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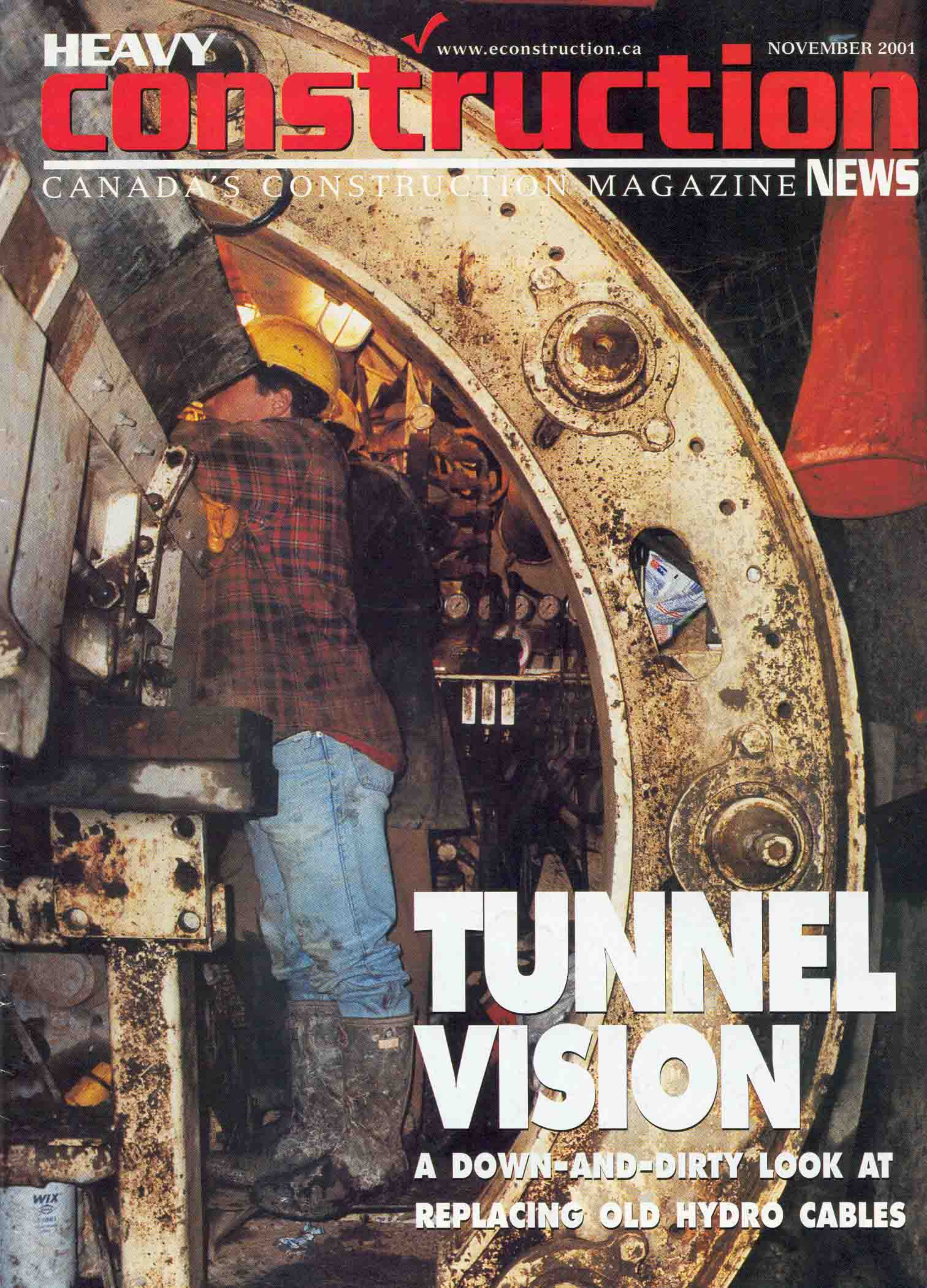


TUNNEL VISION

A DOWN-AND-DIRTY LOOK AT REPLACING OLD HYDRO CABLES

Down and dirty

By Correspondent Tonia Jurbin

With a $24-million budget, five contracts and a duration of 18 months, replacing two underground high voltage transmission cables is keeping Vince Masek, Project Manager for BC Hydro hopping.

The total replacement job is a 3.8 km section of 230 kV cables which includes a 175 m tunnel under the Trans-Canada Highway, the exit and entry points of which are located in parks.

Originally installed in the late 1950s with a design life of 40 years, the cables are an integral part of the system that serves Burnaby, South Vancouver and downtown if needed.

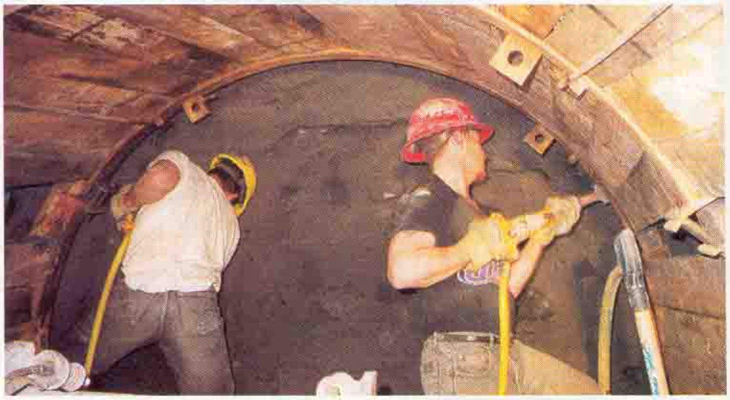
Circuit outages were in the planning and tender documents in the works when a number of oil leaks from one of the cables occurred. Oil leaks, understandably, are a major concern because they can contaminate the groundwater and nearby watercourses and cause maintenance problems, not to mention $200,000 per repair.

