

Canada occupies most of northern North America, extending from the Atlantic Ocean in the east to the Pacific Ocean in the west and northward to the Arctic Ocean. The total land area is about 9 million square km. We are the world's second largest country (after Russia) and our common border with the United States is the longest in the world (about 9000 km). Climate varies from temperate in the south to subarctic and arctic in the north.

The Tunnelling Association of Canada (TAC) promotes the use of underground space and modern technology because of its vital importance to our rapidly expanding infrastructure. TAC supports and encourages innovation primarily in the fields of transportation, hydropower, rapid transit, water and wastewater. Measured against other world countries, Canada is relatively young, with a brief history of development of underground space. However, the level of tunnelling expertise within Canada has been extensive, with the large number of tunnels that have been completed in a variety of geological settings, both in soil and rock. Most of Canada's large cities are located in areas of extensive past glacial activity, which has created challenging tunnelling conditions, while our abundant natural resources have created a mining industry with extensive experience in deep, hard rock excavation.

Canada's extensive mining industry is known throughout the world, especially in hard rock exploration and tunnelling. Many of the methods developed in the mining industry have been transposed into the field of underground civil engineering works.

Transportation tunnels are of a paramount importance in Canada due to its vast size, spanning five time zones from the Atlantic to the Pacific coast. Developments of our transportation system and industrial base have been, and still remain, a tremendous challenge, often requiring the necessity to go under rivers or other natural obstacles, and through mountains. The first tunnel in Canada was constructed between 1854 and 1860 near Brockville, Ontario to provide rail access to the St. Lawrence River. From the late eighteenth up to the mid-twentieth century, most major tunnels in Canada were associated with railways including many on the trans-Canada rail lines through the Rockies. Two famous rail tunnels of note were constructed at the end of the 19th century. The St. Clair railway tunnel between Sarnia and Port Huron, built with a Greathead shield equipped with a segment erector, was the first tunnel in North America to be shield driven and the first in which compressed air was used. This tunnel was placed into service in 1891. The second was a world first, an immersed twin-tube tunnel, the Detroit River Rail Tunnel between Detroit and Windsor, which entered service in 1910.

EPB technology was first used in North America to bore a rail access tunnel under the St. Clair River in Sarnia. The Lovat soft ground TBM used was 8.5 m inside diameter and bored a distance of 1868 m at less than half a diameter below the river bed.

Canadian Tunnel activity in 2011

In the transportation sector, new extensions to the existing subway systems in

Toronto and Montreal are in the works. Major Commuter rail system upgrades are planned for the Greater Toronto area. Light Rail Transit systems are also planned for Toronto, Ottawa, Calgary, Edmonton and Vancouver. Many of these new projects, and extensions to existing ones, will involve significant tunnelling and underground works. Eight Lovat EPB TBMs have been recently procured by the Toronto Transit Commission for the Spadina Subway Extension and the underground section of the Eglinton Cross-town LRT project. A Yonge Subway extension is in concept design. New LRT systems are in the planning stages under the downtown area of Ottawa, and for the Evergreen Line extension to the Sky-Train system in Vancouver. On the Trans-Canada Highway, a tunnel is being considered to improve the road alignment through the Kicking Horse Pass in the Rocky Mountains. Also, a new US/Canada cross border tunnel between Detroit and Windsor is in the planning stage.

Perhaps the largest network of sewer tunnels in Canada has been, and continues to be constructed for the York Durham Sanitary Sewer System. Continued growth and development in the Region of York, north of the City of Toronto, has led to the need for additional capacity. Numerous projects have been completed to date totalling approximately 26 km of tunnels; several projects are planned for coming years, including the 15 km South East Collector, which is scheduled to commence in 2011.

The City of Edmonton has taken a unique (for North America) approach to development of its water and wastewater infrastructure. The city maintains its own tunnelling crews and owns several TBMs. Since the 1960's, the City has constructed numerous tunnels, ranging in size from 900 mm to 6.25 m diameter. Tunnel work for further infrastructure improvements will continue this year.

In the hydropower sector, new sites are being studied. Newfoundland & Labrador Hydro proposes the development of a new \$4 billion, 2000MW generating station at Lower Churchill River (Gull Island), Labrador. Hydro-Québec is progressing with the Eastmain - Sarcelle - Rupert project to divert water and develop a new hydroelectric plant on this system of rivers discharging to James Bay. Engineering studies for an additional 300 MW electric power at Columbia Power Corporation's Waneta Expansion site are underway in southern British Columbia. BC Hydro is encouraging the development of small, private hydro generating sites, some of which feature tunnels from 800 m to 16 km in length.

Canada has two internationally acclaimed examples of intelligent use of underground space. Beneath the streets of Toronto, Canada's largest city, lies an underground world full of stores, restaurants, and other amenities that allow the people to shop, browse, dine, or just explore. The "PATH" system, as it is known, comprises 27 km of tunnels, walkways, passages, access to numerous buildings in the financial, entertainment, and shopping districts with approximately 1,200 stores. It links many important buildings and attractions in the downtown area to 6 subway stations and accommodates 100,000 pedestrians daily. Additionally, Montreal contains the world's largest underground complex, of approximately 12 square km, with direct access to 4,300 hotel rooms, 2,700 apartments, 1000 retailers, 68 metro stops, 9 fitness centers, 3 skating rinks and 2 libraries. Both

systems continue to add new facilities each year.

The Future of Tunnelling in Canada

The tunnelling industry is vibrant in Canada, and the future is encouraging. Many tunnel projects are underway but more significantly, several major projects are also in the planning process. The Tunnelling Association of Canada is prominently positioned to take full advantage of this strong tunnel market, and to promote the industry further into the future. We look forward to many years of continued underground work.