TRENCHLESS REHABILITATION OF THE UPPER HOBSONS BAY MAIN SEWER

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ABSTRACT:

Rehabilitation of the 110-year-old Upper Hobsons Bay sewer in Melbourne saw the completion of one of the world's largest UV-cured fibreglass CIPP lining projects.

The project included 32 lengths of ovoid sewer with internal dimensions of up to 1200m x 825mm over a total of some 3.5 kilometres. In addition, 1,100 metres of 600mm nominal diameter circular sewer was lined and 43 manholes rehabilitated along the route.

Complicating the project was the location – mostly near the shoreline of Brighton Beach, home of Melbourne's iconic bathing boxes. The full length of the rehabilitated section of the Hobson Bay Main was sited within Beach Rd and St Kilda St which serves as a major arterial road for commuters from Melbourne's South-Eastern suburbs.

The ovoid shaped sewers were rehabilitated with high strength, UV cured CIPP fibreglass liners, while PVC spiral wound liners were installed in the circular sewers. Manholes were repaired and internally coated with calcium aluminate cement.

The challenge of installing the fibreglass CIPP liners was exacerbated by the heavy infiltration (tidal) of the sewers as well as heavy calcification built up around the walls and roof of the pipe. These needed to be addressed with special measures to be taken to ensure successful, heat-dependent UV light curing.

Other challenges including flow and traffic management to minimise community disruption were completed by co-operation between the contractor, subcontactors, the Client and other stakeholders including Bayside City Council , Bicycle Victoria and Vicroads.

This paper tells the story of another successful Australian industry leading Trenchless Technology project.

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1. INTRODUCTION (main body of paper should begin immediately after the Abstract)

The Upper Hobsons Bay Main Sewer Upgrade Project involved the rehabilitation of 4.6 kilometres of the 110-year-old Upper Hobson Bay main sewer and associated manholes. The sewer comprises single brick ovoid and circular concrete sections, constructed mostly in tunnels.The sewer is located adjacent to the picturesque foreshore of Brighton and Hampton (Melbourne), beneath Beach Road and St Kilda Street.

Beach Road is a busy commuter route carrying approximately 24,000 cars per day. It is also an important over dimension (OD) road. Additionally, Beach Road is one of Melbourne's most highly valued and utilised cycling routes by both competitive and recreational cyclists. Up to 20,000 cyclists use the route each week.

With this in mind, the project's delivery methodology was developed with a strong community focus to mitigate construction impacts for the cyclists, residents, visitors and other road users while delivering the largest single UV CIPP fibreglass lining project carried out in Australia.

Closed circuit television inspection and hydraulic assessment commissioned by Melbourne Water showed that the condition of a significant length of the brick ovoid sewer had reached a stage where rehabilitation was needed. Several sections of the circular concrete sewer also showed evidence of deterioration. Sewer details were as follows.

Table 1: Upper Hobson Bay Main Sewer details between MH67A and MH108.

Section	Shape	Size (mm)	Material	Length
MH67A to MH70	Ovoid	1200 x 825	Brick	403m
MH70 to MH99	Ovoid	1050 x 675	Brick	3082m
MH99 to MH108	Circular	600	Concrete	1191m

Inspection of the manholes along the route showed that most of these also suffered from deterioration. Depths to the inverts varied from 1.2 metres to 11 metres. Along the sewer's length were 43 manholes with sewer lengths between them of up to 210 metres.

Based on the assessment of the sewer and manholes, the project's specifications for rehabilitation of the sewer called for:

- cleaning of the sewer to a condition that would allow liner installation.
- installation of liners in both the ovoid and circular sewers.
- liners needed to be designed to restore the sewers' structural strength and have an expected service life in excess of 50 years.
- no reduction in flow capacity.
- rehabilitation of the manholes by cleaning and coating with calcium aluminate cement to meet the 50 year design life requirements
- maintain full sewer services to the community while the works are undertaken.
- use work methods and procedures that minimise disruption to traffic and to the community in general.

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Figure 1: Route of the Upper Hobson Bay Main Sewer.

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2. ABOVE THE GROUND - ENABLING THE WORKS

The Contract for the works was awarded to John Holland-KBR Joint Venture (JH-KBR JV) as part of Melbourne Water major projects framework. In recognition of the importance of the project and potential risk JH-KBR JV partnered with subcontractors who were committed to delivering quality work and, when and where possible, seek alternate solutions to minimise impact.

