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	TRENCHLESS TECHNOLOGY RESOURCE CENTRE	
	TRENCHLESS TECHNOLOGY GUIDELINES	THIRD EDITION
	MANHOLE REHABILITATION TECHNIQUES	LAST UPDATED NOVEMBER 2008

OVERVIEW

Many of the techniques covered elsewhere in these Guidelines deal directly with the pipeline or cable being placed, replaced or rehabilitated in the ground. One aspect that is rarely covered by these techniques is that of the surface access to the service. In gravity pipes such as sewers, access is normally via a permanent manhole.

In the past few years, however, this attitude has been changing. Pipeline surveys have shown that infiltration and exfiltration flows can occur just as much in a poorly constructed or maintained manhole, as they can in the mainline service itself.

Problems often seen include: poor jointing in brickwork making up the manhole that allows ground water flows in or wastewater flows out; high pressure ground water around the manhole causing failure of the structure to one degree or other; ground contamination and/or voiding around the manhole leading ground destabilisation.

Excessive infiltration causes problems down stream with fresh ground water diluting foul sewage, making effective wastewater treatment both difficult and costly. This may lead to a need to construct far larger treatment plants than might otherwise have been necessary.

To address this problem, several techniques have been developed to overcome the various types of deterioration encountered in manholes in the field.



A typical deteriorated manhole showing infiltration. (picture courtesy of [waternetsurvey.com](#))

Techniques (click [link](#) to see section):

- Repointing [link](#)
- Grout Injection [link](#)
- Spray Systems [link](#)
- Lining [link](#)
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 - Poured-in-Place [link](#)
 - CIPP [link](#)
- Flood Grouting [link](#)
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REPOINTING

Given the varying degree of damage that may occur in a manhole, one of the simplest solutions is re-pointing of the brickwork or concrete jointing should this be the basic manhole construction. Repairing the brickwork/joints of a manhole by re-pointing can be appropriate where:

- The inflows are low due to low ground water pressures
- Inflow only occurs as weather conditions become adverse
- Outflows only occur when the system is running at near capacity with the manhole running full

Simply repairing the brickwork in this way may be more than adequate to seal the manhole. This does not, however, address any voids that may have occurred over time outside the manhole structure. If this is small in scale there may not be a problem, but if voiding has occurred to any significant degree simply re-pointing the inner wall of the manhole may be an inadequate solution.

Where surface damage is deemed to be significant or where potential for such damage is likely, it is also possible to create a complete inner wall coating simply by trowelling a new inner lining over the whole manhole surface. Normally a cementitious grout would be used for such a liner. Its properties would be designed to suit the potential working conditions of the manhole, i.e. corrosive atmospheres, continual running at capacity so always wet etc.

GROUT INJECTION

Where flows into or out of a manhole are higher and where the stability of the surrounding ground may need to be reinforced without excavation, it is possible to utilise a grout injection process to seal the manhole from the surrounding ground.

This process involves drilling a series of small injection holes around the manhole through the brick or concrete skin into the surrounding ground. A special resin or mortar is then injected, using a pump system, through these holes to fill any voids around the outside of the manhole. This technique does not necessarily leave an obvious new inner surface or 'lining' to the manhole but it does prevent infiltration or exfiltration to or from the surrounding ground. There is no surface protection so the inner manhole wall may still be subject to corrosive atmospheres, should any occur, and may need further protection if this circumstance is expected.

SPRAY SYSTEMS

Of course grout systems do not always require the product to be injected through or into the fabric of the manhole or manually applied to the manhole walls. Another utilisation of grout type materials is as a spray 'lining' system.

Here a manhole is first cleaned to remove debris and to create a bonding surface for the sprayed compound product to adhere to. Then either manual application using man-entry techniques and a spray system or a special 'free acting' remote-controlled spray nozzle (various systems are available to the market) is then utilised to apply a grout product to the inner wall of the manhole. The product may be cementitious or polymer based depending on the criteria required of the lining, the preferred choice of the client and the final product requirements in terms of



Spray lining of a manhole with a specially designed spray nozzle. *Picture courtesy of AP/M Permaform.*

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operating conditions expected. The spray system can be designed to be applied in as thick a coating as required or, as has been more recently developed, a multi-layered system with each layer being designed to achieve a particular characteristic within the aims of the rehabilitation requirements. Many of the systems available may require a level of manhole pre-treatment if infiltration is high, simply to prevent washout of the spray coating before curing is complete by stopping inflows (see re-pointing/grout injection sections above).

The coatings can be designed to give a range of curing times and final cured product, as required by the operations criteria of the manhole in question.

LINING

As well as treatment of and to the existing inner wall of a manhole, it is also possible to install a 'liner', which can offer either a simple new protective surface or, should the condition of the manhole require it, a degree of additional structural integrity without the need to completely rebuild the manhole.

There are various types of liner that can be used to rehabilitate manholes including: Preformed sections, Poured-in-Place linings and CIPP (Cured-in-Place) liners. Normally these liners can be installed within an existing concrete, brick, or pre-cast manhole.

Preformed Sections: This type of lining, as in mainline sewer rehabilitation, comprises the use of factory-built units, either of standard dimensions or specially constructed design to the measured dimensions of the manholes undergoing rehabilitation. Sections can be of concrete or plastic but are more usually designed from Glass-reinforced concrete (GRC) or Glass-reinforced plastic (GRP). The sections are usually designed in single monolithic sections that are positioned within the manhole structure. Once in place the annulus between the new liner



◀A liner inserted into an existing manhole.

