



Niagara River – Hydropower Potential

Boro Lukajic

President - Tunnelling Association of Canada-1994-1998

Boro Lukajic, P. Eng. Toronto, Canada

Niagara River



The Niagara River, 56 km (35 mi) in length, flows from Lake Erie to Lake Ontario and has a total drop of about 99 m (325 ft). About 55% of the drop occurs at the Horseshoe Falls and another 40% occurs through rapids upstream and downstream over a distance of about 8 km (5 mi).

Commitments in the 1950 Treaty for scenic flow over Niagara Falls, domestic and navigation purposes require about one-third of the average Niagara River flow and the remainder is shared between Canada and the United States for clean, renewable energy.

The Great Lakes



The Great Lakes, also called the Great Lakes connect to the Atlantic Ocean through the Saint Lawrence River. They are on or near the Canada–United States border. They are lakes Superior, Michigan, Huron, Erie, and Ontario. The Great Lakes are the largest group of freshwater lakes on Earth by total, containing 21% of the world's surface fresh water by volume. By surface area, Lake Superior is the second-largest lake in the world and the largest freshwater one.

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Niagara Falls



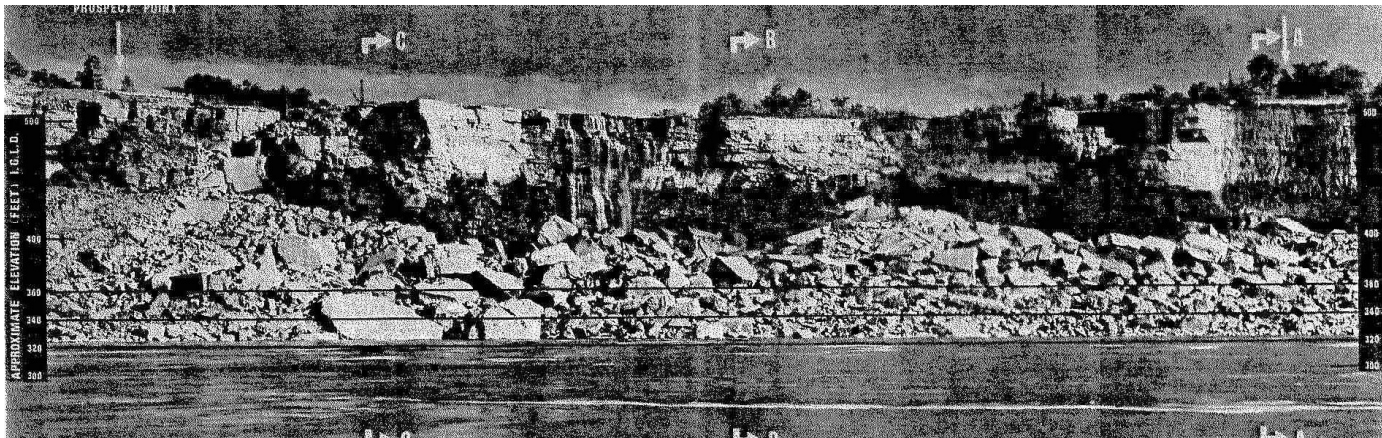
Left : American Falls, right Canadian Falls

The required minimum scenic flow over Niagara Falls is:100,000 cfs (2,832 m³/s) during Tourist Season Daytime (April through October), and 50,000 cfs (1,416 m³/s) during Tourist Season Nighttime and Non-Tourist Season (November through March).

About two-thirds of the average Niagara River flow is available for power generation and is shared equally by Canada and the United States.

The American falls receive approximately 11% of the flow from Niagara River, with most of the rest going over Canadian Falls. It has a straight line crest width of about 830 feet (250 m).

