North American Society for Trenchless Technology (NASTT)
NASTT's 2023 No-Dig North Show

Edmonton, AB
October 23-25, 2023

8 Pages

WA-T1-06
Pre-Chlorinated Pipe Bursting in the North Okanagan

David O'Sullivan, PW Trenchless Construction Inc, Surrey, British Columbia
Tonia Jurbin, P. Eng. (retired) Writer & Editor, Greater Vancouver, British Columbia

1. ABSTRACT

PW Trenchless Construction was contracted by the Regional District of North Okanagan (RDNO) to complete watermain pipe bursting and associated works at three different locations. Site 1 at 27th Avenue in Vernon from 35th Street to 41st Street, Site 2 at Highway 6 in Coldstream from Learmouth Road to School Road and Site 3 along 30th Avenue in Vernon from 13th Street east for approximately 300m.

The scope of works involved watermain replacement via pipe bursting, reinstatement of services, and restorations as outlined:

- Site 1: approximately 760 m of 200 mm pipe. Open construction period with a weather window from March to November.
- Site 2: approximately 2,530 m of 200 mm pipe, 30 m of 150 mm pipe, and 30 m of 100 mm pipe. Restricted construction period, March to November excluding June 15 to Sept 15th to accommodate tourist travel.
- Site 3: approximately 295 m of 200 mm pipe, 6 m of 150 mm pipe, and 6 m of 100 mm pipe. Open construction period from March to November.

Each site had site specific characteristics both known and a few surprises that emerged requiring nimble planning and scheduling to minimize disruptions and make the most of the construction windows. PW Trenchless developed the initial construction sequencing to the best of their capability based on available information, however as underground construction often dictates, on site decisions need to be made when unexpected challenges are encountered. These three sites were chosen for rehabilitation because of the age of the infrastructure, the number of breaks and the need to upsize the pipes. This paper will focus on Sites 1, the 27th Ave site for lessons learned on the water service replacements, and Site 2 along Highway 6 for the steel pipe bursting work.

2. INTRODUCTION & BACKGROUND

Regional Districts (RD) are a unique governing feature in BC that dates back to the 1960's. There are 27 regional districts serving 161 BC municipalities. A simplified explanation of the division of responsibilities is to consider the RD as the wholesaler and the municipalities as the retailers. The municipalities serve the general public while the RDs serve municipalities in all issues that transcend municipal boundaries including drinking and agricultural water, parks, economic development and solid waste. The RD's also offer an administrative framework for moving regional interests forward and for managing large projects or programs such as a community center that benefits multiple municipalities or a fire protection program. The RDNO serves about 91,000 residents in over 27 municipalities.

The three sites under discussion span two municipalities. The RDNO office is located Coldstream where the largest of the three projects under discussion is located, and the much larger City of Vernon where the two smaller urban distribution watermains were rehabilitated. Until recently all municipal work in the region had been done using traditional open cut techniques. RDNO started looking for viable alternatives to open trench which was challenging as specialist trenchless contractors are not general contractors and do not typically provide a complete package with different types of trenchless construction.

While there are a few HDD contractors in the region there are not many pipe bursting contractors locally. PW Trenchless located in Surrey BC performed the contract using three different types of trenchless construction. As with any rehabilitation contract the lack of reliable as-builts are often an issue, on these three sites this caused many, but not all of the delays. At the end of the project, even with the surprises encountered and the associated changes that resulted, the trenchless construction still resulted in about 30% savings over traditional open cut estimates. This figure is based on the engineers' estimates as no open cut bids were received.

3. PROJECT OVERVIEW & COMMONALITIES

Common to all three sites an above ground 50mm bypass was laid out for the length of the project. Information sheets outlining the upcoming service disruptions were prepared by KWL Engineering Consultants and the RDNO using RDNO letterhead. The information sheets were distributed by PW Trenchless to affected residents and businesses. Construction sequencing was set up such that the longest period of service interruption was 3 hours.

