



KASHECHEWAN FIRST NATION'S

Flood Control and Forecasting

Annual Fight with Ice

For the Association of Consulting
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Introduction/Project Summary

The Kashechewan Ring Dyke protects a community of more than 2,000 persons in the Kashechewan reserve in Canada's far north. Starting in 2008 Hatch was charged with determining a solution to upgrade the ageing structure such that it would meet modern dam safety standards. During the performance of the assessments Hatch determined there were some serious dam safety defects that put the community at undue risk. The Kashechewan First Nation council asked that the most serious of these be rectified on a priority basis. To meet the challenge, Hatch was mandated by the community to undertake a fast-track design and construction program to install a stabilizing berm within Lower Albany River upstream from the shores of James Bay.

Hatch met the challenge, designing an earthfill berm that made use of materials readily available within the limits of the reserve to create a safe structure that met all modern dam safety standards. The berm was unique in that it featured a one-of-a-kind concrete armour block system to protect the new berm from the erosive effects of the fast flowing River.

The berm design provided significant benefits to the community. The use of locally available materials maximized participation of local labour and equipment. It also largely eliminated the need to import materials to the site, a real

advantage given the fact that the only access to the community during the construction season was by air or barge. The concrete armour blocks were designed specifically to permit the blocks to be constructed by the community members themselves. This design had the dual advantage that the community would participate in the manufacture of the blocks during the construction phase and would allow them to produce additional blocks should maintenance be needed. Following this strategy the project achieved more than 70% local participation.

The project was completed ahead of schedule and 20% under budget. And better, the berm and the precedent-setting concrete armour blocks have stood the test of time, withstanding the severe conditions of the major northern river.

The safety of the community was further enhanced by means of a flood forecasting tool that was designed by Hatch to provide advance warning of a flood large enough to overtop the dyke in order to provide sufficient time for the community to be evacuated in an orderly manner. The development of such a tool was an unprecedented accomplishment. It has been used for three years and has proven to provide accurate two-week look ahead forecast of the complex mechanisms that have the potential to create an ice jam flood.

Project Description

Commencing in 2008 Hatch studied the ring dyke and adjacent riverbank by means of a comprehensive geotechnical investigation and on site assessments. As a result of this work it was determined that there were serious dam safety defects and significant erosion of the riverbank immediately adjacent to the toe of the dyke. These issues significantly compromised the safety of the structure to the point where focused remedial action was needed to be taken on a priority basis. For this reason, Hatch and Kashechewan leaders entered into a fast-track design-and-construction program to implement a solution that would greatly reduce the risks that the dyke/riverbank system posed to the community. In parallel with the planning and preparations for the construction activities, Hatch developed a flood forecasting tool to assist the community elders in making the difficult decision to evacuate if there were a risk of severe flooding.

Rising Challenges

Around the world, dam owners face increasingly difficult decisions about the ways in which finite financial and human resources should be allocated to ensure the continuing safe operation of ageing dams. Without that investment, dam failure is not only a possibility; it is a certainty.

As is the case with many remote communities, the residents rely on a Ring Dyke for protection from the severe flooding caused by ice jams that form downstream of the community during passage of the spring freshet. In severe cases, the ice jam can cause river levels to rise high enough to overtop the structure, an event that would result in severe human, environmental and economic losses. In this context, Hatch was asked by the First Nation Community to undertake an assessment of the structure and provide recommendations for actions that would be needed to ensure the safety of the residents. A review of the original design of the structure coupled with comprehensive geotechnical



Community faces ice flood each spring

investigations resulted in a number of actions that will be implemented in a logical, phased approach.

The most severe dam safety issue was the fact that river bank erosion was occurring at an accelerated rate and, at one section of the dyke, the available berm between the top of the river back and the toe of the dyke was approaching one meter. This posed a clear and immediate danger that the structure could fail, allowing an inrush of water from the Lower Albany River that would sweep away the community.

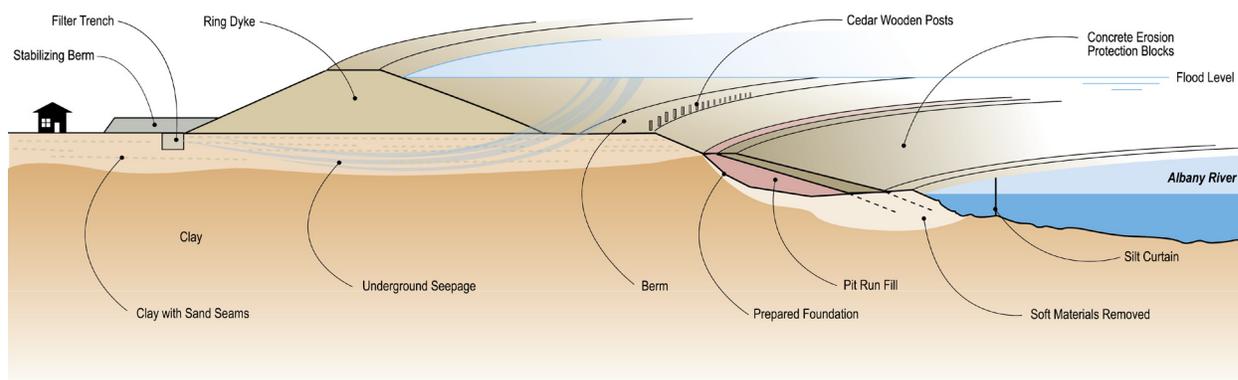
The implementation of a major earthworks program in a remote northern community presented a number of significant challenges:

- All of the designs and permitting had to be completed in a compressed period to allow tenders to be let and construction activities to begin by the middle of August in order to allow the work to be completed within the narrow construction window that exists at this northern site.

- There is no road access to the community during the construction season. Therefore, all materials were to be transported to the site by barge and demobilized by the end of October when the last barge leaves before winter freeze-up. All construction had to be completed in less than three months. Some of the work had to be undertaken in severe winter conditions.
- All of the work would have to be done in the Lower Albany River. The water levels fluctuate due to tidal effects and rise quickly towards the end of the construction season. Therefore, careful planning and scheduling was required to ensure the berm remained “above water”.

Solving the Problem

With the identification of the serious risks that the dam posed to the community, the Kashechewan First Nation leader directed the dam professionals at Hatch to devise remedial measures that would upgrade the safety of the ring dyke/riverbank system to modern standards and that the work



The annual threat of flooding motivates community to fight back

be performed within the time left in that year to avoid exposing the community to the risks of the annual spring flood.

Hatch devised a “fast-track” design-and-construction approach to implement a solution that would buttress the riverbank without interfering with the community’s access to the river. This was a particularly important design requirement to ensure that the community’s traditional access to the Albany River for recreation, transport and fishing and hunting was maintained and enhanced.

The design solution involved the construction of a granular embankment against the toe of the river bank with appropriate filter materials to allow free drainage of water seeping from the bank while filtering the fine-grained soils to prevent erosion. A key to success was ensuring that the granular materials required could be sourced at the site to avoid excessive costs and schedule implications that would occur if the materials needed to be imported. At the start of the construction activities Hatch’s engineers identified a source of materials that could be used without processing that satisfied all of the filter requirements needed to ensure piping of the fine grained river bank materials. This eliminated the need for a separate, processed filter zone significantly reducing costs and enhancing the schedule.

A significant challenge was designing an effective slope protection system that would protect the surface of the granular fill from the erosive effects of the Lower Albany. Typically, a riprap system is used for this purpose. However, there were no sources of suitable rockfill available in the Kashechewan area.

To deal with this challenge, Hatch devised a unique concrete interlocking block system to provide the needed erosion protection to the stabilizing berm. This represented

an unprecedented solution to a complex hydrotechnical problem, but it was the only solution that would permit this essential project to proceed. The problem was that there were no commercially available products that had been subjected to such severe river conditions. Another issue was the fact that maintenance of the blocks would be needed. Therefore, the solution needed to be robust enough to withstand the forces that the river exerted but simple enough that additional blocks could be manufactured on site by community members using available equipment and materials. Hatch’s engineers rose to the challenge and produced an elegant design that has proven to be very effective and one that was manufactured on site by the community.

The Project

Work initiated at the site in July using Kashechewan First Nation Band equipment to strip and prepare the borrow areas and begin hauling the fill materials to a designated location for the earthworks contractor to expedite the tight construction schedule, and enhance community participation in the project.

Construction commenced in August and continued on a seven-day-a-week, 12-hour shift basis throughout the next few months, fighting increasing water levels and deteriorating weather conditions. In total, more than 300,000 m³ of fill were placed and 15,000 concrete erosion protection blocks were manufactured and installed, all within the tight schedule, allowing demobilization to be completed in time to take advantage of the last barge from the site.

The contractor, the community, the client’s project manager and Hatch achieved this remarkable result, despite the almost continuous challenges presented by issues associated with access, weather and working within the community. The



The Albany river berms choked with ice

successful Kashechewan stabilizing berm is a result of a commitment to continuous planning and management of issues as they arose. In the end, Hatch and all of the project participants produced a unique and precedent-setting design that was tailored to the requirements of this important project.

The Ice Jam Flood Forecasting Tool

As a result of a particularly heavy flood in 2006, when the dyke was very nearly overtopped, Hatch was retained by Kashechewan First Nation to assist with developing a remedial action plan for reducing the risk of flooding due to ice-jamming at the community. Identified among the high priority emergency measures was the development of a flood-tool tailored specifically to provide real-time risk assessment of potential flooding of the Kashechewan community. The tool was destined to become a component of the community's spring-time flood-watch program, assisting decision makers in their efforts to ensure the safety of the community.

