Niagara Falls Geology Facts & Figures

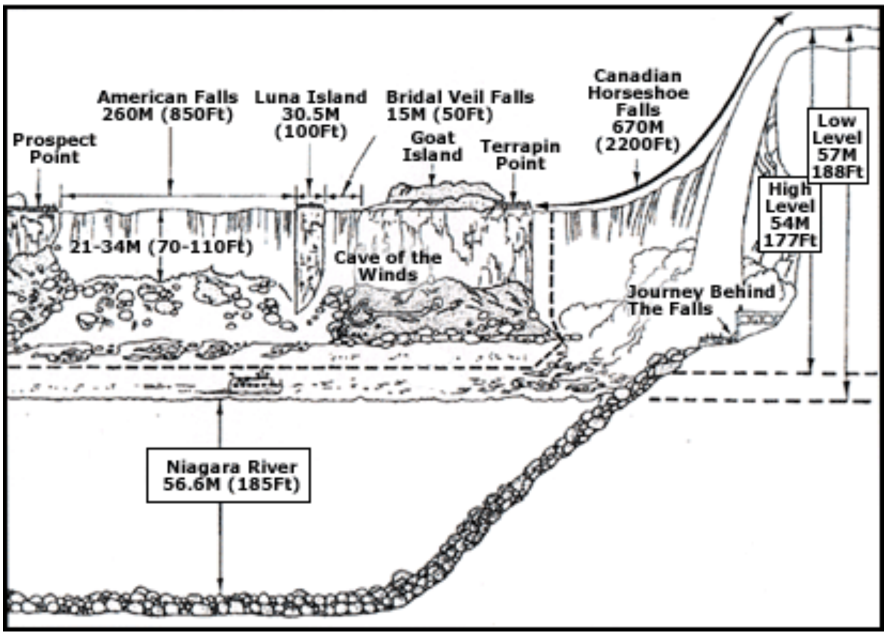
How High is the Falls? How fast is the water?

Here are some of the numbers...

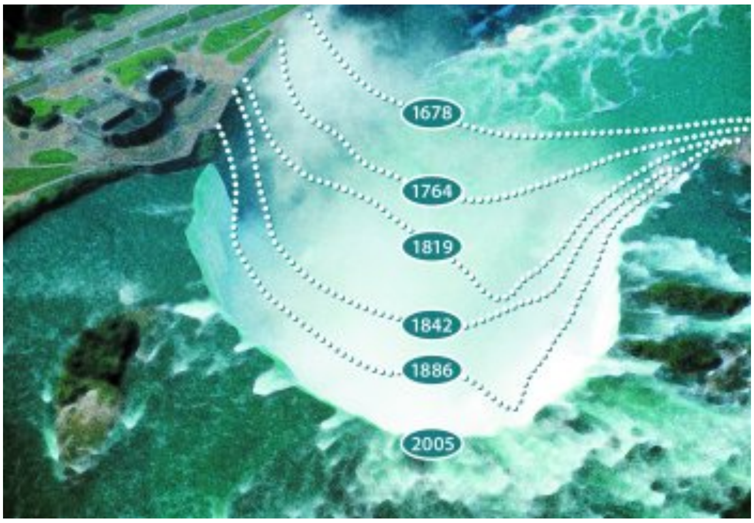
- The Niagara River is about 58 kilometres (36 mi.) in length and is the natural outlet from Lake Erie to Lake Ontario.
- The elevation between the two lakes is about 99 metres (326 ft.), half occurring at the Falls themselves.
- The total area drained by the Niagara River is approximately 684,000 square kilometres (264,000 sq. mi.).
- The average fall from Lake Erie to the beginning of the upper Niagara Rapids is only 2.7 metres (9 ft.)
- Below the Chippawa-Grass Island Pool control structure, the river falls 15 metres (50 ft.) to the brink of the Falls.
- The deepest section in the Niagara River is just below the Falls. It is so deep it equals the height of the Falls above, 52 metres (170 ft.).
- The Upper Niagara River extends 35 kilometres (22 mi.) from Lake Erie to the Cascade Rapids, which begin 1 kilometre (0.6 mi.) upstream from the Canadian Horseshoe Falls.
- At Grand Island, the Niagara River divides into the west channel, known as the Canadian or Chippawa Channel, and the east channel, known as the American or Tonawanda Channel.
- The Chippawa Channel is approximately 17.7 kilometres (11 mi.) in length and varies from 610 to 1220 metres (2,000 to 4,000 ft.) in width. Water speed ranges from 0.6 to 0.9 metres per second (2 to 3 ft. per second). This channel carries approximately 60% of the total river flow.
- The Tonawanda channel is 24 kilometres (15 mi.) long and varies from 460 to 610 metres (1,500 to 2,000 ft.) in width above Tonawanda Island. Downstream, the channel varies from 460 to 1220 metres (1,500 to 4,000 ft.) in width. Speed ranges from 0.6 to 0.9 metres per second (2 to 3 feet per second).
- The Niagara Gorge extends from the Falls for 11 kilometres (7 mi.) downstream to the foot of the escarpment at Queenston.

