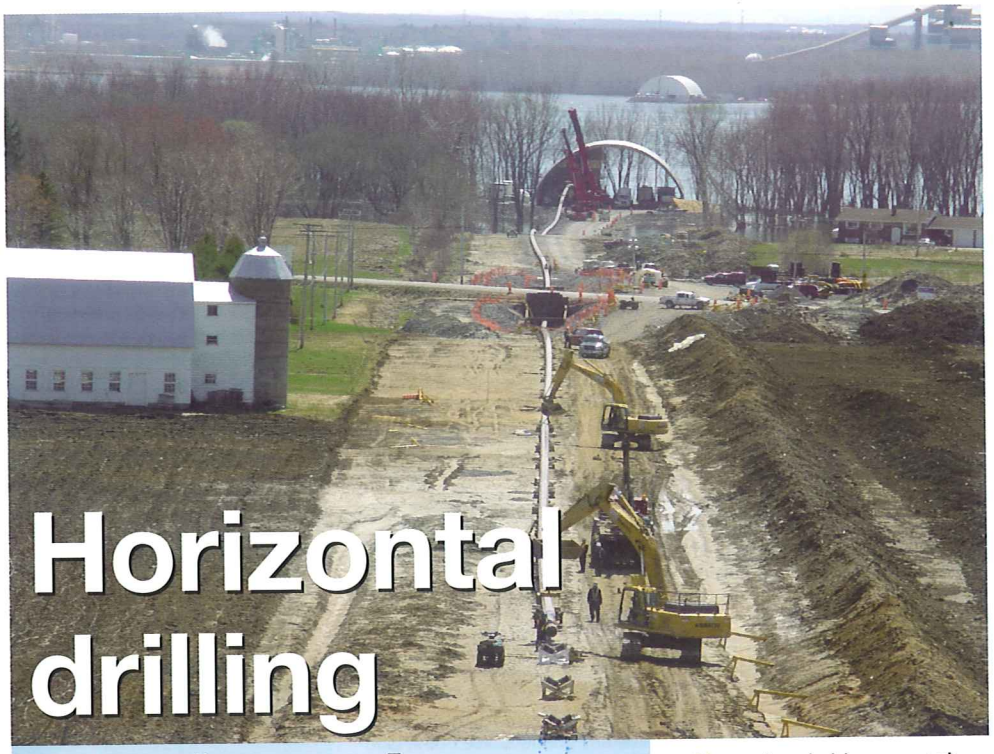
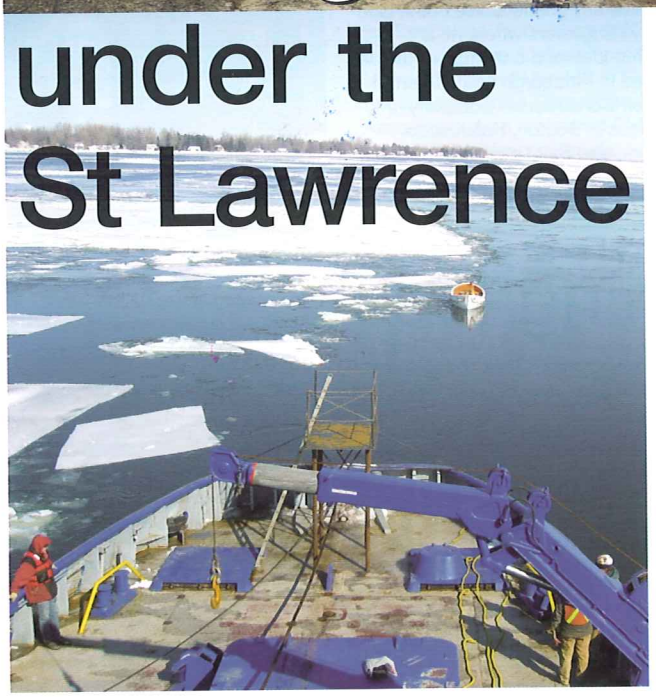
Horizontal drilling under the St Lawrence

How to cross the St Lawrence River was the challenge for designers of a new natural gas pipeline project in Québec. *T&TNA* contributor Tonia Jurbin describes how horizontal directional drilling was the selected and successful option.





