REGIONAL CUMULATIVE EFFECTS ASSESSMENT
FOR HYDROELECTRIC DEVELOPMENTS ON THE CHURCHILL,
BURNTWOOD AND NELSON RIVER SYSTEMS: PHASE II REPORT

PART II: HYDROELECTRIC DEVELOPMENT PROJECT DESCRIPTION IN THE
REGION OF INTEREST
HYDROELECTRIC DEVELOPMENT PROJECT DESCRIPTION IN THE REGION OF INTEREST

PART II
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# ACRONYMS, ABBREVIATIONS AND UNITS

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2.0 HYDROELECTRIC DEVELOPMENT
PROJECT DESCRIPTION IN THE REGION OF INTEREST

To provide context for the Regional Cumulative Effects Assessment (RCEA), the following gives a high-
level overview of the history and description of hydroelectric development in the RCEA Region of Interest
(ROI). A summary of other non-hydro related developments within the ROI have been included to provide
additional context. The locations of hydroelectric developments (for both generation and transmission
components) are shown in Maps 1.2.3-1 and 1.2.3-2, respectively (Chapter 1.2, Overview of the Phase I
and Phase II Reports). The key dates used in the RCEA for all major hydroelectric developments in the
RCEA ROI are shown in Table 1.3.2-1 (Chapter 1.3, Phase II: Scope and General Methods) and, along
with the key dates for environmental legislation events in Manitoba since the 1950s, in Figure 1.2.3-1.
The dates in Table 1.3.2-1 and Figure 1.2.3-1 may differ from that in Part II as additional historical
information was obtained during Phase II to describe the history of hydroelectric developments. For
example, in Table 1.3.2-1, the completion date for the Henday Converter Station is shown as 1985, which
reflects the date that the Bipole II transmission line from the Henday Converter Station was completed.
The Henday Converter Station began converting power from the Long Spruce GS in 1978 and from the
Limestone GS in 1990. Hence, there are different dates reflecting “completion” of a facility.

2.1 Planning

Manitoba Hydro and its predecessors have been a key part of Manitoba’s economy since the Manitoba
Power Commission was established in 1916. Since then, Manitoba Hydro has grown through the
construction of new facilities and the purchase of existing facilities as discussed below
(see Table 1.3.2-1).

The potential for hydroelectric development in the ROI was identified by the governments of Canada and
Manitoba early in the last century. In 1913, the Department of Mines (Canada) conducted a
comprehensive geological survey of the drainage basins of the Churchill and Nelson rivers to determine
the power potential of Manitoba’s northern rivers. At the time, the key challenge for developing this power
was a lack of available technology for transmitting energy over long distances. However, the report
(McInnes 1913) formed the basis for further studies that ultimately led to the development of Manitoba’s
northern water power resources.

A substantial amount of planning regarding potential ways to meet the Province’s future power needs was
conducted by the province of Manitoba during the 1940s and 1950s. In 1947, Manitoba Water Resources
Branch initiated surveys of the upper reaches of the Nelson River and concluded that approximately 160
MW of potential power was available between Warren Landing and Cross Lake. In the 1950s, studies by
the Manitoba Department of Mines and Natural Resources were also conducted at several locations
including Long Spruce Rapids to Limestone Rapids (Verner 1955a), Devils Rapids to Birthday Rapids.
(Verner 1955b), Birthday Rapids to Butnau River (Verner 1956), and the Churchill River and Burntwood River systems (Gould 1958) as well as several other areas.

In 1956, Vale (formerly International Nickel Company or INCO) advised the Manitoba Hydro Electric Board that they would need electricity for a town and mining development that they were planning to build in the future City of Thompson area. Planning for this requirement was not part of previous studies and the Kelsey generating station project was developed very quickly, as described in Chapter 2.2 (Hydroelectric Development from 1950 to 1976).

In 1958, the governments of Canada and Manitoba jointly funded the Lakes Winnipeg and Manitoba Board to determine if the regulation of Lake Winnipeg could be used to reduce flooding around Lake Winnipeg. The study found that although regulation could provide flood control, that the benefits from flood control by itself could not be justified from an economic perspective. However, the Board concluded that Lake Winnipeg Regulation (LWR) would be valuable for hydroelectric development if the total capacity of the Nelson River hydroelectric plants reached several hundred megawatts.

By the early 1960s, Manitoba needed to increase its energy production to meet growing provincial demand either through thermal or hydroelectric production. During this timeframe, advances were made in the field of High Voltage Direct Current (HVdc) power transmission, which would allow power to be transferred more efficiently from the north to the south. Subsequently, the governments of Canada and Manitoba formed the Nelson River Programming Board (NRPB) in 1963, which:

...investigated the power potential of the Nelson River and considered the merits of diverting a substantial portion of the flows from the Churchill River via the Rat and Burntwood rivers into the lower Nelson River to augment the power potential of sites at Kettle Rapids, and downstream areas. A follow-up program was conducted in 1964 and, in December 1965, the NRPB recommended that the Government consider a Phase I plan of hydroelectric generation. (Trischler 1979, pg.35)

The plan originally envisioned four phases of development for the area downstream of Kettle Rapids – namely — Kettle Generating Station (GS), Long Spruce GS, Lower Limestone GS, and Gillam Island GS. The federal and provincial governments entered into an agreement on February 15, 1966, to jointly undertake the development of the hydroelectric potential of the Nelson River in a phased approach. Phase I of the plan consisted of the following:

- the regulation of Lake Winnipeg (now known as Lake Winnipeg Regulation or LWR);
- the diversion of flows from the Churchill River (via the Rat and Burntwood rivers) into the Nelson River (now known as the Churchill River Diversion or CRD);
- a generating station at Kettle Rapids on the lower Nelson River (now known as the Kettle GS); and
- the construction of two converter stations and a HVdc transmission line from the Kettle GS to southern Manitoba (now known as Bipole I).

The NRPB indicated that Phase I of the plan was the lowest cost option that would be economically feasible for hydroelectric development in northern Manitoba and would be fully compatible with, and would facilitate, the development of hydroelectric power in the North. The NRPB stated that the storage capacity in Lake Winnipeg and Southern Indian Lake (SIL) would be required to maximize the financial benefits of the developments. At SIL, both a high level and a low level diversion option were considered, both would cause substantial flooding on SIL but the high level CRD option would require the entire
community of South Indian Lake to be moved and would cause adverse environmental impacts as far upstream as Granville Lake. The result was that the government of Manitoba approved the low level option for CRD, which is discussed further in Chapter 2.2 (Hydroelectric Development from 1950 to 1976).

All four of the recommended projects were constructed between 1966 and 1976: Bipole I (1968 to 1971); Kettle Rapids GS (1966 to 1974); LWR (1970 to 1976), and the CRD (1973 to 1976). It should be noted that construction of Bipole II (a second parallel HVdc transmission line) was initiated at the same time as Bipole I as it was more efficient to build them at the same time. Bipole II was then extended in 1977 from the Radisson Converter Station to the Henday Converter Station. Phases II and III followed respectively when Long Spruce was completed in 1979 and Limestone was completed in 1992.

Manitoba Hydro continuously reviews the requirements for future resource requirements as part of regular Power Planning activities. In recent times, this has resulted in the development of the Wuskwatim Generation Project completed in 2012, and the Keeyask Generation Project currently under construction.
2.2 Hydroelectric Development from 1950 to 1976

2.2.1 Kelsey Generating Station

The Kelsey GS was the first generating station constructed on the Nelson River at a site known as Grand Rapids. Construction of the first phase of the development of the station and associated infrastructure occurred between 1957 and 1961. Initially, the Kelsey GS consisted of a five-unit 160 MW development with the sole purpose to provide power to Vale (formerly International Nickel Company or INCO) mining and smelting operations in the Moak Lake and Mystery Lake areas and to the City of Thompson. A sixth unit was installed in 1969 and a seventh unit in 1972. To deliver the power to Thompson, two 138 kV transmission lines were constructed and in-service by 1960. Over the years, the transmission components into and out of the Kelsey GS, initially dedicated to Vale and the City of Thompson, have been expanded, broadening the station’s role in Manitoba Hydro’s power system. Descriptions of the Kelsey GS, associated supporting infrastructure, transmission facilities, and additional development phases are provided in Appendix 2A (Kelsey Generating Station – Project Description).

2.2.2 Kettle Generating Station & HVdc Transmission System

The Kettle GS was the second generating station constructed on the Nelson River, at a site previously known as Kettle Rapids just upstream of where the Hudson Bay Railway line crossed the Nelson River. Construction of the station began in 1966 and was completed in 1974. In order to get the power to load centers in southern Manitoba a HVdc transmission system was constructed and consists of the Radisson and Dorsey converter stations and Bipole I and II transmission lines. The Radisson Converter Station was constructed south of the Kettle GS and became operational in 1971 with all work completed by 1977. Radisson Converter Station converted power from alternating current to direct current and then transmitted the power along the 556 mi. (895 km) Bipole I transmission line to Dorsey Converter Station in southern Manitoba, located northwest of the City of Winnipeg near the community of Rosser. The development of the HVdc lines were undertaken as a federal-provincial initiative under a 1966 agreement. The federal government was represented by Atomic Energy of Canada Limited, which financed, designed, and constructed two HVdc transmission lines. The province was represented by Manitoba Hydro and the company agreed to pay back the initial financing for the lines over the next 50 years. However, this was accomplished within 21 years and was repaid in full by 1992. Descriptions of the Kettle GS, associated supporting infrastructure, and transmission facilities are provided in Appendix 2B (Kettle Generating Station – Project Description). Descriptions of the Radisson Converter Station and Bipole I and II are provided in Appendix 2C (HVdc Transmission System – Project Description).
2.2.3 Lake Winnipeg Regulation

Lake Winnipeg Regulation was constructed between 1970 and 1976 (installation of the generating units at Jenpeg GS was completed in 1979). Lake Winnipeg Regulation consists of the following operational, supplementary and mitigation components:

- The Jenpeg GS and Control Structure (CS) which regulates Lake Winnipeg’s outflow through the western channel of the Nelson River;
- A series of diversion channels that increase the outflow capacity from Lake Winnipeg into the Nelson River (Two-Mile, Eight-Mile, Ominawin Bypass, and Kisipachewuk Channel Improvement);
- The Kiskitto Lake Inlet CS, Main Dam and Dykes which separate Kiskitto Lake from LWR to minimize flooding caused by backwater effects and to provide regulated inflows;
- The Black Duck CS and Diversion Channel and Stan Creek Diversion to mitigate the effects on Kiskitto Lake, and
- Later in 1991, construction was completed on the Cross Lake Weir to lessen the effects of LWR by increasing the average water level and reducing the range of water levels on Cross Lake.

Descriptions of LWR and associated supporting infrastructure are provided in Appendix 2D (Lake Winnipeg Regulation – Project Description). Descriptions of the Jenpeg GS, associated supporting infrastructure and transmission facilities are provided in Appendix 2E (Jenpeg Generating Station – Project Description).

2.2.4 Churchill River Diversion

The low level CRD was approved by the Province of Manitoba in 1973 with the granting of a Water Power Act (WPA) licence “for the Diversion of water from the Churchill River to the Nelson River, and the Impoundment of Water on the Rat River and Southern Indian Lake”. Construction began in 1973 and the diversion was in operation in 1976.

The CRD has three main components:

- The Missi Falls CS at the natural outlet of SIL, which raises the lake’s level by 9 ft (3 m) and controls the outflow to the lower Churchill River;
- The South Bay Diversion Channel from the South Bay of SIL to Issett Lake, which creates a new outlet that allows water to flow from the Churchill River into the Rat River-Burntwood River-Nelson River systems;
- The Notigi CS located on the Rat River at the outlet of Notigi Lake which regulates the flow into the Burntwood River-Nelson River systems; and
- Subsequently, two mitigation components were added: the Manasan Falls Ice Control Structure and the Churchill Weir.

After construction was completed, initial operations in 1977 revealed that impacts downstream of Notigi during open water conditions were similar to expected and during winter conditions, ice impacts were much less than expected. This led to a decision to explore higher diversion flows. In 1978, Manitoba Hydro requested approval to test the diversion capacity over a wider range than was set out in the WPA
Licence. After a multi-year testing phase, approval to deviate from the terms of the WPA Licence have been the same for each winter and summer period since 1986. This mode of operation has become known as the Augmented Flow Program and continues to the present day. Descriptions of the CRD and associated supporting infrastructure are provided in Appendix 2F (Churchill River Diversion – Project Description).

2.2.5 Long Spruce Generating Station

The Long Spruce GS was constructed at a site previously known as Long Spruce Rapids, downstream of the Kettle GS on the lower Nelson River. Construction began in 1971 and was completed by 1979. The station is operated as a run-of-river plant that passes the water that the Kettle GS releases into Long Spruce’s forebay. When the Long Spruce GS became operational, the Radisson Converter Station converted part of the power from the generating station to direct current for transmission to southern Manitoba. However, only half of the power generated at Long Spruce GS could be converted at the Radisson Converter Station, so the Henday Converter Station was constructed 26 miles (42 km) northeast of the Radisson Converter Station. Constructing the Henday Converter Station also created additional conversion capacity for potential future generating stations. Construction of the Henday Converter Station began in 1970 and began transforming power from Long Spruce in 1978. Descriptions of the Long Spruce GS, associated supporting infrastructure, and transmission facilities are provided in Appendix 2G (Long Spruce Generating Station – Project Description).

In order to accommodate the additional power from the Long Spruce GS, Bipole II was extended 26 miles (42 km) in 1977 from Radisson Converter Station to the Henday Converter Station. Bipole II total length is 582 miles (937 km) long beginning at the Henday Converter Station and ending at the Dorsey Converter Station northwest of the City of Winnipeg. In addition to the above, two sets of three 230 kV transmission lines were constructed to further connect the Long Spruce GS to the Radisson and Henday Converter Stations. Henday Converter Station and Bipole II are described in Appendix 2C (HVdc Transmission System – Project Description).
2.3 Hydroelectric Development from 1976 to 2015

2.3.1 Limestone Generating Station

In 1976, construction began on the Limestone GS downstream from the Long Spruce GS on the lower Nelson River. The location is at the upper Limestone Rapids just above where the Limestone River empties into the Nelson River. In 1978, construction of the supporting infrastructure and the first cofferdam was well on its way when a decision was made to postpone Limestone due to decreased provincial load growth.

Construction of the Limestone GS re-started in 1985 and construction was completed in 1992. The station is operated as a run-of-river plant that passes the water that the Kettle GS releases and is passed through the Long Spruce GS. In 1989, a 25-mile (40 km) extension of an existing 138 kV line from the Radisson Converter Station to the Limestone GS was constructed to provide an emergency back up for the station. In 1992, a 5.6 mile (9 km) back up for the Bipole II HVdc line was added which originates from the Henday Converter Station and extending across the Nelson River. Descriptions of the Limestone GS, associated supporting infrastructure, and transmission facilities are provided in Appendix 2H (Limestone Generating Station – Project Description).

2.3.2 Conawapa Generation Project

In 1990, a power sale agreement for 1,000 MW was signed with the Province of Ontario, requiring the construction of the Conawapa GS, which would be destined to become the fourth phase of the original lower Nelson River development plan. Conawapa was not part of the original plan. Conawapa became an option in the early 1970s once the decision on the location and size of Limestone GS was made. Construction began with an access road from the Limestone area in 1991 and the clearing of a construction power line right-of-way. However, the Province of Ontario cancelled the energy purchase contract with Manitoba Hydro in 1993, resulting in the cancellation of the project and the deferral of all activities.

In 2003, with the projection of a higher demand for energy both domestically and externally, Manitoba Hydro resumed studies for the potential Conawapa Generation Project (GP). Due to the number of years that had lapsed since the Conawapa was last studied in detail, a review of all aspects of the design, construction methodology and schedule was initiated as well as the undertaking of the necessary environmental studies. All work was underway to achieve a 2026 in-service date (ISD) until the conclusion of the Needs For and Alternatives To (NFAT) review by the Public Utilities Board (PUB) of Manitoba Hydro’s preferred development plan, which proposed the construction of the Conawapa GS among other projects. In June of 2014, the PUB recommended that, “Spending on the Conawapa Project and the North-South Transmission Upgrade Project be discontinued immediately and the projects terminated”. The government of Manitoba provided direction to Manitoba Hydro in July of 2014 to which Manitoba Hydro proposed to wind-down Conawapa-related planning activities over a two-year period while a stronger business case is developed. A description of the potential Conawapa GP supporting
2.3.3 Wuskwatim Generation Project

The most recently developed hydroelectric generating station in northern Manitoba is the Wuskwatim GS, which began operation in 2012. The project is located on the Burntwood River between Nelson House and Thompson. Construction began in 2006 and was completed by 2012.

