

Executive Summary



Design and construction of the Gregoire Sanitary Sewer project in Fort McMurray posed significant risks and challenges. The continuous, 1.6 kilometre, 600 millimetre diameter, dual sanitary sewer system traversed a business area, soccer field, children’s play park, a busy roadway, and Highway 63—a major highway and the only transportation link to the oil sands development north of Fort McMurray. The sewer alignment included significant environmental and geological constraints.

Associated Engineering worked closely with the Municipality to develop a design and construction methodology employing horizontal directional drilling, a trenchless construction technique. Using trenchless construction, the sewer was installed in varying and steep terrain through an environmentally sensitive valley, over 50 metres deep, to avoid an actively sliding slope and protected waterway. Using this technical approach for such a long sewer over varying and complex terrain and to such significant depths was an innovative application of this technology.

The project team developed a tactical risk management plan to address critical issues and risks. Construction planning and careful traffic management minimized impact to businesses, the public, and traffic, in particular traffic serving the oil and gas industry—the economic driver of the area.

Strict environmental monitoring was specified to collect and dispose of drilling mud to minimize adverse environmental issues. Drilling mud was combined with drilling fluids from other projects in the area and used to reclaim and restore a local cement factory site for future beneficial use.

The team’s Communications Plan, including traditional and social media, helped mitigate public concerns regarding construction, traffic, safety, and noise.

The design and construction of the Gregoire Sanitary Sewer demonstrates the suitability of horizontal directional drilling for installing a long pipeline through varying and deep terrain to minimize impact on the environment, reduce construction risk, and reduce impact on the public. The new Gregoire Sanitary Sewer facilitates the continued commercial, industrial, and population growth of one of Canada’s fastest growing regions.

The Gregoire Sanitary Sewer helps the City of Fort McMurray to sustain growth and economic development.

Introduction



The Regional Municipality of Wood Buffalo in Northern Alberta continues to experience unprecedented economic expansion, arising from the area's natural energy and oil industries. The Municipality comprises ten communities, of which the City of Fort McMurray is the largest.

With a population of about 120,000 residents, including over 76,000 in Fort McMurray and a large workforce population, the needs of the burgeoning population and growing economy of the Municipality are expanding beyond existing infrastructure capacity. This is causing increased pressure and higher levels of risk to municipal infrastructure supporting this rapidly transforming community in northern Alberta.

In response, the local government is investing hundreds of millions of dollars in new infrastructure projects for the Region, including sewer and water systems, wastewater and water treatment facilities, and roads and bridges.

As part of their infrastructure planning efforts, the Regional Municipality of Wood

Buffalo identified the Gregoire Sanitary Sewer project as a key priority in their 2009 Wastewater Master Plan. Without an upgrade, the Region predicted a higher risk of sewer back-ups and development restrictions, thus hampering future growth.

To address the need for more developed land and housing, the Region embarked on developing Saline Creek Plateau, a new residential area located southeast of Fort McMurray's townsite. This area was planned for an additional 20,000 residents.

In January 2010, the Municipality retained Associated Engineering to assist with preliminary and detailed design and construction oversight of the Gregoire Sanitary Sewer, a twinned pipe comprised of two 1.6 kilometre long, 600 millimetre diameter pipelines to service Saline Creek Plateau.

Using horizontal directional drilling (HDD) is an uncommon approach to install pipes of this length and diameter in a municipal setting and is more common in the energy sector. The focus of this submission focuses on the successful adaptation of HDD to construct the sewer in a congested, urban environment.



Project Challenges



The project included significant technical, environmental and geotechnical challenges that the project team had to consider in developing both the design and construction methodology.

The slopes that needed to be crossed were active slide areas plus the thickest subsurface layer was found to be oil-bearing sands with a medium-to-rich oil content. This challenge necessitated drilling to over 50 metre depths below the slide zone through the underlying geology of the oil sands formation.

