RENEWING SEWERS AND STORMWATER CONDUITS
WHAT CAN AND CAN'T BE LINED

John Monro, Technical Support Manager
Interflow Pty Limited, Sydney Australia

ABSTRACT

Rehabilitation of deteriorated sewers by structural lining has for some time been mainstream technology in the water industry. Advances have seen capabilities reach the stage where liners can be installed in applications which only a few years ago would have been too difficult or impossible. This applies to the type of sewers that can be lined and the circumstances where lining can take place.

Advances have been in the technologies that can prepare deteriorated sewers for lining as well as technologies for installing the liners under the widest range of conditions.

This paper will focus on the decisions that need to be made to determine whether a deteriorated sewer is suitable for lining or whether other options would be necessary.

A deteriorated sewer may have one or a combination of defects including deformations, joint displacements, partial collapses, root intrusions, intruding junctions or heavy infiltration. The sewer may be partly filled with rubble or debris. It may be on a steep grade, have bends or may be carrying fast flowing sewage.

The paper will detail the limits to these conditions which Interflow considers would make the sewer suitable for structural lining. Mostly those limits have been determined by Interflow's 20 years of experience as Australasia's largest specialist sewer lining contractor.

Technology to prepare sewers for lining has also advanced and this paper will address some of the latest and quite ingenious solutions available for the widest range of conditions.

With structural lining considered to be equivalent to sewer renewal, with an expected life at least equal to a new sewer, every effort should be made to allow it to be undertaken successfully.

KEYWORDS

Sewer Deterioration, Sewer Rehabilitation, Lining

PRESENTER PROFILE

John Monro is a professional civil engineer with some 30 year's experience in the pipeline industry. The past 15 years of this has been in the trenchless pipeline rehabilitation industry and John has been involved in developing and gaining acceptance for a range of locally developed technologies for restoring deteriorated underground water and wastewater pipelines.

Initially he worked for Rib Loc, developers of a range of spiral wound liners now used worldwide. He is currently with Interflow, New Zealand and Australia's largest specialist pipeline rehabilitation contractor.

He is a former National Vice President and NSW Councillor for the Australasian Society for Trenchless Technology.

1 INTRODUCTION

Trenchless sewer rehabilitation holds a unique niche in civil engineering, as well as in the water industry.

Rather than the construction of new assets, it is concerned with the renewal of existing assets which have effectively reached the end of their service life. But mostly these assets can't be seen and can't be accessed to carry out the type of work that the civil engineering industry normally does.

For an industry which barely existed only 20 years ago, development has been rapid, supported by a culture demonstrating a willingness to accept innovation rather than a fear to depart from the status quo.

Nowhere is this more apparent than in the sewer rehabilitation branch of the Trenchless Technology industry.

Usually buried beneath densely populated areas of our cities and towns, deteriorated sewers are mostly far too small to allow person-access for inspection, repair or rehabilitation. Their location and importance to the functioning of the community means they cannot be excavated for replacement and the services they provide cannot be interrupted for an extended period of time.

When these sewers reach a state where their age and deterioration means they can no longer function efficiently, their renewal must be carried out by means that need minimal excavation and do not interrupt services either above or below ground.

Sewers may have their effective lives shortened by a wide range of defects that develop through normal use, ground conditions or material degradation. Mostly they are made from rigid materials – reinforced concrete or vitrified clay – which can crack due to ground movement, and cause joints to separate.

They can deteriorate due to corrosion or abrasion. Surrounding soil, roots or groundwater infiltration can enter through these defects leading to blockages and overflows. If these defects are not discovered and addressed, partial or complete collapse can occur. Debris of all types from various sources can enter a sewer, also causing partial or complete blockage.

The need for renovation of these sewers has seen the development of an ingenious range of robotic devices suitable for remote operation in the demanding environment of a small diameter deteriorated underground operating sewer, as well as a range of liners that when installed will mean extending their useful life to at least equal that of a new sewer.