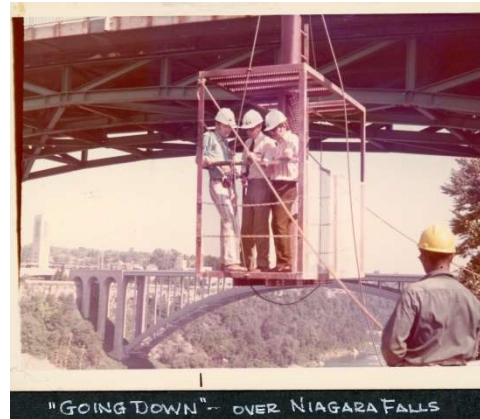
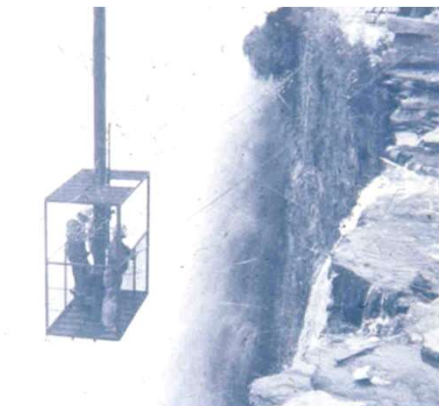
American Falls Dewatering -1969



To survey the rock-fall and determine how to prevent the falls from becoming a series of rapids, the U.S. Army Corps of Engineers blocked the flow of water over the American Falls from June to November 1969. Tourist attendance increased due to the news the Falls was dried off. After inspection, it was decided not to make alterations to the cliff-wall, citing the trend to allow nature to take its course.

American Falls – Remedial Works

Remedial work at upstream and downstream ends of the Falls (at Luna Island and Prospect Point) begin on July 24th 1972, to stabilize major cracks along the edge of the cliff. The Frontier State Parks Commission of New York awarded the contract Darling Construction, with design and supervision provided by Acres American Incorporated of Buffalo, New York.



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Major Canadian Hydroelectric Stations



**Right photo: Sir Adam Beck GS No.1 (SAB1), built in the early-1920's, was the first of the Niagara River hydroelectric stations.
The Sir Adam Beck GS No.2, left photo, was built in the 1950's, and NYPA's Robert Moses GS, built in the 1960's, followed the lead of SAB1 in optimizing capture of the available head.**

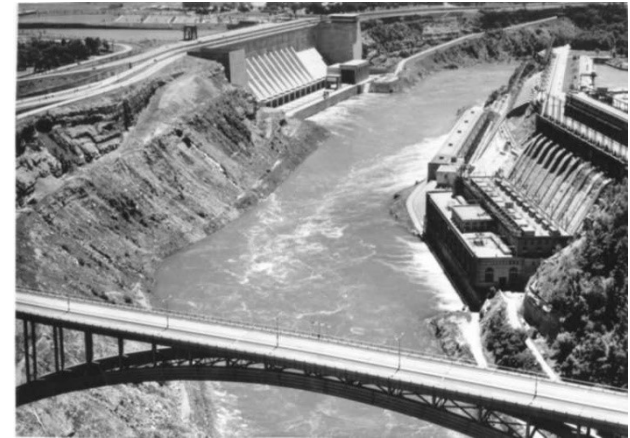
Sir Adam Back 1 and 2



Sir Adam Beck GS No.2 = 1,499 MW (16 units)

