Keeyask Generation Project

Environmental Impact Statement

Response to EIS Guidelines

KEEYASK
Hydropower Limited Partnership

June 2012

KEEYASK GENERATION PROJECT
ENVIRONMENTAL IMPACT STATEMENT

RESPONSE TO EIS GUIDELINES

Prepared by

Keeyask Hydropower Limited Partnership

Winnipeg, Manitoba

June 2012

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PREFACE

The Environmental Impact Statement (EIS) for the Keeyask Generation Project (the Project) is submitted to Canada and Manitoba by the Keeyask Hydropower Limited Partnership (the Partnership), which consists of Manitoba Hydro and four Cree Nations (referred to collectively as the Keeyask Cree Nations or KCNs): Tataskweyak Cree Nation (TCN) and War Lake First Nation (WLFN), acting collectively as the Cree Nation Partners (CNP), York Factory First Nation (YFFN), and Fox Lake Cree Nation (FLCN).

The Partners agreed early on that there would be a Keeyask Cree Nations evaluation process as well as the government regulatory environmental assessment process for the Project.

In the KCNs' process, each of the KCNs, assisted by Manitoba Hydro, evaluated the impact of the Project on their communities and Members in terms of their own worldview, values and experience with past hydroelectric development. This process supported conclusion of the Joint Keeyask Development Agreement by the Partners.

The Partnership's EIS response to the government regulatory environmental process was undertaken by Manitoba Hydro with the support of the KCNs. In summary, the EIS consists of:

- A video, *Keeyask: Our Story*, which presents the Keeyask Cree Nations' history and perspectives related to hydroelectric development. Presented through the lens of their holistic Cree worldview, it explains the journey taken by the KCNs as they evaluated their concerns about the Project, the nature of their participation as Partners, and the decisions they ultimately made to support the Project;
- This executive summary;
- A Response to EIS Guidelines issued by Canada March 30, 2012 in response to an application by the Partnership for environmental approvals under the government regulatory environmental assessment process. This response includes findings and conclusions[1], with charts, diagrams, and maps to clarify information in the text, and a concordance table to cross reference requirements of the EIS Guidelines with information in the EIS; and
- The KCNs' Evaluation Reports providing each of the KCNs' own evaluation of the effects of the Project on their community and Members and including Aboriginal traditional knowledge (ATK) relevant to the Partnership's response to the EIS Guidelines.

[1] Technical supporting volumes are also provided, as developed by the Manitoba Hydro environmental team in consultation with the KCNs and their Members, to provide details on the Project Description and on 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.

LIST OF KEY PERSONNEL

The following is a list of key personnel from Manitoba Hydro, the Keeyask Cree Nations and the consulting firms who worked on the environmental assessment of the Project.

Manitoba Hydro

Ed Wojczynski, M.Sc., P.Eng.

Shawna Pachal, B.Sc. C.R.S.P., M.B.A.

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Halina Zbigniewicz, P.Eng.

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Kurt Fey, C.E.T.

Cree Nation Partners

Tataskweyak Cree Nation Chiefs and Councils

War Lake First Nation Chiefs and Councils

Tataskweyak Cree Nation Elders and Members

War Lake First Nation Elders and Members

Victor Spence, Tataskweyak Cree Nation, Manager of Future Development

Tataskweyak Cree Nation, Overview of Water and Land Staff

Hobbs and Associates

Joseph I. Keeper

Robert F. Roddick Professional Corporation

Waters Edge Consulting

Campbell Marr LLP

Roger Tassé O.C. Q.C.

York Factory First Nation

York Factory Future Development

York Factory First Nation Chiefs and Councils

Elders and Members

Hilderman Thomas Frank Cram

Fox Lake Cree Nation

Fox Lake Community Members

Fox Lake Kitayatisuk & Harvester Core Group

Fox Lake Chiefs and Councils

Fox Lake Negotiations Office and staff

Dr. Terry A. Dick., B.Sc. Forestry, M.Sc., PhD, Aquatics Advisor

Dr. Vince Crichton., B.Sc., M.Sc., Ph.D., Terrestrial Advisor

Kevin Brownlee., BA (Adv) and MA, Heritage Advisor

Grant Wiseman, B.Sc., M.Sc., Geomatics Advisor

InterGroup Consultants Ltd.

