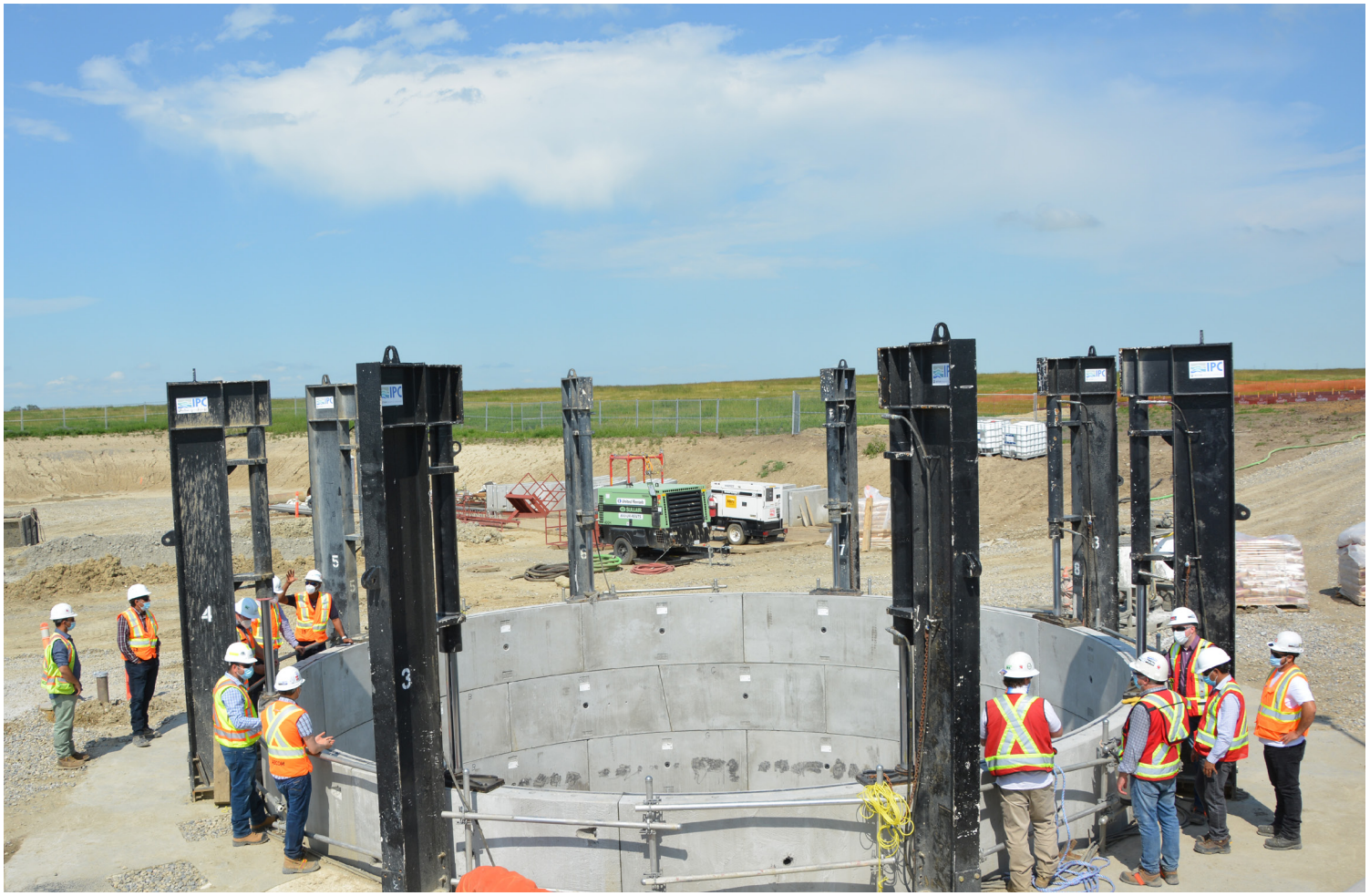
AECOM

Rangeview Sanitary Trunk — Phase 1

Project Overview

AECOM was engaged by the City of Calgary to design the Rangeview Sanitary Trunk to service the future population of the City's deep southeast quadrant. The trunk will connect to the Cranston Sanitary Chamber before travelling through the City's wastewater system to a treatment plant. The complex project involved successfully micro-tunnelling 2.6 km and open cut installation of 0.9 km, a portion of which crosses under major infrastructures and a major electrical powerline.



