TBM drive for clean energy from Ashlu Creek

Crews are past the first of six major fault zones as 4m diameter TBM excavation moves into high gear on the 2.7-mile long tunnel for the Ashlu Creek run-of-the-river hydro project, in British Columbia, Canada. *T&TNA* contributor **Tonia Jurbin** reports

The $125 million, 50MW Ashlu Creek hydro project is one of many clean energy projects in planning or construction by Innergex Renewable Energy Inc in British Columbia (BC). The run-of-the-river project includes excavation of a 4m (13ft) diameter x 4.4km (2.73-mile) long TBM bored tunnel, which is presently in full production and advancing at an average rate of 10–15m/day with peaks of 23m/day.

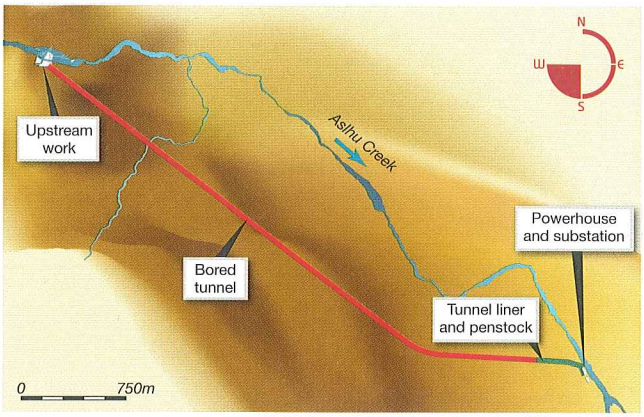
Planned originally to start in 2004, construction was delayed due in large part to the project's high profile location. Situated about a 90-min drive northwest of Vancouver and less than an hour's drive from the Whistler ski resort, the permitting process took longer than anticipated. Run-of-the-river projects in BC typically require more than 50 permits, licenses, reviews and approvals from more than 14 regulatory bodies.

While there are supporters of the project, including the Squamish First Nations who will own the facility in 40 years, there was also considerable opposition, especially from outdoor recreation enthusiasts. There are about 410,000 named creeks in BC with hydro power potential setting off heated debates about who should have the right to use the water and how. Public scrutiny during the community consultation stage of this project presented challenging hurdles for Innergex.

Innergex's prime contractor for the project is Ledcor CMI Inc of Vancouver and Frontier Kemper Constructors Inc (FK) of Evansville, Indiana, USA, has a fixed price contract with Innergex for tunnel excavation. Tunnel designer for FK is the Vancouver office of Hatch Mott MacDonald.

Once notice to proceed was granted, Ledcor CMI excavated the downstream portal area, under about 20m of rock and overburden, between September 2006 and February 2007. The first stage of the 4.08m diameter x 4.4km tunnel then started in mid-February 2007 when Frontier Kemper sub-contracted RokTek Services Inc of Prince George, BC to excavate the starter tunnel. The 600m^3 of the 31m long x 4.6m horseshoe tunnel took about a month to drill and blast and support with rockbolts, mesh and shotcrete in the crown.

With RokTek working the starter tunnel FK's crews were free to focus on the main event – arrival and assembly of some 40 truckloads of TBM parts and supplies from its Indiana home base some four-days drive away. The TBM launched in late June 2007 and tunneling crews in FK's team of about 50 employees and staff were running three 8h shifts/day, 5 days/week towards a contractual completion date of June 2009. This was later increased to 7 days/week to meet an early completion date of December 2008. By late February, excavation was advancing at an average rate of 10-15m/day with peaks of 20-23m/day.



Above: Fig 1 – Plan of the project's 2.7-mile (4.4km) TBM tunnel

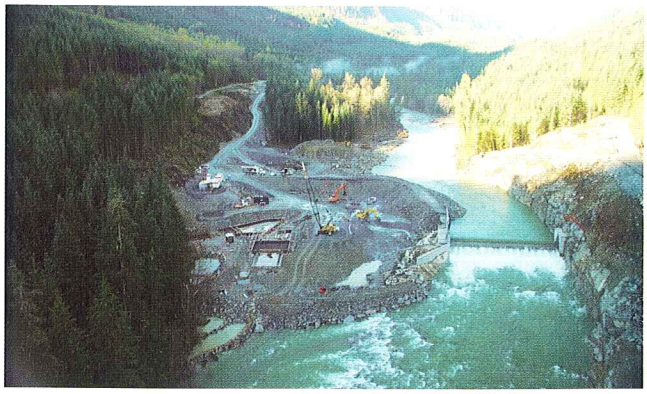
At 620m into the drive, crews encountered the first of six major faults in the massive granitic rock of the alignment. It was said the fault didn't produce a significant volume of water and rockbolts, mesh and 26 partial ring sets were used to traverse the 15-20m zone. The modified 300° sets of steel rib supports, without invert segments and secured with rock bolt connections along lower sidewalls, were successfully installed and facilitated TBM advance through this section of poor rock conditions. "The method provided a stable support system, where subsequent final support/lining can be installed at a later time, and allowed for continued tunnel excavation," said Dean Brox for Hatch Mott MacDonald.

