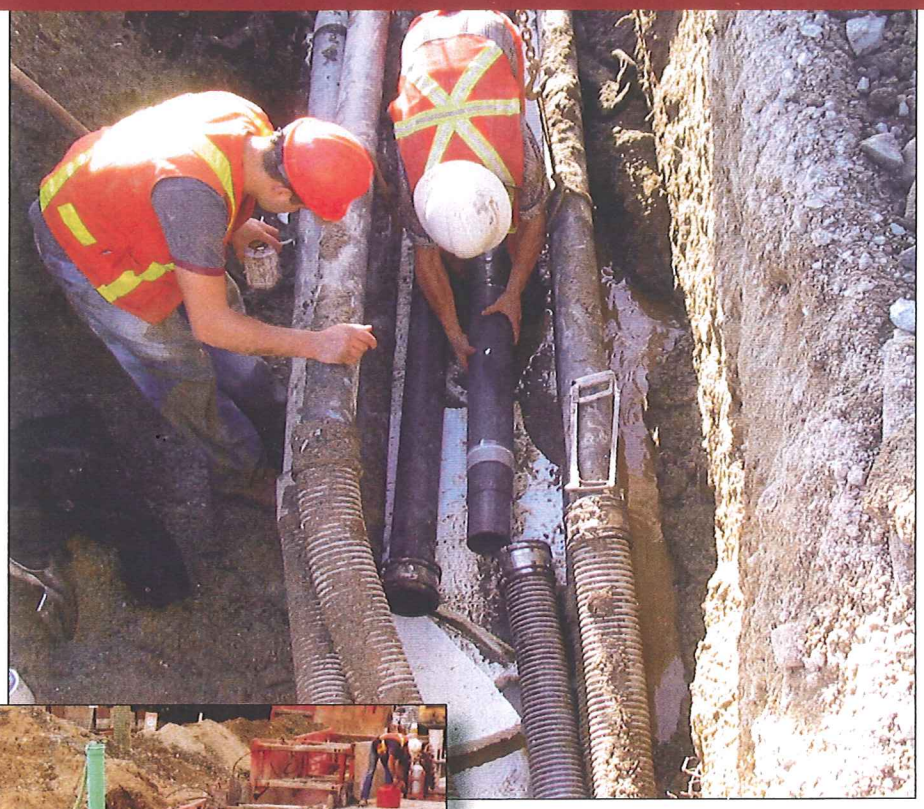
by Tonia Jurbin ■ Contributing Editor

For Peat's Sake



It is always a challenge to run new infrastructure through a congested underground utility corridor in a high traffic developing area, but when you have to worry about whether your 13.8 feet by 7.9 feet by 7.4 feet concrete manholes are going to settle because of the soft soils, or float out of the ground because of the peat and high water table, that makes things a little harder. Add the threat of an earthquake, a fish bearing creek, the nearby tidal Fraser River and it is clear that building in the peatbogs of BC's lower mainland is tough.

In 2002, BC Hydro installed a 2.8 mile long 12kV distribution feeder to serve the rapidly growing industrial park in the 'Big Bend' area of Burnaby, BC. The feeder system is made up of 16, five-inch PVC ducts with manholes every 650 feet. Only four of the ducts had cables installed with the remaining 12 ducts reserved for future expansion. About 1.2 miles of the duct was constructed in peat underlain by soft compressible soils.

The difficulty with installing the ducts was that the combined weight of the ducts and the backfill was heavier then the volume of material, mostly peat, which was removed to install them. BC Hydro is moving away from concrete encased ductwork in soft soil environments on the distribution voltage circuits because in weak soils the concrete will eventually crack, potentially damaging the ductwork and electrical cables.

The city has long had plans for this corridor that is filled with aging infrastructure including a jet fuel line, gas, telephone, water and sewer utilities. The main intersection will eventually be expanded commercially and enlarged. Preloading and moving utilities around has to be phased in due to budget constraints.

Geoff Tsuyuki, manager of contracts and inspections for the city of Burnaby, explains: "We could have put out one large preload contract, but the amount of utilities and the uncertain future development plans on properties adjacent to the site made this impractical. Because of the compressible soils we had to be especially careful with the preload around the existing utilities and, we had to maintain access to the existing businesses. We had known that BC Hydro was planning a new feeder for the area but they had to wait for the demand to justify the expense, so we had to fit these projects into a schedule that had already been established. In fact, coordination between the many utilities along Byrne Road is the biggest challenge for the city."

