

8b.4 What Systems Help Us Navigate the Great Lakes?

Story Extension for This Lesson:

As Sam and Alex proceed along the shores of Lake Ontario, they come upon a natural land feature—the Niagara River and Falls—that acts as a barrier for boat travel between Lakes Ontario and Erie. This piques their interest and they decide to investigate ways in which boating and ship traffic has been enabled in the Great Lakes area.

Grade: 8

Strand: Systems in Action

Big Ideas:

- Systems are designed to accomplish tasks. (Overall expectations 1, 2, and 3)
- All systems include an input and an output. (Overall expectations 2 and 3)
- Systems are designed to optimize human and natural resources. (Overall expectations 1 and 3)

Overall Expectations:

1. assess the personal, social, and/or environmental impacts of a system, and evaluate improvements to a system and/or alternative ways of meeting the same needs
2. investigate a working system and the ways in which components of the system contribute to its desired function
3. demonstrate an understanding of different types of systems and the factors that contribute to their safe and efficient operation

Specific Expectations:

- 1.1 assess the social, economic, and environmental impacts of automating systems

- 1.2 assess the impact on individuals, society, and the environment of alternative ways of meeting needs that are currently met by existing systems, taking different points of view into consideration

- 2.3 use scientific inquiry/experimentation skills (see page 12) to investigate mechanical advantage in a variety of mechanisms and simple machines

- 2.4 use technological problem-solving skills (see page 16) to investigate a system (e.g., an optical system, a mechanical system, an electrical system) that performs a function or meets a need

- 2.6 use appropriate science and technology vocabulary, including mechanical advantage, input, output, friction, gravity, forces, and efficiency, in oral and written communication

- 3.1 identify various types of systems

- 3.2 identify the purpose, inputs, and outputs of various systems (e.g., a garden purpose: to grow things; input: seeds, water, fertilizer; output: flowers, food)

- 3.3 identify the various processes and components of a system (e.g., robot, front-end loader/backhoe, heating system, transportation system, health care system) that allow it to perform its function efficiently and safely

- 3.8 describe systems that have improved the productivity of various industries

Inquiry Skills:

Planning, Designing, Evaluating

Instructions:

Part 1:

Show the two pictures (attached) of the Niagara River and Niagara Falls (with Maid of the Mist below the Falls). They obviously pose problems for the navigation of the Great Lakes. Ask students to brainstorm possible ways to get around obstacles such as rapids, waterfalls, rocky rivers, or other obstructions.

Part 2:

The Welland Canal was built to allow ships to travel between Lake Erie and Lake Ontario, bypassing the treacherous Niagara River and the Niagara Falls.

- Welland Canal resource: <http://www.wellandcanal.com/>

The Great Lakes basin has several canals that facilitate boat and ship traffic: Welland Canal, Erie Canal, Trent-Severn Waterway, and the Soo Locks. In this investigation, students in small groups (two to three students) will investigate one of the various methods used to get ships around natural barriers: canal locks, lift locks, or marine railway. If desired, students could also look at the famous Falkirk Wheel Lock in Scotland or water bridges such as the new one in Germany.

- Falkirk Wheel Lock resource: <https://www.scottishcanals.co.uk/falkirk-wheel/about-the-wheel/how-it-works/>
- Water bridges resource: <http://www.amusingplanet.com/2012/09/3-most-impressive-water-bridges-around.html>

Have students research and analyze their chosen ship transport system, and identify its function, components, inputs, and outputs.

Part 3:

Have students design and build a working model of their chosen transport system. This may involve some research, brainstorming, and definitely trial and error.

Materials List:

Various building materials will be required, depending on student designs. Some suggestions include:

- styrofoam
- plastic containers
- hot glue gun (students should be informed of safety risks and shown how to use it properly: <https://www.gluegun.com/blogs/news/7632387-glue-gun-safety>)

Connections:

Language: Reading and Research skills

Subject Area:

English

Connects to:

Grade 8

Handouts:

- Niagara Whirlpool
- St Lawrence River Regulation

Assessment Strategy:

This assignment could be used as either formative or a summative assessment (assessment for learning or assessment of learning). Students have already had a chance to analyze a system and use Systems Thinking, so this assignment is useful for gauging student understanding of:

- Inputs
- Outputs
- System Processes
- Purpose of a system
- Use of Systems Thinking habits to expand their thinking and problem solving

Use the Technological Problem Solving Continuum from the Ontario Curriculum, Science & Technology, Grades 1 - 8, (pages 17-18) to guide you and your students in co-creating success criteria for this activity.