The rich oil content complicated the environmental issues. This required extensive environmental monitoring of the drilling mud generated during construction which needed special procedures to be collected and disposed to minimize any adverse environmental issue.

The sewer route traverses the City of Fort McMurray, from a plateau through steep

terrain and oil sands geology to the Saline Creek valley, an environmentally sensitive area. Sections of the sewer route along the Highway 63 embankment are unstable, and susceptible to landslide.

The sewer route crossed developed urban areas including a soccer field, a children's play park, a busy roadway, and Highway 63, a major transportation route through Fort McMurray and the only transportation link to the oil sands development north of Fort McMurray. Therefore, safeguarding the public, industry, transportation and minimizing impacts to businesses and the general public were vitally important. While safety was paramount, existing development also placed constraints on construction staging areas.



Early in the project, the team eliminated traditional open-cut or trench-style construction due to the active landslide areas and construction risks, and to minimize impact on the public. While traditional construction would have facilitated design and construction management, the team felt open-cut construction would have significantly impacted the Saline Creek Valley

environment and posed greater risk with slope stability concerns along the Highway 63 embankment. The desired construction method had to prevent slope instabilities and minimize the alteration of the natural surroundings.

The team proposed a trenchless construction method. While horizontal directional drilling reduced the impact on the environment and the public, this technique presented greater uncertainty as to the actual ground conditions that would be encountered, as it was not typically used for such a long sewer main at significant depths.

Horizontal directional drilling required carving out a very long and complex alignment with multiple turning points and through varying terrain.

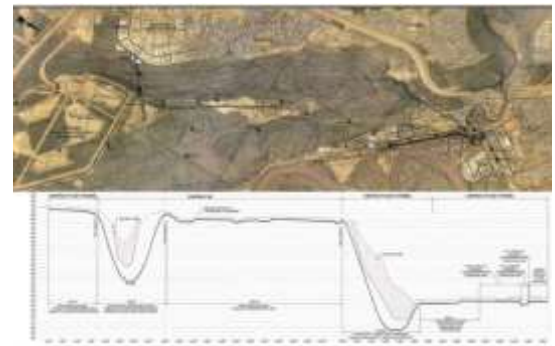
Solution



To confirm the appropriateness of horizontal directional drilling, the project team performed a detailed field investigation along the preliminary drill path. Based on borehole data from the field investigation, the team selected an alignment for which

the majority of the crossing would primarily traverse through limestone bedrock.

Through the field investigation, and the need to reduce the environmental impact during construction, while also mitigating the risk of slope instability along the very steep embankment, horizontal directional drilling was selected as the most suitable method for installing the pipeline. This required a multi-discipline design approach and a significant amount of cooperation between the project team and stakeholders.



In consultation with geotechnical engineers, drilling designers, and the Regional Municipality of Wood Buffalo, the project team carried out constructability and risk reviews, and a value engineering approach to develop the following criteria:

- Identification of feasible tie-in locations at the top and bottom of the valley slope
- Availability of experienced contractors to achieve the required drill lengths
- Ability to avoid active landslide zones along the Saline Creek embankment
- Ability to drill to sufficient depth to reduce the risk of hydraulic fracture to Saline Creek

- Long complex curves, multiple angles and radii to overcome the geological and site constraints
- Proper hydraulic sizing of the sanitary sewer support
- Entry and exit angles to accommodate available space for pipe handling and management of drill cuttings during the installation process
- Proper pipe material satisfying the anticipated stresses from horizontal directional drilling installation.



The team also managed the following non-technical challenges:

- Regulatory coordination with many stakeholders
- Severe winter weather conditions
- Land acquisition
- Maintaining accurate communications with the public, local businesses, and municipal departments.

The project team coordinated with municipal, provincial and local stakeholders to gain permitted use of the boulevard of Highway 63 as a safe work-zone. This area

was then used for pipeline welding, assembly, and testing.