Above: Land side approach to the 2.3km HDD river crossing

Left: Tracking the pilot head beneath the floating ice from the fiberglass dingy

Although it would be asking a lot of the technique, horizontal directional drilling (HDD) was selected for installation of a new pipeline under the St Lawrence River. The 500mm (20in) diameter, 2.3km (7,600ft) crossing is part of a new 14.5km (9.3 mile) natural gas pipeline for GazMétro from Trois-Rivières on the north shore and the Bécancour Industrial Park to the south.

In adopting the long HDD option, "we knew that we were pushing the limits of HDD technology," said Gabriel Pop, technical advisor to the project manager. "Therefore, as well as the preferred option, we prepared two back up plans - either a shorter HDD run to cross the St Lawrence seaway with the remainder of the crossing on a jetty, or a conventional trenching operation."

The riverbed is about 5m deep with the 200m wide shipping channel dredged to 11m.

"We also prequalified our contractors and our consultant Pluritec/Johnston-Vermette of Trois-Rivières, Québec, hired HDD design specialist Engineering Technology Inc (Entec) of Calgary, Alberta to assist with the design," said Pop.

Of the total $Can50 million project cost, about $20 million was related to the crossing. As well as the length, the crossing, winter conditions, tides and historic flood levels, and a bilingual and unionized workforce were going to add to the legwork of the job.

Grant Jameson, Vice President of Entec put the magnitude of the job into perspective. "This project had all the elements of a great challenge including technical, social, and logistical issues."

The project was driven on the premise that if the long HDD attempt failed during the winter of 2004/05, conventional installation of the crossing could begin in May 2005 and still meet the September 2006 supply commitments at Bécancour. "Tenderers prepared bids for all three options," said Pop "and had to offer assurances that if HDD did not work they would be ready with barges and other equipment to start dredging as soon at the ice was off the river."

Ganotec–Kiewit Partnership of Trois Rivières was the general contractor and Michels Corporation of Brownsville, Wisconsin, represented in Canada by Michels Directional Crossings Co of Nisku, Alberta was selected as the HDD contractor.

The crossing was chosen at the river's narrowest point and taking advantage of two islands - L'Iles de la Point aux Roches on the south side and Ile Carignan on the north. New access roads and drilling pads had to be built and high enough to manage the spring run off and spring tides. Some 42,000m^3 (54,900yd^3) of material was imported, about half used for 900m of access road and the rest for the 40m x 60m drilling pads which had to be high and dry for the duration.

Geotechnical investigations, consisting of 13 boreholes, indicated that the upper 20m of material on the north side of the crossing was predominantly sandy clay with traces of gravel in the deeper parts of the stratum close to the upper fractured shale. A drill path of about 40m below the riverbed was chosen to ensure a drilling operation in competent bedrock of about RQD 85.

At the north side of the crossing a 107cm x 60m long (42in x 197ft) casing was installed at 14 degrees. A 92cm casing was hammered inside it to bedrock at about 116m deep. This would reduce the friction on the larger casing to facilitate eventual removal.

On the south side only about 28m of casing was required to get to the rock interface. A final 40cm (16in) casing to guide the drill head was centered inside the larger pipe.

To decrease the length of the 300mm pilot hole drill string, the drill run was started at both ends and met 2/3 of the way from the south side. During pilot-hole drilling the annular pressure was monitored continually to ensure that there was no loss of fluid indicating a possible frack-out or release into the environment, nor any build up of fluid indicating a possible cave in. It was by monitoring the pressures on both drill rigs that the crews were able to confirm the two drill strings had met.

The workhorse at the south side of this project was a Michels built Hercules 1200 rig with a push/pull capacity of 1.2 million pounds. Another Michels built Atlas 840, capacity 840,000

pounds, was used on the north side.

