Keeyask Generation Project

Environmental Impact Statement

Response to EIS Guidelines

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KEEYASK
Hydropower Limited Partnership

June 2012

CHAPTER 4

PROJECT DESCRIPTION

Keeyask Hydropower Limited Partnership

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4.0 PROJECT DESCRIPTION

4.1 PROJECT OVERVIEW

Manitoba Hydro and the Keeyask Cree Nations (KCNs) have worked together since the early 1990s to plan and develop the Keeyask Generation Project (the Project). The KCNs played a major role in defining the Project by providing meaningful input early in the Project planning process when major development options were still being evaluated. In response to Tataskweyak Cree Nation (TCN) concerns and in consideration of potential requirements for mitigation measures, Manitoba Hydro decided in 1996 not to pursue the development of the high-head option. In 1999, a decision was made jointly to pursue a single low head development at Gull Rapids with less flooding—and less power production—than previously studied for the reach of the Nelson River between Split and Stephens lakes. War Lake First Nation (WLFN), York Factory First Nation (YFFN) and Fox Lake Cree Nation's (FLCN) involvement began in 2001. Aboriginal traditional knowledge (ATK), including the Cree worldview, and technical science were used by the Partnership to plan, evaluate and improve the Project.

In 2009, the Joint Keeyask Development Agreement (JKDA) established fundamental construction and operating features of the Project that are of importance to the KCNs. The following features related to the construction of the Project are of fundamental importance to TCN and cannot be altered without its consent:

- The north access road, linking Provincial Road 280 (PR 280) to the Project, will be routed within a corridor defined in the JKDA;
- The south access road, linking the Project to the Butnau Dam and to Gillam, on the south side of the Nelson River, will be routed within a corridor defined in the JKDA;
- The intake and **powerhouse** complex of the Project will be located in the north channel of Gull Rapids on the Nelson River and the **spillway** will be located within a channel excavated on an island within Gull Rapids, as defined in the JKDA;
- The main construction camp for the Project will be located on the north side of the Nelson River, generally in the area defined in the JKDA; and
- No change to the Churchill River Diversion (CRD) Licence, as modified by the Augmented Flow Program, or to the Lake Winnipeg Regulation (LWR) Licence, will be required to construct the Project.

The following three fundamental features related to the operation of the Project cannot be altered without the consent of TCN and the feature set out in the first bullet cannot be altered without the consent of YFFN:

- The operation of the Project will not affect water levels on Split Lake during open water conditions;
- The **full supply level** (**FSL**) of the **forebay** of the Project will be 159.0 metres (521.7 feet) and the minimum operating level (MOL) of the forebay will be 158.0 metres (518.4 feet), provided that the water level of the forebay may exceed the FSL or be drawn down below the MOL under special or emergency conditions, as defined in the JKDA; and
- No change to the CRD Licence, as modified by the Augmented Flow Program, or to the LWR Licence, will be required to operate the Project.

The Project will be a 695-**megawatt** (**MW**) hydroelectric generating station at Gull Rapids on the lower Nelson River, immediately upstream of Stephens Lake in northern Manitoba (Map 4-1)[1]. The renewable hydroelectric energy produced by the Project will be sold to Manitoba Hydro and integrated into its electric system for use in Manitoba and for export. It is anticipated that the average annual production of electricity will be approximately 4,400 **gigawatt** (**GW**) hours.

The Project will be located in the **boreal** forest of the Canadian Shield on provincial Crown land approximately 180 km northeast of Thompson, 60 km northeast of Split Lake, and 30 km west of Gillam. The Project will be located entirely within the Split Lake Resource Management Area (SLRMA). The coordinates of the proposed generating station are 95°11'44"W and 56°20'55"N (0364316E, 6247045N, UTM NAD1983 Zone 15). Gull Rapids has three large channels with a total length of approximately 3.7 km and a drop in elevation of approximately 12 m. The river is approximately 2.5 km wide at the widest part of Gull Rapids. The general site location of the Project is shown on Map 4-1.

The Project consists of principal structures and supporting infrastructure. The principal structures consist of a powerhouse and service bay complex, spillway, dams and **dykes**. A **reservoir** will be created upstream of the principal structures. Figure 4-1[2], Figure 4-2, Figure 4-3 and Figure 4-4 show artist's renderings of the principal structures, powerhouse complex and spillway.

Supporting infrastructure consists of temporary facilities required only to construct the principal structures and permanent facilities required to construct and operate the Project. Temporary infrastructure consists of roads, borrow sources, camp and work areas, safety and security facilities, communication tower, explosives magazine, **cofferdams, rock groins,** boat launch, an **ice boom** and safety booms. Permanent infrastructure consists of

[1]In print version, Chapter 4 Maps can be found in the accompanying Map and Figure Folio.
[2]In print version, Chapter 4 Figures can be found in the accompanying Map and Figure Folio.

roads, borrow sources, placement areas for excavated material, communications tower, portions of some cofferdams and groins**,** a tower spur, barge landings, boat launches, portage, and safety and security facilities. Some infrastructure will be constructed as part of the Keeyask Infrastructure Project (KIP), and power to construct the Project will be provided by the Keeyask Transmission Project. These projects are described in Section 4.3.2.

The Project will take approximately eight and a half years to construct, *i.e.*, from June 2014 to November 2022. The last three years involve commissioning of the seven powerhouse units, **decommissioning** of temporary infrastructure, site cleanup and **rehabilitation**. The operation phase begins with the initial generation of power from the first unit in approximately November 2019. The remaining six units will be brought into operation progressively over the following year, *i.e.*, November 2019 to December 2020. The first three years of the operation phase of the Project will overlap with the last three years of the construction phase. Once operation is initiated, the Project will be operated as part of the overall Manitoba Hydro integrated system.

The Project will use approximately 18 m of the 27 m of **hydraulic head** (*i.e.,* drop in elevation) available between Split Lake and Stephens Lake. About 12 m of this drop occurs through Gull Rapids. It will be operated with a maximum reservoir level (*i.e.,* FSL) of 159 m **above sea level** (**ASL**) and a minimum operating level (*i.e.,* MOL) of 158 m.

Table 4-1 summarizes the main design **parameters** for the Project.

Table 4-1: Keeyask Generating Station Design Parameters

Parameter	Value
Full Supply Level (FSL)	159 m
Minimum Operating Level (MOL)	158 m
Initial Reservoir Area	93.1 km^2
Live Reservoir Storage (storage between MOL and FSL)	81.4 million m^3
Full Gate Discharge with Stephens Lake at 141.12 m (FSL)	4,000 m^3/s
Full Gate Discharge with Stephens Lake at 139.6 m (Low Level)	4,100 m^3/s
Best Gate Discharge with Stephens Lake at 141.12 m (FSL)	3,850 m^3/s
Best Gate Discharge with Stephens Lake at 139.6 m (Low Level)	3,900 m^3/s
Rated Total Output Power with Stephens Lake at 141.12 m (FSL)	630 MW
Rated Total Output Power with Stephens Lake at 139.6 m (Low Level)	695 MW
Generator Rated Output	99.3 MW/117 MVA
Average Annual Energy	4,400 GWh
Annual Dependable Energy	2,900 GWh

Note: Plant discharge is influenced by the level of Stephens Lake, which controls the water level at the downstream end of the Keeyask Generating Station. The FSL for Stephens Lake is 141.12 m. Historically, Stephens Lake levels have been at or below 139.6 m 10% of the time and this condition is used here to represent Keeyask plant conditions at low Stephens Lake levels. Full gate discharge refers to the discharge through all 7 units occurring when the wicket gates are set to allow the maximum flow through the turbines at a given head. The efficiency at this gate setting is typically less than the **best gate** setting. Best gate discharge refers to the discharge through all 7 units occurring when the wicket gates are set to achieve the maximum efficiency for the turbine at a given head. Generally, the preferred setting is best gate discharge to generate the most energy from a given volume of water. If the river flow exceeds the plant discharge capacity, excess water will be discharged over the spillway and full gate settings will generally be used for the water passing through the turbines to generate electricity.

4.2 NEED FOR AND ALTERNATIVES TO

Requirements for power in Manitoba and export markets have presented an opportunity for the Partnership to develop the Keeyask Generation Project.

Manitoba Hydro, the purchaser of the energy produced by the Keeyask Hydropower Limited Partnership, is mandated by *The Manitoba Hydro Act* to:

> …provide for the continuance of a supply of power adequate for the needs of the province, and to engage in and to promote economy and efficiency in the development, generation, transmission, distribution, supply and end-use of power and, in addition, are
>
> (a) to provide and market products, services and expertise related to the development, generation, transmission, distribution, supply and end-use of power, within and outside the province; and
>
> (b) to market and supply power to persons outside the province on terms and conditions acceptable to the board.

Manitoba domestic load is growing, resulting in the need for new power resources around 2020 considering just load growth from Manitoba customers and not including any new export contracts. In addition, consistent with its mandate, Manitoba Hydro has entered into new firm export contracts with Minnesota Power starting 2020, Wisconsin Public Service starting 2021 and Xcel Energy. These export contracts would also involve development of additional export interconnections that will support Manitoba's electricity supply in terms of energy security, reliability and economy. The contracts require electrical energy with the following attributes:

- Reliable and secure source of power in a fixed time frame;
- Accredited capacity;
- Portion of energy priced at a fixed price (certainty in long term energy costs) with annual escalators; and
- Fixed capacity price with annual escalators.

Furthermore, Minnesota Power and Wisconsin Public Service also require the electrical energy to have:

- Environmental attributes associated with a predominately hydroelectric resource, including:
    - Low or no carbon energy; and/or
    - Recognized as renewable as part of a state Renewal Portfolio Standard (for Wisconsin).

The renewable, low carbon reliable energy produced at the Keeyask Generation Project with an ISD of 2019 meets the requirements of these export contracts.

To facilitate the development of the Project, Manitoba Hydro and the KCNs have entered into an agreement to form the Keeyask Hydropower Limited Partnership (the Partnership), which will own, develop and operate the Project. The KCNs have chosen to support the Project, in part because of the opportunities associated with governance, income, business development, and Membership training and employment as well as their involvement in environmental studies and protection, project planning and design. They have expressed this support through referendums in each of the communities with an overall 64% level of support. The KCNs have no other similar opportunities to achieve these benefits for their communities or Members. Manitoba Hydro supports the Project because it meets the requirements of both its domestic and export customers while providing an opportunity to work collaboratively with the local Cree Nations in a manner that provides mutual benefits. No other project could achieve this entire set of objectives.

Manitoba Hydro has agreed to purchase and the Partnership has agreed to sell the entirety of the Project's production to Manitoba Hydro. The Partnership, as proponent for the Project, has no alternative available to develop other than Keeyask; and Manitoba Hydro as purchaser of the production has no alternative available to meet the qualitative, quantitative or temporal requirements referred to above. Manitoba Hydro will be required to fully explain its decision to contract for Keeyask production before an independent panel to be appointed by the Minister responsible for Manitoba Hydro to review the need for and alternatives to (NFAT) major new hydroelectric projects, including the Keeyask Generation Project. Manitoba Hydro's market for the power from the Project will also be subject to review in the NFAT. The EIS does not include an assessment of Manitoba Hydro's markets or the economic feasibility of the Project.

4.3 PROJECT COMPONENTS

As noted previously, the Project is comprised of principal structures, which are permanent, and supporting infrastructure, some of which is required only for construction and some of which will be permanent. These components have been selected after careful consideration of alternative means of building the Project, as discussed in Section 4.5.

This section describes the different components of the Project based on the current status and assumptions of the engineering design studies and reflects input from the KCNs into the planning process. The engineering design and construction methodologies described in this chapter are preliminary and will be refined during the final design stage which is currently underway. The final design phase of the Project will extend into the construction phase. The final design will be subject to conditions of regulatory authorizations.

4.3.1 PRINCIPAL STRUCTURES

The principal structures are the powerhouse complex, spillway, dams and dykes (Map 4-2). A reservoir will be created upstream of the principal structures.

4.3.1.1 POWERHOUSE COMPLEX

The powerhouse is the structure that houses the turbines, generators and associated control equipment. For this Project, the powerhouse will contain seven vertical shaft turbines and generators, each with an intake, **scroll case** and **draft tube**. The intake for each turbine unit will have three openings, each with a **trash rack**, **bulkhead gate**, and **service gate**. An intake channel and a **tailrace** channel to direct flow into and away from the powerhouse will be excavated through **overburden** and **bedrock**.

The powerhouse complex will also include a service bay and control building. The service bay is required during the construction phase to assemble the turbines and generators and to erect other large components. Once the Project goes into operation, the service bay will be used for maintaining and servicing the turbines and generators. It will also contain electrical and mechanical equipment, including ventilation systems, domestic and fire water systems, cranes, water and wastewater treatment systems, compressed air, and oil storage facilities. The control building will house the equipment that will control and monitor the operation of the turbine and generator units. During operation, several people will staff the powerhouse control building during the day shift on weekdays and only a few people will staff it at night and on weekends. During seasonal maintenance work, the number of people working within the powerhouse complex during the day shift will be higher. Workers will not reside at the site. The workforce required for operation is discussed in Section 4.7.7.

The powerhouse will be located within and adjacent to the north channel of the Nelson River at the site location. Two **concrete transition structures** will be used to connect the powerhouse complex to the north and central dams. There will be a concrete gravity wall or wing wall (Wall E) that will abut the upstream face of the powerhouse south transition structure.

4.3.1.2 SPILLWAY

The spillway is a concrete structure used to pass excess flow so the powerhouse, dams and dykes are protected from **overtopping** and failure when **inflows** exceed the discharge capacity of the powerhouse. For this Project, the spillway will also be used to divert the river during the last stages of construction. Once the Project begins operation, the spillway will be used to discharge excess river flows and is designed so that the Project can discharge river flows up to the **probable maximum flood.** The spillway will be a seven bay concrete overflow structure with each bay having a vertical lift gate. It will contain mechanical and electrical systems and equipment needed to operate and control the spillway. An approach channel and a discharge channel, which will direct flow into and away from the spillway, will be excavated through overburden and bedrock.

The spillway will be located within the south channel of Gull Rapids, approximately 1.6 km south of the powerhouse. Two concrete transition structures will be used to connect the spillway to the central and south dams. There will be four concrete gravity walls or wing walls (Walls A, B, C and D) located upstream and downstream of the spillway.

4.3.1.3 DAMS

Three dams (the north dam, central dam, and south dam) will be constructed across Gull Rapids, creating a reservoir upstream of the powerhouse. The dams will be zoned earth fill embankments consisting of an **impervious core** with **granular** and crushed rock filters and outer rockfill shells and riprap. The north dam will have a maximum height of approximately 25 m and will be approximately 100 m in length (Map 4-2). To the north, it will connect with the north dyke and to the south with the powerhouse. The central dam will have a maximum height of approximately 28 m and will be approximately 1,600 m in length. It will extend from the powerhouse to the spillway. The south dam will have a maximum height of approximately 22 m and will be 565 m in length. It will be constructed across the south channel of the river, extending from the spillway to the south dyke.

4.3.1.4 DYKES

A dyke is an embankment constructed to contain water in the reservoir and limit the extent of flooding. For this Project, a series of discontinuous earthfill dykes will be located along both sides of the river. To facilitate inspection and maintenance, a roadway will be constructed on top of the dykes and on high ground between the sections of dykes. Including the roadway sections, these earth dykes will extend 11.6 km on the north and 11.2 km on the south sides of the river.

4.3.1.5 RESERVOIR

The reservoir is an **impoundment** upstream of the dam or hydroelectric generating station in which water can be stored for later use. For this Project, the reservoir (*i.e.*, the upstream open water hydraulic zone of influence) will extend approximately 42 km from the generating station to about 3 km downstream of the outlet of Clark Lake. At FSL, the water level in the reservoir will be approximately 7 m higher than current Gull Lake water levels. Initially, the reservoir area will be 93 km^2, consisting of approximately 48 km^2 of existing waterways and approximately 45 km^2 of newly inundated lands. The reservoir is predicted to expand by approximately 7 to 8 km^2 during the first 30 years of operation due to the **erosion** of some mineral shorelines and **peatland disintegration.** Map 4-3 shows the open water surface profiles and shorelines for the existing and post Project environment.

4.3.2 SUPPORTING INFRASTRUCTURE

Infrastructure is required to support construction of the Project (Map 4-4). It consists of camps and work areas, communication tower, explosives magazine, roads, cofferdams, rock groins, ice boom, safety booms, **borrow areas** for construction materials, placement areas for excavated material, boat launches and barge landings facilities, and facilities for safety and security. Some of this infrastructure will be required for the operation of the Project.

4.3.2.1 MAIN CAMP AND WORK AREAS

The main camp and work areas for this Project involve the operation of facilities constructed as part of the Keeyask Infrastructure Project (KIP) (see Section 4.3.2.11), includes the construction and operation of accommodations for an additional 1,500 workers (bringing total capacity to approximately 2,000 people), and completion of the work areas (Map 4-4).

The camp and work areas will be located on an approximately 120-hectare (ha) site on the north side of Gull Rapids, about 1.8 km from the shore of the Nelson River. A new temporary landfill may also be developed in close proximity to the camp. If the landfill is not feasible, the solid waste will be hauled to the existing Thompson landfill site. While the exact location has not yet been determined, three potential landfill sites with suitable soil characteristics have been identified. These are being evaluated for terrestrial properties, proximity to caribou calving sites, etc. The site, once selected, will require approval from Manitoba Conservation and Water Stewardship. The landfill will be in operation for the duration of the construction phase, and then decommissioned.

4.3.2.2 ADDITIONAL TEMPORARY WORK CAMP

An additional small camp (approximately 100 persons) will likely be established as a temporary construction camp on the south side of the river. When the exact location and size of this camp is established, the camp area will be added to the calculation of the construction footprint; however, this is expected to be nominal relative to the total Project area. This temporary camp will accommodate workers constructing the south access road. This 100-person camp will use temporary bunkhouse trailers and will haul in potable water as well as haul out solid waste and wastewater for disposal at existing Gillam facilities. Alternatively, a packaged wastewater treatment plant will be installed at the camp site. The required provincial approvals will be obtained under either option.

The camp may be used after this period to facilitate construction of the **switching station** for the separate Keeyask Transmission Project.

4.3.2.3 COMMUNICATIONS INFRASTRUCTURE

The KIP will include installation of two temporary 24 m wooden poles that will each support communications equipment for communications at the security gate near the junction of the north access road and PR 280. During construction of the Project the communications equipment will be moved to a communications building that will be installed at the construction power station site. A temporary self-supported 36 m tower will be constructed beside the communications building to provide wireless communications for the main camp and work areas during the construction phase.

A permanent self-supported communications tower will be constructed on the roof of the powerhouse for use during the operation phase for VHF, paging, wireless data and cellular communications. The tower will be 30 m to 40 m tall.

4.3.2.4 TEMPORARY EXPLOSIVES MAGAZINE

There will be no on-site manufacture of explosives. However, a temporary explosives magazine will be required by the contractor. Specifics regarding the storage and use of explosives will become available after this contractor is selected. The contractor will retain a certified blaster responsible for purchasing, safe storage, tracking, and use of explosives. The contractor will be the applicant for authorizations required for the temporary magazine.

4.3.2.5 CONSTRUCTION POWER

Initially, **construction power** is planned to be provided by diesel generators and supplemented by a distribution line constructed in conjunction with the KIP. The diesel generators will be replaced by power from the Keeyask Transmission Project, once it is constructed (see Section 4.3.2.11).

4.3.2.6 ROADS

The Project requires two access roads. The 25-km north access road is being constructed as a component of the KIP and will connect the Project with PR 280, approximately 185 km northeast of Thompson. The south access road will be constructed as a component of the Keeyask Generation Project and will link the Project to Gillam on the south side of the Nelson River. This includes approximately 19 km of new road from the Keeyask Generating Station and approximately 16 km of upgraded roadway from Butnau Dam to Gillam. Other small roads will connect the generating station site to other Project sites and activities, such as dykes and borrow areas. The south access road will be an all-weather gravel road that meets Manitoba Infrastructure and Transportation (MIT) design criteria. The north and south access roads will have a standard 8 m roadtop that will be expanded to 13.5 m near the generating station to accommodate the large haulage vehicles used to construct the Project.

The north access road will be the main corridor for delivery of materials and personnel to the construction site. Once the Project goes into operation, the north and south access roads will be connected by a permanent river crossing over the Project's north dam, powerhouse, central dam, spillway and south dam. MIT has indicated it will assume ownership of the roads and responsibility for the ongoing operations and maintenance of these roads as part of the provincial transportation system.

Temporary or permanent access roads or haul trails are also required to provide access to borrow sites, boat launches and quarries, to construct the ice boom and dykes, to clear trees in the reservoir area and for maintenance. At the start of the construction phase two temporary rockfill causeways will be constructed to access borrows G-3 and N-5 (Map 4-5). Both causeways will be removed at the end of the construction phase. Culverts will be installed in the south causeway to allow fish to move past the causeway. A channel will be excavated east of the north cause to maintain access for fish. Safety booms will be installed on either side of the causeways to restrict access by the public. Since some borrow sites will be retained for the operation of the Project, access roads to those sites will be permanent.