The Wuskwatim GP was developed as a partnership between the Nisichawayasihk Cree Nation (NCN) and Manitoba Hydro. The Wuskwatim GS is owned by the Wuskwatim Power Limited Partnership, a legal entity involving NCN and Manitoba Hydro. The partnership agreement represented a major shift in the way hydroelectric projects are developed in Manitoba. The first of its kind in Canada, the partnership with NCN demonstrated a movement towards collaborative development of projects. The participation of NCN in the entire process resulted in a project that included Aboriginal traditional knowledge (ATK) in both the assessment and monitoring phases. This development was also the first generating station in Manitoba to have undergone both Manitoba Environment Act and a Canadian Environmental Assessment Act approval processes.

The development of the Wuskwatim GS required new transmission lines and stations to deliver electricity into the existing transmission system. Manitoba Hydro owns the transmission components. The points of connection are at a new station called Birchtree near Thompson and at the Herblet Lake Station at Snow Lake. A 230 kV transmission line was also constructed from the Herblet Lake Station to the existing Rall’s Island Station at The Pas, the majority of which is outside of the RCEA ROI. One 28 mile (45 km), 230 kV transmission line runs from the Birchtree Station to the Wuskwatim GS, while two single-circuit 230 kV lines approximately 85 miles each (approximately 137 km each) run from the Wuskwatim GS to the Herblet Lake Station on a shared right-of-way. Descriptions of the Wuskwatim GP, associated supporting infrastructure, and transmission facilities are provided in Appendix 2J (Wuskwatim Generation Project – Project Description).
2.4 Projects Currently under Development

2.4.1 Bipole III Transmission Project

Manitoba Hydro is currently constructing the Bipole III Transmission Project, which is the third HVdc transmission line in the province. The line originates at the new Keewatinohk Converter Station under construction near the potential Conawapa GP site and terminates at the new Riel Converter Station located east of the City of Winnipeg. The Riel Converter Station and the majority of the Bipole III line are outside the RCEA ROI. Apart from the Bipole III line and new converter stations, the Bipole III Transmission Project will require new 230 kV transmission lines linking the Keewatinohk Converter Station to the Henday Converter Station and to the Long Spruce GS. The regulatory approval process for the Bipole III Project included a Manitoba Environment Act review process.

The power transmitted by Bipole III will originate at existing generating stations on the lower Nelson River (Kettle GS, Long Spruce GS, and Limestone GS). As described above, the existing generating stations are linked to Bipoles I and II via the alternating current transmission lines to the Radisson and Henday Converter Stations. The Keewatinohk Converter Station and associated transmission lines will add flexibility and reliability, ensuring that the power generated is transmitted into the transmission system. The connections include five 230 kV transmission lines with one of the transmission lines extending from the Long Spruce GS to the Keewatinohk Converter Station. The additional four transmission lines will extend from the Henday Converter Station to the Keewatinohk Converter Station. A description of the Bipole III Transmission Project is provided in Appendix 2K (Bipole III Transmission Project – Project Description).

2.4.2 Keeyask Generation Project

The Keeyask GP is located at Gull Rapids, upstream of the Kettle GS, and downstream of the community of Split Lake. The Keeyask GP is being developed by the Keeyask Hydropower Limited Partnership (KHLP), which consists of Manitoba Hydro and investment entities representing the four First Nations in the vicinity of the Project – Tataskweyak Cree Nation (TCN) and War Lake First Nation (WLFN; working together as the Cree Nation Partners), York Factory First Nation (YFFN), and Fox Lake Cree Nation (FLCN). The Keeyask GP is composed of the Keeyask Infrastructure Project (KIP) and the Keeyask GS, which will be owned by the partnership. The Keeyask Transmission Project will be owned by Manitoba Hydro.

The KIP began in early 2012 and involved the construction of an access road and camp.

Construction of the generating station began in July of 2014 and is scheduled to begin operation in 2019, with all units online by 2020.

The Keeyask Transmission Project will provide construction power and generation outlet transmission for the Keeyask GP. Manitoba Hydro will own the transmission components.
A description of the Keeyask GP is provided in Appendix 2L (Keeyask Generation Project – Project Description).
2.5 Other Transmission Developments in the Regional Cumulative Effects Assessment Region of Interest

In addition to the above projects, there are other transmission projects within the RCEA ROI that supply power to communities and other electrical loads in the area. Some of the other developments were constructed by other companies prior to the hydroelectric development on the Nelson River. For example, the Hudson Bay Mining and Smelting Company Ltd. initially supplied power to support mining operations and communities in the immediate area, including Snow Lake. In 1973, Manitoba Hydro took over their power operations at Snow Lake and assumed full responsibility for all transmission and distribution in the RCEA ROI.

Apart from the generating stations and converter stations described above, other lower voltage stations are required to operate the transmission system and transform power to lower voltages to supply power to communities. Major sub-stations include the Thompson Birchtree Station, which was constructed as part of the Wuskwatim Generation and Transmission Projects, the Ponton Station and the Herblet Lake Station.

Other lower voltage sub-stations which can convert power to lower voltages for use in the communities are located in Churchill, Gillam, Ilford, Thompson (Thompson Burntwood, Thompson INCO, Thompson Mystery Lake), Nelson House, Leaf Rapids, South Indian Lake, Split Lake, Cross Lake, Norway House, Snow Lake, Stall Lake, and Chisel Lake. All of the communities in the RCEA ROI are now connected to the transmission system.

A 168 mi (270 km) long 138 kV transmission line from (Radisson Converter Station) to the community of Churchill was completed in 1987. A 24 mi (38 km) long 138 kV transmission line from the Kelsey GS to the community of Split Lake was completed in 1993. A 225 mi (362 km) long 138 kV transmission line from the Kelsey GS to the North Central Communities of Oxford House, God’s Lake Narrows, God’s River, Red Sucker Lake, Wasagamack, and Garden Hill was completed in 1997. Service to the community of Southern Indian Lake is provided from a lower voltage sub-transmission line from the Leaf Rapids Station.

The Ponton Station located south of Thompson is an important node in the 230 kV transmission network. A 230 kV transmission line completed in 1965/1966 runs from the Thompson Mystery Lake Station to the Ponton Station. The Ponton Station is also linked to the Jenpeg GS by a 230 kV transmission line, as well as to the Herblet Lake Station, north of the community of Snow Lake, by another 230 kV transmission line. The Herblet Lake Station is also an important node in the 230 kV transmission network. Apart from the line to the Ponton Station, the Herblet Lake Station is linked to Flin Flon via a 115 kV and a 230 kV transmission line, both of which are primarily outside of the RCEA ROI. The station also connects the two 230 kV transmission lines from the Wuskwatim GS to the Rall's Island Station in The Pas (a part of the Wuskwatim Transmission Project), which is outside of the RCEA ROI.
2.6 Other Physical Infrastructure and Activities Affecting the Region of Interest

There are a number of other factors, beyond hydroelectric development, that have affected the RCEA ROI. These include, among other things: mining developments, highway developments, the establishment of commercial resource harvesting activities, government policies and acts (e.g., the signing of Treaty 5 in 1875 and subsequent adhesions to Treaty 5 and The Indian Act in 1876), the introduction of western schools and churches, the establishment of a reliable electrical supply, and connection of some of the RCEA ROI communities to other parts of Manitoba via new highways and other road systems.

While this RCEA focuses on the effects of hydroelectric development, the effects of these other projects (e.g., mines) and activities (e.g., commercial fishing) have also been considered to the extent that they provide: (1) important context; (2) additional information that is relevant to understanding the current state of the environment (e.g., effects of provincial highways on measures of terrestrial intactness or community wellness); and/or (3) where effects of hydroelectric development cannot be separated from other effects in measures of current condition (e.g., water quality). A detailed history of the other factors that have influenced the RCEA ROI is provided in People, Section 3.3. Where relevant, specific changes are also discussed in more detail in the People, Water, and Land sections.
2.7 Bibliography


APPENDIX 2A:
KELSEY GENERATING STATION
PROJECT DESCRIPTION
Location

Kelsey Generating Station (GS) is located at the site of the former Grand Rapids (Photo 2A-1) on the Upper Nelson River just upstream of the confluence with the Grass River. It is approximately 685 km north of the City of Winnipeg and 90 km (56 mi) northeast of Thompson (Map 1.2.3-1 in Chapter 1.2, Overview of the Phase I and Phase II Reports). The station is not located closely to any other Manitoba Hydro generating station.

![Grand Rapids on the Upper Nelson River during Construction of Kelsey – 1957](image)

Photo 2A-1: Grand Rapids on the Upper Nelson River during Construction of Kelsey – 1957

Background

Kelsey GS was the first hydroelectric generating station developed on the Nelson River. The requirements for the project were driven by the confirmation in early 1956 by the mining company Vale (International Nickel Company of Canada or INCO) that a world class nickel source was available in the Mystery Lake - Moak Lake area. In August of that year, Vale informed the Manitoba Hydro Electric Board that over 100 MW of power would be needed to service a new nickel mining and smelting operation and associated town site that INCO was planning to develop in what is now the Thompson area. Given the remoteness of the site and abundance of hydroelectric potential in the region, locally-generated hydroelectric power was the logical energy source.

After reaching an agreement with Vale to deliver power by the summer of 1960, the MH Electric Board initiated survey work on the site in 1956 and moved quickly to complete the project.
Generating Station Components

Principal Works

The station spans a total of 0.9 mi (1.4 km) across the Nelson River and consists of a close-coupled intake/powerhouse with seven generating units (and two 0.675 MW house units), concrete wing walls, main dam, dyke structures and a nine bay gated spillway (called a sluiceway back then) (Photo 2A-2; Map 2A-1).

![Kelsey Powerhouse with the Transformers and the Switchyard on the Top](image)

Photo 2A-2: Kelsey Powerhouse with the Transformers and the Switchyard on the Top

The Kelsey powerhouse was sized for seven turbine generators (called units) with only five units installed to meet the initial expected demand with room to expand capacity as load increased and was anticipated to go as large as 10 units as indicated by the space to the east of the powerhouse as shown in Map 2A-1.

Project Data

- **Turbine generator units:**
  - Type: 7 vertical shaft fixed blade propeller turbines
  - Capacity: 292 MW (63rd Annual Report, March 2014)
- **Powerhouse:**
  - Length: 664.4 ft (202.5 m)
  - Waterfall drop (head): 56.1 ft (17.1 m)
  - Discharge capacity: 81,683 ft³/s (2,313 m³/s)
Main dam:
- Length: 950 ft (290 m)
- Maximum height: 120 ft (37.0 m) (from river bottom)

Spillway:
- Number of bays: 9
- Length: (9 bays) 468 ft (142.65 m)
- Discharge capacity: 322,458 ft³/s (9,131 m³/s)

Reservoir/forebay elevation:
- Full supply level (FSL): 605 ft (184.404 m)
- Flooded area: 64 mi² (165.8 km²)
Infrastructure Supporting Construction

To provide year-round access to the project, a 13.5 mi (22 km) rail spur line called the Kelsey spur was built in the winter of 1957 and is connected to the Hudson Bay Railway line at Mile 256 also known as Pit Siding and is owned by Manitoba Hydro. With no permanent roads in the region, the Bay Line was the only form of year-round ground transportation. The Kelsey Spur line is accessible from the north via Gillam or the south via Thompson and is typically not used or cleared during the winter.

A construction camp, associated work areas and waste water treatment facility were established near the site as shown in Figure 2A-1. Construction power was provided by an onsite diesel generator.
Figure 2A-1: Kelsey GS General Arrangement of Development, 1960
Construction

The basic project sequence was that the rail spur and the camp areas were constructed first, followed by the opening up of rock quarries, impervious borrow areas, and granular borrow areas to allow for the construction of the cofferdams. These temporary structures were necessary to facilitate the construction of the sluiceway structure, intake channel and exit channels. A temporary bridge was built across the river channel to facilitate construction on the west side of the river. This facilitated the construction of the Main River Cofferdam (1958–1959) upstream of the powerhouse with a timber crib rock fill cofferdam on the downstream side (Figure 2A-1; Photo 2A-3) which facilitated the construction of the powerhouse and associated concrete structures in the dry.

Photo 2A-3: Kelsey Generating Station construction – Placement of Rail Launching Platform – September 1957

Most of the rock and impervious construction materials came from the surrounding areas as shown in Figure 2A-1. However, sand was brought in from Pit Siding which was an area previously used for railroad ballast on the Hudson Bay Railway, and a small amount of crushed gravel was brought in from the City of Thompson early in the project.

The first unit went into service in 1960 (Photo 2A-4) with the first five units into service by 1961. A sixth unit was installed in 1969 and a seventh unit in 1972. All units were re-turbined between 2006 and 2013, which increased their operating capacities.
Operations

**Workforce:** The station has approximately 30 to 35 staff comprised of the following: operating staff, maintenance staff (electrical, mechanical, utility), support staff (administration, stores) and supervisory staff. The workforce arrive at Kelsey from various locations within the province. The workforce is split in two shifts who work an eight days on/six days off schedule, allowing the station to be fully staffed every day between 0700 and 1800. After hours, the System Control Centre located in the City of Winnipeg monitors alarms within the station and call out operating staff to investigate any anomalies.

**Accommodation:** The workers stay on site in either the 38-person staff house that was originally built in 1964 and replaced in 1991, or the 13 person mobitel (temporary trailers) that was installed in 1997. The site is serviced by a mechanical waste water treatment plant. Solid Waste is taken to an on-site waste disposal grounds.

**Airstrip:** A 2,590 ft (790 m) long by 75 ft (22.9 m) wide gravel surface airstrip was constructed in 1967. It was extended to 3,800 ft (1,158 m) in 2010/11.

**Public Safety:** The Kelsey GS has a portage around the site and the following public safety features:
- a water release siren is used before adjusting discharge to warn the public in the area;
- life rings are provided at the spillway; and
• warning signs are provided (in English and Cree) at sites to warn the public of: dangerous swift moving waters, steep drop off, overhead power lines, stay off Ice, falling ice, slippery rocks, and rapidly changing water conditions.

**Water Regime:** The Kelsey GS (Photos 2A-5 and 2A-6) is typically operated as a run-of-river generating station with the forebay normally maintained just below the full supply level of 605 ft (184.4 m). For more details on the Kelsey GS operations, including periods when the forebay is drawn down and when the generating station is cycled (see Water Regime, Section 4.3.2.4).

**Licence:** Manitoba Hydro operates the Kelsey GS in accordance with Province of Manitoba’s *Water Power Act* Licence. For further information see the Manitoba Government Water Power Licensing website at: http://www.gov.mb.ca/waterstewardship/licensing/water_power_licensing.html

![General View of Powerhouse Intake](image)
Transmission Components

Generation Outlet Transmission

To deliver power to the City of Thompson, two double circuit 58 mi (93 km) 138 kV transmission lines (KT1 and KT2) were built between 1958 and 1960 as shown in Map 2A-1.

Related Transmission

Over the years the transmission components into and out of the Kelsey GS, initially dedicated to Vale and the City of Thompson, have been expanded, broadening the station’s role in Manitoba Hydro’s power system. A second switching station located to the southwest of the generating station was added in 1972 as part of the enhancements.

The following transmission lines have been added as part of these enhancements:

- A 79 mi (127 km) 138 kV line from the Kelsey GS to the site of the Radisson Converter Station (KN36) was completed in 1967. This line was built to provide construction power for development of the Kettle GS, the Radisson Converter Station, and to supply additional power to the rapidly expanding Town of Gillam. Afterwards, it enabled the Kelsey GS to provide backup or start-up power for the Lower Nelson River generating stations.
A 61 mi (98 km) 230 kV line from the Kelsey GS to the City of Thompson (K24B) and a 79 mi (127 km) 230 kV line from the Kelsey GS to the Radisson Converter Station (R26K) were operational in 1972 and 1973 respectively, and are operating at 138 kV. These high voltage lines increased the capacity and reliability of electrical service to Vale’s mining and smelting operations and to the City of Thompson by providing greater access to Lower Nelson River generation. They also integrate the Kelsey GS more fully into MH’s power system as a primary and backup power source.

A 24 mi (38 km) 230 kV line from the Kelsey GS to Split Lake (KS37) and operating at 138 kV was completed in 1993. This line was built to improve reliability and increase the amount of power available to the community of Split Lake.

A 225 mi (362 km) 138 kV line from the Kelsey GS to the North Central Line communities (KH38) of Oxford House, God’s Lake Narrows, God’s River, Red Sucker Lake, Wasagamack, and Garden Hill was completed in 1997.