Intersect drilling is not unknown but during early planning of this project, the number completed successfully in North America (now about 15) was probably about two.

Floating ice on the river and an active shipping channel did not allow crews to lay down the typical tracking systems used to locate the pilot head. Using a helicopter to position the tracking systems was ineffective as it simply could not be held still enough. Attempts using an icebreaking tug boat also failed because the steel interfered with the tracking system. The best tool for the job turned out to be a coil system run from a fiberglass dingy.

Once the drill heads intersected, the string was pulled to the south side and the casing was removed to allow for an 800mm (31in) reamer to enlarge the hole on the descent part of the drill run. A smaller 750mm reamer was then used to enlarge the 2,181m (4,153ft) of horizontal run. Pressure at the mud pumps and other key variables were monitored throughout the drilling process, however annular pressures were not monitored during the reaming phase. There was no access to a wireless telemetry system and using wireline tools for monitoring would have been too slow. Many passes of the reamer were required to swab the wall of the drill path so as not to damage the double corrosion coatings on the natural gas pipe during the pull.

Above: One of the HDD rigs used to complete the 2.3km run

Right: The crew celebrate success of the record breaker

The pilot hole took 22 days to complete. The reaming took about 35 days. The pipe pull took about 12 hours.

Dealing with 3,000m^3 of cuttings and waste drill fluids proved difficult. "Long drills are not common in Québec and the Department of Environment did not have a lot of experience in dealing with permitting for this kind of waste so it took a lot of time to find acceptable sites," said Mike Prior, Vice President and General Manager for Michels. "Waste disposal was about 10% of our contract."

Acquiring 2.3km of laydown for 350 tonne of assembled pipe on the north side was negotiation with only three owners. Permitting however did require GazMétro to strip, store and replace the topsoil and monitor the restoration for three years.

It is much to the credit of Ganotec-Kiewit and Michels that there were no lost-time injuries though the crews did find it cold. "As well as skilled Québec workers we were permitted eight members of our US crew which worked out really well," said Prior. "Communication was expected to be a concern but the Unions provided enough bilingual workers to translate and the US workers quickly learned some basic French." ■

LA breakthroughs

The two Herrenknecht EPBMs working on the Metro Gold Line Eastside Extension in Los Angeles have completed their first 2,950ft (869m) long drives breaking through into the mid-point Soto Station box on July 21 and August 24, 2006.

Operated by the Traylor/Frontier Kemper JV the machines were launched at the Boyle Heights station box on February 23 and April 26 respectively.

The lead machine set off on its second drive from Soto Station in late July and had advanced 300ft by August 24. The second machine was expected to relaunch about 10 days after breakthrough once elective maintenance was complete and the machine had walked through the station box to the opposite end wall.

The two machines are expected to complete their second 4,125ft (1,258m) long drives to the east tunnel portal by late November/mid-late December.

"Progress is a bit slower than we had anticipated," said Jim Richards, Chief Resident Engineer for the IPMO (integrated project management office), "but everything is well controlled. Best daily advance is 76ft for a 20h-working day and two-week rolling averages are around 55ft/day."

"Tunneling is primarily beneath the water table," said Tom Saczynski, Tunnel Resident Engineer for the IPMO, "and surface settlement is very little - less than a quarter inch. The extra long 196ft screw conveyors on the machines are working well. Friction is not a problem. The geology is much as anticipated. The alluvium is not very abrasive and conditions are better than expected in some reaches. A zone of potential petroleum-product contamination for example didn't materialize. The contractor's engineers incorporated many fail-safe features into the machines. They are performing well."

As the 21.4ft (6.5m) diameter machines advance, the tunnels are lined to 18.8ft i.d. (5.7m) with 5ft (1.5m) long one-pass rings of bolted and gasketed segments supplied by the Traylor/Shea/Ghazi casting yard in Palmdale. ■

Breakthrough 2 in August following the lead TBM's breakthrough in July