Keeyask Generation Project

Environmental Impact Statement

Supporting Volume

Project Description

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KEEYASK
Hydropower Limited Partnership

June 2012

KEEYASK GENERATION PROJECT
ENVIRONMENTAL IMPACT STATEMENT
RESPONSE TO EIS GUIDELINES

PROJECT DESCRIPTION
SUPPORTING VOLUME

Prepared by
Keeyask Hydropower Limited Partnership
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The project description was developed by personnel from Manitoba Hydro and consulting firms.

Project Description Development Team:

Marc St. Laurent, M.Sc., P.Eng., Manitoba Hydro

Ariel Brawerman, B.Sc., EIT, Manitoba Hydro

Ryan Kustra, B.A., Manitoba Hydro

Jarrod Malenchak, Ph.D., P.Eng., Manitoba Hydro

Ross Dewar, B.Sc., P. Eng, KGS-Acres Ltd.

Philippe Pantel, B.Sc., P.Eng, KGS-Acres Ltd.

David Fuchs, M.Sc., P.Eng, KGS-Acres Ltd.

George Rempel, M.Sc., P.Eng., Stantec Consulting Ltd.

Roger Rempel, B.Sc., P.Eng., FEC, Stantec Consulting Ltd.

Khizar Mahmood, M.Sc., P.Eng., Stantec Consulting Ltd.

Nancy LeBlond, M.A., InterGroup Consultants Ltd.

Project Description Mapping Team:

Jennifer Lidgett, H.B.Sc.F., Manitoba Hydro

Marc Totte, B.Sc., Manitoba Hydro

Brent Bencharski, B.Sc., Manitoba Hydro

George Kroupa, RFT, Stantec Consulting Ltd.

In addition to the foregoing, we also wish to acknowledge the contribution of the following people to the project description:

Manitoba Hydro: William DeWit, Halina Zbigniewicz, Ryan Penner, Glen Cook, Reed Winstone, Ed Wojczynski, Brian Beyak, Darryl Olynick, Jim Barnby, Glen Schick, Tom Tonner, Keith Freeman, Jodine MacDuff, David Magnusson, (retired), Vicky Cole, Nick Barnes, Mark Manzer, Monica Wiest, Maria Zbigniewicz, Marilyn Kullman, Stephanie Backhouse, Carolyne Northover, Sarah Wakelin, Sherrie Mason, Marcus Smith, Rob Tkach, Martin Hunt, Mike Kressock, Danielle Kerr, Vernon Smith, Finlay MacInnes

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InterGroup Consultants Ltd.: Denis Depape, Darcy McGregor, Hamid Najmidinov

North/South Consultants Inc.: Frederike Schneider-Vieira, Michael Lawrence

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ACRONYMS AND ABBREVIATIONS

Acronym / Abbreviation	Term
AC	Alternating Current
AE SV	Aquatic Environment Supporting Volume
AEA	Adverse effects agreement
AMP	Access management plan
ANFO	Ammonium Nitrate/Fuel Oil
asl	Above sea level
ATK	Aboriginal traditional knowledge
BNA	Burntwood Nelson Agreement
BOD	Biochemical oxygen demand
BRHA	Burntwood Regional Health Authority
CBN	Churchill-Burntwood-Nelson
CDA	Canadian Dam Association
CEA	Cumulative effects assessment
CEAA	Canadian Environmental Assessment Agency
CLFN	Cross Lake First Nation
CNP	Cree Nation Partners
CO	Carbon monoxide
CO_2	Carbon dioxide
CRD	Churchill River Diversion
DC	Direct current
DFO	Department of Fisheries and Oceans
DNC	Direct negotiated contract
DO	Dissolved oxygen
e.g.	example
EA	Environmental assessment
EC	Environment Canada
EIA	Environmental impact assessment
EIS	Environmental impact statement

Acronym / Abbreviation	Term
EMPA	Excavated Material Placement Areas
EMS	Environmental Management System
EnvPP	Environmental protection plan
EPA	Environmental Protection Agency
EPP	Environmental protection program
et al.	and others
FLCN	Fox Lake Cree Nation
FLRMA	Fox Lake Resource Management Area
FSL	Full supply level
GOT	Generation Outlet Transmission
GS	Generating Station
GW	Gigawatt
HNTEI	Hydro North Training and Employment Initiative
HVDC	High Voltage Direct Current
HZI	Hydraulic Zone of Influence
i.e.	That is
ISD	In-service date
JKDA	Joint Keeyask Development Agreement
KCNs	Keeyask Cree Nations communities including Tataskweyak Cree Nation (TCN), War Lake First Nation (WLFN), York Factory First Nation (YFFN) and Fox Lake Cree Nation (FLCN),.
KHLP	Keeyask Hydropower Limited Partnership
KIP	Keeyask Infrastructure Project
KIP EA	Keeyask Infrastructure Project Environmental Assessment
LWCNRSB	Lake Winnipeg, Churchill and Nelson Rivers Study Board
LWR	Lake Winnipeg Regulation
MB	Manitoba
MH	Manitoba Hydro
MIT	Manitoba Infrastructure and Transportation
MMF	Manitoba Metis Federation
MTS	Manitoba Telecom Services
MVA	Megavolt amperes

Acronym / Abbreviation	Term
MW	Megawatt
MWS	Manitoba Conservation and Water Stewardship
n.d.	No date
N/A	Not available/applicable
NCN	Nisichawayasihk Cree Nation
NFA	Northern Flood Agreement
NWPA	Navigable Waters Protection Act
PD	Project Description
PD SV	Project Description Supporting Volume
PE SV	Physical Environment Supporting Volume
PEMP	Physical Environment Monitoring Program
PIP	Public Involvement Program
PR	Provincial Road
PY	Person years
RMA	Resource Management Area
ROW	Right-of-way
SE SV	Socio-Economic Environment, Resource Use and Heritage Resources Supporting Volume
SEIA	Socio-Economic Impact Assessment
SLRMA	Spilt Lake Resource Management Area
SLRMB	Split Lake Resource Management Board
TBD	To be determined
TCN	Tataskweyak Cree Nation
TE SV	Terrestrial Environment Supporting Volume
TSS	Total suspended solids
WLFN	War Lake First Nation
WMP	Waterways Management Plan
YFFN	York Factory First Nation
YFRMA	York Factory Resource Management Area
YOY	Young-of-the-year

UNITS

Abbreviation	Unit
cm	centimetre
CFU/mL	coliform forming units per millilitre
m^3	cubic metre
m^3/s	cubic metre per second
d	day
d/wk	days per week
d/y	days per year
°C	degrees Celsius
GW	gigawatt
GWh	gigawatt-hours
g	gram
g/L	grams per litre
>	greater than
≥	greater than or equal to
ha	hectare (10,000 m^2)
h (not hr)	hour
kg	kilogram
km	kilometre
kV	kilovolt
<	less than
≤	less than or equal to
L	litre
L/m	litres per minute
MW	megawatt
MWh	megawatt-hour
m	metre
m/s	metres per second
t	metric ton (tonne)
mg/m^3	milligrams per cubic metre
mg/L	milligrams per litre
mL	millilitre
mm	millimetre
M	million
%	percent

Abbreviation	Unit
s	second (time)
cm^2	square centimetre
km^2	square kilometre
m^2	square metre

INTRODUCTION

This Project Description Supporting Volume (PD SV) is one of six volumes produced in support of the Response to EIS Guidelines for the Keeyask Generation Project Environmental Impact Statement (EIS). The EIS has been developed by the Keeyask Hydropower Limited Partnership (the Partnership) as part of the regulatory review of the Project under the *Canadian Environmental Assessment Act* and *The Environment Act* (Manitoba).

The six supporting volumes were developed by the Manitoba Hydro environmental team in consultation with the KCNs and their Members, to provide details about the Project Description and about the research and analysis of the following topics: Public Involvement Program, Physical Environment, Aquatic Environment, Terrestrial Environment, Socio-economic Environment, Resource Use, and Heritage Resources (the latter three topics are included in one volume). The supporting volumes have been reviewed, commented on, and, as appropriate, finalized in a manner consistent with the arrangements of the Partnership.

This project description is divided into six sections:

- Section 1 provides an overview of the proponent, the Keeyask Hydropower Limited Partnership.
- Section 2 describes key planning parameters and components of the Project.
- Section 3 describes when and how the Project will be constructed.
- Section 4 describes the manner in which the Project will be operated.
- Section 5 refers to the de-commissioning of the project and the manner, if required, in which that will be undertaken.
- Section 6 reviews alternative means that were considered by the Partnership for developing the Project. It also describes the major mitigation measures that were considered to reduce adverse effects and enhance positive effects of the Project.

1.0 PROJECT OVERVIEW, PURPOSE AND PROPONENT

The Project is a 695-**megawatt (MW)** hydroelectric **generating station (GS)** located near Gull Rapids on Nelson River in the Province of Manitoba.

As the proponent of the Project, the Partnership has conducted an **Environmental Impact Assessment (EIA)** for the Project and prepared a detailed EIS in support of the submission for regulatory approval to proceed with the **construction** and operation of the Project.

This document describes the Project as it is currently envisioned. Specifics of the Project, including the proposed generating station and associated facilities, are subject to change as a result of the environmental assessment and during final design and construction. The proponent will inform the regulators of changes that would result in a material alteration to this project description.

This section of the Project Description Supporting Document (PD SD) provides an overview of the project, outlines the need for and alternatives to the project, explains the purpose of the Project and provides information about the proponent.

1.1 PROJECT OVERVIEW

Manitoba Hydro and the **Keeyask Cree Nations (KCN)** 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.
- 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 **reservoir near the principal structures** will be 159.0 m and the **minimum operating level (MOL)** will be 158.0 m, provided that the water level may exceed the FSL or be drawn down below the MOL under special or emergency conditions, as defined in the JKDA.
- 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 MW hydroelectric generating station to be located at Gull Rapids on the lower Nelson River at the base of Gull Rapids immediately upstream of Stephens Lake in northern Manitoba (Map 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 1-1.

The Project is entirely within the SLRMA. The generating station and associated structures is located on provincial Crown land and the station and reservoir will be located within the proposed Keeyask *Water Power Act* licence area. The Partnership intends to apply to the Province of Manitoba to acquire all lands on which the generating station will be located, including islands and the bed of the Nelson River, prior to the start of construction. The Project is not located on any treaty land entitlement selections.

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 1-2, Figure 1-3, Figure 1-4 and Figure 1-5 show artist's renderings of the powerhouse complex, spillway and general arrangement.

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 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 2.4.17.

The Project will take approximately eight and a half years to construct, *i.e.*, from June 2014 to November 2022. The last 3 years involves 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 3 years of the construction phase. Once operation is initiated, the Project will be operated as part of the overall Manitoba Hydro's **Integrated Power 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 elevation **above sea level** (**ASL**) and a minimum operating level (*i.e.,* MOL) of 158 m.

Table 2-2 summarizes the main design **parameters** for the Project.

1.2 PROJECT PROPONENT

The Partnership is composed of five partners. There is one general partner, responsible for the management and operation of the business of the Project. It is liable for all of the debts of the Partnership. The general partner is 5900345 Manitoba Ltd., a corporation wholly owned by Manitoba Hydro. There are four limited partners. The limited partners have invested in the Partnership. They have limited rights with respect to the day-to-day management and operation of the business of the Partnership, and they have limited liability for the debts of the Partnership. The four limited partners are Manitoba Hydro, Cree Nation Partners (CNP) Limited Partnership, YFFN Limited Partnership, and FLCN Keeyask Investments Inc. The Cree Nation Partners Limited Partnership is controlled by TCN and WLFN. The YFFN Limited Partnership is controlled by YFFN. FLCN Keeyask Investments Inc. is controlled by FLCN. The communities may be referred to as the Keeyask Cree Nations, a term which has general usage but no legal standing. The location of the proposed Project and the four communities is shown on Map 1-1.

The investments made by the Partners in the Partnership are not equal. The smallest investment (0.01%) is the one made by the general partner, 5900345 Manitoba Ltd. The majority investment is made by Manitoba Hydro. CNP has an option to own up to 15% of the equity in the Project; and Fox Lake and York Factory, up to 5% each.

The affairs of the general partner, 5900345 Manitoba Ltd., are subject to the direction of its board of directors. Manitoba Hydro and the Partnership have agreed the board will include two persons nominated by TCN, one person nominated by WLFN, one person nominated by YFFN and one person nominated by FLCN. Board members nominated by Manitoba Hydro will constitute a majority of the Board. These appointments will be made prior to the start of construction of the Project.

In its capacity as general partner, 5900345 Manitoba Ltd. will contract all the planning, construction and operation to Manitoba Hydro. Manitoba Hydro will subcontract to other parties virtually all of the services and supplies required to build and then operate the Project. A schematic diagram illustrating the Partnership structure is set out in Figure 1-1. Most of these contracts will be entered into with Manitoba Hydro. Manitoba Hydro anticipates subcontracting most of the work and materials required to build the Project to yet other parties. In accordance with the terms of the JKDA signed on May 29, 2009, certain contracts for work, labour and materials are to be offered first to the four KCN or businesses controlled by them. Once the Project is built, 5900345 Manitoba Ltd. will contract with Manitoba Hydro to provide the necessary services to manage and operate the Project and to buy all of the energy produced by the Project. 5900345 Manitoba Ltd. will also contract with Manitoba Hydro to provide all of the debt financing required to construct the Project.

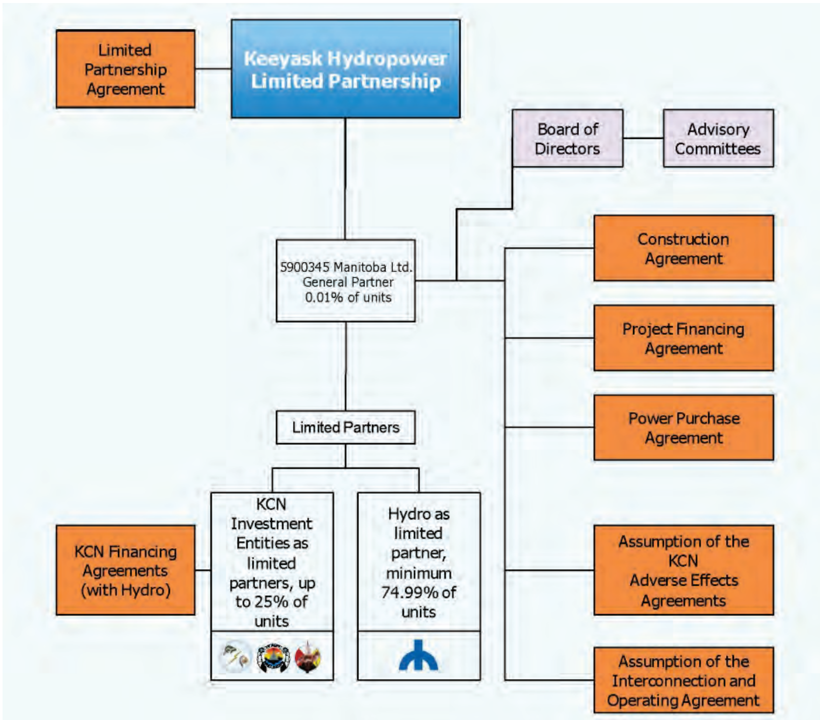

Figure 1-1: Project Partnership Structure

1.2.1The General Partner

Contact information for the Keeyask Hydropower Limited Partnership is:

Ken Adams President
5900345 Manitoba Ltd.
360 Portage Avenue, 18th Floor
P.O. Box 815
Winnipeg, MB R3C 2P4
Telephone: 204-360-3923
E-mail: kradams@hydro.mb.ca

The following is contact information for the environmental assessment:

Ryan Kustra
Manager, Major Projects Licensing Department
Manitoba Hydro
360 Portage Avenue, 15th Floor
P.O. Box 815
Winnipeg, MB R3C 2P4
Telephone: (204) 360-4334
Email: rkustra@hydro.mb.ca

1.2.2 The Partnership Communities

1.2.2.1 Tataskweyak Cree Nation

TCN, a signatory to the Adhesion to Treaty 5 in 1908, is a First Nation located in northern Manitoba at Split Lake, 120 km northeast of Thompson. Tataskweyak Reserve lands comprise Reserve 171, where the main community resides, 171A and 171B totalling 47,086 acres. According to Aboriginal Affairs and Northern Development Canada data of June 2012, Tataskweyak has an on-Reserve population of 2,216 and an off-Reserve population of 1,292, for a total of 3,508 Members. The First Nation is governed by a Chief and six Councillors elected every two years by the Members in accordance with the Indian Act. A custom election code, whereby elections are conducted in accordance with First Nation customs rather than the *Indian Act*, has been developed and is pending ratification by Members before submission to the Minister of Indian Affairs.

Chief and Council is supported by nine departments and each of the Chief and Councillors carry various government portfolios and are responsible for overseeing the delivery of a comprehensive range of community services and programs to Members. Tataskweyak is affiliated with the Keewatin Tribal Council, which facilitates the transfer of local control of First Nation programs and services in northern Manitoba.

1.2.2.2 War Lake First Nation

War Lake First Nation (WFN), whose Members are primarily descendants of TCN and YFFN, was recognized in 1980. The First Nation is located in northern Manitoba at Ilford, 40 km southeast of Split Lake, and 144 km northeast of Thompson. Current War Lake Reserve lands comprise 6.8 acres of Moosecoot Reserve within the Northern Affairs Community of Ilford. War Lake has Treaty land entitlement of 7,156 acres, with approximately 480 acres of such land transferred to Canada in 2008 to set aside as War Lake Reserve. War Lake has 94 Members living on-Reserve and 190 living off-Reserve, for a total of 284 Members.

The First Nation is governed by a Chief and two Councillors elected for three-year terms in accordance with a custom election code.

Chief and Council is supported by four departments and each of the Chief and Councillors carry various government portfolios and are responsible for overseeing the delivery of a comprehensive range of community services and programs to Members. War Lake is affiliated with the Keewatin Tribal Council, which facilitates the transfer of local control of First Nation programs and services in northern Manitoba.

1.2.2.3 York Factory First Nation

The York Factory First Nation (YFFN) signed an adhesion to Treaty #5 in 1910. In 1957, York Factory First Nation members were relocated from their homeland along the Hudson Bay coast, to a site along the north bank of the Aiken River on Split Lake. Kawechiwasik, or York Landing, is located 116 km. northeast of Thompson, Manitoba and is situated on 2,390 acres; it received official reserve status under the Indian Act on April 1990. According to Aboriginal Affairs and Northern Development Canada data of June 2012, 400 Members live on-Reserve and 796 live off-Reserve, for a total of 1,196 Members.

York Factory First Nation government consists of one Chief and four Councillors. The Chief and Council have a two-year term and are elected through Band custom. Each of the Chief and Councillors carry various government portfolios and are responsible for overseeing the delivery of a comprehensive range of community services and programs to Members. Political affiliations that are associated with the York Factory First Nation include the Keewatin Tribal Council (KTC), Manitoba Keewatinnohk Okimahkanak (MKO) and Assembly of Manitoba Chiefs (AMC).

1.2.2.4 Fox Lake Cree Nation

Recognized by Canada as an independent band in 1947, the First Nation reserve lands comprise of four reserve lands. In 1985, Fox Lake No. 2 reserve community of Bird, now known as Fox Lake, was created on 39.5 Hectares of land at the mouth of the Limestone River, approximately 53 km northeast of Gillam. In 2009, a 1.29 ha parcel of land in the Town of Gillam was established as the A Kwis Ki Mahka Indian Reserve in partial fulfillment of FLCN's outstanding treaty land entitlement. In addition, the First Nation has two additional reserves located at Fox Lake (Fox Lake No. 1) and Armstrong Lake (Fox Lake West No. 3). According to the FLCN website and Aboriginal Affairs and Northern Development Canada data of June 2012, FLCN currently consists of about 1,115 members with about 500 residents in the home Reserves in Fox Lake (Bird) and A Kwis Ki Mahka (Gillam) Reserve and the Town of Gillam.

The FLCN is governed by a Chief and three councillors under a custom electoral system. Chiefs and councillors do not have a set term in office. The portfolios of the current councillors cover a broad range of subjects and are responsible for overseeing the delivery of a comprehensive range of community services and program to Members.

1.2.2.5 Manitoba Hydro

Manitoba Hydro is a Crown corporation established in 1949 by the Province of Manitoba and continues pursuant to the *Manitoba Hydro Act*, C.C.S.M., cap. H190. Its mandate is to provide a continuous, reliable and economical supply of energy adequate for the needs of the province. It is also responsible for determining Manitoba's future electricity requirements and for designing, constructing, maintaining and operating facilities to meet these requirements.

The corporation is governed through the Manitoba Hydro-Electric Board, whose members are appointed by the Manitoba Lieutenant Governor in Council. The board reports to the Minister responsible for The Manitoba Hydro Act, who in turn reports to the Manitoba Legislative Assembly.

Manitoba Hydro has more than 5,000 MW of generating capacity, over 95% of which is from 14 hydroelectric stations on the Winnipeg, Saskatchewan, Nelson and Laurie rivers (Map 1-2). A **thermal** station at Brandon uses coal and natural gas and a station at Selkirk uses natural gas. Four remote northern communities rely on small diesel **generators**. The corporation serves 527,000 electric customers throughout Manitoba and 263,000 natural gas customers in southern Manitoba, and exports electricity to over 30 electric utilities in Canada and the mid-western United States.

Manitoba Hydro is guided by its vision and mission statements, goals, and principles of sustainable development (Response to EIS Guidelines Appendix 1A).

1.3 PROJECT PURPOSE

The purpose of the Project is to construct and operate a hydroelectric generating station with 695 MW of capacity, producing an average of 4,400 GW hours of electricity per year. The Partnership will sell all of the energy produced from the Project to Manitoba Hydro. Manitoba Hydro will use the power in its integrated system for export or domestic purposes.

While the electricity will be sold initially to export markets, based upon anticipated load growth, the power will be used to supply future domestic (Manitoba) requirements.

1.4 ELECTRICITY DEVELOPMENT IN MANITOBA

1.4.1 Hydroelectric Development

The Winnipeg River, about 100 km from the City of Winnipeg, was the main source of hydroelectric power for Manitoba throughout the first half of the 20th century. By the time the hydroelectric potential of the Winnipeg River was completely developed in the mid-1950s, the energy resources of Manitoba's northern rivers became attainable with the introduction of new **direct current** (DC) **transmission** technologies. These advances made it economically possible to transmit electricity over long distances.

Kelsey, the first generating station on the Nelson River, was built in 1960 to supply the International Nickel company's mining and smelting operations in Thompson, and Grand Rapids on the Saskatchewan River near its outlet to Lake Winnipeg was completed in 1968. The Kettle GS, completed in 1974, was the start of major plans to develop the Nelson River for the province's growing electricity needs. Since that time, three more generating stations, at Jenpeg (completed in 1979), Long Spruce (1979), and Limestone (1992), have been added to Manitoba Hydro's Integrated Power System. Limestone, the newest station, is the largest in the province with a total capacity of 1,340 MW. The 200 MW Wuskwatim GS on the Burntwood River, owned by a partnership between Nisichawayasihk Cree Nation and Manitoba Hydro, is currently under construction, with a completion date of 2012.

Manitoba Hydro's plan for developing the hydroelectric potential of the Nelson River included two related projects, the **Lake Winnipeg Regulation** Project and the **Churchill River Diversion** Project (See Map 1-2).

Lake Winnipeg, the tenth largest lake in the world, stores water from the Nelson River drainage basin, which encompasses and area of approximately 1,000,000 km² and extends from the Canadian Rockies in western Canada to within 19 km of Lake Superior in eastern Canada. In February 1966, agreement was reached between the Province of Manitoba and the Government of Canada, allowing Manitoba Hydro to regulate Lake Winnipeg as a reservoir for hydroelectric development on the Nelson River and also for flood control and drought management. The Lake Winnipeg Regulation Project included excavation of three channels to substantially increase the outflow capacity of the lake, construction of the Jenpeg GS and **control structure**, and construction of a dam at the outlet of Kiskitto Lake to prevent water from backing up into that lake. Construction began in 1970 and was completed in late 1976.

Regulation of flows on the Nelson River is necessary because the natural flow pattern from Lake Winnipeg does not coincide with the energy needs of the province. Manitobans use more electricity in the winter than in the summer, while the water flow into the Nelson River from Lake Winnipeg in its natural state is less in the winter and more in the summer. In addition, the flow out of the lake depends upon the water level and, during winter, upon the degree of obstruction by ice of the Nelson River channels. It was therefore necessary to be able to reduce the water discharged from Lake Winnipeg in the spring and early summer by storing it in the lake, and increasing the outflow in the fall and winter. The Lake Winnipeg Regulation Project increases winter outflows so the winter demand for electricity can be met.

A license was issued by the Province of Manitoba in 1970 to regulate Lake Winnipeg outflows. Lake levels vary due to runoff periods and drought periods. When the level of the lake is between 216.7 m (711 ft.) and 217.9 m (715 ft.), the licence allows Manitoba Hydro to set the outflows for power production purposes at generating stations along the Nelson River. At times the lake level will rise above or drop below these levels, such as during high or low runoff periods. When the level of the lake rises above an elevation of 217.9 m, Manitoba Hydro must maintain maximum outflow to return the level of the lake to below 217.9 m as soon as possible. During drought periods, the level of the lake may fall below 216.7 m. If this should occur, outflows from the lake are determined by the Minister of Conservation and Water Stewardship.

The Churchill River Diversion diverts flows from the Churchill River into the Rat-Burntwood-Nelson river systems to increase power production at existing and future generating stations on these two rivers (Map 1-2). The basin drained by the Churchill River has an area of approximately 283,350 km². It lies to the north of the basins of the Nelson River and Saskatchewan River, with its headwaters in east-central Alberta, adjoining the Athabasca River drainage basin on the north and west. A considerable economic advantage has been gained by diverting part of the water from the Churchill River into the Burntwood River and Nelson River systems to use at the generating stations on the Burntwood and Nelson rivers. Manitoba Hydro announced its intention in February 1966 to divert the Churchill River as part of an overall plan of northern hydroelectric development, and in December 1972, a licence to proceed with the diversion was issued to Manitoba Hydro. Construction contracts were awarded in 1973, and the diversion was in operation by 1977.

The diversion plan centres around Southern Indian Lake, a lake on the Churchill River system. The project has three main components:

1. Missi Falls control structure at the natural outlet of Southern Indian Lake which controls the outflow and also raises the lake's level by 3 m.
2. Excavated channel from South Bay of Southern Indian Lake to Issett Lake provide a second outlet to allow water from the Churchill River to flow into the Rat River-Burntwood River-Nelson River systems.
3. Notigi control structure on the Rat River, which regulates the flow into the Rat-Burntwood-Nelson River systems.

As originally conceived, the diversion plan was to raise the level of Southern Indian Lake by 10.6 m. However, in order to reduce adverse impacts on the biophysical **environment**, resource use and the community of South Indian Lake, the plan was modified to limit raising the lake's level to 3 m.

Under the terms of the licence, including annual ministerial authorizations, Manitoba Hydro is permitted to divert up to 991 m^3/s from the Churchill River into the Nelson River between May 16 and October 31 and up to 963 m^3/s during the rest of the year. The licence also stipulates that the outflow from the control dam at Missi Falls must be at least 14 m^3/s during the open water season, and 43 m^3/s during the ice-cover period. Manitoba Hydro submitted a request to Manitoba Water Stewardship for a final license in May 2009.

Two **weirs** were built, one on the upper Nelson River and another on the lower Churchill River, to partially mitigate changes in water levels caused by the Lake Winnipeg Regulation and Churchill River Diversion Projects, respectively. The Cross Lake weir was constructed in 1991 to reduce the impacts caused by the reversal of the historic pattern of water levels and fluctuations at Cross Lake. The weir and the related operations at the Jenpeg GS raised the minimum water level on Cross Lake by nearly 1.4 m, and season-to-season fluctuations are more moderate and gradual than in the past. The effectiveness of the Cross Lake Weir continues to be monitored.

The weir on the lower Churchill River near the Town of Churchill was developed to help offset reduced water levels resulting from the diversion of flows out of the Churchill River. Before the diversion, outflows from Southern Indian Lake averaged 991 m^3/s. Below Missi Falls, tributaries bolstered the Churchill River's natural flow to an average of 1,274 m^3/s emptying into Hudson Bay. With the diversion, the river's flows into Hudson Bay were reduced to an average of 510 m^3/s. The weir has raised the water level near the town of Churchill to enhance the recreational use of the river by the public, to improve aquatic life and to improve the reliability of water supply to the town. Following receipt of environmental approvals, construction of the weir began in the late spring of 1998 and was completed in the summer of 2000.

1.4.2 Thermal and Wind Generation

Manitoba Hydro's predominantly hydroelectric generation system (Map 1-2) is supplemented by two thermal generating stations, which produce electricity using natural gas and coal. Located in Brandon (coal and gas) and Selkirk (gas), they are used in the following four ways:

- To help provide power when consumer demands for electricity are high, especially during the winter months.
- To help provide basic electricity supplies during times of low water conditions.
- To provide a reliable year-round alternative supply during short-term emergencies that may occur either at the hydroelectric generating stations or on the transmission line system.
- To guarantee long-term sales of electricity on the export market by providing back-up generation should hydroelectric resources be restricted by unforeseen factors such as low water flows.

Wind power is another renewable energy source in Manitoba. The province has reasonably good wind resources, such as the wind farms developed by private companies at St. Leon (99 MW) and St. Joseph (138 MW). Manitoba Hydro purchases all of the production from these wind farms. Manitoba Hydro is continuing to gauge the potential to integrate wind power into its energy system.

1.4.3 Transmission and Distribution Systems

Delivering the electricity produced at the northern generating stations is accomplished in three **stages**. Manitoba Hydro's high-voltage transmission line system (Map 1-3) carries electricity from convertor stations in northern Manitoba to convertor stations in southern Manitoba where large **transformers** convert the high voltages to low voltages. **Sub-transmission lines** then feed the electricity into a distribution system where the voltages are again converted to lower levels. Manitoba Hydro's major high voltage transmission lines operate at 115 kV, 138 kV, 230 kV, and 500 kV. At the terminal stations located in heavily populated areas, large transformers convert the voltages to 66 kV, 33 kV, or 24 kV.

The electricity is fed into a distribution system where, at various stages, transformers lower the voltages for distribution to Manitoba's cities, towns, and rural communities. The final stage occurs at the pole-top or underground transformers, which provide a 120/240 V service into the customers' premises.

As with most power systems in the world, Manitoba Hydro generates and transmits electricity as **alternating current** (AC) because of the relative ease of transforming voltages to the desired levels. But because of the exceptionally long distances between the Nelson River generating stations and southern Manitoba, where most of the electricity is used, it is more efficient and economical to transmit electricity as high voltage direct current (HVDC). Manitoba Hydro's HVDC transmission system consists of two identical steel tower lines, Bipole I and Bipole II. From Gillam, they follow a 900 km route through the Interlake area to Rosser, located 26 km from Winnipeg on the northwest side. The other main components of the system are three **converter stations**: Radisson and Henday located in northern Manitoba as the northern terminus for Bipole II and Bipole I, respectively, and Dorsey at Rosser in southern Manitoba. At Radisson and Henday, electricity is converted from AC to DC and is then transmitted along the DC lines to Dorsey where it is converted once again to AC and fed into Manitoba's southern power grid. Plans are currently being developed for a third Bipole (*i.e.,* Bipole III) from northern to southern Manitoba, plus new converter stations at both ends of the line. This project is required to enhance the reliability for transmitting power from northern to southern Manitoba. Bipole III will improve security against outages to the existing DC system, such as those that could be caused by severe weather incidents and other outages. It will also provide capacity to transmit power from future potential generating stations in the north, including the proposed Keeyask GS.

Of great value to Manitoba are the transmission systems that connect the province with Ontario, Saskatchewan and the United States. These transmission lines have proved to be mutually beneficial as a back-up supply during emergencies or periods of high demand. They also provide access to out-of-province markets for selling surplus electricity. There are three lines to Ontario, five to Saskatchewan, and four to the United States.

2.0 PROJECT COMPONENTS

This section of the Project Description Supporting Volume (PD SV) provides information about the structures that will comprise the Project and the parameters according to which these structures are designed. It also provides an overview about the location and lands required for the Project. 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 6.0.

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 as well as the fundamental construction and operating features of the Project established in the JKDA (Section 1.1).

Some of the infrastructure is part of the KIP, which was licensed separately from and prior to the Keeyask Generation Project. That Project includes the construction of the north access road and the first phase of the main construction camp. The operation of the north access road and the operation and decommissioning of the camp are included as part of the Keeyask Generation Project, for which regulatory approval is being sought. As well, transmission lines related to the Project will be owned and operated by Manitoba Hydro, rather than by the Keeyask Hydropower Limited Partnership. The regulatory review of the Keeyask Transmission Project (the Keeyask **Construction Power** and Generation Outlet Transmission Project) is being conducted concurrently with but separate from the regulatory process for the Keeyask Generation Project.

2.1 LAND REQUIREMENTS

The Project will require areas totalling approximately 133.5 km^2 for the construction phase and about 138.2 km^2 for the operation phase. The area required for the operations 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. 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. During the first 30 years after full reservoir impoundment, the reservoir is predicted to expand by approximately 7 to 8 km^2 due to the **erosion** of some mineral shorelines and **peatland disintegration**. The construction site and **borrow**

sites will be decommissioned and rehabilitated as described in Section 3.0. 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 2-1 and is illustrated for the construction and operation phases in Map 2-1, Map 2-2 and Map 2-3.

Table 2-1: 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	638	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[3]	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%
Ares 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:

1. Haul road alignments are preliminary.

2. Road corridors provide flexibility for realignment during final design and construction. Includes road corridors located Outside the reservoir.

3. Area is the maximum amount of borrow area or excavated material placement area that may be used; the actual area required for construction will likely be much smaller.

4. Reservoir Clearing Area includes road corridors and unlikely to be used areas that are within the reservoir. This area excludes mitigation and compensation area.

5. Areas unlikely to be used are areas that may be required by the designed and contractors but have a low probability of being utilized. These include all areas unlikely to be used outside of the reservoir.

6. Existing Water Surface Area is depicted in the footprint Map 2-1, Map 2-2 and Map 2-3 as Altered Water Level or Flow.

2.1.1 Leased Lands

The Keeyask Hydropower Limited Partnership has a lease for the lands required for the north access road, camps, contractor work areas and other facilities on the north and south sides of the Nelson River (Map 2-4). This lease grants a purchase right to the Partnership. The Partnership intends to purchase the leased lands and additional lands on the north and south side of the Nelson River and water lots in the Nelson River. These lands will be used for the principal structures and the south access road. After final commissioning, the partnership will re-convey surplus lands to Manitoba.

2.1.2 Crown Lands

The following is an estimate of the Crown lands required, which includes areas that will be purchased by the partnership:

Lands of the province not covered by water required for main diverting works, powerhouse, and similar works, including construction work area, camps, south dam, central dam, north dam and transition structures, powerhouse, spillway, rock quarries, granular and impervious borrow areas, intake and tailrace excavated channels, disposal areas for surplus excavated materials and dykes located in portions of Twp. 84-R12 EPM, Twp. 84-R13 EPM, Twp. 85-R13 EPM, Twp. 85-R14 EPM, Twp. 85-R15 EPM, Twp. 84-R14 EPM and Twp. 84-R15 EPM.

- 3,250 ha during construction phase.
- 2,915 ha during operation phase.

Lands of the province covered by water required for the Project including cofferdams, spillway, south dam, central dam, north dam and transition structures, powerhouse, spillway, rock quarries, disposal areas for surplus excavated materials and channel excavations, located in portions of Twp. 84-R13 EPM, Twp. 85-R14 EPM, Twp. 85-R15 EPM, Twp. 84-R14 EPM and Twp. 84-R15 EPM.

- 557 ha during construction phase.
- 161 ha during operation phase.

Lands of the province required only to be flooded in connection with the storage or pondage of water. This area includes the reservoir expansion that is predicted to occur during the first 30 years of the plant's operation, much of it occurring within the first year of operation. This area is located in portions of Twp. 85-R15 EPM, Twp. 84-R15 EPM, Twp. 85-R14 EPM, Twp. 84-R14 EPM, Twp. 85-R13 EPM, Twp. 84-R13 EPM, Twp. 84-R12 EPM and Twp. 84-R11 EPM.

- 312 ha during Stage I Diversion of the construction phase.
- 2,576 ha during Stage II Diversion of the construction phase.
- 4,537 ha during reservoir impoundment stage of construction phase.
- 5,265 ha during operation phase.

Lands of the province required for rights of way for access roads include the following:

Operation of the north access road from Provincial Road 280 to Gull Rapids will have a length of approximately 25 km. The access road will have a right-of-way width of 100 m. Upon completion of the Project, ownership of the road will be transferred to Manitoba Infrastructure and Transportation (MIT) and become a provincial road. The north access road is located in portions of Twp. 85-R13 EPM, Twp. 85-R14 EPM and Twp. 85-R15 EPM.

- 234 ha during the operation phase.

Construction and operation of a south access road will have a length of approximately 34 km from Gull Rapids to Gillam. The south access road will include 14 km of new and 20 km of upgraded roadway. Upon completion of the Project, ownership of the road will be transferred to MIT and become a provincial road. This road will have a right-of-way width of 100 m and will be 14.4 km long. The south access road is located in portions of Twp. 84-R15 EPM, Twp. 84-R16 EPM, Twp. 84-R17 EPM, Twp. 85-R17 EPM, Twp. 85-R18 EPM.

- 329 ha during the construction and operation phase.

The total estimate of Crown lands required during construction (Map 2-1 and Map 2-3) is 8,673 ha. Total estimate of Crown lands required during operation (Map 2-2 and Map 2-3) is 8,904 ha. It is noted that these estimates include the area of the **Project Footprint**, newly flooded area and reservoir expansion.

2.1.3 Private Lands

There are no known private lands within the project area.

2.2 KEY PLANNING AND DESIGN PARAMETERS

2.2.1 Datum

The Project is being designed and will be constructed and operated based on the Canadian Geodetic Survey of Canada, Canadian Geodetic Vertical Datum 1928, 1929 Adjustment ("GS of C, CGVD28, 1929 Adjustment"). All elevations in this project description and the EIS are referenced to this **vertical datum**. The International System of Units (the metric system) is being used for the design and will be used for the operation of the Project.

2.2.2 Reservoir Levels and Powerhouse Discharge Capacity

The Project will use approximately 18 m of the 27 m of hydraulic **head** available between Split Lake and Stephens Lake, including about 12 m of drop that occurs through Gull Rapids. It will be operated with a maximum reservoir level (*i.e.,* FSL) of 159 m and a minimum reservoir operating level (MOL) of 158 m. The level of its downstream tailrace is effectively determined by Stephens Lake, which has a normal full supply level of 141.1 m and a normal minimum operating level of 139.2 m (5th percentile forebay level). The amount of water passing through the Project site is determined by the reservoir level, the tailrace level, and the setting of the station's gates. When the reservoir is at its full supply level and its gates are fully open to produce the maximum amount of electricity (*i.e.,* **full gate discharge**), the generating station will be able to discharge approximately 4,000 m^3 of water per second when Stephens Lake is also at its full supply level. However, to achieve maximum efficiency for any given flow, the gates may be set at **best gate** discharge. When the reservoir is at its full supply level and the station is operated at best gate discharge, the station will discharge approximately 3,850 m^3 of water per second when Stephens Lake is also at its FSL.

The Project is rated at 695 MW, which is the amount of power available when the reservoir is at its FSL, Stephens Lake is at a low level of 139.6 m (10th percentile), the Project will generate approximately 630 MW at full gate discharge. Generation will not exceed the generator limit, which is currently estimated to be 695 MW, even if the reservoir should be higher than its maximum supply level and the tailrace should be below its minimum supply level. As the **turbines** and water passage through the powerhouse undergo final design, the generator ratings may be slightly smaller or larger. Table 2-2 summarizes the main design parameters for the Project.

Table 2-2: 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 at Stephens Lake at 141.12 m (FSL)	630 MW
Rated Total Output Power at 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

Notes:

1. 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.
2. 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.
3. The Full Gate Discharge, Best Gate Discharge and Rated Total Output Power are current estimates that may change slightly during the final design of the turbines and water passage.

2.2.3 Design Floods

Design floods are river discharges that the Project is designed to safely pass through both the powerhouse and spillway into Stephens Lake. The long-term design flood flow is established for the design of the long-term safe operation of the Project. The **construction design flood** is established to design cofferdams to provide a reasonable degree of protection against high flows during the construction phase of the Project. The magnitude of the design flood during the construction phase (construction design flood) is less than the magnitude of the design flood used for the long-term operation phase (inflow design flood) as explained in the following sections.

2.2.3.1 Construction Phase Design Flood

During the construction phase, the Project structures are designed to withstand flows and levels associated with a flood expected to have a 5% probability of occurring each year or has a frequency of once every 20 years on average. This flood is called the construction design flood (CDF). The structures will also have an additional 1 m of **freeboard** where the design level is governed by open water conditions and 1.5 m where the design level is governed by winter conditions. The freeboard will accommodate an approximate 1:100-year flood.

In the event of water overtopping the cofferdams during a flood exceeding the construction design flood, construction would need to be suspended resulting in a schedule delay. Floods on the lower Nelson River generally do not occur suddenly so advance warning would be available to avoid risk to workers and to minimize or avoid damage to infrastructure.

Both summer and winter conditions were considered when determining the flows and levels associated with the construction design flood. During construction of the Project, the most adverse water levels at the powerhouse cofferdams may occur during low flow conditions in the winter because low winter flows can create an environment conducive to the formation of ice jams in the upper reaches of Stephens Lake which results in higher water levels at the downstream end of Gull Rapids. The winter water level in the vicinity of the powerhouse cofferdam during a construction design flood could be approximately 143.7 m. This level exceeds the open water construction design flood level and therefore it is used to establish the powerhouse cofferdam elevation along with the necessary freeboard.