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Robert Moses



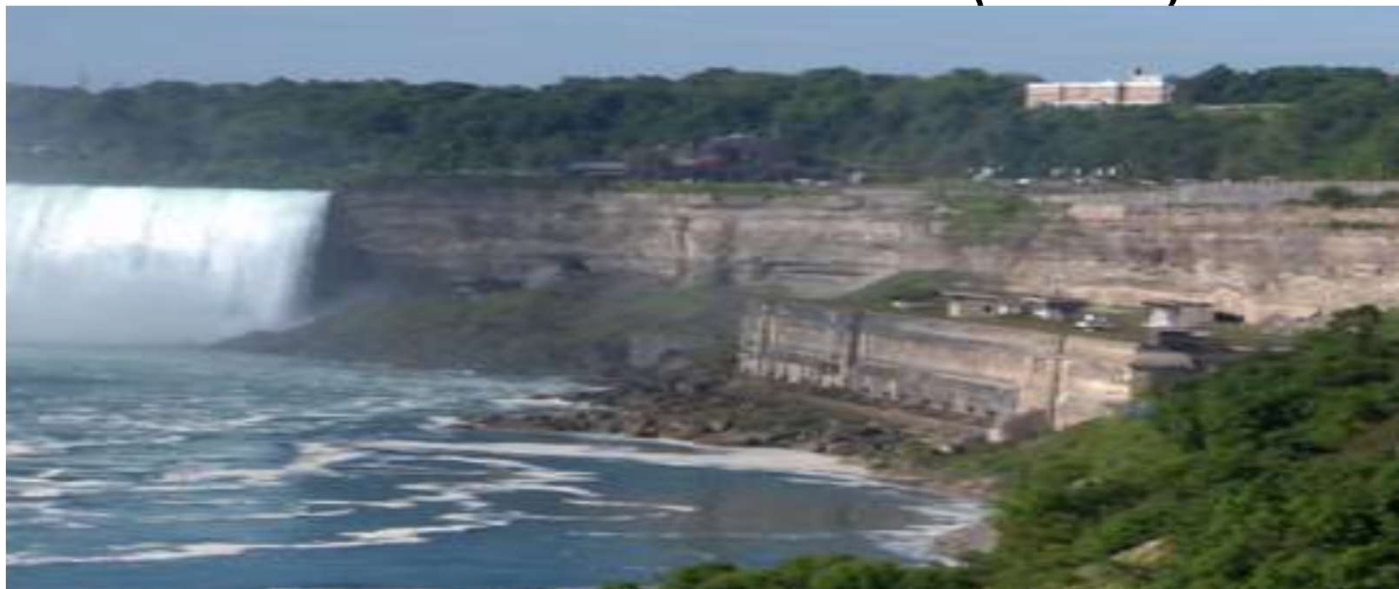
The Robert Moses Niagara Hydroelectric Power Station is a hydroelectric power station in Lewiston, New York, owned and operated by the New York Power Authority (NYPA). It uses 13 generators at an installed capacity of 2,675 MW (3,587,000 hp). Named for New York city planner Robert Moses. It stands across the river from Sir Adam Beck stations in Niagara Falls, Ontario, Canada.

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Cascade Stations



Toronto Power GS 1905 – 1974 = 120 MW (11 units)



Ontario Power GS 1906 – 1999 - 120 MW (12 units)

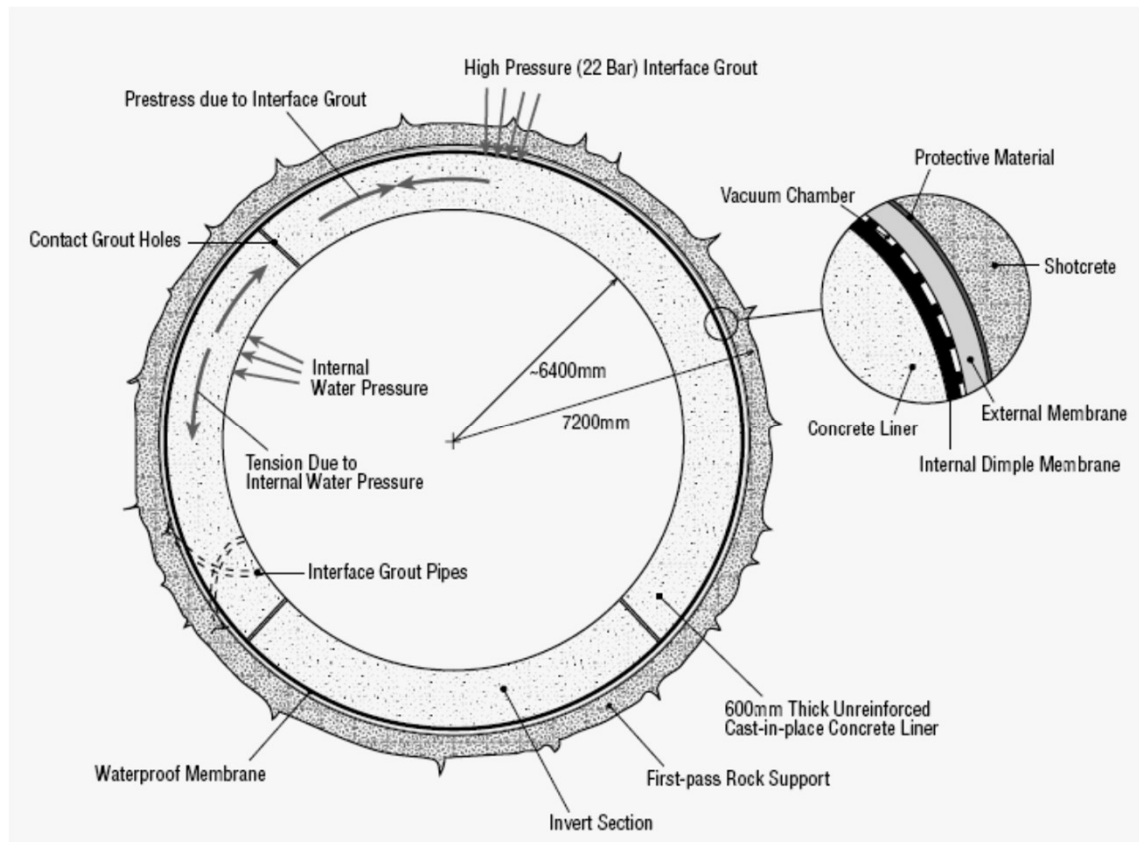
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Niagara – Diversion Tunnel 2006 - 2013



