Lower Mattagami River Project

2016 Canadian Consulting Engineering Awards

HATCH

Project summary

Ontario Power Generation's (OPG) Lower Mattagami River (LMR) project, its largest hydro project in 40 years, added almost 500 MW of power by updating three generating stations and completely replacing a fourth.

Hatch acted as Owner's Engineer for the front-end study and design phases, and as Owner's Representative during implementation.

This $2.6-billion project was delivered on budget and ahead of schedule. It employed 1,200 people, 70% of whom were drawn from local communities.

Little Long: Bird's eye view of the narrow work area sealed off by the cellular cofferdam (seen left).

Project highlights

Complexity

Smoky Falls, built in 1931 with only 52 MW, critically limited the volume of water transmitted through the generation complex of four linked stations. The other three 1960's dams were designed with two extra intakes each. Considering the capacity of modern generating units and water availability, Hatch determined that adding one larger unit at each generating station (GS) would suffice.

With comparable head range at the four stations, OPG sought to balance the flow capacity of each GS and needed to:

- Build a new station at Smoky Falls (3 units of 90 MW, a 275-ton bridge crane, 150,000 m^3 of concrete, 6 intake gates) with a new headrace and tailrace; rehabilitate water-retaining structures and replace 1 of 10 spillway gates; construct new 230 kV transmission lines; and decommission the old station.
- Add one-unit extensions of 68 MW, 100 MW, and 84 MW to the Little Long, Harmon, and Kipling GS (2,000 m3 of concrete, a cellular cofferdam, and generating unit equipment and high-voltage substations at each).

Smoky Falls: Upstream view of the six intakes serving the three units of the new station (March 2014).

Difficult Geology

At Smoky Falls, chloritized rock affected integrity of the rock faces during excavation. Hatch validated the best solution: reinforcement with post-tensioned anchors and pressure-relief drain holes, plus protective shotcrete on a 350-metre-long slope along the right bank of the tailrace and a smaller area on the left bank. Unplanned critical work under unit No. 3 required specialized strand anchors and a redesign of the concrete structure.

Special Dewatering of Working Areas

At Smoky Falls:

- For the upstream cofferdam, an impervious barrier was built by using a cement-bentonite cut-off wall within a dumped granular dyke. Only the portion extending into the reservoir (perpendicular to the dam), which also directs water towards the new station's intake, is permanent.

At other three sites:

- Dewatering congested work areas downstream required construction of non-erodible cellular cofferdams, sealed to the existing stations, allowing generation to continue throughout construction.

Continuing Operation Throughout Construction

- The interdependence of the four sites necessitated a specialized work-planning process. It was essential to replace Smoky Falls' spillway gate No. 5 before commissioning Little Long's turbines (that would increase the water flow from 575 m3/s to 900 m3/sec).
- Use of non-erodible materials addressed the ongoing concern to maintain balance between the river's energy potential and the hydraulic impact on the cofferdams after water passed through turbines at the three extensions.
- Where new construction met existing structures, legacy lead paint was carefully removed and responsibly disposed.

A new station was built at Smoky Falls, including 3 units of 90 MW, a 275-ton bridge crane, 150,000 m^3 of concrete, and 6 intake gates.

Meeting client's needs

From day one until completion of this enormous project, Hatch played a key role. In particular, Hatch developed the Owner's Requirements document; prepared budget cost estimates; prequalified design-build contractors and turbine/generator suppliers; solicited and evaluated proposals; assisted OPG in the final recommendations for selection of the design-build contractor; provided environmental expertise; and delivered Owner's Representative services during construction.

Throughout the project's construction phase, Hatch made sure to maintain a high level of synergy while continually challenging the contractor and OPG in managing numerous requests for changes. Collaboration amongst all participants remained positive from start to finish because Hatch based every decision on preventing errors as well as complying with standards and contract terms.

All stations and their new units were delivered ahead of schedule. Both the Kipling unit and the last unit at Smoky Falls were put into service in December 2014—just before the high energy demand of the holiday season—a bonus for OPG.

"[Hatch's] support with engineering, project concepts and energy modeling, estimating and scheduling, environmental and contract development, and negotiations has been instrumental in getting us to this point,"
— R.J. Jessop, Project Director, Ontario Power Generation.

9

Environmental benefits

The project's Environmental Working Group (EWG), comprised of environmental representatives from OPG, Hatch (as coordinator), Moose Cree First Nation, and Taykwa Tagamou Nation, was mandated to advise the Mattagami Extension Coordinating Committee (MECC) on the 24 terms and conditions of EA approval. Hatch was responsible for coordinating the EWG and preparing various environmental studies to support the development of a post-construction Environmental Effects Monitoring Plan (EEMP).

It was Hatch's responsibility to develop the Western Science Environmental Effects Monitoring Plan (EEMP), and collaborate with OPG and the First Nations to investigate strategies to integrate traditional knowledge methodologies into the overall EEMP (all being equal). An EEMP workshop was organized by the EWG to bring the First Nation Elders, responsible federal and provincial regulators, and Hatch engineers together to discuss how to integrate traditional knowledge and obtain insight from the Elders.

Hatch was also responsible for leading the environmental due diligence audit of the project construction contractor to ensure that the project's environmental commitments and contractual requirements were being achieved. The EWG was responsible for advising the construction contractor on issues related to environmental permitting and site rehabilitation.

Smoky Falls: Installation of the rotor for Unit 1 in March 2014.

Kipling: Successfully dewatered construction area for Unit 3, adjacent to the operating station.

Innovation

Since geological conditions prevented sheet pile from being driven into the rock, the dewatering work required a particularly impressive technical feat: the use of 20-metre-high cellular (circular) cofferdams, which were partly stabilized because of their sheer mass and anchoring. The diameter and height of the cells were determined by the downstream water level from which a drawdown curve within the cell was established to maintain hydrostatic equilibrium. While ingenious, this solution was still very complex given the instability of the riverbed and the fact that power continued to be generated at all stations. In December 2012 a sheet-pile failed in Kipling's No. 3 cell. Despite losing five months to undertake essential reconstruction work and then drain the flooded area, this station's Unit 3 was still delivered ahead of schedule!

Hatch monitored the work proactively and commissioning was rigorously implemented through the use of walk-down validation for subsystems and systems. Particular attention was paid to the concrete semi-spiral scroll cases (distributors) that connect each new turbine to its intake, considering the very precise tolerances for their geometry (location/elevation of structures, flatness) and their impact on overall performance.

Hatch is proud to have contributed to this balancing act between maintaining the proper water level (in particular downstream to submerge the turbines) and achieving peak performance so that the four stations meet their generation requirements for decades.

11

Smoky Falls: Scale of the site before pouring the concrete. View of circular formwork for Units 1 and 2, the only formworks that were so complex they had to be made in a factory.

Smoky Falls: Installation of a turbine with the help of the 275-ton bridge crane.

Social and/or economic benefits

As the only firm involved in all stages of the project, Hatch has significantly contributed to opening the way for future sustainable development, including new professional opportunities for many First Nations workers. Specifically, 350 First Nation people benefited directly from career training with a 96% completion rate. Representing 25% of the workforce, the project allowed these First Nations workers to acquire invaluable training and work experience. On a broader level, the project enabled several First Nations companies to share approximately $250 million in contracts.

First Nations workers will also be actively involved in conducting sampling, data analysis, and reporting during the Environmental Working Group's (with Hatch as coordinator) collaborative efforts to ensure integration of traditional knowledge in the Environmental Effects Monitoring Plan.