Cam Osler, M.A., Study Lead

Janet Kinley, M.A., MCIP, Socio-Economic and EIS Document Lead

John Osler, MBA, Public Involvement Lead

Nancy LeBlond, M.A., Socio-Economic Lead

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Friederike Schneider-Vieira, Ph.D., Aquatic Lead

Don MacDonell, M.N.R.M., CCEP, Resource Use Lead

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Richard Remnant, M.N.R.M., Aquatics (Sturgeon)

Stantec Consulting

George Rempel, M.Sc., P.Eng., Study Lead, Project Description and Physical Environment

Dave Morgan, Ph.D., P.Eng., Lead, Physical Environment

Dale Stewart, M.Sc., Terrestrial Coordinator

Roger Rempel, B.Sc., P.Eng., F.E.C., Project Description and Physical Environment

Blair McMahon, M.Sc., P.Biol., Terrestrial Environment

Karen Mathers, B.Sc., M.Sc., P.Geo., Groundwater

George Kroupa, RFT, GIS, Data Management

Northern Lights Heritage Services

Virginia Petch, Ph.D., Study Lead, Heritage Resources and Culture and Spirituality

Lisa Bobbie, M.A. (Candidate), Heritage Resources Lead

Hani Khalidi, M.A., Culture and Spirituality Lead

ECOSTEM Ltd.

James Ehnes, M. Phil., Ph.D., Terrestrial Environment Lead – Habitat, Ecosystems and Plants, Shoreline Erosion

Wildlife Resource Consulting Services MB Inc.

Robert Berger, M.N.R.M., Terrestrial Environment – Mammals Lead

Plus4 Consultants

John Dyck, Forestry

J.D. Mollard and Associates (2010) Limited

Lynden Penner, M.Sc., P.Eng., P.Geo., Shoreline Erosion

KGS / Acres

Rajib Ahsan, M.A.Sc., M.Eng., P.Eng., Sedimentation

CONCORDANCE TABLE

Concordance between

Final Environmental Impact Statement Guidelines

for the Keeyask Generation Project

and

Keeyask Generation Project

Environmental Impact Statement: Response to EIS Guidelines

KEEYASK

Hydropower Limited Partnership

Final Guideline Section	Final EIS Guideline Requirements Heading	Where Addressed in EIS
2	**PREPARATION AND PRESENTATION OF THE EIS**	
	Acronyms	Acronyms and Abbreviations and Units located before EIS Chapter 1
	Glossary of technical terms	Glossary located after References
	Complete reference list	Following EIS Chapter 10
	Table of concordance	Before EIS Chapter 1
	Title Page containing name and location of the Project, subtitle, name of the proponent, date in month and year and the Canadian Environmental Assessment Registry reference number	Title page
3	**EXECUTIVE SUMMARY**	
	Concise description of all key components of the Project	Separate Executive Summary document
	Succinct description of the consultation conducted with Aboriginal groups, the public, and government agencies, with a summary of the issues raised and solutions found and/or suggested during these consultations.	Separate Executive Summary document
	A description of the key environmental effects of the Project, as per section 2 of the Act, and proposed technically and economically feasible mitigation measures.	Separate Executive Summary document
	The proponent's conclusions on significance of potential residual environmental effects and significance of cumulative environmental effects.	Separate Executive Summary document
	Maps indicating the locations of the Project and its key components.	Separate Executive Summary document
	A summary of the environmental effects analyses in a table format to present the information clearly and accurately.	Separate Executive Summary document

Final Guideline Section	Final EIS Guideline Requirements Heading	Where Addressed in EIS
4	**INTRODUCTION AND PROJECT BACKGROUND**	
4.1	**The Proponent**	
	Identify itself and the name of the legal entity that would develop, manage and operate the Project.	EIS 1.1
	Provide its contact information for the proponent (*e.g.*, name, address, phone, fax, email).	EIS 1.1.1
	Explain its corporate and management structures.	EIS 1.1
	Specify the mechanism that would be used to ensure that relevant corporate policies and EA commitments will be implemented and respected for the Project.	EIS 1.1
	Identify key personnel, contractors, and/or sub-contractors responsible for preparing the EIS including, if required, identifying qualifications of biologists involved in conducting surveys for migratory birds, species at risk and species of conservation concern, and wetland delineations.	List of Key Personnel in front of EIS Chapter 1, EIS Appendix 1A
4.2	**Project Overview**	
	Summary of the Project, by describing the project components, associated and ancillary works, activities, scheduling details, timing of each phase of the Project and other key features.	EIS 4.1
	Project location should be described in conjunction with surrounding land uses and infrastructure.	EIS 4.1
4.3	**Participants in the Environmental Assessment**	
	The main participants in the EA, including, Aboriginal groups, community groups, environmental organizations.	List of Key Personnel in front of Chapter 1 Acknowledgements: EIS Appendix 1A Public Involvement: EIS Chapter 3