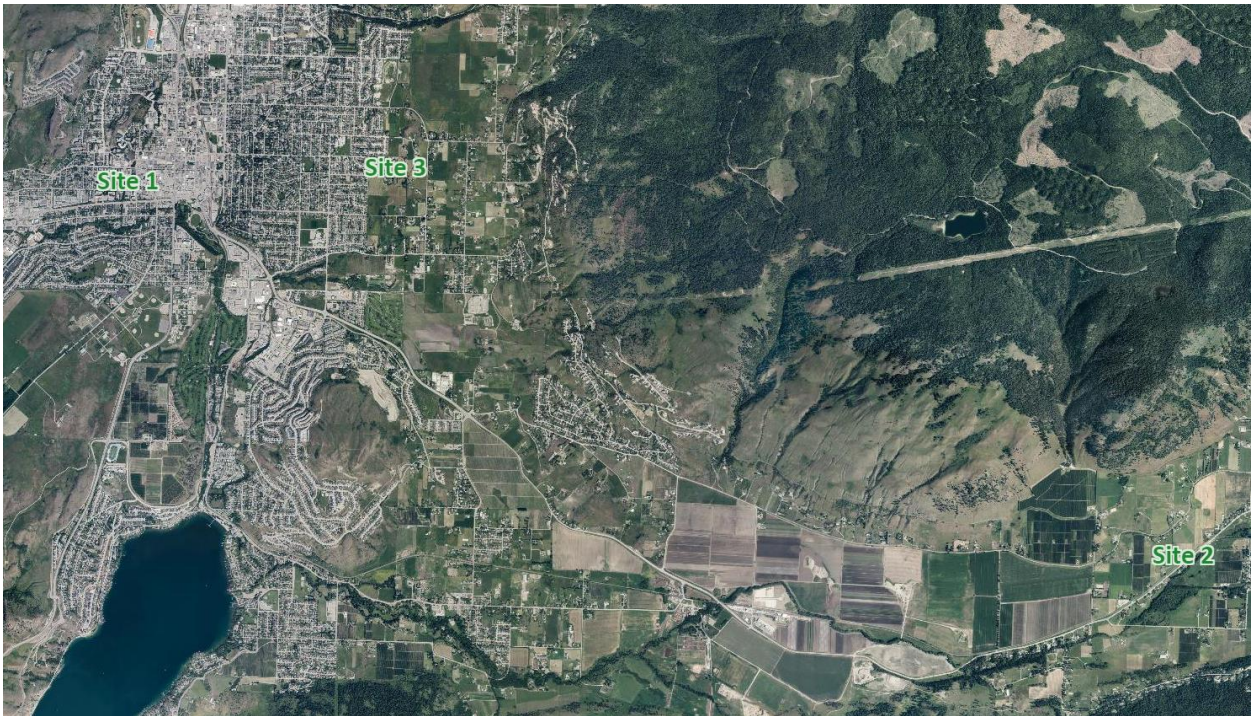

Figure 1 - Project locations

PW Trenchless based in Surrey BC have mainly been using static bursting systems for the last 15 years. The static systems seem to be less problematic with less moving parts. In general, pneumatic systems work best on brittle pipes and in hard, dry ground, but pneumatic systems have more moving parts and thus a higher equipment failure rate. Static systems can work with brittle pipes and pipes with ductility properties such as PVC, ductile iron and steel. This system performs better when under the water table but tends not to have as much bursting force as the pneumatic system. In these case histories bursting force was not an issue. An upsize from 150mm to 200mm is well within the range of a TT800 pipe bursting machine.

4. SITE 1 – 27TH AVENUE, 35TH to 41ST STREET - VERNON

This site upgrade was to replace the existing 150mm cast iron pipe - about half of which was installed in the mid-1920's and the rest in the early 1950's – with 200mm HDPE for 760m. This medium density neighbourhood had about 50 services to houses, low rise strata complexes and apartments. The service connections to the houses were to be replaced with 25mm for domestic dwellings, and 50mm to 100mm for the multi-family dwellings. The were some half dozen 150mm fire hydrant connections along the mostly straight alignment of 27th Avenue.

During the period when the residents were using the water from the bypass pipe – especially on the 27th Avenue site as it was carried out in June 2021 during a heat dome, water quality notices were also issued as a precautionary measure. Although no issues with water quality were anticipated the 50mm black bypass pipe was lying on the surface exposed to 43^0 Celsius daytime temperatures. For the crews, dealing with the excessive heat and wildfire smoke was a serious challenge so with safety concerns into consideration, operations were interrupted for a week.

The work took place in the grassed boulevard which was one of the reasons that trenchless was the preferred method, the roads did not have to be closed nor did any of the mature trees in the boulevard have to be removed to rehabilitate and upsize the distribution main. The project included replacement of all the services using pipe bursting on the assumption that all the existing connections were 19mm, but after discovering that the house connections were only 12mm and the vertical alignment of the service connections from the mains to the properties had been relocated over the years with dips and curves, this plan had to be reevaluated.

