Stormwater Drainage Restoration and Rehabilitation at Liverpool City Council

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Abstract
Liverpool City Council has underground concrete stormwater drains that have been in service for many decades – some up to a century. They range from small diameter pipes providing road side drainage to large diameter pipes and multi-cell box culverts.

In 2010 Liverpool City Council embarked on an extensive investigation into the condition of their oldest underground assets, then developed and commenced a rehabilitation program. The program needed to be carried out within financial constraints and in a manner that did not cause undue disturbance to community activities and lifestyles.

The resulting rehabilitation program will be on-going for several years depending on available Council finance. Trenchless Technology has been applied, using techniques that rehabilitate and renew deteriorated underground pipelines while eliminating or minimising the need for excavation.

1. INTRODUCTION

Liverpool City Council covers 42 suburbs in Western Sydney and its 600 staff service a fast growing community of some 220,000 people.

The region has a long history dating back to when the town of Liverpool was founded by Governor Lachlan Macquarie in 1810. The history of local government dates back to 1848, when a district council was formed. Liverpool Municipality was proclaimed in 27th June 1872.

Among other responsibilities, Liverpool City Council (Council) today is responsible for the control and management of over 590 km of piped drainage and an associated stormwater drainage system with a current replacement cost of over $418 million.

Council's stormwater system comprises concrete drainage pipes, reinforced concrete box culverts, stormwater access pits and outlet structures. Some of these have been in constant use for a period approaching a century.

1.1. Overview of the Project

Liverpool City Council has underground concrete stormwater drains that have been in service for many decades – some for up to a century. They range from small diameter pipes providing local road side drainage to large diameter pipes and multi-cell box culverts.

While underground stormwater drains may be out-of-sight and out-of-mind, concrete pipes deteriorate over time through corrosion, abrasion and ground movement. Deterioration can lead to flooding during rain events and the possibility of dangerous holes and subsidence forming at the ground surface.

But the location of underground pipes and conduits means that digging up and replacing those that have reached the end of their effective lifecycle would be unfeasibly expensive and unacceptably disruptive to the community.

The situation is exacerbated by the fact that the oldest and therefore the most deteriorated of the drains tend to be in the most densely developed areas; in the central business district or long established inner city suburbs. They are also likely to be under roads, footpaths, residential backyards and buildings.

Liverpool City Council has adopted a 10 year program of systematic internal surveying of the stormwater pipe system to determine its current condition and performance. This has enabled Council to proactively develop maintenance and renewal strategies and programs that are responsive and cost effective.

In 2010 Council established their first List of Recognised Contractors and issued associated Standing Offers for drainage pipe rehabilitation works at various locations within the Liverpool Local Government area. Three Panels were established for the following activities:

- CCTV inspection and condition assessment. Enhanced pipe maintenance (high pressure cleaning, root cutting, grinding of heavy deposits)
- Pipe restoration (joint repairs, structural patch repairs)
- Pipe renewal (whole pipeline length relining)

Since 2010 Council has budgeted up to $1.2M annually for pipeline rehabilitation works. The initial contract period was for 2 + 3 years and expired in 2015.

Under this contract, Liverpool Council has undertaken CCTV inspections and condition assessment of its stormwater drainage system at various locations of the Local Government Area. The information captured from these inspections has been used to develop a maintenance and renewal program. To date CCTV inspection has been completed of some 110 kilometres of pipes and rehabilitation completed of approximately 50 kilometres.

In 2015 Council established their second List of Recognised Contractors with associated Standing Orders.

The aim of the program is to remove the risk that deteriorated pipelines could cause to the community. At the same time, the program needs to be completed within financial constraints and in a manner that did not cause undue disturbance to community activities and lifestyles. Trenchless Technology has been applied, using techniques that rehabilitate and renew deteriorated underground pipelines while eliminating or minimising the need for excavation.
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1.2. Identifying the Issues

The stormwater issues addressed by this project concerned the continued effective operation of Council's ageing storm drain system. Failure of any part of the system impacts on flooding and drainage control as well as public health and safety. Issues to be addressed during the works concerned safety, the maintenance of community amenities and minimisation of inconvenience.

