

THE WELLAND CANAL SECTION OF THE ST. LAWRENCE SEAWAY

The chain of lakes and rivers used by early North American explorers and Canadian fur traders has evolved into the unique and efficient water transportation route, the St. Lawrence Seaway. Before the potential of these inland waters could be fully realized, several turbulent

To circumvent nature's wonder, a man-made wonder was required. The Welland Canal, with its eight large locks, was built to fulfil this need. This canal system, the western section of the St. Lawrence Seaway, ranks as one of the outstanding engineering feats of the twentieth century.



sections located at key points had to be overcome or by-passed. The falls and rapids of the Niagara River presented the major obstacle to an uninterrupted waterway to the American heartland. Until 1829, the only route from Lake Ontario to Lake Erie included a lengthy portage around Niagara Falls from Queenston to Chippawa Creek.

The all-Canadian Welland Canal is the first segment of the modern Seaway to have been built. It connects two of the Great Lakes (Ontario and Erie) and forms an integral part of the deep waterway that allows large lakers and ocean vessels to navigate to and from the heart of North America.

HISTORY

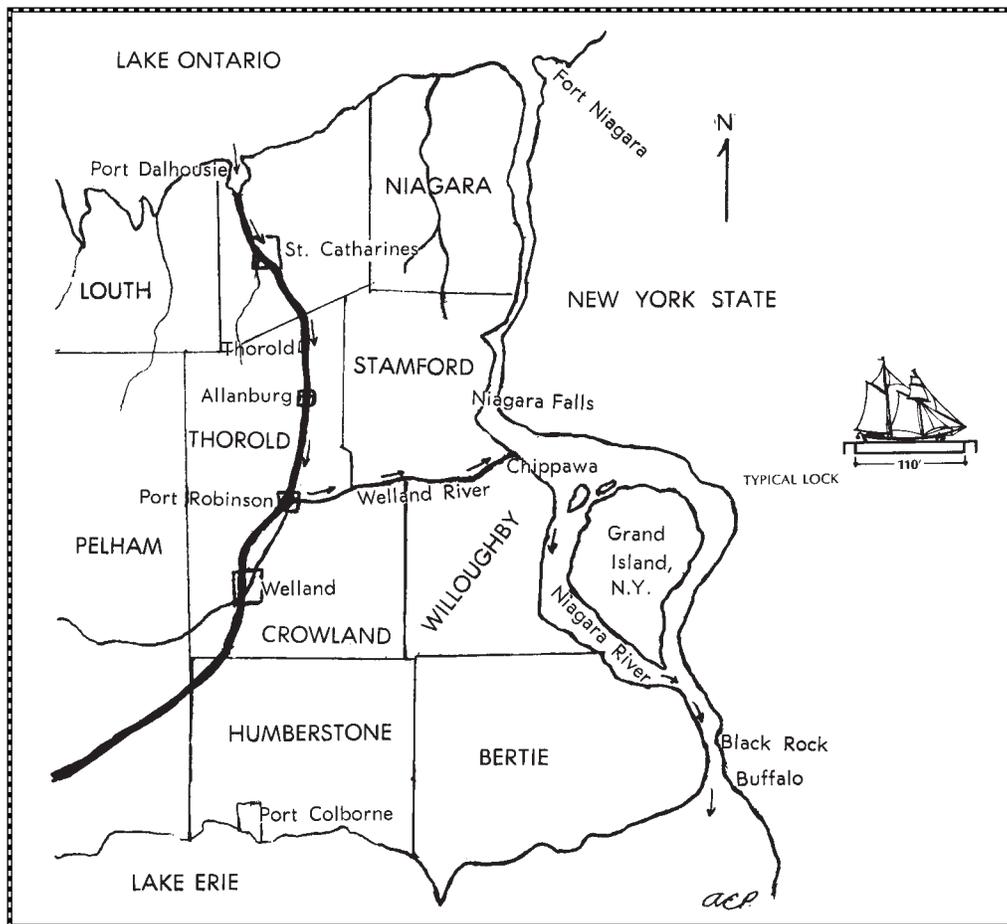
The present Welland Canal, the fourth to be constructed, reflects the evolution of the North American shipping trade during the past 174 years.