For the cofferdams upstream of the powerhouse (*i.e.,* the north channel rock groin, north channel cofferdam and island cofferdam), the water levels during a construction design flood at the upstream end of Gull Rapids during the open water (summer) season of Stage II river diversion would be higher than during winter conditions. Therefore, the design elevation for these cofferdams are based on open water conditions for Stage II river diversion.

2.2.3.2 Inflow Design Flood

The Inflow Design Flood (IDF) is the flood into the reservoir, which the project must be capable of passing. For this Project the Probable Maximum Flood (PMF) was selected for the IDF. This decision was based on the 2007 Canadian Dam Association (CDA) Dam Safety Guidelines which categorize projects as to the potential incremental consequences of dam failure. Under these guidelines, projects are categorized with respect to the impacts that are incremental to the impacts that would occur under the same flood conditions, but without failure of the dam. In assessing these impacts, consideration was given to both pre and post downstream development conditions along the Nelson River. The magnitude of the selected IDF was then based on the magnitude of the potential incremental consequences. Based on the 2007 CDA Dam Safety Guidelines, the Consequence Category of this project would be rated as

Extreme, due to the economic, social, and environmental impacts of a failure. As a consequence, the PMF discharge of 12,700 m^3/s was selected as the IDF.

The PMF is defined by the CDA as:

> An estimate by the hypothetical flood (peak flow, volume and hydrograph shape) that is considered as the most severe 'reasonably possible' at a particular location and time of year, based on a relatively comprehensive hydro-meteorological analysis of critical runoff – producing precipitation (snowmelt if pertinent) and hydrological factors favourable for a maximum flood runoff. (Canadian Dam Association 2007).

The PMF is the flood that would result from the most severe hydrologic and meteorological conditions that could reasonably occur in the Nelson River Watershed at this location. It is based on analyses of local historic precipitation, snowmelt and other factors conducive to producing maximum flows. Statistically, this flood represents an extremely remote event, less than a 1:10,000-year frequency, which is the largest potential flood that could reasonably occur in the river basin. The estimated PMF for this Project is more than double the flow experienced during the summer of 2005, which is the highest recorded daily average on record. The Project is designed to be able to pass the PMF without **surcharge** of the reservoir if the turbines are all operating. In addition, the design considers the potential situation where the turbines could not operate because of a concurrent outage of transmission lines. In such a case, the turbines would operate a speed no-load condition.

The speed-no-load discharge is the amount of water that can be passed through the powerhouse without risking damage to the generating units when no electricity is being produced. The total speed-no-load discharge for six of the seven units is 1,400 m^3/s. During the probable maximum flood event, 1,400 m^3/s would pass through the powerhouse and 11,300 m^3/s would pass over the spillway. In order for the spillway to accommodate this much flow, the reservoir level would surcharge higher than the full supply level of 159.0 m to an elevation of 160.3 m.

2.3 PRINCIPAL STRUCTURES

2.3.1 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** as shown in Figure 2-1 and Figure 2-2. 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**.

Each intake will consist of three water passages separated by two intermediate piers, which will extend from the upstream face of the Intake to the entrance of the semi-spiral scroll case. Each of the three intakes will be approximately 22.7 m tall and 6.4 m wide.

Water will flow from the intake channel through the semi-spiral scroll case to a turbine, where the hydraulic energy will be converted to mechanical energy (through rotation of the turbine shaft) and then to electrical energy by the generators. Discharge from the turbine will pass into the draft tube, which will be divided into two water passages, downstream of the elbow, by a center pier.

The Project reservoir is expected to generate woody debris due to shoreline erosion. A Waterways Management Program (Response to EIS Guidelines 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 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.

The upstream deck of the powerhouse will be 10 m wide and will accommodate the access road. Hatch covers within the roadway deck will provide access to the intake bulkhead gate sections, (*i.e.,* stop logs) which will be stored within a lower area in the service bay. When required for use, the bulkhead gates, will be handled by an overhead monorail crane supported off the upstream wall of the **intake structure**. Hoists mounted on top of the intake structure will raise and lower the intake service gates to shut off the flow to each of the individual units for maintenance and to respond to emergencies. Maintenance of each service gate will be carried out behind the bulkhead gates, which will be lowered into slots upstream of the service gate so that it remains **dewatered** as it is being serviced. Draft tube gates will permit isolation of the draft tubes from the tailrace, thus allowing dewatering and maintenance of the draft tubes and turbines to be undertaken as required.

The Powerhouse enclosure will be framed by using superstructure steel which will support two 207.5 Mg electric overhead travelling bridge cranes. The cranes will traverse the full length of the powerhouse and service bay. Insulated metal cladding supported by the superstructure steel will enclose the powerhouse and service bay, except along the downstream wall in the area of the generator transformers, where the cladding will be precast concrete sandwich panels. These will be designed to protect the interior of the powerhouse should a transformer catch fire and/or explode. The powerhouse will also contain mechanical and electrical equipment to control the turbines and generators and to service the complex. The service equipment includes heating and ventilation systems, domestic and fire water systems, cranes, wastewater treatment, compressed air, and oil storage facilities. Where necessary, equipment will include full containment capacity in the event of an oil spill.

The tailrace structure will include individual draft tube gate **guides**, a draft tube gate travelling crane (located below the tailrace deck) and individual three phase generator transformers for each unit, which will be located on the tailrace deck. An electrical gallery below the tailrace deck will extend the full length of the powerhouse. The electrical gallery will be separated from the interior of the powerhouse by walls and fire doors at every unit to prevent the spread of smoke should a fire develop in the electrical gallery. Below the level of the electrical gallery, an oil-water separation reservoir will be located on the tailrace side of Unit 4. The spacing of the transformers is sufficient to obviate the need for **blast walls** between the transformers. Small shield walls will be provided locally between each transformer and the riser sections of IPB ducts to provide protection in the event of a transformer fire.

To prevent any accidental discharge of oil into the river, the main transformers on the tailrace deck will be supported on concrete pedestal foundations surrounded by tall concrete curbs to contain any oil leaks should a transformer fail. The foundations will drain to the oil-water separation reservoir below the electrical gallery floor. The tailrace deck will also have downstream curbs and drainage slopes to contain any oil spills. Run-off from the deck will be drained to the oil-water separation reservoir.

A service bay is required to assemble the turbines and generators and to erect other large pieces when the Project is under construction. 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 firewater systems, cranes, water and wastewater systems, compressed air and oil storage facilities. The service bay will be constructed at the north end of the powerhouse. Vehicles will be able to enter the service bay from an adjacent parking lot.

The **control building** will be attached to the service bay's downstream wall and will be located above the tailrace deck and extend for the full length of the service bay. The control building will house the equipment that will control and monitor the operation of the turbine and generator units. During the operation phase several people will staff the powerhouse control building during the day shift. During seasonal maintenance work, the number of people working within the powerhouse complex during the day shift would be higher. Workers will not reside at the site.

While detailed design is not complete, initial designs indicate that the intake/powerhouse/service bay complex will be approximately 248 m in length along the axis of the primary structures, about 68 m wide and 62 m high (from rock at its lowest point to the top of the intake hoist housing). The location of powerhouse is shown in Map 2-5, a cross-sectional shown in Figure 2-2, and an artists rendering in Figure 1-3.

The powerhouse complex will be founded on bedrock, 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.

In the event of a wide spread outage or black out in Manitoba Hydro's Integrated Power System, the Project will provide **Black Start** capability to parts of the system. To provide this capability for the Project two standby diesel generators will be located outdoors adjacent to the service bay. In the event of a system black out, one of the two standby diesel generators will be used to get one of the generating station units running. The second standby diesel generator is a back up for the first standby diesel generator in the event that it fails to work. Power generated at the Project will then be used to start other generating stations in the north which can then restore power to Manitoba Hydro's Integrated Power System.

2.3.2 Spillway

The spillway will be a seven bay concrete overflow structure with each bay having a **vertical lift gate**. (Figure 2-3). Based on preliminary design, each bay will be about 13 m wide, separated by 3.5 m thick piers. The spillway will be about 119 m long along the axis of the primarystructures, about 42 m wide and 28 m high from rock to the upstream **bridge deck** (not including the gate hoist tower). The spillway will be located within a channel excavated on the south side of one of the large islands within Gull Rapids, approximately 1.6 km south of the powerhouse (Map 2-5). Two concrete transition structures will connect the spillway to the central dam (to the north) and the south dam (to the south).

Four of the seven vertical lift gates will have heated guides to permit operation in the winter. The gates will be controlled by individual hoists supported on structural steel bridges, which, in turn, will be supported by structural steel towers founded on the piers. The hoist bridges will be enclosed by an insulated metal clad hoist housing which will extend across the seven bays and will also enclose the two end towers, which will contain the access stairs. A monorail, supported by brackets off the upstream side of the towers, will be used to place and remove the stop logs. The stop logs will be stored in the stop log slots, at deck level, when not in use.

Downstream stop logs will permit dewatering, inspection, and maintenance of the concrete floor and **rollways** (Figure 2-3). The spillway will contain various mechanical and electrical systems and equipment needed to operate and control the spillway, including safety, security and **monitoring** systems. A standby diesel generator located at the spillway will provide emergency power to the spillway in the event of a power outage.

A road bridge, supported on the upstream end of the piers, will form a part of the continuous road access across all the structures. A second bridge will be supported on the downstream end of the piers and will be utilized during construction and for installation of the downstream stop logs, should maintenance be required on the structure's concrete surfaces.

Initially, the spillway will be only be partially completed, in order to utilize it to pass the river's flow during the Stage II Diversion construction phase of the project. Each of the seven bays will be constructed as simple **sluices** for this diversion stage. Nearing the end of Stage II Diversion the spillway gates will be used to close the sluices, which will then be dewatered, one or two bays at a time, following placement of stop logs at the upstream and downstream extremities of the piers. Rollways will then be constructed in each bay, in a sequenced schedule, using the downstream bridge deck for access. Once the Project is operating, flows that are larger than the powerhouse discharge capacity will pass through the spillway. The spillway is designed to protect the Project from flows up to the PMF. A PMF would result in a peak discharge of 12,700 m^3/s, and if this extreme circumstance were ever to occur under no load on the turbines (Section 2.2.3.2), the upstream water level would rise to 160.3 m, which is the basis for selecting the elevation for the **crest** of the spillways' concrete structures. The spillway would pass 11,300 m^3/s of the river flow while the remaining flow would pass through the powerhouse, which is assumed to be operating with six of seven units operating with a speed-no-load discharge of 1,400 m^3/s.

The seventh unit is assumed to be out of service. The spillway is designed to accommodate a flow of 9,960 m^3/s at the Project's normal full supply level of 159.0 m.

2.3.3 Powerhouse and Spillway Channels

2.3.3.1 Spillway Channels

The function of the spillway approach channel is to convey river flow from upstream of the axis of the partially completed structures to the Spillway with minimal head loss during the Stage II Diversion phase of the project. The channel is expected to be excavated in bedrock, although there may be pockets of riverbed alluvium. The area upstream of the channel and the channel itself will be cleared of loose debris prior to Stage II Diversion being initiated.

Complementary to the spillway approach channel, the function of the spillway discharge channel is to convey the discharge from the spillway back to the river.

During spillway operation flow will discharge directly into the channel excavated in the rock immediately to the downstream of the structure. Due to high resultant velocities, some erosion of the natural riverbed will occur with time. A decision as to whether or not to pre-excavate a scour hole will be based on an examination of the bedrock geology during the construction of the spillway structure and discharge channel in advance of Stage II Diversion. Currently, it anticipated that pre-excavation will not be required. The bedrock at the Project site has been assessed to be typically fresh and strong, to very strong. It is considered to be of sufficient quality to preclude the requirements for a stilling basin. The approach channel and discharge channel configurations are illustrated on Map 2-6 and Figure 2-4.

2.3.3.2 Powerhouse Channels

The area immediately upstream of the powerhouse intakes will be excavated downward through the bedrock to direct the flow from the higher riverbed to the intakes. The remainder of the riverbed in the area of the intakes will also be shaped as required to minimize head loss and to assure the formation of a competent upstream ice cover with minimal risk of **frazil ice** generation. Establishing smooth, non-turbulent flow in the approach (intake) channel also helps to minimize erosion along the channel's floor and near-vertical sides. To accomplish this, the channel floor will gently drop at a 1:25 slope, 22 m from its upstream entrance to the entrance to the intake. Over the same distance, the channel's width will converge in a bell-mouth shape to a width of approximately 212 m.

Erosion protection for the excavated overburden slopes near the intakes will be designed to ensure that erosion does not occur. The alignment of the intake channel was established such that it promotes an even distribution of inflow to the Intake passages. A rock trap will be provided immediately upstream of the intake to reduce the risk of local bed material entering the units.

The tailrace channel is designed to convey the discharge from the powerhouse draft tubes to the upper reaches of Stephens Lake with a minimum of head loss. The tailrace channel will be excavated in bedrock. The channel walls will be formed by controlled perimeter blasting techniques and the invert by limitation of **sub-grade drilling** and loading. At the draft tube exit the floor of the channel first slopes upwards at a rate of 1:10 over a distance of approximately 115 m to an elevation of 131.0 m. It then remains flat over a distance of approximately 371 m resulting in a depth of water of approximately 10 m. The floor of the channel then slopes upwards at a rate of 1:25 until it matches the natural riverbed.

Several design considerations for the tailrace channel have been identified to enhance the movement of lake sturgeon through the tailrace channel, as well as improvements to sturgeon spawning habitat. These design considerations include a 1:1 bedrock slope cut along the north side of the tailrace channel, as well as creating a bench along the north end of the tailrace channel near the powerhouse. The intake and tailrace channel are illustrated in Map 2-6 and Figure 2-5.

2.3.4 Wing Walls

There will be five concrete gravity walls (Walls A to E) associated with the principal structures shown on Map 2-7.

Wall A will be located upstream and abut upstream side of the spillway south transition. It will serve to contain the upstream slope of the south dam, which will wrap around the spillway south transition, and to prevent any **fill** from encroaching into the spillway approach channel. It will be approximately 37 m long.

Wall B will be located on the upstream side of the spillway north transition and will retain the upstream slope of the central dam where it will wrap around the spillway north transition. It will be approximately 37.5 m long.

Wall C will be connected to the downstream side of the north end pier of the spillway and will retain the fill in the ramp down from the crest of the central dam and prevent ravelling of the fill into the spillway discharge channel. The ramp will provides access to the downstream spillway bridge deck. The wall will be approximately 15.5 m long.

Wall D will essentially be a mirror image of Wall C and will be connected to the downstream side of the south end pier of the spillway. It will be approximately 14 m long.

Wall E will abut the upstream face of the powerhouse south transition and will retain the upstream slope of the fill in the central dam and prevent it from encroaching into the intake channel. The wall will be approximately 47 m long.

2.3.5 Transition Structures

There will be four **transition structures**, two associated with the spillway and two with the Intake/Powerhouse/Service Bay as shown on Map 2-7. The transition structures are the spillway north transition, spillway south transition, powerhouse north transition, powerhouse south transition. All of the transitions will be concrete gravity sections founded on bedrock and will serve to connect the principal concrete structures to the adjacent earthfill dams. Each of the transition structures will provide a wraparound seal for the **impervious core** of the connecting dam. The upstream and end faces of the transitions will be sloped at 1H:10V to ensure continuous seal contact with the impervious core of the abutting earthfill structures.

The spillway north transition will include two concrete buttress walls will be **cantilevered** from the downstream face of the transition to support the spillway load centre and the backup diesel generator. Precast beams will span between the buttresses to form the floor of the building. The space below the floor of the building will be enclosed and divided into two rooms using concrete block walls. The rooms will house the diesel fire pump and the electric fire pump, which will be supported on a reinforced concrete slab founded on the compacted fill surface.

A portion of the powerhouse south transition on the downstream side abutting the intake/powerhouse will be extended to accommodate stair and elevator access to the Intake gate hoist housing, the powerhouse main floor at 152.0 m and the dewatering gallery at 125.5 m. At the deck level of the downstream extension, there will be a steel framed, insulated, metal clad entrance building which will enclose the stairs, elevator, washrooms and a janitor's room. The upper level of the building will form the elevator hoist room.

2.3.6 North, Central and South Dams

Three earthfill dams (the north dam, central dam, and south dam) will be constructed across Gull Rapids, as shown in Map 2-5, creating a reservoir upstream of the powerhouse. The purpose of the dams is to retain and store water in the reservoir before it passes through the generating station and produces electricity.

The north dam will have a maximum height of approximately 25 m and will be approximately 100 m in length. 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.

The elevation of the dams' crests will range between 162.0 m and 162.6 m. The crest elevations of the dams have been set to accommodate the highest reservoir water levels arising from either of the passage of the PMF with no turbine load, or design floods with the reservoir at FSL. The required crest elevations take into account the appropriate combined effects of the wind-generated waves and post-construction embankment settlements, which are associated with each of these two design conditions.

The dams will be earth and **rock fill** embankments consisting of a central impervious core, granular and crushed rock filters, outer rock fill shells and riprap. Typical cross-sections for the dams are shown in Figure 2-6. Filter/transition zones will be located on both the upstream and downstream sides of the core. With the exception of a small portion of the central dam, the dams will be founded on prepared bedrock and the upper portions of the bedrock will be sealed with a grout curtain to minimize seepage. A small portion of the central dam's length will be founded on bedrock for its impervious core and on **till** deposit on the upstream and downstream sections of the dam. The nominal seepage through the dams will be intercepted by a system of granular filters and drains and directed into the nearest channel. The outer surfaces of the dams will be protected with rock fill bedding and riprap materials to prevent erosion of the inner fills by wind generated waves, on the upstream slope, and precipitation runoff on the downstream slope.

2.3.7 North and South Dykes

The purpose of the north and south dykes is to contain water in the reservoir and limit the extent of flooding (Map 2-5) in areas of relatively low-lying **topography**. A series of discontinuous earthfill dykes will be located along both sides of the river, extending 11.6 km on the north and 11.2 km on the south side of the river. A roadway will be constructed on top of the dykes and between the sections of dykes to facilitate inspection and maintenance. The crest of the dykes will vary between elevations 161.8 m and 163.0 m but may be somewhat higher in areas where the foundations are expected to settle over time. The north dyke and south dyke will have maximum heights of about 20 m and 13 m respectively.

Since these dykes will be located within a discontinuous **permafrost** region, their design will take into account the thawing of permafrost affected foundations and the resultant potential for differential settlements.

There are four embankment cross-sectional designs used for the north and south dykes as shown on Figure 2-6. Usage of these various designs is generally related to the local foundation conditions present along the length of the dyke. Following are descriptions of the four types of cross-sections:

Zoned Impervious Core Dyke - Used in areas where the natural ground elevation is below FSL and the dyke is required to retain reservoir water. Founded on glacial till and made up of an impervious core, granular filters and transition zones and outer rock fill shell.

Granular Dyke - Used in areas of limited length, where permafrost affected overburden is relatively thick and uneconomical to excavate. The dyke is founded on postglacial clays and consists of semipervious granular zones, a **downstream toe drain**, and slope protection zones. The dyke design will limit seepage to a controllable volume and accommodate differential foundation settlements, which will occur due to **thaw consolidation** of the permafrost affected postglacial clays.

Freeboard Dyke - Used in areas where the natural ground elevation is above FSL but below the design crest of the dyke. These sections are only required to withhold water due to wave run-up, wind set-up and reservoir tilt (temporary circumstances). A relatively low structure consisting of semipervious granular fill, covered with protective shells of crushed rock, and riprap, where appropriate.

Access Road - Used in areas where the natural ground elevation is above the crest elevation of the freeboard dyke. The road section is needed to provide access between the dyke sections for maintenance and inspections and will consist of **road topping** over granular material that is placed after all **organic**s are stripped.

To minimize the settlements and the problems associated with thaw consolidation, in most areas the top layers of peat and clay will be removed. Explorations have indicated that the permafrost in the glacial deposits is of low moisture content (ice-poor) and is expected to result in relatively small settlements. Areas where the glacial deposits contain large amounts of visible ice are expected to be localized in extent and will be removed prior to placement of the fill.

As shown on Map 2-8, the north dyke is composed of approximately 2,900 m of zoned impervious core dyke, 185 m of granular dyke, 4,800 m of freeboard dykes, and 3,700 m of maintenance road. The south dyke is composed of approximately 5,040 m of zoned impervious core dyke, 4,930 m of freeboard dykes, and 1,230 m of maintenance road. Cross-sections for the granular dyke, impervious core dyke, freeboard dykes and road section dykes are shown in Figure 2-6.

2.3.8 Reservoir

A reservoir is an impounded area upstream of a dam or hydroelectric generating station in which water is stored for later use. The amount of energy that the generating station can produce from the water stored in the reservoir is related to the head (elevation difference between the forebay and tailrace levels), the incoming river discharge and the volume of water in the reservoir.

The reservoir will extend approximately 42 km from the generating station to about 3 km downstream of the outlet of Clark Lake, as shown in Map 2-9. 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. Live reservoir storage at initial impoundment will be approximately 81.4 M m^3.

The reservoir area is predicted to expand by about 7 to 8 km^2 during the first 30 years of operation due to the erosion of some mineral shorelines and peatland disintegration. Water levels will be higher as the reservoir moves upstream from the powerhouse, spillway and dams, as shown in Map 2-9. The total live reservoir storage with the additional reservoir expansion is predicted to be approximately 84.9 M m^3 - 85.4 M m^3.

2.4 SUPPORTING INFRASTRUCTURE

Infrastructure required to support construction of the Project includes 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, and facilities for waterway public safety, site safety and security (Map 2-10).

2.4.1 Ice Boom

As shown on Map 2-11, an 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 consists of a floating structure anchored to the riverbed to initiate the development of an upstream 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. This will prevent significant quantities of frazil ice from passing through the rapids and forming a **hanging ice dam** at the entrance of Stephens Lake. Hanging ice dams are masses of ice composed mainly of frazil or broken ice deposited underneath an ice cover in a region of decreasing water velocity. A severe build-up of frazil ice at the lake entrance could cause the upstream water levels to rise and overtop the Project's cofferdams. Without the ice boom, the cofferdams would have to be built to higher elevations.

The boom will consist of five 120 m spans in the central part of the river. Each section will be anchored to the bottom 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 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. Details of the ice boom are shown in Figure 2-7.

2.4.2 Cofferdams and Rock Groins

A cofferdam is a structure, usually made of rock fill and earth, constructed around a work site in the river, so that the work site can be dewatered to permit construction of structures in a dry area. Once a cofferdam is constructed, water inside the enclosed area will be pumped to a settling pond or directly into the river depending on the concentration of **total suspended solids (TSS)**. Section 3.3.3 provides details and criteria for treating the water pumped from the cofferdams. The cofferdams will be designed such that their crest elevations are not **overtopped** by the construction design flood (Section 2.2.3.1) that would cause high water level conditions due to a flood or ice accumulation. The construction design flood has a 5% probability of occurring each year or an approximately 1 in 20 year return period. An additional 1 m of freeboard will be added to structures where the design level is governed by open water conditions and 1.5 m of freeboard will be added to structures where the design level is governed by winter water levels, which corresponds to a 1 in 20 year event.

A two-stage program of river management will be implemented to divert the Nelson River and allow the construction of the project. Section 3.4 (River Management During Construction) provides a complete description of the two stages of river management, schedule, sequence and construction methodology as well as the purpose of each structure.

During the first two years of construction, a series of six cofferdams and two rock fill groins will be constructed to permit dewatering of the river channels in the locations of the powerhouse and spillway structures as well as the central dam. The locations and layouts of the cofferdams are shown in Map 2-10. The following cofferdams and rock groin will be constructed during Stage I Diversion: north channel rock groin, quarry cofferdam, north channel Stage I cofferdam, Stage I island cofferdam, powerhouse cofferdam, spillway cofferdam, central dam Stage I cofferdam, and central dam rock fill groin.

During Stage II Diversion, the following four cofferdams will be constructed: Stage II island cofferdam, south dam upstream cofferdam, south dam downstream cofferdam and tailrace summer level cofferdam.

As the Project is completed, some of the cofferdams will be removed and some remnants of the balance of the cofferdams and rock groins will be incorporated into other permanent structures such as the south dam, central dam and **transmission tower spur**. The cofferdams consist of rock and granular fill, impervious glacial till, and riprap, as shown in Figure 2-8 and Figure 2-9. In total, they will contain of approximately 1,165,000 m^3 of rock fill, granular and impervious materials.

2.4.3 Camp and Work Areas

The main camp and work areas are being developed in two phases. The first phase is being constructed in accordance with an *Environment Act (Manitoba)* licence issued in February 2010 for the KIP. It consists of a 500 person camp on an approximately 120 ha site on the north side of Gull Rapids, about 1.8 km from the shore of the Nelson River. Pre-engineered bunkhouses for workforce accommodations, a recreation hall, buildings for firefighting and first aid vehicles, and kitchen and dining facilities will be completed in time for the start of construction on the Project. Also included are wells and a water-treatment plant for potable water, a mechanical wastewater treatment plant, diesel generators (about 2.5 MW capacity), and shallow and deep buried utility corridors for electricity, sewer and water. A new landfill site facility for managing solid waste may be developed in proximity to the camp or the solid waste will be hauled to the Thompson landfill site (Section 3.3.1.2). While the exact location for the potential landfill has yet to be determined, Hydro has identified three potential sites with suitable soil characteristics. These are being evaluated for terrestrial properties, proximity to caribou calving sites, *etc*. The landfill site, if selected, will require permitting from Manitoba Conservation. The landfill would be in operation for the duration of the construction phase and then decommissioned.

The operation of these facilities and the construction and operation of the second phase of the main camp are part of the Project. Under the second phase, the camp will be expanded to accommodate an additional 1,500 workers, bringing the total capacity to approximately 2,000 people. The camp may provide trailers for long-term senior management staff employed in the construction of the Project. If this is accommodated, these facilities would be located within relatively close proximity to the camp.

The principal work areas for Manitoba Hydro and the contractors involved in the construction of the Project are shown in Map 2-10. It is also anticipated that there will be small storage and field offices located directly at the various construction sites. The Hydro work area will contain an engineering office, a storage building, a yard for material storage, a fuel storage facility, vehicle-refuelling facility, vehicle maintenance facility, field offices, a soils and concrete laboratory and a maintenance building.

The contractors' work areas will contain buildings, storage facilities, maintenance shops, fuel storage and vehicle refuelling facilities, toilet facilities, an aggregate processing area, a carpenters' shop, a precast concrete yard, a shop to cut and bend **reinforcing steel**, and other facilities including a concrete **batch plant**, required to support construction activities. In addition, a temporary magazine for storing explosives will be located away from the work and camp areas. Its location will be subject to applicable regulations, as well as to the approval of Manitoba Hydro. Explosives will be delivered to the site as needed to undertake the excavation of rock.

At the construction sites of the principal structures, the contractor will provide temporary portable toilet facilities with holding tanks. The waste will be regularly pumped out and taken to the wastewater treatment facility of the main camp.

2.4.4 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 and the south dyke during Stage I Diversion. This 100-person camp would likely use temporary bunkhouse trailers. **Potable** water will be hauled in and solid waste and wastewater will be hauled out for disposal at existing Gillam facilities. Alternatively, a packaged wastewater treatment plant may be installed at the campsite. 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 Keeyask Transmission Project.

2.4.5 Sources of Rock, Granular and Soil Material

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 2-13. 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, summarized in Table 2-3. The Partnership has applied for quarry leases for potential sources in the area that may be utilized.

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 and the **Environmental Protection Plan (EnvPP)**. The Project Footprint includes the full extent of the available material sources, which is more than is actually needed for construction because the potential utilization is only 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 preliminary material utilization plan does not include extraction of materials from borrow areas S-4, S-5, S-11, S-17b and E-1 which are not included in Table 2-3. These borrow areas are included in the Project Footprint in the event that the final material utilization plan requires material to be extracted from these borrow areas.

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 the 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 (Quarry 7) as well 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.

Table 2-3: Preliminary Material Utilization Plan (cubic metres)

Project Component	Total	Impervious Borrow Sources(1)						Granular Borrow Sources(1)			Rock Quarries(1)			
		N-5	N-6	N-21	S-2	S-17	S-18	G1	G2	G3	Q1	Q7	Q9	Other(2)
South Access Road(3)	1,273,170				317,870						240,000		240,000	475,300
Local Site Roads	640,930	107,590				106,730		211,300			93,790	44,600		76,920
Stage 1 Cofferdams	522,070			203,700				82,050				236,320		
GCC Cofferdams	472,560	70,630		98,780				37,630		23,650				241,870
Permanent Construction: Dams, etc.	2,374,980	733,230		21,450	195,220			118,700		102,730	112,540			1,091,110
Permanent Dykes	2,711,420	166,780	80,000	40,450	187,730	62,580	62,580	424,680		862,870	456,760			366,990
Aggregate for Concrete	197,520									197,520				
Additional Quarried Rock fill	205,100											205,100		
Total	8,397,750	1,078,230	80,000	364,380	382,950	169,310	62,580	874,360	0	1,186,770	903,090	486,020	240,000	2,252,190

Notes:

1. All volumes are in cubic metres (bank cubic metres; i.e., undisturbed condition in the borrow /quarry area).
2. Sourced from rock excavations from powerhouse and spillway area or other quarries.
3. Material sources for south access road are currently being evaluated.

Impervious fill will primarily consist of silty sand/sandy silt till, sources of which have been identified on both the north and south shores of the Nelson River (Map 2-13). Deposits N-5, N-6 and N-21 are anticipated to supply the north shore impervious borrow requirements, while Deposits S-2, S-17 and S-18 are anticipated to supply the south shore requirements.

The primary sources of granular fill for the Project's construction is Deposit G-3, which is located on the north side of the Nelson River. The only potential source of granular fill on the south side of the river is at Borrow E-1. It is unlikely that granular Borrow E-1 will be used for construction because it is located quite far from where it would be required. No other suitable source of granular material has been found within reasonable proximity of the site on the south side of the river.

To construct the south access road, impervious fill will be sourced from Borrow S-2 while granular fill, road topping and riprap will be produced by crushing rock and screening at Quarries Q-1 and Q-9. It is possible but unlikely that granular Borrow E-1 will be used to construct the south access road as it is located far from the road.

Rock required for the production of rock products and riprap materials will be available from the area excavated for the powerhouse and spillway, as well as from Quarry Q-7 on the north side of the river and from Quarry Q-1, Q-9 and potentially Q-8 on the south side of the river. Rock from Quarry Q-7 will also be suitable for use as coarse concrete aggregate, following crushing and processing.

Fine concrete aggregate will be sourced from Deposit G-3, which is believed to contain adequate quantities for the Project. Screening of oversize material, washing and stockpiling will be required.

Data from the field and laboratory testing of construction materials will be used during the process of final design for the Project's **earth structure**s and a more detailed borrow utilization plan will then be prepared. This plan will identify the extent and depth of the material sources, and, as required, the identification of the amounts of materials or identifiable areas that are to be protected for specific use.

In general, the decision with respect to the selection and development of borrow sites and quarries will be the responsibility of the contractors, subject to appropriate approvals.

Table 2-3 summarizes the earthwork, granular and rock quantities required for the Project.

2.4.6 North and South Access Roads

Two all-weather gravel access roads will be required for the Project, one 25 km access road on the north side of the Nelson River and one approximately 35 km road on the south side of the Nelson River. The north access road is being constructed as part of the KIP, licensed under *The Environment Act (Manitoba)* separately from this Project. The bridge for the north access road over Looking Back Creek was similarly approved under the *Navigable Waters Protection Act*. The operation of this road is part of the Project. The north access road will be the primary access to the construction site and supporting infrastructure which will be located on the north side of the Nelson River. The road will be used to transport materials, equipment and workers between PR 280 and the Project construction site at Gull Rapids. The north access road is designed to be wider within its southern segment to allow for haulage of granular material payloads from borrow areas.

The south access road is planned to be constructed during the winter of 2014/15 in order to permit starting construction of the south dyke during Stage I Diversion when access across the river is not available. During the operation phase, the south access road will provide direct access to Gillam where it is expected that many of the on-site operation phase workers will live. Gillam serves as the base for operations for the lower Nelson River generating stations. The south access road will be routed along the route shown in Map 2-14. The south access road includes a 13.5 km section of new road between Gull Rapids and Butnau Dam and a 21.5 km section of existing road that will be upgraded to Provincial Road standards (Table 3-1). It will generally follow the existing roadway along the dry side of Butnau Dam. The route was selected through a consultation process involving a selection committee with representatives from the Keeyask Cree Nations, Manitoba Hydro, and MIT. The all-weather gravel roads will meet MIT design criteria.

The north and south access roads will have a standard 8 m road top consisting of a gravel surface (unpaved). The road top will be widened to 13.5 m near the generating station to allow for the larger haulage vehicles used to construct the Project. The south access road will be located in the discontinuous permafrost region of northern Manitoba. The south access road will be designed to allow for the future thawing of the sub-grade.

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. MIT will assume ownership of the roads once the construction of the Project is completed.

The south access road will require four stream crossings at the locations shown on Map 2-15 and similar to Photograph 2-1. Gull Rapids Creek, Gillrat River, Butnau River and an unnamed tributary of Stephens Lake will require proper stream crossings. These crossings will consist of single or double corrugated metal pipe **culverts**, which will be designed to provide fish passage as required. Culvert sizing will be based on hydraulic analysis and using the "*Manitoba Stream Crossing Guidelines for the Protection of Fish and Fish Habitat (1996)*". For streams which require fish passage, the minimum culvert diameter will be 1,000 mm.

Photograph 2-1: Typical access road stream crossing (Wuskwatim Access Road, Manitoba Hydro, 2011)

The Butnau weir is located at the site where the planned south access road will cross the waterway. The current crossing at the Butnau weir will be expanded northward due to a sensitive habitat area located south of the crossing. The width of the road at the Butnau weir stream crossing will be approximately 8.5 m. Culvert sizing is based on hydraulic analysis and using the "*Manitoba Stream Crossing Guidelines for the Protection of Fish and Fish Habitat(1996)*". The minimum culvert size will be 1,000 mm in diameter based on the existing culvert design at the Butnau weir. Construction of the stream crossings will be scheduled to take place in the winter and early spring, before snowmelt runoff occurs,).

2.4.7 Access Roads to Borrow Sites and Construction Sites

Temporary or permanent access roads or haul trails are required to access to borrow areas, excavated material placement areas, boat launches and quarries, to construct the ice boom and dykes, to clear trees in the reservoir area and for maintenance. Since some borrow sites will be retained for the operation of the Project, access roads to those sites will be permanent.

Borrow areas N-5 and G-3 are expected to be the two primary sources of material for the construction of the principal structures. Erosion between 2000-2010 has created new channels in the Nelson River to the northeast of Gull Rapids causing N-5 and G-3 to become islands in Stephens Lake. At the start of the construction phase, two temporary rock fill causeways will be constructed to access borrows G-3 and

N-5 (Map 2-13). Both causeways will be removed at the end of the construction phase. The causeways will be rock fill embankments designed to accommodate two-way traffic for large rock wagons. They will consist of a free draining rock fill groin, with a 0.6 m thick layer of road topping material placed on the crest of the causeway. Typical cross-sections and longitudinal sections of the causeways are shown in Figure 2-10 and Figure 2-11. The causeway crest elevations are set at the same level as the powerhouse Stage I cofferdam crest elevation to account for winter water conditions and provide winter access to the deposits. Including the layer of road topping, the crest elevation for the causeways will be 145.2 m. Two 1.0 m and one 1.5 m diameter culverts will be installed in the causeway to Borrow N-5 to allow fish passage. The culverts will be installed at different elevations to allow fish passage when the water level on Stephens Lake fluctuates. A channel will be excavated east of the north causeway to maintain access for fish. Safety booms will be installed on either side of the causeways to restrict access by the public and maintain public safety.

Access to the construction site will extend from the end of the North Access Road. It is anticipated that the contractors will use the crests of the cofferdams and rock fill portions, or any partially completed dykes, as access haul roads. For haul roads where heavy construction activities are anticipated, the minimum road width will be 13.5 m. This will provide an adequate clearance width between passing construction vehicles.

The north channel Stage I cofferdam, extending across the north channel of the Nelson River, will be located approximately 1.5 km upstream of the powerhouse. It will serve as part of the construction access across the north channel and allow construction of the island cofferdams and the spillway Stage I cofferdam to proceed. Once the powerhouse cofferdam is completed the north channel of the Nelson River will be completely closed, allowing the powerhouse and service bay excavations to proceed in the dry. In turn, this will also allow access to the powerhouse, central dam and spillway areas via a system of temporary access roads that will be constructed within the dewatered north channel.

After the central dam Stage I cofferdam is constructed, access to the spillway area will be via the powerhouse and central dam areas and the north channel Stage I cofferdam.

Prior to river closure, the portion of the south dam within the spillway Stage I cofferdam will be constructed to ramp down from 162.5 m at the upper deck of the spillway to 153.4 m, the crest elevation of the south dam Stage II upstream cofferdam. This will assist with the delivery of fill for construction of the Stage II cofferdams, the south dam and the south dyke.

To access the south bank of the Nelson River and proceed with the construction of both the south dam and the south dyke, the spillway Stage I cofferdam will be breached and a single leg rock fill closure groin will be advanced across the south channel. Access from the north shoreline for hauling materials required for the construction of the south dam and the south dyke during Stage II diversion will be via the south dam Stage II upstream and downstream cofferdams.

2.4.8 Public Access and Site Security During Construction

The public will not have access to the Project sites, 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, ATK monitors and religious leaders performing ceremonies. To facilitate this process, an **Access Management Plan (AMP)** will be developed in consultation with local resource users (also see Section 6.5). Refer to the AMP for a comprehensive description of access management.

Security will be maintained at the junction of PR 280 and the north access road to manage access by the public. The gate will be located at least 30 m south of PR 280 to allow large trucks to pull off the highway and be clear of the intersection. This area will also have a small security office or "gatehouse" which will be staffed at all times of the day and will contain a potable water supply and public washroom with holding tank. Other features will include radio communications, electric heat, overhead exterior lighting, parking stalls and a turnout lane for large trucks. Similarly, 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 launches upstream and downstream of the generating station (shown on Map 2-16) will be accessible to the public only for emergency purposes during construction.

An on-site safety supervisor, reporting to the Project Manager, will be employed during the construction period to assure that Manitoba Hydro's staff receives training and that all contractors comply with the required safety regulations. As well, contractors will have their own safety officer(s). Monthly reports will be provided as well as reports of any incidents.

Emergency response programs will be developed to include procedures to address situations that may occur during the construction period and during operation. A helicopter landing area will be located at the work site to provide a means for emergency access and **egress**. Response procedures to environmental emergencies such as spills will be described in the EnvPP.

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

Under certain conditions that are outlined in the Access Management Plan, authorized resource users will be permitted to transport firearms for protection (e.g., bears) or for carrying out harvesting and spiritual/ceremonial activities. There will be an established 'no shooting' buffer zone of 300 m on either side of the access roads and around the Project work site in which a small-calibre firearm may be used in the buffer zone for emergency purposes.

There will be camp rules to govern the behaviour of workers lodged at the camp.

2.4.9 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 35 designated excavated material placement areas (EMPAs) located near the principal structures as shown on the Map 2-17.

Some materials will be placed in areas within the reservoir and, once flooded, the material will be submerged. Where required, EMPAs within the reservoir will be armored to prevent erosion and sedimentation. The locations and maximum elevations of the excavated material placement areas were chosen based on minimizing the potential for erosion or transportation of material into the flowing waters. For the EMPAs directly upstream of the principal structures, the maximum elevations of the EMPAs were determined from hydraulic computer modelling of flows, which take into consideration the maximum velocities of impounded waters at the normal minimum operating level (158 m). The excavated material placement areas are not expected to be filled to their maximum elevation.

The excavated material placement areas outside of the dyke lines will be gently sloped and covered with salvaged organics and soils, providing an erosion resistant surface layer and promoting the regrowth of natural vegetation. Map 2-17 illustrates the locations of the available excavated material placement areas, both internal and external, to Project dykes.

2.4.10 Construction Power

During the first year of construction, until early 2015, 2.5 MW of construction power will be provided by diesel generators. Additional temporary construction power will be provided by a 2 MVA distribution line from Split Lake constructed in conjunction with the KIP. During the second year of construction, a permanent transmission line from KN36 will be in place to provide the primary source construction power. This transmission line will be constructed under the Keeyask Transmission Project (see Section 2.4.17). Once the new transmission line from KN36 is in service, the diesel generators will then remain on site during the construction phase as a source of emergency backup power. As discussed in Section 2.4.17, a permanent transmission line from the Radisson Convertor Station will be constructed to provide an additional source of back up power during the Project construction phase.

2.4.11 Communications Infrastructure

The existing Manitoba Hydro communications network in the Project area includes microwave radio links between McCusker, Wivenhoe, and Kettle with the closest mobile radio repeater at Wivenhoe and a fibre-optic link between Split Lake and Long Spruce routing along PR 280. These facilities provide HVDC control, EMS/SCADA, transmission line relay and metering, computer network, telephone, and mobile radio communications services. The MTS Allstream Inc. communications network includes microwave radio links using the same Manitoba Hydro towers and buildings noted above. These links provide public and private data, video, and voice communication services.

The KIP will include installation of two temporary 24 m wooden poles that will each support communication 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. Most of the construction data and voice communications will be provided by fibre optic cable that is to be installed adjacent to the north access road and will be connected to the existing fibre optic cable system running adjacent to PR280. Communications requirements between camp buildings will be supplied by a fibre optic cable installed along with the power distribution. All of the communications infrastructure will be installed at the beginning of the construction phase of the Project.

