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## The Wandering River Regional Water System

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**ABSTRACT:** The Wandering River Regional Waterline project is the longest directionally drilled Fusible PVC project and the longest design-build regional water system in Canada. This paper describes the award, design and construction of the 88-km project which occurred in 2011 and 2012.

### 1. INTRODUCTION

The Wandering River Regional Waterline project is unique for various reasons. The selected method of installation was directional drilling for the entire 88 kilometer (55 mile) length of the system. In addition, the system consists primarily of fusible polyvinyl chloride pipe (FPVC). The application of FPVC for this project represents the largest project by length of FPVC directionally drilled as well as the largest project by length of FPVC installed to date in Canada. It is also the first regional water project in Alberta completed under a Design-Build delivery model.

The Wandering River Regional Waterline is a 150mm (6") waterline that extends from Boyle to Wandering River via Grassland in Athabasca County, Alberta, Canada and includes a new potable water reservoir at Wandering River and reservoir modifications at Grassland. The project is intended to provide a secure and reliable potable water supply to the two communities through an extension from an existing Aspen Regional Water system to the south. Wandering River is located in northeastern Alberta, 95 km (60 mi) from the Town of Athabasca and 200 km (125 mi) from Fort McMurray, Alberta (see Figure 1). Despite Wandering River being a community of only approximately hundred people, its relative remoteness along Highway 63 positions itself of strategic importance to the 11,000 vehicles that travel to and from the Alberta Oilsands region daily.

Wandering River's existing Water Treatment Plant is scheduled for demolition by the end of 2012 to accommodate a major highway expansion in the area, thus necessitating a new potable water supply source for the community. Athabasca County and Alberta Transportation (AT) determined that a regional potable water supply would be the most appropriate replacement water source due to a combination of factors, including the quality of the water available through the recently constructed Aspen Regional Water system, the remoteness of the community relative to the population, high demand for qualified Water Treatment Plant operators, future demand projections for the community, and changing standards for Drinking Water Quality in Alberta.

In addition to being of net benefit to the community of Wandering River, a regional water system extension carried the added benefit of enabling a connection to the community of Grassland 55 km (34 mi) to the south, as well as the farming community and acreage owners along the proposed system.