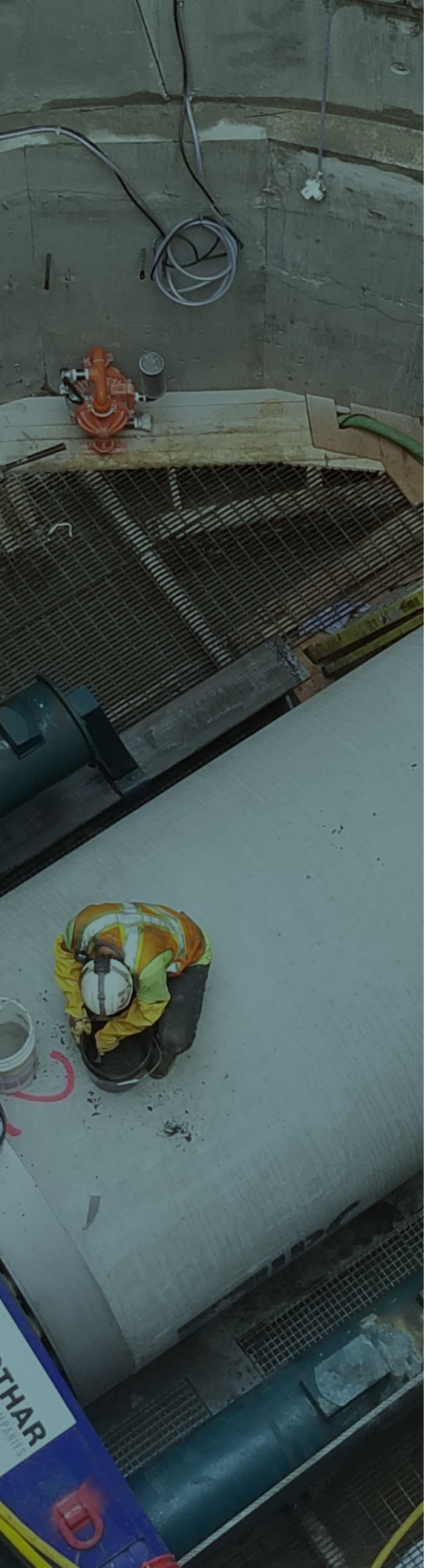


Table of Contents

1. Innovation

The Rangeview Sanitary Trunk has been designed for future population growth in Calgary's southeast quadrant. The trunk is 3.5 km long and 1.8 m in diameter, and will convey a design sanitary flow of 285 ML/d from the new development areas to the wastewater treatment plant. The project involved 2.6 km micro tunnelling and open cut installation of 0.9 km. Adding to the complexity, the tunnel portion crosses under major structures and a major electrical powerline. The trunk also crosses a major gully and wetland before it connects to the existing wastewater treatment plant's siphon chamber. At the time of construction, the Rangeview Sanitary Trunk had the longest tunnel drive in North America.

Of significance, the shafts were designed as cast in place concrete walls but later constructed from pre-cast segmental walls. Hydraulic machines were used to sink the segmental walls uniformly to support the excavation of the shaft. This method reduced the duration of the construction substantially while improving the quality of work. Most of the shaft construction was done in wintertime and cast in place construction involved tie of the reinforcement bar, casting concrete and hording and curing of the structure. As a result of this new method, construction of 1m ring of the shaft was reduced from the usual 2 to 3 week period to just one day. This significantly expedited the overall project schedule.

The entire tunnel was below groundwater with pressure of about 1.5 bar at the tunnel invert. About one-third of the shaft depths was below the groundwater table making the shaft construction challenging due to the high hydrostatic pressure. As a result, the contractor had to pump outside water into the shafts to counterbalance the pressure and continue underwater excavation using special excavation equipment.

One of the exit portals was in the gully area, designated as an environmental reserve consisting of wetlands and native plant species. The embankment's slope consisted of mostly silty sand and the ground had gone through several slope failures in the past. To minimize potential damage, several mitigation measures were taken: concrete lock blocks were built up as additional support to the exit portal wall at the bottom; the bottom of the exit portal was lowered to contain tunnel slurry; the bottom layer was sealed to avoid any infiltration into the ground and; a hydrovac machine was placed on standby 24 hours for any potential escape of slurry.