4.3.2.7 COFFERDAMS, ROCK GROINS AND TOWER SPUR

A cofferdam is a temporary dam, usually made of rockfill and earth, constructed around a work site in the river, so the work site can be **dewatered** or the water level controlled during construction of structures inside the cofferdam. Two stages of cofferdam development will be used for river management during construction. The Project includes nine cofferdams plus two rock groins. Some selected remnants of the cofferdams and rock groins will be incorporated into the principal structures.

The Project will include a rockfill transmission tower spur to support the foundations for the first row of transmission towers supporting the transmission lines running from the powerhouse to the permanent switching station on the south side of the river. A portion of the spur will be constructed by using a remnant of the powerhouse cofferdam. The transmission lines and towers are part of the Keeyask Transmission Project (see Section 4.3.2.11).

4.3.2.8 ICE BOOM

The ice boom consists of a floating structure anchored to the riverbed to initiate the development of an ice cover. While constructing the Project, a temporary ice boom will be required to assure that ice bridging occurs upstream of Gull Rapids. This will result in a competent ice cover on Gull Lake early in the winter season during construction of the

Project. The ice boom will reduce accumulation of ice at Gull Rapids which will reduce the water levels within Gull Rapids during the winter construction seasons and reduce construction risks, costs and environmental effects. The ice boom will consist of five 120 m spans in the central part of the river. The area between the ends of the boom and the shoreline currently develops **border ice** cover under natural conditions, thus precluding the requirement for the ice boom to extend to the shore. However, safety booms will connect each side of the ice boom to the north and south shores to restrict access to the dangerous waterway at Gull Rapids.

The ice boom will be located approximately 3 km upstream of the powerhouse and about 600 m upstream of where the Nelson River splits into the north and south channels. The ice boom will remain in place during the construction phase and will be removed prior to reservoir impoundment. Signage and buoys will be established in the vicinity of the ice boom. The location of the ice boom is shown in Map 4-4.

4.3.2.9 Sources of Rock, Granular and Soil Materials

Materials required for the Project include impervious fill, granular fill/crushed rock, rock fill, riprap and concrete aggregates. Site investigations have identified a number of natural sources for these materials, as shown in Map 4-4. A preliminary material utilization plan was developed to demonstrate the amount of materials that could be extracted from each material source to construct the Project (see Table 2-3 of the PD SV).

The use of any or all of the potential material sources as well as the extent of utilization of each source will be at the discretion of the contractor, subject to relevant environmental approvals. The Project footprint includes the full extent of the available material sources, more than is actually needed for construction because the actual utilization is estimated at this time. The extent of the actual area that will be utilized by the contractor will likely be much less than the full extent of the material sources included in the Project footprint because the potential material sources contain much more material than will actually be required for the Project.

The majority of granular material will be sourced from borrow areas on the north side of the Nelson River. Impervious material will be sourced from borrow areas on both sides of the Nelson River. The majority of rock required for the Project will be sourced from a bedrock quarry to be developed within Gull Rapids as well as from excavations of the principal structures. Some of the organic material removed from the surface of excavations will be re-used in the rehabilitation of borrow sites, temporary roads/trails and excavated material placement areas.

4.3.2.10 PLACEMENT AREAS FOR EXCESS EXCAVATED MATERIAL

A substantial amount of earth and rock materials will be excavated during the construction of principal structures and much of this material will be used during the construction phase. Approximately 4,200,000 m^3 of unclassified material, which cannot be used for construction, will be placed within designated excavated materials placement areas (EMPAs) located near the principal structures as shown on the Map 4-6. Some materials will be placed in areas within the reservoir and, once flooded, the material will be submerged. Where required, EMPAs will be armored to prevent erosion and sedimentation.

4.3.2.11 INFRASTRUCTURE OF OTHER PROJECTS / FACILITIES

Infrastructure developed prior to the start of the Project will be utilized to construct and operate the Project. This includes provincial roadways, rail lines, fibre optics cable, and electrical distribution lines. Additional infrastructure will be built as part of KIP and the Keeyask Transmission Project.

The following are being constructed as part of KIP: a start-up camp for about 150 workers; the north access road, including a bridge over Looking Back Creek; Phase 1 of the main camp including workforce accommodations near Gull Rapids for 500 workers (including kitchen facilities, dining hall, recreational facility, offices, potable water supply, and wastewater treatment facilities); work areas; power supply; a pad for a transformer station; a helicopter pad; and garages for firefighting and first-aid vehicles. KIP has been reviewed and approved and Manitoba Environment Act License No. 2952 has been issued. Although these facilities are being constructed as components of KIP, their operation is part of the Keeyask Generation Project as defined in this EIS.

The Keeyask Transmission Project will be developed, owned and operated by Manitoba Hydro to provide construction power to the Project site. Manitoba Hydro will make a separate application for regulatory approval for this project. It includes the following:

- A 22 km transmission line to provide construction power to the Project. The construction power line will connect the Project site to an existing 138-kilovolt (kV) transmission line (KN 36) located south of the construction site.
- Three transmission lines to transmit electricity within a single corridor (approximately, 35 km) from the Keeyask Generation Project to the Radisson Converter Station (near Gillam), where the power will enter Manitoba Hydro's integrated power system. One of these lines will be built earlier than the other two to serve as a back-up source of construction power.

The potential routes for these transmission lines during the construction and operation phases are shown on Map 4-7 and Map 4-8.

KIP and the Keeyask Transmission Project are considered as part of the cumulative effects assessment of the Keeyask Generation Project.

4.3.2.12 BOAT LAUNCHES, BARGE LANDINGS AND PORTAGE

During the construction phase, boat launches and barge landings will be required upstream and downstream of the generating station. The location of the boat launches and barge landings are shown on Map 4-9. The barge landings are required to construct aquatic mitigation measures during the construction phase. The boat launches will be used to access the waterway and to support activities such as environmental monitoring, waterways management and reservoir clearing during the construction phase.

The downstream boat launch and barge landing developed for the construction phase will continue to be used during the operation phase. A new boat launch and barge landing will be constructed upstream of the generating station for use during the operation phase because the upstream boat launch used during the construction phase will be inundated once the reservoir is impounded (see Map 4-3). The barge landings are required to facilitate construction of potential aquatic mitigation measures during the operation phase. Also, in the operation phase, boat launches will be accessible to the public and will support activities such as environmental monitoring, waterways management and resource harvesting.

A 3.2 km long portage will be constructed on the north side of the Nelson River to allow people using the waterway to move between Stephens Lake and the Keeyask reservoir. Portions of the portage will use the north access road and other service roads.

4.3.3 ENVIRONMENTAL MITIGATION / COMPENSATION

This section describes the various environmental mitigation/compensation measures identified by the Partnership for the Project (Map 4-10). These measures were selected from a range of alternatives that were considered in the development of the Project, as discussed in Section 4.5, Planning, Alternative Means and Mitigation.

The Partnership's approach to addressing potential adverse effects of the Project, in order of priority, has been and continues to be:

- Prevent or avoid works or measures which will cause adverse effects;
- Mitigate unavoidable adverse effects;
- Provide appropriate replacements, substitutions or opportunities to offset adverse effects; and
- Compensate for the loss or damage suffered as a consequence of adverse effects, to the extent such effects are not fully addressed by other measures.

These measures are summarized in the following sections.

4.3.3.1 MEASURES IN JOINT KEEYASK DEVELOPMENT AGREEMENT

After many years of negotiations, meetings and consultations, the membership of each of the KCNs partners approved both the Joint Keeyask Development Agreement (JKDA) and the community-specific adverse effects agreements (AEAs) by way of independent referendums. These agreements outline procedures for the avoidance of adverse effects from the generation station and the establishment of programs to offset unavoidable effects on each of the KCNs (see Chapter 2 and the KCNs' Environmental Evaluation Reports) including the following:

- **Reservoir Clearing and Waterways Management:** In early negotiations with Manitoba Hydro, TCN insisted that the reservoir be cleared of timber. This principle became a plan in the JKDA and together with the Waterways Management Program, these were developed with the KCNs to address issues around travel, access and human safety resulting from floating debris. Clearing the reservoir also addresses other issues including improving the aesthetics of the environment, encouraging fishing with nets and reducing the production of **methymercury**. KCNs Members will be involved in boat patrols to manage floating debris, **monitoring** safe ice trails and liaising with users of the waterway. For further details, refer to the PE SV Section 10, Debris.
- **Offset Programs:** Each AEA includes offsetting programs that are intended to provide appropriate replacements, substitutions and opportunities to offset unavoidable Keeyask adverse effects on practices, and customs and traditions integral to the distinctive cultural identity of each of the Cree Nations. Many of these programs provide opportunities for the Cree to pursue traditional activities away from Gull Lake on other off-system lakes and rivers.

4.3.3.2 BIOPHYSICAL AND SOCIO-ECONOMIC MITIGATION MEASURES

4.3.3.2.1 PHYSICAL ENVIRONMENT

Measures to avoid adverse effects were major considerations in developing plans for the Project, as discussed in Section 4.5 Project Planning, Alternative Means and Mitigation Measures. Other mitigation measures related to the physical environment consist mainly of the application of best practices, which will be outlined in the **Environmental Protection Plan** (Section 4.3.3.3) and discussed in Section 6.3, Effects and Mitigation: Physical Environment. These comprise measures such as the following:

- Controlling dust on roads during construction;
- Limiting the burning of cleared vegetation to favourable weather conditions; and

- Cofferdam designs, construction methodology and sequencing have been developed to minimize erosion and **sediment** inputs during construction. A Sediment Management Plan describing these mitigation measures will be developed and submitted to the regulatory agencies for their approval.

4.3.3.2.2 Aquatic Environment

KCNs representatives, aquatic biologists and planning engineers worked together to identify a suite of mitigation measures to address the effects of the Project on the aquatic environment. Depending on the measure, the following will be undertaken when the Project is being constructed or when it is being operated:

- Spawning habitat will be constructed in the GS tailrace and near Stephens Lake, to replace lost spawning habitat in Gull Rapids for species such as lake sturgeon, walleye, and lake whitefish;
- Spawning habitat will be constructed in the lower reservoir to replace lost walleye and lake whitefish spawning habitat in Gull Lake;
- Access to small tributaries in the reservoir will be maintained by removing accumulations of debris;
- Channels in the reservoir at Little Gull Lake will be constructed to allow fish to avoid mortality due to over-winter oxygen depletion;
- Channels will be constructed below the spillway to enable fish to move into Stephens Lake, rather than being stranded after the spillway is operated;
- A comprehensive stocking plan will be implemented to maintain/enhance lake sturgeon populations in the Project area and the broader region;
- Turbines were designed to minimize mortality and injury of fish passing through the powerhouse; and
- A trap/catch and transport program for upstream fish passage will be implemented at the Project for key fish species, including lake sturgeon. Downstream fish passage is being provided via the turbines and spillway. The Project will be designed and constructed in a manner that would allow it to be retrofitted to accommodate other upstream and/or downstream fish passage options if required in the future.

Implementation of the following measures will be subject to post-construction monitoring:

- If monitoring demonstrates that lake sturgeon no longer spawn at Birthday Rapids, modification of the riverbank upstream of Birthday Rapids will create hydraulic features that would be attractive to spawning sturgeon; and

- If monitoring demonstrates that newly hatched young-of-the-year sturgeon are not able to use habitat in the reservoir, then sand/fine gravel will be placed at the upper end of present-day Gull Lake to create habitat known to be suitable for young-of-year sturgeon.

In addition to the measures listed above, the Partnership, Fisheries and Oceans Canada, and Manitoba Conservation and Water Stewardship are continuing to discuss Project effects and mitigation, and additional measures may be identified that would be implemented prior to or during Project operation. Mitigation measures are described in greater detail in Section 6.4, Effects and Mitigation: Aquatic Environment. Additional design details related to the turbines and fish passage are provided in Section 4.5.1.

4.3.3.2.3 TERRESTRIAL ENVIRONMENT

KCNs representatives, terrestrial biologists and planning engineers worked together to identify a suite of mitigation measures to address the effects of the Project on the terrestrial environment. Depending on the measure, the following will be undertaken when the Project is being constructed or when it is being operating:

- Extraction of materials will be limited to portions of the N-6 deposit to minimize the loss of white birch and poplar mixed forest (Map 4-5). This area is also an important habitat type for ruffed grouse and is also of interest to the KCNs and the Province due to Paleo-Archaic heritage resources found along the southern margin;
- EMPAs were selected to avoid sensitive terrestrial areas;
- Boundaries of EMPAs were modified to avoid sensitive terrestrial areas;
- Boundaries of borrow areas were modified to avoid uncommon habitats;
- Caribou calving habitat was avoided during the siting of the temporary and permanent access roads and borrow areas;
- Blasting will be minimized to the maximum extent feasible from May 15 to June 30, to reduce the effects on calving females and their young;
- Blasting will be restricted during the bird breeding season (April 1-July 31) to the extent practicable;
- Clearing activities will be restricted during the bird breeding season (April 1-July 31) to the extent practicable;
- Tern nesting platforms will be installed in select areas, such as **wetlands** and other suitable marsh sites within the Nelson River and/or parts of the reservoir;
- Wetlands will be developed to offset the loss of particularly important wetlands;

- Existing bird nesting islands for colonial waterbirds will be enhanced or new sites created;
- Eagle nesting platforms will be installed for any nest disturbed during construction/operation; and
- CNP is developing a moose harvest sustainability plan.

These measures are described in more detail in Section 6.5, Effects and Mitigation: Terrestrial Environment.

4.3.3.2.4 SOCIO-ECONOMIC ENVIRONMENT

The JKDA and the **Burntwood Nelson Agreement** include a number of provisions that serve to enhance the participation of and Project opportunities for the KCNs communities and northern Manitoba residents.

Additional socio-economic mitigation measures are either included as standard mitigation measures in the EIS or have already been identified by other disciplines. Examples of the latter include the following:

- The Reservoir Clearing Plan will address issues around travel, access and human safety resulting from floating debris as well as other issues including improving the aesthetics of the environment and reducing the production of methymercury.
- The Waterways Management Program specifically addresses concerns about safe landing sites, safe winter/ice trails, and safe travel routes through the reservoir.
- Upstream and downstream boat launches, including portages, will be developed around the generating station (addresses travel safety), as discussed in Sections 4.6.13 and 4.7.8.
- The KCNs' Adverse Effects Agreements provide for offsetting programs to enable the KCNs to access country foods in areas not affected due to the Project or previous hydroelectric projects.

The list of socio-economic mitigation measures are identified and discussed in Section 6.6, Effects and Mitigation: Socio-economic Environment.

4.3.3.2.5 RESOURCE USE

The previous sections have identified many measures that will avoid or mitigate potential effects of the Project on resource use. These include the Reservoir Clearing Plan, Waterways Management Program, safe landing sites, and ice monitoring and safe trails program, all of which will facilitate people's travel to hunt, fish and gather in the area. The AEAs will also provide KCNs Members with opportunities to undertake these traditional resource-use activities while expressing their respect for *Askiy* (Mother Earth) and passing on these skills and worldviews to younger generations.

These are discussed in more detail in Section 6.7, Effects and Mitigation Resource Use.

4.3.3.2.6 HERITAGE RESOURCES

The KCNs and professional archaeologists have worked together for many years to identify sites of cultural and heritage importance and have worked with planning engineers to develop the following measures to avoid or mitigate potential effects:

- Heritage resources that may be disturbed by the Project will be salvaged to enable long-term preservation of tangible heritage and to enhance public and local awareness through education kits, interpretive displays and other forms of cultural media.
- A cemetery, prepared and consecrated for the reburial of human remains found during construction and operation of the Project, including a memorial marker, will be developed in an area selected by TCN, in consultation with the other Project partners.
- KCNs Members will be involved in identifying and contributing to impact management measures at important spiritual and heritage sites.
- These are discussed in more detail in Section 6.8, Effects and Mitigation: Heritage Resources.

4.3.3.3 ENVIRONMENTAL PROTECTION PLANS

Manitoba Hydro implements Environmental Protection Plans (EnvPPs) for all major projects to mitigate potential adverse environmental effects. Together with KCNs input, the Partnership will develop EnvPPs for the south access road and the generating station. Each EnvPP will include guidance to protect the environment during construction, operation, maintenance of the Project and decommissioning of temporary infrastructure. This includes guidance on best practices, mitigation measures, construction restrictions related to critical wildlife sensitivities and drainage management, detailed mapping data specifying sensitive locations, and information to preserve heritage resources. A spill response plan will also be developed specifically for the Project. The EnvPPs will be submitted for review by the regulators. A more comprehensive description of the EnvPPs is provided in Section 8.1.2.2.

4.4 LAND REQUIREMENTS

The development, construction, and operation of the Project will require the granting of easements and the transfer of land ownership. A survey of lands required for the KIP north of the Nelson River has been completed. Manitoba has leased these lands to the Partnership with an unqualified right to purchase at a raw land (unimproved) value. The balance of the lands, including water lots and lands for the south road, will be surveyed and acquired in due course by the Partnership prior to construction.

As noted in Section 4.3.2.6, MIT has confirmed that they will assume ownership of the north and south access roads. These roads will be integrated into the provincial highway network once the Project is completed.

4.4.1 ABORIGINAL AND RESERVE LANDS

Federally designated First Nations reserve lands will not be encroached upon by the Project's principal structures, reservoir and infrastructure. There are no Treaty Land Entitlement selections extant or pending on these lands.

4.4.2 PROJECT FOOTPRINT

As noted earlier, the Project consists of principal structures and supporting infrastructure. The principal structures will be permanent, while some of the supporting infrastructure will be permanent and some will be required only for construction of the Project. The Project will require areas totalling approximately 133.5 km^2 for the construction phase and about 138.2 km^2 for the operations phase (Map 4-11, Map 4-12, Map 4-13). The construction phase footprint includes areas that are unlikely to be used, which are areas that may be required during final design where adjustments to the location of structures may be implemented. Portions of the areas unlikely to be used may be required by contractors to carry out construction activities but have a low probability of being used. The footprint also includes corridors which provide flexibility to make slight adjustments to the alignment of roads during final design and construction. The area required for the operation phase includes the reservoir. The reservoir will be approximately 93 km^2 in total, made up of approximately 48 km^2 of existing waterways and approximately 45 km^2 of newly inundated lands as part of the Project. During the first 30 years after full reservoir impoundment, the reservoir is predicted to expand by approximately 7-8 km^2 due to the erosion of some mineral shorelines and peatland disintegration. The reservoir area is included in the Project footprint. The environmental assessment was carried out for all areas included in the **footprint** with the exception of Borrow E-1 and the haul road to this borrow area because it has a very low probability of being used for Project construction. A summary of lands required is provided in Table 4-2 and is illustrated for the construction and operation phases in Map 4-11.

Table 4-2: Summary of Lands Required for the Project

Footprint Category	Area (ha)*		Percent of Footprint	
	Construction Phase	Operation Phase	Construction Phase	Operation Phase
Roads[1]	621	634	4.6%	4.6%
Road Corridors[2]	122	119	0.9%	0.9%
Infrastructure	317	208	2.4%	1.5%
River Management	27	1	0.2%	0.0%
Borrow Areas[3]	1,321	1,052	9.9%	7.6%
Camp and Work Areas	154	154	1.2%	1.1%
Excavated Material Placement Area	181	99	1.4%	0.7%
Mitigation and Compensation Area	133	–	1.0%	0.0%
Possible Disturbed Area	672	219	5.0%	1.6%
Reservoir Clearing[4]	3,602	–	27.0%	0.0%
Areas Unlikely to be Used[5]	945	936	7.1%	6.8%
Existing Water Surface Area[6]	5,161	5,038	38.6%	36.4%
Dewatered Area	100	100	0.7%	0.7%
Flooded Area		4,463		32.3%
Reservoir Expansion (First 30 Years)		800		5.8%
Total Construction/Operating Phase	**13,354**	**13,824**	**100.0%**	**100.0%**

Notes:

- Haul road alignments are preliminary.
- Road corridors provide flexibility for realignment during final design and construction. Includes road corridors located outside the reservoir.
- Area is the maximum amount of borrow area that may be used; the actual area required for construction will likely be much smaller.
- Reservoir Clearing Area includes road corridors and unlikely to be used areas that are within the reservoir. This area excludes the mitigation and compensation area.
- Areas unlikely to be used are areas that may be required by the designers and contractors but have a low probability of being utilized. These include all areas unlikely to be used outside of the reservoir.
- Existing Water Surface Area is depicted in the footprint Map 4-11, Map 4-12 and Map 4-13 as Altered Water Level or Flow.