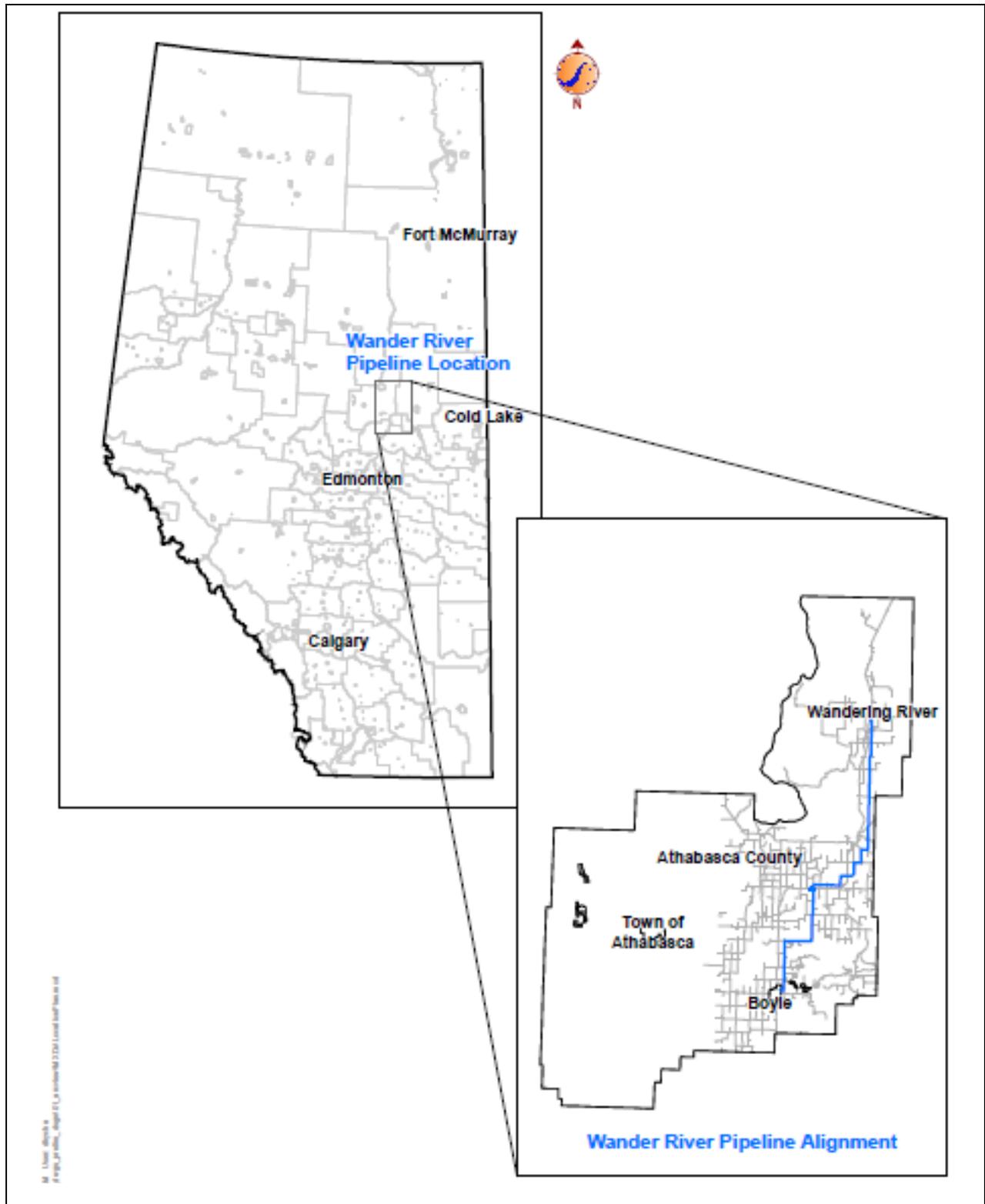


Figure 1 Location Plan

Like Wandering River, Grassland is a community of approximately one hundred people along Highway 63 that is expected to grow as a service center within the Alberta Energy Corridor for the oil and gas sector, as well as the

large local forestry industry. Although expansion of Highway 63 would not conflict with the community's existing filter plant or well water source, AT and the County elected to connect Grassland to the Wandering River regional waterline in order to enhance the quality of water provided to the community and ensure a sufficient water supply to meet the growth needs of the community. Similarly, the County and AT agreed that capacity would be included in the system to allow for the future connection of all existing residences along the waterline route and that tee-off locations would be provided roughly every 3.2 km (2 mi) for future rural water co-operatives located off of the alignment.

The County and AT elected to proceed with development of the system through a Design-Build delivery model – the first of its kind in Alberta - in order to achieve cost and schedule certainty on this time and budget sensitive project. This project was also seen as a test case for the application of the Design-Build process towards the development of future regional water systems in Alberta.

## **2. DESIGN-BUILD TEAM SELECTION PROCESS**

The County's selection of a Design-Build Team began with a Pre-Qualification process, which was published in January 2011 and closed in February 2011. After evaluation of the Pre-Qualification submittals by the County, three proponent teams were shortlisted and invited to submit Proposals based on Request for Proposal and Terms of Reference developed by the Owner's Engineer, and issued on April 11, 2011.

The Terms of Reference included several key parameters for the project, including:

- An alignment that extended primarily along Municipal road allowances, with an additional 5 m (16.4') right of way added to each side of the road;
- System supply pressures, ranging from 98 to 560 kPa (20 to 114 psi);
- A minimum waterline internal diameter of 155 mm (6.1");
- A minimum line pressure of 98 kPa (20 psi) at any point in the system;
- A pipeline design flow of 2.5 L/s (40 US gal/min) for Grassland and 1.5 L/s (24 US gal/min) for Wandering River;
- A 520 m<sup>3</sup> (137,000 US gal), two cell reservoir at Wandering River, with peak hour distribution pumping capacity of 2.34 L/s (37 US gal/min), and a distribution system ranging in pressure from 350 – 550 kPa (50-80 psi);
- Truck fill systems at Grassland and Wandering River, each with a capacity of 14 L/s (222 US gal/min).

Two of the three shortlisted proponents submitted Proposals on May 24, 2011, and conducted interviews with representatives of the County, AT, Alberta Environment and the Owner's Engineer in June 2011. Following a due diligence review, the County selected Graham Design Builders of Edmonton, Alberta, along with its key partners of M. Pidherney's Trucking Ltd. (Pidherney's) - pipeline installation subcontractor - and Stantec Consulting Ltd. (Stantec) - engineering and environmental services consultant. The Design-Build Team was awarded the project in late July 2011 and started pipeline construction in early September of that year, with a contract mandated completion of December 2012.

## **3. PIPELINE INSTALLATION METHOD**

The Design-Build Team decided to directionally drill the entire system based on a combination of factors including:

- the reduced regulatory approvals required in comparison to open cut trenching;
- ease of construction within the available workspace;
- reduced topsoil handling efforts;

- reduced settlement along the alignment in the years following construction;
- mitigated disturbances to private landowners and farmers along the right-of-way;
- ensured the least amount of disruption / inconvenience to traffic;
- ease of construction under frost conditions; and
- improved scheduling implications resultant from reduced environmental approval requirements.