The project was not possible without Interflow Pty Limited as the sub-contractor for the lining and manhole rehabilitation works, Welltech Total Water Management (bypass pipeline and pump operation), JHL Civil (manhole modifications), Construct (traffic management), JMFBC (pedestrian ramps) and Delcon Civil (civil works for bypass pipeline).

The trenchless solution selected for the sewer rehabilitation provided significantly less impact to the community and environment as an alternative, however it is recognised that JH-KBR JV led and managed considerable planning, strategy, approvals, stakeholder consideration and preparation works to enable the relining activity to take place. Project management was key to the success of the project, which was time sensitive due to the requirement to have the work completed before the summer season arrived while restricted in work hours due to the demand of traffic (car and cycle) on Beach Road.

APPROVALS

The project considered the following Acts to identify the level of approval activity that was required prior to works commencing:

- Environment Protection and Biodiversity Conservation Act 1999
- Environment Effects Act 1978 (EE Act 1978)
- Aboriginal Heritage Act 2006 (AH Act 2006)
- Planning and Environment Act 1987 (P&E Act).
- Coastal Management Act 1995

Consideration of state legislation relating to European heritage, flora and fauna, and infrastructure was also undertaken during the development of the design in order to secure approval prior to construction.

The bypass alignment for the main sewer was positioned predominantly within the foreshore reserve, in addition areas adjacent to the alignment which may have been required for construction compounds include areas which are zoned PPRZ and are subject to a Vegetation Protection Overlay (VPO1), a Special Building Overlay (SBO) and Design and Development Overlays (DDO1 and DDO2).

Under the Bayside planning scheme a planning permit is not required for buildings and works associated with a 'minor utility installation' pursuant to Clause 62.02-1. However, this exemption does not extend to native vegetation under Clause 52.17 of the planning scheme or vegetation (including non-native) located within the Vegetation Protection Overlay (VPO1).

Consent under the Coastal Management Act 1995 (CMA Act) for use and development of coastal crown land was required in accordance with Clause 37 of the Act.

JH-KBR JV prepared the CMA Act consent and all associated documentation required for the submission and Melbourne Water led the consultation with DELWP.

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Additionally several Heritage Overlays exist within and adjacent to the project area.

JH-KBR JV undertook further flora and fauna assessment based on the ultimate design and construction footprint which would occur from installation of the proposed bypass alignment and connections within the foreshore reserve, manhole works and construction laydown areas.

JH-KBR JV worked closely with regulatory stakeholders including Bayside City Council, DELWP, Parks Victoria and Heritage Victoria to discuss the project and confirm approval and consent requirements.

Given the nature of the project, proximity of residents to the works and the high visibility of the project to the local community, a third party consultant was engaged to undertake an assessment of the predicted vibration impacts, both Vibration Dose Values (human comfort) and building structural criteria, based on the construction methodology and plant/equipment proposed for the works. This assessment was then incorporated into the project specific Noise and Vibration Management Plan to manage noise and vibration levels from construction activities which supported distribution areas for community notices.

STAKEHOLDER AND COMMUNITY ENGAGEMENT

The construction area has significant community recreational, environmental and amenity value and contains many long-established community and public facilities, including several sports and recreational reserves, walking and cycling paths, popular beaches and parklands,including war memorials. The works were highly visible and adjacent to residential areas of well-established homes protective of their location and views.

Due to the bypass pipeline, businesses along the coast would have a long running interface with the project including Royal Brighton Yacht Club, Brighton Baths, and Quest Brighton on the Bay. High Street shopping strips and restaurants located on Bay Street, Church Street and Hampton Street had significant interest in traffic flow in the area and ease in accessibility to shopping precincts.

During planning, key decisions were made, motivated by the importance to minimise inconvenience for the community, businesses and stakeholders including:

- Selecting a UV CIPP liner which enables monitoring during installation, and can easily be removed prior to curing, if an issue arises. This reduces the risk of works in one location being delayed due to a stuck liner requiring removal.
- Listened to stakeholder feedback and considered it during planning for example Council identifying preferred areas for bypass pumping line to be positioned, pedestrian ramps adjacent to the Royal Brighton Yacht Club were constructed with removable segments to allow boats to be unloaded along the pier.
- Road plates to be recessed, non-slip surface, a bright yellow to increase visibility and safety for cyclists.
- Identified locations and methodologies for the bypass pipe in sections to alleviate impact to driveways to residential properties, businesses and car parks.
- Bypass pump locations identified in areas to minimise community disruption and selection of type of pumps and housing to reduce potential noise experience.
- Timing of bypass set up works to be considerate to timing of peak activity in the area ie pipe trenched, laid and reinstated near memorial without impacting Anzac Day to ensure project is invisible and respectful to memorial activities.