Experimental design

For this installation, BC Hydro experimented with a design that would accommodate large post construction differential settlement. The ducts were installed with spacers to keep the four by four rows (or eight by two rows) of ducts separate while being backfilled with sand. The whole assembly was wrapped in a geotextile to prevent the fill from washing away into the soft surrounding soils and to add strength and stiffening to the system. Flex joints were designed for connecting the main duct run to the manholes using stainless steel couplings and a tough abrasion resistant vacuum hosing.

A one-foot extension lip around the floor of the manholes was cast to allow for additional backfill to resist the buoyant forces on the manholes during high water. Styrofoam blocks were placed under most of the manholes; the thickness of the block varied from three to four inches with the thickness and the depth of the peat removed. Finally, a tough biaxial geogrid was placed one foot under the temporary pavement slightly larger than the footprint of the manhole vault. The idea was to spread the

upward forces over a larger area during high water levels.

Shortly after the installation was complete, the city of Burnaby placed preload on both sides of Byrne Road, off of the BC Hydro right-of-way, to improve the soils for future utility installations. About 2½ years later, the condition of the underground circuits were inspected. BC Hydro Distribution Engineer Michael Prinsloo picks up the story from here, "Another engineer in my group that was relocating an overhead line decided to inspect the last phase of the new duct. In December 2004, we inspected the ductwork from inside the manholes and discovered that some of the flexible connectors were steeply dipping as they left the manholes (which settled only minimally). We try to avoid sharp angles and bends in the alignment because it increases the pulling tension on the cables and decreases the length we can have between manholes.

"We decided to excavate the worst of the manholes to fully learn the extent of the damage from the settlement which was well in excess of what we had anticipated. It appeared that the top two rows of ductwork had settled up to 12-inches while the bottom rows only settled two to three inches."

A few of the connectors pulled away from the manhole windows, and while repairs were necessary, there was no damage to the cables and more importantly, no outages. The trick now was to design and install repairs at nine manholes before the end of February when Burnaby planned to add up to three-feet of additional fill before paving. Fortunately, most of the cables were in the bottom rows that sustained the least amount of damage leaving the empty ducts to be repaired for future expansion. Or, in the worst case scenario, to pull new cables through if the existing non-repairable ducts had to be abandoned in the future due to additional settlement that would follow from the installation of a permanent pavement structure.

Initially, the BC Hydro designers considered excavating the ducts 30 feet back from the manholes and installing two 11½ degree bends in each of the layers to elevate the entry into the manholes by about a foot. This was deemed labor intensive as each of the nine manholes had 24 ducts to be repaired.

Final design

The final design involved excavating 20 feet back from the manholes and cutting out all the empty ducts. The layers of ducts were replaced, gradually raised from the stub end towards the manhole, and separated by two-inches of closed cell styrofoam. The system was strapped together with steel bands to act as a unit. An expansion joint specially manufactured in Abbotsford, BC, was placed between the newly installed, elevated ductwork and the flexible connectors before entering the manholes at an elevation higher than the manhole windows. That, coupled with the expansion joint which can open up to 20-inches and the flexible connectors, should enable the system to tolerate at least another foot of settlement.

No attempt was made to lift the bottom row of ducts as the settlement was tolerable and further disturbance of the underlying soils would only create further problems with the installation. Fred Thompson from Burnaby, BC, worked on the original installation and completed the repairs in about eight weeks at a cost of about $90,000 CDN ($74,700 US).

"We plan to monitor the settlement by inspecting the dip of the ducts from inside the manholes. Normally we would inspect these on a five year cycle, but in this case we will inspect shortly after the permanent pavement structure is installed and definitely three years after, sooner if we need to install more cables, or, if there are surface indications of excessive settlement," Prinsloo continued. "The biggest challenge for this repair was to come up with a design, source out the expansion joints, and finish the work before the city of Burnaby started paving. We were fortunate that the contractor consistently showed due diligence with his paperwork, safety requirements and was helpful in establishing an efficient method for installing the repairs." ■