The First Welland Canal - 1829-1844

Much of the credit for building the first canal goes to an enterprising businessman, William Hamilton Merritt, of the then Province of Upper Canada. It was the need for a regular flow of water to his mills, coupled with the proximity of the Erie Canal, in the United States, that prompted Merritt to undertake initial engineering studies. In 1824, convinced that the

construction of a canal was feasible, he founded the Welland Canal Company which was financed by government and private sources.

The first sod was turned on November 30, 1824, at Allanburg. Today, a commemorative cairn located at the west end of Bridge No. 11 marks the location of that historical event. The Welland Canal Company pressed on with the gigantic tasks of earth excavation and marine construction, made so much more arduous by the limited tools available at that time. Five years later, the schooner "Ann and Jane" completed the first upbound transit, a two-day voyage.



Wherever possible, natural waterways became part of the canal. From Port Dalhousie, on Lake Ontario, the canal followed the route of Twelve Mile Creek through St. Catharines to Merritton, and up the escarpment to Thorold. In those early years of operation, the canal terminated 8 km (5 miles) south of Thorold, at Port Robinson on the Welland River. Ships then proceeded east on the Welland River to

Colborne, was made the southern terminus of the new 18 km (11-mile) cut. Completed in 1833, the first Welland Canal was 44 km (27 miles) long. There were 40 wooden locks with a minimum size of 33.5 m by 6.7 m (110 x 22 feet) and a depth of 2.4 m (8 feet).

The maintenance of hastily constructed wooden locks proved expensive for the Welland



This painting by J.D. Kelly was commissioned by Confederation Life Association. The schooner "Ann and Jane" is shown entering Lock One, at Port Dalhousie when the Welland Canal opened on November 30, 1829.

Chippawa, and continued up the Niagara River to Lake Erie.

As traffic increased, the canal was extended directly to Lake Erie from Port Robinson in order to avoid the strong currents of the Niagara River. Gravelly Bay, now Port

Canal Company and toll revenues were not sufficient. Appeals were made for additional government assistance and, in 1839, the Government of Upper Canada voted to purchase the privately held company stock.

The Second Welland Canal - 1845-1886

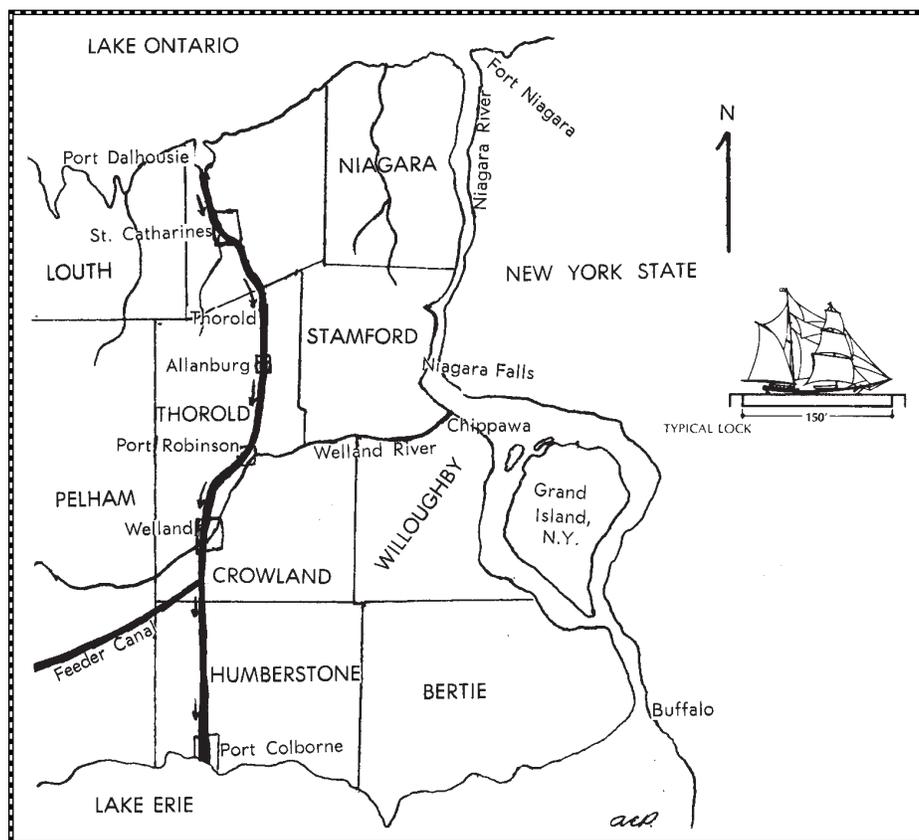
The purchase of the Welland Canal Company was completed shortly after the Union of the Provinces in 1841, and soon thereafter plans were drawn for an improved Welland Canal. Plans were also made for canals and locks of similar dimensions in the St. Lawrence River to provide a direct water route from Montreal to the interior and thus join Quebec and Ontario.