> **"At the time of construction, the Rangeview Sanitary Trunk had the longest tunnel drive in North America."**

Construction of 1m ring of the shaft was reduced from the usual 2 to 3 week period to just one day.

This significantly expedited the overall project schedule.

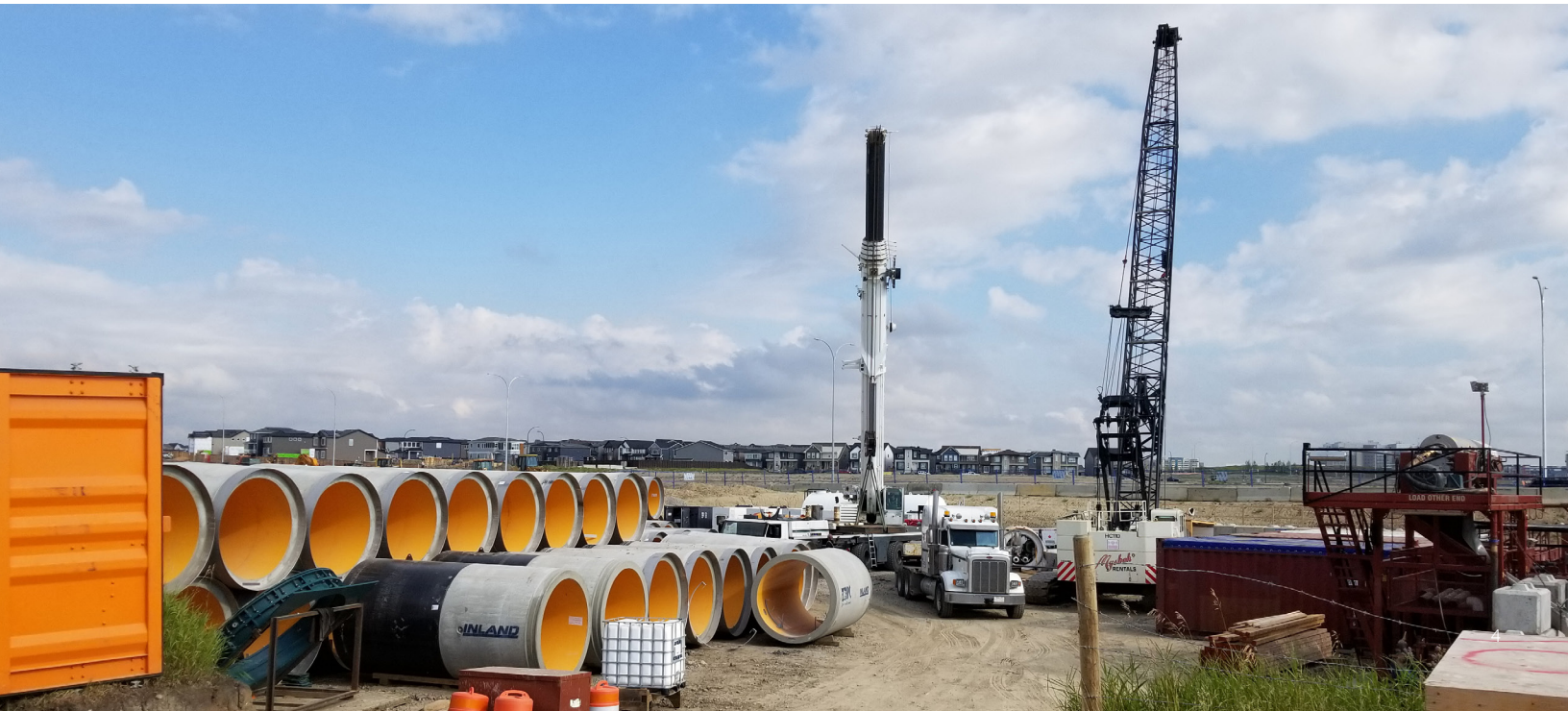
3.5km long, 1.8m internal diameter

2. Complexity

There were several complexities with this project including the requirement for the trunk to cross a large gully before connecting to the siphon chamber. This crossing presented technical challenges for both ground conditions and existing slope failure given that this area is an environmental reserve for wetlands and protected native plant species. Accordingly, the team successfully preloaded with embankment fill prior to the trunk's installation. In fact, the land bridge had to wait for about a year until the settlement was completed.