A permanent self-supported communications tower will be constructed on the roof of 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.

2.4.12 Temporary Explosive Magazine

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

2.4.13 Transmission Tower Spur

The Project will provide a spur, *i.e.,* a rock fill structure, to support four transmission towers, as shown in Figure 1-4 and Figure 1-5. The purpose of the transmission tower spur is to support the foundations for the first row of the generation outlet transmission towers from the powerhouse to the permanent switching station on the south side of the river. The transmission towers and switching station are part of the Keeyask Transmission Project discussed in Section 2.4.17.

Following the completion of the required construction activities in the Powerhouse area, a portion of the Stage I powerhouse cofferdam will be removed in the dry inside the Tailrace Summer Level Cofferdam. Another portion (*i.e.,* the south leg of the powerhouse cofferdam) will be partly removed and the remainder will be incorporated into the transmission tower spur. The spur, constructed to an elevation of 145.5 m, will support four 47 m high towers each with a square base of 15 m x 15 m. Each tower will be anchored to four 4.5 m x 4.5 m concrete footings. The footings will extend approximately 5.0 m in depth into the spur. Each of the four single circuit structures will have a centre-to-centre spacing of 45.72 m. A minimum distance of 10 m has been provided around the tower footprint in all directions to provide access for maintenance vehicles. An access ramp to the transmission tower spur will be tied into the downstream **berm** of the central dam. Virtually the entire spur will be constructed on alluvium or bedrock and no foundation preparation is required. Figure 2-12 provides a cross-section of the transmission tower spur.

2.4.14 Boat Launches and Barge Landings

2.4.14.1 Construction Phase

During the construction phase, boat launches will be used to access the waterway to support activities such as **environmental** monitoring, waterways management and reservoir clearing during the construction phase. Barges will also be required upstream and downstream of Gull Rapids to construct aquatic mitigation measures during the construction phase.

A temporary boat launch will be constructed 2.5-3.0 km upstream of Gull Rapids on the north side of Gull Lake. This boat launch will also be used for the installation of the ice boom. The boat launch will be in place for the entire duration of the construction phase and will be submerged once the reservoir is impounded.

Another boat launch and a barge landing will be constructed approximately 1.2 km downstream of Gull Rapids on the north side of the Nelson River adjacent to the contractor's work area (Map 2-16). A parking lot and turn around area will be located near the boat launch.

If required a temporary barge landing will be located upstream of the site, near borrow area B-1. This barge landing will be used to support the development of aquatic habitat upstream of the Project if deemed necessary.

During the Project construction phase, Gull Rapids will become a construction work area that will not be accessible to the public. The upstream boat launch and access trail and the downstream boat launch and barge landing will not be accessible to the public except in the event of an emergency. Details of how public access will be managed including control points are documented within the Keeyask Generation Project Access Management Plan.

2.4.14.2 Operation Phase

During the operation phase, the boat launches will be used to access the waterway to support activities such as environmental monitoring and waterways management. The boat launches will accommodate motorized and non-motorized vessel activity and movement over the Keeyask GS. The public may also access the waterways by driving to the Project and launching their boats to access upstream and downstream areas. Barges will also be required upstream and downstream of Gull Rapids to construct aquatic mitigation measures during the construction phase.

A boat launch will be constructed approximately 1.5 km upstream of the powerhouse on the north side of the Nelson River because the upstream construction phase boat launch, discussed in Section 2.4.14.1, will be submerged once the reservoir is impounded. The operation phase upstream boat launch and barge landing will be located closer to the powerhouse on the north side of the river. The water will be relatively shallow near the upstream boat launch so material will be excavated to ensure safe navigation. A barge landing will be constructed adjacent to the boat launch. All facilities will be constructed in the dry prior to reservoir impoundment.

The downstream boat launch and barge landing used during the construction phase will also be used during the operation phase and will require no modifications.

Unlike the construction phase, the upstream and downstream boat launches will be accessible to the public during the operation phase. A communication system (*i.e.,* telephones) will be in service at the upstream and downstream boat launches, which will allow communication with the powerhouse to request assistance during an emergency or to transport people and boats between the two boat launches. Assistance will be provided by staff working at the generating station.

2.4.15 Trail and Portage

2.4.15.1 Existing Environment Portage

Gull Rapids is the largest set of rapids in the river reach between Split Lake and Stephens Lake. The numerous rock outcrops create a system of multiple channels of flow that are approximately 3.7 km long and drop approximately 12 m. The rapids include turbulent flow and very high velocities at numerous locations which does not permit navigation. Currently, there is no actively used portage around Gull Rapids.

Birthday Rapids is another large set of rapids located downstream of Clark Lake and upstream of Gull Rapids. The water drops approximately 2 m at a narrow section of the river. The rapids are navigable by experienced waterway users, however, some waterway users utilize an established portage trail location on the north side of Birthday Rapids.

The Project EIS Physical Environment SV, Section 4.3.1 provides a detailed description of the **hydrology** and river hydraulics including numerous photos and maps for the river reach between Split Lake and Stephens Lake.

2.4.15.2 Trail During Construction Phase

The water levels at Birthday Rapids will be marginally impacted prior to reservoir impoundment therefore navigation through this set of rapids will not be impacted. Waterway users will be able to move through Birthday Rapids and access Gull Lake.

A portage for the public around the construction site will not be available during the construction phase. An access trail (Map 2-16) will be used by site workers to access the upstream boat launch at Gull Lake as well as the downstream boat launch. The upstream access trail during construction will extend approximately 3-4 km from the north access road to the boat launch located on the north side of the

Nelson River on Gull Lake. The downstream access trail during construction will extend 1.2 km from the north access road.

2.4.15.3 Portage During Operation Phase

A portage will be established on the north side of the river to accommodate motorized and non-motorized vessel movement over the Keeyask GS. The location and alignment of the portage was selected to minimize the Project Footprint and portage length, which will be approximately 3.2 km. A 1.7 km section of the portage will use the north access road. The upstream portage will extend 360 m south from the north access road, crossing the north dyke and extending to the upstream boat launch and barge landing. The portage clearing width will be approximately 20 m. The access trail to the downstream boat launch and barge landing established for the construction phase will remain unchanged for the operation phase. The portage will be accessible to the public during the operation phase. Signs will be established along the entire length of the portage to provide directions for users.

2.4.16 Waterways Public Safety

2.4.16.1 Waterway Public Safety - Construction Phase

Warning Waterway Zones and **Dangerous Waterway Zones** for the Project construction phase are shown on Map 2-18. The following areas during the construction phase were identified as dangerous waterway zones:

- The area immediately downstream of the Powerhouse tailrace cofferdam on the north shore.
- The shore immediately across from the future spillway outflow.
- The area from the future spillway to a distance approximately 3 km upstream, along the south channel.
- The area immediately downstream of the spillway and tailrace, for a distance of approximately 700 m downstream of the Powerhouse tailrace cofferdam.

A number of preliminary control measures, shown on Map 2-18, were selected for the Project to comply with the requirements of Manitoba Hydro's Public Water Safety around Dams Program. These preliminary measures will be installed and maintained annually, unless otherwise noted, at the beginning of the boating season and removed before the winter season, if required. All safety booms and buoys will be designed and installed in accordance with the requirements identified under the *Navigable Waters Protection Act*, the *Canadian Private Buoy Regulations* under the *Canadian Shipping Act*, and the *Canadian Coast Guard Aids to Navigation Program*.

During the construction phase several hazards will exist within the Gull Rapids areas consistent with a construction work area. The main hazard will be the river flow and high velocities along the south side of the river into the south channel of Gull Rapids. Heavy machinery will be moving along cofferdams and groins near the waterway and blasting of rock and flying debris will occur in the general vicinity.

A temporary ice boom will be installed upstream of Gull Rapids. Two safety booms will be installed at both ends of the ice boom and will each extend to the north and south shores of the Nelson River. The safety booms and ice boom will provide a visual and physical barrier upstream of Gull Rapids and the construction work area and serve to limit and determine access to the downstream area by waterway users. The ice boom and adjacent safety booms will be removed during reservoir impoundment. Signage and buoys will be established in the vicinity of the ice boom. The safety boom units will have a minimum freeboard of 0.305 m in still water conditions.

Two rock fill causeways will be constructed on the north side of the Nelson River near the downstream boat launch in order to access borrow areas G-3 and N-5. The causeways will be designed to accommodate two way traffic for large rock wagons. Safety booms will be installed on either side of the two causeways to limit access to the causeways by waterway users. The causeways and safety booms will be removed once construction of the Project is complete.

During the construction phase buoys will be installed near the ice boom and safety boom upstream of Gull Rapids and downstream of the Project where water velocities may risk public safety in the waterway. A communication plan will be developed during the construction phase that will inform the public of construction activities near the Project and provide education to correctly identify hazard areas and control measures.

Warning and danger signs will be located near the upstream and downstream boat launch and barge landing facilities, safety booms (upstream and near the rock fill causeways to Borrows G-3 and N-5) and the ice boom upstream of Gull Rapids. Additional signage will be located on the shoreline upstream and downstream of the Project.

2.4.16.2 Waterway Public Safety - Operation Phase

Warning Waterway Zones and Dangerous Waterway Zones for the Project Operation phase are shown on Map 2-19. The following areas during the operation phase were identified as dangerous waterway zones:

- The area immediately downstream of the Powerhouse on the north shore;
- The shore immediately across from the Spillway outflow;
- The shorelines immediately adjacent to and upstream of the Spillway;
- The shorelines immediately adjacent to and upstream of the Powerhouse;
- The area from the Spillway to a distance approximately 150 m upstream; and
- The area immediately downstream of the Spillway and tailrace, for a distance of approximately 900 m downstream of the Powerhouse.

A number of preliminary control measures, shown on Map 2-19, were selected for the Project to comply with the requirements of *Manitoba Hydro's Public Water Safety around Dams Program*. Safety booms, buoys, sirens, lights and signage will assist in mitigating public exposure to hazards in the reservoir, tailrace channel and spillway. These preliminary measures will be installed and maintained annually, unless otherwise noted, at the beginning of the boating season and removed before the winter season, if required. All safety booms and buoys will be designed and installed in accordance with the requirements identified under the *Navigable Waters Protection Act*, the *Canadian Private Buoy Regulations* under the *Canadian Shipping Act*, and the *Canadian Coast Guard Aids to Navigation Program*.

A boat launch will be located approximately 1.5 km upstream of the powerhouse on the north side of the Nelson River. The water will be relatively shallow near the upstream boat launch so material will be excavated to ensure safe navigation. A barge landing will be constructed adjacent to the boat launch. All facilities will be constructed in the dry prior to reservoir impoundment. The downstream boat launch and barge landing used during the construction phase will also be used during the operation phase with no modifications. The upstream and downstream boat launches will be accessible to the public during the operating phase. A communication system (i.e. telephones) will be in service at the upstream and downstream boat launches, which will allow communication with the powerhouse to request assistance during an emergency or to transport people and boats between the two boat launches. Assistance will be provided by staff working at the generating station.

A portage route will be established on the north side of the river to accommodate motorized and non-motorized vessels movement between the upstream and downstream boat launch locations and over the Keeyask Generating Station

A safety boom will be located immediately upstream of the spillway to prevent boats from straying too close to the open spillway and prevent unpowered boats from being carried through the spillway. This boom will be connected to an in-stream anchor located approximately 150 m upstream of the spillway. Two boom sections will be connected at this in-stream anchor and continue in an approximate v-shape, in a self-rescuing configuration to a shore anchor on the left and right abutment of the spillway. The length of these boom sections will be approximately 180 m. The installation of the safety boom will provide visual and physical boundary around the hazardous areas, which may experience high flow conditions during some operations and will assist in preventing inadvertent access. The safety boom will be placed after the spring **freshet** has passed, as soon as it is safe to do so (when ice is no longer present on the river and spill operations can be safely curtailed during the installation). If at all possible this installation will occur prior to the opening of fishing season provided it is safe to do so.

A warning buoy will be located approximately 300 m upstream of the spillway to complement the safety boom. A second set of buoys will be located downstream of the tailrace channel providing warning of dangerous waters to vessels traveling from the Stephens Lake or from the downstream boat launch. Other buoys may be installed in the reservoir delineating safe navigation areas and identifying hazards which may include shallow waters, rocks and reefs. The location of the hazards and potential location of the buoys is not currently known; however, during the operation phase these hazard areas will be identified.

Warning and danger signs will be used to notify the public of potential hazards at the generating station. This type of public safety measure will inform the public of the purpose for the restriction, possible consequences should they disregard the warnings and will provide contact information in the event of an emergency situation. Signs will be located as appropriate in both the reservoir and the tailrace with consideration for appropriate viewing distances, as well as at the boat launches and along fences. The location of warning and danger signs for the Project is intended to mitigate public exposure to the following major hazards,

- Water velocities near the spillway that can overpower boaters, with the possibility of becoming pinned against or carried through the structure;
- Rapid flows that can create vortices and eddies with strong undercurrents in the downstream of the spillway;
- Fluctuating water levels that can produce slippery surfaces along the shoreline; and
- Downstream areas that can suddenly be inundated with water due to Powerhouse and Spillway operations.

Signs and maps will be located along the portage route as well as at the upstream and downstream boat launches to guide waterway users through these facilities. The signs will also show relevant maps of the area and the waterway danger and warning zones. Signage located on the shoreline will provide users with sufficient warning to safely reach any of the identified boat launches.

The powerhouse complex and spillway structures will have warning lights and video cameras installed on both structures. Directional sirens will be located at the spillway and powerhouse aiming upstream and downstream. The sirens will be used to warn waterway users 15 minutes before the opening or closing of the spillway gates. Video equipment will be used to inspect areas upstream and downstream of the powerhouse and spillway before gate operations are initiated and when gate settings are changed. Audiovisual equipment will be selected to meet both design and regulatory requirements.

Fencing and guard rails will be installed to limit or restrict access by the public to warning and dangerous waterway areas located immediate upstream and downstream of both the spillway and the powerhouse, the north/central/south dam, transmission tower spur. The fence installed will be 2.4 m non-climbable with barbed wire strands at the top, unless specified otherwise. Guard rails will be 1.4 m non-climbable located on the upstream side along the principal concrete structures and will meet Manitoba Infrastructure and Transportation standards along the embankment structures. Signage will be installed along the fences to provide information and deter the public from accessing the dangerous waterway zones.

Barricades will be located on the north and south dykes to restrict motor vehicle access to the earth structures. The south dyke will be accessible along the south access road, while the north dyke will be accessible by using the access road to the upstream boat launch which crosses over the north dyke.

2.4.17 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 and substation to provide construction power to the Project. The construction power line will connect the Project site to an existing 138 kV transmission line (KN 36) located south of the construction site. The substation will be located immediately north of the Keeyask Generation Project (Map 2-20).
- Three transmission lines and switching station 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 switching station will be located approximately 3.5 km southeast of Keeyask Generation Project.

The potential routes for these transmission lines during the construction and operation phases are shown on Map 2-20 and Map 2-21. The Keeyask Transmission Project is being assessed and reviewed in a separate regulatory process conducted concurrently with the Project's regulatory process.

Keeyask Infrastructure project and the transmission project are considered as part of the cumulative effects assessment of the Keeyask Generation Project.

2.5 ENVIRONMENTAL MITIGATION/COMPENSATION

This section describes the various environmental mitigation/compensation measures identified by the Partnership for the Project. These measures were selected from a range of alternatives that were considered in the development of the Project, as discussed in Section 6.0.

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

1. Prevent or avoid works or measures, which will cause adverse effects.
2. Mitigate unavoidable adverse effects.
3. Provide appropriate replacements, substitutions or opportunities to offset adverse effects.
4. 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.

2.5.1.1 Measures in Joint Keeyask Development Agreement and Adverse Effects Agreements

After many years of negotiations, meetings and consultations, the membership of each of the KCN partners approved both the 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' 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 principal became a plan in the JKDA and together with 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 methyl mercury. KCN **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.

2.5.1.2 Biophysical and Socio-Economic Mitigation Measures

2.5.1.2.1 Physical Environment

Measures to avoid adverse effects were major considerations in developing plans for the Project, as discussed in Section 6.0, Alternative Means. Other mitigation measures related to the physical environment consist mainly of the application of best practices, which will be outlined in the EnvPP, (Section 3.10.1) and discussed in the PE SV . These comprise measures such as the following:

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

2.5.1.2.2 Aquatic Environment

KCN 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. Map 2-22 shows the approximate location of some the measures described in this section.

- **Downstream Spawning Habitat – Lake Sturgeon:** Artificial spawning habitat for lake sturgeon will be constructed downstream of the powerhouse. The new spawning habitat will be designed specifically to attract lake sturgeon, but it could also be used by other species that spawn under similar conditions.

  Key features to this spawning habitat are a minimum substrate thickness of 0.6 m (with 3 mm to 0.6 m diameter rock), water depths of 1 m to 10 m and water velocities of 0.5 m/s to 1.5 m/s. Micro spawning sites will be created by placing three 1 m to 2 m diameter boulders in V-shape (upstream chevron) clusters. In addition, refinements will be made to the design of the left (north) wall of the powerhouse tailrace channel to incorporate a slope in the channel and a bench along the north end of the tailrace channel near the powerhouse parking lot. These design considerations have been included to provide spawning habitat to sturgeon that may move upstream past the constructed spawning habitat.

  At the project in-service date, spawning habitat available to sturgeon downstream of the powerhouse will consist of the modified north bank of the tailrace channel, the first phase of the constructed spawning habitat (up to 5.3 ha), and areas where coarse material remains from cofferdam removal/side-casting. Use of these areas by spawning sturgeon will be monitored and, if a requirement for other spawning habitat is identified (*e.g.*, if conditions in the phase 1 habitat are not suitable), then additional habitat will be constructed in a phased approach. Potential areas downstream of the powerhouse adjacent to the phase 1 habitat was identified based on hydraulic modeling; however, actual locations would be adjusted depending on site-specific conditions and responses of sturgeon to the flows downstream of the powerhouse.

- **Downstream Spawning Habitat - Lake Whitefish:** An additional 1000 m^2 of spawning habitat for lake whitefish will be constructed along the south shore of Stephens Lake approximately 1.5 km downstream of the powerhouse. The spawning habitat will be designed and constructed to have water depths of 1.5 m to 2.5 m below the Stephens Lake 5th percentile open water level of 139.1 m and depth averaged velocities of between 0.2 m/s and 1.0 m/s. The shoreline in the vicinity of the proposed location for the spawning habitat presently experiences significant erosion some years due to the presence of a large hanging ice dam. Velocity measurements near the proposed lake whitefish spawning habitat locations during the Project operation are required to determine the optimum location for the spawning shoals. For this reason, the final location will be selected once the Project is operating.

- **Lower Reservoir Spawning Habitat – Walleye and Lake Whitefish:** This mitigation measure will consist of the development of up to seven shallow spawning shoals at a depth of 3-4 m and six deep spawning shoal at depths greater than 4 m. The deep spawning shoals will compensate for lake whitefish spawning habitat and the shallow spawning shoals will compensate for walleye spawning habitat. The total area of the shallow and deep spawning shoals are 0.7 ha and 0.6 ha respectively. The construction of rocky shoals within lacustrine portions of the reservoir will ensure that spawning habitat is available early in the development of the reservoir environment. The creation of boulder/cobble/gravel habitat will, in addition to providing spawning habitat, also provide rearing and foraging habitat, thereby improving habitat diversity within the newly-formed reservoir. The spawning shoals will be constructed at, or near to, known and suspected spawning locations, thereby improving the likelihood of success.

- **Maintenance of Access to Small Tributaries:** To ensure that fish are able to access upstream habitat in tributary streams, debris created by flooding of the reservoir will be mitigated through the monitoring and removal of debris as described in the Reservoir Clearing Plan (Section 3.6) and in the Waterways Management Program (Section 4.5).

- **Construction of Channels to Mitigate Over-Winter Oxygen Depletion:** Prior to reservoir impoundment two channels will be excavated in the dry near Little Gull Lake. Once the reservoir is impounded, the channels will allow fish to avoid mortality due to over-winter oxygen depletion within Little Gull Lake. These channels will be 4-6 m wide with a bottom elevation of 156.0 m to provide a water depth of between 1-2 m below the ice surface, depending on reservoir water surface elevation and ice thickness. The two channels will be approximately 800 m and 400 m long. These channel dimensions are similar to Looking Back Creek which supports winter-season fish movements and therefore they are expected to be adequate to support year-round movements of fish to and from the Little Gull Lake area.

- **Construction of Channels to Prevent Fish Stranding at the Spillway:** Following the use of the spillway a pool of water within the spillway discharge channel will likely trap fish. Other pools downstream of the spillway may also trap fish. A series of channels will be excavated between the spillway and Stephens Lake to enable fish to move into Stephens Lake and prevent stranding within these pools. Since the collection of bathymetric data in the south channel of Gull Rapids has not been possible due to high water velocities in this area, the location of the isolated pools and the alignment of the proposed excavated channels can only be determined once the Powerhouse is operational and the Spillway is closed, thus allowing the location of the pools to be determined and bathymetric data to be collected. Initial design concepts includes an approximately 1000 m channel that will be 2 m wide by 2 m deep. Plans can only be developed and construction carried out once the Project is operational.

- **Implementation of a Fish Stocking Plan:** A comprehensive stocking plan will be implemented to maintain/enhance Lake Sturgeon populations in the Project area and the broader region. Stocking effectively improves natural recruitment by ensuring survival through the very young life history stages, thereby bypassing a significant portion of mortality that occurs in wild fish populations. Stocking rates for three lake sturgeon life history stages (early fry, fall fingerlings and yearlings) were developed as described in the Lake Sturgeon Stocking Strategy (insert ref). Plans for the reservoir include the stocking of both fall fingerlings and spring yearlings. Monitoring will be undertaken to evaluate the relative success of each life stage stocked and to modify stocking rates to maximize recruitment. Lake sturgeon fry would also be stocked in years where hatchery fry production exceeds rearing capacity.

- **Turbine Design Considerations to Minimize Fish Mortality:** The turbines for the Project will be designed to minimize mortality and injury to fish passing through the powerhouse. The use of a **fixed-blade**, vertical-shaft turbine design for the Project 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 that 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.

- **Fish Passage:** A trap/catch and transport program will be undertaken to facilitate upstream fish passage at the Project site for key fish species, including lake sturgeon. The Project will be designed and constructed in a manner that would allow it to be retrofitted to accommodate other upstream fish passage options, if required, in the future. Downstream passage will be provided via the turbines and spillway (when it is in operation) without substantial impacts to the surrounding fish populations. Post-Project monitoring may indicate the need for another form of downstream passage.

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

- **Spawning Habitat at Birthday Rapids – Lake Sturgeon:** If monitoring demonstrates that lake sturgeon no longer spawn at Birthday Rapids, modification of the river bank upstream of Birthday Rapids will create hydraulic features that would be attractive to spawning sturgeon. These modifications could include the addition of cobble and boulder substrate at locations slightly upstream of the current spawning site at Birthday Rapids to create turbulent flow to attract spawning fish.

- **Lake Sturgeon Young-of-the-Year Habitat:** If a three year monitoring program demonstrates that newly hatched young-of-year sturgeon are not able to use habitat in the reservoir, then a sand blanket will be placed at the upper end of present-day Gull Lake to create habitat known to be suitable for young-of year sturgeon. The sand blanket, consisting of sand/fine gravel 1 mm to 2 mm in size, will have a thickness of approximately 0.20 m. The first phase would provide up to 20 ha area of sandy habitat. After subsequent monitoring over one or more years to determine the success of the Phase I pilot placement, Phase II would be implemented if required. Phase II would consist of sand placement for an additional 20 ha which may or may not be adjacent to the Phase I pilot placement area.

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 the Aquatic Environment Supporting Volume (AE SV).

2.5.1.2.3 Terrestrial Environment

KCN 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. Map 2-22 shows the approximate location of some the measures described in this section.

- **Controlled Development of Borrow Area N-6:** Deposit N-6 is one of several sources of impervious materials that was identified and investigated early in the project planning phase (Map 2-22). Deposit N-6 has been proven to be a high quality source for impervious materials for the Project. Deposit N-6 provides habitat to the only stand of large white birch in the Keeyask study area. It is also provides regionally rare habitat for ruffed grouse. Finally, it is of interest to the KCNs and the Province due to Paleo-Arcaic heritage resources found along the south margin.

  In the event that contractors require material from this deposit, extraction of the materials will be limited to certain areas within the deposit to minimize the loss of white birch and poplar mixed forest. Although Deposit N-6 is an important potential source of high quality impervious material, it may not be developed by contractors because its location is further removed from the main work areas than the other impervious sources that have been identified.

- **Selection of EMPAs to Avoid Sensitive Terrestrial Areas:** Unclassified excavated materials produced from excavations, and which will not be used in the construction of the generating station, will require permanent placement in designated areas within the Project's limits. Contractors will develop their own plans for disposing of unclassified excavated materials, working within constraints and guidelines imposed upon them by the Environmental Protection Plan.

An inventory comprised of 35 EMPA locations was developed for the Project with a focus on minimizing the environmental impact of the EMPAs. The locations and extents were selected to avoid sensitive areas where possible and to maximize the utilization of the unclassified excavated materials for both aquatic and terrestrial habitat creation, or rehabilitation. The EMPAs are shown on Map 2-17. They include areas both within and outside of the dyke lines. Their selection was based on assessments of the quality of terrestrial and aquatic habitats within the Project area, the avoidance of known sensitive areas, and the identification of adjacent habitats that would be impacted positively from the placement of materials surplus to the project. Section 6.12.3 describes the approach to assessing alternatives for the EMPAs.

- **EMPA and Borrow Area Boundaries Modified**: The Project Footprint was overlaid with the terrestrial habitat mapping to determine if there was any overlap of Project components with sensitive terrestrial habitat areas. Where overlap was identified and where practicable, modifications to EMPA and borrow area boundaries were made to avoid these sensitive areas.
- **Siting of Access Roads and Borrow Areas to Avoid Habitat:** The Project Footprint was overlaid with the caribou calving habitat mapping to determine if there was any overlap of Project components with sensitive calving areas. Where overlap was identified and where practicable, modifications to temporary and permanent access roads were made to avoid these sensitive areas.
- **Blasting Restrictions:** Blasting will be minimized to the maximum extent feasible from May 15 to June 30, to reduce the effects on caribou calving females and their young.

  Blasting will be restricted during the bird breeding season (April 1- July 31) to the extent practicable.
- **Clearing Restrictions:** Clearing will be undertaken outside of the sensitive breeding period (April 1–July 31) to the extent practicable to minimize disturbance to breeding birds.
- **Bird Nesting:** 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.

  It is estimated that there are about 1,000 nesting pairs of gulls at Gull Rapids, and that the majority of the birds nests are on islands in the south channel of Gull Rapids, downstream of the principal structures. Alternative locations were identified for constructing islands in Stephens Lake or within the reservoir that would provide suitable habitat for bird nesting.

  Eagle nesting platforms will be installed for any nest disturbed during construction/operation.
- **Development of Wetlands:** Wetlands will be developed to offset the loss of particularly important wetlands.
- **Moose Harvest Sustainability Plan:** CNP is developing a moose harvest sustainability plan.

These measures are described in more detail in the Terrestrial Environment Supporting Volume (TE SV).

2.5.1.2.4 Socio-Economic Environment

The JKDA and the **Burntwood Nelson Agreement (BNA)** 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 methyl mercury.
- 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 4.6.3.1.
- The KCN 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 the Socio-economic Environment Supporting Volume (SE SV).

2.5.1.2.5 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 worldview to younger generations.

These are discussed in more detail in the SE SV.

2.5.1.2.6 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.
- KCN 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 the SE SV.

2.6 REFERENCES

Fisheries and Oceans. Manitoba Natural Resources. 1996. Manitoba Stream Crossing Guidelines for the Protection of Fish and Fish Habitat. http://www.gov.mb.ca/waterstewardship/fisheries/habitat/sguide.pdf

3.0 CONSTRUCTION SCHEDULE, ACTIVITIES AND WORKFORCE

This section describes the process of constructing the Keeyask Generation Project (the Project). It begins with a summary of activities that will occur in each of the eight years that construction will occur and then explains how each component of the Project will be constructed. It concludes with a review of the manner in which the Project will be managed and contracted, workforce estimates, hiring parameters, and training for this workforce.

3.1 OVERVIEW OF CONSTRUCTION SCHEDULE

Construction is scheduled to begin in 2014 and be completed in 2022. The actual start date will be dependent upon the receipt of Project approvals; most notably the licences and authorizations required from regulatory authorities. The preliminary summary schedule is shown in Figure 3-1. This schedule is based on the preliminary design of the Project and proponent's current estimates and assumptions regarding the workforce, equipment fleet and construction methodology and durations. It should be noted that once contractors are hired, they may propose innovative changes to the design and methods of construction that may alter schedule duration. All applicable regulatory processes will be followed and approvals, permits and authorizations will be obtained where changes to schedule and design require them prior to implementation. It is prudent to note that some construction activities are seasonally sensitive, and delays of a few weeks during critical periods have the potential to result in loss of a year to the schedule.

The sequencing of Project phases, staging and main activities during the construction of the Project are illustrated in Map 3-1, Map 3-2 and Map 3-3. 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 EIS CV Chapter 6, Effects Assessment. The following section outlines key Project phases and main activities and summarizes the primary construction activities year by year:

3.1.1 Construction Activities - 2014

Construction activities during 2014 will include:

- June to August:
    - Cofferdams and Groins:
        - Construct quarry cofferdam and north channel rock groin; and
        - Begin construction of, north channel Stage I cofferdam, Stage I island cofferdam and powerhouse Stage I cofferdam.

- Others:
  - Continue construction of contractor's work areas;
  - Begin construction of ice boom;
  - Construct rock fill causeway to Borrows N-5 and G-3; and
  - Construct downstream boat launch and barge landing
- September to December:
  - Cofferdams and groins of north channel Stage I cofferdam, Stage I island cofferdam and powerhouse Stage I cofferdam.
  - Others:
    - Complete construction of ice boom;
    - Begin clearing the reservoir;
    - Begin expansion of camp accommodations for additional 1,500 workers; and
    - Begin construction of south access road.

3.1.2 Construction Activities - 2015

Construction activities from January to December 2015 will include:

- January to December:
  - Powerhouse:
    - Begin excavations for powerhouse structure, and intake and tailrace channels.
  - Spillway:
    - Begin excavation for spillway structure, and approach and discharge channels.
  - Cofferdams and Groins:
    - Construct spillway Stage I cofferdam, central dam Stage I cofferdam and central dam rockfill groin.
  - Dams and Dykes:
    - Begin excavations and fill placement for north dyke.
  - Others:
    - Continue expansion of camp accommodations;
    - Complete Stage I river diversion; and
    - Complete construction of south access road.

3.1.3 Construction Activities - 2016

Construction activities in Year 3 include the following:

- January to December:
  - Powerhouse:
    - Complete excavations for powerhouse structure, and intake and tailrace channels (inside powerhouse cofferdam).
    - Begin placing powerhouse and service bay concrete – first year.
  - Spillway:
    - Complete excavations for spillway structure, and approach and discharge channels;
    - Begin placing spillway concrete first year; and
    - Begin installation of spillway gates.
      - Begin placing spillway concrete – first year.
  - Cofferdams and Groins:
    - Complete Stage I spillway cofferdam, central dam Stage I cofferdam and central dam rock fill groin.
  - Dams and Dykes:
    - Continue excavations and fill placement for north dyke.
    - Begin construction of central dam.
    - Begin clearing and grubbing for south dyke.
  - Others:
    - Complete camp accommodations.

3.1.4 Construction Activities - 2017

Construction activities from January to December 2017 will include:

- Powerhouse:
  - Begin installation of steel for service bay and powerhouse Units 1, 2, 3 and 4.
  - Continue placing powerhouse and service bay concrete – second year.
  - Install powerhouse crane.

  - Commence installation of powerhouse intake gates.
- Spillway:
  - Continue placing spillway concrete – second year.
  - Complete installation of spillway gates.
- Cofferdams and Groins:
  - Construct the Stage II island cofferdam.
  - Remove sections of Stage I spillway cofferdam (and divert river through spillway).
  - Construct upstream cofferdam for south dam.
- Dams and Dykes:
  - Continue excavations and construction of central dam.
  - Complete excavation for south dam (inside Stage I spillway cofferdam), north dam.
  - Complete construction of north dyke.
  - Commence excavation and fill placement for south dyke.
  - Complete excavation for south abutment.

- Others:
  - Complete the north access ramp and parking lot.
  - Begin Stage II river diversion through the spillway structure.

3.1.5 Construction Activities - 2018

Construction activities during 2018 will include:

- January to July:
  - Powerhouse:
    - Continue installation of powerhouse intake gates.
    - Complete installation of superstructure steel for service bay and powerhouse units 1, 2, 3, 4.
    - Begin installation of superstructure steel for service bay and powerhouse units 5, 6, 7.
    - Begin installation of turbines and generators.
    - Begin installation of bulkhead domes for units 3, 4, 5, 6, 7.
    - Begin installation of mechanical and electrical systems.
    - Continue placing powerhouse and service bay concrete – third year.

- Cofferdams and Groins:
  - Complete the downstream cofferdam for south dam.
- Dams and Dykes:
  - Complete central dam.
  - Complete excavation for south dam (river section).
  - Continue construction of south dyke.
  - Begin construction of south dam (river section).

- July to December:
  - Powerhouse:
    - Complete installation of superstructure steel for powerhouse units 5, 6, 7.
    - Continue installation of turbines and generators.
    - Continue installation of bulkhead domes for units 3, 4, 5, 6, 7.
    - Continue installation of mechanical and electrical systems.
    - Continue placing powerhouse and service bay concrete – third year.
    - Continue excavation of tailrace channel.
    - Begin installation of draft tube gates.
    - Complete installation of powerhouse intake gates.
  - Cofferdams and Groins:
    - Complete construction of tailrace channel summer level cofferdam – first year.
  - Dams and Dykes:
    - Continue construction of south dyke.
    - Continue construction of south dam (river section).
  - Others:
    - Begin construction of transmission tower spur.

3.1.6 Construction Activities - 2019

Construction activities during 2019 will include:

- January to July:
  - Powerhouse:

- Complete installation of unit 7 bulkhead dome.
- Complete installation of draft tube gates.
- Continue installation of turbines and generators.
- Continue installation of mechanical and electrical systems.
- Continue placing powerhouse and service bay concrete – fourth year.
- Continue installation of tailrace channel.

o Cofferdams and Groins:
  - Remove powerhouse Stage I cofferdam.
  - Partial removal of north channel cofferdam, Stage II island cofferdam, and north channel rock groin.
  - Repair and maintain tailrace summer level cofferdam – second year.

o Dams and Dykes:
  - Continue construction of south dyke.
  - Continue construction of south dam (river section).
  - Begin impounding north and central river channel.

o Other:
  - Complete reservoir clearing.

- July to December:
  - o Powerhouse:
    - Complete tailrace channel excavation.
    - Complete placing powerhouse and service bay concrete.
    - Complete rollways for Bays 1, 3, 5, 7.
    - Continue installation of turbines and generators.
    - Continue installation of mechanical and electrical systems.
    - Complete Unit 1 commissioning – first power.
  - o Cofferdams and Groins:
    - Remove tailrace summer level cofferdam.
  - o Dams and Dykes:
    - Complete south dame and south dyke.
  - o Others:

- Complete transmission tower spur.
- Remove ice boom.
- Impound reservoir.
- Remove rock fill causeway to Borrows G-3 and N-5.
- Construction upstream boat launch and barge landing.

3.1.7 Construction Activities - 2020

Construction activities from January to December 2020 will include:

- Powerhouse:
  - Complete installation of turbines and generators.
  - Complete installation of mechanical and electrical system.
  - Remove bulkhead domes for Units 3, 4, 5, 6, 7.
  - Commission additional units, first power for Units 2, 3, 4, 5, 6, 7.
- Spillway:
  - Complete spillway rollway for Bays 2, 4, 6.
- Others:
  - Begin construction infrastructure decommissioning.

3.1.8 Construction Activities - 2021

Construction activities from January to December 2021 will include:

- Construction infrastructure decommissioning.
- Station in full service.

3.1.9Construction Activities - 2022

Will include the following tasks:

- Infrastructure decommissioning.
- Site rehabilitation.
- Station in full service.

3.2 SITE PREPARATION

Site preparation will consist mainly of clearing and grubbing and will be the first step in the construction of many of the facilities, including the south access road, borrow sources, powerhouse, spillway, dams, dykes, and excavated material placement areas for excess excavated materials that are outside the reservoir. The clearing required for the reservoir is discussed in Section 3.6.

Site preparation work will commence in Year 1 (2014) in areas where the Stage I cofferdams are to be constructed including associated access roads. Site preparation in Year 1 will also be carried out where the powerhouse is to be constructed. This work will proceed through the first quarter of Year 2 (2015). Clearing and grubbing for the south access road will occur during the winter of 2014/15; the granular borrow sites will be cleared between 2014 and 2016; and the dyke lines during the winters of 2014/15 and 2015/16.

The clearing will be undertaken with heavy machinery. Organic material removed during the clearing and grubbing will be stockpiled and used later in the rehabilitation of borrow sites, temporary roads and excavated material placement areas. Equipment used for clearing includes brush mowers, large tractor-type crawlers using shear blades, rubber-tired skidders, logging trucks and pick-up trucks. Grubbing, the removal of the tree roots will only be undertaken where essential, including the area where the access road and drainage ditches are located. Equipment used for grubbing includes bulldozers with hydraulic rippers.

3.3 CONSTRUCTION OF SUPPORTING INFRASTRUCTURE

Infrastructure required to support construction of the Project includes camps and work areas, communications 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, and facilities for safety and security.

3.3.1 Development and Operation of Camp and Work Areas

The main camp and work areas are being developed in two phases. The first phase, which includes a 500 person camp, is being constructed in accordance with a licence issued in 2010 under *The Environment Act (Manitoba)* for the Keeyask Infrastructure Project. It will be completed by July 2014. The operation of these facilities and the expansion of the camp to accommodate an additional approximately 1,500 people are part of the Generation Project. Construction of this second phase of the main camp will start in July 2014 and will be completed by April 2016.

The camp consists of dormitories, a recreation hall, bays for fire and first-aid vehicles and kitchen/dining facilities (similarly as seen in Photograph 3-1). Utilities servicing the camp include potable water supply, wastewater disposal, solid-waste disposal (possibly including a new landfill) and power supply.

Photograph 3-1: Camp Area (Wuskwatim Camp, Manitoba Hydro, 2011)

The work areas will contain field offices, storage facilities, maintenance shops, fuel storage and vehicle-refuelling facilities, an aggregate processing area, and other facilities required to support construction activities.

Camp residents will be subject to camp rules. Among these rules, personal recreational and all-terrain vehicles will not be allowed at the Project site. See Section 2.4.8 for rules regarding use of firearms at the construction site.

The camp and work areas will be located on an approximately 120 ha site on the north side of Gull Rapids, about 1.8 km from the shore of the Nelson River.

3.3.1.1 Water Supply and Treatment

Water for the camp will be obtained from two wells located north-west of the camp shown on Map 2-10. The water will be treated in a packaged treatment system (installed under the KIP) using a conventional chemical coagulation, clarification and filtration process to reduce turbidity and colour. Chlorine will be added for disinfection and deactivation of *giardia*, *cryptosporidium* and other viruses will be accomplished by UV disinfection to meet the Drinking Water Safety Regulation (2007) Drinking Water Quality Standards Regulation (2007).

The water treatment will be designed to protect expected peak water consumption of 655 L/min. As well, distribution pumps located in the water treatment plant will provide domestic and fire protection flows via pipelines to the camp and office areas. Freeze protection for the pipelines will be provided.

Storage tanks will provide storage capacity requirements to meet fire-protection requirements stipulated by the National Fire Protection Association 851 (2 hours of available water at 750 US gallon per minute). Fire pumps will draw water from the same source as the potable water supply and will be pumped through the same system. The camp and work area buildings will contain fire detection sensors, which will be continuously monitored by the site security forces.

Filtered backwash from the water treatment plant operations and settling chamber sludge will be discharged to the main channel of the river downstream of the powerhouse.

3.3.1.2 Wastewater and Solid Wastes

A packaged wastewater-treatment plant will be installed as part of the KIP. The wastewater effluent will discharge into the Nelson River and will meet Manitoba Conservation's Tier 1 Water Quality Standards for Secondary Treatment Technologies Discharging into Receiving Waters (2011). 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 TSS. It is planned that the residual sludges resulting from the wastewater treatment will be dewatered by **centrifuges** and hauled to the construction landfill or taken to the existing Thompson landfill for disposal. This will occur approximately on a weekly basis.

Solid waste from the main camp will be collected and either taken to a new landfill site or to the existing Thompson solid waste facility for disposal.

The waste stream is expected to comprise kitchen waste, on-site lunch services waste and sleeping quarter waste. Recyclables, bulky waste (white goods, scrap metals), waste wood, etc., will be diverted from the waste stream in accordance with Hydro's Waste Management Plan.

Several potential landfill sites have been investigated. Due to the poorly drained sands, silty soils and discontinuous permafrost, suitable sites are limited. An engineered liner system would be necessary to provide adequate containment of leachate. Approximately 4 ha would be required for a facility, including a perimeter fence (to deter wildlife and people access), restricted access gate, litter control fencing and storage compounds (for tires, metals, *etc.*). Several sites that avoid sensitive caribou habitat have been identified. If used, a closure/decommissioning plan would be developed. The less expensive option is to haul the solid waste to the approved Thompson landfill.