The plan was flexible to adapt to changing ground conditions and new information coming in from multiple sources during construction. At the same time, the process was structured to manage change requests and actively engage stakeholders.

Innovation

Unique to the Gregoire Sanitary Sewer project were construction specifications related to horizontal directional drilling, materials, site management, environmental monitoring, noise mitigation, and mud disposal.

This process originated in the oilfield drilling and extraction sector many decades ago and was adapted to the requirements of municipal public projects, which are mandated to maintain a high degree of cost control and minimize cost variation post-tender.

Typically, horizontal directional drilling is used to cross rivers and lakes to minimize disruption to the environment. Using horizontal directional drilling to install a



continuous pair of 1.6 kilometre sewers was a unique application of an oil field application in a municipal setting.

Employing horizontal directional drilling through the steep terrain and oil sands geology of Fort McMurray was an innovative application of HDD due to the terrain, land uses, and environmental issues.

The project demonstrated the suitability of horizontal directional drilling for installing a long sanitary sewer in a municipal environment.

Complexity



Degree of Difficulty & Public Safety

This drill path was extremely unusual in that it required a long, complex curve under a creek and up through an active slope-failure zone. Construction traversed both privately-owned and public land parcels, all of which were secured in advance.

During construction, assembly and welding activities for the steel pipeline had to be confined to a very narrow corridor within

the Highway 63 road right-of-way. This required coordination with private, municipal and provincial authorities to permit the uninterrupted peak-hour use of busy and critical major roads located inside the workspace and ensure public safety.



Working closely with the contractor and municipality, the team helped to coordinate the complex roadside erection of steel A-frame structures that would provide support for the pipe string.

At one point during construction, the continuous twinned steel pipe string was carefully suspended overtop of a busy Hwy 63 intersection by industrial cranes, with on-going use of the road by commercial and industrial traffic during pipe installation.

Traditionally, the roadway would have been closed during pull-back of the pipe-string, but this method would have greater costs and impact on all stakeholders and the public.

To maintain the aggressive project schedule, the team coordinated with the Municipality to allow 24 hour construction operation in a residential area. This required design and construction of extensive sound barriers and use of noise reducing equipment during construction.



The project team identified a small area for staging of entry-side operations within the existing public soccer field, and adjacent to the children's play-park. After construction, the soccer field and play park were restored and improved upon for the public and community's future benefit.

Project Management Plan



Effective project management and communications played a large component in the success of this project to address project risks, budget, and schedule control.

Risk Management

The project team employed a tactical, risk-based approach to develop the design and construction methodology. A risk management workshop involving key stakeholders was held in the early stages of the project.

Key stakeholders and attendees included the Regional Municipality of Wood Buffalo, local horizontal directional drilling contractors and the engineering team. Risks included the location, geology, topography, environmental impacts, public impacts, regional business impacts, and horizontal and vertical alignments.

From the risk register, the team derived values for each element of risk, and developed risk mitigation strategies. The resulting Risk Management Plan was incorporated into the Project Management Plan. Critical issues and risks were meticulously tracked and overcome through cooperation and communication with key stakeholders, and reviewed by the project manager on a monthly basis.

The project team successfully addressed the challenges that arose from the design, procurement, and construction phases through risk management. If the risks could not be mitigated, a change process was followed that required justification for any of the deviation to cost or schedule.

Communications



Although the contractor was ultimately responsible for construction site safety, the project management team implemented a

process that documented progress on a daily basis and tracked any safety violation and subsequent remedies.

Daily reporting between the project managers on both teams, representing engineering and the contractor, maintained effective communication and helped identify and address issues as they arose.

The daily reports were supplemented with bi-weekly meetings of all construction stakeholders to review new issues. Specifically, during these meetings, a pipeline lift strategy was generated which listed all the tasks to be implemented to mitigate uncertainties and risks.

A stakeholder communication plan was developed to foster acceptance of horizontal directional drilling installation.