Work began to increase the canal depth to 2.7 m (9 feet) and to reduce the number of locks to 27. The new locks were masonry structures 45.7 m (150 feet) long and 8.1 m (26.5 feet) wide. The route of the new canal was much the same as that of the first since the channels and locks of the original canal became the control weirs of the new works.

Concurrently, a canal of similar depth was completed between Montreal and Lake Ontario

and, by 1848, navigation with a draft of 2.7m (9 feet), was possible from Lake Erie to the lower St. Lawrence River. By that time, steamers had begun to replace sailing vessels; they were larger ships and their number was increasing rapidly. In 1870, a Government-appointed Commission recommended canal improvements. Its report stated that "wheat, lumber, copper and iron from the Upper Lakes would pass through the Welland Canal in increasing amount were it not for the fact that the larger boats cannot go through". The report further pointed out that the existing locks could not handle three quarters of the tonnage that could come from the Great Lakes hinterland.

The Commission's recommendations gave rise to the construction of the third Welland Canal and related improvements on the St. Lawrence River.



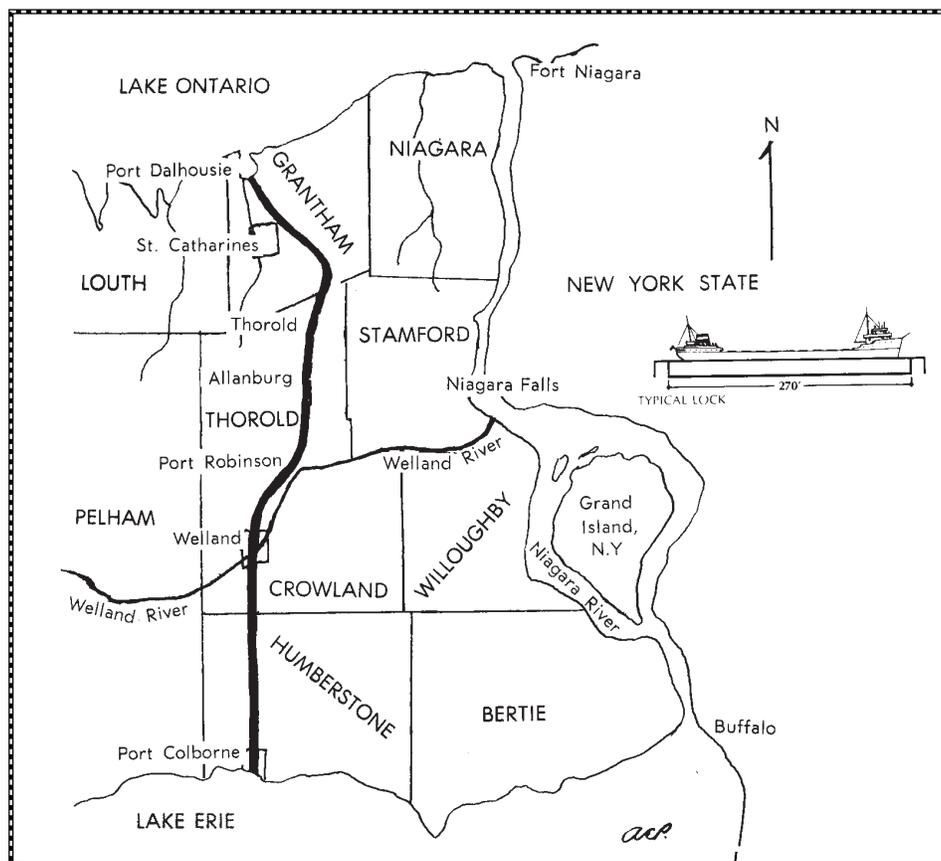
The Third Welland Canal - 1887-1931

The third Welland Canal played an important role in the development of Canada's grain export trade and its steel industry. Following the same route as the second canal from Lake Erie to a point 5 km (3 miles) above the escarpment, it then left Twelve Mile Creek and followed a more direct line to Port Dalhousie.

