Taking a Shot in Richmond

By: Tonia Jurbin, P.Eng.

Like a 7th game of the Stanley Cup Finals, this rehabilitation attempt in Richmond, BC was a nail biter down to the end! The challenge was to repair a breach in a 16m long 350mm diameter fiberglass sanitary sewer that connects a pump station to a manhole. The crown of the breached pipe was sitting on the on the pipe invert along with a considerable volume of backfill that has been migrating from the surrounding area into the pump station about 1.5m away from the breach. The City of Richmond installed a temporary bypass while they scrambled to explore repair options.

It would be a simple matter to repair the breach using open trench methods were it not for the multiple services between the failed pipe and the road surface about 5 metres above it including but not necessarily limited to two twin Metro Vancouver 900mm trunk sewers, a 600mm storm sewer, a 300mm watermain, a 300mm sanitary forcemain, a Fortis gas line and possibly a BC Hydro distribution cable.

Also noteworthy on the list of challenges, the original piece of pipe that needed repairs enters the pump station offset from the centre, almost at the edge of the station resulting in an awkward confined space to work in. More importantly the site is a mere 400m away from the bank of the Fraser River resulting in a high and fluctuating water table as the Fraser River is very much tidal in Richmond, BC.

The city received estimates in the order of $1.5 to $2 million for a conventional repair. With a long track record of successful and innovative pipe rehabilitation projects in their portfolio the City of Richmond invited PW Trenchless to sharpen their pencil and come up with a proposal for a less expensive, less disruptive solution.

David O'Sullivan of PW Trenchless proposed attempting the repair by sliplining and microbursting a new 300mm diameter PVC pipe using about 20 pieces of custom-made 750mm long sections with a modified bell and spigot joint, reminiscent of an old-fashioned woodworking tongue and groove joint to avoid having to fuse the pipe sections under wet confined space conditions. To ensure good connections between the pipe sections after installation, a 16.4m long ready rod from the newly installed sections to the MH was added to act as a clamping devise to hold the new pipe sections together while giving the glue a chance to cure.

Installed 750mm pipe section with ready rod 'clamp'. Note 'awkward' position of pipe entering pump station

Depth of the repair work about 5 metres down

Custom 750mm PVC sections - note the modified bell and spigot joint

The PW Trenchless estimates came in at about $200K. "This is a unique situation and we hope this methodology will work, if it does, great, if it doesn't, we haven't lost anything, we will have learned something, and we will propose something else so we'll give this proposal our best shot." To slide the new pipes into the existing failed pipe, PW had a specially designed sliplining head fabricated by Charlie Smith Machine Works Ltd of Surrey, BC. This device was pushed into the failed pipe from the pump station and acted as a guide or a casing for pushing the fabricated pipe sections from the pump station while at the same time being pulled by a cable through the pulling eyes from the manhole 16 metres away.

Two issues were at play that caused this repair attempt to fail. First the sliplining head got hung up and the job had to be shut down. David suspects that the bottom leading and cutting edge of the sliplining head dug itself into the existing much weakened fiberglass, or, had possibly become stuck on the some of the backfill inside the failed pipe that was once pipe bedding for any of the utilities in the congested utility corridor.

The second reason for the keeping the site shut down for further evaluation was the discovery that somewhere between $5m^3$ - $9m^3$ of material had infiltrated the breach and migrated back through the breached pipe into the pump station. This unanticipated movement of fill explains the large sinkholes shown in the attached photographs. Although this material was easily removed from the pump station the concern is the alarming volume of material migrating below the surface possibly creating risk to the other services in the immediate vicinity of the breach and perhaps even well away from the repair area.

In view of these issues, the stuck repair equipment with only 4 of the specially fabricated pipe sections installed, and the migrating backfill, the City of Richmond made the prudent decision to stop the repair work, to further investigate the issues at this site and come up with a new rehabilitation plan. Liam O'Connell of Aplin Martin elaborates, 'The City is planning on using ground penetrating radar (GPR) methods to identify other voids in the area where densification will be necessary to prevent further loss of material causing

Sinkhole caused by migrating fill

more sinkholes in the area. Once the areas at risk are identified they will be prioritized and densified before further repair attempts can be carried out'.

A GPR contractor was retained to carry out a survey in the vicinity of the breach and surrounding area however the engineers did not find the results reliable, voids were identified but there was not sufficient resolution of the results to be useful in shaping the details for the next repair attempt.

About 3 weeks after the failed attempt PW excavated a rescue / exploration pit at the location of the sliplining head to better understand the nature of the failure so they could propose a new repair plan. The roughly 1.8m wide by 2.4m long excavation was as described earlier about 5m down and required extensive dewatering before a determination could be made.

Once exposed it quickly became apparent that the pipe on either side of the breach, where the crown of the pipe was sitting in the pipe invert, had become severely ovalized, and at risk of imminent collapse. After some deliberation between the City and the Contractor a consensus to install the largest possible diameter pipe that could confidently be installed as quickly as possible was reached. PW was able to easily install off-the-shelf 200mm HDPE pipe in roughly 2m lengths using conventional sliplining techniques from the rescue pit by pushing the pipes away from the breach in both directions, towards the pump station and the manhole. With PW now able to work in the excavation pit which had considerably more room than working from the pump station the pipes could be fused conventionally where they were being installed.

The final step of the repair involved building 4 bulkheads, 2 at the rescue pit on either side of the breach, one at the pump station and one at the manhole as well as a cradle for the 8-inch pipe at the breach. Everything was then grouted in place around the newly inserted 200mm pipe. Once the repair was completed a CCT camera was run through the pipe for a final inspection.

The final price tag for the work by PW Trenchless was about $275K while the total cost to the City of Richmond including dewatering, debris and water removal (vacuum excavation), the GPR study, the bypass, traffic control etc. was about $800,000, still well under the original estimates of $1.5 to $2.0 million.

The City has since been monitoring the pump station daily because of the reduced storage capacity in the newly repaired pipes. The intent is to alert the operators if the pumping rates need to be adjusted to accommodate the overall reduced capacity. Four months after the final repair no volume issues due to reduced flow and storage capacity have been noted indicating that the original 350mm pipe may have been oversized.

Although it is unfortunate that the original repair attempt was unsuccessful, the deeper exploration of the area through both the rescue pit excavation and the GPR raises issues that may or may not materialize in the future. While the repair of the breach has been solidly addressed it is possible that over time the other issue identified, that is the voids in the surrounding vicinity, may still create difficulties for the City of Richmond as the high and ever fluctuating water table could cause sediment (fill) migration to continue over time. Whether the volume of material migration creates further issues for the City remains to be seen but it couldn't hurt to occasionally check the area for alarming rates of settlement around the repair.

ABOUT THE AUTHOR:

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