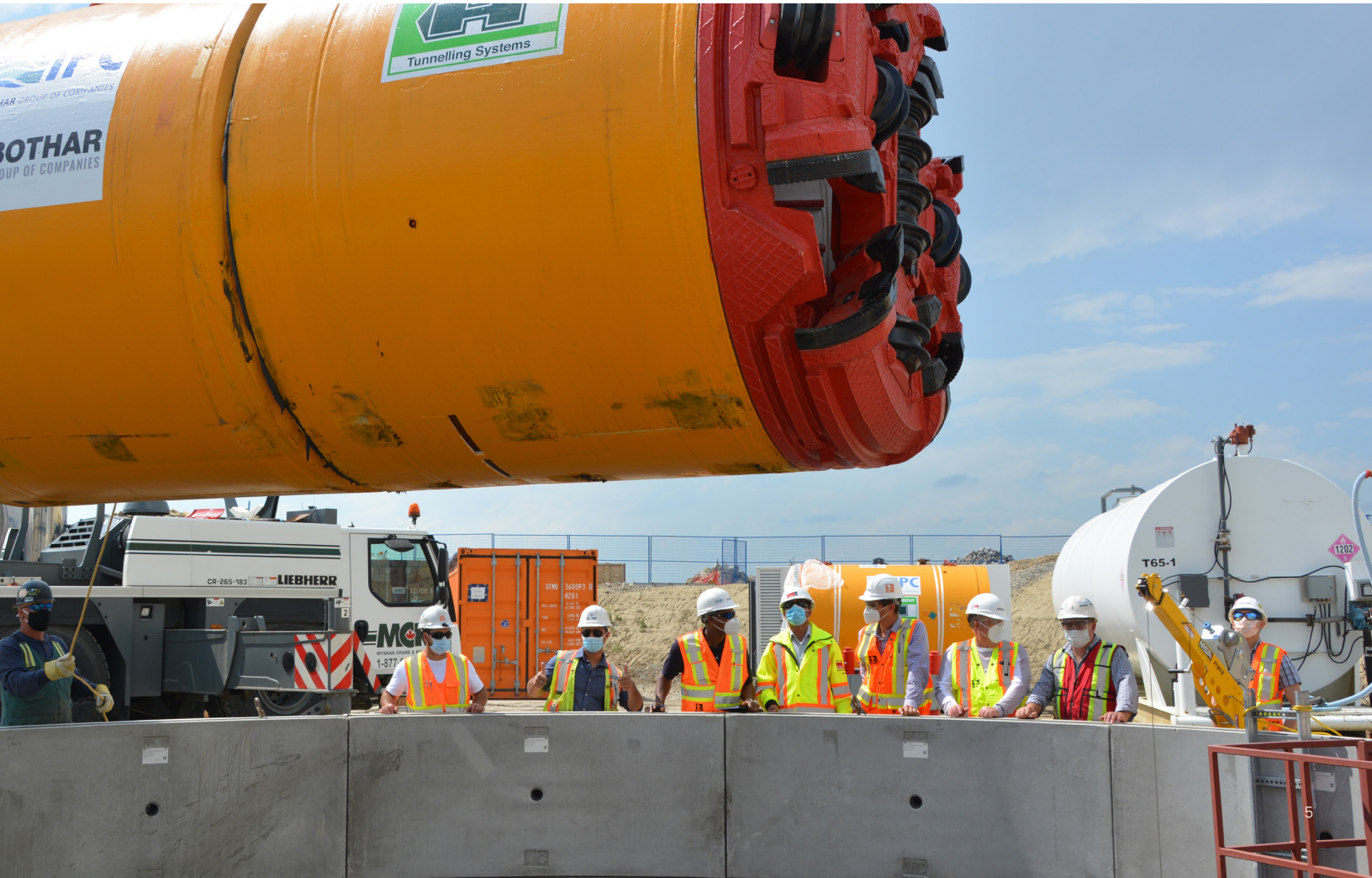
The trunk also crosses under a highway with a daily average traffic volume of over 110,000 vehicles. The tunnel under this highway was the longest drive and the depth of cover was less than 3 m. This crossing was identified as the riskiest item during the design phase due to potential frac-out and release of slurry to the environmentally sensitive area downstream and potential traffic disruption on the busiest highway in the province. During construction, the team applied a number of mitigation measures reducing the potential risks including tunnelling rate advance at the highway crossing; reducing tunnelling target pressure at the highway crossing by 40%; establishing a cleaning crew ready with hydrovac equipment and keeping the crew on-site and on standby for 24 hours in case of any frac-out to reduce impacts on the highway traffic; implementing a strong real-time communication system with the City Council Alberta Transportation, police and emergency services, and engaging the community ahead of time in case of any emergency and road shutdowns.