The foundation for development of such a tool is a good database of historical long-term hydro-meteorologic data collected from within the basin. The focus of data collection is based upon practical considerations. The information needed to be available in real-time and make the best use possible of the traditional knowledge available within the community.

Following this process, Hatch developed an innovative tool that applies correlative relationships for predicting snow melt and consequential flooding from meteorological forecasts of temperature and rainfall. In other words, they developed a simple algorithm for assessing flood risk.

The tool complements and enhances the current flood monitoring program executed by the combined efforts of the Kashechewan community, the Mushkegowuk Council, Emergency Management Ontario, Ontario Ministry of Natural Resources, and Indian and Northern Affairs Canada. It provides a systematic procedure for assembling, manipulating and summarizing readily available data to support as rational an assessment as possible of the ice jam flooding risk on the basis of clearly defined criteria.

The 2008 spring melt served as the first trial application to test and monitor the tool's performance. The tool provided excellent results, in line with observations and predictions using traditional knowledge. However, the community asked that the tool be enhanced to provide a minimum of two weeks advance warning so that evacuation plans could be executed in a planned manner.

Since this initial success the tool has been used in each subsequent spring to assist the KFN flood-watch program. Hatch met the challenge posed by the community. The tool has successfully predicted the potential for flooding for the last four years; and has met and exceeded all of the community's expectations, providing reinforcement and support to the elders' decision-making procedures. It now provides for a pragmatic, disciplined assembly and interpretation of readily available information to obtain an assessment of the risk of ice-jam flooding and the need to prepare for and undertake evacuation of the Kashechewan community.

The tool is truly unique, providing a 10-day look ahead of the potential flood risk based on science that, coupled with the traditional knowledge of the community elders, will allow any future evacuation requirements to be planned and executed in an orderly manner. Development and refinement of this tool and the methodology used to develop it will have applications to other communities facing similar challenges.

News of the tool's existence has garnered interest from Emergency Management Ontario and the Moosonee office of the Ontario Ministry of Natural Resources, who assist with the community's flood watch program. Every spring for the last four years, Kashechewan First Nation has retained Hatch to utilize the tool and provide input to members of the flood-watch program. It has been gratifying to note that the tool has, over the last four spring melts, accurately forecast that flooding would not be an issue at Kashechewan.

Moving forward with the integration of the forecast tool into Kashechewan's flood-watch program, Hatch has trained the Kashechewan



A new, better ring dyke is built

Hood Coordinator, two members of the Mushkegowuk Council and an Area Technician from the Moosonee office of the Ontario Ministry of Natural Resources in its use. Kashechewan First Nations looks forward to adopting this useful tool for the 2012 flood watch program.

Hatch and sub-consultant, WR&PP Inc. have produced a simple and portable software tool for the Kashechewan Flood Coordinator to aid his efforts during the flood monitoring program. The accurate forecasts of no flood over the last four years has recently excited interest in the tool among provincial agencies and is poised to be a useful reference to Kashechewan flood monitors.

The Environmental Benefits

The Kashechewan community has a long tradition of respecting the environment and using its resources for food and building materials as do all aboriginal communities. Hunting and fishing, in particular, provide a source of recreation and food. In the north the ecosystem is fragile and even minor disturbances can result in losses that take years to recover from.

Failure to have completed this project would have resulted in significant risks associated with irreversible environmental losses in the fragile Northern environment, irrecoverable economic losses and unquantifiable cultural losses. Of more importance is the fact that an unexpected breach of the ring dyke could have resulted in significant loss of life.

Social and Economic Benefits

The completion of this project provided significant benefits to the Kashechewan community. Prior to the implementation of these remedial measures, community members had daily worries about their safety, about the future of their community and whether or not they would need to be evacuated on an annual basis. With the completion of this project, one of the community's most significant fears have been reduced, allowing the KFN leadership to focus on other matters that affect the quality of life at the Kashechewan First Nation.

The project designs were specifically tailored to avoid the huge cost, and economic consequences that would have been associated with importing large riprap to the site by barge, resulting in savings that have been invested to good cause. The designs were tailored to allow manufacturing on site by the community for both the construction program and for future maintenance of the erosion protection system providing real sustainable benefits.

In addition the project designs enhanced access to the waterway providing increased recreational opportunities to the residents.

Meeting/Exceeding Client Needs

The project was completed ahead of schedule and 20% under budget. The unique concrete armour block design allowed community participation of more than 70% during the construction phase and provided real sustainable benefits associated with technology transfer and a new concrete batch plant being provided to the community. This project represents a true partnership between a consulting engineer,

contractors and the client (in this case an entire community) to achieve a remarkable result.

The project exceeded all of KFN's expectations and has very significantly enhanced the safety of the community. The berm and the unique concrete armour blocks have withstood a cycle of the severe ice and water loadings imposed on them proving the precedent-setting designs that Hatch developed and the quality of workmanship by the contractor and the KFN community members.