It is likely that scrap wood and paper products will be burned in a designated area at the construction site, under a permit from Manitoba Conservation or taken to the existing Thompson landfill. Other waste will be disposed of in a new landfill to be approved by Manitoba Conservation. Food refuse which is not disposed of through the wastewater system, as well as those other wastes destined for the waste disposal site, will be stored temporarily in bear-proof containers.

The options for managing solid waste are still under further investigation. The required provincial approvals would be obtained for either option.

Both hazardous and non-hazardous solid wastes will be produced[2]. Non-hazardous waste will be diverted from landfills when practical for reuse and recycling. Hazardous wastes and materials will be managed according to applicable regulatory requirements.

3.3.1.3 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, as shown in Photograph 3-2, 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 Department of Fisheries and Oceans Freshwater Intake End-of-Pipe Screen Guidelines (1995). The contractor will determine the water requirements for the batch plant and will obtain the water withdrawal permits for its plant. The amount of water withdrawn for batch plant use will be very small relative to the flow in the Nelson River. 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. The aggregates required for use in the concrete will be produced from local rock and gravel sources, as discussed in Section 3.5.

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[2] Hazardous wastes include aerosol containers, light bulbs, antifreeze, batteries, chemical containers, surplus chemicals, compressed gas cylinders, oil and fuel filters, fire extinguishers, grease, oil, paint, solvents and tires stored in designated areas (transfer station) and disposed of regularly to reduce potential for unsafe conditions and negative impacts. Other waste streams include aluminum cans, cardboard, paper, packaging material, plastics, glass, building material, scrap metals, street light heads, wood pallets, and surplus equipment.

Photograph 3-2: Typical Concrete Batch Plant (Wuskwatim Project, Manitoba Hydro, 2009)

Coarse aggregates for the concrete will be produced by crushing, screening, washing and stockpiling bedrock obtained from Quarry 7. Fine concrete aggregate will be sourced from deposit G-3, which is believed to contain adequate quantities for the Project. Typical crushing, screening, washing and stockpiling operations utilize a number of crushers and conveyor belt systems, similar to those pictured in Photograph 3-3 and Photograph 3-4. 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.

Photograph 3-3: Typical Aggregate Crushing and Stockpiling Operations (Wuskwatim Project, Manitoba Hydro, 2007)

Photograph 3-4: Typical Aggregate Crushing and Stockpiling Operations (Wuskwatim Project, Manitoba Hydro, 2007)

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 the Manitoba Surface Water Quality Standards, Objectives and Guidelines criteria of 25 mg/L. The discharge will not be continuous.

3.3.2 Development of Borrow Sources and Rock Quarries

Borrow sites will start to be developed in 2014 (Year 1) and will be utilized throughout the years of construction period, with the most intensive use between 2014 and 2019. In general, the decision with respect to the selection and development of borrow sites and quarries will be the responsibility of the contractors, subject to appropriate approvals and the Environmental Protection Plan.

Typical equipment used in the operation of borrow sites and quarries include crawler-tractors, front-end loaders, drills, screens, crushers, washers and gravel trucks.

Blasting will be required for the production of rock products and **riprap** materials that will be available from the area excavated for the powerhouse and spillway, as well as from Quarry Q-7 on the north side of the river and from Quarry Q-1, Q-9 and potentially Q-8 on the south side of the river.

Specifics pertaining to the storage and use of explosives will not be available until a general civil contract is in place. The selected contractor will ensure there is a certified blaster on site who will be responsible for purchasing, safe storage, tracking and use of explosives. It will therefore be the contractor who will be the applicant for the magazine licence/certificate, which will be temporary in nature to support the construction of the Project.

Restrictions will be placed on blasting coincident with the caribou calving season and bird breeding season. See Terrestrial SV for details of the restrictions. All blasting is expected to be carried out in dry conditions and will follow DFO "Guidelines for the Use of Explosives in or Near Canadian Fisheries Waters." The use of dynamite is planned for all excavations or quarries where water will contact the final rock face. The use of Ammonium nitrate fuel oil (ANFO) is planned for the other blasting activities.

3.3.3 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.

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 (MBQSOG 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 3.3.1 provides details of the settling ponds.

3.3.4 Transportation of People and Materials to Site

The Project will require materials and equipment from numerous sources in Manitoba and elsewhere. Typically materials will be shipped through the City of Thompson with a greater proportion of the materials likely to be shipped by truck, rather than by rail. The decision for the mode of transportation will be the discretion of the contractor and suppliers. If shipped by rail, materials will be offloaded in Thompson to trucks and hauled to the site via the north access road. A small portion of freight may be handled at the rail siding in Gillam after the south access road is built.

The north access road, which is being constructed as part of the KIP, will be the main access route for hauling materials, equipment and transporting workers to the construction site. While the Project is being constructed, the north access road will be operated and maintained as a private road. As such, the operation and maintenance of the north access road is a component of the Project. There will be a bus stop/rest area with a small shelter located near the gatehouse. A shuttle van service will be established to transfer workers and mail to and from the main camp during the construction of the generating station. This service will be coordinated by the service contractor.

Traffic volumes for construction vehicles active on the construction site have yet to be determined by the contractors. While traffic data specific to construction-activities have yet to be determined, traffic forecasts were developed for three construction-support related traffic categories, namely:

1. Traffic hauling freight (heavy trucks).
2. Traffic providing support services to the camp and construction work areas.
3. Traffic transporting personnel to/from the Project site.

Forecasts of traffic attributed to the Project were developed March 2010. As the extent of rail service to be used for shipping freight is unknown, two forecast scenarios were developed:

1. 85% of freight transport by rail and 15% of freight transport by road.
2. 15% of freight transport by rail and 85% of freight transport by road.

In the 85% of freight shipped by rail scenario, only 15% of freight shipments arrive at Thompson by road, with the rest arriving by rail at Thompson and transferred to trucks for shipment by road along the route from Thompson to the Project construction site. In the 15% of freight shipped by rail scenario, 85% of freight shipments would arrive in Thompson via PTH 6 to Thompson and proceed along the route from Thompson to the Project site. Consequently, the difference between the two freight shipping scenarios results in a change only in traffic along PTH 6 to Thompson, with remaining routes of entry to the Project past Thompson requiring use of PR 391 and PR 280 from Thompson or from Gillam.

The forecasts are based on the assumption that traffic for the Project would access the Project site via PR 280, on the north side of the Nelson River. Project traffic is expected to travel from Winnipeg, Thompson, Split Lake, Nelson House, Gillam or other communities before turning onto the north access road to the Project Site.

The assumption that all traffic accesses the Project site via PR 280 is made even though additional access will be available in 2016 by means of the south bank of the Nelson River via the south access road that will link Gillam to the Project site. This assumption is considered reasonable given the relatively small volume of freight and construction personnel traffic that is anticipated from Gillam.

3.3.5 South Access Road

The south access road will be constructed between December 2014 and October 2015. Construction equipment will typically include rubber-tired earth moving scrapers, crawler tractors, hydraulic excavators, dump trucks, compaction equipment, motor graders, rubber-tired loaders and water tank trucks. Rock processing operations will require a rock crusher, screening equipment and conveyors. The transportation of the materials from the various quarries will utilize hauling equipment, such as 45-tonne rock wagons or possibly larger equipment.

In general, road construction methods will follow the latest revision of Manitoba Infrastructure and Transportation (MIT) Standard Construction Specifications for Grading and Surfacing Works, as summarized in Table 3-1.

Table 3-1: Current Design that Meets Manitoba Infrastructure and Transportation (MIT) Geometric Design Criteria for Secondary Arterial Roadways

Criteria Description	Secondary Arterial
Number of lanes	Two lanes
Design speed	100 km/hr
Gradient (maximum percent)	6%
Minimum stopping sight distance	200 m
Minimum passing sight distance	680 m
Minimum vertical curve	Sag = 50, Crest = 70
Minimum curvature (radius)	440 m
Lane width	3.7 m and 5.7 m
Shoulder width	1.0 m gravel
Shoulder edge treatment	0.25 m
Right-of-way width	100 m

The area to the south of the Nelson River does not have readily available sources of granular materials. The south access road will traverse along the south side of Quarry Q-1 and traverse eastward to the impervious Deposit S-2 and Quarry Q-9 before reaching the Butnau Dam. Sub base, road topping, and culvert gravel materials will therefore have to be imported to the site or be produced from the quarries. To construct the south access road impervious fill will be sourced from borrow S-2 while granular fill, road topping and rip rap will be produced by crushing rock and screening at Quarries Q-1 and Q-9. Rock may be sourced from the **right-of-way (ROW)** and impervious material may be side cast from the ROW where this material is available. If borrow is obtained from pits within the 100 m right-of-way, a 30 m buffer will be maintained between the edge of the road and the borrow site. Borrow sites may also be utilized if wet soil conditions are encountered. As a result, the exact amount of borrow is difficult to estimate. Some of the organic material removed from the footprint of the access road or removed from the ROW where material may be sourced will be re-used in the rehabilitation of borrow sites and temporary roads/trails. It is possible but unlikely that granular borrow E-1 will be used to construct the south access road as it is located far from the road.

Construction of the roadbed in wetland areas will begin by placing a layer of **geotextile** material along the proposed alignment of the road. Clean granular fill ("pit-run") will then progressively be dumped over the geotextile and pushed forward using a dozer. Dumping will continue until the primary settlement and consolidation of the foundation and the embankment has stabilized to the extent practicable during construction. Long term settlement at these locations is expected. Since the road traverses an area of discontinuous permafrost, soils affected by permafrost will likely be encountered sporadically throughout the length of the south access road. To address this issue, the roadbed within these areas will be constructed by placing a layer of geotextile material on top of the unstripped peat and then placing granular fill material on top. To mitigate the anticipated subsidence (settlement) of these sections of the road, additional granular fill will be placed as required during construction.

Temporary soil erosion and sedimentation control measures will be implemented as dictated by local conditions, consistent with Manitoba Transportation and Government Services "Manual of Erosion and Sedimentation Control" (Manitoba Government 2000) and "Manitoba Stream Crossing Guidelines for Protection of Fish and Fish Habitat". These may include seeding of exposed areas, riprap at culvert inverts and on steep ditch slopes, straw or coconut fibre erosion control blankets on grade and back-slopes constructed with soils of high erodibility, and silt fences to prevent sediment from entering watercourses. The grass mixture used to seed ditches will contain only native and/or non-invasive introduced grasses (*i.e.,* will not contain sweet clover [*Melilotus offincianilis*] or other herbs).

Known cultural and environmentally sensitive areas to be avoided will be identified in the Environmental Protection Plans, in advance of construction. All borrow pits will be sited at least 100 m from active stream channels and other water bodies.

Construction of the stream crossings will be scheduled to take place in the winter and early spring, before runoff. Construction procedures at stream crossings will minimize in-stream time and disturbance of the watercourse bed and banks. Temporary soil-erosion and sedimentation control measures will be implemented to the extent practical based on local site conditions and in accordance with Manitoba Infrastructure and Transportation's Manual of Erosion and Sedimentation Control (Manitoba

Government 2000) and the Manitoba Stream Crossing Guidelines for Protection of Fish and Fish Habitat (Manitoba Department of Natural Resources and Fisheries and Oceans 1996). A minimum buffer zone of 10 m will be left at stream crossings. Location of the proposed stream crossings are shown in Map 2-15.

3.3.6 Installation of Ice Boom

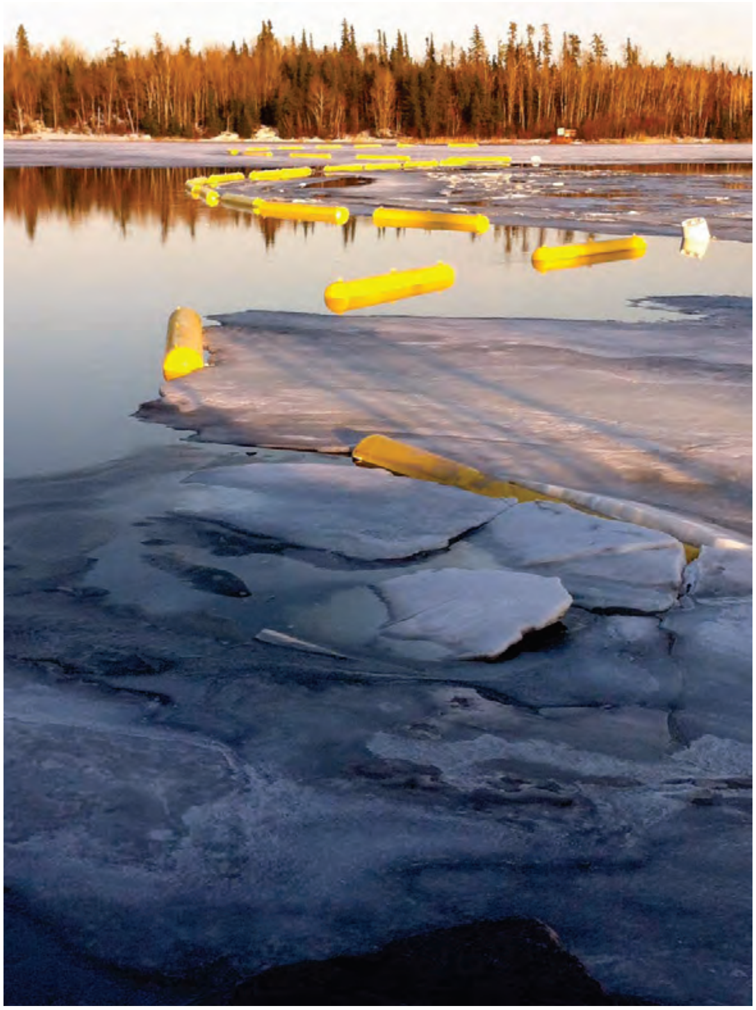
The ice boom will be assembled and installed in 2014 approximately 3 km upstream of the powerhouse site, as shown on Map 2-11 Ice boom sections will be fabricated off site and shipped to site. The ice boom will be preassembled as much as possible in the lay down area and along the north shore. A mobile crane will be employed for this latter work, and for offloading the boom sections. A barge will be used as a platform to drill holes into the riverbed where anchors will be installed. The barge and divers will be used to install and pressure grout anchor chains into the holes and to install the cable junction plates, buoys and main cable spans.

There are three potential drilling techniques to install the ice boom anchoring system. The method will be determined by the contractor.

- Option 1: Hammer drill holes and pulverize the rock which would be washed downstream. A barge and divers would be used to install anchor chains into the holes using underwater pressure **grouting** techniques.
- Option 2: Hollow core drilling would remove the majority of the rock as the core has minimal drill cutting in the water. Anchors would be installed similar to Option 1.
- Option 3: Conduct drilling and grouting within a large diameter hollow pipe which extends from the riverbed to above the water surface. The pipe is drilled deep enough into solid rock to create a seal. Subsequently, a hammer drill or core drill is inserted into the pipe and drill cuttings are pumped out and disposed as directed. Similarly, grouting is done inside the pipe, eliminating potential for grout in the water. The pipes would be cut off at the riverbed after the anchors are in place.

Installation of the ice boom will require approximately one month and will be completed prior to ice formation in fall 2014. The installation would commence once all the equipment and materials are on site and the barge is fully installed in the water.

The ice boom will be anchored in place from the time it is installed in the fall of 2014 to its removal during the fall of 2019. The preliminary ice boom anchoring system is shown in Photograph 3-5.The following photograph shows a typical ice boom installed,



Photograph 3-5: Ice Boom (Manitoba Hydro, 2012)

3.4 RIVER MANAGEMENT DURING CONSTRUCTION

A two-stage program of river management involving the construction of nine dams and two rock groins will be implemented to divert the Nelson River and allow the Project to meet the schedule for constructing the principal structures. The first stage involves blocking off the north and central channels of the river to facilitate construction of the central dam cofferdam, powerhouse cofferdam and spillway cofferdam. The entire flow of the Nelson River will be directed to Gull Rapids south channel. The second stage of diversion will involve removal of the spillway cofferdam and construction of the south dam Stage II upstream and downstream cofferdams, to divert the entire flow of the Nelson River to pass through the partially completed spillway. The sequencing of cofferdam construction is shown on Map

3-4, Map 3-5 and Map 3-6. To the extent practical, the schedule for in-water activities has been developed to avoid or reduce activity during sensitive periods for the aquatic environment.

The following sections describe the sequencing of the cofferdams which are illustrated in Map 3-4, Map 3-5 and Map 3-6. The locations and layouts of the cofferdams are shown on Map 2-10. The estimated dates and durations for construction of each structure are provided to illustrate how river management could occur. The construction dates and durations are approximations and are based on a preliminary schedule intended to illustrate the approximate timing and approximate duration based on preliminary engineering. Events such as weather or other unforeseen issues may cause the schedule to change. The GCC may also choose to carry out the Project using different methods which could also cause the schedule to change. Schedule changes will adhere to the EnvPP and will be communicated to and approved by regulators when required to do so.

3.4.1 Timing of In-Stream Work

The Department of Fisheries and Oceans (DFO) general guidelines restrict in-water work in northern Manitoba to the period of July 16 to August 31. The guidelines protect spawning fish and developing eggs and fry. The DFO guidelines indicate that site or project specific review may alter the restricted periods. After consideration of dates of actual spawning in the study area, the proponent has determined that in water, work would be permissible between July 16 to September 15. Where practical, the construction schedule was developed and adjustments were made to avoid in-water work during the following sensitive periods:

- May 15 to July 15 which corresponds to spawning period for Lake Sturgeon and other spring spawning fish.
- September 16 to May 15 which corresponds to the spawning period for lake whitefish.

Permission from DFO will be requested where it is not practical to avoid in-water work during these restricted periods.

3.4.2 Stage I Diversion

During the first 2 years of construction, a series of six cofferdams and two rock fill groins will be constructed to permit dewatering of the river channels in the locations of the powerhouse and spillway structures as well as the central dam.

The layout of the Stage I Diversion structures will direct the entire flow of the Nelson River to the southern portion of the river, allowing the construction of the following structures in the dry; north dam, powerhouse intake channel, powerhouse, the upstream portion of the powerhouse tailrace channel, spillway (Stage II diversion structure), spillway approach channel, spillway discharge channel, central dam and a portion of the south dam.

The first cofferdam to be constructed will be the quarry cofferdam from July 17 to 22, 2014 over a period of 6 days. This cofferdam ensures no river flow into the north channel so that Quarry 7 can be developed in the dry. Sourcing rock from Quarry 7 will be required to construct the remaining Stage I cofferdams and rockfill groins.

The next structure to be constructed will be the north channel rock groin from July 28 to August 18, 2014 over a period of 22 days (similarly as seen in Photograph 3-6).

Photograph 3-6: Progressive Rock Fill Cofferdam (Wuskwatim Project, Manitoba Hydro, 2010)

The north channel rock groin will block nearly all flow into the north and central channels of Gull Rapids. Working in tandem with the ice boom, installed later in August 2014, the groin will also promote the formation of a stable upstream ice cover by increasing water levels on Gull Lake slightly which will reduce water velocities. The formation of the upstream ice cover will minimize the formation of an ice dam downstream of Gull Rapids. This will reduce the increases to water levels due to ice in the vicinity of the some cofferdams and will also reduce the height to which those cofferdams will need to be constructed.

The north channel Stage I cofferdam will be constructed from August 18 to September 3, 2014 over a period of 17 days. This cofferdam will block off the north and central channels of the river to facilitate construction of the central dam cofferdam and powerhouse cofferdam.

The powerhouse cofferdam will be constructed from July 28 to October 15, 2014 over a period of 79 days. This cofferdam is required to establish a dry work area so that excavation of the powerhouse can occur in the dry.

The Stage I Island Cofferdam will be constructed from September 3 to 18, 2014 over a period of 16 days. This cofferdam extends from the North Channel Stage I Cofferdam. It ensures the construction of the Powerhouse and approach channel, and Central Dam and utilization of Quarry 7 will be in the dry during Stage I Diversion

In the following year of Stage I Diversion, a U-shaped cofferdam (spillway cofferdam) in the south channel will be constructed from July 16 to October 14, 2015 over a period of 91 days. The spillway cofferdam will complete the diversion of the river into the south channel and permit construction of the spillway structure, and spillway approach and discharge channels in a dry work area.

The central dam cofferdam and central dam rock fill groin will be constructed from August 10 to October 6, 2015 over a period of xx days. The central dam cofferdam permits the construction of the central dam in a dry work area. The central dam rock fill groin deflects river flow away from the toe of the central dam cofferdam to minimize erosion.

The minimum allowable crest elevations of the Stage I cofferdams were selected to provide protection against the annual 1:20 year construction design floods during open water conditions and monthly flows during winter conditions. The stage I Cofferdams will also be in service during the Stage II River Diversion through the spillway structure.

3.4.3 Stage II Diversion

The Stage II island cofferdam will be constructed between August 1 to 23, 2017 over a period of 23 days. This cofferdam ensures the continued construction of the powerhouse and approach channel, and central dam and utilization of Quarry 7 in the dry during Stage II river diversion.

Upon completion of the spillway concrete (excluding rollways) and spillway north and south transitions, and the installation of the spillway gates, the dry area within the cofferdam upstream of the spillway will be filled with water using pumps. Portions of the Stage I spillway cofferdam upstream and downstream of the spillway will then be removed from August 2 to September 7, 2017 over a period of 37 days. These portions of the spillway Stage I cofferdam will be removed (Photograph 3-7) to permit the diversion of the river flow through the spillway. The partially completed spillway will operate as a simple sluice structure without rollways to accommodate river flows for the Stage II river diversion period.

Photograph 3-7: Cofferdam Removal 'in the wet' (Wuskwatim Project, Manitoba Hydro, 2011)

Prior to opening the spillway gates for the first time, cofferdam material will be removed as much as possible and excavated channels cleaned to minimize the generation of TSS. Increases in TSS will be managed by controlling the flow through the spillway. Flow will be gradually increased based on observed effects on turbidity. This activity is scheduled during September 2017.

River closure will take place in the summer of 2018 following the diversion of the Nelson River through the partially completed Spillway structure. The river will be closed by advancing the rock fill portion of the south dam Stage II upstream cofferdam from the Stage I spillway cofferdam to tie-in to the south bank of Gull Rapids. The south dam Stage II upstream cofferdam will be constructed September 8 - October 20, 2017 over a period of 43 days. From May 10 to July 17, 2018 additional work will be carried out to complete the south dam upstream cofferdam and the south dam downstream cofferdam will be constructed. These two cofferdams will ensure that the south dam is constructed in the dry between the two cofferdams.

The tailrace summer level cofferdam will also be constructed in the summer of 2018 from July 16 to September 14, 2018. This cofferdam will permit the completion of the excavation of the powerhouse's tailrace channel. It will be constructed to a level that could possibly be overtopped during the winter of 2018 and 2019. In the spring of 2019, water will be pumped out of the tailrace summer level cofferdam and the crest will be repaired, if required, from June 1 to 28, 2019 over a period of 28 days. Repairs will likely be made above the open water level adjacent to the cofferdam.

Once construction of the tailrace channel is completed a portion of the tailrace summer level cofferdam will be removed from September 9 to October 3, 2019 over a period of 25 days. This enable flow through the powerhouse later in 2019.

The higher levels on Gull Lake during passage of the annual 1:20 year CDF would flood some land on the south side of Gull Lake. Based on a review of the depth to mineral soils in the area, it is expected that the water will stay within Gull Lake during the annual 1:20 year CDF. Subsurface water levels in low lying areas to the south of Gull Lake will be monitored during construction and actions will be taken, if required, to contain subsurface seepage and overland flow southward out of Gull Lake. A potential mitigation measure to contain the seepage and overland flow would be to construct additional containment dykes.

3.4.4 Cofferdam Construction Methodology

The general method of construction for the cofferdams will consist of placing the fill materials in the river "in-the-wet" up to an elevation of approximately 1 m above the prevailing water level. The construction of the structures will proceed by progressively end dumping the rockfill directly into the water from a point as close to the water as possible along the alignment of cofferdam (Figure 2-8 and Figure 2-9). The placement of finer materials (i.e. the granular filter and impervious seal) will be dumped onto the upstream side of the rockfill materials near the front of the advancing face of the rockfill zone and pushed into the river by utilizing dozers so that the fill enters the water as a sliding mass, thereby minimizing the amount of fill that will come in direct contact with the water. The Rockfill groin will be kept some 20 to 30 m ahead of the placement front of the finer grained materials.

Depending upon the location and river flow conditions, either single or dual groins of rock fill 20 to 30 m ahead of the finer granular materials will be used to limit sediment releases and total suspended solids levels in the river. This is generally followed with the placement of granular filters and an impervious seal. The latter materials are placed by dumping them on the surface of the cofferdam, and then large dozer tractors are used to push the material into place below the water.

Once the cofferdam is constructed, the water will be pumped out of the enclosure, and construction of the principal structures can proceed "in the dry." Sump pumps will be used with settling ponds established within the enclosed area, and water that collects in the sumps and ponds is discharged back into the river. Cross-sectional details for these cofferdam structures are shown in Figure 2-8 and Figure 2-9.

The Stage I and Stage II island cofferdams will be the only cofferdam constructed "in the dry", and they will be located on prepared overburden. The stage II island cofferdam's impervious core will be tied into the central dam's impervious core.

The rock groin for the Stage II south dam upstream cofferdam will be advanced across the south channel and onto the south bank of the river at a location containing a relatively high bedrock outcrop, thus minimizing the potential for erosion of the riverbank. The placement of the transition fill and impervious fill will lag behind the rock fill, so these materials will be placed in relatively low velocity flow conditions.

3.5 CONSTRUCTION OF PRINCIPAL STRUCTURES

The principal structures include the powerhouse complex (including the control structure and service bay), intake and spillway channels, dams, dykes and reservoir.

3.5.1 Powerhouse Complex

The powerhouse complex will consist of seven units, each with three major structural parts: the intake, the powerhouse and the tailrace. Generally, two units will be constructed concurrently, with the seventh and final unit completed in January 2020. Construction of the powerhouse, which will be founded on bedrock, will involve the excavation of about 695,000 m^3 of rock and 68,000 m^3 of overburden.

It is expected that two mobile tower cranes, traveling on temporary rails, will be required upstream of the intake structure to erect forms, set reinforcing steel, and place concrete in the powerhouse area over two summer construction seasons. Similarly, two cranes will be located to the downstream of the tailrace structure. A creter crane (a telescopic conveyor belt delivery system) may also be available to service mass concrete pours. In total, there will be approximately 305,000 m^3 of concrete and 7,000 m^3 of precast concrete are required to construct the Powerhouse complex.

Once excavation is substantially completed in the primary structures area in June 2016, concrete will be placed at the powerhouse, beginning with the intakes and followed thereafter with the powerhouse and tailrace. Upon completion of the intake concrete, the intake gates and hoisting equipment will be installed.

Once all seven gates are installed, impoundment of the water to the upstream of the intakes can begin. These gates will keep the powerhouse's water passages dry, allowing other concrete and equipment to be installed in the powerhouse. It is anticipated that the peak concrete placement rate will reach 37,000 m^3/ month in the summer of 2017.

Construction of the service bay, with approximately 27,000 m^3 of concrete, is scheduled to start in June 2016, with the clad structural-steel building system enclosed in the last quarter of 2016. This will permit completion of the installation of the two powerhouse electric overhead traveling cranes, which is a critical schedule item for the start of the turbine and generator installation.

Erection of the steel superstructure for the metal clad powerhouse building will commence after the concrete structure has advanced beyond elevation 140.0 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.

3.5.2 Spillway

The spillway will be a concrete overflow structure consisting of seven bays, which will be founded on bedrock. Construction will involve the excavation of about 64,000 m^3 of rock and 17,000 m^3 of overburden. The piers that form the spillway bays will subsequently be constructed followed by the deck slabs, superstructure, and hoist room. There will be approximately 49,300 m^3 of concrete, in the first stage of the spillway's construction, including transition structures and walls. Approximately 8,300 m^3 of concrete will poured during construction of the final rollways in 2019 and 2020. There will be 1,000 m^3 of precast concrete installed in the structure. Concrete placement and associated formwork and reinforcing steel will be achieved by a combination of a tower crane and concrete pumps, supplemented with the use of a mobile crane.

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.

During the construction of the final rollways, access for concreting and associated work will be available from both the upstream Spillway deck and from a construction bridge located on the downstream spillway piers, via a ramp from the central dam. Gate installation will be completed to allow the river to be diverted through the spillway in 2017.

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.

3.5.3 Powerhouse and Spillway Channels

Channels to and from the powerhouse and spillway will be excavated through bedrock once the related cofferdams are in place. Controlled perimeter blasting techniques will be used to ensure the near-vertical faces of the excavation conform to the design requirements. This technique will also minimize disturbance to the rock located beyond the excavation faces. A bulldozer with a hydraulically operated ripper tooth may be used to dislodge material, and the rock will then be removed by dump trucks, using equipment such as a front-end loader, backhoe or dragline. The overburden and bedrock will either be hauled to a temporary stockpile for future use as impervious or rock fill in the dams and dykes or will be hauled for final disposal.

Construction of the intake and tailrace channels will involve the excavation of approximately 1,100,000 m^3 of overburden and approximately 890,000 m^3 of rock. The construction of the intake channel is to be completed in two phases. The first phase will occur from July 2015 to April 2016, and the second phase which will be the excavation of forebay channel improvements, will take place during October 2016 to January 2017.

The construction of the tailrace channel will begin in 2015 and will be completed in 2016.

The construction of the spillway and its associated approach and discharge channels will involve the excavation of approximately 336,000 m^3 of rock and approximately 17,000 m^3 of overburden. This work will also be undertaken in 2015 and 2016.

3.5.4 North and South Dykes

The locations of the north dyke and south dyke are shown in Map 2-5. These are all zoned earthfill structures, which are required to contain water impounded within the reservoir. The dykes will consist of four design sections; the zoned impervious core, granular dyke, freeboard dyke and a road section. The north dyke will be constructed between the spring of 2016 and summer of 2017, and the south dyke between the fall of 2017 and fall of 2019. The construction of dykes will require equipment such as bulldozers, scrapers, drills, compaction equipment, front-end loaders, rock wagons, gravel trucks and backhoes. To build the dykes, fill materials will be placed in lifts of specified thickness, water will be added if necessary, and the fills will be compacted.

The north and south dykes will generally be founded on **glacial till** overburden containing discontinuous permafrost. The scheduling of foundation excavation for the dykes will therefore require special attention. The overburden will be excavated to the founding levels during the winter season, and covered by a nominal depth of granular fill to act as an insulating cover for protection to prevent thawing of the permafrost, and the development of problems with respect to settlement of the structure in the excavations. The impervious and granular fills will then be placed in the summer months when they can be properly compacted without freezing.

In the case of the zoned impervious core dyke, the granular backfill that has been placed as a cover will have to be removed in short sections during the following summer; being careful not to open too much of the foundation surface to the warm summer air. This allows the impervious fill to be compacted directly on top of the glacial tills to limit water seepage through the structure. It is anticipated that approximately 50% of the clean granular backfill materials that are placed during the winter and then subsequently excavated, could be re-used in the construction of the dyke.

The granular dyke section will have sand drains drilled into the foundation by large scale drilling equipment operating from the excavated foundation surface during the winter. The holes will be backfilled with sand immediately after drilling. Once the drains in a given area have been completed, layers of granular fill will be placed over the surface of the excavation and the drains. The granular fill material will act as an insulating layer and it will postpone the thawing of the permafrost foundations until after construction is completed (Figure 2-6).

Approximately 593,000 m^3 and 620,000 m^3 of overburden materials will need to be excavated for the north and south dykes, respectively, and 1,310,000 m^3 and 1,500,000 m^3 of fill will need to be placed, respectively. The dykes make up almost 42% of the total fill required on the Project. The volumes of summer and winter placement of fill materials for both dykes are split about 75% and 25%, respectively.

3.5.5 North, Central and South Dams

The locations of the north dam, central dam and south dams are shown in Map 2-5. These are all zoned earthfill structures, which are required to contain water impounded within the reservoir. Construction of the central dam will start in May 2016, with work continuing during the spring, summer and fall of each year up until it is completed in July 2018. The north dam will be built in the summer of 2017. The south dam will be built during the two summer/autumn periods of 2018 and 2019.

The construction of the earthfill dams will involve bulldozers, scrapers, compaction equipment, front-end loaders, rock wagons, gravel trucks and backhoes. The dams will be constructed in a manner similar to the dykes, with fill materials being placed in lifts of specified thickness, water being added if necessary, and the fills then being compacted. Prior to placing the fill, the bedrock surface will be thoroughly cleaned and any joints and fissures sealed with grout to establish a suitable surface on which to seal the dam to its foundation.

Materials for the construction of the dams will be largely derived from rock excavated for the principal structures foundations, 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 34,000 m^3 of overburden materials, respectively, and the placement of 200,000 m^3, 1,520,000 m^3 and 460,000 m^3 of fill, respectively. Typical cross sections for the north, central and south dam are shown in Figure 2-6.

3.6 RESERVOIR CLEARING

The reservoir will be cleared before impoundment in 2019, beginning in the winter of 2014/15 according the Reservoir Clearing Plan (Response to EIS Guidelines Appendix 4A). The majority of the clearing will be done during the winters, with a less clearing between April and October. 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.

Equipment used for clearing includes brush mowers to large tractor type crawlers using shear blades. Other equipment used for clearing activities includes rubber-tired skidders, logging trucks and pick-up trucks. The clearing will be undertaken with heavy machinery, except for designated cultural or heritage sites, 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. These areas will be cleared by hand.

Mechanical clearing will take place by shear blading during the winter when the ground is frozen. Using this method, the cleared material will be deposited in windrows or piles, left to dry, and then burned the following winter. Materials will be burned in areas selected to minimize the risk of peat fires. The machinery will enable stumps to be sheared off at ground level, along with any other vegetation in the area. Most of the loose and dead woody debris along with hummocks of sphagnum moss will also be accumulated, thereby minimizing the amount of debris left in the reservoir when it is flooded.

Approximately 3,600 ha of the reservoir will be cleared to an elevation of 159 m, as shown in Map 3-7. Standing woody material, which includes trees and shrubs 1.5 m tall or higher, and fallen trees 1.5 m or longer with a diameter of at least 15 cm at its largest point will be cleared. There are some shallow sites that will not be cleared, thereby reducing erosion rates and providing a more stable shoreline for new growth of **riparian** shrubs and trees.

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. These areas will be cleared by people using chain saws, brush cutters and appropriate hand tools. The preliminary extent of clearing methods are shown in Map 3-7. The final extent of hand clearing will be determined in the field. These areas will be marked before mechanical clearing begins. Typically, trees and shrubs will be cleared about 15 to 30 cm from the ground. The stumps and other forest floor debris will remain on the ground.

3.7 RESERVOIR IMPOUNDMENT

Reservoir impoundment to elevation 159.0 m is expected to commence in August 2019 and be completed by October 2019. Full reservoir impoundment by October 2019 will allow commissioning of the first unit for commercial operation. Interim regulation of the reservoir level will be provided by the use of the spillway gates. The four spillway bays with completed rollways along with commissioned units will be of sufficient capacity to pass the monthly 1:20 year flows and will allow the remaining sluiceway sections to remain closed. At that time, regulation of the reservoir will be possible with the use of the four spillway gates in the spillway bays with completed rollways.

A period of approximately 2 weeks will be required to raise the reservoir level to FSL. The rate of water level rise at the principal structures will be limited to 0.5 m to 1.0 m per day due to embankment performance considerations, however, water level changes will likely be smaller on most days. A modest cutback in outflows of 100-300 m^3/s would be required to fully impound the reservoir by the target date. This is equivalent to approximately 3-10% respectively, of the average monthly discharge of the Lower Nelson River at Keeyask.

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 mobilized during reservoir impoundment 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.

3.8 CONSTRUCTION CLEANUP, DECOMMISSIONING AND REHABILITATION

The decommissioning and clean-up of the Project construction camp will begin in 2021 and will conclude after the construction of the generating station is completed, the units have been placed into commercial service, and the camp is no longer needed. The cleanup and decommissioning phase is expected to conclude in November 2022. Decommissioning will involve removal of supporting infrastructure, including specific roads and buildings; collection and disposal of wastes, recyclables and hazardous materials; and removal of water intake, wastewater treatment and landfill facilities.

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.

Reclamation and re-vegetation programs will be initiated for the vacated sites and borrow sites to control/prevent erosion, re-establish wildlife habitat, and create buffer zones. Reclamation measures and vegetation species selection will be undertaken as determined by regulatory requirements, site conditions and management objectives. Consideration will be given to feasibility, practicality, effectiveness and management requirements. The Partnership will monitor site reclamation/revegetation programs, in consultation with the appropriate authorities. The general description of the rehabilitation approach during decommissioning will be described in the Environmental Protection Plans (Section 3.10.1). 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. Borrow pits will be rehabilitated in accordance with the Environmental Protection Plans (Section 3.10).

3.9 WATERWAYS MANAGEMENT PROGRAM

Manitoba Hydro establishes Waterways Management Programs for most of the waterways impacted by hydro facilities. The Program consists of several components, including boat patrols, debris clearing, shoreline stabilization, supplementary work, safe ice trails and community relations. A Waterways Management Plan will be in place during construction of the Project.

The first phase of the Waterways Management Program (Response to EIS Guidelines Appendix 4B) will consist of implementing the impact-reduction measures in the pre-flooding period, including support for clearing activity before impoundment of the reservoir.

An important activity before impoundment will be to work with Members of the Keeyask Cree Nations (KCNs) to identify and contribute to impact management measures at high priority spiritual and heritage sites that will be flooded.

In each year of the 4-year period after construction start and before impoundment, two boat patrols, four persons in total employed as Hydro seasonal employees, supplemented as required with local labour, including two persons required for a winter ice trail crew, hired on a short-term basis through a local KCN Business, will:

- Operate a multi-purpose boat patrol, monitor waterway activities and liaise with individuals and groups using the Nelson River.
- Stabilize shoreline at sensitive streams using low impact techniques.
- Plan and implement protection and preservation measures using low impact techniques at high priority, spiritually and culturally significant, historical or heritage sites from Gull Rapids to Split Lake.
- Assist with the relocation of graves to sites not affected by Keeyask, in cooperation with involved Members.
- Construct and maintain a safety cabin.
- Cut and maintain trails and portages.
- Install and monitor regularly the condition of safe ice trails and the nature and extent of their use.

Initial equipment required will consist of two boats, motors and a trailer, two snow machines, sleighs and trailers and safety clothing and equipment, chainsaws, a GPS, ice auger and related equipment.

3.10 THE PROJECT'S ENVIRONMENTAL PROTECTION PROGRAM

Environmental protection is a fundamental component of planning, construction and operation of a project. This section briefly describes the Environmental Protection Program (the Program) that the Partnership will implement to minimize the environmental impact of the Project during construction and operation. A more detailed description can be found in Chapter 8 of the Response to EIS Guidelines. A variety of environmental protection plans (EnvPP), management plans and monitoring plans will be developed for the Project

The primary purpose of the **Environmental Protection Program (EPP)** is to ensure that construction and operation of the proposed Project remains in compliance with all regulatory requirements. The purpose of the program is to specifically outline what measures will be put in place to mitigate environmental impacts and what will be monitored to verify predictions made in the EIS. If unexpected impacts are detected during monitoring, the protection program defines the process for the measures that will be taken to mitigate these unforeseen impacts.

3.10.1 Environmental Protection Plans

Environmental protection plans provide construction staff practical mitigation measures to be implemented to minimize the negative effects of their activities. An Environmental Officer will monitor contractor's compliance with the plans. The following EnvPPs are being developed for the Project.

- Keeyask Generating Station South Access Road Environmental Protection Plan.
- Keeyask Generating Station Environmental Protection Plan.

3.10.2 Management Plans to be Developed

Environmental management plans focus on minimizing effects of a specific environmental parameter. They outline specific actions that must be taken during construction and in some cases following construction to mitigate Project effects. Many of the management plans include monitoring to determine success of the actions taken and to determine other actions that need to be undertaken (**adaptive management**).

The following list provides the titles of the individual management plans to be developed for implementation during construction and operation of the Project.

- Sediment Management Plan.
- Fish Habitat Compensation Plan.
- Access Management Plan
- Heritage Resource Protection Plan
- Vegetation Rehabilitation Plan
- Terrestrial Mitigation Implementation Plan
- Waterways Management Program
- Reservoir Clearing Plan.

3.10.3 Monitoring Plans to be Developed

Preliminary plans for monitoring 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 of the Response to EIS Guidelines. 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.

The following list provided the titles of the individual monitoring plans to be developed for implementation during construction and operation of the Project.

1. Aquatic Effects Monitoring Plan
2. Terrestrial Effects Monitoring Plan
3. Physical Environment Monitoring Plan
4. Resource Use Monitoring Plan
5. Socio-Economic Monitoring Plan
6. ATK Monitoring Plan

3.11 CONSTRUCTION CONTRACTORS AND WORKFORCE ORGANIZATIONAL STRUCTURE

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

3.11.1 Employment

The construction phase of the Project will provide employment opportunities for KCNs, Churchill Burntwood Nelson (CBN) and northern Aboriginal residents, and other candidates external to the KCNs, CBN and northern Aboriginal available workforce.

T Employment estimates, both high- and low-estimate scenarios for the Project Construction Phase are provided in Table 3-2 and Table 3-3. KCNs workers are projected to account for between 6% in the low employment estimate and 14% in the high employment estimate of the total construction workforce for the Project. This would constitute between 235 and 600 person-years of the 4,218 person-years of total construction employment. The participation percentages are strongly influenced by the relatively small number of qualified KCNs Members who could work on the Project relative to the large number of Project construction jobs that are available. While the percentage of the total appears to be relatively small, the absolute amount of employment is substantial for the KCNs as the Project is expected to involve a large percentage of available workers from the KCNs.