A number of public open houses were conducted to educate and inform residents about the project and the unique horizontal directional drilling technology that would be employed to minimize impact to the public and the environment. The extensive public consultation during planning and communication during construction allowed the project to advance smoothly.

It was critical to ensure that public stakeholders were informed of the progress throughout the planning and construction phases. Communications included mass media advertisements and news articles, website information and public open houses, plus weekly updates on the Municipality's website. The clear communications via traditional and digital media helped foster public acceptance and approval.

Consultations with local businesses, municipal departments and residents were critical to the success of the project.

The stakeholders needed to be apprised of construction progress and understand the impact on local parking, temporary road closures and business access. These consultations helped mitigate concerns about noise, road closures, safety, and impacts to scheduling of community activities.

The team addressed the project challenges through risk management and open communications.

Social & Economic Benefits



The Gregoire Sanitary Sewer project facilitates growth and development in the Regional Municipality of Wood Buffalo by providing sewer capacity to support growth. The additional sewer capacity mitigates

potential for sewer back-up, potential municipal liability associated with sewer back-up, as well as associated clean-up costs.

As part of the project, the soccer field and children's park were improved, creating additional value for the community.

Environmental Benefits



Using trenchless technology protected the natural values of Saline Creek Valley.

By analyzing and selecting an optimal drilling route, the project team addressed concerns with slope stability along the Highway 63 embankment. Using horizontal directional drilling minimized disruption to natural areas and avoided further destabilization of potential landslide areas.

Potential additional risks, such as drill mud escaping to the surface through hydraulic fractures, disposal of the drill mud and reclamation of staging areas, were mitigated by conducting extensive pre-disturbance assessments before construction, followed

by monitoring and a drilling mud disposal plan during construction.

During construction, the team also continuously monitored water turbidity levels. Monitoring confirmed there was no drilling mud seepage or related fluids coming back up through to the surface.

Using trenchless techniques to install the sewer protected the environmentally sensitive Saline Creek valley and nearby creeks from adverse impacts of construction.

Drill mud from the horizontal directional drilling operation needed to be collected and disposed. During construction, the team identified that drill mud could be combined with drilling fluids from other horizontal directional drilling projects in the area, and disposed of at a common site.

Typical disposal required hauling waste several hundreds of kilometres away.

Working with the Region, the team identified an old cement plant site on municipal land that would accept the drilling mud, which would also help restore and reclaim this site.

Disposal of drill fluids in this manner significantly minimized the cost and time for hauling the waste to offsite disposal sites, and prevented potential environmental discharges and air pollution by large vehicles transporting waste materials to distant disposal sites.

For the Municipality, an additional environmental benefit was attained by using the drilling mud to restore the former cement factory site.

Meeting Client's Needs



The Regional Municipality of Wood Buffalo and the City of Fort McMurray benefit from the increased infrastructure capacity and reduced risks to their sewer system. The Gregoire sewer supports and sustains continued growth and prosperity in this expanding area.

The community received added benefit from rejuvenated amenities such as the soccer field and children's play park.

The Municipality gained experience that bolsters their organizational capacity to better manage future horizontal directional drilling projects.

Conclusion

Completed in 2012, the \$16.1 million Gregoire Sanitary Sewer project demonstrates how major infrastructure can be designed and constructed cost effectively, and in an environmentally sustainable manner.

Project management of this environmentally sensitive construction project was challenging, given the wide range of risks, stakeholders, and physical environment. Proactive planning and execution of the project management plan, which included risk management contributed to the success of this project.

With a carefully managed project and communications plan, environmental and construction risks were minimized and major disruptions to local businesses and residents were mitigated.

The Gregoire project also contributed valuable knowledge regarding the application of horizontal directional drilling to the technical community. This knowledge will be applicable to future endeavours.

The project team addressed the challenging geology, environmental issues, a tight working construction area, busy public roads, and residential concerns to install the new Gregoire Sanitary Sewer.