Bibliography


APPENDIX 2B:
KETTLE GENERATING STATION
PROJECT DESCRIPTION
Location

The Kettle Generating Station (GS) is located at the site of the former Kettle Rapids on the lower Nelson River. It is approximately 4.4 mi (7 km) west of the Town of Gillam and 1.9 mi (3 km) upstream from the Canadian National Railway’s (CNR) river crossing near the town. The distance from the City of Winnipeg to the Kettle GS is over 460 mi (740 km) by air (Map 1.2.3-1 in Chapter 1.2, Overview of the Phase I and Phase II Reports).

Background

Studies in the 1960s and early 1970s envisioned a four phase development at Kettle Rapids and downstream, namely the sites at Kettle Rapids, Long Spruce Rapids, Lower Limestone Rapids and Gillam Island to harness the abundant hydroelectric potential of the Nelson River.

The first phase of development was initiated in the spring of 1966 and included the following components:

- a generating station at Kettle Rapids;
- a High Voltage Direct Current (HVdc) transmission line from Kettle Rapids to the City of Winnipeg;
- control works to divert the Churchill River into the Nelson River via the Burntwood River; and
- control works to regulate the outflow of Lake Winnipeg into the Nelson River.

The long range view was that the Kettle GS would be the first in a series of generating stations intended for the lower Nelson River.

Generating Station Components

Principal Works

The station spans a total of 0.9 mi (1.5 km) across the Nelson River and consists of a close-coupled intake/powerhouse with 12 turbine generator units (units), concrete wing walls, non-overflow dam, two main earthfill dams (north and south), ancillary dams and dykes, and an eight bay gated spillway (Photos 2B-1 and 2B-2; Map 2B-1). A series of dams and dykes flank the Nelson River to reduce the extent of flooding from the project.
Photo 2B-1: Kettle Generating Station

Photo 2B-2: Kettle Generating Station – View from the South Shore
Project Data

- Turbine generator units:
  - Type: 12 vertical shaft fixed blade propeller turbines
  - Capacity: 1220 MW (63rd Annual Report, March 2014)

- Powerhouse:
  - Length: 1200 ft (365.76 m)
  - Waterfall drop (head): 101.0 ft (30.8 m)
  - Discharge capacity: 155,900 ft³/s (4,415 m³/s)

- Main dams (North and South dams):
  - Length: North Dam = 2,400 ft (730.0 m); South Dam = 1,000 ft (300.0 m)
  - Maximum height: North Dam = 164.0 ft (50.0 m); South Dam = 167.0 ft (51.0 m)

- Spillway:
  - Number of bays: 8
  - Length (8 bays): 394.0 ft (120.09 m)
  - Discharge capacity: 360,210 ft³/s (10,200 m³/s)

- Reservoir/forebay elevation:
  - Full supply level (maximum): 463.0 ft (141.122 m)
  - Normal minimum operating forebay elevation: 453.0 ft (138.074 m)
  - Flooded Area: 85.2 mi² (220.6 km²)

Infrastructure Supporting Construction

Main access to the region during construction was by the Hudson Bay Railway line (now HBR; CNR at the time) which had a rail station and siding at Town of Gillam. A 1.0 mi (1.6 km) rail spur was added near the generating station site. A new 4.4 mi (7 km) permanent gravel road was built from the Town of Gillam to the generating station site and the Radisson Converter Station site to link these projects to the community. The Town of Gillam was not connected to the provincial road network until well after completion of the project. The community had a permanent airstrip since 1967 that was utilized as required.

A temporary construction camp and associated work areas were established near the site. In 1966 and 1967, a 79 mi (127 km) 138 kV transmission line was built from the Kelsey GS to the site of the future Radisson Converter Station to provide power for upcoming construction activity. Short tie-ins from this line provided electrical power to the Kettle GS construction area and to the nearby Town of Gillam, which was about to undergo a major expansion. Solid waste was disposed of at the Town of Gillam solid waste disposal site and waste water was treated at a local lagoon.

Construction

Beginning in the spring of 1966 construction was started on the access road, main camp, construction power station, and the Stage I cofferdam (Photo 2B-3). Construction materials were sourced from locally
available sites. Rock came from quarries upstream of the project site in the forebay area, granular materials came from the Gillam Esker east of the project site, and impervious materials came from local borrow areas.

Photo 2B-3: Kettle Generating Station during Construction

Most of the construction workforce lived on site in camp while a small percentage lived and commuted from the Town of Gillam on a regular basis.

Clearing of Kettle’s forebay was undertaken immediately upstream of the powerhouse with impoundment beginning in 1970. A dam at the outlet of the Butnau River along with a series of dykes along 15 mi (24 km) of the south shore of Stephens Lake (nee Moose Nose Lake) were built to contain flooding from the backwater effect from Kettle’s forebay. The Butnau River is a tributary of the Nelson River whose flows were cut off by one of these earthfilled dams at Stephens Lake. As a result, it was diverted into the adjacent Kettle River which flows north downstream of the Kettle GS into the Nelson River. To achieve this a 2.5 mi (4 km) long, 60 ft (18 m) wide channel was built from Cache Lake to the Kettle River to redirect the Butnau River.

The first unit went into service in December 1970 and by the time the generating station was officially opened in June 1973, seven units were in service. The twelfth and final unit was up and running in November 1974. With the completion of all its units the Kettle GS became Manitoba Hydro’s largest generating station in its system. It maintained this status for nearly two decades until the Limestone Generating Station came into full service in 1992. Development of the Kettle GS resulted in Moose Nose Lake forming part of the Kettle forebay which was subsequently named Stephens Lake.
Operations

**Access:** Access to the Kettle GS is by road via PR 280 from the Town of Gillam or the City of Thompson. The Kettle GS can also be accessed by boat from the Town of Gillam.

**Workforce:** The station has approximately 30 to 35 staff comprised of the following: operating staff, maintenance staff (electrical, mechanical, utility), support staff (administration, stores) and supervisory staff. The station is fully staffed every day between 0700h and 1800h. Outside of normal business hours the Kettle GS is controlled by operating staff at the Long Spruce GS. The Kettle GS operating staff are on call and would be dispatched in case of an alarm or to initiate spill. Additional support and technical services are located in the nearby Town of Gillam.

**Waste Handling:** The Kettle GS is serviced by a mechanical waste water treatment plant while its solid waste is hauled to the Town of Gillam Waste Disposal Grounds.

**Public Safety:** The Kettle GS has a portage around the site and the following public safety features:
- downstream boat launch area;
- a water release siren is used before adjusting discharge to warn the public in the area;
- life rings are provided on the spillway;
- fencing is used as a barrier to dangerous areas; and
- warning signs are provided (in English and Cree) at sites to warn the public of: dangerous swift moving waters, steep drop off, overhead power lines, stay off Ice, falling ice, slippery rocks, and rapidly changing water conditions.

**Water Regime:** The Kettle GS is operated in a daily and weekly cycling pattern that allows Manitoba Hydro to match energy production to consumption patterns. For more details on operating parameters and their effects on the water regime (see Water Regime, Section 4.3.4.3).

**License:** Manitoba Hydro operates the Kettle GS in accordance with a Province of Manitoba Water Power Act licence. For further information, see the Manitoba Government Water Power Licensing website at: [http://www.gov.mb.ca/waterstewardship/licensing/water_power_licensing.html](http://www.gov.mb.ca/waterstewardship/licensing/water_power_licensing.html)

**Generation Outlet Transmission**

The electricity generated at the Kettle GS is transmitted to the Radisson Converter Station which is located approximately 1.5 mi (2.4 km) south of the generating station. At the Radisson Converter Station the electricity is converted from alternating current (AC) to direct current (DC) and is transmitted via the High Voltage Direct Current (HVdc) Bipole I transmission line to the Dorsey Converter Station, by the City of Winnipeg. Once at the Dorsey Converter Station the electricity is converted back to AC before being fed into the provinces southern distribution system.

**Rehabilitation**

During the upcoming winter season of 2015/2016 a Phase I Environmental Site Assessment will be conducted of the construction waste disposal ground.
Bibliography


APPENDIX 2C:
HVDC TRANSMISSION SYSTEM
PROJECT DESCRIPTION
**Location**

Bipoles I and II transmission lines follow a 556 mi (895 km) route from the Town of Gillam southward through the Interlake region. Bipole I has its northern terminus at Radisson Converter Station near the Town of Gillam. Bipole II extends another 26 mi (42 km) northeast to the Henday Converter Station. The southern terminus of both transmission lines is the Dorsey Converter Station. (Map 1.2.3-2 in Chapter 1.2, Overview of the Phase I and Phase II Reports).

**Background**

A significant amount of the province’s electricity is produced by five hydroelectric generating stations located on the Nelson River in northern Manitoba. The electricity generated must travel this long distance to southern Manitoba where most of the electricity demand is located. It is more efficient and economical to transmit electricity over such long distances as Direct Current (DC) than Alternating Current (AC). The northern converter stations convert the AC electricity coming from the northern generating stations to DC electricity for transmission to southern Manitoba. Once there, the DC electricity is converted back to AC electricity. The southern converter station then use transformers to step down the voltage for distribution to customers.

**Components**

Components of the existing HVdc transmission system within the Regional Cumulative Effects Assessment (RCEA) Region of Interest (ROI) are:

- Bipoles I and II (±500kV HVdc transmission lines);
- Radisson Converter Station; and
- Henday Converter Station.

**Bipoles I and II**

The HVdc transmission lines are a set of bipolar transmission systems called Bipole I and Bipole II. The term bipole refers to a positive (+) pole and a negative (−) pole on each Bipole transmission line. Each pole is further comprised of two 1.5 inches (4 cm) diameter conductors that are supported by steel transmission towers as shown in Photos 2C-1 and 2C-2.

Bipoles I and II deliver over 70% of the generating capacity from the Nelson River in northern Manitoba to southern Manitoba.
Photo 2C-1: Bipoles I and II Right-of-Way

Photo 2C-2: Bipoles I and II Typical Guyed Tower
**Bipoles I and II Project Data**

- **Length of lines:**
  - Bipole I: 556 mi (895 km)
  - Bipole II: 582 mil (937 km)

- **Towers:**
  - Quantity: 4,103
  - Height: 111 ft (33.8 m) to 155 ft (47.2 m)
  - Average height: 125 ft (38 m)
  - Distance between towers: 1,400 ft (427 m) to 1,600 ft (488 m)
  - Right-of-way: width 449 ft (137 m)
  - Distance between lines I and II: 245 ft (74.7) m
  - Clearing: 41.7 mi² (108 km²)

**Radisson Converter Station**

An aerial view of the Radisson Converter Station is shown in Photo 2C-3. The Radisson Converter Station is the northern terminus of Bipole I and is located 1.2 mi (2 km) south of the Kettle Generating Station (GS) and about 460 mi (740 km) north of the City of Winnipeg by air (Map 2C-1). It converts the AC electricity produced at the nearby Kettle GS and Long Spruce GS on the Nelson River to DC electricity for transmission south to the Dorsey Converter Station. The Dorsey Converter Station converts the power back to AC electricity then uses transformers to step down the voltage for distribution to customers.

![Photo 2C-3: Radisson Converter Station](image-url)
Radisson Principal Structures

**AC switchyard:** The electricity produced at Kettle Generating Station and one-half of that produced at Long Spruce Generating Station enters Radisson at its 138 kV switchyard. The switchyard which contains the high voltage breakers, disconnect switches, and AC filters directs the incoming AC power to the converter transformers.

**Converter transformer area:** The converter transformer changes the AC voltage to the required voltage level for the DC conversion equipment.

**Valve halls:** At the heart of the converter process are the converter valves, which are located in the valve halls within the converter building which also contains the maintenance shops, the control, mechanical, and electrical rooms.

**HVDC switchyard:** Electricity converted to DC leaves Radisson from the HVDC switchyard and is transmitted south to Dorsey Converter Station. This switchyard contains the necessary switches for isolation or connection of the poles from and to the DC transmission lines.

**Henday Converter Station**

The Henday Converter Station (Photo 2C-4; Map 2C-2) is the northern terminus for Bipole II. It is located next to the Limestone GS and is 26 mi (42 km) northeast of the Radisson Converter Station.

*Photo 2C-4: Henday Converter Station*
Henday Principal Structures

**AC switchyard:** All of the electricity produced at Limestone and one half of that produced at Long Spruce enters Henday through its 230 kV switchyard, where the incoming AC electricity is directed to converter transformers.

**Converter transformer area:** The converter transformer changes the AC voltage to the required voltage level for the DC conversion equipment.

**Valve Halls:** The actual conversion process takes place in the valve halls. They are located in the converter building, which also contains the maintenance shops, the control, mechanical, and electrical rooms.

**HVDC switchyard:** Electricity converted from AC to DC at Henday is transmitted south to Dorsey via the DC transmission line. The switchyard contains the necessary switches to shut off the current if Bipole II is not working, or to switch the current over to Bipole I, if enough room is available to carry the current.

Infrastructure Supporting Construction

**Bipoles I and II**

Various temporary mobile construction camps and access trails on or adjacent to the transmission line right-of-ways were used for the construction of Bipoles I and II.

**Radisson Converter Station**

Main access to the region during construction was by the Hudson Bay Railway line (now HBR; Canadian Pacific Railway [CNR] at the time) which had a rail station and siding at the Town of Gillam. A 0.6 mi (1 km) rail spur was added near the Kettle GS site to the Radisson Converter Station site as part of construction. A new 4.4 mi (7 km) permanent gravel road was built from the Town of Gillam to the Kettle GS site and the Radisson Converter Station site to link these projects to the community. The Town of Gillam was not connected to the provincial road network until after completion of the projects. The community has had a permanent airstrip since 1967, which was used as required during construction.

The temporary construction camp for the Kettle GS was used for the Radisson Converter Station. Work areas were established near the Radisson site. The workforce commuted from the Kettle GS camp to the Radisson site on a daily basis and lived there for several weeks at a time and travelled to their homes during their days off. A 79 mi (127 km) 138 kV transmission line was built from the Kelsey GS to the Radisson site to provide construction power for both the Radisson Converter Station and the Kettle GS. To achieve this short tie-ins from the line provided electrical power to the Kettle construction site and nearby Town of Gillam, which was about to undergo a major expansion. Solid waste was disposed of at the Town of Gillam solid waste disposal site and a local lagoon was used for waste water treatment at the camp.
Henday Converter Station

Access to the site was by a 14 mi (23 km) extension of the permanent gravel access road at the Long Spruce GS and a 1.5 mi (2.5 km) rail spur from the Hudson Bay Railway line (now HBR; CNR at the time) to the Henday site. The access road was not connected to the provincial road network until just after completion of the converter station.

No on site construction camp was created as the workforce commuted from the Long Spruce GS construction camp. A 21.5 mi (34.6 km) extension of the 138 kV transmission line (KN36) called the Kettle Station Tap to the Limestone GS was built from the Kettle GS to the Henday Construction power station to provide construction power for both the Henday Converter Station and ultimately for the Limestone GS.

Construction

Bipole I

Construction on Bipole I started in 1968 and was completed in 1971. Routing of the line included large tracks of muskeg country, providing difficulties for construction. For economic reasons, construction of the line had to be undertaken during winter months when the ground was frozen to allow for the passage of heavy equipment.

Radisson Converter Station

Construction on the Radisson Converter Station began in 1967 and was completed in 1977. The converter station was not ready when the first units at the Kettle GS were commissioned in the fall of 1970 so the DC line was used to transmit AC power to the south until early 1971 when the Radisson Converter Station began operation. After 1978 the Radisson Converter Station began converting power for half of the Long Spruce GS.

Bipole II

The Bipole II transmission line was previously constructed along with the Bipole I transmission line as far north as the Radisson Converter Station. Construction of the 26 mi (42 km) extension of the Bipole II transmission line to the new Henday Converter Station started in 1977. The first stage of Bipole II was complete in 1978 and the second stage was completed in 1985. In 1992 a 6 mi (9 km) Bipole II back-up loop originating at the Henday Converter Station was constructed.

Henday Converter Station

Operations

Access: The Provincial Road (PR) 280 to the Long Spruce area was constructed at the end of construction of the Long Spruce GS. It connected with the existing permanent roads used for construction of the Kettle GS, the Long Spruce GS, the Radisson Converter Station and the Henday Converter Station to become part of the provincial road network as seen today. PR 280 now goes to the Town of Gillam and the segment from the Long Spruce GS turnoff to the Limestone GS/Henday Converter Station area is now designated as PR 290.

Communication System: An essential component of the HVDC transmission line system is a complex high-performance communications system that is used to protect and control the HVdc Transmission System. Prior to 2004, the communication system consisted of two microwave systems each linking the Radisson and Henday converter stations in the north to the Dorsey Converter Station in southern Manitoba. This dual route microwave system was operated to protect and control the HVdc Transmission System and other facilities in the north, such as the Grand Rapids, Jenpeg, and Kelsey generating stations.