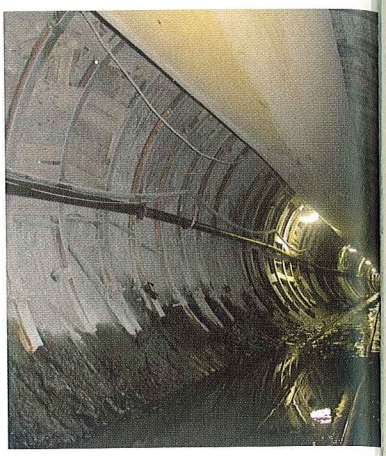
The report from Brox in late February explained that the TBM was just over 1km or about 25% through the tunnel drive. At that time he told *T&TNA* that crews are "currently going through what we expect to be the worst of the faults, F2. There is some altered rock but the TBM is progressing okay with the crews installing pattern bolting and mesh in the crown."

Of the other faults it was reported that fault F4 could be up to 1.5 times the length of the F1 fault.

The TBM is fitted with two drill rigs for rockbolting and probing. Probe drilling is

Below: Aerial views of the upstream intake working site on Ashlu Creek (left) and of the downstream site and portal of the TBM drive (right)





Above left: TBM launch zone at the face of the starter tunnel; Middle: Installing support through fault zone F1; Right: Modified 300° steel set supports without invert sections through fault F1 (above photos by D Brox)

Above: The 4.08m diameter Wirth TBM and its crew during on-site assembly at Ashlu Creek

undertaken 50m in advance of each fault and the probe length and overlap is 12–15m. If a probe hits water it will either be left to drain off or, depending on the volume, the location will be grouted. Water inflows over the 1km long heading to late February was said to be low at about 6 litres/sec (100gpm).

Water make over the 4.4km length of the tunnel, under the maximum overburden of 600m and measured at the portal, is expected to be some 32litres/sec.

The 1% uphill grade of the drive allows water to drain to the portal and makes mucking the 57,000m^3 of material easier using trains of four 10m^3 muck cars. Ledcor is using much of the tunnel muck at the intake and for Forest Service Road improvements. Locals are happily volunteering to use the bulk of the remainder for property improvements and flood protection downstream of the project.

The 1200kW Wirth TBM cutterhead is dressed with 30 x 17in cutters. The high quartz content granite is abrasive but at time of press there was insufficient data to comment on cutter consumption.

The TBM is about 16m long and totals 140m with the trailing backup. The machine is fitted with a PPS precision guidance system to manage the alignment that can be challenging in the massive hard rock with compressive strength in excess of 225MPa. There is one major curve of 450m radius on the alignment. The TBM does have steerability and difficulties are not anticipated on such a wide turn.

The tunnel exit shaft at the intake end of the project will be a 130m deep x 3.5m raisebore that is scheduled to start in 2008 and take about three months to complete. It will be undertaken by a division of FK that specializes in raisebores.

The hard rock TBM tunnel is expected to remain largely unlined with lining only required at fault zones "where shotcrete will likely suffice," said Brox. A steel lining at the downstream end will be installed by others.

Green credentials

Construction of the substation and 2.5km of 230kV transmission line with a price tag of $Can4.5 million was completed in advance of heavy civil work so the TBM could be powered off the grid. It takes about 3MW to run a TBM and being powered off the grid alleviates noise, smoke and fuel transportation issues associated with generators. There is a full time mechanic and electrician on every shift as well as a full time technician dedicated to maintaining the cutterhead. There is also a full time environmental monitor.

To ensure environmental protection, only biodegradable hydraulic fuels are permitted on the project, a decision that added about $0.5 million to the project cost according to Richard Blanchet, Vice President of the Western Region for Hydroelectric Energy, Innergex. "Of course the earlier projects were much cheaper to build but that is because the environmental costs were not taken into account. Environmental costs are built into our projects and so they become a much larger proportion, close to 10%, of the overall cost. Our projects are framed to embed the environmental costs up front in the construction phase."

One of the big challenges has been getting supplies. Site management describes local sales reps as generally unhelpful and report that orders take weeks to arrive. Managers have found it faster and cheaper, especially with the strong Canadian dollar (currently at about par with the $US), to order tools and parts through their Evansville home office or from Seattle. "The economy in BC is red hot right now and working in the heart of one of BC's most popular resorts comes with unique challenges," explained Serge Moalli, Project Manager for FK. Some of these include grizzly bear mating zones near the laydown area and campers that encroach on the site every weekend.

As with everywhere in western Canada, recruiting and retaining personnel has been another pressing challenge. "About 80% of the crew at Ashlu are local hires with little construction experience if any," said Moalli. "Many are part-time ski patrollers at Whistler so recruiting employees to work in a tunnel and turnaround of our workforce, has been a major issue."

Training has been a priority. As Dave Watson, Field Engineer for FK explained: "The industry as a whole is far safer now than it used to be and on this project we give the crews a lot of safety training, especially since the average age is in the early 20s and about two thirds of them are new to the tunneling business. We spend a lot of time on the operating procedures for example. Procedures such as the whistle signals for operating the muck skip dump station and the horn signals for the locomotives."

To late February 2008, with the TBM about 25% through its drive and despite the skilled labor shortage in the construction industry in western Canada and the inexperience of the young, local-hires, there had been no lost-time accidents to report. ■