To prepare Aboriginal people for jobs on the Project, a multimillion-dollar training initiative, the Hydro Northern Training and Employment Initiative (HNTEI) was implemented. The program was administered by the Wuskwatim and Keeyask Training Consortium Inc. As a partner in the Keeyask Project, provisions were negotiated to ensure that the KCNs can take maximum advantage of the hiring preferences for its people.

Table 3-2: Construction Phase Estimated Total Employment in the Keeyask Generation Project – High Employment Estimate (Person Years)

	High Employment Estimate									
Employment	**Construction Support**		**Non-Designated Trades**		**Designated Trades**		**Manitoba Hydro and Supervisory**		**Total**	
Total KCN Participation	325	8%	170	4%	95	2%	10	0%	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	102	2%	417	10%	1,036	25%	963	23%	2,518	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.
Note: Numbers are subject to rounding. Actual results will vary from estimates provided here.

Table 3-3: Construction Phase Estimated Total Employment in the Keeyask Generation Project – Low Employment Estimate (Person Years)

	Low Employment Estimate									
Employment	**Construction Support**		**Non-Designated Trades**		**Designated Trades**		**Manitoba Hydro and Supervisory**		**Total**	
Total KCN Participation	125	3%	45	1%	55	1%	10	0%	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	13%
Non-Northern Non-Aboriginal	627	15%	837	20%	1,241	29%	963	23%	3,668	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.

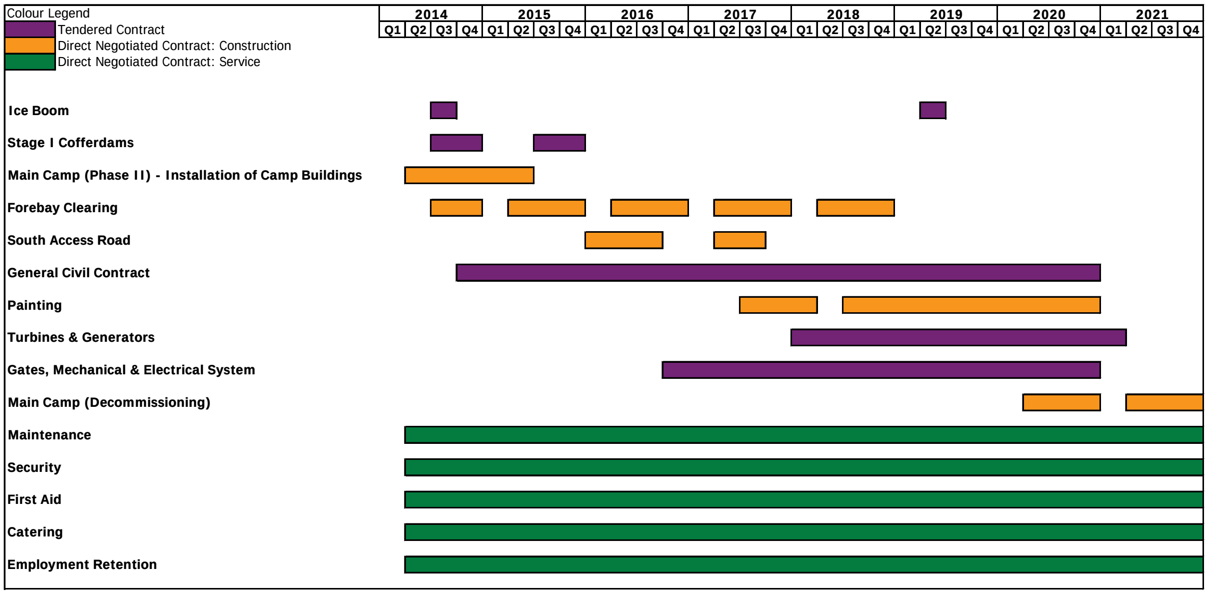
Analysis prepared by InterGroup Consultants Ltd. 2012
Note: Numbers are subject to rounding. Actual results will vary from estimates provided here.

3.11.1.1 Construction Work Packages and Types

It is anticipated that construction of the Project will be organized around individual work packages, each having separate contracts and contractors. The JKDA, which sets out the terms for the Project partnership between Manitoba Hydro and the KCNs, specifies two categories of contract that will be offered to contractors.

- **Direct Negotiated Contracts (DNC) –** These contracts will be offered to KCNs on a directly negotiated basis, without having to go through the tender process. The JKDA lists these contracts and allocates them among individual KCNs partners. 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.
- **Tendered Contracts** (TC). The remainder of the construction will be offered as **tendered contracts (TC).** These contracts will be available for competitive bids by any qualified contractor.

Figure 3-2 identifies these contracts, denotes which are TCs and DNCs, and illustrates their timing. DNC's are further broken down into one time construction and ongoing service opportunities.



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

Notes:

- This work would be carried out through construction work packages comprised of DNC and TCs.
- Construction of the Keeyask Generation Project is estimated to commence in 2014.
- The workforce estimates were provided by Manitoba Hydro on August 31th in 2010.
- Tendered Contracts include Ice Boom, Stage I Cofferdams, Turbines, Generators and Gate, Mechanical and Electrical System.
- Direct Negotiated Contracts include Main Camp Buildings, Reservoir Clearing, South Access Road, Painting and Main Camp Decommissioning and the five Service Contracts (Maintenance, Security, First Aid, Catering and Employment Retention).
- Actual timing of work packages could be different from those presented here.

Figure 3-2: Schedule of Construction Phase Work Packages for the Keeyask Generation Project

Table 3-4 identifies which DNC contracts are available to each of the KCNs communities.

Table 3-4: Direct Negotiated Contracts for the Keeyask Generation Project

Contract Code		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.

The activities related to the DNC and tendered contracts are pivotal in determining the composition of the overall workforce on site at any given time.

3.11.1.2 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[3] and non-designated trades and construction support positions.

3.11.1.2.1 Workforce Size and Composition

Workforce size and composition will change continually throughout the construction stage. The workforce estimates were based on construction activity from 2014 to 2021. The construction workforce size and composition are commonly measured by two criteria:

[3] 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.

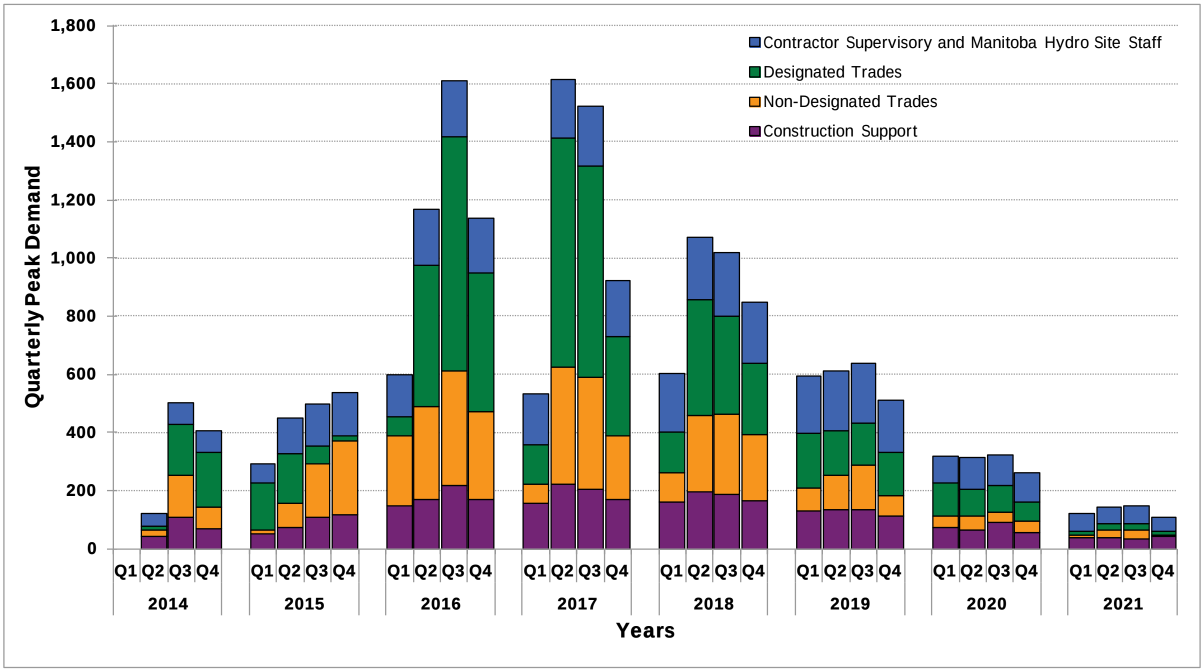
- Quarterly or yearly peak employment measures the greatest number of workers required during each quarter or year of construction. Peak employment analysis is most useful for understanding the number of people affected by Project employment opportunities.
- Person-years of employment summarizes full-time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

The workforce estimates presented are a useful indication of the size and composition of Project-related employment opportunities. All employment estimates in this section, including all graphic representations of workforce demand, are based on current regulations, Project plans as of 2010, and past experience with similar projects. Contractors will determine specific job requirements when the Project is being built. Actual workforce requirements will vary from the estimate presented in the following sections.

3.11.1.2.2 Workforce Levels (Quarterly Peak Analysis)

Peak quarterly workforce requirements will be highest during the Project's middle years, from 2016 to 2018, reaching its very highest level in 2016 and 2017. Peak quarterly employment levels would occur in Q3 of 2016 and Q2 of 2017 at 1,610 workers, with an average of 630 workers on-site throughout the Project. Employment on the Project will tend to be seasonal. On average, peak summer (Q2 and Q3) work forces will increase in size compared with the previous winter (Q4 and following Q1). The work force will grow from 2014 to 2017, with summer work forces averaging two times the size of the previous winter's workforce. Starting from 2019 summer workforces will be declining, with summer employment levels projected to be even smaller than the previous winter's levels.

Figure 3-3 illustrates quarterly peak work force requirements during the Project's construction phase broken down into four broad occupational categories: construction support, non designated trades, designated trades and contractor supervisory and Manitoba Hydro site staff.

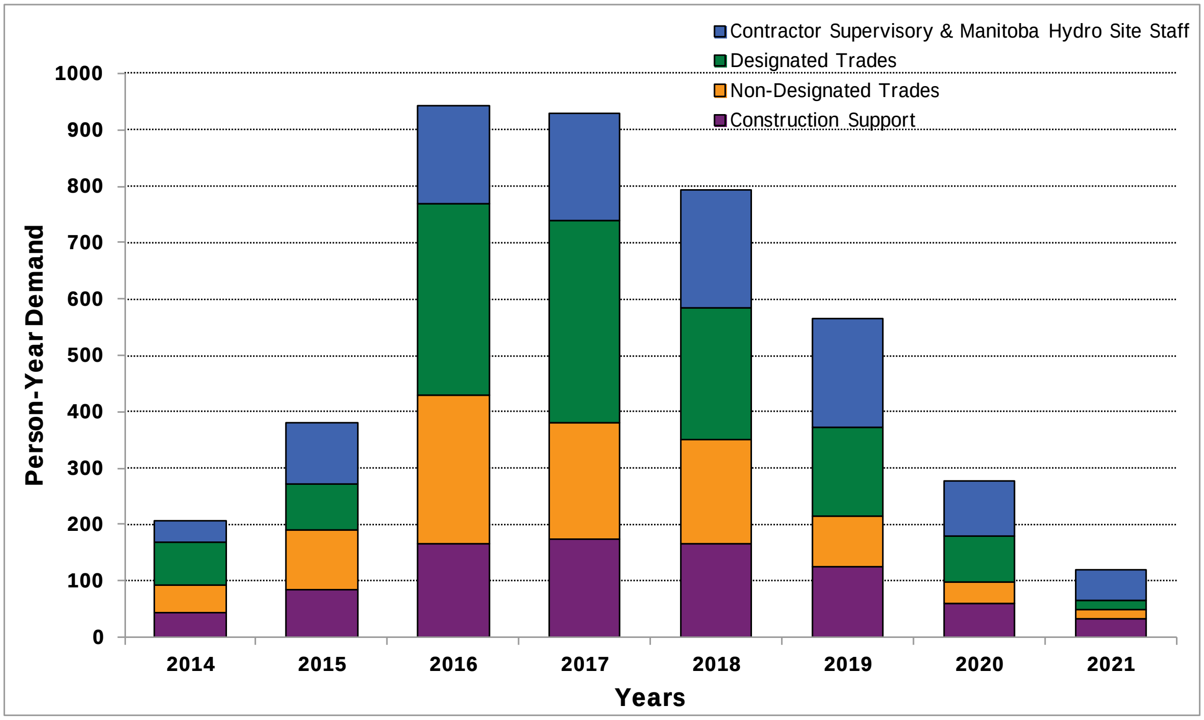


Source: Derived from data provided by Manitoba Hydro in 2010.

Figure 3-3: Construction Phase Estimated Workforce Requirements (Quarterly Peak) for the Keeyask Generation Project

3.11.1.2.3 Workforce Volume (Person-Years Analysis)

A breakdown of the person-years of construction employment that will be generated by the Project is shown in Figure 3-4.



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

Figure 3-4: 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. The Project is expected to generate 4,218 person years of employment, as shown in Table 3-5. 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 3-5: Construction Workforce Requirements by Job Category

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

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

3.11.1.2.4 Construction Phase Estimated Gross Employment Income Analysis

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 SE SV.

Table 3-6: Construction Phase Estimated Gross Employment Income Earned (in Millions of Dollars)

	Gross Employment Income	
	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: Derived from data provided by Manitoba Hydro in 2010 with analysis prepared by InterGroup Consultants Ltd.
Note: Numbers do not always add due to rounding. Actual results will vary from estimates provided here.

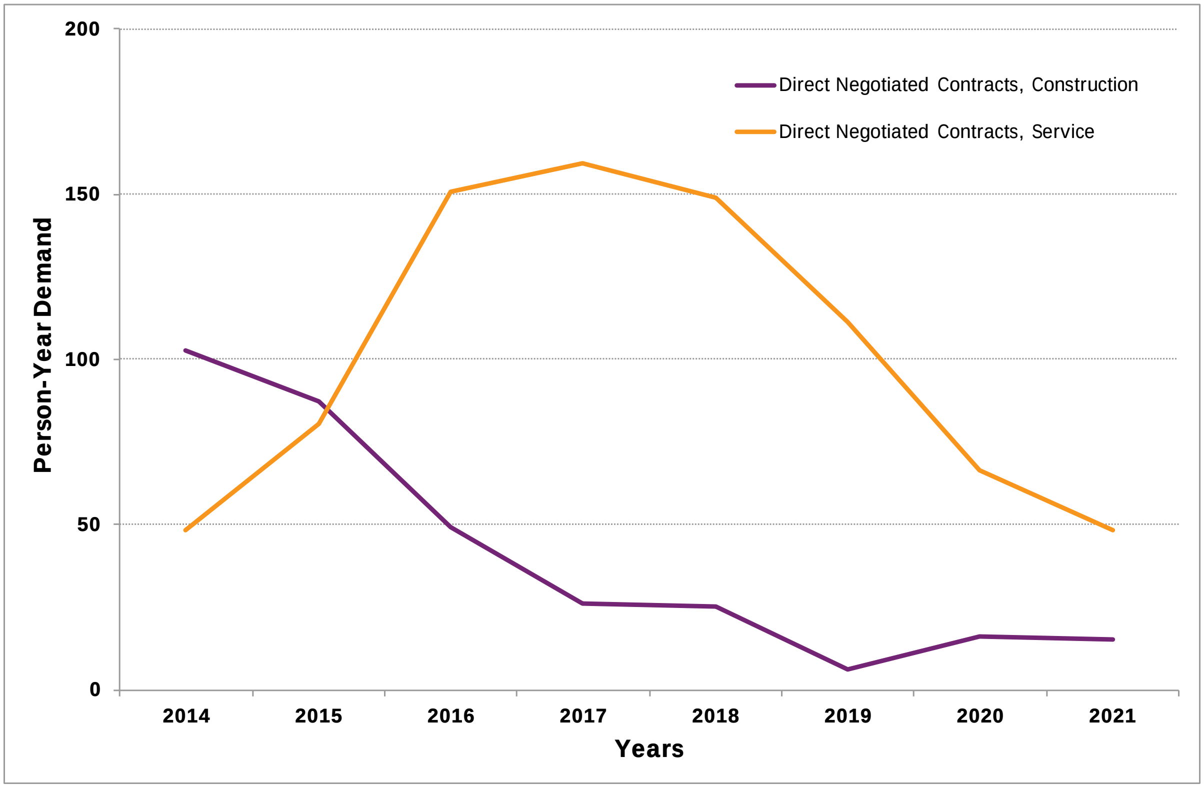
3.11.1.2.5 Workforce Volume by Contract Type

Total Project employment generally follows a normal distribution over the 8-year construction phase. However, within this distribution, there will be some large transitions in workforce composition based on the types of contracts, and related activities that will be occurring during construction of each of the Project's various components.

DNC Contracts

DNCs will account for 1,142 person-years of employment. These contracts will begin in 2014, the first year of the Project.

Figure 3-5 illustrates peak annual workforce estimates for two categories of DNCs.



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

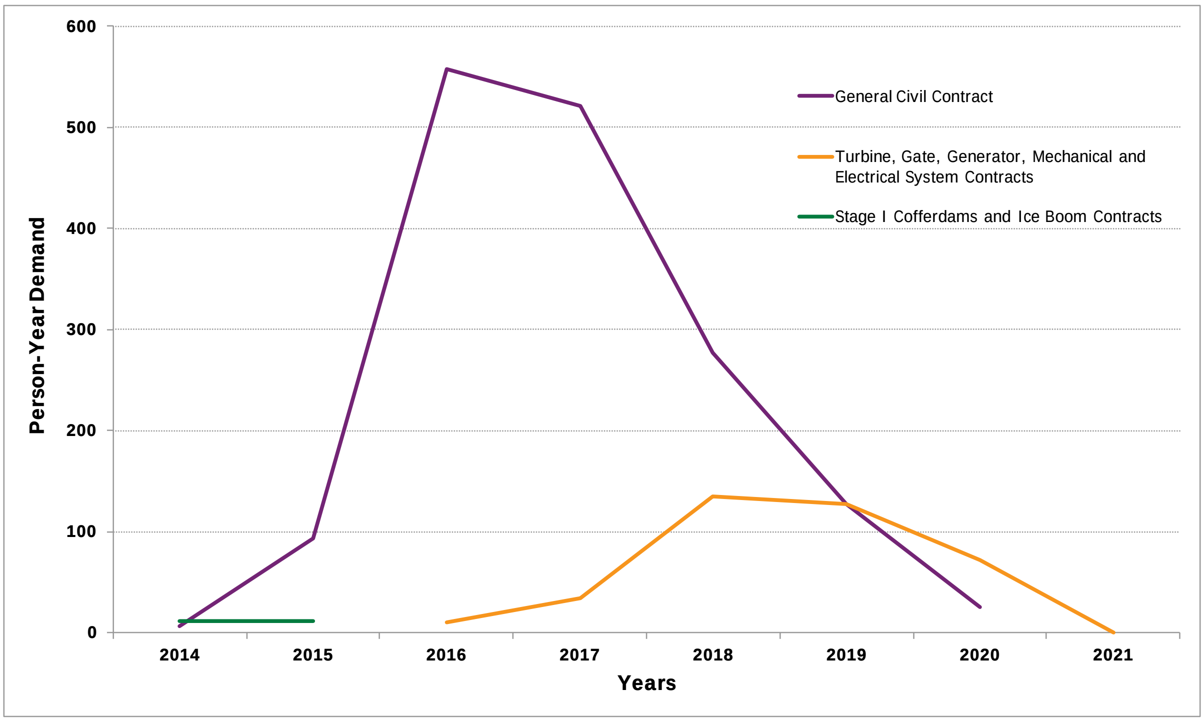
Figure 3-5: Construction Phase Estimated Workforce Requirements by Direct Negotiated Contract for the Keeyask Generation Project

Construction-oriented DNCs will account for 328 person-years of employment and will peak in 2014 at 103 person years. DNC construction employment will then decline each year until 2019, when it will rise back to 15 person years as part of the Project's demobilization activities.

Service-oriented DNCs will account for 814 person years of employment and will be active through the full duration of the project. Employment related to DNC service contracts will follow a bell-shaped curve over the course of the Project. DNC service contracts will peak at 159 person years of employment in 2017, with employment levels declining to 48 person-years by the end of the Project.

Tendered Contracts

Figure 3-6 illustrates projected yearly peak workforce requirements for three categories of tendered contracts.



Source: Derived from data provided by Manitoba Hydro 2010.

Figure 3-6: Construction Phase Estimated Tendered Contracts Workforce Requirements for the Keeyask Generation Project

Tendered contracts will account for 2,008 person years of employment. Of that, general civil employment will account for 1,607 person-years of this employment. General civil employment will begin in 2014 and last until 2020. General civil will peak in 2016 at 558 person-years and decline each year after, with only 25 person-years of general civil employment expected in 2020. More than 92% of the person-years of general civil contract work will take place between 2016 and 2019, with 67% taking place in 2016 and 2017 alone.

Employment related to the turbine-generator, mechanical-electrical and gate components of the Project will occur during the latter half of the schedule. These contracts will begin generating employment in 2016 and peak in 2018 at 135 person-years. Employment related to these contracts will occur through to the end of the Project as each of the final turbines becomes commissioned. Work related to Stage 1 cofferdams and ice boom contracts will create 22 person years of employment during the first 2 years of the project.

3.11.2 Hiring and Training

3.11.2.1 Hiring Processes and Preferences

The Burntwood-Nelson Agreement (BNA), a collective bargaining agreement between the Hydro Projects Management Association and The Allied Hydro Council of Manitoba, will govern wages and working conditions, including hiring processes. The Hydro Projects Management Association is made of representatives of Manitoba Hydro and construction contractors, while the Allied Hydro Council is comprised of representatives of the construction trade unions. The BNA prescribes wages and working conditions for Project workers, except contractor supervisors and Manitoba Hydro staff, during the construction of the Project, and it provides employment preference for qualified northern Aboriginal residents. Definitions are provided regarding who is considered a northern resident and who is considered Aboriginal under the agreement Separate hiring processes are prescribed in the BNA for DNCs and tendered contracts. Additional details on the reason for and scope of the BNA are presented in Section 3.11.2.4.

3.11.2.2 Direct Negotiated Contracts

Northern Aboriginal businesses that have DNCs can directly hire northern Aboriginal residents for their workforce. This provision will apply to the 11 DNCs being offered to KCNs businesses and to other joint ventures in which KCNs organizations or members maintain majority ownership that may be hired to work on the Project. Once the supply of northern Aboriginal workers has been exhausted, employment opportunities must be filled using a job order process through which the general public can apply to work on the Project.

The direct hire provisions for DNC's will be implemented by setting up a three-layered preferential hiring structure for DNC contractors, as follows:

- The first preference will be for qualified members of the Keeyask Cree Nation(s) that the contractor represents. The members must be residents of Manitoba.
- The second preference will be for qualified Members of the remaining Keeyask Cree Nation(s). The members must be residents of Manitoba.
- The third preference will be for qualified Aboriginal residents of northern Manitoba not covered by the first two hiring categories listed above.

In order to receive this favourable treatment, KCNs members must be registered with the job referral office and are northern Aboriginal, or are deemed to be northern Aboriginal under the BNA Letter of Agreement of May 24, 2009.

Tendered Contracts

People interested in being employed on tendered contracts must register with a job referral office set-up to serve the Project. In order to hire employees to work on tendered contracts, contractors will contact a designated job referral office and provide their specific requirements through a job order. The job referral service will identify and forward a list of eligible people who meet or exceed the training, accreditation, skill, and experience stipulated in the contractor's job order, according to the following preferential hiring sequence:

- Northern Aboriginal residents of the Churchill-Burntwood-Nelson River (CBN) region, as shown in Map 3-8.
- Northern Manitoba residents who are members of the respective union.
- Northern Aboriginal residents who live outside the CBN region.
- Any other northern Aboriginal residents not covered by previous hiring categories.
- Union members who live in southern Manitoba.
- Other Manitoba residents.
- Others.

The Contractor has the right to reject any candidate under the following conditions:

- The candidate is not job qualified.
- The candidate was previously employed on the Project and resigned within 30 calendar days of being hired or re-hired or was discharged during the twelve month period preceding the job order.
- The candidate was previously employed on the Project and received more than two written warnings or a suspension for inappropriate workplace-related conduct or activities.
- Any other reasonable grounds.

Contractors also have the right to hire all foremen and general foremen from a referral list provided by the job referral office. The applicable unions have the right to grieve the decision of a contractor to reject any candidate on the grounds that a candidate actually did meet the required qualifications specified in the job order.

The BNA specifically excludes contractor supervisory and Manitoba Hydro staff positions. Contractor supervisory positions will typically be filled by experienced contractor employees. Manitoba Hydro staff will be hired using the corporation's standard hiring process which includes employment equity criteria.

3.11.2.3 Pre-Project Training -– Hydro Northern Training and Employment Initiative

A pre-project training initiative, called the Hydro Northern Training and Employment Initiative was implemented to prepare Aboriginal northerners to participate in the construction employment and business opportunities available from northern hydroelectric development, including the Wuskwatim and Keeyask Projects. This initiative was intended to add skills to the labour force of the KCNs and of the Aboriginal labour force of the Socio-Economic Regional Study Area as a whole. In addition, this initiative was intended to increase the size of the northern Aboriginal labour force that could be employed during the construction phase of the Project (see SE SV Section 3.3.1 for more details on HNTEI).

The Aboriginal Partners, consisted of the following groups that provided largely community-based programs:

- Tataskweyak Cree Nation.
- War Lake First Nation.
- Fox Lake Cree Nation.
- York Factory First Nation.
- Nisichawayasihk Cree Nation.
- Manitoba Keewatinowi Okimakanak Inc.
- Manitoba Métis Federation Inc.

The non-profit corporation Wuskwatim and Keeyask Training Consortium acted as the administrative and coordinating body for the HNTEI. Inc.

Over the life of the initiative, approximately 2,600 training opportunities were provided in communities throughout the Socio-Economic Regional Study Area. Of that total, over 1,070 Aboriginal people were registered for occupational training courses or programs. Nearly all the participants were from communities in the CBN area, which includes communities affected by past hydroelectric development and a sizeable proportion from the KCNs.

3.11.2.4 Collective Bargaining Agreement

As noted above, work at the Project site will be guided by a collective bargaining agreement known as the Burntwood-Nelson Agreement (BNA). The BNA was negotiated by the Hydro Project Management Association, which represents Manitoba Hydro and contractors, and the Allied Hydro Council, which represents the construction unions, in 2005, and will apply to the Keeyask Project. This agreement is intended to ensure labour stability (*i.e.,* no strikes or lock-outs during construction) and provide cost-competitive wages and benefits. The agreement, among other things, sets out wages, employee benefits, work hours, overtime pay, job referral process, hiring preferences, trainee/apprenticeship ratios, the lay-off process and the grievance process. All contractor employees that will be covered under the CBA will be required to become union members once they are hired to work on the Project, if they are not already union members.

The work week will vary by contractor. A typical work week is expected to consist of six work days of 10 hours per day, typically on a Monday to Saturday schedule. Employees will be expected to work on statutory holidays. A worker can take an unpaid leave of up to 6 days after 35 or 40 calendar days on the job (depending on the trade). Overtime is paid after 40 to 45 hours per week, again depending on the trade. Employees can live at no cost to them in the construction camp. Those who choose to live in a nearby community and commute to the job site are responsible for their own transportation costs and are provided with a modest housing allowance.

3.12 SAFETY, SECURITY AND EMERGENCY RESPONSE

An on-site safety supervisor, reporting to the site manager, will be employed during the construction period to ensure that Manitoba Hydro's staff receives training and that all 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.

All construction activities and specific safety requirements will be contained in the contract packages. It is the responsibility of the project manager to assure that all contractors comply with these requirements.

Emergency response programs will be developed to include procedures to address situations that may occur during the construction period and during operation. A helicopter landing area will be located at the work site to provide a means for emergency access and egress. Response procedures to environmental emergencies such as spills will be described in the environmental protection plans. Spill response programs and equipment will be in place for spillage or leaks of any oils or contaminants. During construction, on-site emergency response teams will receive training with respect to fuel spill containment, clean-up and other emergency measures.

Security officers will provide roving security and fire watch patrols throughout the camp and Manitoba Hydro work areas and related facilities. The security personnel will operate access gates for approved personnel and vehicles and maintain surveillance of a remote monitor on a 24-hour basis.

No personal firearms will be permitted on the Project site. Under certain conditions that are outlined in the Access Management Plan, authorized resource users will be permitted to transport firearms for protection (e.g., bears) or for carrying out harvesting and spiritual/ceremonial activities. There will be an established 'no shooting' buffer zone of 300 m on either side of the access roads and around the Project work site in which hunting will not be permitted. A small-calibre firearm may be used in the buffer zone for emergency purposes. Those in possession of firearms must find suitable storage off site. All firearms will be declared and secured in accordance with applicable firearm legislation at the security gatehouse. The location of this area will be set out in the Access Management Plan for the Project. Development of this plan will include input from Partner First Nations and resource harvesters who engage in traditional activities in this area.

There will be camp rules to govern the behaviour of workers lodged at the camp. These are expected to be similar to those being applied at the Wuskwatim construction camp.

3.13 WATERWAYS PUBLIC SAFETY

The wateways public safety identifies hazards measures to implement during the construction phase to reduce interaction of the public with risk areas. For further details, refer to Section 2.4.16.1.

Following are additional measures to mitigate or avoid risks to public on the waterway:

- 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.
- Designated winter safe trails will be developed and maintained at a safe distance from the construction zone.

4.0 PROJECT OPERATION

4.1 OVERALL SYSTEM OPERATION

Manitoba Hydro operates its hydraulic system within the constraints of all licenses granted for its facilities, including the Lake Winnipeg Regulation (LWR) and Churchill River Diversion (CRD) Projects, as discussed in Section 1.0 (History of Hydro Development).

The purpose of the CRD is to divert water from the Churchill River to the Nelson River via the Rat and Burntwood rivers. The Lake Winnipeg Regulation Project allows Lake Winnipeg to be used as a reservoir for flood control and hydroelectric generation. The discharge capability of the lake was substantially increased by construction of the Two Mile channel, the Eight Mile channel, and the Ominawin Bypass channel. This allows the lake to be operated within a narrower range of levels than occurred under natural conditions and enables Manitoba Hydro to discharge more water during the winter months when energy demand is greater.

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 Wuskwatim GS (currently under construction), the Jenpeg, Kelsey, Kettle, Long Spruce, and Limestone generating stations, and the proposed Keeyask GS. The fundamental purpose and operation of these projects will not change as a result of the construction of the Project.

Inflow to the Project is a key input considered in the planning, design and operation of a hydroelectric generating station. Manitoba Hydro has developed a long-term (94 years) simulated flow record of inflows to Split Lake, termed "**Project inflows**". This inflow record forms part of a system wide long-term flow record that is also used by Manitoba Hydro for the long range planning of all new generation. This inflow record is assumed to represent future inflow conditions with the Project included in Manitoba Hydro's Integrated Power System. To develop a long-term flow file that will be representative of future inflows into the study area with the Project, a synthetic record was developed that considered how the hydraulic system would be operated given the following:

- The long term inflow patterns (April 1912 to March 2006) to Manitoba Hydro's hydraulic system, from local unregulated **watersheds** on the Nelson and Burntwood rivers and larger regulated watersheds such as Winnipeg River, Saskatchewan River (upstream of Grand Rapids GS) and Churchill River (upstream of Southern Indian Lake).
- Hydraulic operating regulations (*e.g.,* CRD, LWR).
- Installed generation capacity, including Keeyask Generation Project and transmission components.
- Future projected demand for power.

Additional details about the simulated Project Inflow file is available in the Physical Environment Supporting Volume Section.

4.2 STATION OPERATION

The Project will operate as a **modified peaking plant**, meaning that it will operate either, in a **peaking mode of operation** or a base loaded mode of operation. The extent of peaking or base loaded mode of operation will be determined by the flows in the Nelson River at the time and the requirements of the Integrated Power System to meet the power demands at that time. There also will be occasions when the Project will be required to operate in a special or emergency mode of operation. With the exception of two constraints for lake sturgeon spawning (see Section 4.2.5), no other constraints on the mode of operation are required to meet downstream flow requirements. The various modes of operation are as described in this section.

4.2.1 Peaking Mode of Operation

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 day to coincide with peak power demand. At night, when power demand is lower, flow through the station will be reduced to store water in the reservoir for use during the following day, resulting in an overnight increase in the reservoir level. The volume of water available in the reservoir for a peak mode of operation is 81.4 M 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 to 8 km^2 due to the erosion of mineral shoreline and peatland disintegration. Reservoir storage would increase to 84.9 to 85.4 M 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.

The Project reservoir will fluctuate up to 1.0 m, within any given day between the FSL (159 m) and the MOL (158 m), during a peaking mode of operation. The reservoir level is brought up by reducing the flow through the station to less than the inflow. The largest daily water level fluctuations will occur when Nelson River flows are low to above average. The daily water level fluctuations will be less at higher flows. Peaking operation will not be possible when the inflow is greater than or equal to the full-gate discharge capacity.

When the Nelson River inflows are in the range that permits operation in the peaking mode, the reservoir will typically be at its FSL at the beginning of the week (Monday morning). The inflows to the reservoir will be augmented by water drawn out of reservoir storage during the day to allow the station to generate more power during the 16 on-peak hours (6 am to 10 pm). Typically, the reservoir will then be partly refilled at night by reducing power generation during the 8 off-peak hours (10 pm to 6 am).

The Project will be operated to use the reservoir storage over the five weekdays, so the reservoir will reach its MOL at the end of the week (Friday evening) and be brought up to FSL at 6 am Monday morning.

Although the foregoing describes what typically will happen, there is no requirement to fill the reservoir to its FSL by Sunday or Monday morning, or at any other particular time under this mode of operation.

4.2.2 Base Loaded 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.

Base loaded operation will occur whenever inflows are greater than or equal to the **plant discharge** capacity of 4,000 m^3/s. Based on inflow records since the LWR and CRD have been in operation, this would occur about 12% of the time or more. It also may occur when the integrated power system is short of system energy, which, based on historic inflow records, would occur approximately 15% of the time and typically would correspond with low inflow conditions. While the Keeyask GS could be operated in a base loaded mode during any inflow condition, this would only be done when the reservoir is above its MOL, except in emergency conditions. Based on inflow records since the LWR and CRD have been in operation, the Project could be expected to operate in using a based loaded mode of operation 27% of the time or more.

4.2.3 Special Operating Conditions

Special conditions may occur in which the Project may not be operated in either a peaking or base loaded mode of operation. Special conditions include **load rejection** (units tripping off due to mechanical, transmission or other problems), flood management, or meteorological events.

If a load rejection occurs when the reservoir is at the FSL, the reservoir level will rise until either the spillway gates are raised to pass the surplus inflow or the units are brought back on line and the reservoir brought back to the FSL. The static water level of the reservoir may rise above the FSL during extreme flood events such as the Probable Maximum Flow (PMF).

In addition, meteorological events (such as a heavy rainstorm) and non-Keeyask Project related hydraulic effects (such as a sudden change in ice conditions) from time to time may cause the water level in the reservoir of the Project to exceed the FSL slightly or be drawn down below the MOL slightly.

When the water level in the reservoir exceeds the FSL or is drawn down below the MOL during these special operating conditions, the Project will be operated as described in Section 4.2.5.

4.2.4 Emergency Operating Conditions

Emergency conditions may require the Project to operate in a mode of operation that is different than all other modes of operation. Emergency conditions, which are unlikely to occur, 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, for example, due to a downstream accident. During emergencies there may be a rapid reservoir **drawdown** (such as during an imminent failure scenario) or a rapid reservoir surcharging (such as when outflow through the station is halted in the event of a downstream accident). In circumstances such as these, the static water level of the reservoir could rise above its FSL or fall below its MOL. At the same time, the flow increases or decreases necessitated by the emergency, including flow reductions to zero if necessary, would result in greater changes in the **tailwater** levels than would be experienced during normal operating conditions.

4.2.5 Mode of Operation Constraints

In most cases under special or emergency operating conditions, the variations from the normal operating range between the FSL and the MOL will be 0.5 m or less. At any time when the reservoir level is above 159.5 m , the Project will be operated to increase the combined discharges through the powerhouse and spillway to the maximum extent that safety or licence considerations allow, without regard for economic considerations. At any time when the reservoir level is below 157.5 m, the Project will be operated to decrease the combined discharges through the powerhouse and spillway to the maximum extent safety or licence considerations allow, without regard for economic considerations.

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 AE SV).

The surface water and ice regimes during operation are described in the AE SV. The existing environment and post-Project environment shorelines (at FSL) and **water surface profile**s for open water conditions are shown in Map 2-9.

4.3 HYDRAULIC ZONE OF INFLUENCE

The operation of the Project will affect water levels both upstream and downstream and the effects will be different during open water and winter conditions. Map 2-9 illustrates the spatial extent of the open water hydraulic zone of influence of the Project. Greater detail on the open water and winter flow and water level characteristics are provided in the Surface Water and Ice Regime Section of the Physical Environment Volume.

4.3.1 Open Water Conditions

4.3.1.1 Upstream

Engineering calculations were used to estimate water surface elevation profiles for the Split Lake to Stephens Lake reach of the Nelson River during a range of flow conditions, assuming the Project is in operation, as shown in Map 2-9. The **water surface profiles** are the best estimates that can be made with present data. They show that 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 which is fundamental feature of the Project (Section 1.1). 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 reservoir level and inflow conditions.

When the Project is operating in a peaking mode, the water level in the section of the reservoir about 19 km upstream of the powerhouse could fluctuate as much as 1 m within a 24-hour period. The magnitude of the water level variation will diminish further upstream to the upstream boundary of the open water hydraulic zone of influence. If a flood as significant as the probable maximum flood (12,700 m^3/s) were to occur during open water conditions, there would be no effect on the level of Split Lake or Clark Lake caused by the Project. If the powerhouse were discharging **speed-no-load** flow for six of seven units and no flow through one unit, the reservoir would rise above the FSL to 160.3 m, as discussed in Section 2.0. If the powerhouse were able to maintain normal operations during the probable maximum flood, the reservoir would not rise above the FSL.

4.3.1.2 Downstream

The water level downstream of the powerhouse will be primarily dependant on the level of Stephens Lake. There will be a slight gradient over the approximately 3 km reach between the powerhouse tailrace and Stephens Lake; the gradient will depend on the discharge through the powerhouse and the level of Stephens Lake. The change in water elevation along this short river reach will typically be small (less than 0.2 m); however, the maximum drop in elevation along this river reach could be as much as 0.4 m or more when Stephens Lake is at a low level.

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. The magnitude of the variation will depend on the plant discharge and the amount of water level cycling at the Project. This small water level will be superimposed on the larger range of water level fluctuations that occurs on Stephens Lake because of the operation of the Kettle GS.

Since the Kettle GS began operation, the water level on Stephens Lake (measured at the Kettle GS) has varied between 137.5 m and 141.2 m. For 90% of the time, the Stephens Lake water level has varied between 139.3 m and 141.1 m). During extremely high inflow conditions, the maximum water level on

Stephens Lake could reach 141.7 m. The range of elevations on Stephens Lake will remain unchanged after the Project is operational.

Based on the long-term Project inflow record, the spillway would have been used to pass excess river flow 11% of the time.

4.3.2 Winter Conditions

Many climatic and hydraulic factors affect the formation of ice on the reach of the Nelson River between Split Lake and Stephens Lake. During the winter months the water levels along this river reach are affected by ice processes. Ice conditions can vary considerably from year to year, depending on factors such as weather, ice bridging locations and river flows. The following sections describe how the ice processes will change once the Keeyask GS becomes operational.

4.3.2.1 Upstream

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. Frazil **ice pans** and sheets will collect at the upstream edge of this **thermal ice cover.** The ice cover will advance through Birthday Rapids earlier in the winter compared with Pre-project conditions.

Currently, **anchor ice** restricts river flows and causes upstream water levels to rise on both Clark Lake and Split Lake every winter. The conditions and events that would cause increased water levels on Split Lake also occur at present.

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.

4.3.2.2 Downstream

At the onset of winter, the reach of river between the Project and Stephens Lake will develop a relatively smooth thermal ice cover. 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.

4.4 OPERATIONAL WORKFORCE

Manitoba Hydro has estimated that a total of 46 staff will be required to operate and support the Project. A total of 37 staff will be required for the operation work at the generating station and nine support staff will work in Gillam. The table below lists the types and number of staff estimated to be required.

Table 4-1: Estimated Keeyask GS Operating Staff Requirements

Workforce Type	Number of Staff
Staff Located at Keeyask Project:	
Power Supply Worker – Electrical	8
Power Supply Worker – Mechanical	8
Plant Manager	1
Supervisor – Electrical	1
Supervisor – Mechanical	1
Planner	1
Engineering Technician	1
Administration Representative	1
Store Keeper	1
Utility Workers	4
Welder	1
Apprentice – Electrical	4
Apprentice – Mechanical	4
Janitor	1
Subtotal Workers On-Site	37
Staff Located in Gillam:	
Engineering Technician – Mechanical	1
Engineering Technician – Electrical	1
Engineering Technician – Civil	1
IT/Communications/Testing	1
Gillam Services – Trades	3
Debris Management/Safe Winter Trails	2
Subtotal Workers Off-Site	9
Total Staff at Keeyask Project and at Gillam	**46**

Employees will receive training on an ongoing basis. Employee training will be monitored in a management system to ensure that the station will be operated to the requirements described below.

4.5 WATERWAYS MANAGEMENT PROGRAM

Some shoreline areas will erode and some peatland areas will disintegrate after initial flooding, which is predicted to add approximately 7 to 8 km^2 to the reservoir area during the first 30 years after it is impounded. 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.