It is anticipated that the trunk will have low flows during early stages since most of the communities are yet to be built. This low flow can result in low velocities resulting in deposition of solids which can be a maintenance hindrance. To minimize such a problem, AECOM designed a flushing line connecting the truck to the newly built pond where the maintenance crew can open and flush the line at a regular interval until the velocity inside the trunk gets to self cleansing level (estimated 7 to 10 years from completion of the first phase of the project.)



3. Social and/or Economic Benefits

The societal benefits of this project are numerous. The Rangeview trunk sewer, in conveying waste from smaller tributaries toward the waste treatment plant, is part of a multi-tiered wastewater collection system for the City of Calgary. By proactively managing its underground infrastructure, the City can optimize its infrastructure investment, level of service and performance, particularly in anticipation of the community's future growth in the deep southeast quadrant of Calgary. In fact, the project is designed to service a large number of communities, an estimated 246,000 people, located at the southeast part of the City for the coming 70+ years. In addition to residential development, new commercial areas will be connecting to the sanitary trunk, further stimulating the vibrant community and growth of its surrounding area. Indeed, the completion of the Rangeview Sanitary Trunk Sewer will support the City's objectives to optimize its infrastructure investment, level of service and performance.

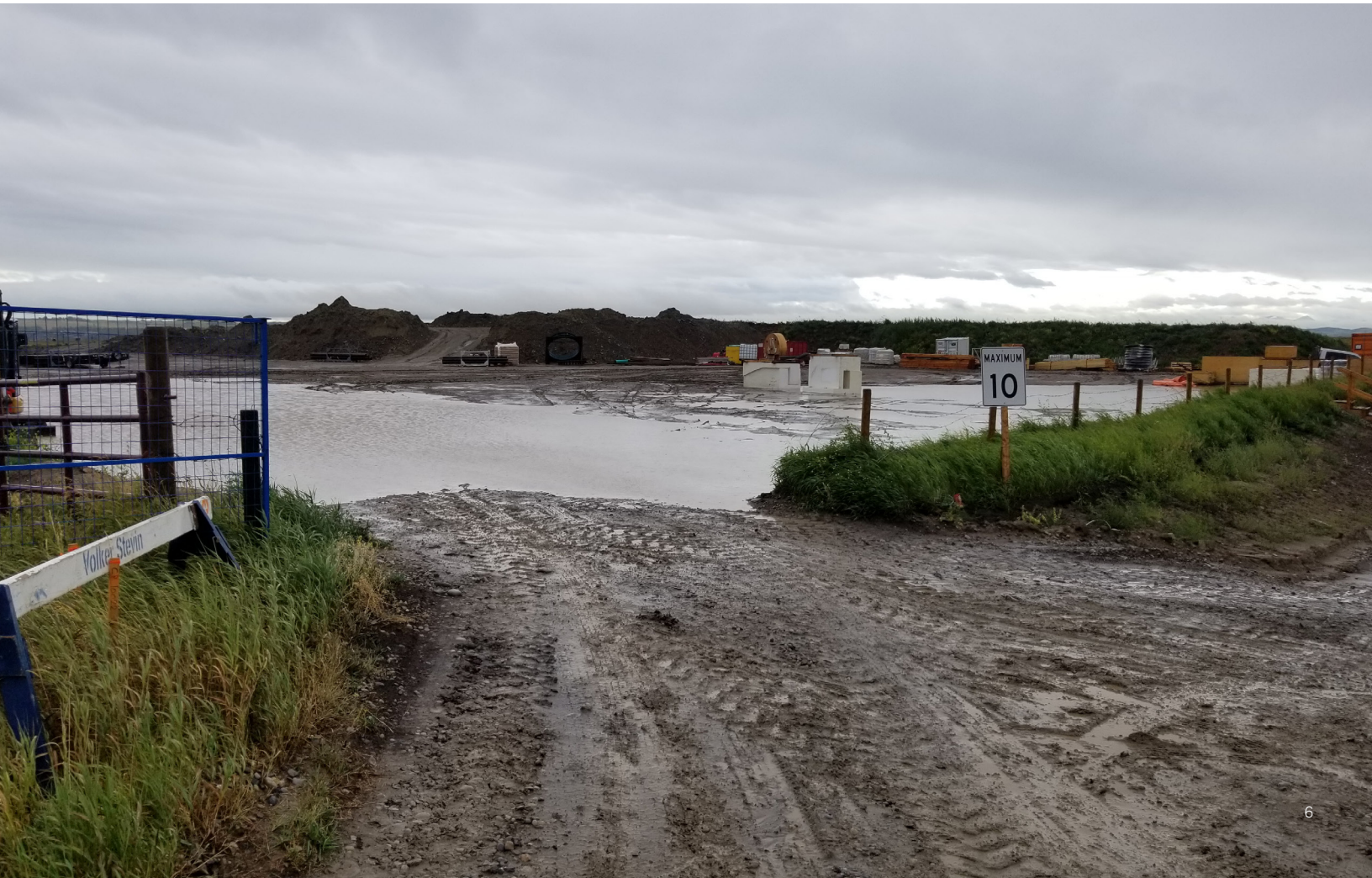


4. Environmental Benefits

Although mostly greenfield, there were significant subsurface, environmental, and permitting challenges on this project. That said, the team minimized the project risk early with proactive scheduling and team / stakeholder communications relating to approval of highway crossings, third party utility crossings, and environmental / regulatory permitting. For example, the footprint of the land bridge used to cross the wetland was minimized though various design iterations to reduce the environmental impact.

One of the environmental aspects identified during the value engineering was to make the 80m long culvert under land bridge large enough to account for escape of wild animals in case they entered the culvert. Accordingly, the culvert was designed and constructed above the flow design capacity to accommodate this need.

The seeds of native plant species in the wetland area were harvested prior to construction and dried and reseeded after completion of the construction. Similarly, the topsoil at the wetland was stockpiled separately and put back once the land bridge was completed. As a result, the site is revegetated and has blended well with the local environment.