There were now 26 cut stone locks, each 82.3 m (270 feet) long and 13.7 m (45 feet) wide. Originally, the limiting depth was to have been 3.7 m (12 feet) but it was increased to 4.3 m (14 feet) during construction. These new works were partially opened in 1881 but it was not until 1887 that the 4.3 m depth was available throughout. In 1889, nearly 2,000 vessel transits were recorded, 820 by steamships and 1,141 by sailing vessels.

A distinctive type of vessel was developed for use in the inland canal system. The Great Lakes "canaler", a bulk carrier that is literally a self-propelling barge, with machinery at the stern and navigating bridge up forward, had a long, almost box-shaped cargo hold between. The "canalers" using the third canal had a maximum length of 79.9 m (262 feet) and could carry as much as 2 700 tonnes (3,000 tons).

Larger ships were also built to sail from the Lakehead (Lake Superior) to Port Colborne where their 13 500 tonnes (15,000 tons) of cargo were transferred to several small "canalers". However, it soon became evident that these larger vessels should be able to move into the lower lakes and, between 1907 and 1912, plans were made for enlarging the canal once more.



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The Fourth Welland Canal

Studies led to the decision to build locks of greater size and to reduce their number as much as possible. An almost direct north-south route was selected and the Lake Ontario connection was moved to Port Weller, 5 km (3 miles) east of Port Dalhousie. Since no natural harbour existed at Port Weller, an artificial one was created with embankments extending 2.4 km (1.5 miles) into Lake Ontario.

Construction of the canal started in 1913, was interrupted by World War I, resumed in 1919 and continued until 1932.

"It is a privilege to dedicate this canal to the trade of the world. I hereby declare the Welland Canal open to the commerce of the world." Those were the words of the Governor General of Canada, the Rt. Hon. Earl of Bessborough, as he officially opened the canal, on August 6, 1932.

Into the lock chamber eased the S.S. "LEMOYNE", then the largest freighter on the Great Lakes. Her holds were filled with some 19 000 m³ (530,000 bushels) of wheat. The S.S. "LEMOYNE" was 192.9 m (633 feet) long, had a beam of 21.3 m (70 feet) and was sailing that day on a draught of 5.9 m (19.5 feet).



THE PRESENT WELLAND LOCKS

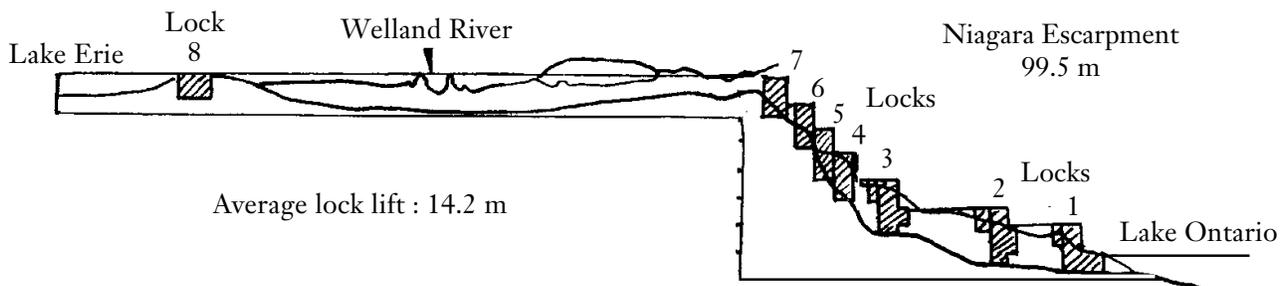
The difference of 99.5 m (326.5 feet) between the levels of Lake Ontario and Lake Erie is now overcome with eight locks and 43.4 km (27 miles) of canal. Each of seven lift locks has an average lift of 14.2 m (46.5 feet) while Lock 8 at Lake Erie is a control lock with a shallow lift varying from 0.3 to 1.2 m (1 to 4 feet) to make the final adjustment to the lake level.