Preformed Manhole liners.▶

Pictures courtesy of Containment Solutions Inc



and the existing manhole wall is grout filled to form the permanent bond between liner and existing manhole, making the new lining an integral part of the manhole and so part of its structural integrity.

Typically, standard units are available for manhole depths from 0.9 m to 7.5 m, and with inside diameters from 1,066 mm to 1,830 mm. However, most manufacturers can supply non-standard units on request.

Poured-in-Place: Poured-in-place systems are very much self-explanatory, in that what it says is what you get. The technology relies on a formwork being placed in the manhole to be rehabilitated, that fits to the shape and size of the required lining. The formwork can be made of either steel or plastic material and is normally available in a variety of standard sizes depending on the manufacturer providing the formwork. They can also be custom-made to specified dimensions.

A typical manhole rehabilitation former, shown in a manhole above left. Picture courtesy of Improved Construction Methods.



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With the formwork in the manhole concrete is poured around it into the annulus created between formwork and manhole wall, often using vibration to ensure the concrete settles correctly, until the annulus is fully filled. Once the concrete is full to the top of the former it is allowed to cure according to the concrete's curing specification.

Once cured the formwork is removed from the manhole to leave the new liner in place.

If a plastic inner wall liner is required as a final product in the manhole, it is also possible to design a plastic skin that is placed around the outer surface of the former during its construction. The design allows for the plastic to anchor into the concrete as it is poured into the annulus, so creating an integrated concrete/plastic liner within the manhole.

CIPP (Cured-in-Place-Pipe): Manholes can also be rehabilitated using similar materials to those used in CIPP (Cured-in-Place-Pipe) lining technology, as used in the lining of sewers and other pipes. Inversion techniques are not however commonly used. Felt, PVC or Fibreglass liners are available for this purpose, that can be heat or ambient cured, depending on how each is installed and inflated.

Where felt/glass-fibre resin liner material is used, it can be resin impregnated either at site for immediate use or under factory conditions and transported to site.

With the product fabric chosen, the liner is inserted into the manhole under repair from the top of the manhole. Once in the manhole the liner is 'inflated' using a flexible bladder that is itself inflated with compressed air. This pushes the liner against the existing manhole wall where it is allowed to cure. Once cured, the bladder is deflated and removed leaving the liner in place.

In some circumstances, normally in more difficult access situations where an inflated bladder would not work sufficiently well, the liner is simply pressed into place by hand and left to cure.

Again, a variety of systems are available for this type of rehabilitation, and given the nature of the liner materials and the lining that has to be achieved, liners are often 'made-to-measure' for each manhole, giving the best possible liner for each circumstance.

Once cured, the liner is cut in the relevant places to reopen lateral connections should there be any, and to open the base inlets and outlets.



CIPP manhole rehabilitation before (top) and after (bottom).

Pictures courtesy of Poly-Triplex.

FLOOD GROUTING

Previously covered in detail in both the pipeline rehabilitation and localised repair sections (Guideline Sections 5 and 7 respectively), flood grouting also works extremely well as a manhole sealing system. As in most cases the flooding of a pipeline occurs through existing manholes, so that when the flooding operation is undertaken, not only do flaws in the pipeline get treated but also those in the manholes. Should the system be used only for manhole rehabilitation inlets and outlets to the manhole would be sealed so that the flooding compounds would remain in the manhole only during the process. For full details of how flood grouting systems work see Sections 5 and/or 7.

CORROSION PROTECTION

As mentioned above, many sewer systems carry flows that generate, to some degree at least, corrosive atmospheres in the form of Hydrogen Sulphide, Ammonia and other products that

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are produced in the atmosphere above the flow level. Therefore there can often be a significant problem with corrosion of the manhole surface that needs to be addressed when choosing the most relevant option for manhole repair from those listed above.

Whilst each individual system has its own advantages and disadvantages, unless it is utilised in the correct situation, given the corrosive fluids and/or atmospheres it will encounter, a lot of expensive material and manpower could all be for nothing. The cheapest renovation system may not be the most applicable to any given situation and the full spectrum of conditions will need to be considered before making a final choice. Knowing what flows are expected and what properties/characteristics they have is vitally important in this respect whichever system it is decided to use.

SUMMARY

1. Maintenance of manholes is often just as important as the maintenance of the pipelines they serve.
2. Several technologies exist to enable engineers to keep manholes in a well-maintained condition.
3. A wide range of cost-effective systems is available, offering products from simple resurfacing of manhole walls by hand or utilising spray systems, to complete structural enhancement using a variety of pre-formed or 'formed in place' materials.
4. Several of the systems available are based on technologies which are widely used in pipeline renovation. They are therefore easy for the contractor to use. However, training is still essential, and is available from all systems' manufacturers.

Bibliography: The Bibliography may be viewed via the TRC Home page where this Guideline was accessed.

Conference Papers: These may be viewed via the TRC Home page where this Guideline was accessed.

If there is any information that you consider to be missing from this Guideline or have seen any information that you feel is incorrect please contact ISTT directly stating the omission or incorrect item. ISTT will endeavour to correct any such omission or error subject to further investigation to validate any such inaccuracy/ommission. Email: info@istt.com

Bibliography additions:

1. ASCE manhole rehabilitation books articles and papers listed and available at: <http://cedb.asce.org/cgi/WWWsrchkwx.cgi?Manholes>