One of the microwave systems follows a route through Manitoba’s Interlake corridor while the other was located on the east side of Lake Winnipeg. In October 2004, Manitoba Hydro replaced the east of Lake Winnipeg microwave system with a new fibre optic cable system installed in the Interlake corridor. This new fibre optic cable works alongside the remaining Interlake digital microwave system, providing enhanced reliable communications for all major substations and generating stations along the 653 mi (1,050 km) route as well as facilitating voice and data communications at district offices and other Manitoba Hydro facilities.

Rehabilitation

Radisson Converter Station: The former construction waste disposal ground was investigated in early 2001, with a subsurface drilling investigation (Phase II Environmental Site Assessment) conducted later in 2001 and into 2002. Groundwater monitoring and sampling has been conducted on an annual basis since 2002.

Bibliography


APPENDIX 2D:
LAKE WINNIPEG REGULATION
PROJECT DESCRIPTION
Location

The components of the Lake Winnipeg Regulation (LWR) are located between the outlet of Lake Winnipeg and the Jenpeg Generating Station (GS) and are shown on Map 2D-1 (also see Map 1.2.3-1 in Chapter 1.2, Overview of the Phase I and Phase II Reports).

Map 2D-1: Lake Winnipeg Regulation (LWR) Components
Background

LWR was announced by the Government of Manitoba in 1970 and developed by Manitoba Hydro to achieve two key objectives: to reduce shoreline flooding on Lake Winnipeg, and to support hydroelectricity generation to meet growing demand in Manitoba. The project is a network of channels and structures that are used to control the outflow of water from the lake and allow higher outflow during flood conditions. During flood conditions it increases the outflow capability of the lake by approximate 50% than would otherwise occur naturally. LWR went into operation in 1976.

Lake Winnipeg Regulation Components

The components of LWR are grouped into two broad categories, operational components and other important components. Operational components are those components required for the proper and efficient operation of increasing outflows from Lake Winnipeg. Other important components are those components required to limit backwater effects and forebay flooding.

Operational components:
- Two-Mile Channel;
- Eight-Mile Channel;
- Ominawin Bypass Channel;
- Kisipachewuk Channel Improvement; and
- Jenpeg GS and Control Structure.

Other important components:
- Kiskitto Lake Inlet Control Structure, and Kiskitto Dam, and Dykes;
- Black Duck Control Structure and Diversion Channel; and
- Stan Creek Diversion (not shown on Map 2D-1)

Project Data

Project data of the main channels constructed to improve the outflow from Lake Winnipeg is presented in Table 2D-1 below.

<table>
<thead>
<tr>
<th>Component</th>
<th>Construction Period</th>
<th>Approximate Dimensions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Length</td>
</tr>
<tr>
<td>Two-Mile Channel</td>
<td>1973–1976</td>
<td>2 miles</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(3.1 km)</td>
</tr>
<tr>
<td>Eight-Mile Channel</td>
<td>1971–1976</td>
<td>8 miles</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(12.9 km)</td>
</tr>
<tr>
<td>Ominawin Bypass Channel</td>
<td>1972–1975</td>
<td>2.1 miles</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(3.4 km)</td>
</tr>
</tbody>
</table>
Operational Components

The operational components of LWR are: Two-Mile Channel, Eight-Mile Channel, Ominawin Bypass Channel, Kisipachewuk Channel Improvement, and the Jenpeg GS.

Two-Mile Channel

Two-Mile Channel connects Lake Winnipeg and Playgreen Lake to provide a second outlet for Lake Winnipeg water. The channel is about two miles (3.2 km) long, 600–700 ft (183–213 m) wide, and about 30 ft (9 m) deep (Photo 2D-1). The natural outlet for Lake Winnipeg is located east at Warren Landing. This outlet has a few major islands with one wider channel, and then transitions to one channel with numerous vegetated shallows, rock outcrops, and smaller islands. These features impede the flow of water during the open water season, with even more significant flow constrictions in winter as ice grows.

Photo 2D-1: Two-Mile Channel
Eight-Mile Channel

Eight-Mile Channel provides a direct flow of water from Playgreen Lake to Kiskittogisu Lake, allowing water to flow more directly from Lake Winnipeg to the Nelson River. It ranges in width from approximately 700 to 1,200 ft (213–366 m) and is approximately 20 ft (6 m) in depth and is shown in Photo 2D-2. This channel creates an alternative route that bypasses a relatively narrow portion of Playgreen Lake and an even narrower portion at the north end of the lake called Whiskey Jack Narrows.
Ominawin Bypass Channel

The Ominawin Bypass Channel is located at the north end of Kiskittogisu Lake and allows water flow to bypass the natural restrictions of the Ominawin Channel. The bypass channel is approximately 1,400 ft (427 m) wide, approximately 20 ft (6 m) deep, and approximately 2.1 mi (3.4 km) long and is shown in Photo 2D-3. In addition the channel has a centre division (a rockfill groin) designed to reduce ice thickness.

Photo 2D-3: Ominawin Bypass Channel
Kisipachewuk Channel Improvement

The Kisipachewuk Channel Improvement was constructed to increase water flows through the outlet channel from Kiskittogisu Lake into the Nelson River. The channel improvement is an excavation of the existing river bed over a length of approximately 260 ft (80 m) and width of 200 ft (60 m) and is shown in Photo 2D-4.
Jenpeg Generating Station

The Jenpeg GS is located approximately 62 mi (100 km) north of Lake Winnipeg on the upper portion of the Nelson River. The Jenpeg GS controls most of the outflow of water from Lake Winnipeg for flood protection on Lake Winnipeg and for power generation along the Nelson River. Originally envisioned to be exclusively a control structure, a later decision was made to add generating units at the structure. A view of the station from the forebay can be seen in Photo 2D-5. Descriptions of the Jenpeg GS, associated supporting infrastructure, and transmission facilities are provided in Appendix 2E, Jenpeg Generating Station Project Description.

Photo 2D-5: Jenpeg Generating Station
Other Important Components

Other important components of LWR are the Kiskitto Lake Inlet Control Structure, its main dam and dykes, the Black Duck Control Structure and Diversion Channel, and the Stan Creek Diversion Channel. A description of these components is provided below.

**Kiskitto Lake Inlet Control Structure, Main Dam, and Dykes.**

The Kiskitto Inlet Control Structure regulates water flow into Kiskitto Lake so that Kiskitto Lake water levels can be maintained within their natural range. The impoundment of water from the construction of the Jenpeg GS required the development of works to prevent flooding of Kiskitto Lake. While a dam and dyke prevent this, some inflow is required to control the water level. This is achieved with the use of a culvert which regulates flows by using a vertical lift gate. The original gated steel culvert was replaced in 2003/2004 with a concrete box culvert (Photo 2D-6).

![Photo 2D-6: Kiskitto Lake Inlet Control Structure](image)

The Kiskitto Main Dam is approximately 2,000 ft (600 m) in length, with a maximum height of 49 ft (15 m) from its base. There are also 16 separate dykes with a combined length of 8.75 mi (14 km). These dykes protect Kiskitto Lake and the surrounding area from the higher water levels of the Nelson River’s west channel.
Black Duck Control Structure and Diversion Channel

The Black Duck Control Structure regulates the amount of water diverted from Kiskitto Lake into the Minago River via Black Duck Creek. The control structure is made of concrete with wooden stoplogs used to regulate flow. The purpose of the structure along with the Kiskitto Lake Inlet Control Structure is to regulate the water level of Kiskitto Lake within its natural range (Photo 2D-7).

![Black Duck Control Structure](image)

Photo 2D-7: Black Duck Control Structure

The Black Duck Diversion channel, also known as the Kiskitto-Minago Drainage Channel, diverts water from Kiskitto Lake to the Black Duck Control Structure. The channel is approximately 10 ft (3 m) wide at its base. Its length is approximately 2 mi (3.3 km) from Kiskitto Lake to the Black Duck Control Structure, and approximately 0.9 mi (1.5 km) from there to Black Duck Creek.

Stan Creek Diversion Channel

The Stan Creek Diversion Channel routes naturally occurring local drainage into Kiskitto Lake which was blocked from flowing into the Nelson River by the construction of containment dykes. The channel is approximately 10 ft (3 m) wide at its base, is on average 9 ft (2.7 m) deep, and is approximately 5,000 ft (1,500 m) in length.
Mitigation Components

Cross Lake Weir

The Cross Lake Weir was developed to lessen the effects of LWR on Cross Lake by increasing the average water level and reducing the range of water levels. Construction of the weir was completed in 1991 and modified the lake’s main outlet channels by filling in a portion of the Centre Channel and excavating a portion of the East Channel (Figure 2D-1).

![Cross Lake Weir and Channel Excavation](image)

Infrastructure Supporting Construction

An access road was constructed from the Jenpeg area along the Kiskitto Dyke line to the various construction sites in 1972. Construction power was provided by portable generators. Construction camps and work areas were set up near the work sites.

Construction

Construction activities were sufficiently complete in 1976 to permit regulation of Lake Winnipeg for the first time.

Operation

Water Regime: As described above, LWR was developed to achieve two main purposes: flood reduction around Lake Winnipeg, and energy production on the Nelson River. LWR reduces peak water levels on Lake Winnipeg by increasing discharge capacity during floods. LWR also provides greater flow reliability during the winter and enhances the availability and timing of water for hydroelectric production along the lower Nelson River. The Jenpeg GS is operated primarily as a control structure as part of LWR. For more details on LWR operations, the Jenpeg GS operations, and their effects on the water regime, see Water Regime, Section 4.3.2.
Licence: Manitoba Hydro operates LWR in accordance with a Province of Manitoba Water Power Act License. For further information, see the Manitoba Government Water Power Licensing website at: http://www.gov.mb.ca/waterstewardship/licensing/water_power_licensing.html.

Rehabilitation

Two-Mile Channel

Historical construction activities at Two-Mile Channel resulted in soil and groundwater contamination along with the presence of construction debris at the former construction sites. Manitoba Hydro has been actively investigating and remediating the Two-Mile Channel former construction sites since 2002. In 2003, an intensive surficial construction debris clean-up was initiated, with debris collected from the channel outlet buried at a provincially registered waste disposal ground (WDG) along the West Channel. Groundwater monitoring wells were installed and have been sampled regularly.

In 2007, an environmental drilling investigation was commissioned which resulted in contamination being discovered on the west and east sides of the channel outlet. These impacts were delineated during a 2009 investigation and a Remedial Action Plan was developed. The plan was implemented between 2011 and 2015. Approximately 6,600 m$^3$ of contaminated soils were excavated and placed into bioremediation cells for treatment. Approximately 180 m$^3$ of concrete and metal debris was removed from the site. Planned future activities include a geophysical magnetic survey, additional soil remediation activities, and biennial soil and groundwater sampling.

Eight-Mile Channel

Historical construction activities at Eight-Mile Channel resulted in soil and groundwater contamination along with the presence of construction debris at the former construction sites. Manitoba Hydro has been actively investigating and remediating the Eight-Mile Channel former construction sites since 2002. Intensive surficial construction debris clean-ups were undertaken in 2004 and 2005, as well as electromagnetic surveys at 14 sites along the north and south sides of the channel. In 2006 and 2007, environmental drilling investigations were commissioned which resulted in contamination being discovered on the north side of the channel. During the 2006 investigation, groundwater wells were installed at five sites and have been sampled regularly since 2006. In 2007 a Remedial Action Plan was developed and implemented in 2008. These activities included the construction of a soil treatment facility to receive approximately 6000 m$^3$ of impacted soils from the Eight-Mile Channel area. Soil within the facility has been aerated on a regular basis since 2008 to hasten the remediation process. Manitoba Hydro has been conducting groundwater and soil sampling on a regular basis since 2006 and 2008, respectively.

In 2015, additional soil contamination was discovered at one site along the north channel. This area will be investigated during the 2016 season. Planned future activities also include groundwater sampling, aeration of soil within the soil treatment facility and eventual decommissioning of the facility, and removal of the limited remaining construction debris.
Ominawin Bypass Channel

Manitoba Hydro initiated a ground and air search for construction debris in 2002. In 2003, stacked pipes were removed from the site. Additional environmental investigations are planned for the area.

Bibliography


Manitoba Hydro. 2014. Lake Winnipeg Regulation, A Document in Support of Manitoba Hydro’s Request for a Final License under the Manitoba Water Power Act. Manitoba Hydro. Winnipeg, MB.

APPENDIX 2E:
JENPEG GENERATING STATION
PROJECT DESCRIPTION
Location

The Jenpeg Generating Station (GS) is located on the West Channel of the upper Nelson River where the channel flows into Cross Lake. It is approximately 12 mi (19 km) southwest of the community of Cross Lake and 325 mi (525 km) north of the City of Winnipeg (Map 1.2.3-1 in Chapter 1.2, Overview of the Phase I and Phase II Reports).

Background

Lake Winnipeg Regulation (LWR) was announced by the Government of Manitoba in 1970 and developed by Manitoba Hydro to achieve two key objectives: to reduce shoreline flooding on Lake Winnipeg, and to support hydroelectric generation to meet growing demand in Manitoba. The project is a network of channels and structures that are used to control the outflow of water from the lake and allow higher outflow during flood conditions. During flood conditions it increases the outflow capability of the lake by approximately 50% more than would otherwise occur naturally. LWR went into operation in 1976.

The Jenpeg GS is one of the major components of LWR and, being located on the West Channel, controls most of the outflow from Lake Winnipeg (the East Channel of the upper Nelson River remains unregulated). Originally envisioned to be exclusively a control structure only, a decision was made during the final planning of LWR to add generating units at the structure. Descriptions of LWR and associated supporting infrastructure are provided in Lake Winnipeg Project Description (Appendix 2D).

Generating Station Components

Principal Works

The station spans a total of 0.4 mi (0.6 km) across the West Channel and consists of a close-coupled intake/powerhouse with six units, an earthfill dam, and a five-bay gated spillway (Photo 2E-1; Map 2E-1).
Photo 2E-1: Jenpeg Generating Station
Jenpeg Generating Station
General Arrangement

Legend
- Generating Station (Existing)
- Highway
- Road (Major All Weather)
- 500KV - 69KV Transmission Line
- Overhead 25KV - Primary Circuit
- Underground - Primary Circuit
- Overhead - SubTrans Circuit

Map 2E-1
Project Data

- Turbine generator units:
  - Type: 6 horizontal axis bulb propeller turbines
  - Capacity: 125 MW (63rd Annual Report, Mar. 2014)

- Powerhouse:
  - Length: 555 ft (169 m)
  - Waterfall drop (head): 24 ft (7.31 m)
  - Discharge capacity at full supply level: 92,984 ft³/s (2,633 m³/s)

- Main Dam:
  - Length: 853 ft (260 m)
  - Maximum height: 84 ft (24 m)

- Spillway:
  - Number of bays: 5
  - Length (5 bays): 260.0 ft (79.25 m)
  - Discharge capacity at full supply level: 163,013 ft³/s (4,616 m³/s)

- Reservoir/forebay elevation
  - Full supply level: 713.7 ft (217.54 m)
  - Normal minimum operating forebay elevation: 702.0 ft (213.969 m)
  - Flooded area: approximately 17.6 mi² (45.6 km²)

The Jenpeg GS was the first generating station in North America to use bulb-type turbine generators. This design reduces the depth of excavation required into the underlying bedrock. See Figure 2E-1 below for a cross-sectional view through the powerhouse.

The main dam extends across the west channel of the Nelson River, diverting water to the Jenpeg powerhouse and a spillway.

Infrastructure Supporting Construction

Main access to the site was achieved by extending PR 373 to the Jenpeg site with construction beginning in 1972. At a point on the Ponton-Thompson road (now PTH 6) approximately two miles (3.2 km) south-west of Pipun, a forestry road to Sipiwesk Lake was in place. The first 15 mi (24.1 km) of this road was up-graded and a new permanent gravel road was extended south-easterly for approximately 35 mi (56 km) to the Jenpeg site. The road was designed to carry construction traffic including the heavy loads associated with the turbine and generator components. In addition there was a 2,500 ft (762 m) long paved airstrip constructed during the project for use as required.

A temporary construction camp and work areas were established near the project site. Construction power was provided by pre-building the 230 kV transmission line (J30P) from the Ponton Substation to the Jenpeg Switching Station that would ultimately be used to transmit power to the transmission grid once the project was completed. Solid waste was disposed of at local solid waste disposal sites and waste water was treated at a local lagoon.
Excavation of the spillway and powerhouse channels through solid granite bedrock in the dry began in 1972. These channels were excavated leaving a portion of the rock along the riverbank as a plug to prevent the river from flowing in. The rock plug was later removed and the river was diverted into the powerhouse and spillway channels. The first concrete was poured in 1973 and all six of the units were in service in 1979 (Photo 2E-2).

