

Millbrook Dam Rehabilitation & Upgrade

2020 Canadian Consulting Engineering Awards





Millbrook Dam circa 2003, pre-rehabilitation and upgrade

Built in the 1820s, the Millbrook Dam is historically important to the local community. The Otonabee Region Conservation Authority (ORCA) required the rehabilitation and upgrade of the dam to meet dam safety guidelines whilst maintaining the social significance of the area.

Hatch provided technical investigations, designs, drawings, specifications, procurement assistance, and inspections for critical components. The project involved engineering innovation to resolve foundation material and seepage challenges, while providing an optimized design for spill capacity.

Project Highlights

Innovation

ORCA engaged Hatch to provide upgrade and rehabilitation services for the 200-year-old dam, as it did not meet the requirements of the Ontario LRIA Dam Safety Guidelines. Through all phases of work, Hatch provided services which included conducting geotechnical assessments, feasibility studies, and detailed designs for the Millbrook Dam repairs and spillway upgrades.

The 'As Low as Reasonably Practicable' (ALARP) principle (CDA 2011) was applied to develop a spillway hydraulic capacity solution of concrete spillway and emergency embankment overflow that OMNRF would accept for LRIA approvals. The spillway was designed to:

- Maximize the flow through the concrete spillway structure at a reservoir water level of 216.5metres (crest level of embankment dam) minimum of 1:5000-yr flood. This was accomplished through the use of a u-shaped weir that doubled the capacity of the concrete overflow weir spillway.
- Pass the major portion of the IDF flow through the enlarged concrete spillway structure and over a hardened embankment at the peak reservoir water level, 216.75 metres.



The hydraulic design of the new concrete spillway was verified using Computational Fluid Dynamics (CFD) software FLOW-3DTM. A three-dimensional CFD model of the weir, spillway chute, and stilling basin was developed to:

- Evaluate discharge capacity of the proposed U-shape concrete weir at key reservoir water levels.
- Verify spillway chute water velocity and depth under IDF conditions.
- Verify the adequacy of the stilling basin design—energy dissipation—under the range of design conditions and sensitivity to tailwater level.



Concrete spillway profile



Engineered multi-layer foundation



Millbrook Dam general arrangement

Because of native silty-clay material that was to form the foundation for the new concrete spillway, a multilayer engineered foundation was required to relieve pore pressure under the concrete spillway and maintain an intact foundation under all water level conditions.

A sheet pile wall design was incorporated under the concrete U-shape weir and side walls to provide improved seepage cut-off and vertical stability under the weir and sidewalls, and horizontal stability for the entire concrete spillway chute under design loads by engaging a large weight/depth of the weak native foundation materials to prevent siding.

Laboratory testing of material samples was conducted in Hatch's in-house geotechnical laboratory.









Complexity

The project presented challenges which included:

The exiting spillway was the only outlet for the river/pond

The old penstock was removed, and a temporary weir and outlet channel were installed to release river flows, which allowed for a cofferdam to isolate the old spillway for removal and construction of the new upgraded spillway.

The foundation characteristics under the spillway were not fully understood

To form the foundation for the new concrete spillway, a multi-layer engineered foundation was designed to allow for over-excavation of the native soils and replacement with engineered soil to support the concrete spillway.

Time was of the essence

ORCA was under order to repair the dam within a two-year period and before works could be undertaken, the MNRF must approve the design and drawings: A fast-track design was initiated, and approval was obtained through early open discussions with MNRF. Construction also started early through early coffer dam installation in fall 2017 for removal of the penstock, allowing early start of excavation to avoid environmental restriction periods for in-water work.

The size of spillway required for the IDF exceeded available space

The 'As Low as Reasonably Practicable' (ALARP) principle (CDA 2011) was applied to develop a spillway hydraulic capacity solution that OMNRF would accept for LRIA approvals. The concrete spillway capacity was maximized through the use of a u-shaped weir that doubled the capacity of the concrete spillway, and the remainder of the flow was passed over the hardened embankment dam at the peak reservoir water level.

Social and/or Economic Benefits

Originally built to supply water to a grist and flour mill, the dam, online pond, and creek, Medd's Mountain Park today attracts recreational users to its picnic areas and walking trails.

The town of Millbrook was named as such because of the presence of a mill on a brook. The mill, the dam, and the mill pond are the historic and cultural roots of the community. The dam, although small, is also a large part of what makes Millbrook a historical town. Memories of fishing for Brook Trout in Baxter Creek, canoeing, and skating on the pond are what caused the community at large to express their desire to save the aging dam.

The reconstruction of the Millbrook Dam renewed confidence in dam security and safety to the residents in the village of Millbrook, while the reconstructed dam preserved Millbrook's historical, cultural, and social attributes and characteristics for the enjoyment of current and future generations. Hatch was instrumental in the successful delivery of the project. Their services were completed within the approved timeframe and budget and they maintained their professional support throughout the life of the project that included planning, design, and construction.

> —Dan Marinigh, CAO/Secretary-Treasurer, Otonabee Region Conservation Authority





Environmental Benefits

OCRA staff and volunteers, with the support of the MNRF, rescued and released over 800 fish, crayfish, and frogs that were caught in a pool of water at the base of the Millbrook Dam spillway. This pool was being dewatered to permit the reconstruction of the spillway as part of the Millbrook Dam Reconstruction project. The rescue took place on March 7th, 2018 and resulted in the capture and release of 797 fish (9 species including 275 Brown Trout, 1 Brook Trout, 85 White Suckers, and over 400 Sculpins). In addition, over 200 crayfish and a handful of frogs were also captured and released downstream into Baxter Creek. The contractor FACCA Inc. kept the worksite safe and provided support when needed.

Turtle surveys were conducted prior to construction beginning. Based on the survey results, barriers were installed and maintained during construction to prevent turtles from laying their eggs in the gravel areas around the construction site. Where turtles were observed to be nesting, these sites were marked and protected with fencing.

The pond is an important resting area for geese and ducks and remains as such. Additionally, during the construction phase, otters were observed swimming and fishing in the pond.

Meeting Client's Needs

Hatch was instrumental in the successful delivery of this project. The project was completed within the approved timeframe and budget with Hatch providing professional support throughout the life of the project, including during the planning, design, and construction. This project is both an example of engineering innovation and an illustration of the engineer's role in society.

This was a challenging file to manage for the dam owner. The residents of the community felt strongly about retaining the dam, mill, and mill pond. The historic and cultural significance of the dam outweighed many of the other considerations typical to a dam reconstruction project. Hatch understood this important context and worked to provide effective engineering and design solutions that met the important community cultural needs, while ensuring dam safety standards were met in a cost-effective manner.



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