmanship, or inadequate curing. The only exception is inherent defects, as defined in the General terms & definitions, which must satisfy the requirements of this clause.

For each lining system, inherent defects must be those nominated in the Schedule of Technical Data. The acceptance limit for each defect must be those accepted by Sydney Water.

If during the execution of the works it becomes apparent that there are further inherent defects which have not been nominated, then, provided such defects satisfy the definition of “inherent defects” these may be accepted as such by Sydney Water. In this instance Sydney Water may nominate the acceptance limit for the defects in terms of its frequency and dimensions and this will be binding.

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

- under strength finished lining 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 delamination
- pinholes
- leakage through welded, glued or mechanical locked joints
- poor quality cut outs
- inadequate seals at access chambers or laterals
- any other defect not nominated as inherent to the lining system
- non-compliance to Clause 2.4

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 cutouts, at access chambers or at cutouts (variation > 1mm in every 2m or 0.05% measured 14 days after installation) refer Clauses 4.4 and 4.5.
- excessive longitudinal wrinkling of the lining in straight, non-defective portions of the host pipe (wrinkling > 2.0% of the O_H).

Defects which may be nominated as inherent for the proposed lining system may include, although not necessarily be limited to the following:

- bulges
- longitudinal or circumferential wrinkling
- excessive reduction in cross sectional area
- longitudinal or circumferential shrinkage

4. Testing

4.1 General

Testing must be carried out on the lining material and its constituents as outlined in the following subsections.

Sydney Water must be given seven (7) days prior notice of the date, time and place of all the testing activities.

All work on the testing of the lining constituents, manufacture of the lining, during and after installation must be covered under a Quality Management System certified to AS/NZS ISO 9001.

4.2 Pre-installation testing

If existing local or overseas test data is being relied upon to justify the suitability of the lining system in terms of its physical and chemical properties, Sydney Water may request copies of such test results. These results must be forwarded to Sydney Water prior to commencement of lining manufacture. Certified English translations must be provided for any international documentation written in a language other than English. Any property which cannot be verified by such test data must be retested prior to installation.

Where the lining system is manufactured by a combination of a number of constituents which can be varied to suit the requirements of the works, the testing program must include the testing of three prepared samples for the same series of tests (excluding leak tests) to those required for the installed liner.

All tests on the constituents of lining material and manufacture of the liners must be in accordance with the relevant Australian or overseas standards.

4.3 Post Installation testing

This clause lists the minimum requirements for testing which must be carried out on installed lining. Each of the listed tests must be carried out once for every twenty (20) linings installed.

Alternative overseas or Australian standards to those listed may be accepted by Sydney Water for testing purposes providing that the test method provides an accurate measure of the required physical property or aspect of installation quality.

- Hydrostatic test or vacuum test in accordance with AS/NZS 2566.2 carried out prior to cutting of laterals. In addition to the acceptance criteria outlined therein, any linings with evidence of leakage will be deemed defective.
- Hardness in accordance with ASTM D2583
- Short Term Tensile Strength in accordance with ASTM D638 or BS 2782: Method 1003 (3 samples for each line being tested).
- Short Term Flexural Strength and Flexural Modulus in accordance with ASTM D790 or BS 2782: Method 335A (3 samples for each lining length) OR Short Term Ring Stiffness in accordance with AS 3572.10.
- If applicable, Grout Cube Strength in accordance with AS 1012.9 (three for each batch of grout with a maximum of six for any one length of lining).

Samples for testing may be prepared using the procedure given in Appendix B of WIS 4-34-04. Samples should not be taken from the liner installed within the host pipe, but may be taken from lengths of lining protruding from either end of the host pipe.

4.4 Monitoring of longitudinal shortening

Monitoring of longitudinal shortening must be carried out and reported for nominated lining lengths installed. A minimum of one (1) out of every twenty (20) liners installed must be checked. This requirement applies only to liners that are subject to dimensional change after installation, including, but not limited to, where heating, curing, longitudinal force (e.g. winching), or die reduction is used as part of the installation process.

Monitoring must comprise the measurement of the longitudinal movement of both ends of the installed lining relative to a fixed point on the adjacent access chamber wall. Linings should be cut with 100mm of additional length protruding into the access chamber. Alternatively, where agreed with Sydney Water, linings may be trimmed to match the face of the access chamber, provided that a suitable methodology is proposed for accurate measurement of longitudinal shortening and any defects (associated with shortening or end seals) present at the end of the monitoring period are rectified. Fixed marks must be placed on the liner and access chamber wall for measurement purposes. Regardless of the methodology, the lining must be appropriately sealed at all interfaces with access chambers as noted in Clause 3.2.

Three series of measurements must be made as follows:

- At completion of cutouts, or after 24 hours of installation for linings without cutouts.
- Fourteen days.
- Ninety days.

Interim results of the monitoring must be forwarded to Sydney Water after the fourteen day readings.

On acceptance of the longitudinal monitoring results by Sydney Water, the lining must be cut to its final length and resealed at the ends, if necessary.

4.5 Monitoring of internal dimensions

A laser profiling measurement survey must be carried out on existing sewers following cleaning, and prior to lining, to confirm internal dimensions of the oviform sewer.

A post lining installation survey must also be carried out to aid in assessment of degree of fit in accordance with Clause 2.4 for a minimum of one (1) out of every twenty (20) liners installed. Post lining surveys must be carried after cut-out and junction seals are installed, as applicable.

Any length where the surveyed dimensions after the lining are less than determined based on a neat fit, when allowance is made for any localised defects at restrictions in the host pipe, will be considered defective.

Other survey methods may be used where it can be demonstrated that measurement accuracy is at least equivalent to laser profiling.

4.6 Failure during post installation testing

A test result will be deemed to have failed if the minimum values nominated in the Schedule of Technical Data are not achieved.

If only one sample has been prepared for a length of lining then failure of the sample will be interpreted as indicating that the lining in question is defective.

If three samples are prepared for a length of lining, testing will indicate the lining is acceptable when two of the three results and the average of the three results exceed the nominated minimum values.

Where a lining is deemed to be defective, the lining installer must develop a rectification plan for acceptance by Sydney Water.

Sydney Water, at their discretion, may take account of any reserve structural capacity of the lining under design loading, when assessing the acceptability of a lining with a test result(s) deemed to have failed.

4.7 Test records

Results of all tests must be recorded and certified by the lining installer. Test records must be provided to Sydney Water upon request at any time.

Ownership

Ownership

Role	Title
Group	Asset Lifecycle
Owner	Norbert Schaeper, Engineering Manager
Author	Dan Leong-Scott, Principal Civil Engineer

Change history

Version No.	Prepared by	Date	Approved by	Issue date
1	Sudipta Basu	1/03/2009	Jerry Sunarho	1/03/2009
2	Jerry Sunarho	25/06/2012	Peter Gillman	25/06/2012
3	Robert Loncar	23/02/2022	Norbert Schaeper	23/02/2022
4	Dan Leong-Scott	30/06/2025	Norbert Schaeper	31/07/2025