Lake Ontario St. Lawrence River Regulation

Water flows from Lake Ontario into the St. Lawrence River and passes through the hydropower project near Cornwall, Ontario and Massena, New York. The International Joint Commission approved this project in 1952. During construction, the Commission amended its order of approval with the concurrence of the United States and Canadian Governments. The 1956 amendments added requirements to reduce the range of Lake Ontario water levels, and to provide dependable flow for hydropower, adequate navigation depths and protection for **shoreline** and other interests downstream in the Province of Quebec.



One requirement in the Commission's order was to regulate Lake Ontario within a target range from 74.2 to 75.4 meters (243.3 to 247.3 feet) above sea level. The project must also be operated to provide no less protection for navigation and shoreline interests downstream than would exist without the project. Another provision, known as criterion (k), was included because water supplies would inevitably be more extreme at some time in the future than in the past (1860-1954). When supplies exceed those of the past, shoreline property owners upstream and downstream are to be given all possible relief. When water supplies are less than those of the past, all possible relief is to be provided to navigation and power interests.

Regulatory Facilities

Lake Ontario outflows have been regulated since 1960, primarily through the Moses-Saunders power dam near Cornwall and Massena, about 160 kilometers (100 miles) from the lake. This facility is jointly owned and operated by Ontario Power Generation and the New York Power Authority. Another dam, located near Long Sault, Ontario, acts as a spillway when outflows are larger than the capacity of the power dam. A third structure at Iroquois, Ontario, is principally used to help form a stable ice cover and regulate water levels at the power dam.

The other projects in the St. Lawrence River are not supervised by the Commission.

These include three navigation locks in the international section of the St. Lawrence River, two at Massena and one at Iroquois, Ontario, as well as hydropower and navigation facilities downstream in the Province of Quebec. The Commission doesn't manage the seaway locks because the operation does not affect water levels and flows on a daily basis. The Commission also does not manage the downstream power plants because they are not on the international border and operation does not affect water levels and flows in boundary waters.

Lake Ontario Regulation Plan

The uncontrolled, naturally occurring, water supplies into Lake Ontario are the major factor in determining lake water levels and outflows. The water supplies are inflows from Lake Erie, **precipitation** minus **evaporation** over the lake, and **runoff** from the **basin**. Plan 1958-D, the current plan, specifies weekly outflows based on the **water level** of Lake Ontario and the water supplies to the lake. Generally, higher levels and greater water supplies result in higher outflows, and vice versa. The plan has a number of flow limitations to protect various interests in the St. Lawrence River that may be affected by extreme flows or levels. These include adequate flows for hydropower production, minimum depths for navigation, and protection against **flooding**.

Regulation of Lake Ontario outflows does not ensure full control of Lake Ontario levels or levels downstream. The major natural factors affecting levels (precipitation, evaporation, runoff, inflow from Lake Erie, and wind effects on Lake levels) cannot be controlled. Their prediction is very complex and may not be accurate.

During periods of sustained high or low water supplies, regulation of outflows has helped to make water levels less extreme. During the very low **water supply** period of the mid-1960s, for example, Lake Ontario levels were maintained higher than they would have been without the project. During the high water supply periods of the early and mid-1970s, mid-1980s, and 1993, water levels were held well below pre-project levels, providing considerable relief to shoreline interests.

At the beginning of winter, outflows are usually reduced to help form an ice cover on the St. Lawrence River. After a stable ice cover forms, flows can be increased to offset any flow reductions. Experience has shown that during spring runoff from the Ottawa River which is a major tributary, flooding in the Montreal area has been reduced by temporary reductions in Lake Ontario **outflow**.