The objective of the debris prevention work set out in the Waterways Management Program (Response to EIS Guidelines Appendix 4B) is to prevent trees and other large woody debris from entering the water by removing them before they fall into the water dragging soil material with them.

The first phase of the Waterways Management Program was discussed in Section 3.9 for the Construction Phase, and will consist of implementing waterways management activities during the Project construction phase but prior to reservoir impoundment.

The second phase involves activities to be undertaken at various intervals following impoundment, and include the following:

- Collecting floating debris.
- Monitoring waterway activities and liaising with individuals and groups.
- Preparing reservoir depth charts and travel routes.
- Marking safe travel routes, by installing and maintaining navigation and hazard markers. Installing and maintaining water level staff gauges.
- Constructing and maintaining safe landing sites and required docks and shelters.
- Installing and monitoring regularly the condition of safe ice trails and the nature and extent of their use.
- Planning and implementing the remaining protection and preservation measures at spiritually and culturally significant, historical or heritage sites using low impact techniques.
- Remove debris that accumulates at creek mouths to keep them free of debris.
- Maintaining trails and portages.

4.5.1 Years 1 to 5 Following Impoundment

A crew of up to 25 workers, configured as two primary boat patrols and three supplementary work crews, will operate five multi-purpose boats for 100 days in each open water season for the first three years following impoundment and potentially two years thereafter. A two-person ice trail crew would also operate in this 5 year period.

It is expected that concerns will arise regarding the unknown effects of flows downstream of the powerhouse. To help manage downstream issues one of the supplementary work crews will operate as a temporary boat patrol for the first three years. The primary function of this boat patrol will be to implement safety measures, deliver information to downstream resource users, and help residents and resource users become accustomed to the powerhouse's operating mode. Following this period, future requirements for this measure would then be evaluated.

4.5.2 Years Six to Ten Following Impoundment

In each year from Years Six to Ten following impoundment, it is expected that during the open water season, one or more maintenance crews of up to 12 local workers be required. The maintenance crews would work in conjunction with a two person boat patrol crew. During the ice covered season, when it is safe to travel, there will be a two-person ice trail crew.

4.5.3 Following Year Ten

In each year after Year 10, it is expected there will be two people making up a boat patrol crew during the open water season and two people making up a two-person ice trail crew during the ice covered season.

4.6 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 the Water Power Licence, Manitoba Environment Act Licence and any other regulatory requirements and licenses that may apply, including authorization under the *Navigable Waters Protection Act* and the *Fisheries Act*. This section describes a variety of management and maintenance activities that will be undertaken and systems that will be put in place to ensure the safe and efficient operation of the Project while protecting the environment.

4.6.1 Environmental Management System

Manitoba Hydro is committed to the practice of environmental stewardship and will ensure that employees operating the station will continue to integrate environmental practices and enhancement measures into their daily operations in accordance with our Environmental Management System (EMS).

The operating procedures will be specifically prepared for the station and will be revised as required.

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.

. The following is a summary of the EMS procedures that will be in place.

- Waste water treatment and monitoring.
- Drinking water treatment and monitoring.
- Storage and Handling of Petroleum Products.
- Testing and inspection of oil-filled equipment (*e.g.,* transformers).
- Water quality monitoring of the station sump.
- Handling of treated wood products (*e.g.,* poles).
- Testing and inspection of Sodium Hexafluoride (SF6) filled equipment (*e.g.,* breakers).
- Storage, use, and disposal of hazardous materials.
- Vegetation management.
- Stop log plugging using granular agents.
- Maintenance of vehicles and mobile equipment.

4.6.2 Safety Management System

Manitoba Hydro is committed to safety in the work place. Safety Management System (SMS) was created to reach occupational safety and health objectives and to increase safety awareness in the workplace. The SMS includes measures related to peoples actions, work processes and the physical environment. Some of the measures related to the physical environment include:

- Workplace hazardous material information system
- Asbestos Containing Material
- Releases – Response and Prevention
- Transportation of dangerous goods
- Hazardous waste
- Confined spaces

- Fall protection
- Respiratory protective devices
- Spill containment and response
- Protocols to address the Transportation of Dangerous Goods Regulation
- WHMIS (Workplace Hazardous Materials Information Sheets

4.6.3 Safety, Security and Emergency Response

4.6.3.1 Waterways Public Safety

During the operation phase, waterway public safety measures will be installed to reduce public interaction with risk areas. For further details, refer to Section 4.6.3.1.

4.6.3.2 Security

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 publicly accessibility as the main road leading to Gillam.

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. 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.

4.6.3.3 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 (CDA) Dam Safety Guidelines (2007). Elements of the program include:

- Design and construction of new structures to meet or exceed the CDA 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.
- 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.

4.6.4 Vegetation Management/Landscaping

For the safe and efficient operation of the Project, vegetation management will be undertaken for right-of ways, fire breaks (fire guards), station yards and earth-fill dams. Landscaping, erosion controls, pest control and drainage management will comprise a vegetation management program.

Activities would include the removal of new growth, cutting grass and spraying for invasive species, disease and insect control. Equipment used would include sprayers, water trucks, tractors and mowers. Mechanical means of vegetation control would be the preferred method and chemicals would only be used if mechanical methods were unsuccessful and only when authorized by the appropriate authorities.

4.6.5 Plant Equipment Rehabilitation

Equipment such as turbines, generators and transformers will need to be overhauled or replaced at the end of their useful life. With proper maintenance this equipment can be expected to last 25 to 50 years. Equipment will be monitored and maintained to operate in compliance with manufacturer and corporation standards. 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, approximately every 25 years.

Exterior structures exposed to the elements will be maintained and replaced as required. Where work is being undertaken adjacent or near to water, appropriate precautions will be taken to ensure that harmful substances do not enter the aquatic environment.

4.6.6 Hazardous Materials/Petroleum Handling and Storage

During normal operations approximately 19,000 litres of petroleum products will be stored within the powerhouse with appropriate spill containment and inventory control and documentation. A spill response plan for those operating and maintenance activities involving increased risk to the environment will be kept in the control room and engineering office and with the emergency response crews. These activities will be assessed annually.

4.6.7 Wastewater, Potable Water and Water Quality Management

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 upon approval from Manitoba Conservation.

A waste-water-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) and any other effluent requirements stipulated in the authorizing Environment Act licence. Wastewater sludge will be dewatered and hauled to an approved landfill for disposal in accordance with the licence.

Only trained and certified operators will operate the water and wastewater treatment infrastructure.

4.6.8 Maintenance of Roads

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. Manitoba Infrastructure and Transportation Department (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.

4.6.9 Stream Crossings Maintenance

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.

4.6.10 Spillway and Powerhouse Structures

Concrete structures will infrequently need maintenance to ensure safety and effective operations. Examples of this maintenance could include: groundwater level sensor replacements, grouting and exterior concrete repair work.

Activities associated with these repairs could include drilling, changes in reservoir water levels, and working in the water. All such activities will be prescribed as required by regulatory agencies.

4.6.11 Earth Dams and Dykes

Maintenance of earthfill structures will include vegetation management so that the impervious core is not damaged by the roots of trees and shrubs. Dams and dykes will be inspected periodically. General repairs will occasionally need to be carried out due to settlement or to the protective riprap due to erosion.

4.6.12 Distribution Lines

During operations of the Project, distribution lines will be needed for onsite storage buildings. Maintenance of these distribution lines will include change over of poles, insulators, pole-mounted transformers and other hardware. Manitoba Hydro utilizes standard procedures for such maintenance work that addresses the inherent environmental risks associated with them. Only PCB-free oil will be used in distribution line infrastructure.

4.6.13 Non-Hazardous Waste Management

During operation of the Project, wastes will be generated from domestic sources: wood, scrap metal, tires, surplus equipment, packaging materials and office paper. Station recycling programs provide opportunities to reduce, reuse and recycle the wastes whenever possible. Wastes will be stored in protected areas to reduce the potential for unsafe conditions and negative aesthetic impacts. Wastes will be hauled regularly to a local permitted waste disposal ground for disposal. Where landfill disposal is used, disposal methods must comply with local and provincial regulatory requirements.

4.6.14 Hazardous Waste Management

Hazardous Wastes will be stored in approved bins, handled, transported and disposed of in compliance with regulatory requirements.

5.0 PROJECT DECOMMISSIONING

A hydroelectric generating station may operate for a century or more. If, and when the Project is decommissioned at some future date, it will be done so according to legislative requirements and industry standards prevalent at that time.

6.0 ALTERNATIVE MEANS, DESIGN ENHANCEMENTS AND MITIGATION ALTERNATIVES

6.1 INTRODUCTION

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 that could avoid and mitigate potential environmental effects. This section will describe the Project planning process and the consideration of alternative means of developing the Project that was studied on the Nelson River between Split Lake and Stephens Lake. It includes a number of Project features including the reservoir level, general arrangement and operating parameters. It also describes the meetings and consultations held with the KCNs, particularly TCN and its members who use and occupy this reach of the Nelson River for avoiding and/or reducing adverse effects from the selected development. This section then describes the approach to developing major mitigation measures.

6.2 KEEYASK PROJECT PLANNING PROCESS

Manitoba Hydro's resource planning process continually assesses various locations and configurations for potential hydroelectric generation in Manitoba. When certain locations and configurations better suit the requirements of Manitoba Hydro, more detailed levels of study are undertaken for the most promising sites. In addition to engineering designs, environmental and socio-economic issues are integrated and addressed, as appropriate, through various studies and consultations with potentially affected communities.

Hydropower planning studies typically follow a staged approach:

- Stage I – Inventory: Identifies potential hydroelectric development sites.
- Stage II – Feasibility: A nominal amount of mostly engineering studies are undertaken using available information to assess the feasibility of hydroelectric development at a particular site.
- Stage III – Conceptual Development: A number of mostly engineering and field studies are undertaken to identify a range of options to develop a site. The conclusion of Stage III is a recommendation for a preferred option.
- Stage IV – Preliminary Engineering: Additional engineering studies and field work is carried out for the preferred option to a level of detail that reduces as much **uncertainty** as practicable. A cost estimate with a sufficient level of confidence is developed so that a decision regarding project commitment can be made. The regulatory and licensing processes are initiated during Stage IV.

- Stage V – Final Design and Construction: This includes detailed engineering design to develop the drawings needed to construct and commission the project.

As a project advances through each stage, the confidence in the project information increases and uncertainty in project characteristics decreases as more effort is expended to progressively refine the concepts, until only one concept is carried through to Stage IV. The Keeyask Project is currently nearing completion of Stage IV and is in the early part of Stage V. Information developed during Stage IV was used as the input into the public consultation and environmental review, licensing and approval processes for this Project.

6.3 GENERATING STATION SITE SELECTION AND RESERVOIR LEVEL

After a decision was made by the Province of Manitoba to develop the lower Nelson beginning with the Kettle GS in 1966, Manitoba Hydro studied various hydro development alternatives to develop the 27 m of head on the Nelson River between Split Lake and Stephens Lake. Over time, a full range of development options has been considered for this reach, including single-site, high-head and single-site, low-head developments at Gull Rapids as well as two site combinations with a low head development at Gull Rapids and another low head development at Birthday Rapids. The following section summarizes the planning studies over the last 5 decades and consultations with the Keeyask Cree Nations.

6.3.1 Stage I – 1960s

In the early 1960s, the Government of Canada, the Province of Manitoba and Manitoba Hydro conducted studies to assess the feasibility of developing hydroelectric generating sites on the Nelson River between Split Lake and Hudson Bay. The studies were carried out as part of an overall development plan for the Lower Nelson River. This led to a multi-decade process of evaluating 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. Map 6-1 and Map 6-4 illustrates 10 axes studied at Birthday Rapids and five axes studied at Gull Rapids.

6.3.2 Stage II – 1970s to 1998

From the late 1970s to early 1980s, Manitoba Hydro reviewed a variety of concepts, and prepared and updated cost estimates for the river reach. The results of these studies contained considerable uncertainty because geotechnical field exploration studies had not yet been carried out to assess subsurface conditions at Birthday Rapids and Gull Rapids. Fieldwork had also not yet been carried out to assess the local rock and borrow sources. Based on the limited information, Manitoba Hydro concluded in 1978 that hydroelectric developments at either Birthday Rapids or Gull Rapids could be attractive alternatives for development after Conawapa. At the time, Manitoba Hydro planned to construct Conawapa in the early 1990s. Studies identified a need to undertake field explorations and further engineering studies to evaluate the viability of hydro development at Birthday Rapids and Gull Rapids.

Two options to develop the reach were examined in the 1970s to early 1980s:

- Birthday Rapids – four different axes were identified which could produce between 485 to 585 MW, with an FSL of 168.5 m.
- Gull Rapids – two different axes were identified which could produce between 510 to 522 MW with an 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. The selection of a general arrangement at the downstream end of Gull Rapids was preferable because it would 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 GS.

In 1987, fieldwork was undertaken including a **reconnaissance survey** to assess the availability of construction materials in the vicinity of the Gull Rapids and Birthday Rapids areas.

After meetings and discussions with First Nation communities of Split Lake Cree (now TCN) and YFFN in the late 1980s and early 1990s, additional Stage 2 studies were carried out to study multiple axes that would have varying levels of impacts on Split Lake. Section 6.4 describes the alternative axes at Birthday Rapids and Gull Rapids. The objectives of these studies were to:

- Develop options that maximize power production on the river reach.
- Identify options that minimize construction costs.
- Determine the preferred development concept for the entire Split Lake to Stephens Lake reach of the Lower Nelson River.
- Determine the minimum reservoir that is technically and economically viable at Gull Rapids which would minimize flooding and associated environmental effects.
- Recommend either Birthday or Gull for advancement to a Stage 3 level of study.
- In response to concerns raised by TCN, develop options that would not impact community shorelines above the TCN **Northern Flood Agreement (NFA)** Severance Line on Split Lake.

The development options studied from the late 1980s to early 1990s were as follows (Map 6-2):

- High Head Single Site Full Reach Development - The first option was to develop the full hydraulic potential of the river reach regardless of water level impacts on Split Lake. This option producing 1,150 MW had a reservoir level of 168.5 m with a single plant at Gull Rapids and would require an upward adjustment of the existing severance line established as part of the Northern Flood Agreement (NFA) of 1977.

- Intermediate Head Single Site Partial Reach Development - This option would limit the development of the river reach so as to not impact the NFA severance line. This option would develop the river reach with a single plant at Gull Rapids producing approximately 900 MW with a FSL of 162.5 m.
- Two Site Full Reach Development - Similar to the High Head Single Site option, the objective of this option was to develop the full hydraulic potential of the river reach using two smaller generating stations at Birthday Rapids and Gull Rapids. The two low-head generating stations included a 640 MW project at Gull Rapids with a FSL of 158 m, and a 380 to 460 MW project at Birthday Rapids with a FSL of 168.5 m. The site at Birthday Rapids would also require an upward adjustment of the severance line at the community of Split Lake.

The project parameters for these options are included in Table 6-1. The amount of flooded land varied from 183 km^2 for the single-site, high-head option at Gull Rapids to 78 km^2 for the intermediate head option. The two-site 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.

Table 6-1: Options for Kelsey to Kettle Reach Development – 1991

Development Option	Forebay Level (m)	Capacity (MW)	Key Water Level Impacts	Flooded Area (km^2)
Single High Head Site at Gull Rapids	168.5	1,150	3 m rise above average water level on Split Lake	183
Single Intermediate Head Site at Gull Rapids	162.5	900	No impact on Split Lake	78
Two Low Head Sites at: Birthday Rapids and Gull Rapids	 168.5 158.0	 380-460 640	3 m rise above average water level on Split Lake if and when Birthday Rapids is constructed	106

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. Options to further reduce environmental impacts by lowering the reservoir below 162.5 m were considered but not studied in detail.

Uncertainties associated with some geotechnical conditions contributed to the need to evaluate multiple axes. During Stage II planning studies Manitoba Hydro undertook field exploration studies that included site reconnaissance for sources of granular material, hand dug test pits, soil sampling and laboratory testing. Exploration drilling and seismic surveys were also carried out to determine bedrock elevations and foundation conditions for four potential axes (locations) for a development near Birthday Rapids and at three potential axes for a development near Gull Rapids.

While studying the two-site full reach development option, it was determined that the reliable formation of a stable ice cover in the immediate forebay would indicate the minimum reservoir level for the Gull Rapids site. The operation of hydroelectric generating stations in cold climates, requires that the powerhouse intake channel be designed to allow a stable ice cover to form in the immediate forebay. Without a stable ice cover, open water areas can persist through the winter, allowing frazil ice to form and accumulate in the powerhouse intake, thereby restricting the flow through the powerhouse. Water velocities must be sufficiently low to allow a stable ice cover to form and to remain in place during the winter months. To overcome the frazil ice issue, velocities can be lowered using two methods:

- Raising the reservoir level.
- Excavating channels upstream of the powerhouse (*i.e.,* channel improvements).

A range of reservoir levels as low as 156.0 m were studied in the late 1980s. It was determined that reservoir levels at 158.0 m and lower would require upstream excavation in order to ensure a stable ice cover forms in the immediate forebay area. The quantity of upstream excavation increases with decreasing reservoir level. A reservoir level of 156.0 m requires 1.2 to 2.7 million m^3 more channel excavation than a reservoir level of 158 m. The capital costs for the project with reservoir levels of 156.0 m would be the same as or greater than a project with a reservoir level of 158.0 m because cost savings resulting from smaller structures with a lower reservoir level are offset with higher costs for channel excavations.

When lowering the reservoir level from 158 m to 156 m the amount of energy produced decreases significantly by approximately 12% thereby reducing the economics of the project. Flooded area and associated environmental effects decrease with decreasing reservoir level. It was estimated that a reservoir level of 156.0 m would flood about 19 km^2 and 158.0 m would flood about 37 km^2. A subsequent study determined that a reservoir level of 158 m was the minimum level that ensures that a stable ice cover would form without requiring channel improvements upstream of the powerhouse for axis GR-3. It was found that a reservoir level of 158.0 m provides an optimum balance between capital cost, efficiency of development, and environmental and social effects.

A comprehensive agreement to implement the 1977 Northern Flood Agreement was reached with Split Lake Cree (now TCN), Canada, Manitoba and Manitoba Hydro in 1992. Subsequently, Manitoba Hydro initiated future development planning studies in late 1992 together with consultations with the First Nation to review the hydro development options in the area. The options, shown on Map 6-2, included:

- <u>High-Head Option at Gull Rapids FSL =168.5 m):</u> This option consisted of a 1,150 MW generating station. This facility would raise average annual water levels on Gull Lake by 15.2 m and cause

78 km^2 of flooding between Gull Rapids and Clark Lake, with additional flooding on Split Lake of 2.4 m at the community of Split Lake.

- Intermediate-Head Option at Gull Rapids (FSL =162.5 m): This option consisted of an 900 MW generating station, resulting in a 11 m rise in average water levels on Gull Lake and causing 78 km^2 of flooding, with no flooding on Split Lake.

The 1992 TCN Northern Flood Agreement initiated the Joint Studies Process carried out between Hydro and TCN between 1992 and 1996. This process recognized that the Gull and Birthday projects being considered were located within the Split Lake **Resource Management Area (RMA)**, under joint resource management by TCN and Manitoba, and that it was important to obtain input from the TCN Chief and Council and its membership early in the project planning process when major development options were still being evaluated. The 1992 implementation agreement provided the framework for Manitoba Hydro and TCN to collaboratively work together to review the hydro development options in the area and to undertake, where appropriate, joint environmental and community studies such as the following:

- Community Planning and Hydro Impacts Study: This study examined the implications of hydroelectric developments at Gull Rapids causing flooding on Split Lake and its effects on community infrastructure and planning in the Split Lake community. It estimated the mitigation costs associated with adverse effects that would be created. The study considered the high head and intermediate head hydroelectric development options at Gull Rapids.
- Post-Project Environmental Review (PPER): Pursuant to the 1992 agreement, the PPER was undertaken to review the effects on TCN from the Lake Winnipeg Regulation project, Churchill River Diversion project and other Manitoba Hydro projects that affected the flows and water levels of water bodies within the Split Lake Resource Management Area between 1957 and 1996. The PPER studies provided a baseline against which to measure the anticipated effects of further hydro development. The five volume PPER reviewed the impacts from both **Aboriginal Traditional Knowledge (ATK)** and technical scientific perspectives and identified baseline research in preparation for the potential future development of a hydroelectric project at Gull Rapids.

The Joint Studies Process included a working group comprised of Manitoba Hydro and TCN representatives, meetings with Chief and Council, and public meetings and open houses in Split Lake.

In response to TCN concerns and in consideration of potential requirements for mitigation measures, Manitoba Hydro decided in 1996 to drop the high-head option from further consideration and focus on the lower head options at Gull Rapids.

From 1996 to 2000, Manitoba Hydro considered future development options in the Gull reach that would not require an upward adjustment of the existing surveyed severance line at Split Lake and these included low head and intermediate-head Gull options.

In 1998, TCN proposed a joint process with Manitoba Hydro to explore ways in which a future development could be mutually beneficial. It appointed TCN members to a Gull Planning Committee to meet with Manitoba Hydro and start the process. Manitoba Hydro accepted this offer from TCN and in

December 1998, Manitoba Hydro made the initial presentation to TCN. At that time Hydro introduced a new corporate approach to future development, enabling potentially affected Aboriginal communities to participate in the ownership of a future hydroelectric project in the north.

Hydro's new approach sought to achieve several goals:

- Maximize Cree Nation advocacy of Gull development.
- Produce practical financial benefits for affected Cree Nations.
- Provide appropriate sharing of financial risks.
- Develop wider public and customer support for the new project.

The new approach initiated a process that eventually led to the establishment in 2000 of an agreement in principle between TCN and Hydro for a business relationship on the future Gull Project, later to be renamed Keeyask. Later, other nearby First Nations were invited to join, which eventually led to an agreement called the Joint Keeyask Development Agreement, signed in 2009, among Manitoba Hydro, TCN, WLFN, YFFN and FLCN (in full) to develop the Keeyask Project.

6.3.3 Stage III and Stage IV Studies – 1999 to 2012

Beginning in 1999, the Stage III and Stage IV planning processes involved determining an economic, efficient, safe and functional way of developing the site while balancing engineering, environmental, economic and social considerations.

Manitoba Hydro reviewed the timing of its new resource requirements and proposed options for TCN to consider (Map 6-3).

- Low-Head Gull Option: A 640 MW Generating Station operating at a forebay level of 158 m, with flooding of about 37 km^2 , and with no effect on Split Lake levels and its associated environmental and social impacts.
- Intermediate-Head Gull Option: A 900 MW Generating Station operating at a forebay level of 162.5 m, with flooding of about 78 km^2; with some effects on Split Lake water levels during low-flow open-water conditions, plus other effects during certain winter ice conditions.

In September 1999, after considerable deliberation by TCN and Manitoba Hydro, 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 this reach. The reasons for the decision were the following:

- TCN concerns with flooding and environmental impacts on Split Lake as well as flooding on the Lower Nelson River that would stem from higher level options.
- Joint interests in developing the river without having to initiate an upward adjustment of the established severance lines on TCN Reserve lands on Split Lake.

- Recognition of the importance of minimizing the project effects, including flooding, of any future development on the environment and people.
- High head (full) development at Gull could possibly produce a plant that was larger than the potential access to export markets at the time.

Following the decision to pursue a low head development at Gull Rapids, Manitoba Hydro commenced the Stage IV planning process and initiated preliminary engineering studies and environmental assessment studies based on the agreed upon option.

The previous Stage II studies recommended that the forebay level for a Low Head Gull option be a minimum of 158.0 m. Upon further consideration, the full supply level was raised from 158.0 m to 159.0 m for the following reasons:

- Reservoir Ice Formation – Additional engineering studies determined that there was risk in forming a stable ice cover at a forebay level of 158.0 m. Raising the full supply level by 1 m would increase the likelihood that a stable ice cover could be established and would minimize channel improvements that might be required, if deemed necessary following future more detailed studies.
- Generation Capacity – An additional 1 m of operating head would increase the generation capacity and **average annual energy** by approximately 6%.

Important environmental factors considered for a reservoir design level of 159.0 m were that it floods less land than higher head options and it was expected to maintain lake sturgeon and other aquatic habitats between Clark Lake and Birthday Rapids.

An additional benefit to raising the reservoir level by 1 m to 159.0 m was that it would provide greater operational flexibility. To allow Keeyask to provide energy during peak demand periods of the day it would be necessary to utilize water that would be stored in the new reservoir by drawing down the reservoir. Raising the reservoir level by 1 m allows Keeyask to operate using a peaking mode of operation where the reservoir level is drawn down 1 m to a minimum operating level of 158.0 m. This allows the generating station to generate additional on-peak energy without impacting water levels on Split Lake during the open water season (illustrated in Map 6-4).

The October 2000 Agreement in Principle between Hydro and TCN set out a framework to guide the negotiation of a Joint Keeyask Development Agreement for addressing the planning, design, construction, ownership and operation of the Gull Generating Station. Shortly thereafter, the name of station was changed to “Keeyask Generating Station” from “Gull Rapids Generating Station.” This new relationship was an unprecedented and historic step, which demonstrated a new way to develop future hydroelectric power in Manitoba and Canada at that time. This step preceded discussions which would later be held between Hydro and Nisichawayasihk Cree Nation (NCN) to develop the Wuskwatim site on the Burntwood River.

During the Stage IV studies, extensive consultations with the KCN were carried out. These consultations, which are described in Chapter 2 of the Response to EIS Guidelines, have had a significant impact on defining the Project.

In 2002, an evaluation of alternative axes at Gull Rapids recommended development at axis GR-4. The GR-4 axis was selected on the basis of construction risk, project location and environmental considerations, as described in the next section. This axis remained the preferred option for the rest of Stage IV and is currently being used in the Stage V planning and design stage. Section 6.4 provides an explanation of axis GR-4 as well as other axes considered for Keeyask.

6.4 GENERAL ARRANGEMENT OF PRIMARY STRUCTURES

Map 6-4 shows the locations of the five alternative axis (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.
- 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 158.0 m) 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 to 2002, 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 and GR-4. Alternatives considered included a 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).

In 2002, 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 to 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 the 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 20-30% 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 to GR-4 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 would 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 of the spillway toe and discharge channel. 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 20-30% 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 unlikely that fish can ascend the steep gradient and overcome the high water velocities to take advantage of the new habitat in 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 would likely require an excavated channel, a bridge and rock fill 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 Joint Keeyask Development Agreement. 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 could also increase the potential for adverse workforce interaction with residents of Gillam.

6.5 RESERVOIR OPERATING RANGE

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 (see Map 6-5).

Keeyask 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. The operating range of 1 m would be the smallest among Manitoba Hydro's larger generating stations on the Lower Nelson. By contrast, Kettle, Long Spruce, Limestone, Grand Rapids and Jenpeg generating stations have operating ranges that are between 2.1 and 4.0 m. Typical operating ranges at the smaller run-of-river plants on the Winnipeg River system are less than the planned 1 m operating range for Keeyask. The operating range for Keeyask is also small relative to other hydro developments in Canada. For example the operating range for generating stations in Quebec (Eastmain 1/1a, Sarcelle, Sakami Lake, La Grande 2/2a) have operating ranges between 4.0 m and 9.0 m.

6.6 MODE OF OPERATION

A flexible mode of operation has been established for Keeyask as it will operate using either a base load 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. The mode of operation is discussed in detail in Section 4.0, Project Operation.

The demand for electricity from Manitoba Hydro's Integrated Generation System varies through the day resulting in peak electrical demand typically from 6 AM to 10 PM, also known as the on-peak period. The off-peak period is typically from 10 PM to 6 AM. Less electricity is typically required during the weekends than during weekdays. There is a minimum amount of power that is required throughout the entire day, which is known as the base load while the power exceeding the base load is described as the peaking load. Manitoba Hydro's Integrated Generation System meets the capacity and energy requirements by obtaining peak power from certain hydro generating stations, typically the stations on the Lower Nelson River. Other generating stations such as those on the Winnipeg River provide primarily base load power. When choosing the mode of operation for Keeyask, consideration was given to utilizing some of the available storage in the newly formed reservoir to provide valuable additional peaking power. It is anticipated that there will also be a requirement for additional base load power that could be generated at Keeyask.

In the selection process for the mode of operation, the objectives were to provide operating flexibility and allow Keeyask to provide either peaking or base load power. The modes of operation allow Manitoba Hydro to operate Keeyask GS and generate power to its best economic advantage within the 1 m allowable range.

A flexible mode of operation at Keeyask is made possible because the station discharges almost directly into Stephens Lake and limits 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 and not by the discharge from Keeyask. With the exception of two potential operating constraints for Lake Sturgeon spawning, no other constraints on the mode of operation are required to meet any downstream flow requirements.

6.7 POWERHOUSE

6.7.1 Discharge Capacity

During the various planning stages, a range of discharge capacities (*i.e.*, maximum total river flow that can pass through the powerhouse) between 3,600 m^3/s and 5,200 m^3/s for the high head, intermediate head and low head development options. During the Stage IV engineering stages a smaller range of discharge capacities between 3,600 m^3/s and 4,100 m^3/s were evaluated to determine the optimum value for the low head development option. Factors considered during the analysis included the following:

- Resource development consistent with the 2008-2009 Manitoba Hydro Resource Development Plan.
- Sufficient north/south transmission capability.
- Expected market participation and prices.
- The reservoir operating limits (including draw down and re-**ponding** rates).
- The anticipated plant inflow based on historic system inflows and expected system operation.
- Value and frequency of spillway flows.
- Value of capacity during maintenance.

The Stage 4 engineering studies determined the optimal discharge capacity should be 4,000 m^3/s when both the Keeyask GS and the Kettle GS are at their respective full supply levels. The gross head is 17.7 m for this condition. This is equivalent to a design discharge of 4070 m^3/s at an 18.3 m head condition. The design flow will allow the powerhouse to pass the river flow the majority of the time (approximately 88% based on historical flow records) as well as provide the ability to discharge as much water during the peak period if desired, to increase revenue.

6.7.2 Type of Generating Unit

Fixed-blade, vertical-shaft generating units have been selected for the Project (Figure 6-1). Compared 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 selected for the Project has a low fish mortality rate compared to other turbine designs.

Initial studies indicated that, due to the relatively low head selected for the Project, horizontal units might offer a potential cost advantage over a vertical unit configuration. Figure 6-1 illustrates horizontal and vertical units. Powerhouses with horizontal units typically require less excavation and concrete than powerhouses with vertical shaft units. However, horizontal bulb turbines have a lower inertia than vertical turbine/generators. Manitoba Hydro system studies identified this as an early concern in controlling the output of Keeyask in tandem with the existing Nelson River stations, which are mostly vertical units.

Horizontal generators behave differently from vertical units during a system fault. With the installation of bulb turbines, additional equipment would need to be installed to ensure that the electrical characteristics of the power produced from Keeyask GS would be compatible with the power delivered from other generating stations into Manitoba Hydro's transmission system. This would require the purchase and installation of additional electrical equipment to alter the characteristics of the power produced by the bulb turbines and generators. The cost for this equipment would offset the savings in civil works costs provided by bulb turbines. Additional costs would also be incurred to add intake gates to the conceptual design, to make the station comparable to the other stations along the Lower Nelson River, all of which are equipped with intake gates. . In light of the system constraints and economic evaluation, it was concluded that the preferable units would be vertical shaft propeller units.

Kaplan units, a type of vertical turbine, allow the blades to be adjusted in order to maximize the unit efficiency over a wider range of flows. Typically, they are used when there are relatively few units in the powerhouse and when there is a relatively large range in the operating head. Drawbacks of Kaplan units include higher maintenance costs, higher capital cost and relatively flat efficiency curves with lower peak efficiency relative to fixed-blade vertical-shaft units. Due to the limited operating range for the Keeyask reservoir and the influence of the Kettle GS reservoir on the water levels at the tailrace, the hydraulic head at Keeyask will vary over a relatively small range. By turning units on and off in response to inflow and power demand requirements, vertical-shaft fixed-blade units could be operated at or near peak efficiency under all flow conditions. Given that Kaplan units are more expensive than vertical shaft fixed blade units and given the narrow range in operating head, vertical-shaft fixed-blade propeller units were selected for Keeyask.

6.7.3 Number of Generating Units

The physical size of each turbine/generator unit is a primary consideration in selecting the number of units for a generating station. Typically, the lowest number of units that can be installed at a given site while meeting all physical constraints imposed by the site, provides the lowest capital and operating costs.. The most cost effective powerhouse is found in a balance of costs, physical constraints, and mode of operation requirements including minimum load, operational flexibility and optimization of energy by maximizing combined unit efficiencies.

For a discharge capacity of 4,000 m^3/s, consideration was given to three alternative powerhouse designs equipped with six, seven or eight units. The diameter and water passages required for a turbine sized for a 6-unit powerhouse would have been very large, but within precedent. However, at the Keeyask site the turbines for a six-unit station would need to be set lower than the smaller diameter turbines required for a seven-unit station. The additional excavation and concrete required for a six-unit station would have resulted in a higher development cost than a seven-unit station. An eight-unit station will require a slightly larger footprint than a seven-unit station, also resulting in additional excavation and concrete quantities. As well, the costs for the mechanical and electrical systems required to support the additional unit would not be entirely off-set by the overall smaller size of the units.

Based on a discharge capacity of 4,000 m^3/s, an operating head of about 18 m and system requirements, seven vertical-shaft, fixed-blade units were selected for Keeyask.

6.7.4 Design of Generating Units to Reduce Fish Injury and Mortality

Due to the potential for injury and mortality of fish as they pass downstream through turbines, a number of variables were considered in the selection and development of turbines for the Keeyask GS to minimize the risk of injury and mortality. These variables include the number, alignment, and shape of **stay vanes** and **wicket gates**, clearance at the wicket gates and **runners**, wicket gate overhang, number of blades, blade leading edge thickness, blade trailing edge (related to turbulence), rotation rate, runner diameter, blade speed, and absolute lowest pressure.

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 that 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.

In keeping with the Partnerships commitment to honour Sustainable Development and stewardship, the Partnership has included these variables relevant to fish survival as part of its evaluation in the turbine design selection process, and as a priority for further turbine design development. Although there are many variables to consider beyond those relevant to fish survival (particularly efficiency and cost), the objective for the Keeyask turbines is to achieve a minimum survival rate of 90%. Based upon the Franke formula for estimating the probability of survival of fish passing through turbines, it is estimated that fish up to 500 mm in length passing through the Keeyask turbines will have a survival rate of over 90%. Additional details are provided in the AE SV.

6.7.5 Trash Racks

The Project reservoir is expected to generate woody debris due to shoreline erosion. A Waterways Management Program 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 Keeyask 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 6.7.4, 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.

6.8 SPILLWAY

Early in the planning process consideration was given to providing a **fuse plug** constructed with earth fill in the North Dyke in addition to a concrete spillway at Gull Rapids. This option was considered because it could result in building a smaller concrete spillway at Gull Rapids, thereby reducing costs. After further study, this option was rejected because the resultant concrete spillway would not be large enough to divert high river flows during construction. Other reasons for rejecting it were the significant environmental effects that could occur on Looking Back Creek if the fuse plug were used.

The evaluation of alternative spillway designs was based upon the fundamental premise that it must pass the Spillway Design Flood (SDF), the Probable Maximum Flood (PMF) and the Construction Design Flood (CDF) with various constraints on surcharging the reservoir.

To determine the impact of these three fundamental premises, a study was undertaken of several spillway alternatives. The spillway arrangements studies included six-, seven-, eight-, nine- and 10-bay configurations with 13 m wide bays and 3.5 m piers.

The bay width of 13 m was selected for the sake of conformity with existing plants on the Nelson River and the potential for cross utilization of existing **stop logs**.

A six-bay spillway alternative was briefly considered, but rejected because this arrangement did not provide sufficient flexibility to handle diversion flows during closure of bays for the construction of rollways. Similarly, a 10-bay spillway was discarded because its width would restrict the diversion flows through the South Channel of Gull Rapids.

Of the remaining alternatives, the nine-bay arrangement had the technical advantage of reduced potential for rock scouring downstream of the structure due to less discharge per unit width. However, the study concluded, that due to its substantially lower concrete volumes and costs, the seven-bay scheme should be adopted over the eight- and nine-bay arrangements.

6.9 DYKES

The design and evaluation of alternative dyke alignments and cross-sections was undertaken with the main objective to optimize the design with respect to costs and least environmental impacts.

6.9.1 Dyke Alignments

During the early planning stages, potential alternative alignments were reviewed for intermediate head and high head development options. The Stage 4 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 the 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 selection of the proposed dyke alignments was 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.
- Extent of flooding and reservoir 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 River on lower terrain, 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 to:

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

Map 6-6 illustrates the various dyke alignments that were studied for the Keeyask GS low head development option. The following is a brief summary of each of the alternative alignments studied:

North Dyke Alternative Alignment No. 1 – This alignment reduced the dyke length by about 900 m and was considered to be more economical than the original dyke alignment. This alignment would result in a slight increase in the reservoir clearing requirement. It was rejected because of the increase in reservoir clearing and a creek crossing.

North Dyke Alternative Alignment No. 2 – This alignment was selected as a means of reducing the maximum dyke heights. It runs along the original North Dyke alignment and then turns northward for approximately 1600 m where it ties into the first North Dyke alternative alignment. It is about 750 m longer than the North Dyke Alternative No. 1. Also, it was assumed that this alignment is not likely to have an area of deep post-glacial sediments associated with the creek crossings of the original and first alternative alignments. This alignment would result in a slight increase in the reservoir clearing compared to the original alignment. This alignment was selected as the preferred alignment for the North Dyke.

North Dyke Alternative Alignment No. 3 – This alternative alignment is located upstream of the original dyke line. It would take advantage of a topographic high (known as Deposit N-6), increasing the length of actual dyking, albeit reducing excavation and fill volumes. This alignment would result in a slight decrease in the amount of flooding and reservoir clearing but would also result in a requirement for rerouting drainage from Little Gull Lake and the surrounding area. The topographic high is Deposit N-6. This deposit has been identified as a prime source of impervious fill for the project. Relocation of the dyke alignment to this area would impact the way in which Deposit N-6 could be exploited. In addition, a large portion of the topographic high was classified as a highly sensitive terrestrial habitat which would be highly impacted this dyke alignment.

South Dyke Alternative Alignment No. 1 – This alternative was investigated as a means of reducing the maximum height of the dyke, as well as alleviating some of the downstream ponding and drainage concerns. This alignment would eliminate excessive ponding and drainage by enclosing the lowest portion of the drainage area within the reservoir. It was envisioned that the drainage of the second lake just to the west of the alignment would be easily rerouted through the existing natural drainage system. This alignment would result in an increase in the reservoir clearing requirements.

South Dyke Alternative Alignment No. 2 – This alternative, located along the western portion of the South Dyke, was proposed as a means of reducing the excavation and fill volumes required to construct the dyke in this area. This alignment would result in a slight increase in the reservoir clearing requirement.

South Dyke Alternative Alignment No. 3 – This alternative, located at the west end of the South Dyke, was proposed as a means of reducing the fill volume required to construct the dyke and eliminating a creek crossing.

6.9.2 Dyke Cross-Section

Existing dykes located at the other hydro developments on the Lower Nelson River have featured homogeneous sand fill cross-sections with relatively flat outer slopes. These dykes are designed to settle downward, while maintaining their integrity as a water retention structure, as the permafrost in their foundations thaws and results in differential settlements of the structure. At the Keeyask site, there is a lack of sand fill at economic haul distances, particularly on the south shore. This feature led to the development of alternative cross-sections that utilize as much local material as possible to minimize haul distances. In most locations, the dyke designs will feature a multi-zoned section with an impervious core and outer shells of granular and rock fill materials using local materials. This cross-section also features steeper outer slopes than at other Manitoba Hydro generating stations (*e.g.*, Kettle and Long Spruce), thus reducing the overall footprint of the structures and reducing the quantities of fill needed from the borrow areas. This modified cross-section was made possible at Keeyask by the relatively thin layer of permafrost-affected clay in the foundation, thus permitting the economical excavation of this material in most cases so that a solid foundation for the structures can be constructed. There are, a number of short lengths of dyke where the permafrost affected clays are deep and the homogeneous sand fill cross-section will be need to be utilized.

The selected cross-sections and alignments of the dykes represent an optimization based on a balance between costs and environmental impacts.

6.10 FISH PASSAGE

Based on several meetings and discussions with the federal Department of Fisheries and Oceans (DFO) the Keeyask Hydropower Limited Partnership (KHLP) has made a commitment to implement fish passage for the Keeyask Generation Project (the Project). The intent of fish passage would be to maintain existing connections between upstream and downstream populations in order to mitigate the uncertainty with respect to the function and importance of these movements. It was noted during discussions with DFO that providing fish passage may be counter-productive because: a) fish moving upstream will encounter a reservoir rather than a riverine environment and may decide to move back downstream through the turbines resulting in some fish mortality; and b) that moving lake sturgeon upstream may further deplete the small stock of lake sturgeon in Stephens Lake. Therefore, a precautionary, phased approach is being implemented, with the initial phase consisting of a manual trap/catch and transport program. Appendix A1 in the Aquatic Environment Supporting Volume provides additional information on this topic.

The following will be conducted in the initial phase:

- Undertaking a trap/catch and transport program for upstream fish passage for key fish species, including lake sturgeon coincident with the in-service date of the Project;
- Monitoring the results of the trap/catch and transport program, fish movements, and fish populations to determine the need for adjustments to the program to provide the greatest benefit to fish populations.
- Designing and constructing the GS 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.

To assist in the long-term assessment of fish passage options, an analysis of alternatives will be undertaken. The Partnership will work closely with DFO and Manitoba Conservation and Water Stewardship (MCWS) Fisheries Branch during this process.