Most of the rock and impervious construction materials came from local borrow areas, while the granular materials were hauled from the Whiskey Jack deposit approximately 8 mi (13 km) east of the construction site.

The construction workforce lived in camp for several weeks at a time and traveled to their homes during their days off.

**Mitigation Measures**

The Cross Lake Weir was developed to lessen the effects of LWR on Cross Lake by increasing the average water level and reducing the range of water levels. Construction of the weir was completed in 1991 and modified the lake’s main outlet channels by filling in a portion of the Centre Channel and excavating a portion of the East Channel (Figure 2D-1 in Appendix 2D, Lake Winnipeg Regulation Project Description).
Operations

Access: The Jenpeg GS is accessible by the Provincial Road network via PR 373 as well as by air. Provincial Road 373 crosses the powerhouse and spillway decks and provides access to previously isolated northern communities. The airstrip built during construction has subsequently been extended to 3,800 ft (1,158 m) and continues to be used as part of the access options for the site.

The Kiskitto Dyke line is accessed by a gated gravel road that branches off from PR 373 and connects to a causeway following along the dyke line.

Workforce: The station has approximately 46 staff comprised of the following: operating staff, maintenance staff (electrical, mechanical, utility), support staff (administration, stores) and supervisory staff. The workers arrive at the Jenpeg GS from various locations within the province. The workforce is split into two shifts (23 persons per shift) who work an eight days on/six days off schedule, allowing the station to be fully staffed every day from 0700h to 1820h. After hours, the System Control Centre located in the City of Winnipeg, monitors the alarms within the station and call out operations staff residing in the staffhouse to investigate any anomalies.
Accommodation: The workers stay on site in a 54 person staffhouse, completed in 1984 and located upstream of the station (Photo 2E-3).

Waste Handling: Waste water is treated at a local lagoon while solid waste is hauled to the City of Winnipeg waste disposal grounds.

Public Safety: The Jenpeg GS has a portage around the site and the following public safety features:

- a water release siren is used before adjusting discharge to warn the public in the area;
- life rings are provided on the spillway;
- fencing is used as a barrier to dangerous areas;
- the station and spillway are well lit at night, indicating to boaters that they are approaching a water control structure;
- warning signs are posted on site to warn the public of: Dangerous swift moving waters, Slippery rocks and Fluctuating water levels; and
- the Mitigation Department of Manitoba Hydro aids by:
  - marking off safe routes across the river while frozen over;
  - notifying local radio stations of water levels in the area; and
  - removing trash and debris from the river and ice boom.

Photo 2E-3: Jenpeg Generating Station – Staffhouse in background, 1998
**Water Regime:** The Jenpeg GS functions as both a generating station and a control structure. The station is operated primarily to schedule Lake Winnipeg outflows and generation along the lower Nelson River with seasonal load requirements. The Jenpeg GS produces energy using the outflow targets set by LWR.

The Jenpeg GS employs an ice boom (Photo 2E-4) upstream of the station that is used in conjunction with an Ice Stabilization Program to ensure proper ice formation and prevent frazil ice accumulation on the unit intakes during freeze up. For further information on LWR operations, the Jenpeg GS operations, and their effects on the water regime, see Water Regime, Section 4.3.2.

**Licence:** Manitoba Hydro operates the Jenpeg GS in accordance with a Province of Manitoba *Water Power Act* License. See the Manitoba Government Water Power Licensing website for further details at, http://www.gov.mb.ca/waterstewardship/licensing/water_power_licensing.html.

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**Photo 2E-4:** Jenpeg Generating Station – Upstream Ice Formation with an Ice Boom
Generation Outlet Transmission

The electricity generated at the Jenpeg GS is transmitted to the Jenpeg Switching Station adjacent to the Jenpeg GS and then is transmitted along a 230 kV line (J30P) to the Ponton Substation. Additional transmission lines connect the Jenpeg GS to the nearby communities of Cross Lake and Norway House.

Rehabilitation

In 1993 ten areas were investigated by Manitoba Hydro for potential remediation activities, including former storage areas, waste disposal grounds, and temporary sites. Several areas were remediated in 2000. In 2001 Manitoba Conservation inspected the ten sites and indicated that they could not find evidence of any outstanding concerns, and that remediation or further testing of these areas was not required at this time.

In 2004 the former 4-66 kV Substation and 4-12kV Setup Station was investigated and subsequently salvaged in 2006. In November 2010 the station areas underwent remediation, with 77.4 tonnes of impacted soil excavated and removed from the Jenpeg area. Groundwater wells in this area were decommissioned in 2012. Manitoba Hydro is completing subsurface investigations to decommission the current waste disposal ground, and a waste transfer station will operate in its place in the future.

Bibliography


Manitoba Hydro. 2014. Lake Winnipeg Regulation, A Document in Support of Manitoba Hydro’s Request for a Final License under the Manitoba Water Power Act. Manitoba Hydro. Winnipeg, MB.

APPENDIX 2F:
CHURCHILL RIVER DIVERSION
PROJECT DESCRIPTION
Location

The Churchill River basin lies to the north of the Nelson and Saskatchewan River basins, with its headwaters in east-central Alberta. The river flows across Saskatchewan in an easterly direction, at an average distance of about 150 mi (240 km) north of the Saskatchewan River. In its lower reaches through Manitoba it runs in a north-easterly direction, roughly parallel to and at a distance of about 100 mi (160 km) from the Nelson River (Map 1.2.3-1 in Chapter 1.2, Overview of the Phase I and Phase II Reports).

The Churchill River Diversion (CRD) centers on Southern Indian Lake, which is a widening in the Churchill River in the northwestern part of Manitoba (Map 2F-1). The project is not a single location but a collection of works that are collectively described as the CRD. The Missi Falls Control Structure (CS) regulates the amount of water allowed to flow out of Southern Indian Lake, down the Churchill River (the natural outlet of Southern Indian Lake). Water is diverted from Southern Indian Lake through the South Bay Diversion Channel, into the Rat River, and through the Notigi CS to the Burntwood River and then to the Nelson River (Map 2F-1).

Background

The Manitoba portion of the Churchill River originally had a hydroelectric potential of more than 3,000 MW. Instead of harnessing this hydroelectric potential by building hydropower stations along the river itself, a considerable economic advantage was gained by diverting most of the Churchill River water into the Burntwood and Nelson River systems to use at the generating stations planned on these rivers.

Following joint federal-provincial studies, Manitoba Hydro, in February 1966, announced its intention to divert the Churchill River as part of an overall plan of northern hydro development.

Components and Principal Works

The components of the CRD are comprised of two control structures, an excavated channel, and two mitigation structures as shown in Map 2F-1. Following, are descriptions of each of these components.
Operational Components

Missi Falls Control Structure

The Missi Falls CS (Map 2F-2; Photo 2F-1) regulates the amount of water allowed to flow out of Southern Indian Lake, down the Churchill River (the natural outlet of Southern Indian Lake). The Missi Falls CS is located 106 mi (170 km) north of the City of Thompson. The control structure is capable of discharging 113,000 ft³/s (3,200 m³/s) at a forebay elevation of 847.5 ft (258.32 m). The principal works include a six-bay gated spillway, the South Channel Dam, the North Channel Dam, the Main Dam, the South Dyke, and an electrical services building. The Missi Falls CS was built between 1973 and 1976.

Photo 2F-1: Missi Falls Control Structure
South Bay Diversion Channel

The South Bay Diversion Channel (Photo 2F-2) diverts water from the South Bay of Southern Indian Lake into Issett Lake which flows into the Rat, Burntwood, and then Nelson Rivers. The channel is approximately 200 ft (61 m) wide at its base and 5.8 mi (9.3 km) long. The South Bay Diversion Channel was opened in 1976.

Photo 2F-2: South Bay Diversion Channel
Notigi Control Structure

The Notigi CS (Photo 2F-3; Map 2F-3) regulates the amount of water diverted to the Nelson River via the Rat River and Burntwood River. The Notigi CS is located on the Rat River between Notigi Lake and Wapisu Lake. The control structure is capable of discharging 66,000 ft³/s (1,869 m³/s) at a forebay elevation of 847.5 ft (258.32 m). Principal works consist of a three bay spillway, an adjacent electrical service substation building, the Main Dam and a Saddle Dam. The Notigi CS was built between 1974 and 1975. In addition, the structure provides a crossing for PR 391.

Photo 2F-3: Notigi Control Structure
Notigi Control Structure
General Arrangement

Legend
- Control Structure (Existing)
- Highway
- Road (Major All Weather)
- Overhead 25kV - Primary Circuit

Manitoba Hydro; Government of Manitoba; Government of Canada
Imagery - DOI Rat River Notigi 20cm - 2011
Manitoba Hydro - GIS Studies

Scale: 1:14,000

File Location: \geodata\GIS_groups\GISS\RCEA\Maps\ProjectDescriptions\RCEA_ProjectDescription_NotigiCS.mxd

Date Created: 09-DEC-15
Renumbered: R A T  R I V E R
Map 2F-3
Mitigation Components

Manasan Falls Ice Control Structure

The Manasan Falls Ice Control Structure is a passive control structure designed to reduce the risk of inundation (flooding) in the City of Thomson due to ice. The control structure is located on the Burntwood River approximately 5 mi (8 km) upstream of the City of Thompson. Principal works consist of an ice boom across the river, a by-pass channel with a concrete overflow weir, and a flood channel protected with a fuse plug dyke. The project was initially constructed in 1976 followed by rehabilitation in 1986 and the incorporation of additional safety features in 1988. An aerial view of the structure is shown in Photo 2F-4.

Photo 2F-4: Manasan Falls Ice Control Structure
Churchill Weir

The Churchill Weir (Photo 2F-5) is a mitigation structure designed to increase water levels on the Churchill River to ensure a potable source of water, to enhance recreation and to enhance aquatic habitat. The structure was built 6 mi (10 km) south of the Town of Churchill, upstream of Mosquito Point and the salt water intrusion zone in the Churchill River estuary. The principal works consist of an overflow section and two dyke sections. The overflow section is 7,500 ft (2,300 m) long with a 1,000 ft (300 m) fishway segment at the lowest point of the weir. The west dyke is 450 ft (140 m) long and the east dyke is 3,850 ft (1,170 m) long. The east dyke incorporates the Goose Creek fishway and an emergency flood relief section. These works were essentially completed in October 1999.

Photo 2F-5: Churchill Weir

Infrastructure Supporting Construction

Access to each of the components consist of the following:

- Missi Falls CS: by winter trail, air and water;
- South Bay Diversion Channel: by winter trail, air and water;
- Notigi CS: initially by winter trail along the 138 kV transmission line. PR 391 was constructed at the same time, originally as a gravel all-weather road between the City of Thompson and the community of Leaf Rapids;
- Manasan Falls Ice CS: by a temporary construction road; and
- Churchill Weir: by Hudson Bay Railway line, local roads and air.

Temporary construction camps and work areas were established near the sites. Waste water was treated using portable sewage treatment plants.
Construction power for each of the components was provided by:

- Missi Falls CS: diesel generators;
- Notigi CS: a tap from the 138 kV line between Mystery Lake and Laurie River #1 G.S. (WL43);
- South Bay Diversion Channel: diesel generator (likely);
- Manasan Ice CS: diesel generator; and
- Churchill Weir: a tap to the 138 kV Radisson to Churchill (RC60) line, or may have been by a generator.

**Construction**

All of the CRD components were undertaken utilizing local materials. For construction dates, see the description of the components above.

**Operations**

**Workforce:** The Notigi CS is not normally manned. Operation of the spillway gates is directed by the Energy Operations Planning Department, with operations staff from the City of Thompson traveling to the Notigi CS by PR 391 to operate the gates as required.

The Missi Falls CS is not normally manned. Operation of the spillway gates is directed by the Energy Operations Planning Department, with operations staff from the City of Thompson being dispatched to the Missi Falls CS to operate the gates as required. Operation of the spillway gates occur at least six times a year, generally in the spring and fall.

The Missi Falls CS is accessible by water by boats launched from the Notigi CS or by air. There is an airstrip 1.2 mi (2 km) from the Missi Falls CS site, but the site is also commonly accessed by helicopter.

There is a staff house at the Missi Falls CS with a water and sewer system.

**Water Regime:** The Missi Falls CS and the Notigi CS operate to control outflow from Southern Indian Lake as part of the CRD. The majority of flow is typically diverted through the Notigi CS, while a smaller portion flows through the Missi Falls CS. The discharge at both the Missi Falls CS and the Notigi CS typically remain constant for long periods of time up to several months in duration. For more details on CRD operations and their effect on the water regime see Water Regime, Section 4.3.3.

**Licence:** Manitoba Hydro operates the CRD in accordance with a Province of Manitoba Water Power Act License. Authorizations granting temporary amendments to this licence first began for the 1979/1980 winter operating season to optimize CRD operations. Variations to these amendments occurred until 1986. Every year since then, these amendments have been unchanged and have been referred to as the Augmented Flow Program. For further information see the Manitoba Government Water Power Licensing website at http://www.gov.mb.ca/waterstewardship/licensing/water_power_licensing.html
Transmission

Of the CRD components, only the Notigi CS is connected to the provincial transmission grid. The Notigi CS is connected by a 12 kV line to the 138 kV line, WL43, from Mystery Lake to the Laurie River #1 GS. Electrical power required for the operation of the Missi Falls CS is supplied by a house unit.

Mitigation and Rehabilitation

As a result of the increased flows in the Burntwood River at the City of Thompson, it was necessary to modify the city's water intake system and to rebuild the floatplane base. As a result of the decreased river flows on the Churchill River, modifications were required to the water supply works for the Town of Churchill. As a result of flooding of approximately 3.1 mi² (8.1 km²) of Indian Reserve land, remedial works and other mitigation measures were required in the area of Nelson House.

Construction of the South Bay Diversion Channel in the 1970’s resulted in residual construction debris and the contamination of soil at the former South Bay Construction Area. In 2003, environmental drilling investigations were initiated at the former diesel generating and transformer station sites at South Bay. Remediation subsequently took place at the former transformer station in 2005, comprising of the excavation of approximately 2,100 ft³ (60 m³) of impacted soils and the removal of construction debris. In 2005 and 2006, thirteen sites were assessed for buried metal debris using a geophysical electromagnetic survey to quantity and locate historical construction debris; eight areas of buried debris were confirmed by the survey. In 2007, an environmental drilling investigation comprising 127 test pits and/or test holes was conducted at eighteen sites to determine the presence or absence of impacted soil; approximately 919,100 ft³ (26,030 m³) of petroleum hydrocarbon impacted soil was identified at three sites. To treat the impacted soils, a soil treatment facility is required. Manitoba Hydro and O-Pipon-na-Piwin Cree Nation are currently investigating the suitability of a parcel of land close to South Bay for the construction of the facility. Once the suitability of the land is confirmed, the soil treatment facility will be constructed and remediation of impacted soil and removal of debris will commence. At the Missi Falls CS, no significant environmental work has been completed. Investigations are planned when South Bay Remediation concludes.

Bibliography


APPENDIX 2G:
LONG SPRUCE GENERATING STATION
PROJECT DESCRIPTION
Location

The Long Spruce Generating Station (GS) is located at a site previously known as Long Spruce Rapids (Photo 2G-1) upstream of where Wilson Creek and Sky Pilot Creek connect with the lower Nelson River. It is approximately 13.3 mi (21 km) east of the Town of Gillam, 10.3 mi (16.5 km) downstream of the Kettle GS, and 463 mi (745 km) north of the City of Winnipeg (Map 1.2.3-1 in Chapter 1.2, Overview of the Phase I and Phase II Reports).

Background

Studies in the 1960s and early 1970s envisioned a four phase development for the area at Kettle Rapids and downstream, namely the sites at Kettle Rapids, Long Spruce Rapids, Lower Limestone Rapids and Gillam Island. The first phase of development included the following components:

- a generating station at Kettle Rapids;
- a High Voltage Direct Current (HVDC) transmission line from the Kettle GS to the City of Winnipeg;
- control works to divert Churchill River water into the Nelson via the Burntwood River; and
- control works to regulate the outflow of Lake Winnipeg into the Nelson.

The second phase of development included the Long Spruce GS which was Manitoba Hydro’s fourth generating station built on the Nelson River.
Generating Station Components

Principal Works

The station spans a total of 0.9 mi (1.4 km) across the Nelson River and consists of a close-coupled intake/powerhouse with ten units, concrete wing walls, a non-overflow concrete dam, two main earthfill dams (north and south), east and west dykes, and a six-bay gated spillway (Photo 2G-2; Map 2G-1). This general arrangement is similar to that of the Kettle GS and the Limestone GS. Eight miles (13 km) of dykes flank the Nelson River to reduce the extent of flooding from the project.