4.5 PROJECT PLANNING, ALTERNATIVE MEANS AND MITIGATION MEASURES

A joint process has been undertaken between the KCNs and Manitoba Hydro over many years to optimize the Project design, including consideration of alternative means to develop the Project which could avoid and mitigate potential environmental effects. This section will first describe the Project planning process and the consideration of alternative means of developing the Project, such as the selection of the site for the generating station, its size and turbine design. The section then describes the approach to developing major mitigation measures for avoiding and/or reducing adverse effects from the selected development. Greater discussion of alternative means and mitigation is provided in the PD SV Section 6.0.

4.5.1 PROJECT PLANNING

4.5.1.1 GENERATING STATION SITE SELECTION AND RESERVOIR LEVELS

Since the 1960s the Government of Canada, the Province of Manitoba and Manitoba Hydro have studied a number of options to develop the 27 m of head on the lower Nelson River between Split Lake and Stephens Lake. The objective of the studies was to assess the feasibility of hydroelectric development along the reach and develop preliminary concepts and cost estimates.

During the 1970s and 1980s, various options to develop hydroelectric power at Gull and Birthday rapids were considered. At Birthday Rapids, four different axes were identified that could produce between 485 to 585 MW, with a FSL of 168.5 m. At Gull Rapids, two different axes were identified that could produce between 510 to 522 MW with a FSL of 153.0 m.

Multiple axes were studied to identify the optimum axis that would minimize construction costs and risks at both Gull and Birthday rapids. Uncertainties associated with geotechnical conditions contributed to the need to evaluate multiple axes.

The selection of a general arrangement at the downstream end of Gull Rapids was considered preferable because it captures 12 m of head across the rapids. Power production is a function of both the magnitude of water flow and the height that the water falls. The Project fully utilizes the drop in elevation across Gull Rapids while the tailrace level essentially coincides with the level of Stephens Lake, the reservoir for the Kettle Generating Station.

In the late 1980s and early 1990s, Manitoba Hydro undertook further studies and identified three potential options to develop the reach of the river from Split to Stephens lake. Two of the options involved single-site developments at Gull Rapids: one was a high-head generating station producing 1,160 MW with an FSL of 168.5 m, and the second was an **intermediate head** generating station producing between 910 to 930 MW with a FSL of 162.5 m.

The third option would have resulted in the development of two low-head generating stations on this reach of the river, a 640 MW project at Gull Rapids with a FSL of 158 m, and a 380 to 460MW project at Birthday Rapids with a FSL of 168.5 m. The amount of flooded land varied from 183 km^2 for the single-site, high-head option at Gull Rapids to

78km^2 for the intermediate head option. The two sites development would flood approximately 106 km^2 of the land including shoreline areas on Split Lake. In evaluating the various options, the extent of flooding was used as a proxy for adverse environmental and socio-economic effects, *i.e.*, more flooding was considered to relate to more potential adverse effects. The single-site intermediate head development was designed not to impact the TCN Northern Flood Agreement (NFA) Severance Line at Split Lake. This option was studied to determine the incremental cost of not impacting water levels on Split Lake and to determine the amount of power that would be foregone by avoiding this project impact. It was determined that the maximum elevation to which this reach could be developed without affecting Split Lake water levels was 162.5 m.

In early 1993, Manitoba Hydro advised TCN that it was studying several development options, including a high-head option at Gull Rapids (168.5 m reservoir level) with approximately 183 km^2 of flooding, and an intermediate-head option (162.5 m reservoir level) with about 78 km^2 of flooding. As the potential projects were located in the Split Lake Resource Management Area, these options were considered through a joint studies process with TCN and Manitoba Hydro, in a manner consistent with TCN's 1992 NFA Implementation Agreement (subsection 2.8.3 (b)).

In response to TCN concerns related to flooding and in consideration of potential requirements for mitigation measures, Manitoba Hydro decided in 1996 to drop the high-head option from further consideration.

TCN and Manitoba Hydro continued to work together to further review options. A decision was made to pursue a single development at Gull Rapids with less flooding—and less power production—than previously studied for this reach of the river. A station at the GR-3 North Axis with a FSL of 158.0 m and discharge capacity of 4200 cms would have a rated plant capacity of 640 MW. It was determined that this reservoir elevation would not impact open water levels on Split Lake. As well, this option floods much less land than other higher-head options, and minimizes impacts on lake sturgeon and other aquatic habitats between Clark Lake and Birthday Rapids. However, compared to the high-head or intermediate-head options, this option results in a substantial reduction in generating capacity. The reduction in capacity is approximately 500 MW relative to the high head developed with the FSL of 168.5 m and the discharge capacity of 4,700 cms.

Later studies determined that the ability to form a stable ice cover immediately upstream of the powerhouse governed the minimum reservoir level at this site. The operation of hydroelectric stations in cold climates requires that the powerhouse intake channel has a stable ice cover to avoid **frazil ice** accumulating in the intake, which restricts flows through the powerhouse. For Keeyask, a stable ice cover could not be assured with a FSL of 158 m; therefore, an additional meter was added to the reservoir level to ensure that a stable ice cover will form. Lower elevations would require substantial and costly channel excavation, resulting in a generating station that would produce less power. Accordingly, 159 m was adopted as the FSL with an operating range between 158 to 159 m, as discussed in Section 4.5.1.3.

4.5.1.2 GENERAL ARRANGEMENT OF PRIMARY STRUCTURES

Map 4-14 shows the locations of the five alternative axes (GR-1 to GR-5) studied at Gull Rapids, beginning in the 1960s.

During the 1970s and 1980s, these axes were studied further to evaluate alternative concepts for a single site high head development at Gull Rapids, a single site intermediate head development at Gull Rapids and a two site low head development option with sites at Birthday and Gull Rapids. These studies concluded that:

- Axis GR-2 should be eliminated because it is too far downstream into Stephens Lake;
- Axis GR-1 should be eliminated because it is nearly the same axis as GR-3; and
- Axis GR-3 was the preferred axis for the low head options.

Axes GR-4 and GR-5 were not recommended for the low head options (reservoir levels less than or equal to 158.0m) because they would require excessive upstream channel excavations in order to form a stable ice cover in the immediate forebay. Axis GR-5 was the preferred axis for the high head option. This conclusion was reached because axis GR-3 would require a south dyke that would be too high to construct on permafrost affected soils. The south dyke for GR-5 uses higher ground so the dykes are not as high and construction on the permafrost affected soils would be feasible.

In the mid-1990s, subsequent studies concluded that a low head development at Axis GR-5 would be more costly than low head developments using Axes GR-4 or GR-3. The need for construction infrastructure to be developed on both sides of the river is unique to GR-5 and would not be required for GR-4 or GR-3. GR-5 would also require upstream channel improvements, and this further supported the recommendation that GR-5 no longer be considered for the low head option. Axis GR-3 with a south side powerhouse and spillway was the preferred axis for the low head option and GR-4 continued to be carried as an alternative to GR-3 because the cost estimate was nearly the same.

During the period of 1999–2003, various Stage 3 studies were carried out to develop and evaluate a series of general arrangements and alternative structure axes with a forebay level of 159.0 m. The two alternative axes that were studied were GR-3 North option (powerhouse and spillway on the north side of river) and GR-3 South option (powerhouse and spillway on the south side of river) and GR-4 North option (powerhouse on the north side of the river).

An evaluation of these options resulted in axis GR-4 North being selected as the preferred option for the following technical, environmental and socio-economic reasons:

- GR-4 North has a slightly lower capital cost than the GR-3 options.
- GR-4 North has less construction risk than the GR-3 options. For example, a late start in the project or delays during the construction of access roads, ice roads or causeways would adversely impact the schedule and add costs for a GR-3 development to a greater degree than for a GR-4 North development. Construction of the multiple Stage I cofferdams for the GR-4 North development has less construction risk than the construction of the single larger cofferdam for the GR-3 developments.
- GR-4 North has better materials transportation logistics than the GR-3 options. GR-3 options would require materials to be transported to the other side of the river either by bridges or causeways. This would not be required for GR-4.
- GR-4 North could likely be completed one year earlier than the GR-3 options. The shorter schedule is a result of being able to construct smaller Stage I cofferdams over a shorter duration, as well as not having to construct a temporary bridge and causeway.
- TCN preferred that the camp and associated infrastructure be located on the north side of the river to provide better opportunities for community Members to participate in the construction project.
- Compared to GR-3 options, GR-4 North was anticipated to have relatively fewer adverse environmental impacts and provides greater potential for aquatic and terrestrial mitigation and compensation measures downstream of the project.

GR-4 North has fewer adverse effects than the GR-3 options because:

- Axis GR-4 would flood approximately 177 ha less land than GR-3 although it creates 278 ha less productive fish habitat relative to GR-3.
- Development of downstream lake sturgeon spawning habitat would be less challenging and more likely to be effective for the GR-4 option relative to axis GR-3.
- Axis GR-4 provides the ability to construct aquatic and terrestrial enhancements in the dewatered channel downstream of the south dam. GR-3 does not provide that potential.
- Axis GR-4 provides the opportunity to preserve and construct additional lake sturgeon spawning habitat during the operation phase, should it be required. Axis GR-3 does not provide this opportunity.
- Based on historical flow records, GR-4 would spill water down the south channel approximately 30% of the time in the spring, which could create spawning habitat if it occurred in the spring; GR-3 does not provide this option.
- GR-4 North is expected to have a lower potential for adverse effects related to workforce interaction in the community of Gillam during construction (Fox Lake Cree

Nation prefers less interaction between construction workers and its Members in Gillam).

In 2012, axis GR-5 was re-visited to assess the potential of preserving a greater amount of lake sturgeon spawning habitat in Gull Rapids. Based on past studies it was determined that axis GR-4 is a more efficient and environmentally suitable development than GR-5 because:

- Economically, axis GR-5 would be substantially more costly than axis GR-4 to construct and would likely require an extra year to construct relative to axis GR-4. Axis GR-5 would require additional supporting infrastructure on the south side of the river, a longer and more complex central dam and dyke, greater upstream channel excavations, substantially more excavation for the spillway, and larger cofferdams.
- Environmentally, axis GR-5 has limited opportunity for environmental benefit compared with GR4 and several more adverse effects because of the following:
  - While axis GR-5 would flood slightly less land (approximately 150 ha) than axis GR-4, axis GR-5 also creates less productive fish habitat (approximately 235 ha) in the dewatered area of Gull Rapids.
  - Since the spillway will not be utilized the majority of time, axis GR-5 would create about 186 ha of dewatered area downstream of the spillway compared to 101 ha for axis GR-4.
  - Fish stranding would be a substantially greater issue for axis GR-5 than axis GR-4 because of the larger dewatered area, and mitigation of stranding through the use of channels, as is planned for axis GR-4, is not feasible due to the greater elevation. A fish salvage following a spill event would be a large undertaking because of the spatial extent of the dewatered area.
  - During spill events (approximately 30% of time in the spring based on historic records), existing lake sturgeon spawning habitat at the base of Gull Rapids will be wetted by both axis GR-4 and axis GR-5. While spill from axis GR-5 would wet additional existing habitat in the middle and upper sections of Gull Rapids south channel, it is likely that this area would provide little benefit to fish because they likely cannot ascend the steep gradient and high water velocities to the middle and upper sections of the channel.
  - Axis GR-5 would not permit some of the potential fish habitat compensation measures that could be implemented in the dewatered area for Axis GR-4.
  - Construction of the principal structures for axis GR-5 may require an excavated channel, a bridge and rockfill causeway to be constructed in the lower reach of the south channel of Gull Rapids. The construction and decommissioning of this infrastructure would disturb and possibly permanently destroy some existing spawning habitat.

As well, construction of axis GR-5 would not comply with some of the fundamental construction and operating features established within the JKDA. It is fundamentally important to TCN that the configuration of powerhouse, spillway and main camp remain in the same general location shown in the JKDA. GR5 would depart from this arrangement and would also require a large new camp on the south side that has not been included as part of the consultation process. This will also minimize the potential for adverse workforce interaction with residents of Gillam.

4.5.1.3 RESERVOIR OPERATING RANGE AND MODE OF OPERATION

The Project will be operated within a 1 m range, with reservoir levels maintained between 158 m and 159 m. An operating range limited to 1 m was considered beneficial in order to minimize environmental impacts as well the KCNs expressed a strong desire for relatively stable **post-project** water levels. While a larger operating range would provide greater flexibility and therefore greater economic benefits, the 1 m operating range provides some operating flexibility, allowing the reservoir to be drawn down to produce additional energy when it is required during peak periods of the day.

The Project will be the fourth largest generating station in Manitoba Hydro's system; however, the operating range will be small relative to other hydro developments in Manitoba and in Canada. The Project will operate using either a base loaded mode of operation or **peaking mode of operation**. The mode of operation used each day will depend on the requirements of Manitoba Hydro's Integrated Generation System (always within the 1 m allowable range). The mode of operation is discussed in detail in Section 4.7.1 of this chapter and also in Section 4, Project Operation of the PD SV.

A flexible mode of operation is made possible because the station discharges almost directly into Stephens Lake, thereby limiting the downstream hydraulic zone of influence of the plant operations. Unlike many other hydroelectric stations, the **tailwater** level is largely controlled by the level of Stephens Lake, rather than by the discharge from the Project. With the exception of two constraints for lake sturgeon spawning (see Section 4.7.1), no other constraints on the mode of operation are required to meet downstream flow requirements.

4.5.1.4 TURBINE DESIGN

Fixed-blade, vertical-shaft generating units have been selected for the Project (Figure 4-6). Relative to hydroelectric generating stations worldwide, Keeyask will be a relatively high-flow and low-head plant. For a plant discharge of 4,000 m^3/s and head of approximately 18 m, only vertical-shaft propeller turbines or horizontal-shaft bulb turbines are suitable. The fixed-blade vertical-shaft propeller turbine design used for the Project has a low fish mortality rate compared to other turbine designs.

The use of a fixed-blade, vertical-shaft turbine design for Keeyask results in several advantages for fish passage survivability compared with other turbine types:

- The fixed-blade pitch of the vertical shaft units allows for the gap between the runner blades and the discharge ring to be minimized, reducing the likelihood of fish **impingement** and injury.
- The relatively-low rotational speeds associated with large-diameter, vertical-shaft turbines also result in greater fish survivability.

Other features designed to reduce the risk of striking or impingement injuries include: runner blades incorporate a thicker rounder leading edge; the gaps between wicket gates and both the bottom ring and head cover are minimized; and the wicket gate overhang is also minimized. Features designed to reduce turbulence levels experienced by fish passing through the turbines include: the runner blades incorporate a thinner trailing edge; units will operate at best gate whenever possible; and the shape of the draft tubes incorporate large sweeping radii. These are all known to improve the probability of a fish passing through a turbine without incurring significant injury or mortality.

4.5.1.5 FISH PASSAGE

A phased approach to evaluating and developing fish passage alternatives is being undertaken to allow for the collection of more site specific fish behavior and hydraulic data during the initial stages of the operating phase. This information will help guide the development of fish passage, enable optimization of the performance, and provide a means to select the most ecologically responsible and cost effective alternative. Various trap/catch and transport measures are being examined and the most effective measure will be implemented. Plans for the design and location of a long term collection facility are ongoing and will integrate knowledge based on examining fish movements/behavior once the Project is operating. They will include an assessment of alternatives beyond trap/catch and transport, such as a fish lock/lift, nature-like bypass channel and fish ladder. The analysis will build on the preliminary screening approach using various social, economic, environmental and engineering criteria to break down alternatives into discrete elements for comparison, evaluation, and optimization. The Project will be designed and constructed in a manner that would allow it to be retrofitted to accommodate another upstream and/or downstream fish passage option if required in the future.

It should be noted that considerable effort and cost has gone into optimizing the turbine design to reduce fish mortality and the turbines and spillway are designed in a manner that will allow fish to move downstream without significant impact to the populations as described in the previous section.

4.5.1.6 TRASH RACKS

The Project reservoir is expected to generate woody debris due to shoreline erosion. A waterways management program (Appendix 4B) has been developed to prevent the majority of debris from reaching the powerhouse, however it is likely that some woody debris will reach the intake of the powerhouse. The main purpose of the trash rack is to protect the wicket gates and turbines from larger debris that could cause very costly damage or interrupt power generation. A key consideration when designing the intake for low head hydro-power stations is the minimization of energy losses at the entrance which includes the intake gates, bulkheads and trash racks.

While the main purpose of the trash racks is to prevent debris from passing through the powerhouse they can also affect the movement of fish downstream through the turbines. Trash racks will be installed on the upstream face of each intake to the powerhouse and will be approximately 22.7 m tall and 6.4 m wide. The trash racks for the Project will be comprised of vertically oriented rectangular shaped steel bars with a clear bar spacing of 16.75 cm. The spacing between the horizontal support bars will be 50 cm. As discussed in the AE SV Appendix 1-1, only a few extremely large sturgeon (greater than 1.4 m in fork length) will be physically excluded from passing downstream. Based on the estimated velocities at the intake (which would range from 1 m/s to 1.2 m/s), it is unlikely that more than a few large bodied fish will become permanently impinged on the trash racks each year. Smaller fish that are moving downstream would move past the trash racks and the turbines. As discussed in Section 4.5.1.4, the design of the turbines includes features to reduce the risk of injury and mortality to these fish, with the goal of greater than 90% survival for fish up to 0.5 m in length.

An analysis of reducing the spacing of trash racks to exclude more fish indicated that the velocity at the trash rack could result in the permanent impingement of smaller fish than the trash rack was designed to exclude (AE SV Appendix 1-1). Given that permanent impingement would result in 100% mortality, it was concluded that fish passage through the turbines was a better option than reducing the bar spacing.

4.5.1.7 DYKES

During the early planning stages, potential alternative alignments were reviewed for intermediate head and high head development options. The Stage IV engineering studies investigated potential alternative dyke alignments for the north and south dykes for a FSL between 158.0 and 159.0 m.

A review of alternative dyke alignments was intended to identify potential savings in construction costs and minimize impacts on creek crossings and effects on local drainage patterns. Minimizing flooding and effects on local drainage pattern was considered to correlate to lesser environmental effects. The selections of the proposed dyke alignments were made on the basis of the following:

- Terrain and stratigraphy (depth to till surface / excavation and fill volumes);
- Drainage pattern and creek crossings required;
- Height of the structure;
- Estimated volume of excavation;
- Estimated volume of fill; and
- Extent of flooding and forebay clearing requirements.

Terrain mapping and subsurface explorations were undertaken to identify areas where the depth of the organic layer as well as the thickness of the surficial layer of **lacustrine** clays were minimal. These analyses, along with reviews of the topography, facilitated the locating of the dykes in areas where the required depth of excavations could be minimized. Where possible, considering many factors, the dykes have also generally been sited on or close to the high land between the Nelson River and adjacent tributary streams. The selection of these prime locations resulted in reduced fill quantities as well as the minimization of water ponding to the downstream of the dykes, which would occur if the dyke alignment were to be moved closer to the banks of the Nelson River. Where the dykes are located closer to the Nelson where the land is lower, it will be necessary to excavate drainage ditches to connect the low lying areas to the drainage streams located beyond the height of land.

Alternative dyke alignments were evaluated and the preferred alignments were selected in order to:

- Minimize creek crossings;
- Reduce the maximum height of the dykes and reduce fill volumes;
- Minimize forebay clearing and flooding;
- Minimize the impact on moderately sensitive habitats;
- Avoid impacting the white birch habitat at Borrow N-6; and
- Provide adequate drainage management.

4.5.1.8 SOUTH ACCESS ROAD

Once the Project begins operations, staff are expected to reside in Gillam and commute approximately 35 km daily from Gillam, using the south access road. Staff may also commute from approximately 72 km from Split Lake, using the north access road. By commuting, staff will be able to live with their families, thereby increasing staff morale and retention.

In 2005, a committee was formed to evaluate various routes for the south access road. The committee consisted of representatives from the KCNs, Manitoba Hydro, Manitoba Infrastructure and Transportation, and engineering, environmental, socio-economic and heritage resource consultants working on the Project. Three alternative routes were identified within a corridor that extended from the western terminus of the Butnau Dyke to the south shore of the Nelson River at the south dam axis.

The committee recommended the most southerly option of the three alternative routes, primarily because it minimized the number of stream crossings, was the shortest route and had the least impact on sensitive **terrestrial habitats**. An additional adjustment was subsequently made to the extreme westerly portion of the route to take advantage of more favourable terrain and minimize costs.

A further adjustment to the route was made during the final design stage. The road was moved off the Butnau Dam due to driver safety, dam safety and costs (construction and maintenance).

4.5.1.9 EXCAVATED MATERIAL PLACEMENT AREAS

Approximately 4.2 million m^3 of unclassified materials will be produced, primarily from excavations for the north and south dykes, the principal structures, potential channel improvements and removal of cofferdams. Contractors will develop their own plans to dispose of excavated materials, working within constraints and guidelines imposed upon them by the proponent and/or regulatory agencies.