Is Niagara the highest falls in the world?

View of the Falls from the Canadian side



- About 500 other waterfalls in the world are "taller" than Niagara. The Angel Falls in Venezuela is tallest at 979 metres (3,212 ft.). However, some of the tallest falls in the world have very little water flowing over them.
- It's the combination of height and volume that makes Niagara Falls so beautiful.
- More than 168,000 cubic metres (6 million cubic ft.) of water go over the crestline of the Falls every minute during peak daytime tourist hours.
- The Canadian Horseshoe Falls drops an average of 57 metres (188 ft.) into the Lower Niagara River.
- The crest line of the Canadian Horseshoe Falls is approximately 670 metres (2,200 ft.) wide. The plunge pool beneath the Falls is 35 metres (100 ft.) deep.
- The height of the American Falls ranges between 21 to 34 metres (70-110 ft.). This measurement is taken from the top of the Falls tothe top of the rock pile at the base, called the talus slope. The height of the Falls from the top of the Falls to the river is 57 metres (188 ft.). The crest line of the American Falls is approximately 260 metres (850 ft.) wide
- The rapids above the Falls reach a maximum speed of 40 km/hr or 25 mph, with the fastest speeds occur at the Falls themselves (recorded up to 68 mph.) The water through the Whirlpool Rapids below the Falls reaches 48 km/hr or 30 mph, and at Devil's Hole Rapids 36km/hr.



- The Niagara River is a connecting channel between two Great Lakes, Erie and Ontario.
- Niagara Falls has moved back seven miles in 12,500 years and may be the fastest moving waterfalls in the world.

Where does the water come from?

- The Great Lakes is the world's largest surface freshwater system in the world, about 18 percent of the world's supply.
- The volume of water in the Great Lakes would cover North America in about 1 metre (3.5 ft.) of water.
- The water flows from streams and rivers that empty into the Great Lakes, from Lake Superior down through Niagara to Lake Ontario, then into the St. Lawrence River to the Atlantic Ocean. Water always flows down to the sea, and the land slopes downward through the Great Lakes Basin from west to east, but the Niagara River actually flows north.
- Today, less than one percent of the water of the Great Lakes is renewable on an annual basis (precipitation and groundwater). The rest is a legacy from the last ice age, or "fossil" water.
- There's still water in the Great Lakes because they rely heavily on replenishment/renewal from precipitation (rain, sleet, snow, hail) and groundwater.
- The brown foam below Niagara Falls is a natural result of tons of water plummeting into the depths below. It is not dangerous. The brown colour is clay, which contains suspended particles of decayed vegetative matter. It is mostly from the shallow eastern basin of Lake Erie.

How was the Whirlpool created?

The huge volume of water rushing from the Falls is crushed into the narrow Great Gorge, creating the Whirlpool Rapids that stretch for 1.6 kilometres (1 mi.). The water surface here drops 15 metres (50 ft.) and the rushing waters can reach speeds as high as nine mps (30 fps).

- The whirlpool is a basin 518 metres (1,700 ft.) long by 365 metres (1,200 ft.) wide, with depths up to 38 metres (125 ft.). This is the elbow, where the river makes a sharp right-angled turn.
- In the whirlpool, you can see the "reversal phenomenon." When the Niagara River is at full flow, the waters travel over the rapids and enter the pool, then travel counter-clockwise around the pool past the natural outlet. Pressure builds up when the water tries to cut across itself to reach the outlet and this pressure forces the water under the incoming stream.
- The swirling waters create a vortex, or whirlpool. Then the waters continue their journey to Lake Ontario. If the water flow is low (water is diverted for hydroelectric purposes after 10 p.m. each night) the reversal does not take place; the water merely moves clockwise through the pool and passes to the outlet. Below the whirlpool is another set of rapids, which drops approximately 12 metres (40 ft.).