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- Identification of site office within an existing building to reduce footprint of site compound in recreational areas.

Proactive and focussed engagement with each resident and business along the 4.6km alignment and 4.5km of bypass pipeline, was paramount in developing a trusted and personal relationship with the community. With multiple, daily changing work fronts along the alignment, it allowed the entire project team, from design to construction and traffic controllers, to work closely with the community and key stakeholders to overcome challenges in delivery.

This personal, one-to-one approach has helped to increase efficiencies and lesson the impacts of the construction experience and has been commended by both members of the community and the client, Melbourne Water. The project itself received a 4.5 (out of 5) on a project community survey which is one of the highest result achieved for a Melbourne Water project.

MANHOLE MODIFICATIONS

To facilitate the sewer relining works, modifications were required to nominated manholes to allow lining equipment to be used within the manhole and ensure safe access could be maintained during the lining works. JH-KBR JV nominated key manholes that required modification with the view to minimise civil works required at major intersections in the roadway. From each modified manhole, CIPP lining activities typically ran in each direction, minimising the quantity of manholes requiring modifications.

The extent of modification works to the CIPP manholes involved the removal of the conical brick section at the top of the manhole and replacement of this section with a poured in-situ concrete section to provide a straight shaft. The manhole had a pre-cast conversion slab installed on top complete with a 1200mm x 900mm manhole lid.

Manhole modification works were maintained to the designated times from VicRoads Monday to Friday 9:30am to 3:30pm. Works each day required precise planning and monitoring to ensure that pack down works started in time. At the completion of each shift an engineered temporary cover was installed.

Special road plates were developed to enable the quick set up and pack-down of work sites. The road plates were designed with subcontractor JHL to ensure practicalities and experience were utilised. The road plates were specially designed to be fully recessed into the roadway, resting on isolation rubber to minimise noise (due to rocking plates) and finished in a high-visibility, non-slip coating to provide a smooth transition from the road surface onto the road plate. The recessed roadplates were a finalist in the 2018 Work Safe Awards and Bicycle Network prasied the initiative as a practice which should be embraced across the industry.

No complaints or property damage claims were received by the project team during the 3 ½ month duration that road plates were installed.

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Figure 2: Road plates were recessed flush with the road surface and coated with a highly visible, non-slip finish. A new standard praised by Bicycle Network.

SEWER FLOW MANAGEMENT - BYPASS PIPELINE AND PUMPING

To complete the CIPP lining and manhole rehabilitation works flow management via bypass pipeline was an essential consideration to allow this project to be undertaken successfully.

Given the various recreational and community uses of the project area and impacts to amenity, careful consideration of the bypass pipeline's 4.5km route and how it would interact with the community was paramount during planning stages. In addition to the main bypass pipeline, approximately 1km (across three areas) of secondary bypass pipelines were set up in side streets to manage residential flow. Due to the shallow depth of the sewer main and the large number of basement connections on grade, retention time within the network was limited (with some locations limited to 7 minutes capacity prior to surcharging property branch connections), rigorous controls and constant onsite monitor was required to ensure surcharging did not occur.

In close consultation with local authorities, VicRoads, Bicycle Network and other community groups, the project devised a bypass route that sought to minimise the visibility of the pipeline and enabled the continued enjoyment and use of the foreshore, shared paths and roadways.

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At places where the bypass pipeline crossed shared user paths, the project engaged a specialist contractor to produce fully accessible modular ramps so that cyclists were not required to dismount. The ramps can be installed and removed quickly to minimise impact to pathways and are easily adaptable for changes to access. The ramps have a solid ply base with non-slip surface to cater for narrow bicycle wheels and hand rails painted in bright yellow for maximum visibility for both cyclists and pedestrians. All 17 constructed ramps complied with the Disability Discrimination Act and consisted of a continuous deck with chamfered transitions, eliminating gaps which are often hazardous for road cyclists. When needed, area lights were installed to provide additional visibility in the changed conditions. The ramps were designed and constructed with a modular focus, not only facilitating reuse of the ramp components between bypass stages but also allowing the ramps to be utilised on future projects, minimising waste.

Figure 3: Modular ramp built on foreshore shared user path for cyclists and pedestrian accessibility.