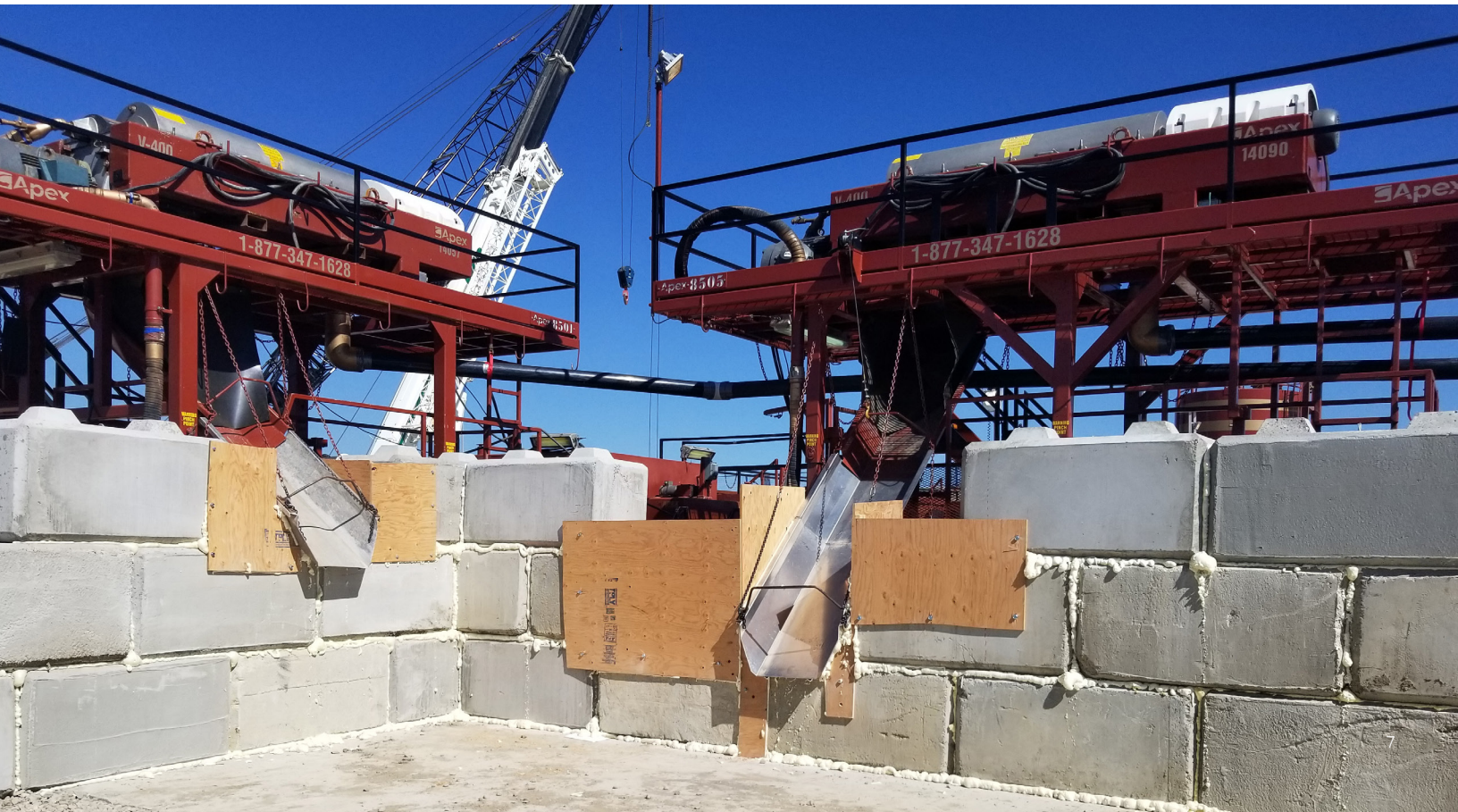
5. Meeting Client's Needs

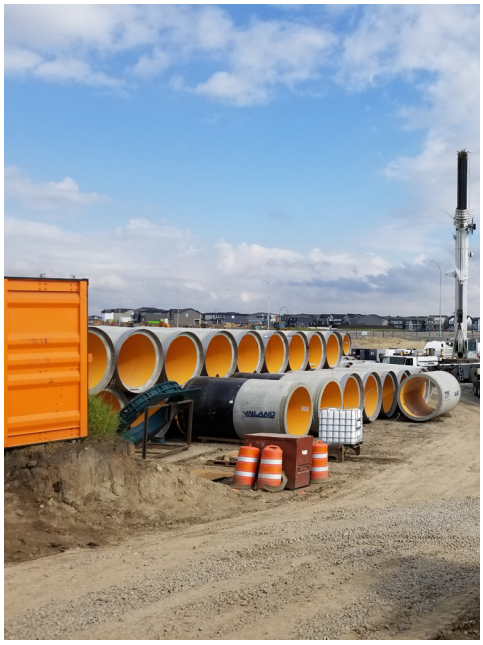
AECOM executed a comprehensive value engineering following the preliminary design, which involved bringing together notable North American tunneling experts to review the proposed design. Through this exercise, certain design components were optimized resulting in reduced project risks and cost savings.