Overall length of canal	43.4 km (27 miles)
Total lift	99.5 m (326.5 feet)
Average lift of locks	14.2 m (46.5 feet)
Size of locks (breast wall to gate fender)	233.5 m (766 feet) long 24.4 m (80 feet) wide
Depth of water (over the sill)	9.1 m (30 feet)
(in channels)	8.2 m (27 feet)

The seven lifts are located in the northern 11.6 km (7.2 miles) section of the canal, between Lake Ontario and the top of the Niagara escarpment. A 27.8 km (17.3 miles) man-made channel runs through level ground to the shallow-lift control lock at Lake Erie. Piers projecting into the lakes account for an additional 4.0 km (2.5 miles).

The Welland Canal provides more than half the lift needed between tidewater and the Lakehead.

WELLAND CANAL PROFILE



IMPROVEMENTS

When construction of the St. Lawrence River sections of the Seaway began, in 1954, the available governing depth of the canal was 7.6 m (25 feet). To bring it to Seaway standards, dredging was undertaken by The St. Lawrence Seaway Authority to reach a governing depth of 8.2 m (27 feet). On the other hand, the lock dimensions of the Welland Canal were adopted as the governing dimensions of the Seaway locks constructed on the St. Lawrence River during the 1954-1959 period.

With the increased traffic generated by the completion of the Seaway, and the fluctuation in the arrival rate of vessels, often combined with unfavourable weather conditions, queuing problems resulted signalling transit demand was at times close to the capacity limit of the canal.

Early in the 1964 navigation season, a coordinated program of operational improvements and major construction work was initiated. In 1967, a new traffic control centre using closed circuit television and telemetry, considerably improved the scheduling of vessels and helped to reduce the lock cycle and round-trip transit times. Other improvements included the installation of variable intensity lighting along the southern half of the canal, the automation and centralization of controls at Locks 1, 2, 3, 7 and 8, the extension of lock approach walls, the widening of several canal sections, modifications to lock hardware and the installation of navigation signal light displays at the locks.

In more recent years, the capacity of the canal has been further increased by the elimination of the guard gate south of Lock 7, Thorold, which was made obsolete by the

addition of sector gates at Lock 7, and the widening of the channel north of Port Robinson.

The same year marked the beginning of the Welland Canal Rehabilitation Program. This seven-year, \$175 million project, funded by the Government of Canada, covered the major civil engineering refit of all primary facilities.

The Welland Realignment

By far the most beneficial improvement to the Welland Canal was the construction of the Realignment - often referred to as the "By-Pass" - which opened to navigation in March of 1973. This new channel replaced a 14.6 km (9.1 miles) section of the Welland Canal that bisected the City of Welland.

After studying various alternative solutions, the realignment project was adopted. Government approval having been granted in May of 1966, the Authority immediately proceeded to buy or expropriate the 2,600 hectares (6,500 acres) of land required for the new route. By the summer of 1967 the giant task was underway. The main channel required the removal of some 50 million m³ (65 million cubic yards) of earth, clay rock and silt.

One of the first undertakings of the project was the construction of a siphon to divert the waters of the Welland River under the new navigation channel. Building a new course for a waterway, although not an easy task, is a common engineering procedure today; making an underground stream out of a full size river is something else again!

Located near the Port Robinson end of the channel, the reinforced concrete box culvert designed to meet this challenge is a four-tube siphon, 28.7 m (94 feet) wide and 194.5 m (638 feet) long. Founded on bedrock, it can accommodate a maximum flow of 340 m³ (12,000 cubic feet) of water per second. Upon its completion, in the spring of 1971, the waters of the Welland River were rerouted through a new diversion channel leading to it and the old river bed was filled in.