But there are limitations to what can be achieved by Trenchless Technology. While the boundaries continue to be expanded by new and ingenious developments, knowing what can and can't be renewed is essential for the success of a sewer rehabilitation program

2 MATCHING PROBLEMS WITH SOLUTIONS

2.1 SOLUTIONS TO RENEW DETERIORATED SEWERS

There are basically 3 different types of full-bore liners that, provide trenchless full length structural renewal for deteriorated sewers – spiral wound, fold-and-form and cured-in-place (CIPP). This paper deals only with the first type – spiral wound liners - as installed in New Zealand and Australia by Interflow Pty Limited.

Contact: Interflow Marketing Department – marketing@interflow.com.au

2.1.1 EXPANDED SPIRAL WOUND LINERS

Spiral wound liners in diameters up to 1,200mm are installed by a winding machine placed in a manhole at one end of the sewer pipe section to be lined.

A continuous strip of T-ribbed PVC is spirally wound with its edges locked together inside the deteriorated sewer, extending from one manhole to the next. It is then expanded tightly against the wall of the existing pipe.

The main differences, and advantages, over other types of sewer liners when lining deteriorated sewers are:

- Spiral wound liners are not installed in a soft state and so don't mould to the irregular shape of the deteriorated existing pipe. They can span many types of defects, providing a circular liner with consistent wall dimensions and properties.
- They are not manufactured to a pre-set diameter. Once installed they are mechanically expanded to the actual maximum diameter that will fit into the deteriorated sewer. This is an advantage where the actual diameter differs from the nominal diameter, or when the actual diameter varies along the length of the sewer due to deterioration.

2.1.2 PATCH LINING

Local and isolated defects can be repaired by installing a short – 1.2 metre – length of cured-in-place fibreglass liner, spanning the defect and adhering to existing pipe.

Patch liners are recommended when the defect is not due to age or general deterioration and the remainder of the sewer is in good condition.

2.1.3 LOCAL SEWER REPAIR

Where a defect makes installation of a continuous liner impossible, a local repair can be made by excavating and removing the defect then installing a new length of pipe. The rest of the sewer can be lined, including through the just-installed section.

This may be preferable to excavating and replacing the full length of the sewer.

2.2 CONDITIONS THAT CHALLENGE LINER INSTALLATION

Spiral wound liners can be routinely installed in sewers whose future service life is compromised by corrosion, abrasion, leaking joints or cracking, unless conditions are extreme.

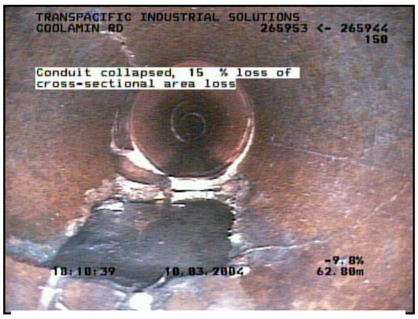
Determining limitations requires understanding of the lining technology and the capabilities of the equipment needed to prepare the sewer for liner installation.

Conditions which limit the possibilities for lining fall into two basic categories:

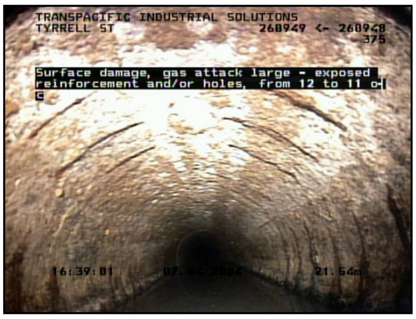
- Obstructions and intrusions, for example silt or debris in the line, intruding junctions, roots, heavy infiltration
- Sewer conditions, such as diameter reduction (deformation, partial collapse etc) steep slope, high friction, high flow