An inventory of 50 areas that would be potentially suitable for the disposal of unclassified excavated material was first developed based on a preliminary material balance plan (shown in Map 4-6). The initial 50 EMPAs were generally selected from low lying areas in close proximity to the excavations. Selection criteria were established by the engineering and environmental teams on the basis of cost, construction logistics and environmental impact. The environmental considerations included an assessment of the quality of terrestrial and aquatic habitats, sensitive areas, and adjacent habitats that would be impacted or that would benefit from opportunities provided by the EMPAs. The inventory of 50 EMPAs was reduced to 35 EMPAs areas following a preliminary review and ranking by the project team. These 35 EMPAs will be made available for use by contractors.

4.5.2 ALTERNATIVE MITIGATION MEASURES

In addition to the mitigation measures outlined in this section, a wide range of specific mitigation measures have been considered to address individual aquatic, terrestrial, socio-economic, heritage resources and resource use Project effects. The alternative measures, as well as the approach to developing them, are described in the PD SV.

4.5.2.1 AQUATIC ENVIRONMENT

During the environmental assessment for the aquatic environment, a range of options for mitigating effects to the aquatic environment was investigated. Emphasis was placed on mitigating effects that were predicted to have marked effects on environmental components of particular importance (*i.e.*, VECs including **water quality**, lake whitefish, northern pike, walleye and lake sturgeon).

Aquatic mitigation measures were developed in consultation with the Project engineers, aquatic specialists and the KCNs Partners.

Measures were discussed with the multilateral Keeyask Aquatic Working Group, a technical working group comprised of KCNs community Members and technical advisors, Manitoba Hydro representatives, and environmental consultants working on the technical aquatic studies for the Project. Measures were also presented to representatives of Fisheries and Oceans Canada (DFO) and Manitoba Conservation and Water Stewardship. The consultation resulted in the selection of the mitigation measures outlined in Section 4.3.3. The evaluation of alternatives is described in the Aquatic Environment SV.

4.5.2.2 TERRESTRIAL ENVIRONMENT

A range of terrestrial mitigation measures were developed in consultation with the Project engineers, terrestrial specialists and the KCNs communities. Mitigation concepts were reviewed by the engineers for technical feasibility and costing purposes, as a first step to determining whether an option should be developed further. Mitigation concepts were also presented to and discussed with the multilateral Keeyask Mammals Working Group (MWG), a technical working group comprised of KCNs community Members and technical advisors, Manitoba Hydro representatives, and environmental consultants working on the technical terrestrial studies for the Project.

While the focus of the MWG was on caribou, a key terrestrial topic and valued environmental component (VEC) for the environmental assessment, mitigation options for terrestrial habitat, birds and other mammals were also discussed through this technical working group. These discussions resulted in the selected mitigation measures identified in Section 4.3.3 and discussed in greater detail in the Terrestrial Environment SV.

4.5.2.3 SOCIO-ECONOMIC ENVIRONMENT

In addition to provisions in the JKDA, AEAs and Burntwood Nelson Agreement (BNA), specific mitigation measures have been developed during the Project planning process to address other VECs with regard to socio-economic, resource use and heritage resources components.

A multilateral Mercury and Human Health Technical Working Group was established by the EIS Coordinators to deal with concerns and mitigation measures regarding mercury and human health. Issues relating to other VECs that were raised from KCNs community Members through key person interviews and meetings were pursued in a variety of ways, resulting in consideration of a range of mechanisms. The selected measures are identified in Sections 4.3.3 and 6.6.

4.6 PROJECT CONSTRUCTION

4.6.1 CONSTRUCTION SCHEDULE

Construction of the Project is scheduled to begin in 2014 and be completed late 2022. However, it is important to note that some construction activities are seasonally sensitive, and delays of a few weeks during critical periods have the potential to result in a loss of a year to the schedule. The following section outlines key Project phases and main activities. It also outlines the most current estimate for the staging of these Project phases within the construction schedule. This schedule is based on the proponent's current estimates and assumptions regarding the workforce, equipment fleet and construction methodology and durations.

The sequencing of Project phases, staging and main activities during the construction of the Project is illustrated in Figure 4-5. To the extent practical, the construction schedule has been developed to avoid or reduce work activities during sensitive periods for aquatic and wildlife periods, as discussed in Chapter 6, Effects Assessment.

4.6.2 INSTALLATION OF ICE BOOM

An access trail will be used to transport workers and equipment to a boat launch located on Gull Lake. Individual sections of the ice boom will be offloaded by a mobile crane and pre-assembled in the water near the shore.

Anchors will be installed into the riverbed through holes drilled from a barge in open water. The pre-assembled sections of the ice boom will be transported on the river by boat or barge, and divers will use a steel cable system to connect the ice boom to the anchors.

The ice boom location is shown on Map 4-4.

4.6.3 RESERVOIR CLEARING

Much of the reservoir will be cleared prior to impoundment in 2019, the majority of it during the winter seasons, starting in winter 2014/15. Lands closest to the existing shoreline will be cleared last, as close as possible to the date of reservoir impoundment, thereby providing a natural **buffer** between the construction activities and the water body.

Approximately 3,600 ha of the reservoir will be cleared to an elevation of about 159 m. Standing woody material, which includes dead and living trees and shrubs 1.5 metres tall or taller, as well as all fallen trees 1.5 metres or more in length with a diameter of 15 centimeters (cm) or greater at its largest point, will be cleared. Most of the clearing will be undertaken with heavy machinery. Hand clearing will be undertaken in areas that are designated sacred, cultural or heritage sites, areas that are environmentally sensitive, areas where trees are being salvaged for firewood or building materials, areas within 10 m of the existing normal high water mark on the Nelson River and within 5 m of tributary banks, and areas not accessible to heavy equipment (Map 4-15). Selected locations will not be cleared if they are deemed to provide environmentally sensitive habitat. A Waterways Management Program, as discussed in Section 6 and the PE SV, will be applied to facilitate safe use of the waterway during construction.

4.6.4 SITE PREPARATION AND SUPPORTING INFRASTRUCTURE

Initial construction activities will involve site preparation and establishing infrastructure required to construct the Project, including the camp, ice boom and cofferdams. Initial site preparation will consist mainly of clearing and grubbing. This clearing will be undertaken with heavy machinery. Organic material removed during the clearing and grubbing will be stockpiled and some will be used later in the rehabilitation of borrow sites, temporary roads and excavated material placement areas.

4.6.5 EXCAVATIONS

Large volumes of overburden or rock will be excavated at the powerhouse, spillway, dams, dykes and quarries using heavy equipment. Excavated materials will be stockpiled for reuse or moved to excavated material placement areas. Organic material removed during the excavation will be stockpiled and used in the rehabilitation of borrow sites.

Explosives will be used to break up rock so that it can be removed using heavy machinery. Blasting activities will follow DFO guidelines for use of explosives. The use of dynamite is planned for blasting where the final rock face will be in contact with water. Ammonium nitrate fuel oil will be used for all other blasting.

Surface water, snowmelt and seepage entering excavations and cofferdams will need to be pumped as required. The water will be discharged into the river when the total suspended solids (TSS) are below Manitoba Surface Water Quality Objectives, Standards and Guidelines (Manitoba Water Stewardship 2011) of 25 mg/L total suspended solids. If the water has a TSS concentration that exceeds 25 mg/L, the water will be pumped into settling ponds to further reduce the TSS, and the clarified effluent will be discharged into the river when the TSS is below 25 mg/L. Section 4.6.8 provides details of the settling ponds.

4.6.6 ACCESS ROADS DURING CONSTRUCTION

The north access road will be the main access route for hauling materials and equipment and transporting workers to the generating station construction site. It will be operated and maintained as a private road during construction.

The south access road will be constructed between December 2014 and October 2015. Road construction methods will follow the latest revision of the Standard Construction Specifications for Grading and Surfacing Works from MIT. The roadbed for the south access road will be constructed using impervious fill from an impervious borrow area south of the Nelson River and granular fill, road topping and rip rap will be produced by crushing rock and screening at one of the quarries. Construction of the roadbed in wetland areas will utilize geotextile material with clean granular fill progressively dumped over the geotextile along the road alignment. Where the road traverses an area of discontinuous permafrost, the roadbed within these areas will be constructed by using granular fill material and geotextile placed directly on top of the unstripped **peat**.

The "National Guide to Erosion and Sediment Control on Roadway Projects (Transportation Association of Canada 2005)" and the Manitoba Stream Crossing Guidelines for Protection of Fish and Fish Habitat (Manitoba Natural Resources and DFO 1996) will be applied to minimize erosion and sediment when constructing access roads.

Known heritage resource sites and environmentally sensitive areas to be avoided will be identified in environmental protection plans in advance of construction. All borrow pits will be sited at least 100 m from active stream channels.

The south access road will cross four streams as shown in Map 4-11. The stream crossings will consist of single or double corrugated metal pipe culverts. Culverts will be designed to provide fish passage as required. The existing crossing at the Butnau River immediately downstream of the Butnau Dam will be widened to meet MIT's design requirements for provincial roads.

The public will not have access to the Project sites, including the north and south access roads, while the Project is being constructed. Details for site access and security are in Section 4.6.13.

4.6.7 Construction of Cofferdams

The sequence of cofferdam construction is shown on Map 4-16, Map 4-17, and Map 4-18. Nine cofferdams and two rock groins will be constructed for the Project in two stages. All but one of the cofferdams will be constructed "in the wet" by progressively dumping rockfill or gravel from the shore along the alignment of the cofferdam. Either single or dual groins of rockfill will be built before the placement of the finer granular materials to seal the cofferdam.

Stage I diversion, which includes six cofferdams and the north channel rock groin, will direct the entire flow of the Nelson River to the river's south channel, facilitating construction of the powerhouse, spillway, north and central dams (Map 4-16). Stage II diversion, which includes an extension of the island cofferdam and construction of the south dam cofferdam, will divert the entire flow of the Nelson River through the partially completed spillway, facilitating construction of the south dam (Map 4-16 and Map 4-17).

4.6.8 Production of Concrete and Aggregate

A concrete **batch plant** in the contractors' work area will be mobilized for the Project. It will be used to manufacture approximately 362,000 m^3 of concrete required to construct the Project. The contractor will be responsible for determining the layout and installation of the concrete production facilities within the contractors' work area. A typical batch plant mixes water, cement, aggregates and additives to produce concrete. Water will be obtained from the Nelson River near the batch plant via a small pumphouse, complete with screens that are constructed in accordance with the Freshwater Intake End-of-Pipe Screen Guidelines (DFO 1995). The amount of water withdrawn for batch plant use will be very small relative to the flow in the river and a provincial water rights licence will be obtained. The cement will be delivered to site by truck throughout the duration of the Project and may be stored temporarily in silos located adjacent to the batch plant.

Aggregates for the concrete will be produced by crushing, screening, washing and stockpiling bedrock obtained from a quarry, as well as granular material obtained from one or more of the granular deposits. In order to produce concrete during the winter months, a heating system will be used to maintain the aggregate at suitable temperatures. No heated water will be discharged directly into the river. Wash water for the **concrete aggregate** and batch plant will go into a multi-cell settling pond to reduce suspended solids. The pond will be located in an area of relatively impermeable soil or the ponds will be lined with clay or a synthetic liner to avoid seepage into the groundwater. The larger particles will settle out in the primary cell and the finer ones in the secondary. If required, baffles will also be used to facilitate the settling of sediment in the ponds. The clarified effluent will be discharged into the river when the total suspended solids are below (Manitoba Water Stewardship 2011) of 25 mg/L total suspended solids. The discharge will not be continuous.

4.6.9 CONSTRUCTION OF POWERHOUSE

Construction of the powerhouse will begin with overburden and rock excavation followed by foundation preparation. Approximately 1,100,000 m^3 of overburden and 1,580,000 m^3 of rock will be excavated in the powerhouse area, intake channel, and tailrace channel. The placement of concrete will start in the summer of 2016 and will continue over a four year period. The powerhouse complex, consisting of the intakes, powerhouse, tailrace and service bay structures, and an associated wall and transition structures will require the placement of approximately 305,000 m^3 concrete and installation of 7,000 m^3 of precast concrete.

Erection of the steel superstructure for the metal clad powerhouse building will commence after the concrete structure has advanced beyond elevation 152.0 m. Once the superstructure is well underway the contractor will start to enclose it with insulated metal cladding. The building will be completed in two stages, with the outer shell of units 1 to 4 and the service bay being totally enclosed by the end of 2017. This will permit completion of the installation of the two powerhouse overhead traveling cranes essential for the installation of the turbine embedded parts. Once the first section of the powerhouse is enclosed embedment of the turbine parts, construction of the concrete semi-spiral scroll case roofs, and installation of the generating equipment and its associated control equipment will carry on year round. The remaining three units within the powerhouse will be enclosed by the end of 2018.

The first unit will be ready for operation early in November 2019. Each additional unit will be brought on line at two-month intervals, with the last unit being placed into service in December, 2020. Typical powerhouse cross-section is shown in Figure 4-6.

4.6.10 CONSTRUCTION OF SPILLWAY

Construction of the spillway will begin with overburden and rock excavation followed by foundation preparation. Approximately 17,200 m^3 of overburden and 400,000 m^3 of rock will be excavated in the spillway area, approach channel and discharge channel. The placement of concrete will start in the summer of 2016 and will be completed in the following construction season. Approximately 58,000 m^3 of concrete will be placed in the spillway structures and installation of 1,000 m^3 of precast concrete.

Concrete work on the spillway structure will start with construction of the base slabs and then progress to the piers and a road deck. This work will also include the construction of transition structures and associated walls at either end of the spillway structure to tie in with the central and south dams. As the concrete work is nearing completion, towers and overhead bridges will be erected to support the hoists and the spillway gates. Installation of the spillway gates will be the last major step in the construction of the spillway as a control structure.

Initially, the spillway will serve as a sluiceway when the river is diverted through the structure at the start of Stage II diversion in the fall of 2017. Prior to impounding in 2019, construction of the rollways will commence in four of the spillway bays and will continue late into the fall. The remaining three rollways will be constructed in the following summer, after the first units are on line.

4.6.11 Construction of North and South Dykes

The north and south dykes will be constructed with fill materials placed and compacted in layers of specified thickness. The north and south dykes will generally be founded on **glacial till** overburden containing discontinuous permafrost. The overburden will be excavated to the founding levels during the winter season and covered by granular fill to act as an insulating cover to prevent the permafrost from thawing.

Approximately 593,000 m^3 and 620,000 m^3 of overburden materials will be excavated for the north and south dykes, respectively, and 1,310,000 m^3 and 1,500,000 m^3 of fill will be placed, respectively. Cross sections of the dykes are shown in Figure 4-7.

4.6.12 Construction of North, Central and South Dams

Similar to the dykes, materials for the construction of the dams will be largely derived from excavations and from quarries and borrow deposits. Construction of the north, central and south dams will require the excavation of approximately 100,000 m^3, 600,000 m^3 and 67,000 m^3 of overburden materials, respectively, and the placement of 200,000 m^3, 1,500,000°m^3 and 500,000 m^3 of fill, respectively. Cross sections of the dams are shown in Figure 4-7.

4.6.13 Public Access and Site Security

Public access to the Project site will be restricted, including the north and south access roads, while the Project is being constructed. However, consideration will be given to resource users who normally use the general area. To facilitate this process, a Construction Access Management Plan (AMP) will be developed in consultation with local resource users.

Security will be maintained at the junction of PR 280 and the north access road to manage access by the public. For similar reasons once the south access road is complete, security will be maintained near the Butnau Dam. Access control for the south and north access roads will consist of gates and gatehouses staffed by security personnel.

Boat launching facilities upstream and downstream of the generating station (shown on Map 4-9) will be accessible to the public only for emergency purposes.

Following are additional measures to mitigate or avoid risks to public:

- Warning signs will be posted at a number of locations;
- Buoys will be installed upstream and downstream of the construction site;
- An ice boom and several safety booms will also be installed; and
- Designated winter safe trails will be developed and maintained at a safe distance from the construction zone.

An on-site safety supervisor, reporting to the Project Manager, will be employed during the construction phase to assure that staff receives safety training and that contractors comply with the required regulations. As well, contractors will have their own safety officer(s). Monthly reports will be provided as well as reports for any incidents. Site emergency response programs, which include notification by siren or radios, evacuation procedures, identification of assembly points and escape routes, will be developed to address situations that may occur during the construction period. For example, emergency plans will be established, updated and practiced to assure that people working within the cofferdams are familiar with the appropriate evacuation procedure. A helicopter landing area will be located at the work site to provide a means for emergency access and egress.

Security officers will provide roving security and fire watch patrols throughout the camp and work areas and related facilities.

No personal firearms will be permitted on the Project site.

Camp rules will govern the behaviour of workers lodged at the camp.

4.6.14 WATER AND WASTEWATER TREATMENT

Water for the camp will be obtained from a well and will be treated in a packaged treatment system to meet the Drinking Water Safety Regulation (2007) and Drinking Water Quality Standards Regulation (2007).

The water treatment system will be designed to meet peak potable water consumption. Water from the water treatment plant will be pumped via pipelines to supply water for domestic consumption and fire protection to the camp and office areas. Freeze protection for the pipelines will be provided. Filtered backwash from the water treatment plant operations will be discharged to the Nelson River.

Wastewater will be treated in a packaged plant installed as part of the KIP. The treated wastewater effluent will discharge into the Nelson River. The effluent will meet Manitoba Conservation's Tier 1 Water Quality Standards for municipal wastewater effluent discharged to a water body. Effluent quality will meet or exceed Manitoba's standards of 200 fecal coliform organisms/100 mL for fecal coliform, 25 mg/L for **biochemical oxygen demand** (BOD) and 25 mg/L for total suspended sediments (TSS). Wastewater sludge will be dewatered and hauled to an approved landfill for disposal.

4.6.15 RESERVOIR IMPOUNDMENT

Reservoir impoundment to elevation 159.0 m is expected to commence in August 2019 and be completed by October 2019. The rate of water level rise at the principal structures will be limited to 0.5 m to 1.0 m per day however water level changes will likely be smaller on most days. A modest reduction of 100-300 m^3/s to the spillway discharge would be required to fully impound the reservoir by the target date. This is equivalent to approximately 3-10% of the average monthly discharge of the Lower Nelson River at Keeyask. During reservoir impoundment all flow will pass through various spillway bays as rollways are being constructed. The majority of the 45 km^2 flooded area is expected to develop during the reservoir impoundment period. Boat patrols operating under the waterways management program will monitor the reservoir during impoundment and remove woody debris that may present a hazard to navigation or impact Hydro's operations. Large debris is not expected because the reservoir will be cleared prior to impoundment. The PE SV provides details of the expected water level changes during reservoir impoundment as well as details about the anticipated debris.

4.6.16 DECOMMISSIONING OF TEMPORARY INFRASTRUCTURE

Once all concrete is poured and structural steel erected, the batch plant and relevant work areas will be dismantled. Much of the decommissioning of the temporary infrastructure will begin after the generating station is constructed. Decommissioning will involve:

- Removal of specific roads and buildings;
- Collection and disposal of any remaining wastes, recyclables and hazardous materials;
- Closure of the landfill;
- Removal of water intake and sewage treatment facilities; and
- Rehabilitation of borrow and material placement areas.

A portion of the area required for the camp and work areas will be required for long-term operations. The remaining area will be rehabilitated to the degree practical. A detailed decommissioning and rehabilitation plan for infrastructure not required for the operation of the Project will be developed during the construction phase and provided to regulators for review and approval. Wherever practical in developing the plan, consideration will be given to using principles that give regard to the KCNs concern for respecting the land.

4.6.17 CONSTRUCTION WORKFORCE AND CONTRACTS

This section describes the work packages and contracts, workforce requirements, and special hiring and training features of the construction phase of the Project.

4.6.17.1 EMPLOYMENT, HIRING AND TRAINING

The construction phase of the Project will provide employment opportunities for KCNs Members, residents of the Churchill, Burntwood and Nelson (CBN)[1] area, northern Aboriginal residents, and other candidates.

Total northern Aboriginal employment (including KCNs and CBN employment) is estimated (Socio-economic SV Section 3.4.1) to be in the range of 550 and 1,700 persons years of employment depending on the influence of factors such as a attraction to project jobs, availability for project employment and qualifications for meeting job requirements. More detailed employment estimates, for both high- and low-estimate scenarios for the Project construction phase, are provided in Table 4-3 and Table 4-4.

To prepare Aboriginal people for jobs on the Project, a multimillion-dollar training initiative, the Hydro Northern Training and Employment Initiative (HNTEI), was carried out over a nine year period, ending in 2010. The program was administered by the Wuskwatim and Keeyask Training Consortium Inc.

[1] The CBN area is defined in the Burntwood Nelson Agreement Schedule D, and includes northern Aboriginal people and other residents who reside along the Churchill, Burntwood and Nelson rivers (see SE SV Section 3.2.1).