A 150 mm (6") diameter FPVC Dimension Ratio 26 pipe was selected for the installation as it met the Owner's established minimum internal diameter of 155 mm, could achieve cost effective drill lengths of 250 – 500 m (820' – 1640') and was available at a competitive cost in comparison to the High Density Polyethylene (HDPE) alternative, 200mm (8") diameter DR11 Iron Pipe Size (IPS).

The selection of FPVC – manufactured locally at IPEX's Edmonton, Alberta plant – made the project by far the longest FPVC project in Canada. The manufacture of the pipe began in August 2011 and delivery to the site proceeded over a four month period beginning in September 2011.

#### **4. GRASSLAND FILL POINT**

The Grassland Fill Point component of the project consisted of a retrofit of the existing Grassland Water Treatment Plant and potable water storage reservoir into a metering station for water from the new regional system plus a truck filling station and ancillary SCADA and communications systems. The truck filling station addition involved the conversion of the plant's existing filter backwash pump into a truck filling pump.

Construction of the fill point occurred in January and February of 2012, and with the completion of commissioning of the regional waterline between Boyle and Grassland at that time, the first 33 km (21 mi) of the system were put into service, enabling the Grassland distribution system to receive potable water via the regional water system, and the shutdown of Grassland's existing well water supply system.

In May of 2012, the Owner approached the Design Build team about an additional of a chloramine booster station within the Grassland Fill Point, primarily to increase the concentration of chloramines in the new water line between Grassland and Wandering River, a distance of approximately 55 km (34 mi), with an estimated travel time in the order of two weeks under average day demand conditions. This change presented substantial design challenges due to the high pressure in the system (>700 kPa) at the injection point, the low flow in the line and the needed additions of both chlorine and ammonia at Grassland to achieve a higher chloramine concentration. The low ammonia dosing was especially problematic as ammonia solutions were not commercially available in sufficiently low concentrations to accommodate the low system flows.

Ultimately, it was determined that the most operationally efficient and cost effective method to achieve the desired level of chloramine dosing in the system was to add chlorine in low concentration liquid form and with an ammonia solution prepared from powder and mixed into a solution in containers providing in the order of two weeks' worth of storage. These new systems were designed to be located within the footprint of the unused water treatment plant clarifiers and filters and as such, the pre-existing package water treatment plant had to be cut into pieces and removed from the building.

#### **5. WANDERING RIVER RESERVOIR**

The new Wandering River Reservoir was designed to meet the minimum requirement of 520 m<sup>3</sup> (137,000 US gal) of active storage and has a two cell configuration which provides the capability to isolate a cell of cleaning or other maintenance without disrupting operations. Also included in the reservoir is a truck fill system, a laboratory, a standby generator, three distribution pumps designed to provide 25 year peak flow demands and a standby pump, and space allocation for a future fire pump, should Wandering River's distribution system be upgraded in the future

to enable fire flow delivery through the community. It was also required that SCADA programming be incorporated into this reservoir and the Grassland fill point so that instrumentation communications could be directed back to the operators at the Water Treatment Plant in Athabasca, Alberta.

Additional future planning was incorporated into the design with the addition of pipes to allow for a twinning of the reservoir to accommodate community growth beyond its 25 year design horizon population.

## **6. CONSTRUCTION STARTUP**

The quick turnaround between award and construction startup was attributable to a fast tracking of many of the design and regulatory approval activities. For example, many approvals for crossing of foreign highways and pipelines and power lines, as well as environmental features were sought concurrently, and construction proceeded in areas where approvals were in place, even if approvals were still outstanding in nearby areas. This process led to several remobilizations across the alignment in the early months of construction while long lead time approvals trickled in, however this approach was considered necessary to ensure the project timelines could be met.

Pipe fusing operations occurred inside of two pairs of retrofitted sea cans set end to end to allow for a temperature controlled environment for fusing operations, pipe cooling and data collection. Fusing was generally undertaken to remain one to two weeks in advance of pipeline installation, and the sea cans were relocated along the alignment as needed throughout construction.

## **7. PROJECT CHALLENGES**

Several project challenges were encountered and overcome as a result of directionally drilling the system. The most significant was the changing geotechnical conditions across the length of the alignment. For example, unexpected boulders and gravel areas were encountered in the southern portions of the alignment. Several were found when hit straight on by the drill head, whereas others at slight offsets were only discovered when the pipe was pulled into place and found to have been damaged or crushed. While it was a straightforward process to identify the straight on hits and remove the obstructing boulders, finding the rocks that had crushed the pipe became a trial and error exercise of exposing the buried pipe with an excavator and hydrovac and led to a few hundred meters of pipe needing to be replaced. In areas where the presence of rocks and boulders were particularly common at pipe depth, the Contractor shortened the drill lengths first from 500 m to 250 m (1640' to 820'), then to 150 m (492') in order to minimize production losses from rock hits.