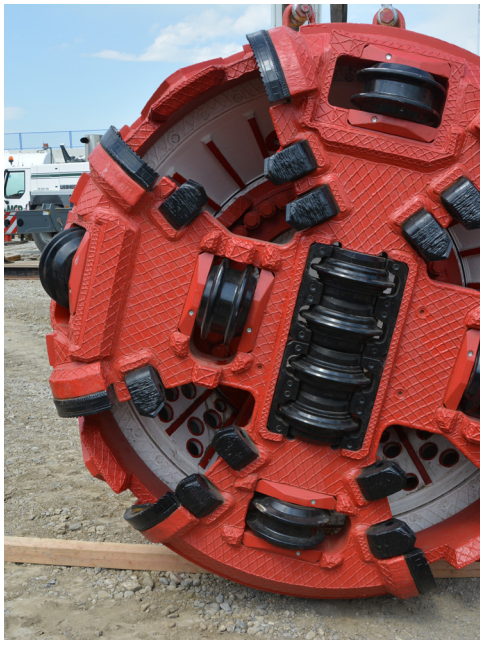
A thorough risk analysis was conducted during the preliminary and detailed design stages. This identified major risks - mitigating them through design and transferring the residual risks to the construction phase. This helped the client determine the cost contingency to be added to the construction budget, and to effectively determine third-party insurance requirements.