A straight pull offers the least amount of friction, and the size of the cable can drastically change the pulling force that can be applied. An existing 12mm water service will only allow for an 8mm cable to be used. This limits the pulling force to 4 tonnes. A 19mm service connection will allow a for a 16mm cable to be used, which can apply a force of 14 tonnes. As the length of the service increases so too does the friction generated and the required pulling force increase. Every additional bend the service pipe goes through also adds friction. Therefore, the pull lengths had to be adjusted to suit the available strength of the 8mm cable. Partial open excavation of the existing 12mm connections added 50 additional service pits, which added extra costs (approx. $100,000) to the contract. The costs were still estimated to be cheaper than traditional open cut by approx. 30%.

All the pre-chlorinated watermains were tested above ground for pressure, super chlorination and bacterial prior to installation. It was tested as if it were in the ground, rather than on the ground, as per AWWA C651-14, see Figure 2. After the installations, a standard pipe flushing operation was done with all the flushing water discharged safely, and normal reconnections were made to the existing water pipes. By testing and chlorinating the pipe before installation in this manner, the pipe was returned to service immediately as opposed to the week that would have been required for testing and chlorination using conventional methodologies. This also allowed the bypass to be removed a week earlier, restoring regular service to the properties.

Figure 2 -Pressure tested pipe ready for installation.

5. SITE 2 HWY 6, LEARMOUTH → SCHOOL ROAD – COLDSTREAM

There were several compelling reasons why trenchless methods were preferred for this 2.5km plus pipe rehabilitation project. The existing pipe was in the Ministry of Transportation & Infrastructure (MOTI) Highway 6 Right of Way (R/W), MOTI only gives permits for open-cut construction when no other options are available. As Pipe bursting is a rehabilitation methodology (rather than a replacement) it is an accepted methodology for pipe replacement within the highway.

To rebuild the system to the south of the R/W would have required up to 40 statutory right-of-way acquisitions, both being expensive and time-consuming endeavors. The new alignment would have had to be installed in a low-lying area that has a high-water table and floods often. Not only would open-cut installation have been extremely disruptive, considerable dewatering would have also been required. For the most part by working with the existing alignment the contractor was able to work in the higher elevation road shoulders in mostly dry conditions with no property acquisitions required. As the watermain was required to cross perpendicular to the CN tracks a small property statutory R/W was required for the CN rail crossing.

The trouble started for the project right out of the gate. Turns out that the existing very uncommon 1/8" thick spiral steel pipes from the 1940's were quite different from today's standard steel pipe and were particularly challenging for the pipe bursting application, at least with the standard equipment the contractor had. Rather than splitting the pipe the bursting head crushed and crumpled the pipe in front of it as demonstrated in Figure 3. Pipe bursting is a process where the existing pipe is broken or split but *left in place* while the new pipe is pulled. Pipe bursting is not piping extraction, extraction requires far more energy and is only used in road crossings and lengths of 20m to 50m.

Figure 3 - Original bursting head crumpling rather than splitting the existing pipe.

The bursting of this steel pipe required different bursting tools and different methodologies, which the construction team needed time to review to find the right solution before the work could continue. The first 5 burst attempts involved research and collection of data; thus, results were carefully recorded. The outcomes were that this very thin-walled steel pipe needed careful attention to keep the splitting process going and not start a crumpling event. PW had to design a new bursting head better suited to the thin spiral steel pipe. If this new head were too big the steel pipe would not split but crumple, if the new bursting head was too small the steel pipe rebounded and gouged the newly installed HDPE pipe. The new bursting head was designed so that even if the steel pipe rebounded during the splitting process, it was still far enough from the new pipe to not cause damage. Eventually, an innovative design was decided on and a bursting head was manufactured in the lower mainland. Figure 4 shows the different options for bursting heads.

Figure 4 - The three bursting head options; the white head is a manufactured supplied head that was too large, the blue head is an HDD pulling head which was the same OD as the host pipe and too small, the black head was PW's design which worked.

While this might have caused a delay under other circumstances, PW simply mobilized to another site which fortunately coincided with the work window permits that did not allow any highway lane closures between June 15th

and September 15th. Because of the requirements to close this project during the summer tourist traffic, the contractor was not punished for the time lost.

Other issues that arose were, an intermediate pressure (IP) gas main that was installed above the existing watermain for over 200 meters, a CN rail crossing, daily work windows of 7am to 3pm, and the previously stated requirement to be off site during the tourist season.

In the 1970's Fortis BC installed a 150mm Intermediate Pressure (IP) pipeline, directly above the existing watermain, with little horizontal or vertical separation between the two pipelines in parts of the alignment. This contract called for HDD to be used to install a completely new section pipe at a new location that was removed from the Gas pipe location. To allow the HDD to proceed Fortis required a physical conformation of their pipe and asked for vacuum excavation every 10 meters to confirm the location before the HDD could proceed. This level of verification was not known at the time of tendering and was managed as additional work. PW did offer to use other non-invasive methods of verification, none of which was acceptable to Fortis. In retrospect a gas pipe strike with a pipe reamer could be catastrophic during construction, or even long after construction if undiscovered such a strike could cause damage to the pipe coating eventually leading to a leak.