Table 4-3: Construction Phase Estimated Total Employment in the Keeyask Generation Project – High Employment Estimate

Employment	High Employment Estimate (Person-Years)									
	Construction Support		Non-Designated Trades		Designated Trades		Manitoba Hydro and Supervisory		Total	
Total KCN Participation	325	8%	170	4%	95	2%	10	<1%	600	14%
Total CBN (incl. KCN)	510	12%	420	10%	230	5%	35	1%	1,195	28%
Total Northern Aboriginal (incl. CBN)	750	18%	535	13%	310	7%	105	2%	1,700	40%
Non-Northern Non-Aboriginal	152	2%	442	10%	1,061	25%	963	23%	2,618	60%
Total Demand	852	20%	952	23%	1,346	32%	1,068	25%	4,218	100%

Source: Workforce estimates derived from data provided by Manitoba Hydro, 2010. Analysis prepared by InterGroup Consultants Ltd. 2012.

Notes:

- Numbers are subject to rounding. Actual results will vary from estimates provided here.

Table 4-4: Construction Phase Estimated Total Employment in the Keeyask Generation Project – Low Employment Estimate

Employment	Low Employment Estimate (Person-Years)									
	Construction Support		Non-Designated Trades		Designated Trades		Manitoba Hydro and Supervisory		Total	
Total KCN Participation	125	3%	45	1%	55	1%	10	<1%	235	6%
Total CBN (incl. KCN)	160	4%	100	2%	95	2%	35	1%	390	9%
Total Northern Aboriginal (incl. CBN)	225	5%	115	3%	105	2%	105	2%	550	12%
Non-Northern Non-Aboriginal	652	15%	842	20%	1,241	29%	963	23%	3,698	88%
Total Demand	852	20%	952	23%	1,346	32%	1,068	25%	4,218	100%

Source: Workforce estimates derived from data provided by Manitoba Hydro, 2010. Analysis prepared by InterGroup Consultants Ltd. 2012.

Notes:

- Numbers are subject to rounding. Actual results will vary from estimates provided here.

4.6.17.2 CONSTRUCTION WORK PACKAGES AND TYPES

It is anticipated that construction of the Project will be organized around various individual work packages, each having separate contracts and contractors. Some packages will be negotiated with the KCNs; others will be available for public tender, as follows:

- **Direct Negotiated Contracts** (DNCs) – The JKDA lists contracts that will be offered to the KCNs on a directly negotiated basis, without having to go through the tender process. Businesses or joint ventures that are at least 50% owned and controlled by one or more of the KCNs can be awarded these contracts based on terms agreed upon with Manitoba Hydro. Table 4-5 summarizes the contracts to be negotiated with the KCNs as identified in the JKDA.
- **Tendered Contracts** (TCs) – The remainder of the construction will be offered as tendered contracts (TCs). These contracts will be available for competitive bids by qualified contractors.

DNCs for the Keeyask Generation Project are listed in Table 4-5.

Table 4-5: Direct Negotiated Contracts for the Keeyask Generation Project

Code	Contracts	KCNs Allocation
	SERVICE CONTRACTS	
SC-1	Catering	FLCN and YFFN
SC-2	Camp Maintenance Services	CNP
SC-3	Security Services	FLCN and YFFN
SC-4	Employee Retention and Support Services	FLCN and YFFN
SC-5	First-Aid Services	CNP
	CONSTRUCTION CONTRACTS	
IC-2	Main Camp (Phase II only) Site Preparation and Development	CNP
IC-5	Main Camp - Decommissioning	CNP
IC-8	South Access Road Construction	CNP
PS-1	Forebay Clearing	CNP
PS-2	Painting and Architectural Finish	CNP
PS-5	Rock and Unclassified Excavation	CNP

Source: JKDA, Schedule 13-1, 2009.

4.6.17.3 WORKFORCE OVERVIEW

Construction of the Project will require a large workforce comprised mainly of experienced workers, apprentices and labourers across a wide variety of designated[1] and non-designated trades and construction support positions.

4.6.17.4 WORKFORCE SIZE AND COMPOSITION

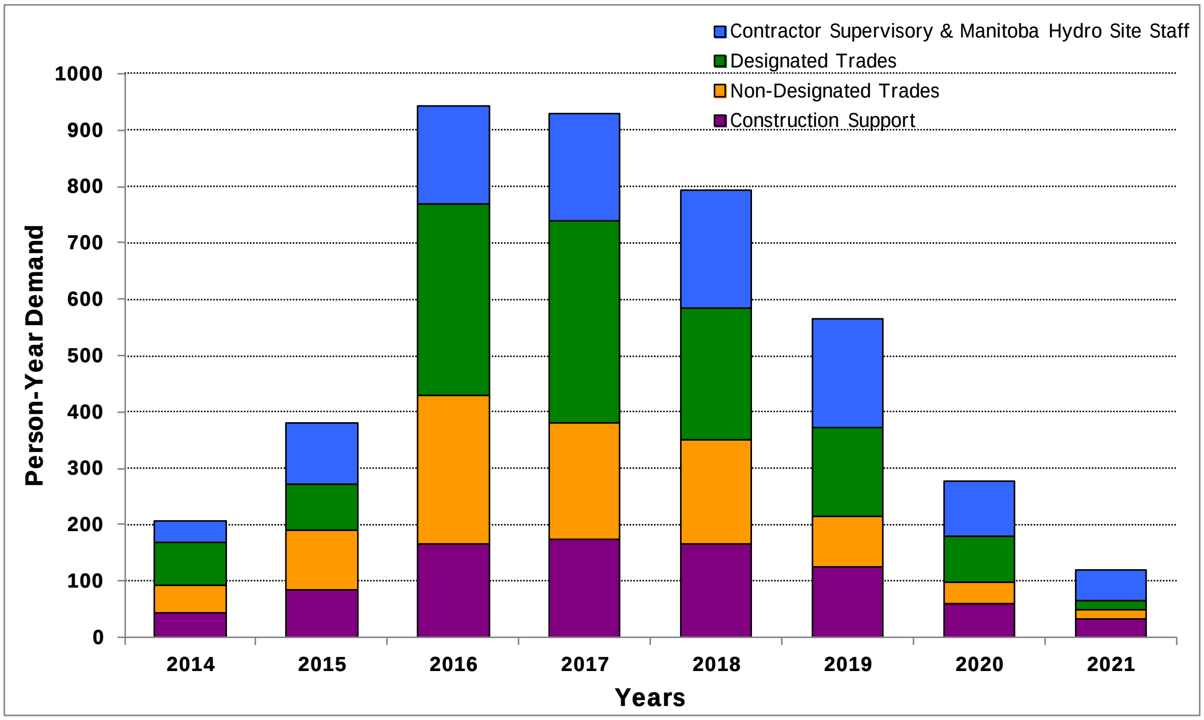
Workforce size and composition will change continually throughout the construction stage. The construction workforce size and composition are commonly measured by the following two criteria:

- Quarterly or yearly peak employment measures the greatest number of workers required during each quarter or year of construction. Peak employment analysis is most useful for understanding the number of people affected by Project employment opportunities.
- **Person-years** of employment summarizes full-time equivalent employment. Person-years analysis is most useful for understanding the level of economic benefits arising from Project employment opportunities. One person-year is defined as 12 months of

[1] Designated trades are occupations that have formal apprenticeship programs that provide supervised training leading to certification as a fully qualified journeyperson in the trade. Apprenticeships in the designated trades typically entail four or more years of in-class technical training and on-the-job work experiences. Examples include carpenters and electricians.

employment by a person. As an example, one person-year could consist of one person working at a job for 12 months. Alternatively, one person-year could consist of two people working two different jobs for six months each. The months of employment may be in any job and do not need to be consecutive.

A breakdown of the person-years of construction employment that will be generated by the Project is shown in Figure 4-8.



Source: Derived from data provided by Manitoba Hydro, 2010.

Figure 4–8: Construction Phase Estimated Workforce Requirements (Person-Years) for the Keeyask Generation Project

The workforce estimates are based on construction employment from 2014 to 2021. The additional employment related to camp decommissioning and site rehabilitation in 2022 has not been factored into the analysis; however, the numbers associated with this activity are very small and will not change the conclusions of the analysis.

4.6.17.4.1 WORKFORCE VOLUME (PERSON-YEARS ANALYSIS)

The Project is expected to generate 4,218 person-years of employment, as shown in Table 4-6. Designated trades, non-designated trades, and construction support are expected to account for 3,150 person-years, with another 1,068 person-years generated by Manitoba Hydro and key contractor personnel.

Table 4-6: Construction Workforce Requirements by Job Category

Job Category	Person-Years	Percent of Total
Designated Trades	1,346	32%
Non-Designated Trades	952	23%
Construction Support	852	20%
Manitoba Hydro and Contractor Supervisory	1,068	25%
TOTAL	4,218	100%

Source: Derived from data provided by Manitoba Hydro, 2010.

4.6.17.4.2 CONSTRUCTION PHASE ESTIMATED GROSS EMPLOYMENT INCOME ANALYSIS

Table 4-7 provides a summary of estimated gross employment income that would accrue to KCNs, CBN and Northern Region workers during the construction phase. These estimates are provided for all contracts (DNCs and TCs) and have been presented for two scenarios: high and low wage ranges. Methodological details regarding these wage ranges are provided in Section 3 of the SE SV.

Table 4-7: Construction Phase Estimated Gross Employment Income Earned

	Gross Employment Income (in millions of dollars)	
	High Employment Estimates	Low Employment Estimates
KCNs	$62.2	$21.6
CBN Region (includes the KCN)	$127.8	$36.3
Northern Region (includes the CBN)	$180.1	$48.5

Sources:

- Workforce estimates provided by Manitoba Hydro, 2010.
- Wage rates derived from BNA (Hydro Projects Management and Allied Hydro Council of Manitoba 2009).
- Analysis prepared by InterGroup Consultants Ltd., 2012.

Notes: Numbers are subject to rounding. Actual results will vary from estimates provided here.

4.7 PROJECT OPERATION

Manitoba Hydro will be contracted by the Partnership to operate the Project once construction is completed. The Project will operate as part of the Manitoba Hydro hydraulic system within the constraints of licenses granted for its facilities, including those for the

Lake Winnipeg Regulation and Churchill River Diversion Projects, as discussed in Section 6.2.2.3 (History of Hydro Development).

The operation of LWR and CRD determines the seasonal flow patterns that occur on the Nelson and Burntwood rivers, and consequently the flows available for generation at the Kettle, Long Spruce, and Limestone generating stations, as well as the Wuskwatim Generating Station (currently under construction) and the proposed Keeyask Generating Station. The fundamental purpose and operation of the LWR and CRD projects will not change as a result of the construction of the Project.

4.7.1 MODES OF OPERATION

The Project will operate as a modified peaking plant, meaning that it will operate either in a peaking mode or a base-loaded mode. The extent by which the Project will be operated in a base-loaded mode or a peaking mode will be determined by the flows in the Nelson River and the requirements of the Manitoba Hydro integrated power system to meet the power demands at that time.

There may be occasions when the Project will be required to operate in a special or emergency mode of operation. Special conditions include load rejection (units tripping off due to mechanical, transmission or other problems), flood management, or meteorological events. Emergency conditions include a risk of imminent failure of one of the dams or dykes or when the flow passing through the station needs to be halted temporarily.

When the Project operates in a peaking mode, water stored in the reservoir will be used to augment Nelson River inflows so that maximum power can be generated during the weekday on-peak periods to coincide with peak power demand. At night, when demand for power is lower, flow through the station will be reduced to store water in the reservoir for use the following day, resulting in an overnight increase in the reservoir level. During weekends, flows through the station will be reduced to fill the reservoir to the FSL by the following Monday morning. The reservoir may fluctuate up to 1.0 m in one day between the FSL and the MOL during a peaking mode of operation. When the Project operates in a base-loaded mode, the reservoir will remain relatively stable at or near the FSL and the outflow from the station will be approximately equal to the inflow. The volume of water available in the reservoir for a peak mode of operation is 81.4 million m^3 when the reservoir is at its full supply level. During the first 30 years of operation the reservoir is predicted to expand by 7-8 km^2 due to the erosion of mineral shoreline and peatland disintegration. Reservoir storage would increase to 84.9 – 85.4 million m^3. Based on historic flow records since the LWR and CRD have been in operation, the Project could operate in a peaking mode up to about 88% of the time.

There will be two potential constraints on the mode of operation to mitigate environmental effects. The first potential constraint would be a minimum plant discharge equal to two units at best gate setting and five units closed during the lake sturgeon spring-spawning period to ensure sufficient water velocities exist in the sturgeon spawning areas to be constructed downstream of the powerhouse. The results of monitoring will be used to assess if this constraint is required or if the spawning shoal requires modification. The second constraint would be applied if monitoring shows that lake sturgeon eggs are deposited downstream of the spillway during its operation and requires that the spillway discharge be maintained at levels sufficient to permit egg hatch and survival of larval fish until they emerge and drift from the site (see Section 6.4.6.2.2).

The surface water and ice regimes during operation are described in Section 6.3. The existing environment and post-Project environment shorelines (at FSL) and water surface profiles for open water conditions are shown in Map 4-3.

4.7.2 HYDRAULIC ZONE OF INFLUENCE

The operation of the Project will affect water levels both upstream and downstream of the Project. Map 4-3 illustrates the spatial extent of the open water hydraulic zone of influence of the Project. During open water conditions, the backwater effects created by the Project will partially inundate Birthday Rapids and cause some increases in water levels upstream of Birthday Rapids, but will not affect the water level on Clark Lake and Split Lake during open water conditions. The upstream boundary of the hydraulic zone of influence of the Project will be located between the outlet of Clark Lake and Birthday Rapids; its specific location at any particular moment being dependent on the forebay level and inflow conditions. When the Project is operating in a peaking mode, the water level upstream of the Project could fluctuate as much as 1 m within a 24-hour period. The water level downstream of the powerhouse will be primarily dependant on the level of Stephens Lake. Due to varying outflow from the Project, water levels between the station and Stephens Lake will fluctuate a small amount within any given day and will be limited to the tailrace area.

During winter conditions, the reservoir will resemble a lake environment, similar to the conditions found on Stephens Lake. At the onset of winter, it will develop a **thermal ice cover**, which will extend approximately 25 km upstream of the station. Currently, anchor ice restricts river flows and causes upstream water levels to rise on both Clark Lake and Split Lake every winter. At present, anchor ice formation at the outlet of Clark Lake typically leads to water level increases on both Clark Lake and Split Lake of up to 0.6 m every winter. There may be a possibility that peak Split Lake winter water levels could increase by up to 0.2 m during infrequent (1 year in 20) low flow conditions due to the Project. Should this occur, resulting winter water levels would still be well within the range of winter levels experienced in the existing environment on Split Lake since CRD and LWR have been in operation. An open water area immediately downstream of the powerhouse will exist throughout the winter, due in part to the continued turbulence in this area. The ice cover downstream of the Project and into Stephens Lake throughout the winter will resemble an ice cover typically found on lakes. The Project will prevent the formation of the ice dam that typically develops at the base of Gull Rapids and into Stephens Lake.

4.7.3 VEGETATION AND DEBRIS MANAGEMENT

As noted previously, some shoreline areas will erode and some peatland areas will disintegrate after initial flooding, adding approximately 7 to 8 km^2 to the reservoir area in the first 30 years after it is created. Areas that will convert from land to water over time as a result of peatland disintegration and shoreline erosion will be cleared on an ongoing basis through the implementation of the Waterways Management Program (Appendix 4B).

Vegetation management, including landscaping, erosion controls, insect control and drainage management will be undertaken for rights-of-way, fire breaks (fire guards), station yards and earth-fill dams. Mechanical means of vegetation control will be the preferred method, and chemicals will be used only if mechanical methods are unsuccessful and only when authorized by the appropriate authorities.

4.7.4 OPERATING AND MAINTENANCE PROCEDURES AND REGULATORY COMPLIANCE

Manitoba Hydro, on behalf of the Partnership, will operate the generating station in accordance with the terms and conditions of authorizations under the *Navigable Waters Protection Act* (Canada), the *Fisheries Act* (Canada), *The Environment Act* (Manitoba) and *The Water Power Act* (Manitoba), as well as any other regulatory requirements that may apply.

Manitoba Hydro has an ISO 14001-registered environmental management system that covers all of its generating facilities and it is expected that the Project will be included in that registration. Manitoba Hydro has also implemented a Safety Management System to achieve occupational health and safety objectives, to increase safety awareness in the workplace and to avoid or reduce workplace accidents. Existing procedures and codes of practice cover environmental management, workplace safety, emergency preparedness, public access safety, and spill response. Site-specific procedures will be developed for other operational activities.

During normal operations, petroleum products will be stored within the powerhouse with appropriate spill containment and inventory control and documentation. Wastewater will be treated to meet or exceed regulatory requirements. Treated effluent outflows will be monitored by staff. Potable water for use at the Project will be treated and monitored to meet regulatory requirements. Wastes will be stored in protected areas to reduce the potential for unsafe conditions and negative aesthetic impacts. Wastes will be hauled to a licensed landfill for disposal. Non-hazardous waste will be diverted from landfills when practical for reuse and recycling. Hazardous wastes will be stored in approved bins, handled, transported and disposed of in compliance with regulatory requirements.

Periodically plant equipment such as turbines, generators and transformers will need to be overhauled or replaced at the end of their useful life. Leaks, mechanical failures and reduced performance will be recorded and remedial actions taken as needed. Systems for heating and ventilation, domestic and station water, wastewater treatment, drainage, compressed air and oil storage will need to be overhauled or replaced as required. Exterior structures exposed to the elements will be maintained and replaced as required and appropriate precautions will be taken to ensure that harmful substances do not enter the aquatic environment. Concrete structures and earth-fill structures will require infrequent maintenance.

4.7.5 MAINTENANCE OF ROADS AND STREAM CROSSINGS

During the operation of the Project, the generating station site and roads to the dykes and selected borrow areas will require regular, year-round maintenance. Activities will include road inspection, repair, erosion control, dust control, snow removal, and maintenance of ditches and culverts.

Once the Project goes into operation, the north and south access roads will be connected by a permanent river crossing over the Project's north dam, powerhouse, central dam, spillway and south dam. MIT has indicated it will assume the responsibility to maintain these roads as part of the provincial transportation system. Once the Partnership has completed construction of the new permanent road from PR 280 to Gillam via the Keeyask generating station, MIT intends on abandoning the north eastern section of PR 280. The portion to be abandoned runs from approximately Kilometre 174 of PR 280 (the Keeyask Junction) to PR 290.

Regular inspection and maintenance of the stream crossings by MIT along the access roads will be required during the operation of the Project. This will ensure proper water flow, fish passage, and reduce the chance of erosion and sedimentation.

4.7.6 ENVIRONMENTAL MONITORING

Preliminary plans for monitoring programs during the construction and operation phases of the Project will be submitted for regulatory review and finalized once terms and conditions of the licence and authorizations are known. These preliminary monitoring plans are described in Chapter 8, Overview of Monitoring and Mitigation Activities. The KCNs will be involved in the monitoring programs. The monitoring programs will determine if the effects of the Project are consistent with the analysis and predictions in the environmental impact assessment. They will also assess the effectiveness of the remedial measures. If the results demonstrate unforeseen impacts, alternative mitigation measures may be applied.

4.7.7 Operation Workforce

An estimated 46 staff will be required to operate and support the Project. Thirty-seven staff will be required at the generating station and nine support staff will work in Gillam. Table 4-8 lists the types and number of staff estimated to be required.

Table 4-8: Estimated Operation and Maintenance Staff Requirements for the Keeyask Generation Project

Operation and Maintenance Staff Type	Number
Keeyask Site Staff	**37**
Power Supply Worker Journeyman (Electrical)	9
Power Supply Worker Journeyman (Mechanical)	9
Senior Power Supply Worker (Electrical)	1
Senior Power Supply Worker (Mechanical)	1
Maintenance Planner	1
Administrative Representative	1
Utility Workers	3
Senior Utility Worker	1
Storekeepers	1
Welder	1
Manager	1
Electrical/Operating Supervisor	1
Mechanical/Operating Supervisor	1
Power Supply Worker Trainees	6
Gillam Support Staff	**9**
Gillam Services Tradesperson (Carpenter/Plumber, *etc.*)	2
Technical Services Engineers (Electrical and Mechanical)	2
Other, such as equivalent for Safety Officer, Human Resource, Admin, Finance, IT, Protection/Telecontrol	5
TOTAL	**46**

Source: Data provided by Manitoba Hydro in 2009.

4.7.8 SAFETY, SECURITY AND EMERGENCY RESPONSE

4.7.8.1 PUBLIC SAFETY AND SECURITY

The operating phase will include publicly accessible boat launching facilities upstream and downstream of the generating station as well as a designated portage on the north side (preliminary locations are shown on Map 4-4).

The following are preliminary waterways public safety measures developed to mitigate or avoid risks to the public:

- Warning signs will be posted at numerous locations upstream and downstream of the generating station, on the principal structures and rock quarries;
- Buoys will be installed at a number of locations upstream and downstream of the principal structures;
- Non-climbable guard rails and fencing will be installed along the powerhouse and spillway structures;
- Warning signs and high visibility barricades will be installed on dykes;
- A safety boom will be installed upstream of the spillway;
- Phones will connect the powerhouse control room to the upstream and downstream boat launches;
- Closed circuit television cameras will be used to inspect areas downstream of the spillway prior to flow changes;
- Multiple sirens will sound warnings prior to flow changes at the spillway;
- A safe boating program will include hazard buoys, water level staff gauges, safe landing sites and designated safe boating routes in the reservoir to avoid shallow areas and hazards due to flooding; and
- Winter safety trails for snowmobiles will be marked and signed at a safe distance from structures.