2.2.1 SPIRAL WOUND LINING WITHOUT PRE-LINING REPAIRS

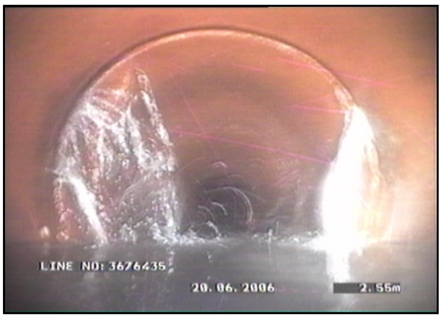
Spiral wound liners can normally be installed in sewers with the following defects unless installation conditions are extreme. The liner would be spirally wound into the sewer and mechanically expanded by the standard procedure.



Picture 1: Sewer with missing section



Picture 2: Sewer with severe corrosion



Picture 3: Sewer with heavy infiltration

As the liner is installed in a rigid condition it will structurally span the missing wall section in Picture 1. The liner will be circular and not attempt to bulge at that location.

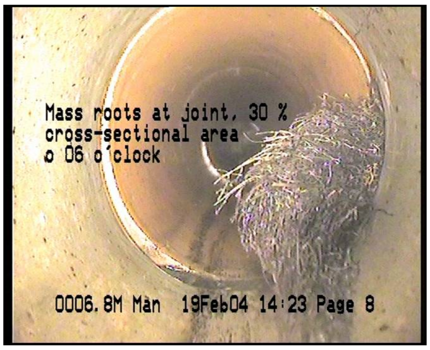
Picture 2 illustrates a concrete sewer with severe corrosion at the crown. The loss of concrete means that the actual diameter will be larger than the nominal diameter and may vary along its length. A spiral wound liner could be installed and expanded to the largest diameter that will fit into the line. The wall will not be thinned.

As heating or curing is not part of the installation process, a spiral wound liner could be installed in a sewer suffering infiltration as shown in Picture 3. There would be no need to provide a seal against the infiltration prior to installation.

2.2.2 SEWERS WITH OBSTRUCTIONS

The following sewers would need obstructions removed prior to liner installation

The roots shown in Picture 4 can be removed by high pressure jetting or by a bladed root cutter.



Picture 4: Roots growing through a crack or joint in the pipe

Picture 5: Intruding lateral junctions

Picture 6: Debris, possibly silt, rubble or concrete

Several types are available.

Intruding lateral junctions require removal by grinding with a robotic cutter.

If the debris in Picture 6 is rubble or silt, it could be removed by jetting. If it is found to be concrete, milling using a high capacity hydraulic milling machine will be needed to clear the line.

In all of the above cases, the choice of robotic equipment needed to remove the obstruction must be made by experienced personnel. A wide range of equipment is available and advances are continually being made.

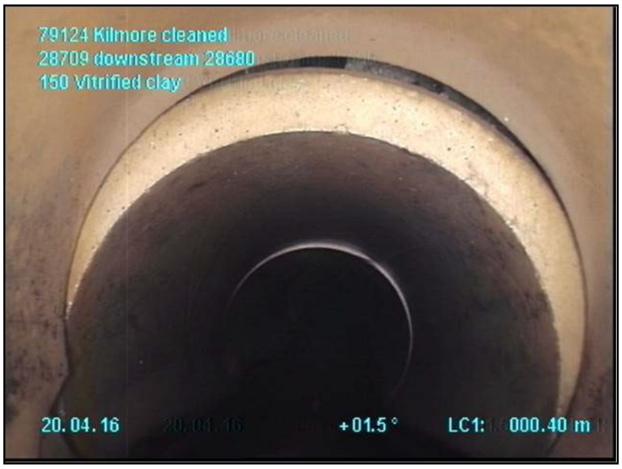
2.2.3 SEWER CONDITIONS THAT LIMIT LINER INSTALLATION

For sewers with mild defects which nevertheless require lining, the following conditions may limit the feasibility of installing a spiral wound liner. Each case will need to be carefully considered by experienced personnel, taking into account other features of the project which may include the length of the line, the diameter, the type and location of defects, bends and deviations etc.