There are three main components to fish passage: upstream collection, upstream passage and downstream passage. Upstream collection defines the ability to collect fish from the Nelson River downstream of the generating station. Upstream passage defines the means to move fish from a fish collection facility to a release site upstream of the dam. The selected option for downstream passage for the Keeyask GS is via the turbines and spillway. The implementation of other downstream passage alternatives will be considered if monitoring indicates that the selected passage method is impeding downstream movements or is associated with unacceptable rates of injury and mortality.

Alternatives that will be evaluated for long term upstream fish passage include trap/catch and transport, fish lock/lift, nature-like bypass channel, and fish ladder. These are being designed and evaluated on the basis of criteria such as fish biology, engineering, operation and Maintenance requirements, Aboriginal Traditional Knowledge, stakeholder and regulatory input, cost, and benefit.

Biological information pertaining to Nelson River fish species will be an important input to the evaluation of fish passage alternatives at Keeyask. Biological information pertinent to the type, location, timing, and sizing of fishway components includes target species and life stages, timing of fish movements, fish size and abundance, movement behaviour and patterns, and fishway hydraulic design criteria.

As discussed above, lake sturgeon will be the primary target species when designing and evaluating the long term fish passage alternatives. The physical and hydraulic characteristics of the Project site and lake sturgeon swimming capabilities and behaviour will be evaluated to develop alternatives that provide the highest likelihood of passing lake sturgeon. Other species such as walleye, northern pike, and lake whitefish will also be considered through discussions with DFO and MCWS Fisheries Branch. Modifications to fish passage alternatives for species other than lake sturgeon will be considered insofar that these modifications do not significantly impact expected passage performance for lake sturgeon.

A trap/catch and transport system will be implemented at the in-service of the Project. The details of the design and operation of this facility will be determined in discussions with DFO and MCWS over the next number of years.

A preliminary evaluation of alternatives indicates that a trap and transport program may be the best long term alternative for upstream fish passage at the Project site in comparison to other alternatives such as a fish/lock/life, nature-like-bypass channel or fish ladder. However, numerous long-term fish passage alternatives will be evaluated using a multi-criteria decision making process that applies various social, economic, environmental and engineering criteria to break down alternatives into discrete elements for comparison, evaluation and organization. Review of the evaluation of alternatives will take place with the fish passage expert consultants and input from the KCNs, stakeholders and regulatory agencies. It is anticipated that a decision on long-term fish passage will be made five years after the Project in-service date in consultation with DFO and MCWS.

6.11 SITE ACCESS

The north access road is required to construct the Keeyask Generating Station while the south access road is required to operate the station. A discussion of the north access road is not included in this assessment because it is being constructed as a component of the Keeyask Infrastructure Project which has received Provincial environmental approvals required for construction.

South Access Road

Initial design and evaluation of the south access road included two key design factors. The first factor was the consideration of whether or not the road was required and the second factor was the preferred alignment of the road.

Under the terms of the JKDA, Manitoba Hydro will be contracted to operate the generating station on behalf of the Limited Partnership. Studies by Manitoba Hydro determined that the most economical way to operate the generating station is to have staff reside in Gillam and commute approximately 35 km daily between Gillam and Keeyask along a south access road.

For Keeyask operations, the following alternatives to transport workers between Keeyask and Gillam were considered and evaluated:

- North Access Road – Staff would commute daily between Gillam and Keeyask via PR 290, PR 280 and the north access road.
- Staff House Near Keeyask – Staff would commute via PR 290, PR 280, and the north access road, as required, and live at the staff house for extended periods of time.
- South Access Road – Staff would commute daily between Gillam and Keeyask via the south access road, Butnau Dam and Butnau Road.
- Helicopters – Staff would commute daily between Gillam and Keeyask using helicopters.

The south access road alignment provides the best balance between cost, efficiency, and travel time. 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 (Map 6-7). 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 (similar to the one shown in Photograph 2-1), it was the shortest route and had the least impact on sensitive **terrestrial habitats**. An additional adjustment was 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 as shown in Map 2-15. The road was moved off the Butnau Dam due to driver safety, dam safety and costs (construction and maintenance).

6.12 CONSTRUCTION

6.12.1 Construction Camp

The construction logistics for axis GR-4 North, dictate that the construction camp be located on the north side of the river as close as possible to the construction work areas. The construction camp location, as well as associated project and contractor facilities and work areas, were selected on the basis of geotechnical considerations (foundation conditions and topography), proximity to the permanent structures, and construction logistics. No environmental concerns were found during the early planning studies that required the original site locations to be moved or other alternatives to be investigated.

Original plans called for sourcing the water supply for the camp and construction site from the Nelson River by means of a water intake structure located on the North Channel Rock fill Groin. Subsequent investigations found an alternative source from wells located in granular borrow deposit G- (Map 6-8) that indicated an abundant supply of good quality water was available without the need to build an intake in the Nelson River. The alternative supply from the groundwater wells was ultimately selected based on reliability and water quality considerations and also avoided effects to the aquatic environment.

Similarly, initial plans called for a lagoon as the treatment method for the wastewater from the camp and construction work areas. A subsequent review of alternatives resulted in the selection of a mechanical wastewater treatment plant. The treatment plant was selected because it is a more reliable method for treating wastewater and would have a smaller footprint, thereby having less overall environmental impact.

Options to dispose of construction waste materials at Keeyask included disposal in a new landfill at Keeyask or, alternatively, hauling the waste to the existing Thompson landfill. Lifecycle cost and environmental studies showed that hauling waste materials to Thompson was the preferred alternative because it was less costly, had a smaller Project Footprint and had less overall environmental impact in the vicinity of Keeyask.

6.12.2 Construction Materials

The construction of Keeyask GS will require the following specific types of material that will be obtained from naturally occurring quarries and glacial deposits in close proximity to the Project. These materials are:

- Impervious fill;
- Granular fill;
- Rock fill;
- Riprap; and
- Concrete aggregates.

Site investigations conducted between 1987 and 2010 by Manitoba Hydro have identified a number of natural sources of bedrock, impervious and granular materials that are near the project site. The location of all of the potential bedrock, granular, and impervious material sources that have been identified in the area are shown on Map 6-8.The objective of the site investigations was to identify sufficient materials for the high head Keeyask development option. In 1996, the high head option was no longer considered for development. The intermediate and low head options require far less material than what was identified as available for construction of the high head Keeyask option.

In general, materials required for the construction of the principal structures and supporting infrastructure temporary and permanent structures will come from the nearest, most economic source, as long as the quality meets the specific use requirements and as long as environmental impacts can be minimized in relation to location, site access and utilization of the materials.

Manitoba Hydro will provide contractors with the specifications for the construction materials available at borrow areas and quarries as well as any limitations on how they will be removed and used. The contractors will then develop a material utilization plan for borrow areas and quarries in order to construct the Project. The Environmental Protection Plans and technical specifications within the contract documents will state the requirements for the protection of streams, ground water, wildlife habitat and adjacent vegetation during extraction by the contractor, as well as the nature and methods for the rehabilitation of the borrow areas after use. The contractor's material utilization will comply with these plans and specifications.

6.12.3 Excavated Material Placement Areas (EMPA)

The approximately 4,200,000 m^3 of unclassified excavated materials produced from excavations which are not used in the construction of the generating station will require permanent placement in designated EMPA within the project's limits. These materials will be produced primarily from excavations for the north and south dykes, the principal structures, potential channel improvements and the 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 6-9). The initial 50 EMPAs were selected based on a selection criteria established by the engineering and environmental teams on the basis of least 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 benefit from opportunities provided by the EMPAs. The inventory of 50 EMPAs was subsequently 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.

The majority of unclassified excavated materials will generally consist of deposits of glacial, preglacial, postglacial, interglacial materials and fluvial deposits classified as peat, postglacial/preglacial sediments, Lake Agassiz clay, various tills (silty sands, sandy silts, granular soils, *etc.*) and preglacial sediments, including organic clays. These materials will also likely contain some cobbles and boulders.

The EMPA selection criteria provide both general criteria common to all EMPAs and specific criteria for EMPAs set inside the dyke lines (within the reservoir area) and for those set outside the dyke lines. The final utilization of the EMPAs by the contractor will likely be a combination of locations both internal (upstream) and external (downstream) to the dyke lines.

6.13 ALTERNATIVE MITIGATION MEASURES

The Partnership's approach to addressing adverse effects of the Project, in order of descending priority, has been to:

1. Prevent or avoid works or measures which will cause adverse effects;
2. Lessen or reduce unavoidable adverse effects (i.e. those than cannot be prevented or mitigated);
3. Provide appropriate replacements, substitutions or opportunities to offset adverse effects; and
4. 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.

Through community ratifications, the membership of each Partner First Nation approved both the Joint Keeyask Development Agreement (JKDA) and the community-specific adverse effects agreements (AEAs). These agreements outline procedures for the avoidance of adverse effects from the generating station and the establishment of programs to offset unavoidable effects. Provision is made for programs to promote culture and language, facilitate ongoing monitoring of environmental effects, increase Members' access to and use of the resource area, and provide ongoing training and jobs for community members.

In addition to the AEAs, specific mitigation measures have been developed to address individual aquatic, terrestrial, socio-economic, heritage resources, and resource use Project effects. These measures, as well as the approach to developing them, are outlined in the following sections.

6.13.1 Aquatic Environment

During the environmental assessment for the aquatic environment, a range of options for mitigating effects to the aquatic environment were investigated. Emphasis was placed on mitigating effects that were predicted to have marked effects on **environmental components** of particular importance (*i.e.,* water quality, lake whitefish, northern pike, walleye and lake sturgeon). Table 6-2 outlines potential effects and the alternative mitigation measures that were considered, and provides a description of environmental and technical considerations, and whether the measure was included.

Aquatic mitigation measures were developed by the environmental team in consultation with the Project engineers and the KCN Partner communities. Mitigation concepts were evaluated through an iterative process involving evaluation of likely success based on biophysical considerations, including input from both technical studies and ATK, and technical feasibility and costs, based on input by Project engineers. As the assessment progressed, a subset of measures was selected for further development. Measures were discussed with the multilateral Aquatic Working Group, a technical working group comprised of KCN Partner 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 (MCWS). On-going discussions with MCWS and DFO may identify modifications to the design of recommended measures or determine additional mitigation measures that will be implemented as part of the Project. The AE SV includes additional details about the alternative mitigation measures.

Table 6-2: Summary Table – Aquatic Environment — Alternative Means and Mitigation Measures – Upstream of Generating Station

Potential Effect	Mitigation Options	Biophysical and Socio-Economic Considerations	Technical Considerations	Cost Range	Probability of Inclusion after Biological Assessment
Loss of Walleye and Lake Whitefish Spawning Habitat	Construction of rocky shoals to provide walleye and lake whitefish with spawning habitat within lacustrine portions of the reservoir.	Construction of shoals in the vicinity of known spawning areas would ensure spawning habitat is available early in the development of the reservoir environment. This would also provide rearing and foraging habitat resulting in improved habitat diversity in the newly-formed reservoir.	Would need to be constructed in the dry prior to reservoir impoundment. Rocky shoals to be a minimum of 1000 m^2 per site. Up to 13 potential sites have been identified for development of shallow and deep rocky shoals.	**High**	**Recommended.** Shoals will provide habitat in the lower reservoir immediately after impoundment when most existing habitat will no longer be suitable. Proximity to existing spawning habitat increases probability of success.
	Modifications to dyke surfaces and the construction of adjacent rock groins.	Surface treatments of gravel or cobble-sized rocks on the north and south dykes where slopes are less steep could be designed to encourage and sustain spawning particularly of fall spawning fish (lake whitefish and lake cisco). Construction of rock groins could enhance fish habitat features at select locations along the dykes in the Keeyask reservoir.	Rock would be added to gradually-sloping dyke surfaces that are a minimum of 3 m below the water surface. Rock groin construction would consider site substrate and depth conditions.	**Not estimated**	**Not Recommended.** Dykes are not situated in areas where spawning fish are expected to aggregate.
Reduction in Suitability of Shallow Water Foraging Habitat	Measures to increase habitat diversity: • Placement of mineral soils to promote growth of aquatic plants. • Planting of willows along shorelines and placement of log bundles to provide cover for fish.	Development of mineral material shelves in the newly-formed shallow-water areas could increase the amount of fish rearing and foraging habitats by promoting aquatic plant growth and increasing benthic invertebrate populations. Planting of willow and other native riparian shrub species could create rearing and foraging habitat in the newly-formed shallow-water areas. Cut trees could be cabled together and anchored in both deep and shallow areas to provide cover for fish.	Ice scour, proximity to potential spawning shoal sites, and existing surface conditions were considered when selecting sites for materials placement. Potential shoreline sites for planting willow would exclude the dyke slopes as they are lined with riprap, but may include planting willows along the toe of the dyke alignment at some locations provided the depth of water (i.e. grade) is suitable. Log bundles would be placed along new shorelines where they would not be disrupted by peat uplift, and where dissolved oxygen conditions are suitable for fish. They would have to be placed deep enough or marked to ensure boat traffic is not impeded.	**High**	**Not Recommended.** After the reservoir is flooded, conditions will be sufficient to support the forage fish community present at impoundment, and suitable habitat in the flooded areas will evolve over time.
Loss of Small Tributary Foraging/ Spawning Habitat	Removal of peat to encourage macrophyte growth in shallow water areas, thereby creating suitable foraging/spawning habitat.	Removal of overlying peat veneers at tributary mouths prior to flooding could promote macrophyte establish in the post-impoundment environment.	Removal and disposal of peat from tributary mouths would be a complicated process as access by machinery is very limited.	**Not Estimated**	**Not recommended.** Peat removal would be very difficult in isolated creek mouths and poses risks to other components (*e.g.*, creation of access trails).
Loss of Access to Tributary Streams	Removal of accumulated debris from the mouths and lower reaches of tributaries	Removal of debris in the mouths and lower reaches of tributaries would ensure that fish remain able to access upstream habitat in tributary streams.	Involves monitoring and removal of debris as described in the Reservoir Clearing Plan and in the Waterways Management Program described in the Environmental Protection Plan.	**Not estimated**	**Recommended.** Will provide access to tributary habitat that would otherwise not be available.

Potential Effect	Mitigation Options	Biophysical and Socio-Economic Considerations	Technical Considerations	Cost Range	Probability of Inclusion after Biological Assessment
Winter Entrapment and Mortality of Fish in Little Gull Lake	Excavation of channels allowing fish to escape to areas with more suitable overwintering conditions.	The excavation of small channels would allow fish to escape to areas with more suitable dissolved oxygen levels, thereby reducing potential winterkill of fish.	Excavation of small channels would allow fish to move between the Little Gull Lake area and the reservoir year round. Current concepts are preliminary however studies conducted to date suggest that the channels will be feasible. Gaps that require further study include: • Permafrost affected soils likely require excavation to be conducted in the winter months • Geotechnical analyses of the side slopes and slope stability of the channels • Review and assess the need for erosion protection along the excavated channels. • Review options for disposing excavated peat materials within the reservoir or outside of the reservoir	**Moderate**	**Recommended.** Channels that allow fish to access areas with more suitable dissolved oxygen levels will be used to mitigate the potential winterkill of fish.
	Excavation of channels to maintain suitable overwintering conditions (i.e., dissolved oxygen)	The excavation of large channels to allow year round flow would elevate winter dissolved oxygen concentrations potentially increasing survival rates of large bodied fish that currently don't, but may after construction, over-winter there.	The excavation of the channels to provide year round flow to Little Gull Lake and prevent oxygen depletion would be a significant construction project in which about 1,340,000 m^3 of unclassified materials would be excavated. The disposal areas needed for these excavated materials would be very large. The need for erosion protection along the excavated channels for flows and wave action in the reservoir requires assessment.	**Very High**	**Not Recommended.** An extremely large amount of material would need to be excavated and there are technical challenges that may limit the probability of success. For these reasons, it is preferred to proceed with smaller access and egress channels discussed above.
Alteration of Lake Sturgeon Spawning Habitat at Birthday Rapids	Monitoring and, if necessary, contingency works to create suitable cues for spawning through the creation of white water in the nearshore immediately upstream of Birthday Rapids.	Depth, velocity and substrate conditions in Birthday Rapids post-Project will be suitable for spawning; however, monitoring will be required to determine if sturgeon continue to use this habitat in the absence of cues such as whitewater. If monitoring indicates poor or no spawning success in the vicinity of Birthday Rapids, contingency works to create the cues for suitable spawning habitat through shoreline modifications will be implemented.	Placement of large boulders/structures in this area would be difficult due to lack of access during the construction phase Options for accessing the site and constructing the works during the operation phase requires further study. Access for construction would be improved during the operating phase.	**Low**	**Recommended.** Will provide additional spawning habitat in the reservoir if Birthday Rapids is no longer used.
	Stocking of fall fingerling and yearling lake sturgeon in the reservoir to offset potential effects of a temporary reduction in spawning habitat.	Stocking will help to mitigate the temporary reduction or elimination of spawning at Birthday Rapids.	Monitoring will be undertaken to evaluate the relative success of each life stage stocked and to modify stocking rates to maximize returns.	**High**	**Recommended.** Stocking is a proven method for the recovery of lake sturgeon populations where habitat is available.

Potential Effect	Mitigation Options	Biophysical and Socio-Economic Considerations	Technical Considerations	Cost Range	Probability of Inclusion after Biological Assessment
Alteration of Lake Sturgeon YOY Rearing Habitat in Northern Gull Lake	Monitoring and, if necessary, contingency works to create habitat suitable for YOY rearing in the reservoir by placement of a blanket of sand/fine gravel over 40 ha in a two phased process (20 ha each phase).	Documented YOY habitat will not be suitable post-Project. However, conditions in the riverine section of the reservoir at the upper end of Gull Lake may be suitable post-Project, therefore monitoring will be conducted prior to habitat creation. If monitoring demonstrates that no juvenile lake sturgeon are being recruited, then coarse sand/fine gravel will be placed in suitable locations.	Creation of a sand blanket is feasible but an extremely large amount of sand is required, which may be challenging to accurately deposit in the river. Additional field investigations are still required to assess the limits and volume of sand available for use in borrow B-1. Environmental constraints still need to be established for B-1 as there will be some terrestrial environment impacts. Additional study required to assess the suitability of the barge off-loading method to ensure it results in an acceptable "blanket".	**High**	**Recommended.** YOY habitat is required to maintain a self-sustaining sturgeon population. Monitoring will determine whether the development of YOY habitat is necessary.
	Stocking of fall fingerling and yearling lake sturgeon in the reservoir to offset potential effects of reduced YOY habitat.	Stocking effectively improves natural recruitment by ensuring survival through the very young life history stages, thereby bypassing a significant portion of mortality that occurs in wild fish populations.	Monitoring will be undertaken to evaluate the relative success of each life stage stocked and to modify stocking rates to maximize returns.	**High**	**Recommended.** Stocking is a proven method for the recovery of lake sturgeon populations where habitat is available.
Reduction of Fish Access to Stephens Lake	Provide upstream and downstream fish passage – for further details see discussion on effects downstream of the GS in Table 6-3.	Information on fish movements and habitat availability indicates that access to Stephens Lake will not be required to maintain fish populations in the reservoir. However, given the uncertainty with respect to the importance of maintaining connections among populations, upstream and downstream fish passage will be provided.	See Table 6-3 – upstream and downstream fish passage	See Table 6-2	**Recommended.** See Table 6-3
Out-migration of Sub-adult and Adult Lake Sturgeon	Design of trash racks to reduce loss of fish from the reservoir.	Current spacing of trash racks excludes the largest fish; analysis of hydraulic conditions indicates that reducing spacing to exclude smaller fish could result in increased mortality due to impingement on the trash racks. Given that downstream fish passage will be via trash racks/turbines and spillway, excluding all fish from passage via turbines would not be beneficial.	See Section 6.7.5 for technical considerations.	**Not Estimated**	**Not Recommended** Risk to fish of passage past turbines is less than risk of impingement if trash rack spacing is reduced. In addition, passage past the trash racks and turbines is a method of downstream fish passage.
	A stocking plan will be implemented to offset potential movement of lake sturgeon out of the reservoir.	Fall fingerlings and spring yearlings could be stocked in the reservoir to help mitigate potential lake sturgeon losses due to movement out of the reservoir.	Monitoring will be undertaken to evaluate the relative success of each life stage stocked and to modify stocking rates to maximize returns.	**High**	**Recommended.** stocking is a proven method for the recovery of lake sturgeon populations where habitat is available.
	Upstream fish passage (see Table 6-3)	Provision of upstream passage would provide the opportunity for sturgeon that move downstream out of the reservoir to return.	See Table 6-3.		**Recommended.** See Table 6-3

Potential Effect	Mitigation Options	Biophysical and Socio-Economic Considerations	Technical Considerations	Cost Range	Probability of Inclusion after Biological Assessment
Increased Lake Sturgeon Harvest	A conservation awareness program will be implemented to reduce the potential for increased harvest due to improved access.	A lake sturgeon conservation awareness program would be developed in consultation with the KCNs to reduce the potential for increased harvest due to improved access. Ideally the program would include Elder involvement in its development and implementation.	Not applicable.	**Not Estimated**	**Recommended.** The existing small populations, additional stresses imposed by Project construction, and increase in road and boat access will require careful management to avoid over-harvest

[1]**Cost Range:** Low = Cost is less than $500,000; Moderate = Cost is between $500,000 and $5,000,000; High = Cost is between $5,000,000 and $15,000,000; Very High = Cost is greater than $15,000,000

Table 6-3: Summary Table –Aquatic Environment – Alternative Means and Mitigation Measures – Downstream of Generating Station

Potential Effect	Mitigation Options	Biophysical and Socio-economic Considerations	Technical Considerations	Cost Range[1]	Probability of Inclusion after Biological Assessment
Loss of Fish Access to Gull Lake	Upstream passage provided with a trap/catch and transport program.	Information on fish movements and habitat availability indicates that access to Gull Lake will not be required to maintain fish populations in the reservoir. However, given the uncertainty with respect to the importance of maintaining connections among populations, upstream fish passage will be provided. The use of a trap/catch and transport program allows selection of individual fish to move upstream to avoid depleting fish populations in Stephens Lake.	See Section 6.10 for technical considerations..	**Moderate to Very High**	**Recommended.** Include upstream fish passage to address uncertainty with respect to maintaining connections among fish populations. Trap/catch and transport is a good option for initial testing of upstream fish passage.
	Provide a nature-like channel through which fish could move to the reservoir and also use habitat in the channel for spawning/rearing.	Six alignments/designs for a nature-like channel were developed at a conceptual level. The best option was located on the north bank of the Nelson River. This channel would provide habitat but there is difficulty in avoiding winterkills when flow is shut down.	North Bank Alternative 1 is approximately 5 km long. It has an upstream exit that is located well away from the Powerhouse and it has an entrance located downstream near the powerhouse within the limits of the Tailrace Channel. Maintaining flows during the in winter may not be readily feasible due to ice and requires further study. Design challenges include: • The design will need to satisfy a head differential of approximately 19.9 m. • The design will also have to accommodate the variable reservoir level (range from 159 m FSL to 158 m MOL), as well as a tailwater level which could vary from 139.1 m to 141.1 m. • Minimize the impact to power production revenues by minimizing diversion of water through the fish passage while providing sufficient flow in the fish passage to maintain appropriate depths and velocities. • Winter operation would prove to be technically difficult. • If only open water operation, fish salvage would may be necessary every fall if there is no winter operation.	**Very High**	**Not Recommended.** Issues with avoiding killing fish when flows in the channel are shut down for winter.
	Other method of upstream passage – *e.g.*, fish lift, fish ladder	Experience with the trap and transport program may indicate that other options for upstream passage are more suitable.	See Section 6.10 for technical considerations..		**Recommended** Addresses uncertainty with respect to the best option for upstream fish passage.
Reduction in Number of Fish Entering Stephens Lake from Upstream	Incorporate measures to pass fish downstream safely via the turbines and spillway.	Design parameters for the turbines were selected in consideration of criteria that would reduce the incidence of injury and mortality. The spillway does not include features that are associated with increased fish mortality (*e.g.*, baffle blocks).	See Section 6.7.4 for technical considerations.	**Not Estimated**	**Recommended.** Will reduce mortality of fish moving through the generating station and provide a means of downstream passage.

Potential Effect	Mitigation Options	Biophysical and Socio-economic Considerations	Technical Considerations	Cost Range[1]	Probability of Inclusion after Biological Assessment
	Designed method of downstream fish passage.	Monitoring during the assessment of upstream passage may indicate that downstream passage is required.	The implementation of other downstream passage alternatives will be considered if monitoring indicates that the selected passage method is impeding downstream movements or is associated with unacceptable rates of injury and mortality.	**Not Estimated**	**Not Recommended.** Post-Project monitoring may indicate that another form of downstream passage (in addition to via the turbines and spillway) is required.
	Stocking sturgeon in Stephens Lake to help increase the size of the overall population, which is currently low, and to compensate for reduced number of sturgeon that may move out of Gull Lake.	Stocking will increase the current small population in Stephens Lake and offset potential losses from a decrease in the number of sturgeon entering from upstream.	Stocking has been successfully used to recover sturgeon populations in other areas.	**High**	**Recommended.** Stocking is viewed as a necessary component of the overall mitigation strategy for lake sturgeon downstream of the generating station. Stocking will help mitigate potential losses to the Stephens Lake population.
Loss of Spawning Habitat at Gull Rapids	The creation of spawning habitat downstream of the powerhouse.	This would provide lake sturgeon spawning habitat following development of the Keeyask GS. The spawning structure would also provide habitat suitable for other fish species that spawn under similar conditions and habitat suitable for colonization by benthic invertebrates that inhabit high velocity, rocky habitats. This could then partially compensate for the loss of foraging habitat in Gull Rapids.	During the spawning period, the operation of the Project may have to be modified to achieve the desired hydraulic conditions during the spawning period. Monitoring will be required to determine if a cycling mode of operation adversely affects the behaviour of spawning fish or if modifications to the spawning shoal are required. Spawning structure is proposed to be built on the north shore of the river downstream of the powerhouse tailrace to ensure adequate and reliable flow. A portion of the sturgeon spawning area can be constructed in the dry within the Powerhouse summer level cofferdam. The remainder will need to be constructed in the wet. This will make placement of boulder micro habitats more difficult.	**Moderate**	**Recommended.** The creation of spawning habitat downstream of the Powerhouse in proximity to where it exists today has a high probability of success for lake sturgeon and could be used by other species.

Potential Effect	Mitigation Options	Biophysical and Socio-economic Considerations	Technical Considerations	Cost Range[1]	Probability of Inclusion after Biological Assessment
	The preservation of spawning habitat downstream of the spillway by releasing flow through the spillway.	Two options are available: provide a designated amount of spill annually; or, continue to spill if spillway operation is initiated. Lake sturgeon could use this habitat during years when spill operations satisfy flow requirements for successful spawning.	Water that goes through the spillway cannot be used for power generation. When total river discharges is less than the powerhouse discharge capacity this measure may be quite costly depending on the amount of water that would be discharged through the spillway, the duration of spill and the frequency of spill. The cost is associated with a loss of generation to preserve spawning habitat. When total river discharge exceeds powerhouse discharge capacity this measure would have no cost and would preserve spawning habitat. The continuation of spill to permit egg hatch and survival of larval fish could have a significant cost during specific years when Nelson River flows drop off during the spawning period. There is also considerable uncertainty in the bathymetry for the area downstream of the spillway. The amount of flow required to preserve spawning habitat in this area is unknown because of the uncertainty in the bathymetry.	**Low to Very High – depends on amount of flow requirements.**	**Not Recommended.** Annual spill not recommended due to high cost. **Recommended.** If lake sturgeon eggs are deposited downstream of the spillway during spillway operation, the spillway discharge will be maintained at levels sufficient to permit egg hatch and survival of larval fish until they emerge and drift from the site
	The creation of lake whitefish spawning reef further downstream towards Stephens Lake.	Lake whitefish spawn in Gull Rapids and in other locations of Stephens Lake. The creation of spawning reefs would replace habitat lost at Gull Rapids.	Design criteria suggest a 1000 m^2 area of spawning habitat be created. Accessibility to the spawning shoal and construction methodology are uncertain. A few alternative methods have been identified however each has challenges. Due to the dynamic nature of the shoreline and bathymetry along the south side of this reach, the depths will need to be confirmed during the final design phase and possibly post-project just before installation. Collection of velocity measurements near the proposed Lake Whitefish spawning habitat area during initial operations will be needed to determine the optimum location for the spawning shoals.	**Low**	**Recommended.** This would compensate for habitat lost in Gull Rapids.
	Provide upstream fish passage.	Fish could be moved to suitable spawning habitat at the upper end of the reservoir, but given the size and depth of the lower reservoir, it is unlikely that the progeny of these fish would contribute markedly to the Stephens Lake population.	See above.		**Not Recommended.** Upstream fish passage would not replace lost spawning habitat in Stephens Lake in terms of supporting the Stephens Lake population.

Potential Effect	Mitigation Options	Biophysical and Socio-economic Considerations	Technical Considerations	Cost Range[1]	Probability of Inclusion after Biological Assessment
Loss of Fish Foraging Habitat at Gull Rapids and Loss of Fish Access to Gull Rapids Creek	Construction of a stream/pool system along the south channel of Gull Rapids, including the provision of flow year-round from the reservoir.	This would provide fish access from Stephens Lake to Gull Rapids Creek and also provide productive fish habitat over the approximate 1.5 km distance from the creek mouth to the permanently wetted area downstream of the dam and tailrace.	Final design and construction would only be possible once the area is dewatered and site conditions can be assessed. There is a risk that the passage structures could freeze up during the winter. This would need to be addressed during the final design stage. Some areas will be shallow which may result in winter fish kill. Over wintering pools would need to be constructed to reduce this affect.	**High**	**Under Review.** Whether or not this measure is implemented will depend on discussions with DFO and MCWS in terms of the suitability for meeting compensation objectives.
Potential for Fish Stranding after Spillway Use	Review how and where the water is flowing after the spillway is in use. Create channels to connect pools so that fish can escape into Stephens Lake.	Necessary to avoid fish mortality.	Since the collection of bathymetric data in the south channel of Gull Rapids has been limited due to high velocities in this area, the location of any potential isolated pools and the alignment of the proposed excavated channel will need to be determined once the Powerhouse is operational and the Spillway is closed, thus allowing bathymetric data to be obtained. Uncertainty in bathymetry in this area could lead to additional excavation and therefore increased cost to prevent fish stranding. Construction is most likely to occur during the operating phase. Regular inspections of the channel for debris will need to be carried out to insure that debris that may come from spillway release or from Stephens Lake do not become habitat or block fish movements.	**Low to Moderate**	**Recommended.** Required to avoid mortality of fish due to stranding.

[1]**Cost Range:** Low = Cost is less than $500,000; Moderate = Cost is between $500,000 and $5,000,000; High = Cost is between $5,000,000 and $15,000,000; Very High = Cost is greater than $15,000,000

6.13.2 Terrestrial Environment

During the environmental assessment for the terrestrial environment, a range of options for mitigating potential effects to the terrestrial environment were investigated. Table **6**-**4** outlines the mitigation measures that were considered, along with a description of the environmental and technical considerations for the measure.

Terrestrial mitigation measures were developed by the environmental team in consultation with the Project engineers and the KCN Partner 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 KCN Partner 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 VEC) for the Project, mitigation options for terrestrial habitat, birds and other mammals were also discussed through this technical working group. The MWG was formed in 2009 after the need for such a group was identified by the EIS Coordinators in early 2007, and the group met every few months over the period of fall 2009 to spring 2012, to review and discuss terrestrial study results, mitigation, and monitoring.

The Terrestrial Environment Supporting Volume includes additional details about the alternative mitigation measures.

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Table 6-4: Summary Table – Terrestrial Environment Alternative Means and Mitigation Measures

Potential Effect	Mitigation Options	Environmental Considerations	Technical Considerations	Cost Range[1]	Conclusion and Rationale
Loss of Rare Habitat in Project Footprints	**Loss of White Birch and Poplar Mixed Forest in Borrow Area N-6:** Restrict extraction of materials to northwestern portion of N-6 deposit.	White birch forest is one of the rarest habitat types in the Regional Study Area. The only large patch occurs within the area of Deposit N-6. This area is also of interest to KCN and the Province due to Paleo-Archaic heritage resources found along the southern margin of N-6. This area also comprises the majority of habitat for ruffed grouse within the region.	It would be feasible to restrict contractor's access to portions of Deposit N-6 that could be used without significantly affecting white birch forest. Under certain circumstances this may result in additional effort for the general civil contract and may add cost to the project.	**Low to Moderate**	**Recommended.** Restricting contractor access to portions of N-6 would avoid sensitive habitat and also allow for the extraction of some materials from this site, should it be required.
	Loss of Priority Habitats in Excavated Material Placement Areas: Placement of excavated material placement areas (EMPAs) to avoid sensitive terrestrial areas.	Sensitive terrestrial areas, including rare habitats and important wildlife habitats, can be avoided by coordination of efforts and identifying and selecting locations for the EMPAs.	All disciplines provided information on preliminary locations and identified any areas that were not preferred due to environmental sensitivities. Based on this input, locations were ranked based on environmental and cost considerations, and the engineering team was able to avoid areas of concern with the final selection of the EMPAs.	**Not estimated**	**Recommended.** For the majority of cases, the sites selected for the EMPAs were selected to avoid high and moderately sensitive habitats. Where possible, opportunities were identified to use/develop EMPAs in degraded areas or to minimize environmental impact of the project.
	Priority Habitats in Other Somewhat Flexible Project Footprints (other disposal or borrow areas): Modifying boundaries of borrow areas to avoid rare habitats.	Avoiding these priority habitat types will reduce the potential for any significant terrestrial habitat effects.	A map of priority habitat sites to avoid was developed based on the final Project Footprint, and modifications to some boundaries of project components were made to avoid rare habitat types.	**Not estimated**	**Recommended.** Boundaries of some project footprint components were adjusted to avoid sensitive habitat areas.
Loss of Off-System Marsh Wetlands	Development of wetlands to replace 12 ha of affected off-system marsh wetlands.	Some alternatives may create benefits for aquatic habitat. Enhancing existing wetlands could also result in enhanced aquatic furbearer (*e.g.*, muskrat) and bird habitat. Some of the medicinal and country food plant species used by local First Nation members are found in wetlands.	Alternatives for wetland development are currently being considered. Implementation of wetland mitigation measures is site dependent on peat thickness, water depth, site hydrology and quality and availability of donor sites for plantings. Access to wetland mitigation sites that are not near the principal structures are deemed to be more challenging and more costly.	**Very High**	**Recommended.**
Additional Habitat Loss due to Peatland Disintegration	Potential mitigation measures to reduce peatland disintegration include: • Rerouting the north dyke across Deposit N-6 • Using energy barriers on the north side.	The Project reservoir may expand in area by 6-7 km^2 during the first 30 years of operation, due to peatland disintegration. Peatland disintegration converts terrestrial habitat to aquatic habitat. Minimizing peatland disintegration also maximizes carbon sequestration and reduces the input of debris into reservoir.	Potential dyke locations have been identified to reduce the area of peatland disintegration. Dyking in three primary areas could reduce area of project footprint by 3 to 4 km2 during the first 30 years of operations. Preliminary costing has been developed for rerouting the north dyke across Deposit N6, and for using energy barriers on the north side. Both of these options are cost prohibitive for the potential benefits (including cost saving related to reduced reservoir clearing).	**Very High**	**Not Recommended.** Options are cost prohibitive for the potential benefits (including cost savings related to reduced reservoir clearing).

Potential Effect	Mitigation Options	Environmental Considerations	Technical Considerations	Cost Range[1]	Conclusion and Rationale
	Potential mitigation measures to reduce peatland disintegration include: Subsurface dykes	The reservoir is predicted to expand by 7-8 km^2 during the first 30 years of operations due to the erosion of mineral shorelines and peatland disintegration. Peatland disintegration converts terrestrial habitat to aquatic habitat. Minimizing peatland disintegration also maximizes carbon sequestration.	Potential for nine subsurface dyke locations to protect several potential areas were evaluated to obtain order-of-magnitude costs.	**Moderate**	**Not Recommended.** Options are cost prohibitive for the potential benefits.
Loss of Caribou Calving Habitat	Avoid calving habitat: • Location of excavated material placement areas to avoid caribou calving complexes. • Routing of access roads to avoid caribou calving complexes.	Some Project footprints have some flexibility in routing/placement to avoid known caribou calving habitats. Avoiding caribou calving habitat will reduce the potential effect of loss of calving habitat as a result of the Project.	The engineering team has been able to adjust the routing of access roads and the placement of excavated material placement areas in order to avoid known caribou calving habitat.	**Not estimated**	**Recommended.** Routing of access roads and placement of excavated material placement areas have avoided known caribou calving habitat.
	Enhance/maintain large islands for calving	Caribou Island supports 2-5 caribou for summer calving habitat. During reservoir impoundment, some parts of Caribou Island will be flooded. Erosion protection through armoring of the shoreline at Caribou Island (approximately 3,700 m of shoreline would require erosion control) could reduce erosion of this island over time.	A preliminary cost estimate has been developed for shoreline protection. The groundwater levels within a large area of the island are predicted to be at or near the ground surface following impoundment, so loss of habitat could occur regardless of shoreline protection measures.	**Moderate**	**Not Recommended.** A rise of groundwater on the island following reservoir creation may result in a change of habitat on the island over time, regardless of shoreline protection measures.
	Develop new islands for calving	Based on preliminary estimates of caribou habitat loss (between 3 - 10 km^2, including potential loss of habitat due to changes in groundwater), excavating channels to create new islands may be an approach for mitigating effects to loss of calving islands in lakes. Creating channels could affect fish habitat, water quality, wetlands, and potentially, existing cabins. Channeling would also result in large volumes of excavated material that would require placement in other areas.	High level studies that assessed potential locations to excavate channels to create islands (including habitat quality at these locations) were carried out and high level cost estimates have been developed for each of the potential locations (within both Gull Lake and Stephens Lake areas). The cost estimates assume all excavation is overburden and no bedrock excavation is required. If bedrock excavation is required the cost of this mitigation option would increase significantly. It is envisioned that channel excavation in the Keeyask reservoir would be undertaken in the dry by completing them prior to reservoir impoundment.	**Very High**	**Not Recommended.** High cost and additional environmental effects of island creation were not deemed to be worth the potential benefit of creating a new calving island. Existing caribou calving habitat is not considered to be limiting in the Regional Study Area.
Disturbance of Wildlife due to Blasting Activities	Blasting at Rock Quarry Q-8 (may not be required): • Restrict blasting during the caribou calving period (May 15 – June 30). • Restrict blasting during the bird breeding season (April 1 - July 31), to the extent feasible.	Blasting results in noise that disrupts the life function at sensitive wildlife habitats.	Blasting will be required year round during the first 3 years of construction. The majority of blasting will occur at Quarry-7, Powerhouse and Spillway. Blasting at these locations cannot be restricted without significantly impacting the construction schedule. It is unlikely that Quarry-8 will be utilized therefore it may be feasible to restrict the timing of blasting at this location. This needs to be confirmed.	**Not estimated**	**Recommend restricting blasting to the extent practicable.** Currently being assessed. Current blasting schedule shows avoidance of critical calving periods in most years, but some overlap in second half of July with bird breeding season.

Potential Effect	Mitigation Options	Environmental Considerations	Technical Considerations	Cost Range[1]	Conclusion and Rationale
	Blasting at Q-7, Q1, Spillway, Powerhouse, and their associated channels: • Restrict blasting during the caribou calving period (May 15 – June 30. • Restrict blasting during the bird breeding season (April 1 - July 31), to the extent feasible.	Blasting results in noise that disrupts the life function at sensitive wildlife habitats. Blasting at the Spillway and Powerhouse areas is greater than 5 km away from Caribou Island. Blasting at these locations is therefore not likely to have an effect on caribou calving at Caribou Island. Gull Rapids islands, adjacent forest bird habitat, nearby potential calving islands in Stephens Lake, and a south shore calving complex would be affected.	Blasting will be required year round during the first 3 years of construction. The majority of blasting will occur at Quarry-7, Powerhouse and Spillway. Blasting at these locations cannot be restricted without significantly impacting the construction schedule. These restrictions would add a full year to the construction schedule. It is not feasible to restricted blasting activities for the entire 4-month duration of the bird breeding season.	**Not estimated**	**Recommend restricting blasting to the extent practicable.** Currently being assessed. Current blasting schedule shows avoidance of critical calving periods in most years, but some overlap in second half of July with bird breeding season.
	Blasting of Quarry-9 for South Access Road: • Restrict blasting during the caribou calving period (May 15 – June 30. • Restrict blasting during the bird breeding season (April 1 - July 31).	Blasting results in noise that disrupts the life function at sensitive wildlife habitats. Blasting at Q-9 will affect land birds nesting in adjacent habitats.	Blasting activities for the south access road can be carried out by avoiding the months of May and June, however it cannot avoid April and July. It is not feasible to restricted blasting activities for the entire 4-month duration of the bird breeding season.	**Not estimated**	**Recommend restricting blasting to the extent practicable.** Currently being assessed. Current blasting schedule can accommodate avoidance of critical calving periods, but there may be some overlap in second half of July with bird breeding season.
Loss of Waterfowl Nesting and Foraging Habitat	See potential mitigation measures above for Loss of Off-System Marsh Wetlands category.	Development of off-system marsh wetlands would improve staging habitat for migrant waterfowl and may provide summer brood-rearing habitat for some waterfowl species. The most desirable wetlands for waterfowl contain mineral soils with emergent vegetation in the form of a hemi-marsh (about 50% emergent vegetation).	Alternatives for wetland development are currently being developed.	**Very High**	**Recommended.**
Loss of Nesting Habitat for Colonial Waterbirds	Replace lost nesting habitat through: • Enhancement of existing islands; and/or • Enhancement of islands created following reservoir impoundment; and/or, • Development of artificial islands within the reservoir area and/or downstream of the Generating Station (*i.e.,* in Stephens Lake).	Complete or partial loss of nesting habitat for approximately 3,000 nesting pairs of gulls as a result of the Project, in addition to nests for terns and other water bird species. Following reservoir impoundment, reefs/islands in the spillway/tailrace area may become unsuitable breeding areas for colonial waterbirds. Gulls, terns and other waterbirds are expected to utilize the man-made nesting island(s) and will likely benefit from the additional enhancements made to islands.	Construction of an artificial island could be either within Stephens Lake or within the Keeyask reservoir (constructed in-the-dry prior to impoundment). Constructing an island at these sites would have a negligible impact on the flows toward the Powerhouse or Spillway structures.	**Moderate**	**Recommended.** Would provide suitable nesting habitat for the existing population of colonial waterbirds.