How Old is the Falls?

The Niagara River does not start small, have many tributaries, and end big like most rivers; nor does it have a typical V-shaped valley, but rather a post-glacial incised valley; this has to do with its Ice Age history.

The Niagara River, and the entire Great Lakes Basin of which it is a part, is a legacy of the last Ice Age. 18,000 years ago, Southern Ontario was covered by ice sheets two to three kilometers thick. As the ice sheets advanced southward, they gouged out the basins of the Great Lakes. Then as they melted northward for the last time, they released vast quantities of melt water into these basins. Our water is "fossil water." Less than one percent of it is renewable on an annual basis, the rest leftover from the ice sheets.

The Niagara Peninsula became free of the ice about 12,500 years ago. As the ice retreated northward, its melt waters began to flow down through what became Lake Erie, the Niagara River and Lake Ontario, down to the St. Lawrence River and on to the Atlantic Ocean. There were originally five spillways from Lake Erie to Lake Ontario. Eventually, these were reduced to one, the original Niagara Falls, at the escarpment at Queenston-Lewiston. From here, the falls began its steady erosion through the bedrock.

However, about 10,500 years ago, through an interplay of geological effects including alternating retreats and re-advances of the ice, and rebounding of the land when released from the intense pressure of the ice (isostatic rebound), this process was interrupted. The glacial melt waters were rerouted through Northern Ontario, bypassing the southern route. For the next 5,000 years, Lake Erie remained only half the size of today, the Niagara River was reduced to about 10 percent of its current flow, and a much-reduced falls stalled in the area of the Niagara Glen.

About 5,500 years ago, the melt waters were once again routed through Southern Ontario, restoring the river and falls to their full power. Then the falls reached the whirlpool.

It was a brief and violent encounter: a geological moment lasting only weeks, maybe even only days. In this moment, the falls of the youthful Niagara River intersected an old riverbed, one that had been buried and sealed during the last Ice Age. The falls turned into this buried gorge, tore out the glacial debris that filled it, and scoured the old river bottom clean. It was probably not a falls at all now but a huge, churning rapids. When it was all over, it left behind a 90-degree turn in the river we know today as the Whirlpool, and North America's largest series of standing waves we know today as the Whirlpool Rapids.

The Falls then re-established at about the area of the Whirlpool Rapids Bridge and resumed carving its way through solid rock to its present location.

Cavitation is a special type of erosion that happens at waterfalls because only at the base of waterfalls is there enough speed to produce enough bubbles close enough to rock to affect it. This is the fastest type of erosion. As the water goes over the falls, it speeds up, loses internal pressure, air escapes as bubbles or cavities. These cavities collapse when the water comes to rest, sending out shock waves to the surrounding rock, disintegrating it.

What kind of rock is in the Great Gorge?

Our river is a young, freshwater system born of ice. But when the falls tore through this section of river 4,500 years ago, it exposed rock layers laid down as sediments in tropical, saltwater seas approximately 400 to 440 million years ago. These layers of clays, muds, sands and shells were then "cooked" under pressure into sedimentary rock.

You will find an excellent view of the strata, one of the most extensive Silurian exposures in Southern Ontario, by looking across the river to the American side as you move out from under the shade of the trees.

Fossils in the Gorge include annelids (worms), bryozoans (look like twigs, branches, crusts, mounds or networks), brachiopods (clam-like), molluscs (clam-like, limpetlike, and snails), echinoderms (flower-like crinoids, still exist in seas today), graptolites (feathery), corals, sponges, fish.

Why is the water so green?

The startling green colour of the Niagara River is a visible tribute to the erosive power of water. An estimated 60 tons of dissolved minerals are swept over Niagara Falls every minute. The colour comes from the dissolved salts and "rock flour," very finely ground rock, picked up primarily from the limestone bed but probably also from the shales and sandstones under the limestone cap at the falls.

How is the water used?

The waters of the Niagara River are used by a combined Canada/United States population of more than 1,000,000 people for a wide range of purposes such as:

- Drinking water
- Recreation (boating, swimming, bird-watching)
- Fishing
- Industrial cooling water supply
- Receiver of municipal and industrial effluents
- Hydro-power generation (Sir Adam Beck Station in Ontario & New York State Power Authority)

How much water is diverted?