Diversion tunnel, 10.2 km long and 12.7 m in diameter, completed in 2013. Increase water diversion capacity at the Sir Adam Beck complex by 500 m³/s (+27%); Increase average annual energy output at the Sir Adam Beck complex by 1.6 billion kWh (+14%). Budget = \$1.6 Billion.

Niagara – Diversion Tunnels

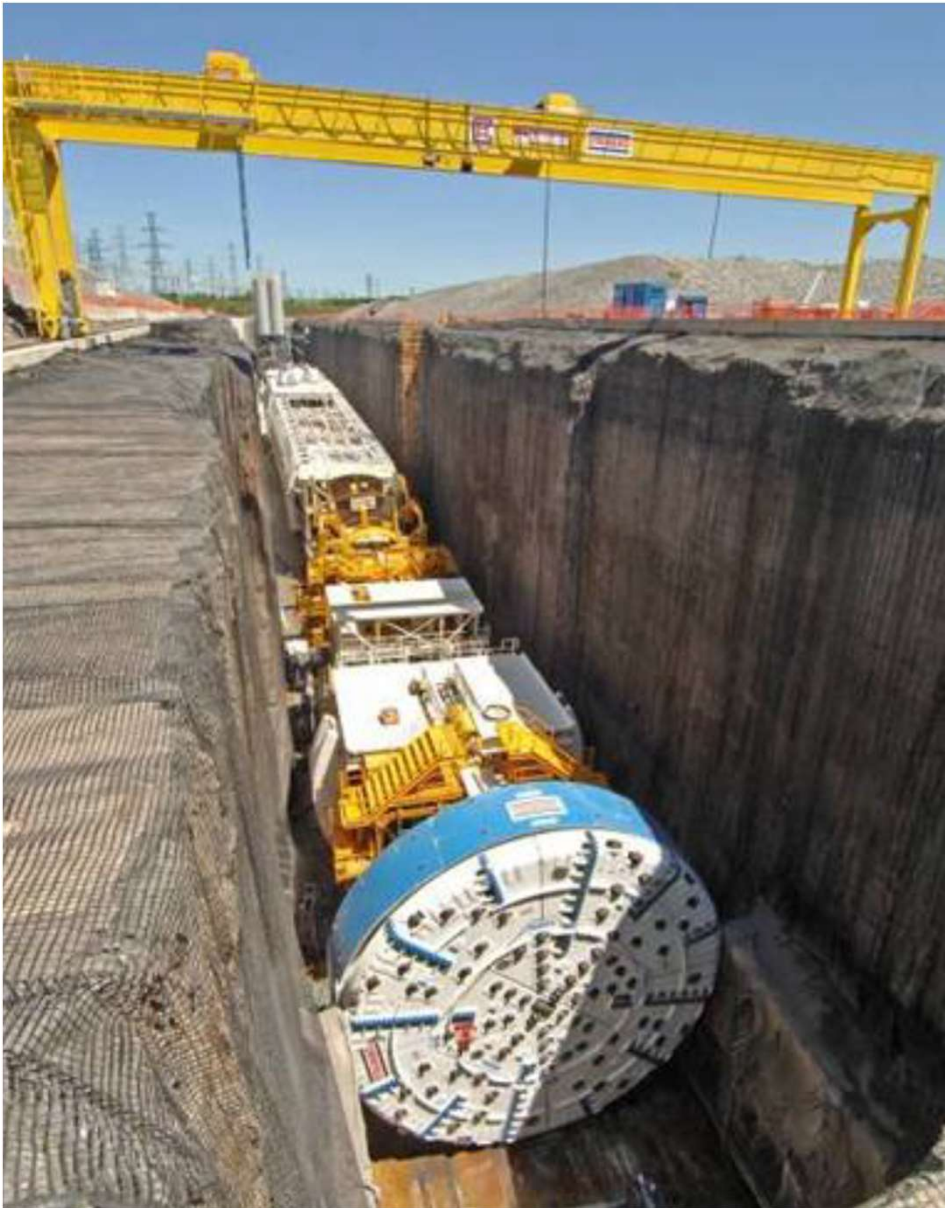


Tunnel Lining:

Impermeable polyolefin membrane to prevent swelling of host shales.

Unreinforced, cast-in-place, pre-stressed, permanent concrete liner, 600 mm thick

Niagara Diversion Tunnel



- **The largest open-gripper hard-rock tunnel boring machine in the world.**
- **Assembled on site May-Aug, 2006.**
- **TBM is 14.44 m high, 150 m long, weighs about 4,000 tonnes and has 85 x 500 mm cutters.**
- **Crew of 20 operates 24 hours per day, 7 days per week to excavate the tunnel.**

Niagara Diversion Tunnel



The arch carrier assembly is about 450m long and includes platforms for handling the ventilation duct and conveyor, for installing the membrane and for concrete placement.

Niagara Diversion Tunnel



Arch Membrane and Concrete near the Outlet

Niagara Diversion Twin Tunnels - 1954



Two 9km-long tunnels to convey the water from Niagara Falls to station. At the time largest excavation by drill and blast in the Western Hemisphere. Each tunnel was 15.51 m in diameter.

Summary