During the operation phase of the Project, Manitoba Hydro will be responsible for the security of the site. Since PR 280 will be rerouted across the principal structures, the north and south access roads will become the main public road leading to Gillam.

Security at the site will include fences and security gates restricting access to the powerhouse. There will be a secured parking lot as well as an unsecured area away from the control room. Video cameras and security lights will be installed where required across the principal structures, parking lot, gates and doors. There are currently no plans to employ security guards.

An Access Management plan for the operating phase will be developed prior to the end of the construction phase and all required equipment will be identified and installed.

4.7.8.2 EMERGENCY RESPONSE

Manitoba Hydro has developed corporate emergency response assessments and plans to document station operating procedures for normal, unusual and emergency operations. The systems and equipment necessary to protect the integrity and safety of the facilities in emergency situations are incorporated into the final design.

Manitoba Hydro's Dam Safety System includes: site specific Emergency Responses Plans; Dam Safety Emergency Classification and Response Guide; and, site specific Dam Safety Reviews. An Emergency Preparedness Plan will be prepared specifically for the very unlikely event of a dam failure. The plan will apply Manitoba Hydro's Dam Safety Program to the Project. The program is in place to ensure that dams, including those associated with the Project, are constructed, operated and maintained in a safe manner. The program is based on the Canadian Dam Association Dam Safety Guidelines (2007).

Elements of the program include:

- Design and construction of new structures to meet or exceed the Canadian Dam Association guidelines;
- Ongoing condition assessment of structures, which includes inspection, instrumentation and analysis in order to detect and address any developing problems early;
- Emergency preparedness planning for the very unlikely event of a dam failure;
- Periodic dam safety reviews by an external engineer; and
- Reporting/documentation.

The plan includes information for emergency responders and local civil authorities about such things as the emergency response structure, emergency classification, notification procedures, and the potential inundation due to an extreme flood or a dam breach. Manitoba Hydro will distribute copies of the emergency preparedness plans as well as offer presentations to local emergency response agencies and local civil authorities about these plans prior to completion of the Project.

4.7.9 WATER AND WASTEWATER TREATMENT

During the operation phase, water will be drawn from the reservoir and treated to produce potable water. Filtered backwash will be discharged into the river below the powerhouse.

A wastewater-treatment plant will be installed inside the powerhouse to serve during operation. Treated wastewater effluent will discharge into the Nelson River and will meet Manitoba Conservation's Tier 1 Water Quality Standards for municipal wastewater effluent discharged to a water body. Effluent quality will meet or exceed Manitoba's standards of 200 fecal coliform organisms/100 mL for fecal coliform, 25 mg/L for biochemical oxygen demand (BOD) and 25 mg/L for total suspended sediments (TSS). Wastewater sludge will be dewatered and hauled to an approved landfill for disposal.

4.8 DECOMMISSIONING

A hydroelectric generating station may operate almost in perpetuity. If decommissioning is required at some future date, it will be undertaken according to the legislative requirements, existing agreements and industry standards prevalent at that time.

KEEYASK Hydropower Limited Partnership

DATA SOURCE:
Manitoba Hydro Artist Concept Rendering - November 2011

CREATED BY:
Manitoba Hydro - Hydro Power Planning - GIS & Special Studies

NOTE(S):	DATE CREATED:	REVISION DATE:
Artist's Rendering - Concept Only	03-AUG-11	13-FEB-12
	VERSION NO: 1.0	QA/QC: APPROVED

Note:
Estimated extent of dewatered area when the spillway is not in operation. The exact extents of this area are uncertain due to the limited bathymetric data in the area.

General Arrangement
Looking North

Figure 4-1

KEEYASK
Hydropower Limited Partnership

DATA SOURCE: Manitoba Hydro Artist Concept Rendering - September 2011		
CREATED BY: Manitoba Hydro - Hydro Power Planning - GIS & Special Studies		
NOTE(S): Artist's Rendering - Concept Only	DATE CREATED: 03-SEP-11	REVISION DATE: 13-FEB-12
	VERSION NO: 1.0	QA/QC: APPROVED

Note:
Estimated extent of dewatered area when the spillway is not in operation. The exact extents of this area are uncertain due to the limited bathymetric data in the area.

General Arrangement
Looking Upstream

Figure 4-2

KEEYASK
Hydropower Limited Partnership

DATA SOURCE: Manitoba Hydro Artist Concept Rendering - September 2011			
CREATED BY: Manitoba Hydro - Hydro Power Planning - GIS & Special Studies			
NOTE(S): Artist's Rendering - Concept Only	DATE CREATED: 03-SEP-11	REVISION DATE: 06-JUL-12	
	VERSION NO: 2.0	QA/QC: APPROVED	

Note:
Map illustrates the estimated extent of the dewatered area when the spillway is not in operation. The true extent of this area is uncertain due to the limited bathymetric data

Powerhouse Complex

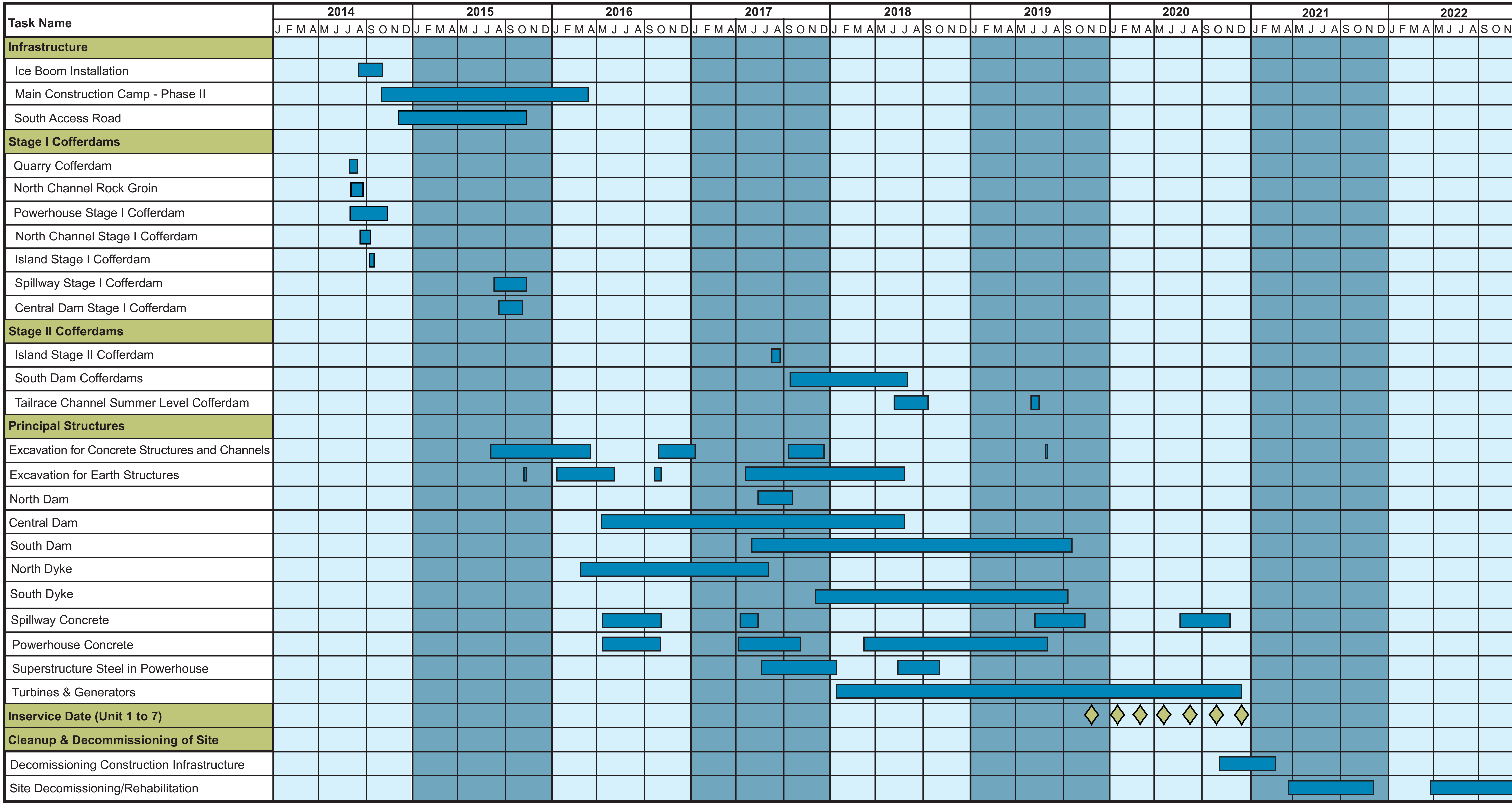
Figure 4-3

DATA SOURCE: Manitoba Hydro Artist Concept Rendering - September 2011			
CREATED BY: Manitoba Hydro - Hydro Power Planning - GIS & Special Studies			
NOTE(S): Artist's Rendering - Concept Only	DATE CREATED: 04-SEP-11	REVISION DATE: 06-JUL-12	
	VERSION NO: 2.0	QA/QC: APPROVED	

KEEYASK Hydropower Limited Partnership

Spillway

Figure 4-4



KEEYASK
Hydropower Limited Partnership

DATA SOURCE:
Manitoba Hydro Preliminary Construction Schedule.
Latest version April 5,2012

CREATED BY:
Manitoba Hydro - Hydro Power Planning - Stantec Consultants

Note(s):

DATE CREATED:	REVISION DATE:
16-APR-12	15-JUNE-12
VERSION NO: 2.0	QA/QC: APPROVED

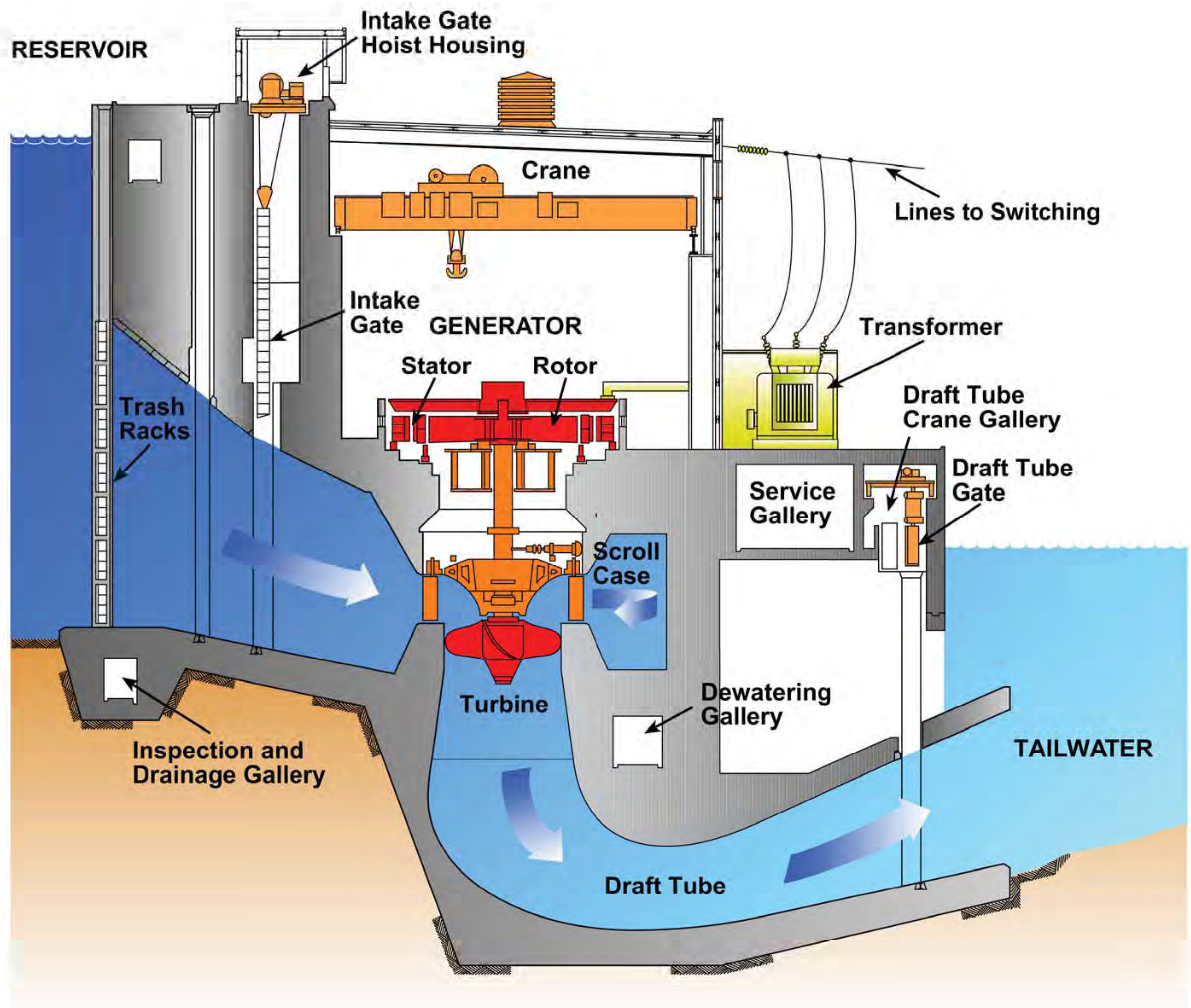
Legend

Task

Milestone

Preliminary Construction Schedule

Figure 4-5



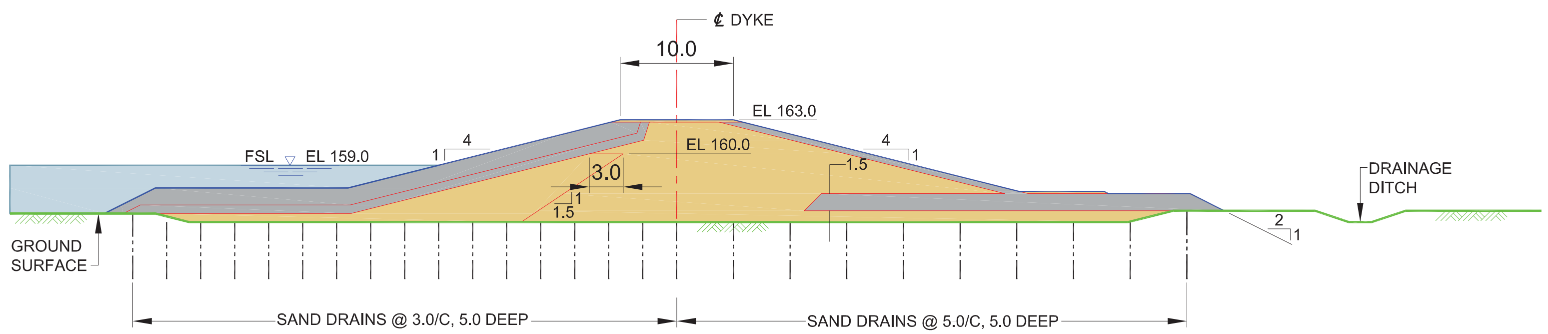
DATA SOURCE: Manitoba Hydro		
CREATED BY: Manitoba Hydro - Hydro Power Planning - Keeyask & Burntwood Planning		
NOTE(S): Artist's Rendering - Concept Only	DATE CREATED: 17-JAN-12	REVISION DATE: 23-APR-12
	VERSION NO: 2.0	QA/QC: APPROVED

KEEYASK Hydropower Limited Partnership

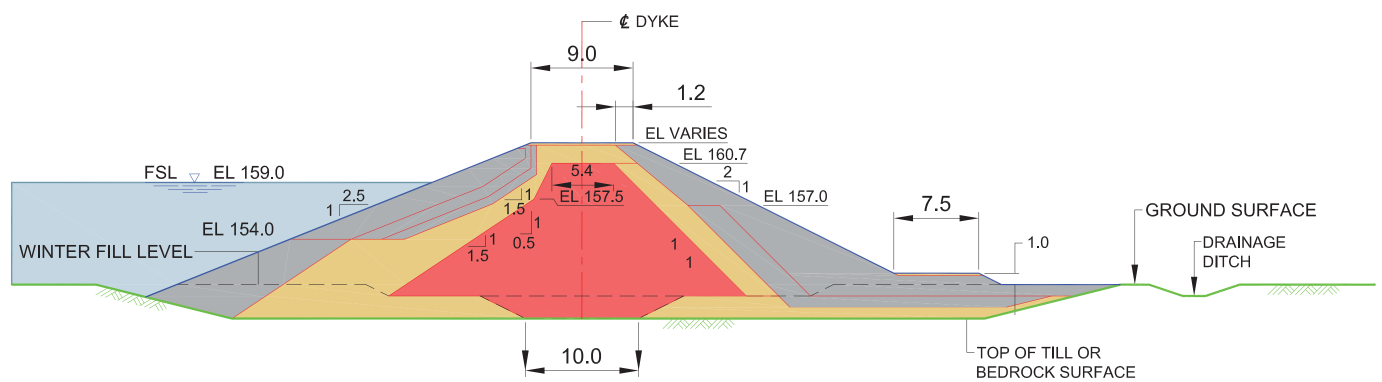
Typical Powerhouse Cross Section

Vertical Shaft Turbine

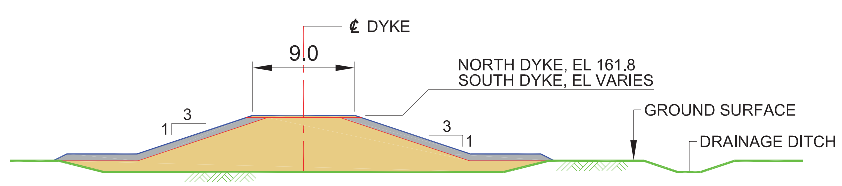
Figure 4-6



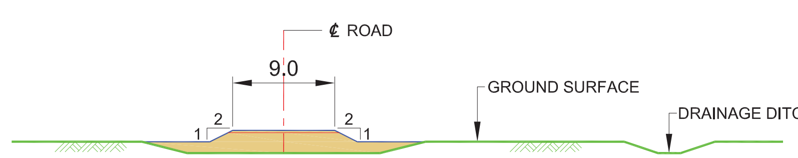
GRANULAR DYKE



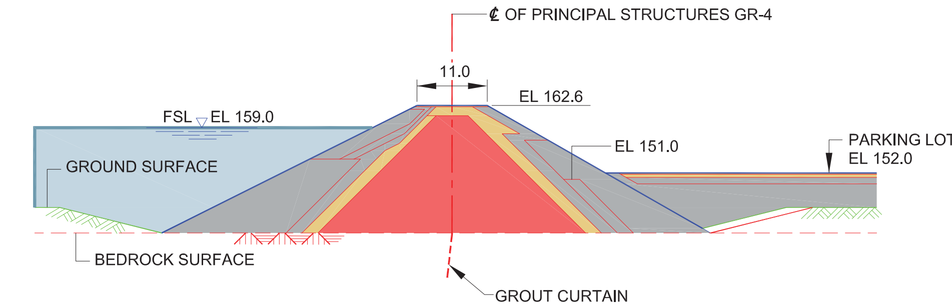
ZONED IMPERVIOUS CORE DYKE



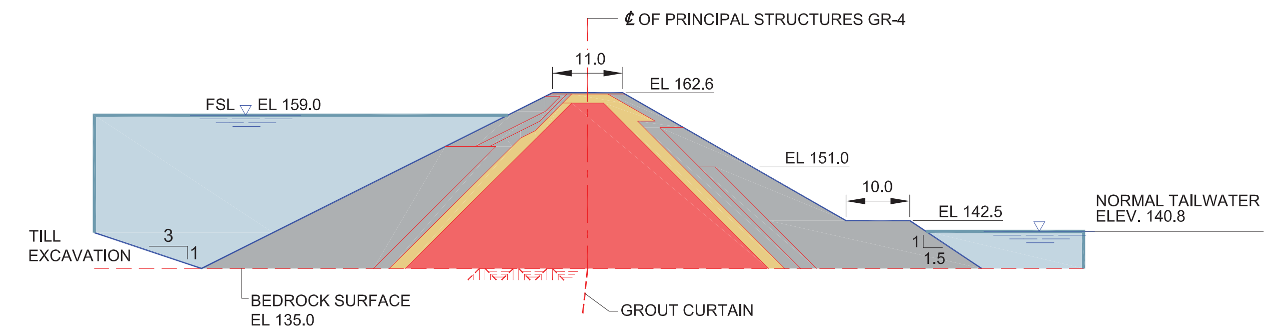
FREEBOARD DYKE



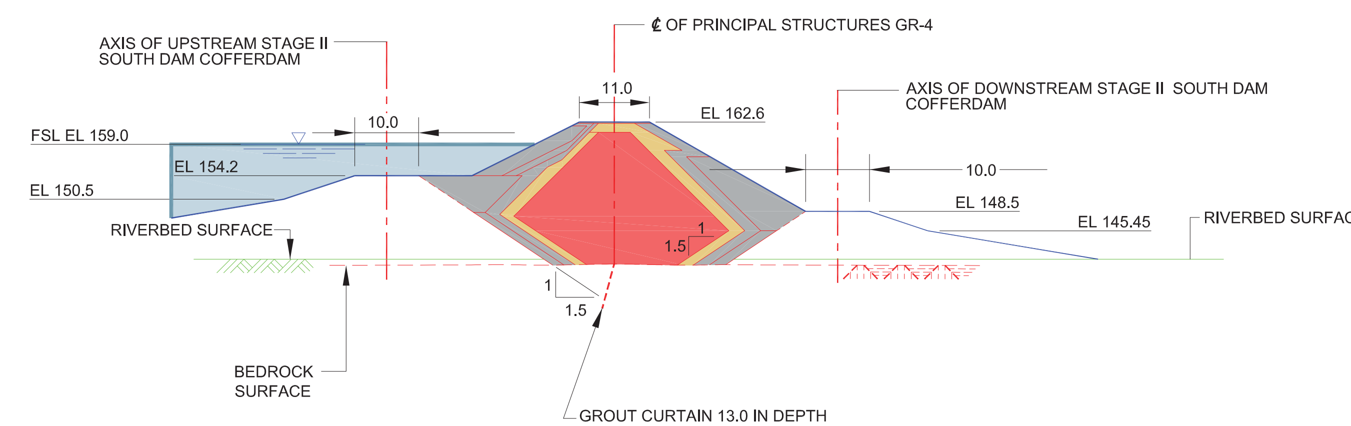
ROAD SECTION



NORTH DAM
MAIN SECTION



CENTRAL DAM
NEAR POWERHOUSE



SOUTH DAM
RIVER SECTION

KEEYASK
Hydropower Limited Partnership

DATA SOURCE: Memorandum GN-4.2.2.2, Rev. 0, Figure 5		
CREATED BY: KGS Acres		
COORDINATE SYSTEM: Not Applicable	DATE CREATED: 12-APR-12	REVISION DATE: 12-APR-12
SCALE: NTS	VERSION NO: 1.0	QA/QC: APPROVED