Bypassing was carried out in three stages along the route with 3 separate secondary bypasses boosting into the primary bypass system. Weir boards were placed in appropriate manholes to store flow, which was then pumped to the surface. From here it was taken by polyethylene pressure pipework to be deposited in a manhole in a suitable location downstream. Pipework ran above ground mostly beside the road, and was trenched beneath road crossings along the route.

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JH-KBR JV sought non-conventional approaches to the installation of the secondary bypass lines to minimise impacts on the local community and provide significant cost savings to the project. These methods included the utilisation of the storm water main drain to install the bypass pipework, eliminating approximately 500m of trenching and subsequent reinstatement works through residential areas. The use of steel Victaulic pipework was also investigated and utilised for two secondary bypass lines. The Dn200 victaulic pipework was installed within the gutter of residential streets where established trees, bluestone gutters and popular thoroughfares for school traffic presented a number of challenges for conventional methods. Temporary asphalt ramps were installed over the pipeline to maintain driveway access with the area readily reinstated following works. The use of Victaulic pipework in combination with the temporary asphalt ramps allowed a readily deployed bypass solution that was trafficable for light vehicle access to each residence while maintaining a low profile sufficient enough to allow a gradual ramping into driveways without encroaching on the roadway.

Each temporary pumping station had both duty and standby (contingency) pumps to ensure continuous service in the event of a duty pump malfunction. Two Welltech technicians were on-site at all times when the system was operating. The location of each pump station also considered the adjacent residents with each compound using noise barriers to minimise impacts. Temporary connections were also made to the existing 415v power so that submersible pumps could be operated electrically where possible, mitigating the noise of duty generators during pump operation.

Welltech was responsible for managing flow bypass of the main sewer and primary branch connections, Interflow was responsible for addressing flow from reticulation lines entering manholes along the route. This was done by plugging the reticulation line and diverting flow into the main sewer, away for the section being lined. This flow was then raised to the surface and tankered downstream of the worksite. Typically a tanker would be filled in about twenty minutes, By prioritising driving tankers along the main road, and not around narrow suburban streets, noise and community disruption was minimised.

Flow management was less critical for the circular sections as installation of spiral wound liners does not block the pipeline and flow can be allowed through a partially installed liner without compromise to its properties. Flow bypass on the circular sections was therefore not needed.

3. BELOW THE GROUND – SEWER REHABILITATION WORKS

Interflow identified the opportunity to utilise two different lining systems to ensure the 4.6km of sewer was upgraded as per Melbourne Water's requirements. This included:

- UV cured CIPP fibreglass liner for the ovoid sections – 3.5km
- PVC spiral wound liner for the circular sections – 1.1km

Liners were structurally designed in accordance with the Specification, with design requirements as follows.

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Ovoid sections:

- All but one segment of the ovoid sewer was considered to be in a condition classified as "Intact." It was considered capable of taking loads from soil and traffic, but required lining to resist the applied water table.
- Design was specified to the method given in the UK Water Research Centre's "Sewer Rehabilitation Manual" taking into account loading from a water table at the ground surface.
- One segment was considered to be fully deteriorated and so full structural rehabilitation would be needed. Rehabilitation required person-entry to re-point the brickwork with Hyperform high-early strength material, and also fill missing brickwork prior to installation of the liner over the manual repairs.
- Design showed that fibreglass liners with structural wall thicknesses of up to 13.1mm were needed to meet requirements.

Circular sections:

- These sewers were classified as "Intact" meaning that the liner should be designed to resist loads from groundwater.

Design showed that these sections could be lined with 20mm wall height Expanda Pipe spiral wound liner.

CLEANING – the challenges of calcification

Cleaning by high pressure jetting removed silt, fat and debis, but showed that the brick section of sewer had significant infiltration, particulary through the invert, and also had sections of 50mm thick of calcification bonded solidly to the brick surface. Calcification could not be removed by jetting and required additional cleaning equipment to be utilised to remove the calcification. Both these situations needed to be addressed before the UV CIPP fibreglass liner could be installed.

While chain flails were used to remove some of the calcification, manual methods using electric hammer drills were needed to remove the hardest material.

The UV CIPP liner installation process requires a dry pipeline. Infiltration, which tries to cool the liner while the UV lamps are trying to heat it to its curing temperature, can lead to incomplete curing and an under-strength liner.

After much testing and evaluation it was found that the best way to stop infiltration was to manually inject each source with expanding, rapid cure polyurethane foam. This was a laborious process, but essential for successful liner installation. Sealing the infiltration was challenging due to the conditions being influenced by Port Philip Bay.

