

SHANGHAI CONSTRUCTION GROUP MAKES NORTH AMERICAN TUNNELLING FORAY

Edmonton trunk sewer line pipe jacking presented several challenges

BY ANDREW TOPF, EDITOR

The recent construction of a major trunk sewer line in Edmonton to accommodate new development is significant for a number of reasons, most significantly that it is the first time a Chinese company has done tunnelling work in North America.

For the past 17 months Shanghai Construction Group has been building a sewage tunnel for the SA1a project, which involved trenchless construction of a 1,250-metre-long, 2,200-mm sanitary sewer tunnel installed between Parsons Road and 91 Street, and underneath Anthony Henday Drive. The balance of the work on SA1a, which encompassed a total length of 2.2 kilometres, was completed by Edmonton city crews using an open-face tunnel boring machine.

The new trunk sewer, one of five in Edmonton, will convey wastewater from South Edmonton to the Gold Bar Wastewater Treatment Plant and is being constructed in stages; SA1a is one of those stages. The City of Edmonton put the 1,250-m section out to tender due to the complexity of the trenchless construction required, including navigating a number of pipeline right of ways and microtunnelling under Anthony Henday Drive, a major transportation corridor that rings the city.

The winning \$11-million bid went to Shanghai Construction Group (SCG), one of the largest building con-

struction conglomerates in the world with about 60 years of tunnelling experience. The Shanghai-based company was the general contractor for the new Chinese Embassy building in Washington, DC that opened in 2008, and is also redeveloping a 1920s-era heritage apartment complex that will house embassy staff.

In 2008 SCG set up an office in Edmonton with the intention of competing for building construction jobs in Canada, but the group found its first opportunity in civil engineering work for the city to complete a section of trunk sewer deemed to be outside the scope of the city's tunnelling expertise, explained K.C. Er, SCG's project manager for SA1a.

Er is a former Edmonton drainage director who worked for the city for over 30 years, before being recruited by SCG; Er is semi-retired and lives in Edmonton.

In an interview with CUI, Er explained that the design of the SA1a trunk sewer required trenchless construction in three stretches: two sections where the sewer line had to be built underneath existing gas utilities – including a 508-mm high pressure gas main, a wide "pipeline alley" that houses six oil and gas mains and a third, major stretch - a 645-m drive which includes 262 m underneath Anthony Henday that connected to an existing 2,340-mm sanitary sewer tunnel.

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longest large-diameter microtunnelling project in Edmonton, and one of the longest and largest in Canada involving large-diameter reinforced concrete pipe, according to Er.

While it was technically possible to open-cut parts of the section that did not run underneath the road, Er said the ground conditions would have made trenched construction difficult.

“The reason we chose tunnelling is because there’s a high water table and the ground was very, very wet. If you were to open-cut that stretch, you’d probably have to take out the material and import fresh material for backfill. So we decided, since we have to tunnel across Anthony Henday, it makes sense that we tunnel all the way.

Custom-built TBM

The first step was finding the right TBM for the job. Er said SCG’s approach to identifying a tunnel boring machine is different from that used by North American contractors. Unlike American and Canadian firms, who will source a TBM from a major manufacturer, SCG will custom-build the TBM to suit the particular needs of the project, even if the job is short-term – in this case, 17 months. The company will spend top dollar to get the best components, such as pumps, bearings and electrical components, and combine those with more generic parts from China. When the job is finished, the more expensive parts get recycled for use on the next project.

Cobbles not clay

Unfortunately for SCG, they weren’t quite prepared for the ground conditions they encountered when they started tunnelling the first 312-metre stretch, between two manholes. The six-member Chinese TBM crew were expecting clay till with some gravel and cobbles but instead, they got a lot more cobbles and boulders, which mixed with the soft “sticky” clay clogged up the slurry discharge pump. The solution was to build a cage that would filter out the cobbles before the slurry entered the pump.

Once they got past the pump clogging issue, SCG went about calibrating the earth pressure balance TBM, which Er deemed to be a great success: after tunnelling 312 metres, the bore was almost completely straight.

“It was bang-on grade, only 4 millimetres offline,” he said. “It looks like a gun barrel. You can’t even lay it that close using the cut-and-cover method. So we were quite pleased.”