Photo 2G-2: Long Spruce Generating Station
Project Data

- **Turbine Generator Units:**
  - Type: 10 vertical-shaft fixed-blade propeller turbines
  - Capacity: 980 MW (63rd Annual Report, Mar. 2014)

- **Powerhouse:**
  - Length: 870.0 ft (265.2 m)
  - Waterfall drop (head): 80.0 ft (24.4 m)
  - Discharge capacity: 159,900 ft³/s (4,528 m³/s)

- **Main Dams (North and South dams):**
  - Length: North Dam = 3,000 ft (914.4 m); South Dam = 750 ft (228 m)
  - Maximum height: North and South dams = 140 ft (42.7 m)

- **Spillway:**
  - Number of bays: 6
  - Length (6 bays): 340.0 ft (103.63 m)
  - Discharge capacity: 342,552 ft³/s (9,700 m³/s)

- **Reservoir/Forebay Elevation:**
  - Full supply level: Maximum Operating Forebay Elevation, Open Water = 361.0 ft (110.0 m)
  - Maximum Operating Forebay Elevation, Ice Cover: 362.0 ft (110.3 m)
  - Flooded Area: 5.3 mi² (13.7 km²)

**Infrastructure Supporting Construction**

Main access to the region during construction was by the Hudson Bay Railway line which had a rail station and siding at the Town of Gillam. A new 10 mi (16 km) permanent gravel road was constructed from the Kettle GS area, as well as a temporary rail spur line from the Hudson Bay line near the Kettle GS in 1971 to the Long Spruce GS site. As was the case for the Kettle GS, there was no road connecting the Long Spruce GS to the provincial road network during construction.

A temporary construction camp and work areas were established near the site. Construction power was extended from the Radisson Converter Station to a new construction power station near the Long Spruce GS. Solid waste was disposed of at a local solid waste disposal site and wastewater was treated at a local lagoon.
Construction

In 1973 the Stage I cofferdam was built which allowed the powerhouse and spillway to be constructed in the river (Photo 2G-3). The materials for construction came from local areas, rock came from the Wilson Creek Quarry downstream from the site, granular and impervious materials came from local borrow areas outside of the forebay area.

Photo 2G-3: Long Spruce Generating Station construction – winter concreting in the tailrace area – Winter 1976

Most of the construction workforce lived in camp (Photo 2G-4) while a small percentage lived and commuted from the Town of Gillam on a regular basis.

The first of the station’s ten generating units went into service in 1977 with all being operational by 1979.
Operations

Transportation: PR 280 was constructed at the end of the Long Spruce GS construction and crosses the Nelson River over the Long Spruce GS.

Workforce: The station has approximately 30 to 35 staff comprised of the following: operating staff, maintenance staff (electrical, mechanical, utility), support staff (administration, stores) and supervisory staff. The station is fully staffed every day between 0700h and 1800h. The operators are located on site 24 hours per day, seven days per week. Additional support and technical services are also located in the nearby Town of Gillam. The majority of staff working at the Long Spruce GS lives in the surrounding area including the communities of Gillam and Fox Lake Cree Nation (FLCN; Bird).

Waste Handling: The Long Spruce GS is served by a mechanical wastewater treatment plant. Municipal solid waste is hauled to the Town of Gillam Waste Disposal Grounds.

Public Safety: Manitoba Hydro’s public water safety guidelines are currently under development. At present, the Long Spruce GS has the following public safety features:
- a water release siren is used before adjusting discharge to warn the public in the area;
- life rings are provided on the powerhouse tailrace deck;
- fencing is used as a barrier to dangerous areas; and
- warning signs are posted at the intake structure, tailrace deck, and spillway for boaters.
**Water Regime:** The Long Spruce GS is operated as a run-of-river generating station with flow patterns matching water releases from the Kettle GS located upstream. The Kettle GS is operated with a daily and weekly cycling pattern that allows Manitoba Hydro to match energy production to consumption patterns. For more details on the Long Spruce GS and the Kettle GS operations and their effects on the water regime, see Section 4.3.4.3.

**License:** Manitoba Hydro operates the Long Spruce GS in accordance with a Province of Manitoba Water Power Act License. For further information see the Manitoba Government Water Power Licensing website at:  [http://www.gov.mb.ca/waterstewardship/licensing/water_power_licensing.html](http://www.gov.mb.ca/waterstewardship/licensing/water_power_licensing.html)

**Generation Outlet Transmission**

Two sets of three 230 kV transmission lines were constructed from 1975 to 1980 to link the Long Spruce GS to the Radisson and Henday Converter Stations. Half of the electricity produced at the Long Spruce GS is first transmitted along the generation outlet transmission lines as alternating current to the Radisson Converter Station (L41R, L42R, L43R) where it is converted to direct current. The other half is transmitted to the Henday Converter Station (L46H, L47H, L48H) where it is also converted from alternating current to direct current. After its conversion to direct current the power is transmitted approximately 560 mi (900 km) to southern Manitoba where it is converted back to alternating current.

**Rehabilitation**

The rail spur was removed following construction and the right-of-way was used to install a fiber optic cable to compliment the original communication system.

In September 2012, three metal cylinders were removed from the Long Spruce Construction Waste Disposal Ground and disposed of at General Scrap in the City of Winnipeg.

During the winter months of 2015/2016 a Phase I Environmental Site Assessment will be conducted at the former Long Spruce Construction Waste Disposal Ground. Additional environmental investigations and remediation are planned for the area.

**Bibliography**


APPENDIX 2H:
LIMESTONE GENERATING STATION
PROJECT DESCRIPTION
Location

The Limestone Generating Station (GS) is located at a site previously known as Limestone Rapids or Upper Limestone Rapids (Photo 2H-1), upstream of where the Limestone River empties into the Nelson River. It is approximately 14 mi (23 km) immediately downstream of the Long Spruce GS, 34 mi (55 km) from the Town of Gillam and 466 mi (750 km) north of the City of Winnipeg (Map 1.2.3-1 in Chapter 1.2, Overview of the Phase I and Phase II Reports).

Background and Construction

Background

Studies in the 1960s and early 1970s envisioned a four phase development at Kettle Rapids and downstream, namely the sites at Kettle Rapids, Long Spruce Rapids, Lower Limestone Rapids and Gillam Island, to harness the abundant hydroelectric potential of the Nelson River. The first phase of development included the following components:

- a generating station at Kettle Rapids;
- a High Voltage Direct Current (HVdc) transmission line from Kettle Rapids to the City of Winnipeg;
- control works to divert the Churchill River into the Nelson River via the Burntwood River; and
- control works to regulate the outflow of Lake Winnipeg into the Nelson River.
The second phase of development included the Long Spruce GS which was Manitoba Hydro’s fourth generating station built on the Nelson River.

The third phase of development included the Limestone GS.

**Initial Construction**

Prior to the commencement of construction on the Limestone GS, a number of supporting infrastructure components were constructed as part of the adjacent Henday CS (see Appendix 2C, HVDC Transmission System Project Description). A permanent gravel access road and a construction power line were extended from the Long Spruce GS area to the Limestone GS area in the early 1970’s, with the road later becoming PR 290. A rail spur from the Hudson Bay Railway line (now HBR; Canadian National Railway [CNR] at the time) near the community of Bird (now Fox Lake Cree Nation [FLCN]) was also constructed to the Henday CS site. Construction of the Limestone GS Stage I cofferdam began in 1976. However, while the cofferdam construction was underway and nearly complete in 1978 (Photo 2H-2), construction of the Limestone GS was suspended indefinitely by Manitoba Hydro as a result of a lower than expected forecast in the provincial demand for electricity. Cessation of the Limestone GS construction brought to an end the busiest period of electrical development activity ever to occur in Manitoba.

*Photo 2H-2: Stage I Cofferdam Construction – 1978*
Reinitiated Construction

In August 1985 construction of the Limestone GS was resumed by Manitoba Hydro as a result of the approval by the National Energy Board for an export sale for up to 500 MW of firm power from 1993 to 2005 to the Northern States Power Company of Minneapolis, Minnesota. As a result of the initial construction activities between 1976 and 1978, the project was able to re-commence development work directly on the principal structures as much of the supporting infrastructure required for construction activities was already in place.

A new rail spur extending the Henday rail spur was added to the Limestone GS work area. There was an airstrip in the community of Bird for some portions of the project but it was not used for construction. The temporary construction camp, work areas, a temporary townsite named Sundance, and the opening of the Limestone River Quarry as a source of rock fill for the Stage I cofferdam were re-established. The entire construction workforce either lived in camp or in the Sundance townsite. Those living in camp stayed for several weeks at a time and travelled to their homes during their days off. Solid waste was disposed of at a local solid waste disposal site and wastewater was treated at a local lagoon.

The Stage I cofferdam constructed in 1978 was originally designed to an elevation of 70.0 m above sea level. During the period from 1979 to 1985 this cofferdam was overtopped on two occasions due to high water levels caused by ice jams (Photo 2H-3). This new information led to the requirement to increase the height of the Stage I cofferdam to a nominal elevation of 73.0 m prior to re-commencing construction (Figure 2H-1). The materials for construction came from local areas, rock came from the Limestone River Quarry and the site excavations, granular and impervious materials came from local borrow areas.

![Photo 2H-3: Nelson River Overtopping the Stage I Cofferdam – 1979](image-url)
Figure 2H-1: Limestone Generating Station during Construction
The generating station was constructed in two primary stages, the first being the construction of the north dam, the powerhouse, and the spillway all contained within the Stage I cofferdam (Photo 2H-4). The second stage began with the full closure of the river, the diversion of water through the spillway, and the completion of the south dam across the river (Photo 2H-5). Following five years of construction activity the first unit went into service in 1990, with the station becoming fully operational by 1992 when the tenth and final unit went into service.

Photo 2H-4: Principal Works Construction – 1987

Photo 2H-5: Stage II Closure – 1989
Generating Station Components

Principal Works

The generating station spans a total of 0.8 mi (1.3 km) across the Nelson River and consists of a close-coupled intake/powerhouse with ten generating units, concrete wing walls, two main earthfill dams (north and south) and a seven-bay gated spillway (Photos 2H-6, 2H-7; Map 2H-1).

Photo 2H-6: Limestone Generating Station Area – Looking South

Photo 2H-7: Limestone Generating Station – 2009
Project Data

- **Turbine generator units:**
  - Type: 10 vertical-shaft fixed-blade propeller turbines
  - Capacity: 1350 MW (63rd Annual Report, March 2014)

- **Powerhouse:**
  - Length: 948.2 ft (268.5 m)
  - Waterfall drop (head): 120.5 ft (31.2 m)
  - Discharge capacity: 176,573 ft³/s (5,000 m³/s)

- **Main dams (North and South dams):**
  - Length: North Dam = 230 ft (70.0 m); South Dam = 2,362 ft (720 m)
  - Maximum Height: North and South dams = 131 ft (40.0 m)

- **Spillway:**
  - Number of bays: 7
  - Length (7 bays): 444.9 ft (113 m)
  - Discharge capacity: 339,021 ft³/s (9,600 m³/s)

- **Reservoir/forebay elevation:**
  - Full supply level: (Maximum Operating Forebay Elevation, Open Water) - 279.9 ft (85.313 m)
  - Normal minimum operating forebay elevation: 270.0 ft (82.296 m)
  - Flooded Area: 0.8 mi² (2.1 km²)

Mitigation and Rehabilitation

As part of the re-initiation of construction activities for the Limestone GS, the project underwent the first environmental assessment for a Nelson River generating station. The environmental assessment included consultation with the Town of Gillam and the FLCN. Most of the recommendations for monitoring potential adverse effects on the biophysical environment and enhancing beneficial effects to the local area were implemented during project construction and operation. Only minimal mitigation was recommended because the environmental effects of the project were assessed to be minimal, largely because the Limestone GS resulted in a relatively small amount of flooding. Select borrow areas underwent pilot revegetation initiatives.

The Limestone/Bird waste disposal ground was in use until approximately 1999. The site was cleaned up to meet regulatory requirements in 2000 and Manitoba Hydro planned to transfer the site to the FLCN, however, the transfer has not been finalized.

Operations

**Access:** Access to the site is by PR 290, which was designated as a provincial road following construction. The rail spur line, stores work area, and various buildings remaining from construction continue to be used for operational purposes.
**Workforce:** The station has approximately 30 to 35 staff comprised of the following: operating staff, maintenance staff (electrical, mechanical, utility), support staff (administration, stores) and supervisory staff. The operators are located on site for 24 hours per day, seven days per week. The remaining of the maintenance staff are on site during normal business hours during the weekdays. The majority of the staff working at the Limestone GS drive in from the Town of Gillam. There are no staff accommodations on site at the Limestone GS. Additional support and technical services are located in the nearby Town of Gillam.

**Waste Handling:** The Limestone GS is served by a mechanical waste water treatment plant. Municipal solid waste is hauled to the Town of Gillam Waste Disposal Grounds.

**Public Safety:** The Limestone GS has a portage around the site and the following public safety features:
- A water release siren is used before adjusting discharge to warn the public in the area;
- Life rings are provided at the spillway; and
- Warning signs are provided (in English and Cree) at site to warn the public of: dangerous swift moving waters, steep drop off, overhead power lines, stay off Ice, falling ice, slippery rocks, and rapidly changing water conditions.

**Water Regime:** The Limestone GS is operated as a run-of-river generating station with flow patterns matching water releases from the Long Spruce GS upstream, which are driven by water releases at the Kettle GS further upstream. The Kettle GS is operated with a daily and weekly cycling pattern that allows Manitoba Hydro to match energy production to consumption patterns. For more details on the Limestone GS, the Long Spruce GS, and the Kettle GS operations and their effects on the water regime, see Water Regime, Sections 4.3.4.3 and 4.3.4.4.

**License:** Manitoba Hydro operates the Limestone GS in accordance with a Province of Manitoba *Water Power Act* license. For further information see the Manitoba Government Water Power Licensing website at: http://www.gov.mb.ca/waterstewardship/licensing/water_power_licensing.html.

**Transmission Components**

In conjunction with the construction of the Limestone GS two transmission projects were undertaken, and are described below.

**Related Transmission**

A 25 mi (40 km) 138 kV transmission line was built in 1989 from the Radisson Converter Station to the Limestone GS to act as an emergency backup to the generating station.

**Generation Outlet Transmission**

The Limestone GS outlet transmission consists of five 138 kV transmission lines built in 1990 from the Limestone GS to the existing Henday Converter Station. This allowed the power to be moved from the Limestone GS onto the High Voltage Direct Current (HVdc) transmission system to southern Manitoba.
Rehabilitation

The facilities built during construction were not totally decommissioned following construction. Several facilities remain and are used for operations or as potential future work areas. There has been some restoration work undertaken in the surrounding borrow areas. The former metal waste disposal ground was decommissioned in 1995.

Bibliography


APPENDIX 2I:
CONAWAPA GENERATION PROJECT
PROJECT DESCRIPTION
Location
The site of the potential Conawapa Generating Station (GS) is on the lower Nelson River at a site called Axis B. It is approximately 17.7 mi (28.5 km) downstream of the Limestone GS, 19.2 mi (31 km) northeast of the community of Fox Lake Cree Nation (FLCN; Bird), and 482 mi (775 km) north of the City of Winnipeg (Map 1.2.3-1 in Chapter 1.2, Overview of the Phase I and Phase II Reports).

Background
The Conawapa Generating Station (GS) (Figure 2I-1) was to become the fourth phase of the northern hydro development plan embarked upon in the early 1970's. The potential Conawapa GP was part of the fourth phase after decisions were made on the location and level of development of the Limestone GS.

Figure 2I-1: Computer Rendering of the Potential Conawapa Generating Station
In 1990, a power sale agreement for 1,000 MW, signed with the Province of Ontario required the development of the Conawapa GS to accommodate a portion of the sale. Construction began in 1991 with an access road from the Limestone GS and the clearing of a construction power line right-of-way. In
1993, the Province of Ontario cancelled the energy purchase contract with Manitoba Hydro, resulting in the cancellation of the project and the deferral of all activities.

In 2003, with the projection of a higher demand in energy, Manitoba Hydro resumed studies for the Conawapa GS. Due to the number of years that had lapsed since the Conawapa GS was last studied in detail, a review of all aspects of the design, construction methodology, and schedule was initiated as well as the undertaking of necessary environmental studies.