- The Niagara generating stations supply 25 percent (one quarter) of all power used in New York State and Ontario.
- Ontario operates 2 major hydro generating stations and 4 cascading stations along Niagara River, totalling 2,090 MW.
- The Robert Moses Hydro Electric Plant is located in Niagara, New York State, totalling 2,700 MW.
- The Sir Adam Beck Generating Stations and the Robert Moses Generating Station are built directly opposite each other. Both Generating Stations are joined to each others electrical grid system by high voltage transmission lines.

	In-Service Year	Diversion Capacity m ³ /s	Station Capacity MW	Annual Energy TWh	Annual Capacity Factor
Sir Adam Beck No.1 ⁽³⁾	1922	600	417	2.1	
Sir Adam Beck No.2	1954	1,200	1,499	9.6	
Sir Adam Beck PGS	1958	-	174	- 0.1	
Current Totals		1,800	2,090	11.6	0.64
Niagara Tunnel	2013	500	-	1.6	
Totals (Canada)		2,300	2,090	13.2	0.72
Robert Moses	1964	3,000	2,400	14.2	
Lewiston PGS	1964	-	300	-0.5	
Totals (USA)		3,000	2,700	13.7	0.60



Resume – Boro Lukajic – Honours and Awards

- President - Tunnelling Association of Canada 1994 – 1998**
- Engineering Institute of Canada –Fellow 2000**
- Lifetime Achievement Award – Tunnelling Association of Canada 2017**
- Practicing hydro power engineering and tunnelling in Canada since 1968.**
- CEO – Boro Lukajic & Associates Inc**

Boro Lukajic, P. Eng. Toronto, Canada