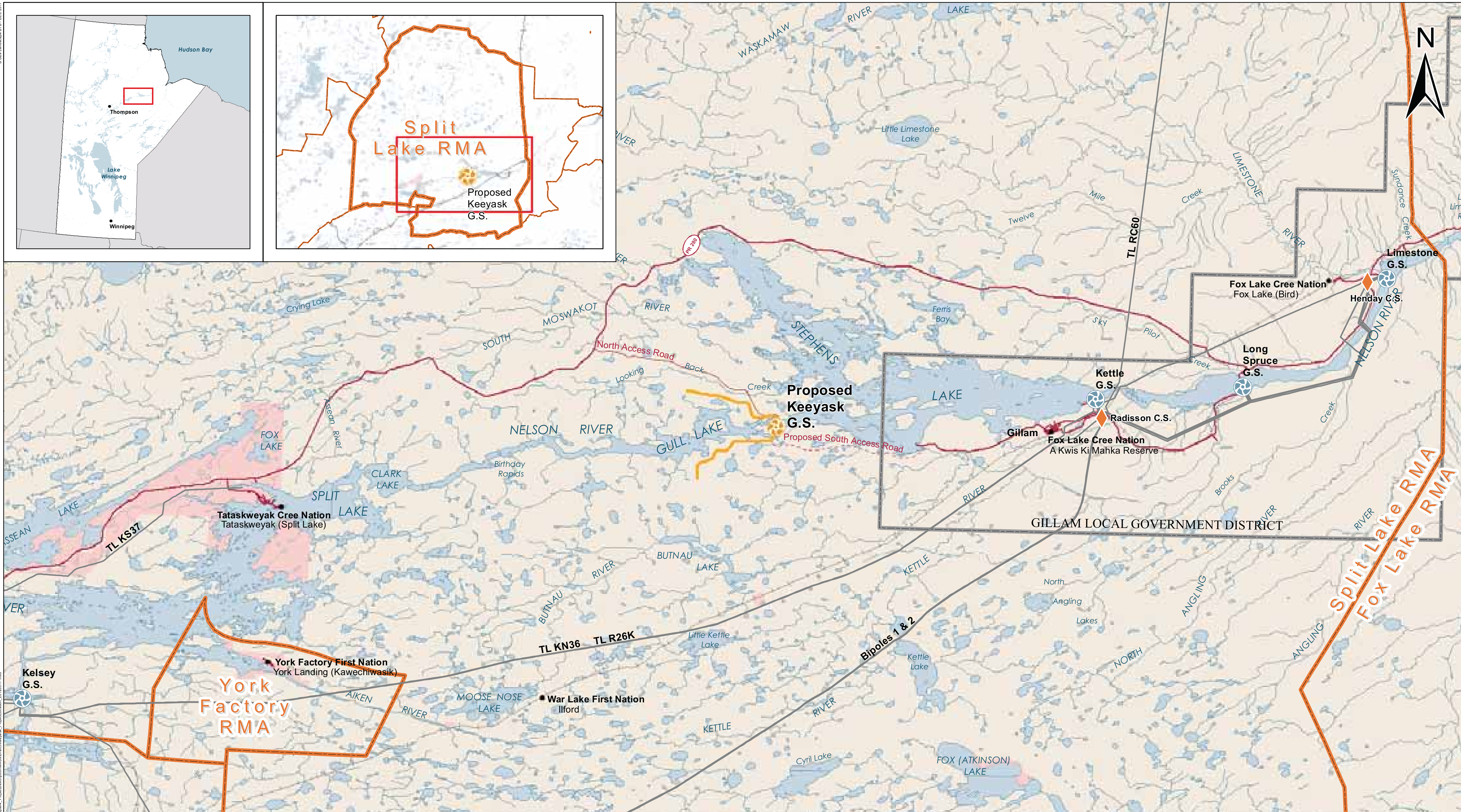
Legend

- Water
- Impervious Fill
- Granular Transition Fill
- Rockfill
- Water Level
- Overburden
- Bedrock

Dykes and Dams

Typical Cross Sections

Figure 4-7



DATA SOURCE:
Manitoba Hydro; Government of Manitoba; Government of Canada

CREATED BY:
Manitoba Hydro - Hydro Power Planning - GIS & Special Studies

COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	03-AUG-11	18-JUN-12
0 4.5 9 Kilometres / 0 4 8 Miles	VERSION NO: 2.0	QA/QC: APPROVED

Legend

- Generating Station (Planned)
- Generating Station (Existing)
- Converter Station
- Keeyask Principal Structures
- Highway
- Access Road
- Proposed Access Road
- Rail
- Transmission Line
- First Nation Reserve
- Local Government District
- Resource Management Area

Project Location

Map 4-1

KEEYASK
Hydropower Limited Partnership

DATA SOURCE:
Manitoba Hydro; Government of Manitoba; Government of Canada; KGSA;
Manitoba Hydro Artist Concept Rendering - November 2011

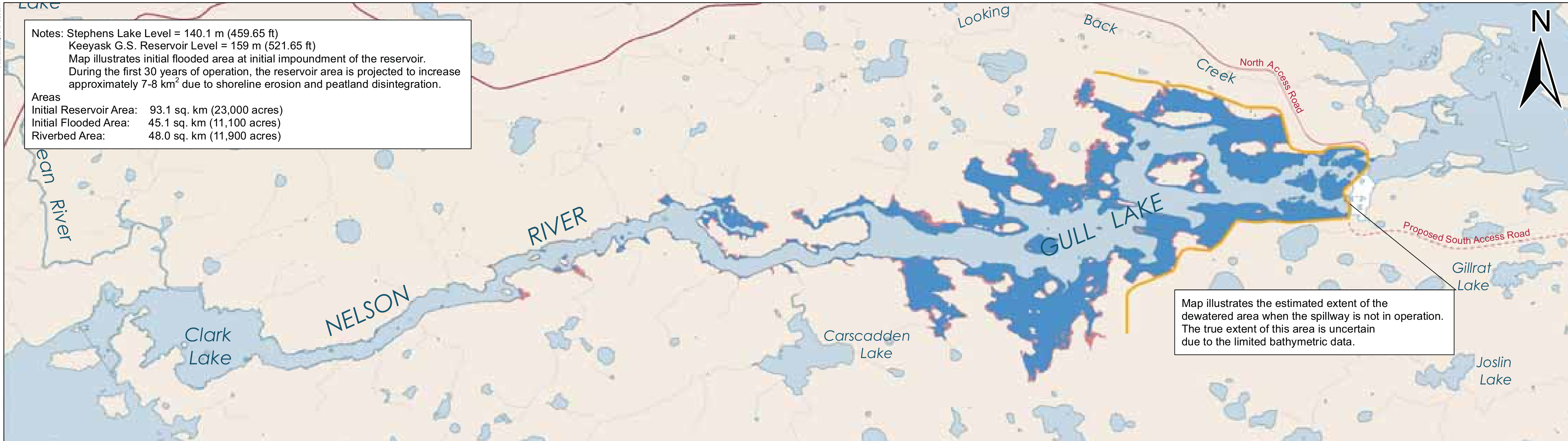
CREATED BY:
Manitoba Hydro - Hydro Power Planning - GIS & Special Studies

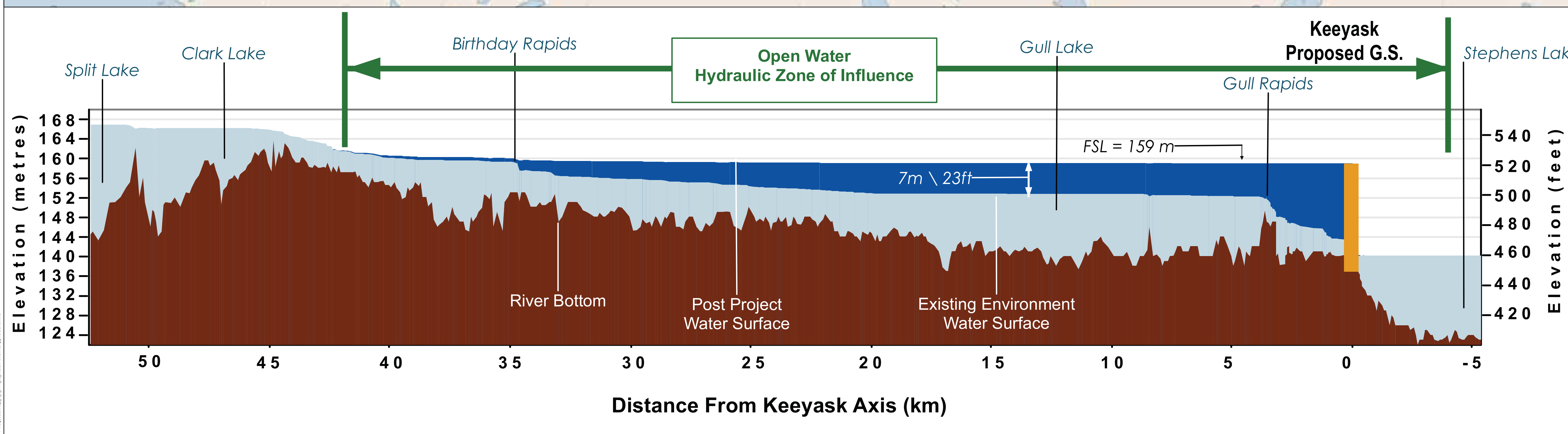
COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	03-NOV-11	11-APR-12
0 0.25 0.5 Kilometres / 0 0.2 0.4 Miles	VERSION NO: 2.0	QA/QC: APPROVED

Note:
Map illustrates the estimated extent of the dewatered area when the spillway is not in operation. The true extent of this area is uncertain due to the limited bathymetric data.

Principal Structures

Map 4-2





DATA SOURCE:
Government of Canada; Government of Manitoba; Manitoba Hydro: gull-ee-50perc-3032cms-rev3; Shore Year 30 Polygon pp-50perc-3032-159-shore-rev3; pp-DS-50perc-3030-140p2-shore-rev1

CREATED BY:
Manitoba Hydro - Water Resources Engineering Department

COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	26-JAN-10	09-MAY-12
0 2 4 Kilometres / 0 1 2 Miles	VERSION NO: 2.0	QA/QC: APPROVED

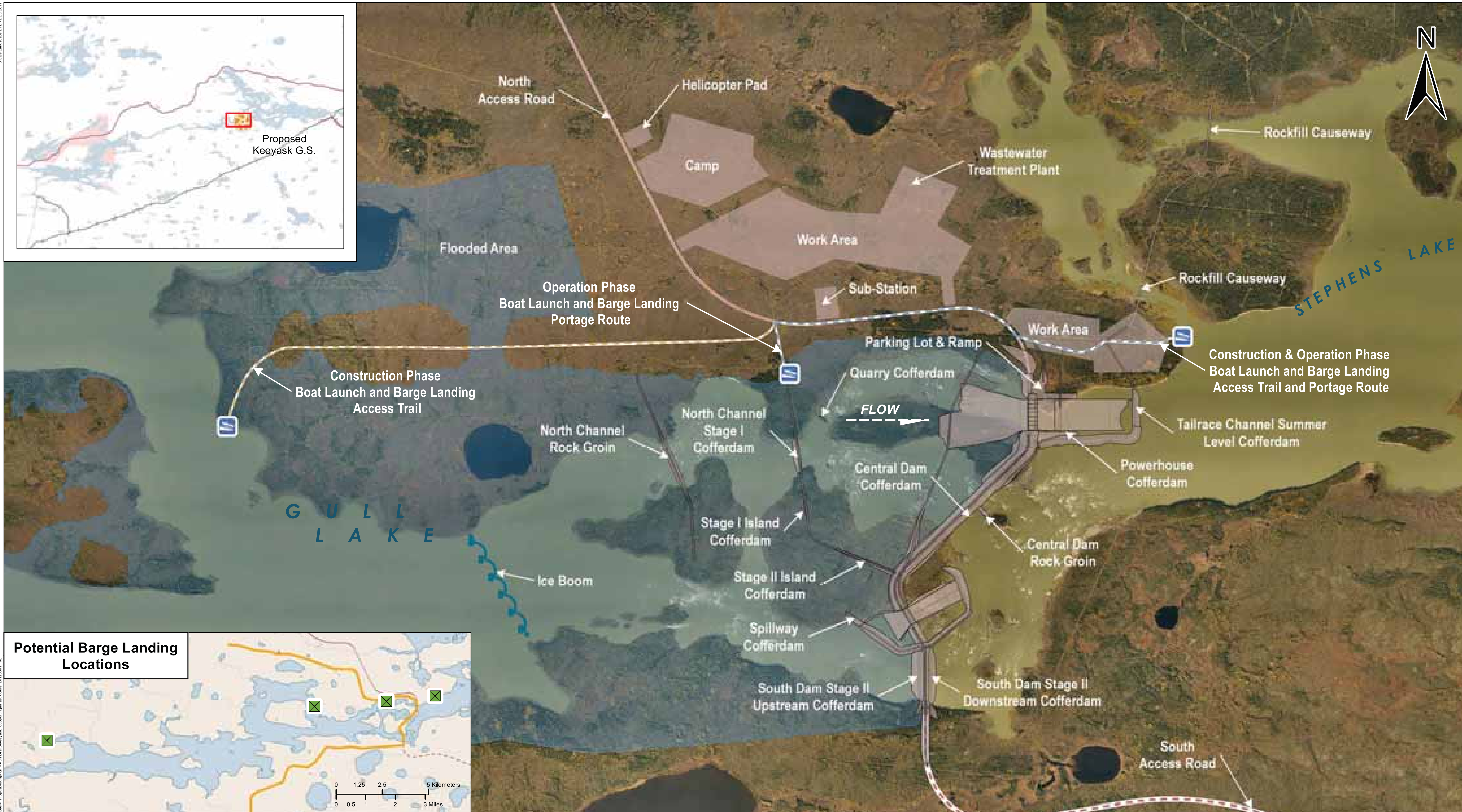
Legend

- Existing Water Surface Area
- Initial Flooded Area (159 m)
- Reservoir Expansion During First 30 Years
- Keeyask Principle Structures

Note:
50th Percentile, Open Water Flow
Existing Environment
and Post-Project Environment

The 30-year shoreline expansion upstream, of Birthday Rapids is not a Project effect as it is predicted to occur without the Project.

Water Surface Profiles and Flooded Area



KEEYASK
Hydropower Limited Partnership

DATA SOURCE:
Manitoba Hydro; Government of Manitoba; Government of Canada; KGSA; Manitoba Hydro 2010 10cm Color DOI

CREATED BY:
Manitoba Hydro - Hydro Power Planning - GIS & Special Studies

COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	03-AUG-11	01-MAY-12

0 0.3 0.6 Kilometres
0 0.25 0.5 Miles

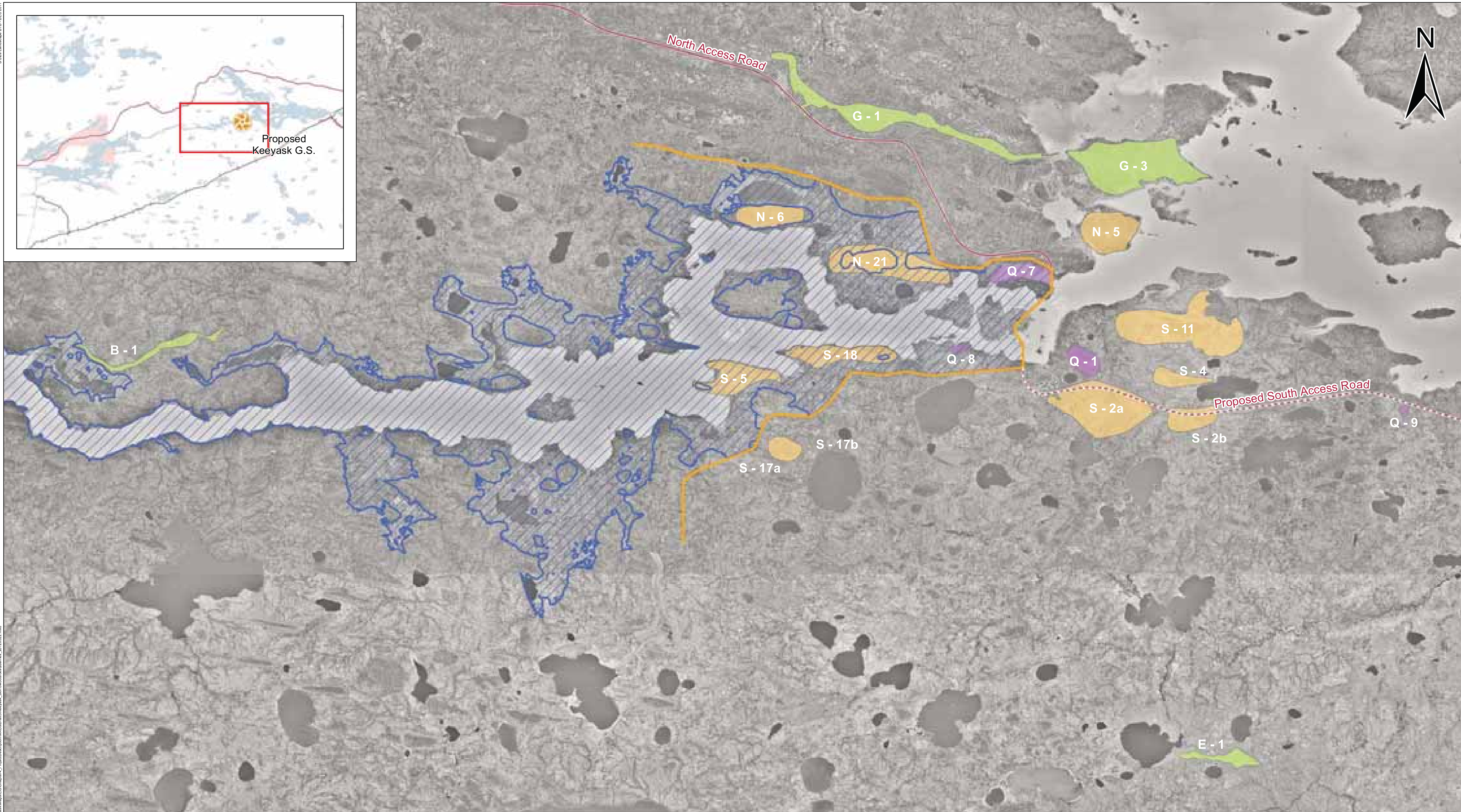
VERSION NO:	QA/QC:
2.0	APPROVED

Legend

- Initial Flooded Area (159 m)
- Infrastructure
- Proposed Access Road
- Access Road
- Boat Launch (Barge Landing)
- Portage Route
- Boat Launch Access Trail
- Potential Barge Landing Location