Ancillary to the main project itself was a major revamping of the road and rail network in and around the City of Welland. The rail relocation was the most complicated and expensive since it involved the building of 161 km (100 miles) of new trackage and marshalling yards, a new station and freight depots as well as a new control centre. The project necessitated the relocation of some 80.5 km (50 miles) of north-south and east-west road arteries under the jurisdiction of provincial, regional and municipal authorities.

The construction of the new channel, the two tunnels running under it and the road relocations called for the installation of new public utilities. Several miles of hydro, gas, telephone and sewer lines had to be laid by the various agencies involved. This phase of the project gave the area new landmarks that are visible for miles. Ontario Hydro erected two of

the highest transmission towers it has ever constructed on either side of the channel. They were designed to provide passing ships a 36.6 m (120-foot) clearance under the high voltage cables they support. In addition, a modern lighting

system was strung along the sides of the new channel to allow safe transit after dark.

As a replacement for several docks on the old canal which were used by local industries, The St. Lawrence Seaway Authority built a 305 m (1,000-foot) dock on the west

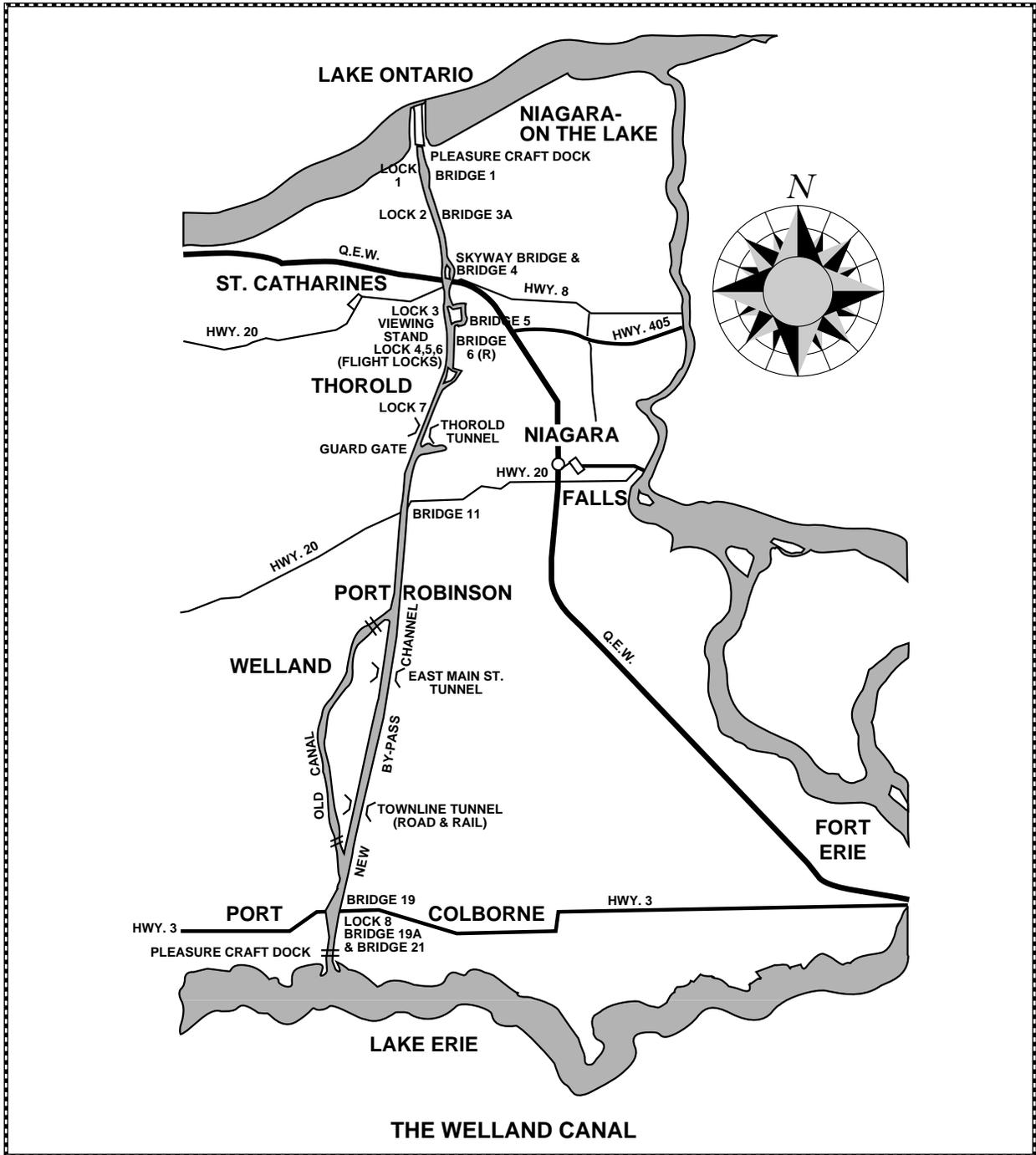


side of the new channel near Ontario Road. It is built on steel supports, has a reinforced concrete deck and it can easily handle the largest lakers and ocean vessels that use the canal.

The Welland Realignment is a comparatively straight 13.4 km (8.3 miles) canal running south from Port Robinson to Ramey's Bend. It provides a navigable 106.7 m (350-foot) width and a 9.1 m (30-foot) depth, without any overhead obstructions such as bridges, since all land traffic is handled by two tunnels. The water level in the new channel is maintained at an elevation of 173.4 m (569 feet) above sea level.

The Present Welland Canal

Operations statistics bear evidence that the use of the Welland Realignment has resulted in safer and faster navigation while the delays to highway and rail traffic have been nearly eliminated. Furthermore, the foresight which went into the planning and design of the new channel will allow it to be incorporated, with little or no change necessary, into any future canal improvement across the Niagara Peninsula.



LOCK PROCEDURES

Ships move under their own power during their entire transit of the Welland Canal and its locks. Once a vessel has been securely moored in the lock chamber by a crew of Seaway linehandlers, the huge steel lock gates close behind it and valves are put into operation to fill or empty the lock by gravity flow. About 91 million litres (20 million gallons) of water are required for each lock transit.