Preparation for spiral wound lining of the circular section was simpler. There was no calcification in the concrete sewer and, as spiral wound liners do not use heating in the installation process, infiltration did not need to be stopped.

LINER INSTALLATION

The circular sections of the sewer were lined with Sekisui Rib Loc Expanda Pipe PVC liner before commenceing the CIPP liner installation in the ovoid sections. This allowed the lined section to be surcharged and could be used for the bypass system that was necessary for the CIPP lining.

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Following sewer cleaning, the winding machine was placed in the downstream manhole of the section to be lined and the PVC profile strip fed to it. The winding machine took the strip, winding it as it joined the edges together to form a continuous helix which "corkscrewed" its way up inside the deteriorated sewer.

Once it reached the terminating manhole, a mechanical process was used to expand the liner until it tightly contacted the wall of the deteriorated circular sewer. No heating was used in the process, and flow could be allowed through the liner while it was being installed.

Where required by design, the liner was encased in cementitious grout after installation.

Expanda Pipe liner installation was completed at night, during low flow periods. The sewer was plugged upstream during liner installation, and the storage level monitored. When it reached a pre-determined level, it was released and allowed to drain through the partially installed liner. When flow subsided, the plug was reinstated and installation recommenced. No flow bypassing was needed.

The 1,191m Expanda Pipe lining section of the contract was carried out throughout March and April of 2018.

Figure 4: Manhole restored and coated with calcium aluminate cement

Prior to ordering of the UV CIPP Fibreglass liner, accurate measuring of the dimensioins of the ovoid sewer was essential so the correct size could be ordered.

While the liner supplier is a German Company, the liners supplied are manufactured in China. Delivery of each length took about six weeks from the time of ordering.

After cleaning and pre-lining repairs, the installation process for each length of UV CIPP fibreglass liner was as follows:

Stage 1: CCTV inspection to confirm the existing ovoid is in suitable condition for relining.
Stage 2: Pulling through the "glide foil" which sits in the invert to the sewer. Glide foil is needed to ensure that a smooth, low friction invert is provided for the liner
Stage 3: Winch the CIPP fibreglass liner into the sewer
Stage 4: Internally seal the ends of the liner, then inflate so the liner takes the shape of the existing ovoid

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Stage 5: Cure the liner. The UV light train is winched up inside the liner in a "dummy run" to confirm it runs smoothly. The UV lights are then illuminated and the "train" winched back along inside the liner. Speed and wattage are monitored and computer controlled to ensure the liner attains the correct curing temperature for the correct length of time, considering the wall thickness. This stage can take from 4 to 10 hours.
Stage 6: Cool down the liner
Stage 7: Dissassemble the lining mechanism, then seal the liner ends with Hypeform sealant.
Stage 8: Reinstate lateral junctions to the sewer manually, by person-entry

This all needs to be a continuous, sequential process. Typically 24 hours is allowed due to the size and thickness of the liner needed for this project.

Installation of the UV CIPP Fibreglass liner was carried out from May to early September of 2018.

MANHOLE REHABILITATION

Manhole rehabilitation was started during changeovers of the flow bypass system to maximise the efficiency of the program. It was coordinated with liner installation and was completed in October 2018.

Cleaning of the deteriorated concrete surface is essential if any coating system is to be effective in the long term. Ultra high pressure jetting was used to clean all acid attacked concrete and tests were conducted to ensure the surface was sufficiently cleaned and prepared for the calcium aluminate cement coating. The pressure varied depending on the circumstance.

The calcium aluminate cement was applied by spraying. For the deep manhole – up to 11 metre deep – temporary platforms were initially assembled, but a "bosuns chair" system was later adopted, which made the process significantly faster..

Figure 5: Installed UV CIPP Fibreglass liner, with end sealed

5. CONCLUSION

This was the largest single UV CIPP fibreglass lining project carried out in Australia, and for the German supplier, one of the largest single project orders they have supplied anywhere in the world.

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The project was at the limit of dimensions of this type of liner that can be installed in terms of cross section, length and thickness and strength testing after installation confirmed that the liner complied with strength assumptions included in the design.

Successful installation was due to careful planning of the works and attention to detail, particulary regarding pre-lining preparation of the sewer, strategic and community minded bypass pipeline arrangements and focus on best practice customer service of the project team including traffic management team.

The team successfully upgraded an important 110 year old sewer in Melbourne's metropolitan bayside suburbs in a way which showcased the capabilities of Australian trenchless technology.

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