Supporting Infrastructure

Map 4-4



Keeyask Hydropower Limited Partnership

DATA SOURCE:
Manitoba Hydro; Government of Manitoba; Government of Canada; KGS Acreas; Manitoba Hydro 1999 1m Black & White DOI

CREATED BY:
Manitoba Hydro - Hydro Power Planning - GIS & Special Studies

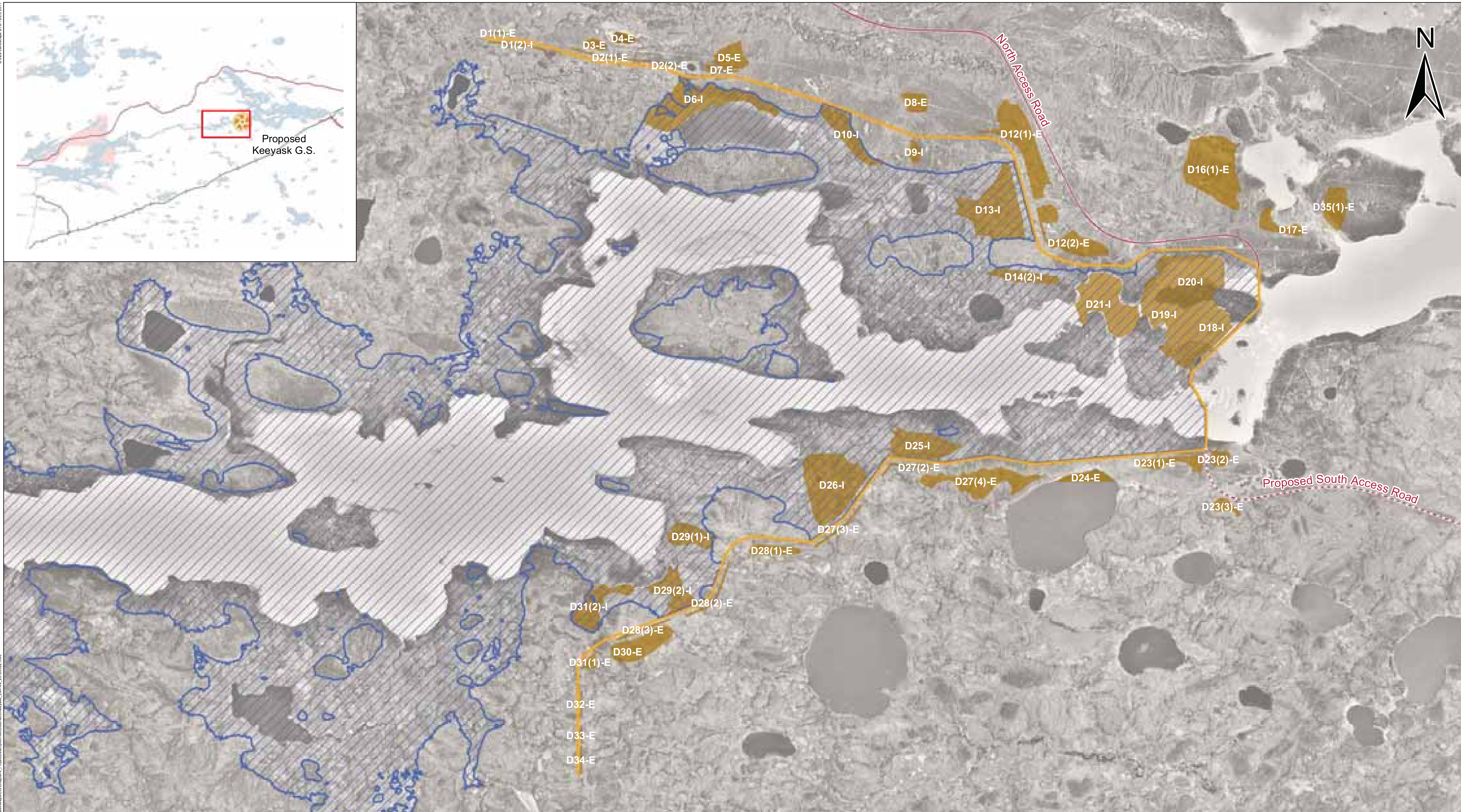
COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	09-FEB-12	22-MAY-12
0 1 2 Kilometres / 0 0.85 1.7 Miles	VERSION NO: 3.0	QA/QC: APPROVED

Legend

Material Sources
- Granular Borrow
- Impervious Borrow
- Rock Quarry
- Access Road
- Proposed Access Road
- Keeyask Principal Structures
- Initial Flooded Area (159 m)

Borrow Sources and Quarries
Potential

Map 4-5



KEEYASK
Hydropower Limited Partnership

DATA SOURCE:
Manitoba Hydro; Government of Manitoba; Government of Canada; KGS Acreas; Manitoba Hydro 1999 1m Black & White DOI

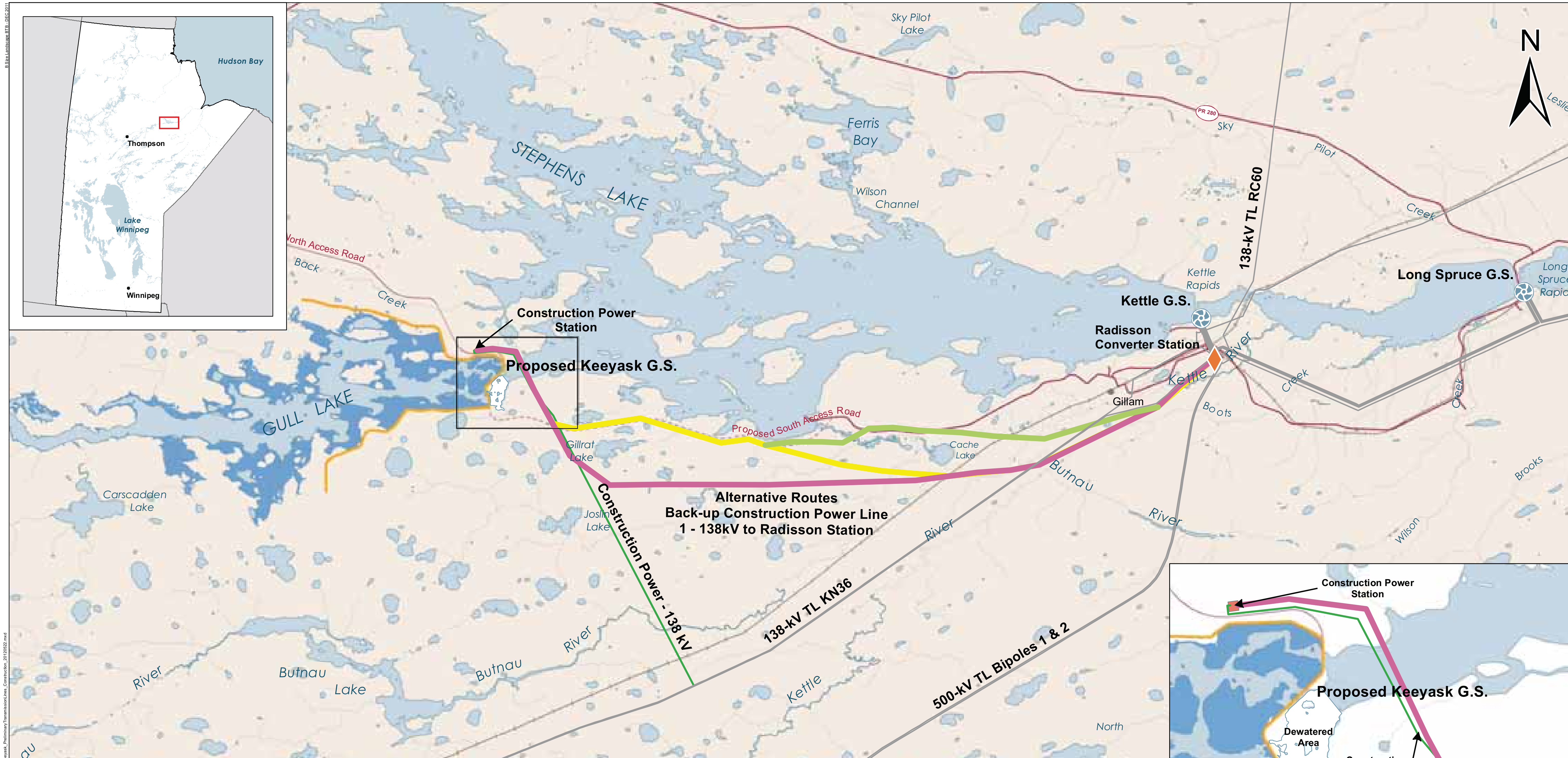
CREATED BY:
Manitoba Hydro - Hydro Power Planning - GIS & Special Studies

COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	09-FEB-12	22-MAY-12
0 0.55 1.1 Kilometres / 0 0.45 0.9 Miles	VERSION NO: 2.0	QA/QC: APPROVED

Legend

- Excavated Material Placement Area
- Access Road
- Proposed Access Road
- Keeyask Principal Structures
- Initial Flooded Area (159 m)

Excavated Material Placement Areas



Notes:

All proposed Transmission Lines are Alternative Routes undergoing initial stages of the site selection process. Alignment and other design parameters are preliminary and subject to change

Map illustrates the estimated extent of the dewatered area when the spillway is not in operation. The true extent of this area is uncertain due to the limited bathymetric data.

KEEYASK Hydropower Limited Partnership

DATA SOURCE:
Manitoba Hydro; Government of Manitoba; Government of Canada; Manitoba Hydro - Transmission; Manitoba Hydro - Water Resource Engineering (PP_95perc_4327_159_shore_rev5)

CREATED BY:
Manitoba Hydro - Hydro Power Planning - GIS & Special Studies

COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	13-FEB-12	22-MAY-12
0 2 4 Kilometres / 0 1.5 3 Miles	VERSION NO: 2.0	QA/QC: APPROVED

Legend

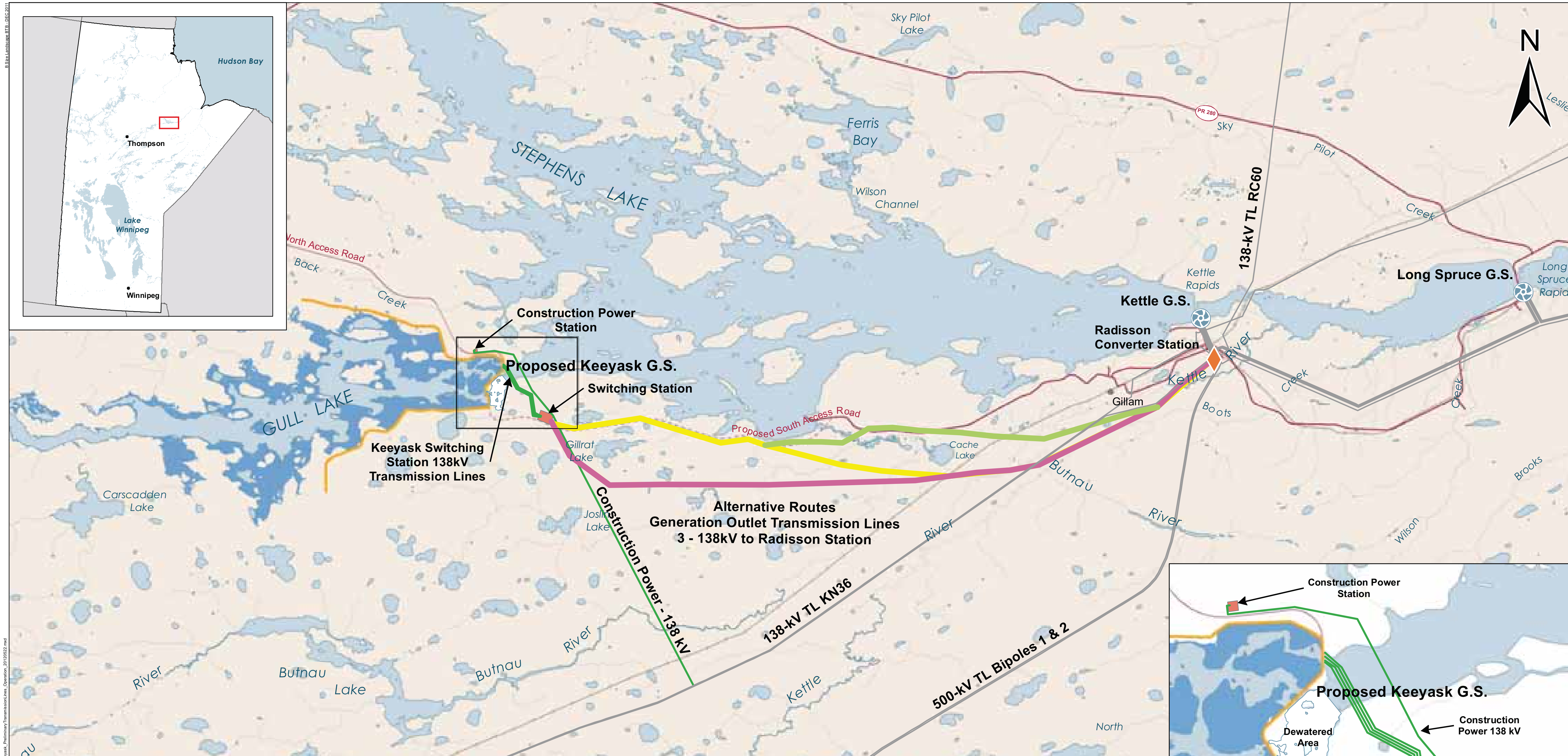
- Transmission Line (Existing)
- Construction Power Line (Proposed)
- **Back-up Construction Power Transmission Line**
- Route Alternative Option A
- Route Alternative Option B
- Route Alternative Option C
- Generating Station (Existing)
- Converter Station (Existing)
- Keeyask Principal Structures
- Transmission Substation (Proposed)
- Potential Dewatered Area
- Initial Flooded Area (159 m)
- Exisiting Water Level
- Highway
- Access Road
- Proposed Access Road

Keeyask Transmission Project

Preliminary Transmission Corridors

During Keeyask Generation Project Construction Phase

Map 4-7



Notes:

All proposed Transmission Lines are Alternative Routes undergoing initial stages of the site selection process. Alignment and other design parameters are preliminary and subject to change

Map illustrates the estimated extent of the dewatered area when the spillway is not in operation. The true extent of this area is uncertain due to the limited bathymetric data.

KEEYASK
Hydropower Limited Partnership

DATA SOURCE:
Manitoba Hydro; Government of Manitoba; Government of Canada; Manitoba Hydro - Transmission; Manitoba Hydro - Water Resource Engineering (PP_95perc_4327_159_shore_rev5)

CREATED BY:
Manitoba Hydro - Hydro Power Planning - GIS & Special Studies

COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	13-FEB-12	22-MAY-12
0 2 4 Kilometres / 0 1.5 3 Miles	VERSION NO: 2.0	QA/QC: APPROVED

Legend

- Transmission Line (Existing)
- Transmission Line (Proposed)
- **Generation Outlet Transmision Lines**
- Route Alternative Option A
- Route Alternative Option B
- Route Alternative Option C
- Generating Station (Existing)
- Converter Station (Existing)
- Keeyask Principal Structures
- Transmission Substation (Proposed)
- Potential Dewatered Area
- Initial Flooded Area (159 m)
- Existing Water Level
- Highway
- Access Road
- Proposed Access Road

Keeyask Transmission Project

Preliminary Transmission Corridors

During Keeyask Generation Project Operation Phase

Map 4-8

KEEYASK
Hydropower Limited Partnership

DATA SOURCE:
Manitoba Hydro; Government of Manitoba; Government of Canada

CREATED BY:
Manitoba Hydro - Hydro Power Planning - GIS & Special Studies

COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	25-MAR-12	10-MAY-12
0 0.1 0.2 Kilometres / 0 0.1 0.2 Miles	VERSION NO: 1.0	QA/QC: APPROVED

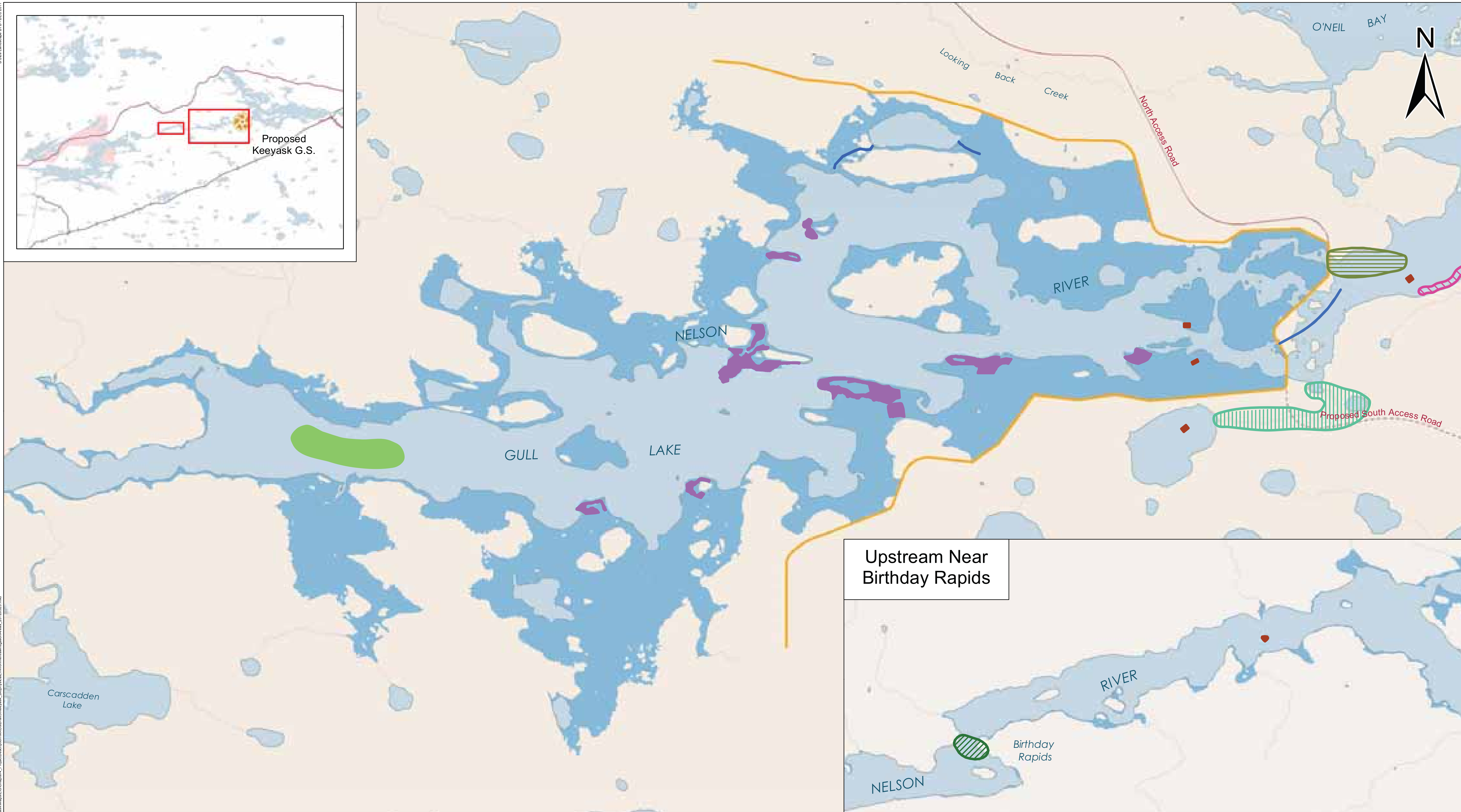
Legend

- Boat Launch
- Portage Route
- Access Trail
- Access Road
- Keeyask Principal Structures

Note:
The Location of boat launches and portage alignments are subject to change.

Boat Launch and Access Routes

Map 4-9



KEEYASK
Hydropower Limited Partnership

DATA SOURCE:
Manitoba Hydro; Government of Manitoba; Government of Canada; KGS Acres. (Design Memo's GN 9.8.11, GN 9.8.10, GN 9.8.3)

CREATED BY:
Manitoba Hydro - Hydro Power Planning - GIS & Special Studies

COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	12-APR-12	23-MAY-12
0 0.7 1.4 Kilometres / 0 0.55 1.1 Miles	VERSION NO: 4.0	QA/QC: APPROVED

Legend

- Planned Lake Sturgeon Spawning Habitat
- Potential Lake Sturgeon Spawning Habitat
- Potential Young-Of-Year Lake Sturgeon Habitat
- Planned Lake Whitefish Spawning Habitat
- Planned Lake Whitefish and Walleye Spawning Habitat
- Planned Fish Egress Channel
- Potential Bird Island Habitat
- Potential High Quality Wetlands
- Keeyask Principal Structures
- Initial Flooded Area (159 m)

Biophysical Environmental Mitigation Areas
General Locations

Map 4-10