The Great Lakes in general are very sensitive to high-or-low precipitation years, and this can affect the flow from Lake Erie into the Niagara River, however the levels have been regulated by the International Joint Commission (USA and Canada) since 1910.

The basis for determining the amount of water that can be diverted for power generation is contained in a treaty between the Governments of Canada and the United States concerning the "Diversion of the Niagara River," dated 1950, and generally referred to as the "1950 Niagara Treaty."

The treaty requires that during the daylight hours of the tourist season (0800 to 2200 hours local time, April 1st to September 15th and 0800 to 2000 hours local time September 16th to October 31st), the flow over Niagara Falls must not be less than 2832 cubic metres per second (cubic m/s) [100,000 cubic ft. per second (cfs)]. At all other times, the flow must not be less than 1416 cu m/s (50,000 cfs).

The treaty also specifies that all water in excess of that required for domestic and sanitary purposes, navigation and the falls flow may be diverted for power generation.

If the river was allowed to return to natural levels, it would rise probably another 5 metres.

More about the flow of the falls

The term tonnes refers to a metric tonne, also known as a long ton. In this case we are referring to water, which at standard temperature and pressure (STP) weighs one tonne per cubic metre. STP is the weight of water at zero degrees centigrade at sea level which is one atmosphere (atm) of pressure. We can disregard temperature and pressure for this calculation although you should be aware that the mass of water decreases as the temperature rises and/or the pressure decreases.

During the high season, the tourist flow over the falls of 100,000 cubic feet/sec (cfs) converts to 2,832 cubic metres/sec (cms) which would mean that 2,832 tonnes/sec are going over the falls.

The non-tourist flow of 50,000 cfs coverts to 1,416 cms which would mean that 1,416 tonnes/sec are going over the falls.

To convert from tonnes/sec to tonnes/minute multiply by 60. To convert from tonnes/sec to tonnes/hour multiply by 3,600.

What is the future of the falls?

- The falls will continue to erode, however, the rate has been greatly reduced due to flow control and diversion for hydro-power generation.
- Recession for at least the last 560 years has been estimated at 1 to 1.5 metres per year.
- Its current rate of erosion is estimated at 1 foot per year and could possibly be reduced to 1 foot per 10 years.
- The current rate of recession is unclear; assessing its value remains the responsibility of the International Joint Commission. The International Boundary Waters Treaty stipulates the minimum amount of flow over the falls during daytime, nighttime and the tourist season.
- Erosive forces include the action of frost from the spray, the dissolving action of the spray itself, and abrasion action of the softer shales by fallen limestone boulders.
- No one knows when the next major rock fall will occur in the Horseshoe Falls; the effect could be to speed up erosion. A stable position is abandoned when the crest line develops a notch configuration and the Falls retreats relatively rapidly until a new stable position is attained.
- It's also possible that the current or future flow and volume of the river will not be sufficient to carve out a deep enough plunge pool to accommodate rock

falls; in this case, the Canadian Falls could be supported by talus in much the same way as the American Falls.

- The Cascade Rapids above the Falls are about 15 metres (50 ft.) higher than the falls today; once that ledge has been breached, the falls will have an extra 15 metres of force.
- Climate change is also an influencing factor on the future of the Niagara River as an integral part of the Great Lakes Basin; models indicate a drying up of the Basin.
- Isostatic rebound continues to affect the Great Lakes Basin and consequently the flow of water through the Niagara River.
- All things considered, scientists **speculate** that perhaps 2,000 years from now the American Falls could dry up. It is a stationary feature collapsing by rock falls and landslides, carrying less than seven percent of flow before diversion; this bit of water is shallow and spread out, therefore ineffective as a major erosive power.
- As a dry falls, it could appear like the Glen does today.
- The Horseshoe Falls will notch back for about 15,000 years, traveling back about four miles to a softer riverbed (from the southern end of Navy Island to Buffalo/Fort Erie the riverbed is no longer the erosion-resistant limestone but soft Salina shale) after which the rate of erosion will change significantly (remember the bedrock tilts downward to Lake Erie).
- The falls could be replaced by a series of rapids.
- 50,000 years from now, at the present rate of erosion, the remaining 20 miles to Lake Erie will have been undermined. There won’t be a falls anymore, but there will still be a river at work.