The Public Utilities Board (PUB) undertook a review of the Needs For and Alternatives To (NFAT) Manitoba Hydro’s preferred development plan beginning in 2013. The plan proposed the construction of the Conawapa GS among other projects that concluded with the PUB’s report issued in June of 2014. The PUB recommended that “Spending on the Conawapa Project and the North-South Transmission Upgrade Project be discontinued immediately and the projects terminated”. The government of Manitoba provided direction to Manitoba Hydro in July of 2014 to which Manitoba Hydro proposed to wind-down Conawapa-related planning activities over a two-year period while a stronger business case is developed. Efforts on wrapping up work on the Conawapa GS is anticipated to be completed by the end of 2016 and archived for later use.

Activities being wrapped up are:

- completion of Environmental Assessment studies which were underway, and have enduring value;
- completion of Aboriginal Traditional Knowledge (ATK) studies, which have enduring value; and
- wind-down of engineering, negotiations, environment assessments, and regulatory activities.

**Supporting Infrastructure**

The main access to the site is by the existing permanent gravel road to the Conawapa GS area. The road was extended 14.9 mi (24 km) from the Limestone GS construction area to the Conawapa GS construction area in 1992. The road is currently being used for the construction of the Keewatinohk Converter Station and will continue be used for operations once the project is complete.

There is also an existing 21.7 mi (35 km) winter trail that was built in the early 1980s on the south side of the river that is accessed by crossing the service road on the forebay deck of the Limestone GS. The access trail has been used for various exploration activities and is currently used by local resource users.

**Field Investigations**

Extensive engineering field and laboratory investigations have been conducted for the Conawapa GS over a number of years. Most of the data was specifically collected for the purpose of assisting with the preliminary engineering design work and specific Axis B investigations (river and abutment areas). Some of the data was used to assist with the physical environment erosion and sedimentation studies needed for the environmental assessment. Field investigations consisted of the collection of aerial photography, air photo interpretation and photogrammetric mapping, reconnaissance surveys, exploratory drilling, test pitting, sampling of overburden and bedrock materials, full scale test excavation, geological mapping and geophysical surveys. The geophysical surveys consisted of seismic refraction, electromagnetic gravity,
ground penetrating radar and downhole geophysical surveys. Investigations were carried out in 1963/1964, 1974/1975, 1980/1981 and between 1987 and 1990. It should be noted that the field investigations prior to 1987 were not specific to Axis B as there were several axes being evaluated at the time. Only the 1987 and subsequent field investigations are specific to the current location of Conawapa at Axis B. Since 1963, the geotechnical inventory for the Conawapa GS consists of approximately 1,400 boreholes, test pits, and test trenches providing a solid understanding of the regional and local soil conditions. More recent fieldwork activities were undertaken from 2005 to 2010, with a major program undertaken in 2006 involving a test excavation of the north abutment area.

Extensive environmental field and office studies were conducted for the Conawapa GS and the area downstream of the Limestone GS from 1989 to 1992 when the project was first postponed. Studies related to Limestone GS monitoring continued from 1985 through 1999. Studies on the lower Nelson River conducted as part of Keeyask GP studies occurred in 2002 and 2003. The most recent environmental studies directly associated with the potential Conawapa GP related to the physical, terrestrial, aquatic and socio-economic environments along the lower Nelson River, the estuary and the Hayes River have been underway for 10 years and, in most cases, were nearing completion in the summer of 2014.

Field works were generally based out of temporary field camps. There was a camp at the Conawapa GS area from 1989 to 1992. The most recent camp (2005 to 2012) was a 50 to 75 person temporary camp located at the current Keewatinohk Converter Station construction camp. The most recent field camp hauled their solid waste to the Town of Gillam solid waste disposal site. Wastewater was hauled to the Town of Gillam lagoon. The workforce lived at camp for several weeks at a time and traveled to their homes during their days off. There were also more remote camps like the Deer Island Camp from 2007 to 2012.

Rehabilitation

An engineering field program at Axis DX is currently being investigated to determine if additional clean-up work is required.

Bibliography

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Hatch Ltd. 2015. Conawapa Generating Station – Axis B – Principal Works Basis of Design. Manitoba Hydro. Winnipeg, MB.
APPENDIX 2J:
WUSKWATIM GENERATION PROJECT
PROJECT DESCRIPTION
Location

The Wuskwatim Generating Station (GS) is located at a site previously known as Taskinigup Falls (Photo 2J-1) on the Burntwood River, one mile (1.6 km) downstream of Wuskwatim Falls, which is the natural outlet of Wuskwatim Lake. The Wuskwatim GS is approximately 23 mi (37 km) southeast of community of Nelson House and 28 mi (45 km) southwest of the City of Thompson (Map 1.2.3-1 in Chapter 1.2, Overview of the Phase I and Phase II Reports).

Photo 2J-1: Pre-Construction Looking Upstream toward Wuskwatim Lake, 2007

Background

The Wuskwatim GS location was identified by Manitoba Hydro as a potential hydroelectric development site following the implementation of the Churchill River Diversion (CRD) in 1966. The site became a higher potential resource option once the CRD began operating in 1976. The project was committed to in the summer of 2006 to meet the needs of continued load growth following a rigorous regulatory review process. The Wuskwatim GS was developed, and is owned by, the Wuskwatim Power Limited Partnership (WPLP) a legal entity involving Nisichawayasihk Cree Nation (NCN) and Manitoba Hydro. Manitoba Hydro operates the Wuskwatim GS as part of the Manitoba power grid on behalf of WPLP.
Generating Station Components

Principal Works

Wuskwatim GS spans a total of 0.4 mi (0.6 km) across the Burntwood River and consists of a close-coupled intake/powerhouse with three units, a non-overflow concrete dam, a concrete wing wall, a main dam, a dyke to contain the immediate forebay, and a three-bay gated spillway (Photo 2J-2; Map 2J-1). The immediate forebay is the area between generating station principal works and Wuskwatim Falls. The immediate forebay area and Wuskwatim Lake together form a reservoir that is typically referred to as the forebay. Channel improvements were undertaken at Wuskwatim Falls to increase the outflow capability of the lake.

Photo 2J-2: Wuskwatim Generation Station – looking Upstream
Project Data

- **Turbine Generator Units:**
  - Type: 3 vertical shaft fixed blade propeller turbines
  - Capacity: 214 MW (63rd Annual Report, Mar. 2014)

- **Powerhouse:**
  - Length: 246.16 ft (75.03 m)
  - Waterfall drop: 70.2 ft (21.4 m)
  - Discharge capacity: 38,846 ft³/s (1,100 m³/s)

- **Main Dam:**
  - Length: 1,056 ft (322 m)
  - Maximum height: 46.3 ft (14.1 m)

- **Spillway:**
  - Number of bays: 3
  - Length (of all bays): 141.08 ft (43.0 m)
  - Discharge capacity: 81,577 ft³/s (2,310 m³/s)

- **Reservoir/Forebay Elevation:**
  - Full supply level (maximum): 767.71 ft (234.0 m)
  - Normal minimum operating forebay elevation: 766.89 ft (233.75 m)
  - Flooded Area: 0.1 mi² (0.4 km²)
Infrastructure Supporting Construction

Access to the Wuskwatim GS site is from the north via a 29.8 mi (48 km) permanent gravel access road from PR 391, approximately 32 km west of the City of Thompson.

A temporary construction camp and work areas (Photo 2J-3) were established near the site. The construction camp comprised of accommodations for upwards of 840 workers, a dining complex, a recreation centre, and a lounge. Construction power was brought in by pre-building the 230 kV transmission line (W76B) from the City of Thompson (Birchtree Station to Wuskwatim Switching Station) and would ultimately be used as outlet transmission once the project was complete. Solid waste was hauled to the City of Thompson and a local lagoon was used for wastewater treatment.

Photo 2J-3: Construction Work Areas
Construction

Construction began in 2006 when clearing for the site access road and start-up camp got underway. Over a two year period, the access road was constructed, borrow areas were developed, and the site construction camp built adjacent to the future location of the generating station.

Work on the generating station began in late 2007 with the opening up of a rock quarry, impervious and granular borrow areas, and construction of cofferdams to isolate the area for the spillway, powerhouse and exit channels to be built. River diversion through the completed spillway structure took place in 2010, allowing for construction of the Stage II cofferdams and the permanent main dam across Taskinigup Falls (Photo 2J-4). The station’s three generating units went into commercial service between June and October 2012 (Photo 2J-5).

All of the construction workforce lived in camp for several weeks at a time and travelled to their homes during their days off.

Decommissioning of construction facilities and restoration of the site continued through 2013 and 2014.
Photo 2J-4: Stage II Diversion - Construction of the Main Dam

Photo 2J-5: Powerhouse and Spillway Looking Upstream
Operations

Access: Access to the site is by the construction road, which was used to build the project and connect the site to PR 391. The access road is private and is not part of the provincial road network. A security gate near the intersection of the access road and PR391 limits access to the area to those authorized. The site is approximately a one-hour drive from the City of Thompson. There is no landing strip at the site for fixed-wing aircraft; however several landing areas are present to permit helicopter access.

Workforce: The station has approximately 10 staff comprised of the following: operating staff, maintenance staff (electrical, mechanical, utility), support staff (administration, stores) and supervisory staff. The workforce arrive at the Wuskwatim GS from various locations within the province. The workforce is split into two shifts who work an eight days on/six days off schedule, allowing the station to be fully staffed every day between 0700h and 1800h. After hours, the System Control Centre located in the City of Winnipeg monitors alarms within the station and calls out operating staff to investigate any anomalies.

The workers stay at site in dormitories retained following completion of construction of the station. The site is supported by a small on-site kitchen/dining complex and is serviced by the construction water treatment plant and sewage lagoon.

Waste Handling: Municipal solid waste is hauled to the City of Thompson waste disposal grounds.

Public Safety: Several safety features were designed into Wuskwatim, including:
- a water release siren that is automatically sounded before adjusting discharge through the spillway gates to warn the public in the area of the generating station;
- a boat restraining barrier (safety boom) which is located upstream of Wuskwatim Falls;
- life rings provided on the spillway, powerhouse intake and tailrace decks;
- fencing used as a barrier to dangerous areas;
- signage (printed in English and Cree) for users of the waterway; and
- security gates which restrict access at the highway access point.

Licenses: Manitoba Hydro operates the Wuskwatim GS on behalf of the WPLP in accordance with the Water Power Act and Environment Act licences issued by the Province of Manitoba. The Wuskwatim GS was the first generating station in Manitoba to be authorized under the Environment Act. For more details on the Wuskwatim GS operations and its effects on the water regime, see Water Regime, Section 4.3.3.6. For further information on the Water Power license, see the Manitoba Government Water Power Licensing website at: http://www.gov.mb.ca/waterstewardship/licensing/water_power_licensing.html.

Generation Outlet Transmission

Development of the Wuskwatim GS required the development of new transmission lines and transmission stations in order to deliver the generated electricity into the existing transmission system. The points of connection are to a new Birchtree Station at the City of Thompson and to the existing Herblet Lake Station north of the community of Snow Lake.
The new transmission facilities include the following:

- a new 230 kilovolt (kV) switching station at the Wuskwatim GS site;
- a new switching station (Birchtree Station), just south of the City of Thompson;
- a new 230 kV transmission line (W76B) to connect the Wuskwatim Switching Station to the Birchtree Station. This line was the first built and was initially used to provide construction power for development of the proposed generating station (Figure 2J-1);
- two new 230 kV transmission lines (W73H and W74H) between the Wuskwatim Switching Station and the existing Herblet Lake Station, to the north of the community of Snow Lake (Figure 2J-1); and
- a new 230 kV transmission line from the Herblet Lake Station to the Rall’s Island Station at The Pas.
Mitigation and Rehabilitation

The Wuskwatim GS was designed to be a low impact project and included the following elements:

- a “low head” design that resulted in minimal flooding;
- an operating plan that stabilized water levels on Wuskwatim Lake and limits the geographic extent and magnitude of downstream water level and flow changes;
- an access road that incorporated environmental and cultural considerations in the route selection process;
- commitment to develop an access management plan; and
- a commitment to develop an Environmental Protection Plan that assured that all work was carried out in compliance with regulatory requirements, project approvals, and proven environmental protection practices.

Rehabilitation efforts of construction activities at the Wuskwatim GS have been ongoing since 2009, and have consisted of tree planting and seeding which concluded in June of 2015. To date, over 600,000 seedlings have been planted and approximately 198 acres (80 ha) of land has been seeded with native plants. Locations of revegetation include: along the Wuskwatim access road, decommissioned borrow pits, excavated material placement areas, impacted areas around the camp and generating station, and at the Wuskwatim village where cultural plantings took place. The rehabilitation has been a success to date and will continue to be monitored for at least 5 to 7 years under the Terrestrial Effects Monitoring Plan.

Bibliography


Manitoba Hydro. 2003. Submission to the Manitoba Clean Environment Commission: Need For and Alternatives To the Wuskwatim Project. Manitoba Hydro. Winnipeg, MB.


APPENDIX 2K:
BIPOLE III TRANSMISSION PROJECT
PROJECT DESCRIPTION
Location

The Bipole III transmission line follows a 1,384 km (860 mile) route from northern Manitoba to southern Manitoba. It will originate at the Keewatinohk Converter Station located northeast of the Town of Gillam. The transmission line route will travel west and south towards community of The Pas, then south, staying west of Lake Winnipegosis and Lake Manitoba. It will then pass south of the City of Portage la Prairie and the City of Winnipeg to terminate at the Riel Converter Station east of the City of Winnipeg, in the Rural Municipality of Springfield (Map 2K-1; Map 1.2.3-2 in Chapter 1.2, Overview of the Phase I and Phase II Reports).

Background

Hydro-electricity is generated at Manitoba Hydro’s most northern generating stations as Alternating Current (AC) power, then converted to Direct Current (DC) for transmission south, then inverted at the southern terminus to AC power for end use. DC power transmission is more efficient than AC transmission over long distances. The converter stations are large complexes consisting of AC and DC switchyards, switch gear, converter transformers, valve groups, filters, and ancillary systems for cooling and operation.

The Bipole III Transmission Reliability Project was proposed in 2007 to improve system reliability by reducing dependency on the Dorsey Converter Station and the existing single HVdc Interlake corridor. Due to the heavy reliance on one transmission corridor (over 70% of northern generating capacity) and a single converter station in the south (Dorsey Converter Station), the system is vulnerable to extensive power outages from severe weather (major ice storms, extreme wind events, tornadoes), fires, or other events. Following extensive environmental assessment, public engagement, and regulatory processes, Manitoba Conservation and Water Stewardship (MCWS) granted an Environment Act Licence for the construction, operation, and maintenance of the Bipole III Transmission Project on August 14, 2013. For more in information regarding the Bipole III Transmission Project, environmental protection plans, and the licence granted by MCWS see the Project website at www.hydro.mb.ca/bipole3.

It should be noted that earlier documentation of the Bipole III Transmission Project may present the name of the northern converter station as Keewatinook Converter Station. In 2014, the name of the converter station was modified to Keewatinohk (pronounced Kee-way-tin-oohk).
Project Components

The project involves the construction of the following components:

- a high voltage (± 500 kV) direct current (HVdc) transmission line (Bipole III);
- two new converter stations – Keewatinohk in the north and Riel in South;
- two ground electrodes - one at each converter station; and
- a series of 230-kV transmission interconnections to tie the northern converter station into the AC system.

This project description focuses on the components in the Regional Cumulative Effects Assessment (RCEA) Region of Interest (ROI). The Riel Converter Station and associated infrastructure in southern Manitoba are not described in this document.

HVdc Transmission Line (Bipole III)

The 1,384 km transmission line will be constructed with steel lattice towers supporting aluminum conductor cables on a 66 m (216.5 ft) wide right-of-way. Towers will vary depending on terrain with the height ranging from 33 - 46 m (108-150 ft) and spaced approximately 400 - 536 m (1,320 to 1,720 ft).

Northern Converter Station (Keewatinohk)

The converter station site will include the following principal structures, a 230 kV AC switchyard, converter transformers, converter building, solid state electronic valve groups, and a DC switchyard as shown in Figure 2K-1.

The operational support infrastructure and features includes the following: site grading and drainage, internal roadways, site security, station lighting, oil storage, oil containment, domestic water and wastewater systems, fire suppression systems, station grounding system, communication facilities, and ancillary buildings and equipment.
Figure 2K-1: Schematic Layout of Proposed Keewatinohk Converter Station
Ground Electrode

A new ground electrode facility is required for the operation of the Keewatinohk Converter Station. A ground electrode is a buried metal ring established to ground the converter station. An overhead transmission line is required to connect the ground electrode site to the converter station.