The relevant steps in the project were:

- Obtaining detailed knowledge of the current condition of the underground stormwater drainage assets

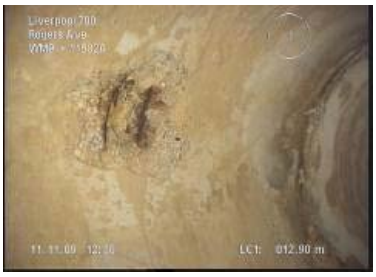
- Analysing the results using a risk-based project selection system to prioritise required actions. Rankings were given based on the pipelines ...
    - Structural condition
    - Hydraulic performance
    - Location
    - Potential for causing flooding
    - The consequences of failure

- Completing the works in accordance with the priority assigned. This involved:
    - Emergency work on any assets considered currently in a condition that posed the greatest risk of flooding or collapse/failure
    - Being pro-active – taking remedial action before deterioration reached a point that their condition caused a danger to the community.
    - Developing an on-going program of future works to maintain the system in accordance with their assessed remaining life

CCTV inspection provided Council with accurate condition data and digital imagery of the pipe network. As well as providing a base for prioritisation of work required, it also made available a record of pipework condition that can be used to compare rates of deterioration following inspections in future years.

Figure 1 shows examples of stills from CCTV inspection of these pipelines, showing how their condition was rated.

Excellent / Good condition
No further action needed



Average condition. To be re-inspected in a few years

Poor condition. Action needed to prevent ground subsidence and possible collapse.

Figure 1: Rating the condition of the stormwater liners from CCTV inspection and determining required action

Since 2010 some 111 kilometres of pipework was inspected by CCTV. The lengths of pipeline given one of five ratings are shown in Figure 2.

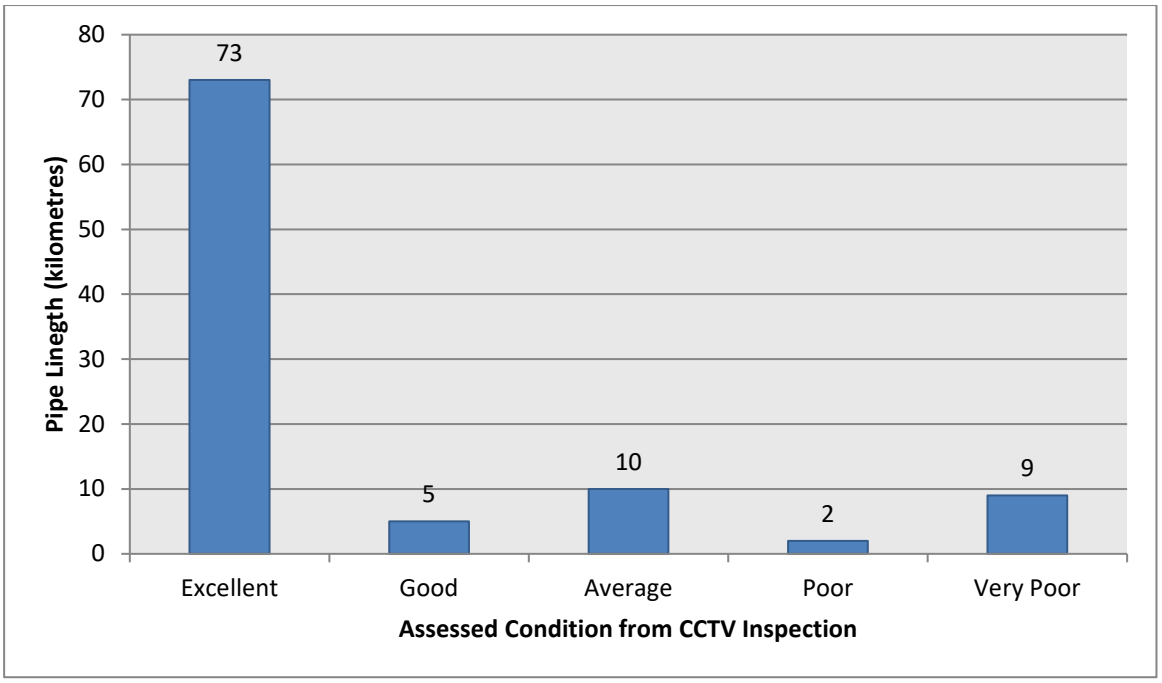


Figure 2: Lengths of inspected stormwater pipeline that were given one of five condition ratings

1.3. Undertaking the Works

A cost-benefit analysis confirmed that "trenchless technology" was the optimum solution compared to the alternative of excavation of long and sometimes deep trenches to replace the deteriorated pipelines.

Undertaking the works by "trenchless" methods offers important social benefits compared to alternative methods. Less noise, less disruption, greater safety because less excavation is needed all lead to obvious social benefits and is an important consideration for Liverpool Council.