The time needed to fill a lock is approximately 11 minutes. As the new level is reached, the forward gates are opened and, at a sign from the spotter, a short blast of the ship's whistle signals "cast off" and the vessel proceeds out of the lock. Some 32 vessels could go through a lock on a very busy day.

IMPORTANT TRADE ARTERY

Vessels 225.5 m (740 feet) long, 23.8 m (78 feet) wide and loaded to a draft of 8 m (26 feet 3 inches) now travel through the Seaway locks. These large ships may carry as much as 29 000 tonnes (32,000 tons) of iron ore or 38 700 m³ (in excess of one million bushels). Iron ore and wheat constitute the most important commodities carried through the canal and the two-way nature of their movement, i.e. grain downbound, iron ore upbound, is significant to the economy of the Great Lakes region, and indeed of the entire continent.

It is rather doubtful that the rapid expansion of the Quebec-Labrador mining complex would have taken place without the Seaway, of which the Welland Canal was the forerunner.

An efficient and cost-competitive Seaway also plays a key role in strengthening Canada's position in global trade. Marine transportation is critical to a number of export markets, including wheat grown in the Prairies.

Grain is brought downbound through the Seaway from Canada's Lakehead to ports on the lower St. Lawrence River. After unloading wheat destined for shipment to foreign ports aboard ocean vessels, the lakers may be loaded with iron ore at one of the nearby ports serving the great ore fields of Quebec and Labrador. Fully loaded on the return trip, the ships either take their cargo to Hamilton or move up through the Welland Canal to steel plants located on the shores of Lake Erie.

Other bulk commodities carried through the Welland include corn, barley, soybeans, coal, fuel oil and other petroleum products. In addition, project cargoes (i.e. a large gas turbine assembly destined for a co-generation plant) also utilize the Seaway in order to reach their intended destinations.

The Welland Canal has played an important role in supporting economic growth throughout Canada. Since the opening of the Seaway in 1959, tens of millions of tonnes of cargo have been shipped every year via this critical shipping channel. Latest traffic statistics

can be obtained on our Web site: www.greatlakes-seaway.com. The Welland Canal continues to be a vital artery connecting the major industrial areas of the North American heartland, thus providing a valuable link with the world's trading nations. It generates an economic impact of \$222 million in the Niagara Region alone each year and is considered one of the biggest employers in the Region.



The Welland Canal Twinned Flight Locks

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