Pipe Jacking was also used to install a 500mm diameter 25mm thick steel casing under the CN rail tracks that was monitored extensively during and after the installation, mostly for settlement but also for water levels. The new HDPE pipe was easily installed within the steel conduit using spacers. One end of the pipe jacking was in the highway prism so little dewatering was required, but the entry pit although not as deep, was excavated in the low-lying area with a high-water table that is subject to flooding and required extensive dewatering.

The pipe jacking and HDD work was managed by PW Trenchless and carried out by The Tunneling Company and Ulmer Contracting, respectively. The use of three different trenchless construction methods on this project demonstrated to the owners the advantages of using trenchless construction.

6. LESSONS LEARNED

- With respect to the service connections encountered at Site I, in the future, depending on the availability and confirmation of as-built data regarding the size, alignment and location of service connections, it may be necessary to consider using open excavations as smaller sizes may not be practical for pulling, or at least to have a provision for that as unit price in the bid.

- While it was known that a section of the pipe in the highway was the 1/8" thick spiral steel pipe, the contractor wasn't prepared for the challenges encountered with bursting this type of pipe. In this case the bursting head that was recommended by the equipment manufacturer was not effective. The lesson in this situation is that when there is an expectation of encountering unusual materials – expectations must be realistic as several adjustments with the equipment and processes may be required.

- The major lesson from this project is that because this is a rehabilitation of existing pipes, every piece of information that can be gathered about the original construction of the existing pipe is helpful. As builts are sometimes unavailable or unreliable. Construction and installation records and photographs might be available, unfortunately not during the bidding process.

- A wealth of information exists with long-time employees and while these were recollections that cannot be included in contract documents as fact, they are very useful when rehabilitating existing pipes. Where possible it can be very useful to interview long-term employees with some corporate memory, especially with regards to abandoned services which may not be recorded on as builts, Figure 5 shows such an example.

Figure 5 - An example of old infrastructure encountered that might have been shared by a long-time operations employee.

7. CONCLUSIONS

Even though there were several noted extra costs and unforeseen experiences observed on this this project, RDNO reports that the trenchless work was about 2/3 the cost of open cut, partially due to maintaining the same alignment as the existing plant therefore requiring only minimal asphalt repairs. The project owner mentioned that they were pleased with how the contractor sequenced the project to minimize disruption to the public.

Lessons learned by the contractor, owner and owner's engineer will all be carried forward when planning the next challenging project in tight spaces with potential for great disruptions where trenchless technologies might save the day.

Considering the observations from this paper, there is an opportunity that could help projects of a similar nature to improve the overall contract execution related to the available information and the level of accuracy given to each document. These could benefit the owner in providing protection as well as the contractor in having a better understanding of any relevant information that can impact risk mitigations strategies during the bidding process. SUE definitions could be looked at to provide the different classification levels of each piece of information.

As the process of designing a project to incorporate historical repairs would be a proactive approach, it could provide significant cost savings and be a key factor on the designed construction method. As the information may be critical, in some cases, it could even be the decisive factor when considering the viability of trenchless solutions.

8. REFERENCES

May 12th, 2023 Phone interview & follow up discussions
Marcelo Nakashima, B. Eng. Project Manager - PW Trenchless

May 12th, 2023 Phone interview & follow up discussions
Rory O'Sullivan, Project Coordinator – PW Trenchless

May 15th, 2023 Phone interview & follow up discussions
Sandy Edwards, Manager, Projects - RDNO

May 18th, 2023 Vernon & Coldstream Site Meeting

Bruce VanCalsteren, P.L.Eng. Project Engineer – KWL Consulting
Karl Mueller, Senior Project Engineer - KWL Consulting Engineers
Alec Busby, EIT, Assistant Utility Engineer – RDNO

May 25th, 2023 Phone Interview & follow up discussions
Phil Russo, Superintendent – PW Trenchless

April 6th, 2021 Fletcher Paine Associates Ltd.
Geotechnical Investigation & Report–Proposed Highway 6 CN Rail Water Main Crossing – Coldstream, BC

2021 – PW Trenchless Construction
Construction Methodology Pre-Chlorinated Pipe Bursting

2021 – IFC Drawings – Kerr Wood Leidal Consulting Engineers

2015-2016_ASCE (2015) Policies and Priorities, American Society of Civil Engineers, Washington, D.C.