The project is economical as it can be completed more quickly, without the need for the surface remediation that would be required with replacement by open trenching.

It offers environmental benefits as it does not disturb ground that could be contaminated if excavation needed to be undertaken. There is less risk of run-off or erosion in the event of heavy rain during the works.

The benefits are accentuated when it is considered that many of the drains to be lined pass under householders' gardens, footpaths and business premises.

A range of technologies is being used to carry out the works depending on the type of work required and the location. When planning for a task, an important consideration is that it must cause minimal disruption or inconvenience to the community. Excavation is avoided if at all possible, or is minimised in both timing and the area required.

Work being undertaken includes:

1.3.1 Cleaning

Removal of debris and obstructions that accumulate in stormwater pipelines is an essential first step before rehabilitation can be carried out.

Interflow has a range of specially developed manual and water operated cleaning tools for cleaning of deteriorated clay, concrete, asbestos cement and cast iron pipes. After reviewing the CCTV video, the Operations Manager selects an appropriate cleaning method for the pipeline condition. The method selected will minimise the chances of causing damage while efficiently cleaning the pipeline to a condition that will allow rehabilitation to be successfully carried out..

Typically, removal of debris uses a low pressure/high volume water jetter with nozzles at 30°. This removes silt and loose stones, while putting minimum force on the pipe wall. A range of jetting nozzles is available so that for badly deteriorated pipe, a nozzle can be selected that will not cause further damage to the pipe.

Various types of scrapers are available for removing large scale debris. Root cutters can be sent up the pipeline to remove areas of infestation.

Debris is collected and removed at the downstream access pit. Cleaning can be observed by CCTV.

1.3.2 Structural Lining

The most common method of rehabilitation of a deteriorated stormwater pipeline is to install a structural liner. These are used extensively for deteriorated sewers, but are equally applicable for stormwater applications.

Typically, structural liners are designed to take all loads from soil and traffic as if each deteriorated host pipeline has no remaining strength. They are structurally designed using the same method applied in relevant Australian Standards for the construction of new pipelines by traditional trenching.

So, whether the deteriorated stormwater drains are excavated and replaced in the traditional manner, or lined by Interflow using the method proposed, the structural design method will be the same. This means that lining is not just a repair or surface covering. Lining effectively provides new pipelines.

The liners installed have been UPVC, the most common material used for sewer and stormwater pipelines in the sizes installed here. UPVC is a material that has been proven in over 50 years of use in Australia to offer better abrasion and corrosion resistance to a wide range of chemicals.

It is also a flexible pipe material, so it can handle ground movement without cracking.

Lining uses the Australian developed Expanda Pipe system, installed by Interflow Pty Limited.

The system consists of a single uPVC plastic strip that is spirally wound into the existing pipeline via a Rib Loc winding machine placed in the channel of an existing access chamber or adjacent to culvert headwalls. Inside the deteriorating pipe the edges of the strip are securely locked together by a built-in interlocking channel to form a strong structural liner.

Once a section of Expanda Pipe is installed, a patented mechanism is used to radially expand it to contact the inside wall of the existing pipe. The loss of internal diameter is minimised.

As the liner is smoother than the original drain, greater flow capacity will be provided allow more stormwater runoff to be carried compared to the original drain. This is despite the small loss of cross sectional area.

1.3.3 Patching of Individual Defects

Localised defects, such as where a pipe may be cracked or leaking, and where the rest of the pipeline is in good condition, can be repaired by applying a glass fibre reinforced fibreglass patch.

Interflow's Interpatch comprises a length of tube (1.2m standard length) with layers of both woven glass fibres and textile (chopped strand) matting, impregnated with silicate based resin.

The Interpatch is installed without the need for excavation. It is mounted on an inflatable packer and pushed into position using access from the nearest manhole or access pit. The packer is then inflated, holding the Interpatch tightly against the host pipe. With a length of 1.2 metres, it spans the crack or leak with a substantial overlap. It is held in that position until the resin is cured, then the packer is deflated and removed.

While Interpatch bonds to the host pipe, it is more than a seal. It is a structural fitting, having sufficient stand-alone stiffness to resist loading and can be structurally designed using the same methods applicable to flexible pipelines.

The Interpatch can be custom manufactured using layers of fibreglass reinforcement and sufficient silicate resin to meet structural requirements. Its strength means that only a thin walled Interpatch is needed to meet structural requirements, so there is minimal loss in cross sectional area.