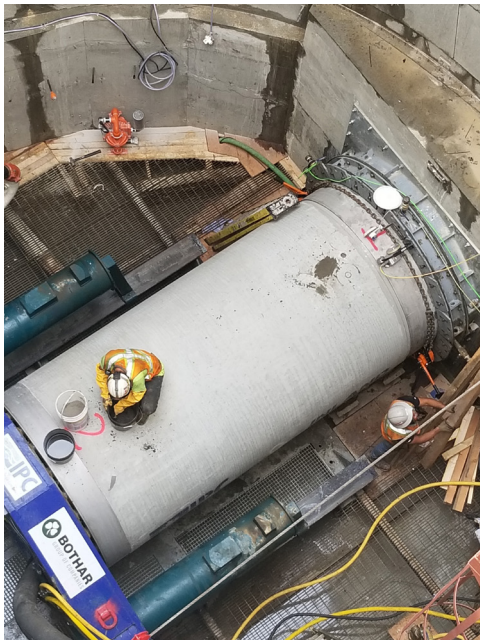
AECOM suggested and supported the client to pre-qualify tunnelling sub-contractors in the pre-bid process and to extend the pre-bid invitation to the international market. This allowed the client to tap into international experiences and to draw competition to the project which contributed to completion of the project on time and underbudget.

Furthermore, AECOM added value to the overall system by minimizing sediment deposition inside the trunk early by connecting the flushing line from the existing pond. The team also conducted air flow models inside the trunk to determine the odour escape levels which are common issues in the City's wastewater system and included the required odour control measures in the design. The trunk design was also revised to accommodate the increased gravity drainage area by the route selection and reduction of the slope of the trunk. Various options were evaluated of the ravine crossing including the land and pipe bridges to connect to the existing siphon chamber.

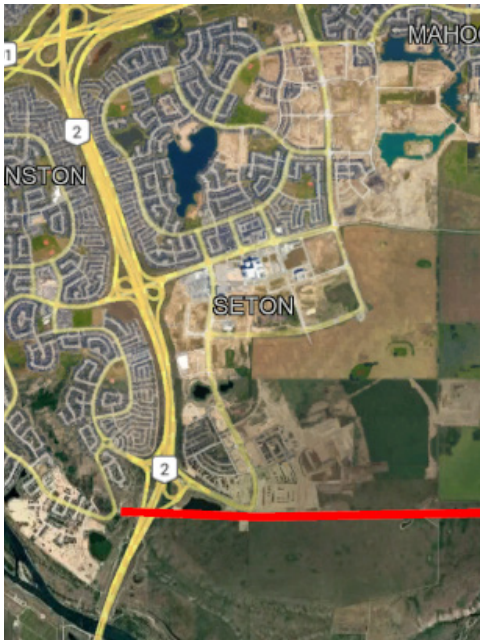


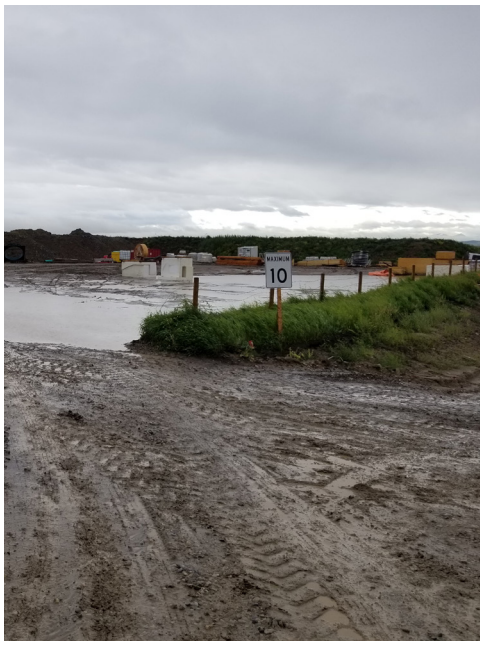





BOTHAR


Herrenknecht
Tunnelling Systems
LIEBHERR


MAHO
NSTON
SETON
2
2


10


INLAND