230 kV AC Transmission

New 230 kV AC transmission lines (Figure 2K-2) will be required to connect the Keewatinohk Converter Station to the existing Henday Converter Station and the Long Spruce Generating Station (GS) in northern Manitoba.

![Figure 2K-2: Keewatinohk Converter Station and Northern Collector System Connections](image)

Infrastructure Supporting Construction

**Keewatinohk Access:** The main access to the site is by the existing permanent gravel road to the potential Conawapa Generation Project (GP). The road was extended 24 km (14.9 miles) from the Limestone GS construction area to the potential Conawapa GP construction area in 1992. There is an existing 2.5 km (1.5 mile) rail spur from the Hudson Bay Railway line to the Henday Converter Station. Both of these items will be upgraded as part of the Keewatinohk Converter Station construction. The access road is private and is not part of the provincial road network.

**Keewatinohk Construction Camp:** A 600-person construction camp was constructed at the end of the access road approximately 4.5 km (2.8 mi) northeast of the future location of the Keewatinohk Converter Station.
Station. A 34.6 km (21.5 mi) extension of the 138 kV transmission line (KN36) from the Henday construction power station to the Keewatinohk construction power station northeast of the Keewatinohk Converter Station site was built for construction power.

**Waste Handling:** Solid waste is hauled to the City of Thompson waste disposal grounds. A local lagoon is being used for waste water treatment.

**Workforce:** As the camp and infrastructure supporting construction were developed, the workforce commuted from the Town of Gillam area. Once portions of the camp were ready for occupancy, the construction workforce began living at the Keewatinohk camp (lodge) for several weeks at a time and travel to their homes during their days off.

**Transmission Line Access:** Various existing and newly developed temporary access trails will be used for construction of the line. Access management has been outlined in the Access Management Plan that was approved for the project.

## Construction

### Bipole III Transmission Line Construction

Construction of the Bipole III transmission line began in early 2014 with clearing of the northern components of transmission lines and installation of foundations. Within the next year, contracts for clearing and installation of foundations will continue on the transmission line, and AC collector line construction will be underway. Construction will continue each winter season, typically November through March, until the project in-service date around 2018. Summer construction will occur in southern and some of the central zones of the line.

Clearing of trees on the proposed right-of-way will be undertaken as part of the construction activities. Right-of-way clearing will be subject to standard environmental protection measures that have been established in association with Manitoba Hydro transmission line construction practices, as well as the project-specific Environmental Protection Plan.

Transmission line construction involves several stages: installing tower foundations and anchors, assembling and erecting structures, and stringing of the conductor and overhead ground wires. The different stages entail the use of various types of vehicles and heavy equipment.

Clearing and construction workers on the HVdc transmission line are being housed in mobile construction camps, or where feasible and practical, in suitable accommodations available in local communities. Camp size can range from 10 to as many as 200 workers, but will vary according to the activity, contract size and labour force requirements.

### Keewatinohk Converter Station Construction

Construction of the Keewatinohk Converter station began in 2013 with site preparation, construction power, as well as continued development of the Keewatinohk Camp. The Keewatinohk AC switchyard
contract was awarded in June 2014, and construction power was put into service in July of 2014. Within the next year, contracts for the HVdc converter equipment and synchronous condenser machines are anticipated to be awarded and design activities started.

Construction activity at the various Keewatinohk Converter Station construction sites will generally involve advance site preparation and access development activities. Initial site preparation has generally consisted of clearing, grubbing and disposal of vegetation, stripping and removal of organic soils, and grading.

A considerable amount of soil will be excavated from the construction site to prepare it for the principal works. Some of the materials excavated (e.g., soil and organic materials) will be stored and used in site rehabilitation. The remainder will be placed in an excavated material placement area.

Local construction materials will be required to support site development for the converter station, the ground electrode, the station access road, the construction camp and other supporting infrastructure. The required materials will include concrete aggregates, random fill, sub base material, insulation stone, road-topping material, erosion control material, oil containment material, and pipe bedding. There are a number of nearby natural sources of impervious (e.g., clay) and granular (e.g., sand and gravel) materials. Offsite borrow sources will be required primarily for supply of granular materials. Materials such as concrete aggregates and granular fill will generally be obtained from borrow pits in close proximity to the construction sites.

**Operations**

Once completed and fully commissioned, the Keewatinohk Converter Station will be operated at all times and will have Manitoba Hydro personnel on-site performing regular operation, maintenance and inspection duties. Actual transmission of electricity will vary with demand and electrical load conditions. Qualified operators and maintenance personnel will routinely inspect and maintain the station and electrode sites and, in the case of contingencies, correct any problems or related environmental effects. Total operations and maintenance workforce has been estimated at 42 workers, exclusive of the periodic presence of contractor staff.

**Monitoring and Mitigation**

As part of the regulatory review process, an Environmental Protection Program was reviewed and approved for the construction and operation of the project. The Environmental Protection Program consists of access management, cultural and heritage protection, biophysical monitoring plans, and socio-economic monitoring plans. An Integrated Vegetation Management Plan will be used to ensure that re-growth in the cleared rights-of-way does not interfere with transmission line operations.

From a land use and environmental planning perspective, the HVdc transmission line is the most significant component of the Bipole III Project. The final preferred route (Map 2K-1) has been selected on the basis of environmental, socio-economic and technical criteria and an extensive program of public and community consultation. To minimize the risk of common outage (e.g., outage involving both the existing Bipoles and Bipole III due to a single extreme weather event), the routing process has avoided the
Interlake area, in order to provide substantial physical separation from the existing Bipole I and II transmission lines. For reasons of provincial policy, the routing process has also avoided the area east of Lake Winnipeg.

The sites chosen for the Keewatinohk Converter Station components and the associated construction camps were reviewed and discussed with representatives of Fox Lake Cree Nation in a series of meetings.

**Bibliography**


APPENDIX 2L:
KEEYASK GENERATION PROJECT
PROJECT DESCRIPTION
**Location**

The Keeyask (Cree for gull) Generating Station (GS) will be located at Gull Rapids, immediately upstream of Stephens Lake on the lower Nelson River.

The Keeyask GS is located:
- 30 km (19 mi) west of the Town of Gillam;
- 35 km (22 mi) upstream of the existing Kettle Generating Station;
- 60 km (37 mi) northeast of Split Lake;
- 180 km (112 mi) northeast of the City of Thompson; and
- 730 km (454 mi) north of the City of Winnipeg.

The generation and infrastructure projects are entirely within the Split Lake Resource Management Area with the transmission project extending into the Fox Lake Resource Management Area (Map 1.2.3-1 in Chapter 1.2, Overview of the Phase I and Phase II Reports).

**Background**

The Keeyask GS was initially identified by Manitoba Hydro as a potential hydroelectric development as part of the northern system expansion work that began in 1966. The site has been considered one of the future hydroelectric development options since that time. It was proposed to be committed as part of the business case submitted in the most recent regulatory review called the Needs For and Alternatives To (NFAT) process that was concluded in the summer of 2014. Regulatory approvals to start the construction of the Keeyask Generation Project (GP) and the Keeyask Transmission Project were received in July 2014. The Keeyask GS is scheduled to be in-service for 2019 to fulfill new export sales agreements with Minnesota Power and Wisconsin Public Service and continued load growth in Manitoba.

The Keeyask GP is a collaborative effort between Manitoba Hydro and four Manitoba First Nations, working together as the Keeyask Hydropower Limited Partnership (KHLP). The four partner first nations include, Tataskweyak Cree Nation (TCN), War Lake First Nation (WLFN) (acting as the Cree Nation Partners), York Factory First Nation (YFFN) and Fox Lake Cree Nation (FLCN). Manitoba Hydro will operate the Keeyask GP as part of the Manitoba power grid on behalf of the KHLP. Manitoba Hydro will own and operate the Keeyask Transmission Project.

For more information on the Keeyask projects, see the following websites:

**Generation Components**

The Keeyask GP consists of principal structures and supporting infrastructure. Some of the supporting infrastructure is being constructed as part of the Keeyask Infrastructure Project (KIP).
Principal Structures

The Keeyask GS consists of a close-coupled intake/powerhouse with seven units, three dams, two dykes and a gated seven-bay spillway (Figure 2L-1). The spillway is required to manage diverted flows when the project is being constructed and to manage surplus water flows once it goes into production. The dams and dykes will contain the reservoir created upstream of the principal structures.

The principal structures will stretch 2.7 km (1.7 mi) across the Nelson River, with the dykes extending 11.5 km (7.2 mi) on the north shore and 11.2 km (7.0 mi) on the south. The reservoir is predicted to expand by 7 to 8 km² (2.7 to 3.1 mi²) due to shoreline erosion and peatland disintegration over the first 30 years of operations.

Figure 2L-1: Computer Rendering of Keeyask Generating Station Principal Structures
Project Data

- **Turbine Generator Units:**
  - Type: 7 vertical shaft fixed blade propeller turbines
  - Capacity: 695 MW

- **Powerhouse:**
  - Length: 211.74 m (694.7 ft)
  - Waterfall drop (head): approximately 18 m (59 ft)
  - Discharge capacity: 4,100 m$^3$/s (144,790 ft$^3$/s)

- **Main Dams:**
  - Length - North dam: 100 m (328 ft), Central dam: 1,600 m (5,249 ft), South dam: 565 m (1,854 ft)
  - Maximum height: 28 m (91.9 ft) (Central dam)

- **Spillway:**
  - Number of bays: 7
  - Length (7 bays): 119.0 m (390 ft)
  - Discharge capacity: 11,315 m$^3$/s (399,585 ft$^3$/s)

- **Reservoir/Forebay Elevation:**
  - Full supply level: 159.00 m (521.65 ft)
  - Normal minimum operating forebay elevation: 158.00 m (519.37 ft)
  - Flooded area: 45 km$^2$ (17.4 mi$^2$) may gradually increase due to erosion

Infrastructure Supporting Construction

Infrastructure supporting construction is being built in both the KIP and the Keeyask GP. The KIP began in early 2012 and involved the construction of the north access road and the main camp to support the Keeyask GP.

Infrastructure supporting construction will consist of permanent facilities to construct and operate the generating station, and temporary facilities required only to construct the principal structures.

Permanent supporting infrastructure will include, a permanent 25 km (15.5 mi) north access gravel road, permanent 21.7 mile (35 km) south access gravel road, transmission tower spur, communications tower, placement area for excavated materials, remnants of some cofferdams and rock groins, boat launches, portage, barge landings, and public safety and security measures, as well as some haul roads and borrow areas required for operations. Once the generating station is completed, the north and south access roads will be connected across the principal structures and integrated into the provincial highway network.

Temporary supporting infrastructure will include the main camp, work areas, water, and waste water treatment facilities, ice boom, boat launches, cofferdams, rock groin, causeways, and safety and security facilities, as well as haul roads and borrow areas not required for operations.
During the first year of construction, power will be provided by diesel generators. During the second year of construction, a permanent transmission line from KN36 will be in place to provide the primary source of construction power.

The Gillam Redevelopment and Expansion Program is also being undertaken to refurbish and enhance that community’s infrastructure and services to meet the needs of the existing and expanding population.

Construction

Construction began in 2012 with the KIP. Regulatory approvals to start the construction of the Keeyask GP and the Keeyask Transmission Project were received in July 2014. The Keeyask GP will take 11 years to construct. The construction phase will conclude with decommissioning of infrastructure no longer required for operations and with rehabilitation of the site in 2022. The first of seven generating units will begin producing power in 2019, with all seven units producing power by 2020. The final three years of construction will overlap with the first three years of operation.

Materials required for the construction of the Keeyask GS will include impervious fill, granular fill, rockfill, riprap and concrete aggregates. Design and construction will maximize the use of rock obtained from the excavations required for the construction of the Principal Structures, minimizing the amount of material required to be obtained from quarries and borrow areas. Except for the construction of the South Dyke, the sources of materials required for the construction of the generating station facilities will generally be obtained within 10 km (6.2 mi) of the facilities structures. Granular material for the South Dyke will be obtained from sources having a round trip haul distance up to 42 km (26.1 miles).

Mitigation Measures

The hydroelectric potential of the lower Nelson River has undergone decades of study, originally by the Governments of Canada and Manitoba and later by Manitoba Hydro. The early studies examined the feasibility of multiple development options. More recently, the local Cree Nations have taken an active role in planning the Keeyask Generation Project, assessing the potential effects and developing mitigation measures. Other First Nations, the Manitoba Métis Federation and the public have also been engaged through bilateral meetings, public involvement programs and self-directed studies. Through this process, Manitoba Hydro is able to avoid, reduce and mitigate many potential adverse effects while enhancing potential benefits.

The following examples illustrate potential adverse effects that have been avoided, reduced or mitigated through the planning and assessment process:

- by reducing the generating station from 1,150 to 695 MW, the initial flooded area was reduced from 180 km² to 45 km² (69.5 mi² to 17.4 mi²) (Figure 2L-2), which avoids flooding on Split Lake where TCN and YFFN have their home reserves;
- the normal operating range of the Keeyask GS will be 1.0 m (3.3 ft), very small for a major generating station in Manitoba, Canada or internationally;
- the north access road was routed away from sensitive sites, such as caribou calving habitat and regionally rare habitat types;
• turbines that minimize fish mortality were selected for the project, over 90% of the fish up to 500 mm (1.64 ft) in length passing downstream through the generating station are expected to survive.
• most of the reservoir will be cleared before flooding;
• important fish habitat, nesting sites for birds, and wetlands will be developed;
• new caribou calving habitat on islands in the reservoir will offset most losses caused by the project; and
• appreciating that the partnership is among many entities with ongoing roles respecting caribou in the region, the partnership is working to develop a process to coordinate its activities with government authorities, caribou management boards and resource management boards.

Figure 2L-2: Alternative Keeyask Development Options

Operation

Transportation: Once the generating station is completed, the north and south access roads will be connected across the principal structures and integrated into the provincial highway network as a new PR 280 route. Once PR 280 is re-routed over the generating station, travel from the Town of Gillam to the community of Split Lake and City of Thompson will be reduced by 53 km (32.9 mi).

Workforce: The station will have approximately 40 staff that will serve operational and maintenance (electrical, mechanical, and utility), support (administration, stores) and supervisory roles. The personnel will be located on site during normal business hours, seven days per week. They will likely work similar schedules to other generating stations in Manitoba Hydro’s system and live in the surrounding area.
Details have not been finalized at this time. Support and technical services will also be located in the nearby Town of Gillam.

**Waste Handling:** Waste water will be hauled to a local lagoon. Solid waste will be hauled to the Town of Gillam.

**Water Regime:** The Keeyask GS will be operated as a run-of-river generating station. For more information on its operation and its effects on the water regime, see the Keeyask GP Environmental Impact Statement (EIS).

**Licences:** On July 2, 2014 the Province of Manitoba issued an *Environment Act* licence (No. 3107) and a *Water Power Act* licence on July 5, 2014 for the Keeyask GP proposed by the KHLP. For further information on the Water Power Licence, see the Manitoba Government Water Power Licensing website at: [http://www.gov.mb.ca/waterstewardship/licensing/water_power_licensing.html](http://www.gov.mb.ca/waterstewardship/licensing/water_power_licensing.html).

### Transmission Components

#### Construction Power

A new transmission line in a single right-of-way will be constructed from an existing 138 kV transmission line (KN36) 22 km (13.7 mi) south of Gull Rapids. The line will terminate at a new substation north of the Keeyask GS and the Nelson River to provide construction power (Figure 2L-3). The line and substation will be retained to provide a backup source of offsite power to the generating station once it goes into operation.

#### Generation Outlet Transmission

Four 3.4 km (2.1 mi) transmission lines will transmit the power from the generating station to a new Keeyask switching station south of the generating station (Figure 2L-3). Three 35 km (21.7 mi) transmission lines in a single route will transmit power from the switching station to the Radisson Converter Station, where the power will enter Manitoba Hydro’s integrated power system. One of the three lines will be built prior to the other two to serve as a back-up source of construction power. Transmission station upgrades to terminate the three lines will also be required at the Radisson Converter Station.
PLAN TO AVOID AND MITIGATE TRANSMISSION EFFECTS

Manitoba Hydro used a Site Selection and Environmental Assessment process to determine the most appropriate sites and routes for its transmission projects. The overarching objective is to minimize adverse effects wherever practicable through siting and routing choices and to maximize environmental management opportunities at each stage of development.

MONITORING

The generation and transmission projects will each implement environmental monitoring and management programs. The monitoring is required to determine if the predictions in the environmental impact statement are correct and if the mitigation measures are working as anticipated. If unexpected effects are detected through monitoring, adaptive management measures will be applied. As part of these programs, the local Cree Nations will be engaged to share their Aboriginal traditional knowledge to monitor the project effects and assist in developing adaptive management measures.

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