Potential Effect	Mitigation Options	Environmental Considerations	Technical Considerations	Cost Range[1]	Conclusion and Rationale
	Leaving a remnant portion of the Tailrace Summer Level Cofferdam to form an artificial island along the south side of the Tailrace Channel	Following reservoir impoundment, reefs/islands in the spillway/tailrace area may become unsuitable breeding areas for colonial waterbirds. Gulls, terns and other waterbirds are expected to utilize a man-made nesting island.	Leaving a remnant portion of the Tailrace Summer Level Cofferdam to form an artificial island would create headlosses, resulting in increased tailwater levels and would reduce power generation. The island would also affect flow patterns, which would adversely affect the planned whitefish spawning habitat along the south shoreline to the area southeast of the Powerhouse. For these reasons, this option is not being explored further at this time.	**Not estimated**	**Not Recommended.** Leaving a remnant of a tailrace cofferdam would reduce power generation and affect flow patterns which would likely impact the effectiveness of recommended aquatic mitigation measures.
	Providing tern nesting platforms in select areas, such as enhanced wetlands and other suitable marsh sites within the Nelson River and/or parts of the reservoir.	Construction of the GS will result in the loss of traditional breeding habitat (islands, reefs) at Gull Rapids and areas upstream. Remaining available nesting habitats would likely be occupied by gulls, which can usually out-compete terns when resources are limited.	Floating nest platforms can be constructed and deployed in calm backwater areas of the Nelson River and/or reservoir. These structures have been used successfully in other areas in Canada, USA and Great Britain. The number of platforms needed and the specific locations for their placement is yet to be determined.	**Low**	**Recommended.** Low cost option that has been successfully implemented in other areas of Canada.
	Deploying a barge lined with suitable surface materials, to provide nesting habitat for waterbirds.	Following reservoir impoundment, reefs/islands in the spillway/tailrace area may become unsuitable breeding areas for colonial waterbirds. Gulls, terns and other waterbirds are expected to utilize a floating barge as nesting habitat, provided it is lined with suitable surface materials.	Deploying a barge as an artificial nesting island would involve the conversion of one of the small barges used for the construction phase into an artificial floating island. One advantage of this option is that the barge could be positioned at different locations each year in an effort to identify areas that will have the greatest effectiveness to attract birds. The barge would be removed each winter prior to ice formation and reinstalled following melting of the ice each spring, so costs would be incurred for annual removal and installation, maintenance and replacement and decommissioning.	**Low**	**Currently being evaluated.**
	Using predator fencing to enhance nesting habitat for colonial nesting birds on islands immediately downstream of the generating station.	Predator fencing would protect nesting birds from predators in areas that have some connectivity with the mainland or GS structures following construction of the Project.	Predator fencing in select island areas would be a low-cost, effective means of enhancing nesting habitat on islands that have some connectivity to the mainland or GS structures.	**Low**	**Recommended.** Locations where predator fencing may be required is currently being evaluated.
Increased Moose Harvest due to Access Programs	Determine sustainable harvest levels and enact measures to ensure these levels are not exceeded. CNP to develop a Moose Harvest Sustainability Plan.	Harvest levels of moose in the SLRMA may change due to the Access Program. Developing a Moose Harvest Sustainability Plan will help to ensure the long-term sustainability of harvest.	A moose habitat stratification survey occurred in March 2009, and a detailed moose population survey was completed in January 2010. CNP is developing a Moose Harvest Sustainability Plan.	**Not Estimated**	**Recommended.** Moose Sustainability Plan is currently under development.

[1]**Cost Range:** Low = Cost is less than $500,000; Moderate = Cost is between $500,000 and $5,000,000; High = Cost is between $5,000,000 and $15,000,000; Very High = Cost is greater than $15,000,000

6.13.3 Socio-Economic Environment, Resource Use and Heritage Resources

Project socio-economic effects will be addressed through a diverse suite of mitigation measures. These measures are designed to avoid, reduce or offset adverse socio-economic effects of the Project as well as to facilitate the provision of substantial benefits of the Project to accrue to Local Study Area communities, in particular the KCNs communities. The extensive list of socio-economic, heritage and resource use mitigation measures are identified and discussed in Chapter 6 and accompanying supporting volumes (SE SV Sections 3.4, 4.4 and 5.4; Resource Use Sections 1.2, 1.3 and 1.4; and Heritage Resources Section 1.6).

Through community ratifications, the membership of the KCNs approved both the 2009 **Joint Keeyask Development Agreement** (JKDA) and the community-specific **adverse effects agreements** (AEAs). These agreements outline procedures for the avoidance of adverse effects from the generating station and the establishment of programs to offset unavoidable effects. Provisions found in the JKDA and AEAs enhance community business opportunities through directly negotiated contracts and generate future revenues from Partnership participation; include programs to promote culture and language, ensure ongoing monitoring of **environmental effects**, increase Members' access to and use of the resource area, and provide ongoing training and jobs for community members.

The JKDA and the **Burntwood Nelson Agreement** (BNA) include a number of provisions that serve to enhance the KCNs communities and northern Manitoba residents' employment participation and Project business opportunities. Measures include the implementation of a pre-project training initiative, called the Hydro Northern Training and Employment Initiative (HNTEI); application of hiring preferences for Aboriginal and northern Manitoba residents; implementation of a Job Referral System; and a direct hiring provision for directly negotiated contracts (construction phase) to Aboriginal-owned companies in the KCNs communities.

In addition to the JKDA, AEAs, and BNA, specific mitigation measures have been developed during the Project planning process to address other key topics of interest with regard to socio-economic, resource use, and heritage resources components.

<u>**Socio-Economic Environment**</u>

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:

- Reservoir Clearing Plan and Waterways Management Program – these are Schedules to the JKDA and were developed with the KCNs to address issues around human safety resulting from floating debris; and travel, access and safety. For further details, please refer to the Physical Environment alternative measures section.
- The Waterways Management Program specifically addresses concerns about safe landing sites, safe winter/ice trails, and safe travel routes through the reservoir.

- A portage around the generating facilities (addresses travel safety) is included in the Project Description.

Elevated levels of methyl mercury in local fish can affect human health. The KCNs Adverse Effects Agreements provide offsetting programs to enable the KCNs to access traditional country foods in areas that are not affected by the Project.

A multilateral Mercury and Human Health Technical Working Group was established by the Partnership to deal with concerns and mitigation measures regarding methyl mercury and human health.

Concerns relating to the remaining issues that arose from community Members through key person interviews and meetings were pursued in a variety of ways including: multilateral and bilateral First Nation/Manitoba Hydro working group meetings, specific mitigation meetings as needed, community workshops, as well as internal Manitoba Hydro meetings to identify and refine additional mitigation measures. These efforts complement and build on existing provisions described above and include the following measures, among others:

- Review of Wuskwatim experience regarding challenges affecting worker availability and identify opportunities for addressing same. This would be a joint effort involving the KCNs, Manitoba Hydro Project staff, the Job Referral Service, key contractors and other relevant stakeholders.
- Video of Gull Rapids to deal with loss of cultural landscape and rapids and to promote cultural memory.
- Preparation of a methyl mercury risk communication strategy for the KCNs, Gillam and other users of the affected lakes prior to impoundment, including the development of communication products and monitoring.
- With regard to the construction workforce at the camp, cultural awareness training, on-site recreation and design features, camp rules (among others) to address concerns about Public Safety and Worker interaction.
- On-going communication between Manitoba Hydro and local service providers to allow for effective and timely planning of service delivery. In Gillam, the Gillam Land Use Planning process currently underway is a forum for addressing demands on housing, infrastructure and services.

Resource Use

The JKDA (Schedule 7-1) contains measures to reduce adverse effects and enhance resource user safety including the following:

- The Reservoir Clearing Plan;
- The Waterways Management Program;
- Reservoir depth charts and travel routes;
- Safe landing sites; and
- Ice monitoring and safe trails program.

These plans were developed specifically in response to concerns expressed by the communities.

In addition to the JKDA provisions, each KCN negotiated AEAs with Manitoba Hydro. As part of the AEAs, offsetting programs were established to provide, where necessary, appropriate replacements, substitutions or opportunities to offset unavoidable adverse effects to domestic resource use including but not limited to the following:

- Hunting, trapping and fishing for food.
- Eating traditional foods.
- Respecting and caring for *Askiy*.
- Learning in traditional ways.
- Living on the land in traditional ways.

Agreements also are offered to KCN resource users where adverse effects cannot be avoided or reduced. Such agreements (*e.g.,* with commercial trappers) are developed in consultation with the resource harvester.

Heritage Resources

The Waterways Management Program consists of measures to work with KCNs to identify and contribute to impact management measures at high priority heritage sites and to provide support, as required, for reclamation of disturbed sites along shorelines. In order to address any undiscovered heritage resources and human remains associated with Project activities, a Heritage Resource Protection Plan, as part of the Environmental Protection Program, will be developed with involvement from the KCNs.

Table 6-5 identifies specific Heritage Resources mitigation measures relating to physical structures or components.

Table 6-5: Summary Table –Heritage Resources Alternative Means and Mitigation Measures

Potential Effect	Mitigation Options	Environmental Benefit	Technical Feasibility	Cost Range[1]	Conclusion and Rationale
Discovered Human Remains and Heritage Resources – construction and operation phase. Construction activities such as clearing, grading, drilling, excavation and dewatering of the riverbed etc. may affect known and unknown heritage resources. Operation effects include initial flooding, ongoing shoreline erosion, changes to water flow and increased vehicular and pedestrian traffic may affect unknown and known heritage resources.	Shoreline protection of existing heritage sites. This, however, is considered as unreliable protection of sites because of the nature of the soils.	In some cases may offer some protection of heritage resources.	Soil characteristics rule this out.	Low-Moderate	**Not Recommended.** Due to vulnerability of soils as well as potentially high cost.
	Avoidance; if not possible, then: Salvage / Recovery	Salvage of heritage resources enables long-term preservation of tangible heritage and ability to enhance public and local awareness through education kits, interpretive displays other forms of cultural media.	Feasible.	Low	**Recommended.** Meets identified best practice (*i.e.,* professional standards), aligns with AEA programming, and is low cost.
	Development of reburial site/cemetery for found human remains to date.	Provide culturally appropriate measures to deal with found and yet-to-be discovered human remains. Site selection based on range of criteria proposed by TCN as well as environmental feasibility (access, terrain).	Feasible	Low	**Recommended.** Fulfills mandate for responsible environment and social stewardship, and is low cost.

[1]**Cost Range:** Low = Cost is less than $500,000; Moderate = Cost is between $500,000 and $5,000,000; High = Cost is between $5,000,000 and $15,000,000; Very High = Cost is greater than $15,000,000

7.0 GLOSSARY

Access Management Plan (AMP): A component of the environmental protection program. The purpose of the AMP is to document commitments to manage access during construction of the south access road and operation of both the north and south access roads associated with the construction of the Project

Aboriginal traditional knowledge (ATK): Aboriginal traditional knowledge is knowledge that is held by, and unique to, Aboriginal peoples. It is a living bit of knowledge that is cumulative and dynamic and adapted over time to reflect changes in the social, economic, environmental, spiritual and political spheres of the Aboriginal knowledge holders. It often includes knowledge about the land and its resources, spiritual beliefs, language, mythology, culture, laws, customs and medicines (Canadian Environmental Assessment Act).

Above sea level (ASL): Elevations are referenced to Geodetic Survey of Canada, Canadian Geodetic Vertical Datum 1928, GS of C, CGVD28, 1929 Adjustment.

Adaptive management: The implementation of new or modified mitigation measures over the construction and operation phases of a project to address unanticipated environmental effects. The need for the implementation of adaptive management measures may be determined through an **effective follow-up program.**

Alternating current (AC): Is the form in which electric power is delivered to businesses and residences. Alternating current reverses its direction in a cyclical fashion.

Alternative means: The various technically and economically feasible ways, other than the proposed way, for a project to be implemented or carried out. Examples include other project locations, different routes and methods of development, and alternative methods of project implementation or mitigation.

Anchor ice: Ice that forms below the surface of a body of water that attaches either to a submerged object or to the bottom.

Average annual energy: The average amount of energy generated by a power plant over one year, usually reported in megawatt hours or gigawatt hours.

Baffles: Structural barriers to flow designed to facilitate the settling of suspended particles in a settling pond.

Base Loaded Mode of Operation: A generating station mode of operation based on a constant forebay elevation and gradual flow changes in response to changing inflows.

Batch plant: A plant used to manufacture concrete by mixing cement, sand, aggregate and water. The aggregate may be either crushed rock or gravel.

Bedrock: t A general term for any solid rock, not exhibiting soil-like properties, that underlies soil or other surface materials.

Berm: A length of raised earth (or other material) which may act as a barrier towards movement.

Best gate: The wicket gate setting at which a hydraulic turbine operates most efficiently. The wicket gates are the main flow control to the turbine.

Black-start: During a system wide blackout or outage, transmission lines are not energized and generating stations are not operating. Some generating stations require a source of power to restore it to operation without relying on an off-site source of power. A standby diesel generator is normally used to provide power to start up the stations generating units. The generating station then provides power to key transmission lines to provide power to start up other hydroelectric generating stations that do not have their own on-site source of back-up power.

Blast walls: A barrier constructed to protect against the affects of an explosion.

Border ice: Ice that forms along the bank or shoreline where velocities are low (also referred to as shore ice).

Boreal: Of or relating to the cold, northern, circumpolar area just south of the tundra, dominated by coniferous trees such as spruce, fir, or pine. Also called taiga.

Borrow sites or borrow 'areas' or 'pits': An area where earth material (clay, gravel or sand) is excavated for use at another location (also referred to as 'borrow sites' or 'borrow pits').

Bridge deck: The travelling surface of a bridge structure.

Bulb turbine: A type of hydro turbine in which the entire generator is mounted inside the water passageway as an integral unit with the turbine.

Bulkhead gates A fabricated steel unit that performs the same function as a number of stop logs when it is lowered into guides and seals against a frame to close a water passage in a dam or spillway.

Burntwood Nelson Agreement (BNA): The collective bargaining agreement between the Hydro Project Management Association (HPMA), representing Manitoba Hydro management, and the unions of the Allied Hydro Council (AHC), representing workers, that will be in effect during the construction of the Project. (See above for definition of collective bargaining agreement.) The BNA was under renegotiation at the time of writing. It is expected that the renegotiated BNA will be completed and in effect for construction of the Project.

Camp: A temporary residence for employees working on a construction project at a remote location, consisting of bunkhouse dormitories, a kitchen and other facilities.

Canadian Shield: A broad region of **Precambrian rock** that encircles Hudson Bay. In total it covers 8 million km^2 and is made up of some of the planet's oldest rock, largely granite and gneiss.

Cantilevered: A cantilever is a beam anchored at only one end. Cantilevered construction allows for overhanging structures without external bracing.

Cement: A dry powder made of burned lime and clay that is mixed with water, sand and aggregate to make concrete.

Centrifuges: A device used to separate two or more substances through the use of centrifugal force. It can be used to separate solid waste from waste water to facilitate disposal.

Churchill River Diversion (CRD): The diversion of water from the Churchill River to the Nelson River via and the impoundment of water on Southern Indian Lake as authorized by the CRD Licence.

Clear-Span Bridge: Small-scale bridge structure that completely spans a watercourse without altering the stream bed or bank, and that are a maximum of two lanes wide. The bridge structure (including bridge approaches, abutments, footings, and armouring) is built entirely above the ordinary high water mark.

Cofferdam: 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.

Compliance monitoring: A broad term for a type of monitoring conducted to verify whether a practice or procedure meets the applicable requirements prescribed by legislation, internal policies, accepted industry standards or specified terms and conditions (e.g., in an agreement, lease, permit, license or authorization).

Concrete: A mixture of sand, gravel, water and cement which hardens to a stone like condition when dry, capable of bearing significant load.

Construction power: The electrical requirements during the construction of the project, including the camp, batch plants, cranes, heaters and other equipment.

Construction design flood: The flow magnitude used to determine the design parameters (i.e. design crest elevations, rock sizes, etc) for all instream structures during the construction phase project.

Control building: A building which houses the controls for the generating station.

Control Structure A type of structure designed to control the outflow from a lake (e.g., Missi Falls control structure, Notigi control structure).

Converter Station: A facility, which converts electricity, either from direct current (DC) to alternating current (AC) or from AC to DC.

CNP: See **Cree Nation Partners.**

Cree Nation Partners (CNP): A partnership between Tataskewayk Cree Nation and War Lake First Nation.

Crest: The top surface of a dam or roadway, or the high point of the spillway overflow section.

Culvert: A drain or pipe that allows water to flow under a road, railroad, trail, or similar obstruction

Dam: A barrier built to hold back water.

Dangerous Waterway Zone : An area where a person can experience a critical injury or fatality due to the hazards created by the water conveyance structure or its operations. In this definition it is acknowledged that flowing rivers are an inherently hazardous environment. This is especially true when an individual enters the water, particularly if they are without a life jacket or are a non-swimmer. Dangerous Waterway Zones are distinguished as areas that, due to the presence of a GS structure, could be hazardous to the stability of pleasure craft away from shore or to a swimmer should they fall in from shore. It is desirable to strongly dissuade or prevent the public from accessing these areas.

Datum: A reference point for measuring elevations.

Decommissioning: Planned shutdown, dismantling and removal of a building, equipment, plant and/or other facilities from operation or usage and may include site cleanup and restoration.

Dependable energy: The energy that can be generated by a generating station during the lowest flow conditions on record for a given length of time (i.e. week, month, year).

Dewater: Removing the water from or draining an area behind a cofferdam so that construction activities can be undertaken.

Direct Current (DC): is the unidirectional flow of electric charge. Direct current is produced by sources such as batteries or solar cells.

Directly Negotiated Contract (DNC): A type of contract that is non-tendered and directly negotiated between parties of interest.

DNC: See **Directly Negotiated Contract.**

Downstream toe drain: A drain which carries seepage away from the base of the dam.

Draft tube: The part of the water passage immediately downstream of a turbine runner, through which the water exits the powerhouse into the tailrace.

Drawdown: Lowering a reservoir by discharging more flow than is coming into it.

Dyke: An earth embankment constructed to contain the water in the reservoir and limit the extent of flooding.

Earth structure: A structure constructed using rock, earth, gravel and sand, or some combination of these materials.

Egress: A means or place of going out; an exit.

EIS: See Environmental Impact Statement; .

Energy: The capacity of an electric generating station to do work, usually measured in megawatts.

Environment: The components of the Earth and includes: a) land, water and air, including all layers of the atmosphere, b) all organic and inorganic matter and living organisms, and c) the interacting natural systems that include components referred to in paragraphs a) and b) (Canadian Environmental Assessment Act).

Environmental assessment (EA): Process for identifying project and environment interactions, predicting environmental effects, identifying mitigation measures, evaluating significance, reporting and following-up to verify accuracy and effectiveness leading to the production of an Environmental Assessment report. EA is used as a planning tool to help guide decision making, as well as project design and implementation.

Environmental component: Fundamental element of the physical, biological or socio-economic environment, including the air, water, soil, terrain, vegetation, wildlife, fish, birds and land use that may be affected by a proposed project, and may be individually assessed in the environmental assessment.

Environmental effect: In respect of a project, a) any change that the project may cause in the environment, including any change it may cause to a listed wildlife species, its critical habitat or the residences of individuals of that species, as those terms are defined in subsection 2(1) of the Species at Risk Act, b) any effect of any change referred to in paragraph a) on i) health and socio-economic conditions, ii) physical and cultural heritage, iii) the current use of lands and resources for traditional purposes by Aboriginal persons, or iv. any structure, site or thing that is of historical, archaeological, paleontological or architectural significance, or any change to the project that may be caused by the environment; whether any such change or effect occurs within or outside Canada (Canadian Environmental Assessment Act).

Environmental Impact Statement (EIS): A document that presents the findings of an environmental assessment in response to specific guidelines or terms or reference. The term EIS is often used in the context of an assessment by a review panel and in the environmental assessment regimes of other jurisdictions.

Environmental monitoring: Periodic or continuous surveillance or testing, according to a pre-determined schedule, of one or more environmental components. Monitoring is usually conducted to determine the level of compliance with stated requirements, or to observe the status and trends of a particular environmental component over time.

Environmental Protection Program (EPP): Provides a framework for delivery, management and monitoring of environmental protection activities in keeping with issues identified in the environmental assessment, regulatory requirements and public expectation.

EnvPP: See **Environmental Protection Plan.**

Environmental Protection Plan (EnvPP): A "user-friendly" guide for the contractor that includes: information such as a brief project description; updated construction schedule; summary identifying environmental sensitivities and mitigative actions; listing of all federal, provincial or municipal approvals, licenses, or permits that are required for the project; a description of general corporate practices and specific mitigating actions for the various construction activities; emergency response plans, training and information; and environmental/engineering monitoring plans and reporting protocols.

Erosion: A natural process, which is either naturally occurring or anthropogenic in origin, by which the Earth's surface is worn away by the actions of water and wind.

Fill: Natural soils or loose rock that may or may not have been processed and are placed to construct an earth fill structure or to construct a grade, dyke or dam.

Fixed-blade turbine: A propeller-type turbine with non-adjustable blades.

Follow-up program: A program for: a) verifying the accuracy of the environmental assessment of a project, and b) determining the effectiveness of any measures taken to mitigate the adverse environmental effects of the project (Canadian Environmental Assessment Act).

Footprint: The surface area occupied by a structure or activity; the land or water area covered by a project. This includes direct physical coverage (*i.e.*, the area on which the project physically stands) and direct effects (*i.e.*, the disturbances that may directly emanate from the project, such as noise). (Cumulative Effects Assessment)

Forebay: Impoundment area immediately upstream from a dam or hydroelectric plant intake structure that forms the downstream portion of the reservoir. The term "reservoir" is used throughout this document to describe the entire reservoir, including the forebay.

Frazil ice: Fine, small, needle-like structures of thin, flat circular plates of ice formed in super-cooled, turbulent water.

Freeboard: The amount of watertight surface between a given level of lake, sea or river water and the lowest possible entry point during flooding or large waves

Freshet: The flood of a river from heavy rain or melted snow.

Full gate discharge: The maximum possible flow through a single hydraulic turbine at a turbine efficiency that is normally less than at best gate discharge.

Full supply level (FSL): The normal maximum controlled level of the forebay (reservoir).

Fuse plug: A collapsible or erodible dam in water retaining structures to increase the dams' discharge capacity. A fuse plug is often used to increase the dams' discharge capacity for very high and unlikely flood conditions.

Generating station (GS): A complex of structures used for the production of electricity, including a powerhouse, spillway, dam(s), transition structures and dykes.

Generator: Machine that coverts mechanical energy into electrical energy.

Geotextile: Permeable fabrics which, when used in association with soil, have the ability to separate, filter, reinforce, protect, or drain.

Gigawatt (GW): one billion watts (1,000,000,000 watts) of electricity.

Glacial till: Material deposited by glaciers, usually composed of a wide range of particle sizes, which has not been subjected to the sorting action of water.

Granular: Composed of granules or grains of sand or gravel.

Granular fill: Fill material including sand and gravel.

Gravity walls A structure that is designed so that its own weight provides the major resistance to the forces exerted on it.

Gradient: The rate at which a water level increases or decreases over a specific distance.

Groin: A rock fill structure extending out into a river or lake from the bank or shore. Used to protect the bank from erosion.

Groundwater: The portion of sub-surface water that is below the water table, in the zone of saturation.

Grouting: Filling cracks and crevices with a slurry composed of a cement and sand mixture or other material to prevent or reduce flow through them.

Guides: Steel channels embedded in concrete, used to guide gates when they are raised or lowered.

ha: Hectares; a metric unit of square measure equal to 10,000 square metres or 2.471 acres.

Hanging ice dam: A deposit of ice, typically at the downstream end of rapids, that builds up through the winter by accumulating frazil ice which then partially blocks the flow of water and causes water levels upstream to rise.

Head: Refers to the hydraulic elevation head at a generating station which is calculated as the difference between the water level upstream of the station (forebay level) and the water level downstream (tailrace level) measured in meters. The amount of hydraulic head results in a specific amount of pressure that would be applied to the turbines to generate power due to the weight of the water.

Hydraulic: 1) of or relating to liquid in motion; and, 2) of or relating to the pressure created by forcing a liquid through a relatively small orifice, pipe, or other small channel.

Hydraulic zone: Reach of river over which water levels and water level fluctuations caused by the operation of a particular project are measurable within the accuracy required for operation and license compliance.

Hydraulic energy: Energy produced by the action of falling/flowing water.

Hydroelectric: Electricity produced by converting the energy of falling water into electrical energy (i.e. at a hydro generating station).

Hydrology: The study of the movement, distribution, and quantity of water around the earth, including all aspects of the water cycle, and used to estimate the magnitude and timing of river flows.

Ice boom: A floating structure, anchored at opposite shorelines and/or the river bottom, designed to help form and hold an ice cover in place.

Ice pans: Free-floating sheets of ice

Impermeable: Relating to a material through which substances, such as liquids or gases, cannot pass.

Impingement: When a fish is not strong enough to swim against the water current near a trash rack, the fish may become trappedagainst the trash racks at the water intakes of the powerhouse.

Impoundment: The containment of a body of water by a dam, dyke, powerhouse, spillway or other artificial barrier.

Impervious core: A zone of low **permeability** material in an earth dam used to prevent or reduce water flowing through the dam. In northern Manitoba the impervious core of a dam is often composed of **glacial till**.

Impervious fill: Fill that has low permeability (usually clay) and used in an embankment structure to reduce leakage through the dam. It can also be used as a liner of a pond or lagoon to prevent leakage into the surrounding area.

Inflow Design Flood (IDF): The most severe inflow flood for which a dam and its associated facilities are designed to safely pass without damaging or overtopping the principle structures.

Infrastructure: Permanent or temporary structures or features required for the construction and operation of the principal structures, including access roads, construction camps, construction power, batch plant and cofferdams.

Intake structure: The portion of the powerhouse that directs water from the forebay towards the turbine runner, including the trash racks, normally made of concrete.

Integrated Power System: means the system of hydraulic, thermal and other electric generation and power transmission facilities in the Province of Manitoba owned and operated or operated by Manitoba Hydro or from which Manitoba Hydro purchases the energy generated by that facility, which system is interconnected with other power systems, which for greater certainty does not include the transmission lines interconnecting such system with the other power systems.

Inundated: land covered by water which is not normally covered by water.

Joint Keeyask Development Agreement (JKDA): An agreement between Tataskweyak Cree Nation and War Lake First Nation operating as Cree Nation Partners, and, York Factory First Nation, and Fox Lake Cree Nation, and, The Manitoba Hydro-Electric Board regarding the partnership, ownership, development and operation of the Keeyask Project.

KCNs: See **Keeyask Cree Nations**.

KCN Community Study Area: This area includes the four First Nation communities in the vicinity of the proposed Project: Tataskweyak Cree Nation (TCN) at Split Lake; York Factory First Nation (YFFN) at York Landing; War Lake First Nation (WLFN) at Ilford; and Fox Lake Cree Nation (FLCN) at Bird and Gillam.

Keeyask Cree Nations: Tataskweyak Cree Nation (TCN) at Split Lake; York Factory First Nation (YFFN) at York Landing; War Lake First Nation (WLFN) at Ilford; and Fox Lake Cree Nation (FLCN) at Bird and Gillam.

Lacustrine: Of or having to do with lakes, and used herein in reference to soils deposited as sediments in a lake.

Load rejection: The sudden and significant reduction of electrical load on a generator. This situation is often caused by a fault in the transmission system.

Lake Winnipeg Regulation (LWR): The LWR project was constructed by Manitoba Hydro in the 1970s to regulate the outflow from Lake Winnipeg to the Nelson River and store water in the lake as authorized by the LWR Licence. The project includes three excavated channels, the Jenpeg generating station and control structure and a dam at Kiskitto Lake. Lake Winnipeg is regulated for hydropower generation and flood control.

Megawatt (MW): a unit of power equal to one million watts. One megawatt is enough to power approximately 50 typical homes in Manitoba.

Minimum operating level (MOL): The normal minimum controlled level of the forebay.

Mitigation: A means of reducing adverse Project effects. Under CEAA, mitigation is "the elimination, reduction or control of the adverse environmental effects of the project, and includes restitution for any damage to the environment caused by such effects through replacement, restoration, compensation or any other means"

Mitigation monitoring: A type of monitoring program that may be used to verify that mitigation measures were properly implemented and that such measures effectively mitigate the predicted adverse environmental effects.

Mode of operation: The method of operating a generating station for meeting electrical demands. The operation method, or mode, will determine the pattern of the outflows from the powerhouse.

Modified run-of-river plant: A plant with a mode of operation that is based on modest flow changes that allows efficient generation, but is restricted so that the outflow pattern does not cause excessive downstream water level fluctuations. Generally the daily average outflow will be equal to the daily average inflow, therefore also limiting the forebay water level changes.

Modified peaking plant: A plant with a mode of operation that includes either a peaking mode of operation or a base-loaded mode of operation.

Monitoring: Continuing assessment of conditions at and surrounding an activity. This determines if effects occur as predicted or if effects during the construction and operations phases remain within acceptable limits and if mitigation measures are as effective as predicted.

Settling pond: Normally a series of small bodies of water used to reduce total suspended solids and turbidity in various sources of effluents or wastewater.

MW (Megawatts): a unit of power equal to one million watts. One megawatt is enough to power 50 average homes.

NFA: Northern Flood Agreement; an agreement signed in 1977 by Manitoba Hydro, the governments of Canada and Manitoba, and five affected Cree Nations regarding the effects of the Churchill River Diversion and Lake Winnipeg Regulation.

Northern Manitoba Study Area: This is the broadest spatial scope used for the socio-economic assessment. This area is defined as Statistics Canada Census Divisions 22 and 23.

Organic: The compounds formed by living organisms.

Overburden: Soil (including organic material) or loose material overlaying bedrock.

Overtopped: when the water level rises above the top of a cofferdam allowing water to flow over.

Parameter: Characteristics or factor; aspect; element; a variable given a specific value.

Peaking: For the purposes of the EIS, the mode of operation that begins with reducing the flow through the generating station during off-peak periods(night time), thereby storing some water in the reservoir, and then increasing the flow and using the stored water to generate extra energy during on-peak periods(daytime).

Peatland: Wetland where organic material has accumulated because dead plant material production exceeds decomposition.

Peatland disintegration: Processes related to flooded peat resurfacing; breakdown of non-flooded and resurfaced peatlands and peat mats; and peat formation on peatlands and peat mats that have hydrological connections to a regulated area.

Permafrost: Ground where the temperature remains below 0°C for two or more consecutive years.

Permeability: The degree to which fluids or gases can pass through a barrier or material.

Plant outflow capability: The total flow through the turbines associated with **rated capacity**, with wicket gates in fully open position, forebay at its full supply level and tailrace at a low level. The plant outflow or discharge is the sum of the maximum outflow through all turbines and is also referred to as the Plant Full Gate Flow.

Plant discharge: Rate of flow of water that passes through the powerhouse and spillway combined.

Ponding: formation of a reservoir due to the damming of a river or creek; retention of water to replenish an existing reservoir.

Potable: water which is safe to drink

Power: The instantaneous amount of electrical energy generated at a hydroelectric generating station, usually expressed in megawatts.

Powerhouse: Structure that houses turbines, generators, and associated control equipment, including the intake, scroll case and draft tube.

Precambrian bedrock: bedrock formed in the Precambrian era, which began with the consolidation of the earth's crust and ended approximately 4,000 million years ago.

Primary structures: The main structures of a hydroelectric development that when combined, work together to contain the water on the upstream side of the structures so that the flow can be directed through the intake gates towards the turbines which turn the generator.

Probable Maximum Flood (PMF): is the flood that would result from the most severe combination of hydrologic and meteorological conditions that could reasonably occur. It is based on analyses of precipitation, snowmelt and other factors conducive to producing maximum flows.

Project activity: Elements of a project component that may result in environmental effects or changes. Example project activities include clearing, grubbing, excavating, stockpiling, reclaiming, etc.

Project component: A component of the project that may have an effect on the environment. Example project components include access road, construction camp, wastewater treatment facility, etc.

Project Footprint: The maximum potential spatial extent of clearing, flooding and physical disturbances due to construction activities and operation of the Project, including areas unlikely to be used.

Project inflows: a synthetic record of Split Lake outflows developed using historical monthly system inflows (1912 to 2006) current hydraulic operating regulations, current and future installed generation capacity and future projected demand for power. This inflow record is assumed to represent future inflow conditions with the Project included in Manitoba Hydro's Integrated Power System.

Proponent: A person who is undertaking, or proposes to undertake a development or who has been designated by a person or group of persons to undertake a development in Manitoba on behalf of that person or group of persons (The Environment Act).

Qualitative analysis: Analysis that is subjective. Also refers to analysis that does not involve precise numerical analysis, often addressing differences as direction of change or orders of magnitude.

Quantitative analysis: Analysis that uses environmental variables represented by precise numbers or ranges and is often accompanied by numerical modeling or statistical analysis.

Quarry site: An open pit where rock is mined for use as a building material at the construction site.

Rated capacity: The maximum power that a generator is designed to deliver without exceeding mechanical safety factors or allowable temperatures.

Reach: A section, portion or length of river.

Reconnaissance survey: A preliminary survey, usually executed rapidly and at relatively low cost, prior to mapping in detail and with greater precision.

Rehabilitation: restoring to a more normal state; when referring to land, restoring the area to promote re-vegetation.

Reinforcing steel: A steel rod imbedded in reinforced concrete to provide tensile strength.

Relief: Variation in elevation on the surface of the earth.

Reservoir: A body of water impounded by a dam and in which water can be stored for later use. The reservoir includes the forebay.

Resource Management Area (RMA): An area to be jointly managed by a Resource Management Board established by agreement between Manitoba and a First Nation or a local Aboriginal community.

Right-of-Way (ROW): Area of land controlled or maintained for the development of a road, pipeline or transmission line.

Riparian: Along the banks of rivers and streams.

Riprap: a layer of large stones, broken rock, boulders, or other suitable material generally placed in random fashion on the upstream and downstream faces of embankments, or other land surfaces to protect them from erosion or scour caused by current, waves, and/or ice action.

RMA: See **Resource Management Area.**

Road topping: processed sands and gravels with trace fines, or gravel sized crushed rock with some sand and trace fines used for site roads and for topping of the dams, dykes, cofferdams.

Rockfill: fill material typically consisting excavated and crushed rock that is used to provide mass to a structure while protecting it from erosion

Rock groin: a rock fill structure extending out into a river or lake from the bank or shore. Used to protect the bank from erosion.

Rollway: The concrete portion of the spillway that water flows over when the spillway is in operation.

ROW: see Right-of-Way

Runner: The part of a turbine upon which water impinges, causing the turbine shaft to rotate.

Semi-spiral scroll case: A reinforced concrete semi-spiral part of the turbine water passage, located between the intake and the turbine runner, with a gradually contracting cross-section (much like a snail shell), designed to distribute the water evenly over the turbine runner.

Secondary structures: Those structures that are not directly required to contain the water as part of the primary structures. These structures typically perform other tasks, like serve as a location of excavated material or improve the outflow from a lake i.e. channel excavation.

Service bay: An open area of the powerhouse where turbine and generator components are assembled during construction, and later, where maintenance and repairs are performed to major generating equipment.

Service gate: Gates that are used to dewater a unit to allow inspections, maintenance and repairs to occur within the water passage.

Shore: The narrow strip of land in immediate contact with the sea, lake or river.

SLRMA: See **Split Lake Resource Management Area.**

Sluice: Control water levels and flow rates in rivers and canals

Speed-no-load flow: The speed-no-load discharge is the amount of water that can be passed through the powerhouse without risking damage to the generating units when no electricity is being produced.

Spillway: A concrete structure that is used to pass excess flow so that the dam, dykes, and the powerhouse are protected from overtopping and failure when inflows exceed the discharge capacity of the powerhouse.

Split Lake Resource Management Area (SLRMA): Formed by a Comprehensive Implementation Agreement between Tataskweyak Cree Nation and Manitoba in 1992 the area covers about 4,150 ha in northern Manitoba,

Stage: A point, period, phase or step in a process or development.

Stay vanes: A set of fixed vanes between the scroll case and the wicket gates designed to align the flow of water from the scroll case onto the wicket gates.

Stop logs: Fabricated steel units, designed to be placed horizontally on top of one another while fitting tightly into guide*s* at their ends and sealing against a frame so as to close a water passage in a dam or spillway.

Stratigraphy: Scientific study of rock strata, especially the distribution, deposition, correlation, and age of sedimentary rocks.

Sub-transmission line: Lines feed electricity from converter stations that reduce the voltage of electricity delivered by Manitoba Hydro's high voltage transmission system and connect to regional converter stations where the voltage is again reduced.

Sub-grade drilling: extra depth drilled below the grade level to assure that the full face of the rock can be broken to the desired excavation level.

Surcharge: A condition in a forebay in which the water level rises above the full supply level.

Surface permafrost: Permafrost that occurs within the top 2 m of the surface materials.

Switching Station: A facility used to terminate transmission lines operating at the same voltage, and enable individual lines to be taken out of service or connected to other lines to redirect or control the flow of power.

Tailrace: A channel immediately downstream from a powerhouse that directs the water away from the turbine and into the river channel.

Tailwater: Water located in the powerhouse tailrace area or area immediately downstream of the powerhouse.

Thaw consolidation: Compaction of soil material after thawing of permafrost within the soil.

Thermal ice cover: An ice cover that forms where velocities are low.

Thermal plant: A generating station that uses coal or natural gas to create steam to drive a generator. Thermal plants are used at both Brandon and Selkirk, as well as a natural gas-fired simple-cycle combustion turbine at Brandon.

Till: An unstratified, **unconsolidated** mass of boulders, pebbles, sand and mud deposited by the movement or melting of a glacier.

Timber: The wood of growing trees suitable for structural uses; the body, stem or trunk of a tree.

Topography: General configuration of a land surface, including its **relief** and the position of its natural and manmade features.

Total Suspended Solids (TSS): Solids present in water that can be removed by filtration consisting of suspended sediments, phytoplankton and zooplankton.

Trailing edge: the rear edge of a moving body.

Transformer: A device which uses electromagnetic induction to transform electric energy in one circuit into energy of similar type in another circuit, but with different values of voltage and current.

Transition structure: A concrete structure that connects an earth structure such as a dyke or dam to a concrete structure such as the powerhouse or spillway.

Transmission: The electrical system used to transmit power from the generating station to customers.

Transmission line: A conductor or series of conductors used to transmit electricity from the generating station to a substation or between substations.

Transmission tower spur: A rock filled structure located in the river channel adjacent to the powerhouse that supports a transmission tower.

Trash rack: A grid of metal bars placed in front of the powerhouse intake to prevent larger objects from entering the intake where it could damage the turbine and other components.

Turbine: A machine for converting the power of flowing water to rotary mechanical power that is then transferred by a large metal shaft to the generator for conversion to electric power.

Uncertainty: The lack of certainty or a state of having limited knowledge where it is impossible to exactly describe existing state or future outcome, more than one possible outcome. In environmental assessment not knowing the nature and magnitude of environmental effects or the degree to which mitigation measures would prevent or reduce adverse effects.

Unconsolidated: Not compact or dense in structure or arrangement; i.e., "loose gravel."

Vertical datum: The elevation of a specific point on the earth's surface to which other elevations are referenced.

Vertical lift gates: Rectangular gates set in vertical guides which open by being lifted straight up, such as the intake gates or spillway gates.

Warning Waterway Zone: An area where a person can experience a minor injury or be stranded due to the hazards created by the water conveyance structure. However a critical injury or fatality is not expected as a result of Manitoba Hydro operation. Access by the public to these areas is not prevented but warnings are posted. A Warning Waterway Zone may also serve as an opportunity to provide additional warning to the public that they are approaching a Dangerous Waterway Zone, usually upstream of a structure.

Water regime: a description of water body (i.e., lake or river) with respect to water levels, flow rate, velocity, daily fluctuations, seasonal variations, etc.

Watershed: A geographic region bounded by ridges, crest lines and other high points of land in which all surface water drains into a river, river system or other body of water.

Water surface profile: A two dimensional section view of a reach of the river that shows the elevation of the water surface along that reach.

Watt: A unit of electrical power.

Weir: A low dam built across a river to raise the level of water upstream or regulate its flow.

Wetland: A land ecosystem where periodic or prolonged water saturation at or near the soil surface is the dominant factor shaping soil attributes and vegetation composition and distribution. Peatlands are wetlands where organic material has accumulated because dead plant material production exceeds decomposition.

Wicket gate: A series of movable gates between the fixed stay vanes and the turbine runner that control the amount of water flowing through the turbine.