The next most significant geotechnical challenge was the presence of muskeg soils along an undeveloped portion of the alignment. Muskeg is very soft soil consisting of organic material in various stages of decomposition with very high moisture content and construction equipment will often sink into it. As such, contractors typically avoid construction except during frozen conditions. Because of this, drilling through the muskeg area was timed to proceed in January and February, typically the coldest months of the year. While the winter had been warmer than normal, it was nevertheless cold enough for frost to penetrate the ground and for construction to proceed as planned.

A third significant geotechnical challenge on the project was the presence of sands and gravels at pipe depth at river crossings. In the worst case, at the Wandering River - a few kilometers south of the community of the same name - the initial drill was unsuccessful due to sand extending well below the design pipe depth at the launch pit. A Geotechnical Engineer was brought in to review test pits and boreholes on either side of the river and concluded that even with a change in drilling fluids, it was probable that the sand would collapse into the hole during the directional drilling operation. This challenge was mitigated with the use of a conductor barrel to a depth in excess of 15 m (50').

A fourth challenge on the project was the assembly of the crossing agreements for the 300 foreign utility crossings forming part of the work, including oil and gas pipelines, telephone and fiber optic communication lines, low and high voltage transmission lines, railways, highways and municipal roads. While the oil and gas industry targets the

processing of foreign utility crossing agreements in three weeks, this timeframe was not met for a majority of the pipelines. Unfortunately, the project schedule objectives did not allow for protracted crossing agreement approvals, and as such, directional drilling started near Boyle, at the south end of the project, prior to most agreements being received. As construction approved foreign utilities for which crossing agreements were not in place, the drilling crew had to skip ahead to a clear area and return once the agreement was processed. This issue was compounded by the presence of pipeline corridors, in which up to six pipelines would have parallel rights of way. Thus, if even one pipeline in the corridor had an agreement outstanding, the entire corridor would have to be skipped until the agreement was in place. This caused numerous remobilizations over the course of the first three months of construction.

Additionally, there were instances of unregistered utilities crossing the alignment, some of which were abandoned. In one case, an active, unregistered fiber optic line was discovered, however none of the foreign utilities with operations in the area would claim ownership. In that instance, after several weeks of attempting to find the owner to secure an agreement, the fiber optic line was ultimately exposed and crossed at a vertical separation of 2 m (6.6') without incident.

## **8. DIRECTIONAL DRILLING PROCESS**

Overall, the directional drilling component of the project proceeded well ahead of schedule, finishing in April 2012 instead of the originally forecast drilling completion of June. This was primarily due to a second drilling crew being brought onsite in December of 2011. Commissioning of the work was completed in segments, first with “bump tests” or short duration pressure tests undertaken in advance of system swabbing, full length pressure testing and disinfection activities. Commissioning of the first segment of the line, from Boyle to Grassland occurred over a six week period in January and February 2012, and was brought into service in mid-February 2012. Commissioning of the second segment, from Grassland to Wandering River was completed in July 2012.

## **9. SYSTEM FLUSHING**

In addition to the design, construction and commissioning of the new regional water system extension and facilities at Grassland and Wandering River, the project included the flushing of all communities receiving water from the Aspen Regional Water Services Commission, including Athabasca, Boyle, Collinton, and Grassland. The reason for the flushing is the conversion from the Water Treatment Plant’s chlorine disinfection system to a chloramine disinfection system. Due to a limited transmission capacity in the Aspen Regional Water system from Athabasca to Boyle and limited excess flow availability for the regional system as a whole, the flushing operations had to be scheduled for a period of approximately two weeks in August 2012 and consisting of incremental isolation and flushing and each community’s distribution system beginning at Athabasca, and working downstream towards Wandering River.

Following completion of the Aspen Regional System flushing, the new pipeline between Grassland and Wandering River was flushed, as was the distribution system in Wandering River, which was planned to coincide with the commissioning of the new reservoir and pumping station in Wandering River. On September 8, 2012, the pipeline between Grassland and Wandering River, as well as the Wandering River reservoir and pumping station were brought online for continuous active service.

## **10. CONCLUSION**

Feedback on the directional drilling process, material selection and design-build process has been very positive from the perspectives of the Design-Build Team, and judging from the positive feedback from the County and AT, this project could serve as a showpiece for the future delivery of Design-Build regional water system projects throughout Alberta in the future. The decision to use directional drilling on the project enabled the Design-Build team to

execute the work within the planned timelines, even though the length of drills had to be shortened to accommodate the unanticipated subsurface conditions.

## **11. REFERENCES**

Government of Alberta (2008) – Alberta Energy Community Profiles