- Flow velocity. Additional consideration needs to be made if velocity of flow is greater than 3 metres per second
- Flow depth. If the depth of flow is greater than 20% of diameter, further assessment is required
- Steepness. For sewers up to 300mm diameter, a slope of up to 20 degrees is considered to be a standard condition. For larger diameters, slopes above 12 degrees and more than 50 metres in length need additional consideration
- Bends. Sharpness of the bend needs to be considered as well as the total angle of the bend. A special spiral wound profile strip is now available that increases the capacity for installation in non-straight lines, but each application needs specific consideration.
- Length. This is only typically an issue for lines greater than 600mm with long distances between manholes. For most sewers it is not a limitation unless some of the conditions listed above apply.

2.2.4 SEWERS THAT CAN BE LINED, IF COMPROMISE IS ACCEPTABLE

Spiral wound liner installation is possible in the following sewers, however the nature of the defect means that the installed diameter will be less than optimum. Agreement will be needed from the Client that this will be acceptable, and is preferable to the alternative of excavation and carrying out a local repair



Picture 7: Displaced or dropped joint

Picture 8: Deformed pipe, partial collapse

Installation of a spiral wound liner would be possible through these defects, although grinding may be needed at the displaced joint to remove the sharp edge. However, the conditions at these defects mean that the full diameter of the liner will not be achieved. Installation will not proceed unless the Client agrees that this is acceptable.

The following are the limits to diameter of sewers which Interflow will line. Note that smaller diameter lines are possible, but are not considered in the Client's long-term interests.

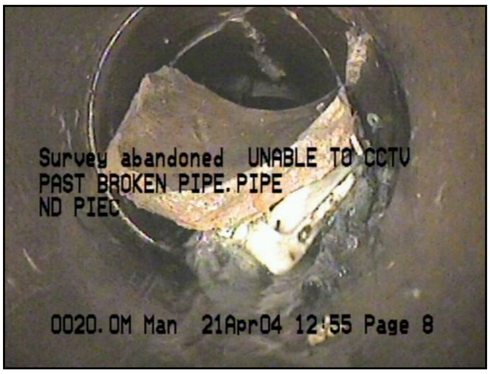
Table 1: Minimum deformed diameter for lining

Nominal Diameter	Minimum Clear Bore
150mm	140mm
225mm	200mm
300mm	275mm

2.2.5 SEWERS THAT CANNOT BE LINED

Sewers with the following defects cannot practically be lined without a local repair being performed. This involves excavation then removal of the defective section and installation of a section of new pipe.

Picture 9: Broken pipe or joint with excessive displacement



Picture 10: Collapsed section of pipe

Picture 11: Pipe filled with concrete

If the defect is due to age or deterioration, then a liner can be installed along the entire sewer length from manhole to manhole, including continuously through the newly repaired section. This will effectively renew the entire length.

3 CONCLUSIONS

Developments in trenchless sewer rehabilitation technology mean that sewers with all but the most severe deterioration can be successfully and effectively lined without the need for disruptive excavation.

Spiral wound liners can be directly installed in most deteriorated sewers without the need for pre-lining actions or repairs. In some cases, compromises to the size of the installed liner needs to first be agreed with the Client.

The choice of equipment and methods to remove obstructions needs to be made by personnel experienced in the industry. These need to be chosen to effectively remove the obstruction without causing further damage to the existing sewer. Advances in robotic equipment to clean and remove obstructions are continually being made.

There is no substitute for experience in making the most effective and efficient choice and it is essential for practitioners to keep up to date with latest developments from around the world.

As with other aspects of Trenchless Technology, particularly in relation to sewer rehabilitation, resources available in New Zealand and Australia are equal to world-leading.