As a result, the cable was taken out of service and the schedule including the design and cable manufacturing was accelerated.

The largest contract, $10.8 million, was awarded to Fujikura America Inc. of Marietta, Georgia to supply and install the made-in-Japan cable. Before new cables could be installed, however, other contracts had to be completed.

Jack Cewe Ltd. of Coquitlam, BC, did the site access and site preparation work worth about $500,000. Access highlights included upgrading a 2 km park road complete with nine water crossings, a modern fish ladder, and a bridge to span the 0.9 m Greater Vancouver

Steel beams and hardwood laggings were used through much of the tunnel.



Workers use pavement breakers in critical area of the tunnel.

A look deep within the TBM controls.

Regional District watermain. Cewe also built a workpad in the swampy north side for the ground improvement and tunneling contractors.

Originally the conduit under the highway was to be directionally drilled, but geotechnical investigations revealed enough boulders to render drilling risky so it was decided to tunnel instead.

Subsurface materials through this part of Burnaby are soft and wet organic silts and peats underlain by a very dense bouldery glacial till with contorted layers of waterlogged sand seams. Because the soft and wet materials are susceptible to liquefaction during an earthquake, a ground improvement program was needed.

The $300,000 soil densification contract was carried out by Agra Foundation Limited of Richmond, BC. The densification method used was unusual in that stone columns were built like Franki Piles instead of using conventional vibro replacement methods. A 7-m long, open-ended steel pile was positioned on 1.5 m centres on a triangular grid.

Once in place, gravel was dropped into the pile and compacted with a very heavy hammer dropped from 5 m. That caused the gravel to bridge in the bottom of the pile. The pile was advanced down to competent soils by hammering on the gravel plug, and the stone columns were built to the surface by continually dumping gravel into the top of the pile while at the same time raising the pile, pounding the gravel into the weak surrounding soils. This method doesn't require the expensive vibro equipment which is subject to wear from working the aggregates, but it is labour intensive.

Each bucket of gravel has to be handled several times by a loader, and a worker has to climb the leads to dump every bucket. About 800 m^3 of gravel went into building 360 stone columns at the Hill Avenue Terminal Station on the north side of the highway. The area immediately surrounding the entry shaft for the tunnel was not densified.

With all of this work complete, contractors started work on the 12-m deep entry shaft for "Rosie," the Tunnel Boring Machine.

The exit shaft on the south side of the highway was already under construction by Dibco Underground Limited, a tunneling contractor from Bolton, Ontario. During this $1.3 million contract, several unanticipated ground conditions threw the schedule off target by about 12 weeks. Most of the delays were attributable to large volumes of sand flowing from the crown of the tunnel into the tunnel. Furthermore, the sheet piling installation at the entry shaft where the till was so dense that the ends started to curl also added to

A view from above showing TBM nose at exit shaft.

the problems.

"The densification columns improved the site drainage while at the same time the pile driving liquefied the undensified saturated sands near the entry shaft as an earthquake might, says Vince Masek.

"The gravel columns attracted the water to our site from the sand seams. Maybe next time we would densify after building the tunnel."

After several attempts, it was decided to lower the 12 m shaft by an additional 4 m to get underneath the wet sand layer. The cavity created by the first try had to be filled before the shaft was deepened using a shotcrete mesh wall with tie-back anchors. Boulders up to 1.5 m dia slowed progress on the second attempt, but when in full production, the 3 m dia, 175-m long tunnel moved forward at a rate of about 13 m per day.

Adding to the excitement, there was also a rescue "Rosie" mission when she got stuck about 32 m from the target. The crews had to build a smaller diameter tunnel from the exit using pavement breakers to rip the till and release boulders.

Worker releases gravel into one of the jobs many caissons.

Duct repairs at an intersection along the route.

As the tunnel advanced, the crew installed the rib sets, the three round "I" beams and hardwood timber lagging. Before the .3 m-thick concrete liner was installed over the lagging, all of the steel connector bolts on the ribs had to be replaced with Teflon rods.

"You cannot have a continuous steel connection around the electrical cables because of induction and hotspots," says Hagen. "Heat dissipation and stray electrical currents are a general concern when designing cable ducts."

Building a fish ladder was just one of the challenges.

Once the liner was installed, eight 203 mm dia HDPE ducts were installed for present and future use, four 76 mm dia HDPE communication ducts, and four 152 mm dia water cooling pipes were also installed for when the cables are operating at the high end of their ratings. When all the ductwork was installed and tested, the annulus was grouted.

Early in the design phase, all of the existing ductwork was inspected using a video camera. Unfortunately the original ductwork construction was typical of that era and when the old cable was pulled out of the first duct, the insulation wrapping got hung up at almost every bend in the alignment causing significant damage.

At least 30 repairs or replacement sections were built for each of the two ducts. BC Hydro crews did about 50% of the ductwork repairs, while Kingston Construction Ltd. of Surrey repaired the balance as extras.

Their $900,000 contract was for all of the station civil and electrical work at ends of the cable replacement including a total of five manholes, some new and some existing.

At the end of the job, the entry shaft was converted into a manhole and the exit shaft backfilled with concrete. ◆