The reason for such high level of accuracy, according to Er, is

SCG's method of fusing together pipe sections when the TBM is launched. A metal cradle is lowered into the working shaft which serves as a kind of a launching pad for the TBM. After the cradle is perfectly levelled using four adjustment screws, it is welded to the metal plates that were cast into the concrete floor. The TBM is lowered onto it. Then, to prevent the TBM from dropping down as it moves forward, two sections of 1.8-m pipe are bolted to it, effectively making the TBM one solid piece of pipe around 7 metres long. The distributed weight allows the TBM to stay on grade.

"In North America in a lot of the cases, our pipe manufactured here does not have those brackets to hold it together, and the weight of the tunnel boring machine has the tendency to immediately drop below its grade once the TBM leaves its launching pad. So this is something very, very unique that we do differently," Er explained.

Chinese vs. Canadian pipe

Speaking of pipe, the type used for the SA1a project, and its source, turned out to be somewhat controversial, since SCG recommended to the City of Edmonton that the 2,200-mm pipe need for the Anthony Henday section be manufactured in China and shipped to Edmonton, via sea containers, for the installation.

Er explained that the jacking force required to push the pipe the length of the drive meant the pipe needed to be strong enough to withstand the thrust; for that reason, and the fact that the city could not risk pipe failure underneath Anthony Henday, SCG decided to go with Chinese pipe rather than pipe sourced by local suppliers. The decision raised questions by the Canadian Concrete Pipe and Precast Association (CCPPA), regarding the quality of the pipe brought in from China. Er defended SCG, stating at the time, spring of 2014, that the Chinese pipe was the only pipe that would allow the 645-m single drive to be completed without having to worry about the pipe quality and integrity. He also said that a professional engineer from Alberta who designed the pipe, travelled to China prior to construction to ensure that the pipe met CSA standards.

Asked whether the decision to specify Chinese pipe over Canadian pipe caused any concerns for the city, the manager responsible for the project said no. Diane Wirtz, project manager with the City of Edmonton, told CUI that the city sent their own concrete experts to the plant in China. The experts took random core samples of the pipe in China and also from the sections that were shipped to Edmonton.

"There were no concerns on our end. We did our inspections and testing and were well satisfied with what was being provided," said Wirtz. She noted that Lafarge, which has a plant in Edmonton, provided concrete pipe for 1,500-mm product used in another section of the SA1a project.

The SCG pipe was shipped from China in 1.8-metre sections, three to a container, around 220 containers in all. The job used about 650 pieces of pipe, with each piece weighing 8 tonnes. The containers arrived in Vancouver and were railed to Edmonton, then loaded onto flat-bed trucks and driven to the site.



Top: The metal cradle that serves as a launching pad for the TBM, ensures the tunnel stays on grade.

Above: SCG had to push a large boulder 140 metres away from the bore path, for later extraction.



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Keep bouldering on

SCG faced another challenge when completing the 262-m drive under the Anthony Henday roadway. Around halfway through the bore, the TBM encountered a large boulder measuring around one cubic metre. A boulder of that size, more than a third of the diameter of the cutter head, could not be broken up, so SCG had to determine how to move the boulder out of the TBM's path. Excavating a shaft under the roadway to remove the boulder was not permitted under the contract. The crew was also not permitted to encroach on the Anthony Henday right of way, further limiting their options. In the end, SCG had no choice but to continue tunnelling with the TBM and push the boulder 140 metres so that they could excavate a pit and remove the rock once it was outside the right of way, on the northern side of Anthony Henday.

"The cutting head keeps on turning, keeps on cutting into the soil. At the same time, it's grinding and breaking up the rock, and pushing the rock forward into the soil. That's basically how we overcome this obstacle. It's a tough thing to do. You damage your TBM," Er explained.

Indeed pushing the boulder wrecked the entire cutter head, meaning the cutter head had to be replaced, along with the rock crusher unit inside the TBM.

The whole process of pushing the boulder out of the way, excavating a shaft, removing the boulder and repairing the TBM delayed the project by about a month.

Still, according to Wirtz, the city was pleased with SCG's performance, especially their approach to solving problems as they came up.

"They were a very proactive contractor. They worked hard to find ways to better do the work so that it wouldn't be an issue. We found in the second part of their tunnelling, they learned a lot from that Anthony Henday portion and when they hit the final legs of this section it went very quickly."

SCG finished up the last portion of tunnelling in mid-February and since then, they have been completing the structural elements of the project including manholes and the connections between the manholes and the pipe. Site restoration work will continue into the summer and by fall, the new sewer trunk line should be operational, said Wirtz. **CUI**