1.3.4 Civil Works

When trenchless rehabilitation is not possible, there is no option but to dig-and-replace.

Examples of where such work is needed may be:
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- Excavation and local repair of collapsed pipeline sections
- Construction of manholes
- Installation of pipelines

As this work usually takes place in a built-up area, identification of the location of other underground services is an essential part of the starting process. As a minimum, this takes the form of using the resources of Dial Before You Dig. This is a national not-for-profit group of State Associations made up of member organisations that own Australia's underground assets. It provides a free national referral service designed to prevent damage and disruption to the vast pipe and cable networks which provide essential services.

If considered necessary, potholing is carried out to identify the precise location of the relevant services and any adjacent services that could potentially be impacted. The locations of the services are marked and appropriate controls put in place to ensure that they are not damaged.

All work is carried out to minimise disruption. The smallest possible site "footprint" is used and where possible excavated material is re-used to fill the excavation at the completion of the repair or renewal works. This is typically possible because the pipework to be repaired was originally installed in a trench, with suitable backfill that can be re-used once the collapsed section has been replaced.

Due to the location of most of these works, site remediation is an important part of any civil works project associated with pipe rehabilitation. A standard procedure is to reach agreement with the resident and/or Council regarding suitable reinstatement prior to commencement of works.

All areas affected by the activities are put back into their prior condition to the satisfaction of the property owners. This may mean replacing soil, grass or plants depending on pre-existing site conditions.

1.4 Stakeholder Relations

The location of this project – throughout the central business district and built up residential areas of Liverpool City – means that collaboration with a wide range of stakeholders is required.

Key stakeholders included:

- Liverpool City Council
- Residents and businesses directly affected by the work, especially those whose properties front the Hume Highway and other major roads and those affected by any partial closures of roads joining the Hume Highway
- Traffic using major roads
- Bus passengers who use the bus stops near the works
- Energy Australia, RMS, local police, Ambulance, SES and Fire Brigades
- Vehicles and personnel accessing Liverpool Hospital
- Pedestrians or motorists travelling near the work sites
- Surrounding community

The Interflow Community Relations Plan applied on this project details how relationships with these stakeholders were to be managed. The Plan aims to ensure that in carrying out the works Interflow's employees apply the following values:

- Cause minimum disruption to resident properties and the local environment by programming works to minimise re-visits and leaving premises the way they are found.
- Inform residents about the nature of works and the impact on their property and the local environment.
- Achieve what is promised to residents, especially in relation to timing of the works.
- Treat residents with the same dignity, courtesy and respect that they themselves would expect if they were the resident, displaying a helpful, friendly demeanour.
- Respond to all complaints promptly, effectively and, where appropriate, in accordance with contractual requirements.
- Obtain permission to enter private property from the resident, prior to entry.
- Be easily identifiable as Interflow employees, by appropriate uniform and identification, always on site.

2. CONCLUSIONS

As underground stormwater conduits are out-of-site and out-of-mind, maintenance works can often be random and reactive, and only carried out when it becomes apparent that something needs to be done because of a threat to the safety of public or property. This is often neither cost effective nor efficient in ensuring adequate levels of service are provided to the community.

By being proactive and investing in a program of thorough investigation into the condition of their underground assets, Liverpool Council has been able to embark on a program that maximises the efficiency of maintenance work while delivering high levels of safety and service.

The program is being carried out by specialist contractors to Council who apply innovative methods to meet Council's requirements for high standards of community service.

Installation of the liner uses existing access chambers and manholes. The need for excavation is eliminated or minimised. Equipment used to support the works is no larger than a table top truck.

Work methods cause minimal traffic disruption. When work is completed at the end of the day, or at the start of peak hour, the maintenance hole lid replaced and the site above ground restored to its original condition. There is no noise beyond a generator and small compressor.

Inconvenience to the community is minimised. It is not uncommon for people in the vicinity of the works to be unaware of the type of work that is going on.

These works being carried out to effectively renew Liverpool Councils deteriorated underground stormwater drainage assets. The risks of flooding and land subsidence are being removed. As well as prolonging the lifecycle of the stormwater assets, the works are taking place in a manner that will allow Liverpool City Council to continuously provide the standard of service expected by the community.

This project provides an example of excellence in how metropolitan Councils can renew a vital but often neglected asset, so that their underground stormwater drains can continue to provide service for 100 years or more into the future.

3. ACKNOWLEDGEMENT

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