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4.4	**Regulatory Framework and the Role of Government**	
	The environmental and other specific regulatory approvals and legislation that are applicable to the Project at the federal, provincial, regional and municipal levels.	EIS 1.3 EIS Appendix 1B
	Government policies, resource management, planning or study initiatives pertinent to the Project and/or EA, and discuss their implications.	EIS 6.2, 6.3, 6.4, 6.5, 6.6, 6.7, 6.8, Appendix 6B EIS 9.2.1, 9.2.2, 9.2.3, 9.2.4 Complete references following EIS Chapter 10
	Policies and guidelines of the Aboriginal groups being consulted that are pertinent to the Project and/or EA and discuss their implications.	EIS Chapter 2 EIS Chapter 3 EIS 9.2.1
	Any treaty or self-government agreements with Aboriginal groups that are pertinent to the Project and/or EA.	EIS Chapter 2 EIS Chapter 3 EIS 6.2.2
	Any relevant land use plans, land zoning, or community plans that are pertinent the Project and/or EA.	EIS 6.2, 6.2.3.5.3, 6.2.3.5.4
	In a summary form, the (national, provincial and / or regional) objectives, standards or guidelines that have been used by the proponent to assist in the evaluation of any predicted environmental effects.	EIS Appendix 6B EIS Chapter 9
5	**PROJECT DESCRIPTION**	
5.1	**Purpose of and Need for the Project**	
	The "purpose" of the Project can be described by answering the question: *What is to be achieved by carrying out the Project?*	EIS 4.2
	The "need for" the Project can be described by answering the question: What is the problem or opportunity the project is intended to solve or satisfy?	EIS 4.2

Final Guideline Section	Final EIS Guideline Requirements Heading	Where Addressed in EIS
	The analysis to be documented in the EIS relating to the objectives and "need for" the Project should identify the requirements of the proposed purchaser of the electricity to be produced by the Project. The purchaser's requirements should be concisely described.	EIS 4.2
5.2	**Project Alternatives**	
5.2.1	***Alternatives to the Project***	
	Describe functionally different ways to meet the project need and achieve the project purpose	EIS 4.1, 4.2
	Clearly describe its objectives in undertaking the Project.	EIS 4.2
	Identify, from the perspective of the proponent, alternatives to the Project that were considered, including "the No Go" scenario.	EIS 4.2
	Develop criteria to identify the major environmental, economic, social and technical costs and benefits of the alternatives.	EIS 4.2
	Identify the preferred alternatives based on the relative consideration of the environmental, economic, social and technical costs and benefits.	EIS 4.2
	Describe the process the proponent used to determine that the Project is viable (technical, social, cultural, economical and environmental).	EIS 4.2
5.2.2	***Alternative Means of Carrying out the Project***	
	The EIS must identify and describe any alternative means of carrying out the Project that were determined to be technically and economically feasible. The EIS will provide a parameter-based multiple accounts analysis of the alternative means described, including a comparison of the likely environmental effects of each alternative to those of the Project. The analysis must include consideration of each phase of the Project (construction, operation, modification, decommissioning). The analysis will:	EIS 4.5.1

Final Guideline Section	Final EIS Guideline Requirements Heading	Where Addressed in EIS
	Identify the alternative means considered toward carrying out the Project. The analysis described above will list the criteria used to determine the technical and economic feasibility of the alternative means considered, show the analysis, and list and describe the alternatives that were considered technically and economically feasible. Each alternative means will be described in sufficient detail to facilitate an understanding of the alternative.	EIS 4.5.1
	Identify, along with other parameters, the likely extent of environmental effects of each alternative. Identification of environmental effects, at a conceptual level, of those elements of each alternative means considered will include sufficient detail to allow a comparison of the effects with the environmental effects of the Project.	EIS 4.5.1
	Identify the reasoning behind selection of the preferred means identifying the preferred means based on the relative consideration of all parameters will include the technical, environmental and the economic feasibility of each. The analysis will involve applying criteria that will identify each alternative means as acceptable or unacceptable on the basis of likely significant adverse environmental effects, including the potentially adverse environmental effects of the technically and economically feasible alternatives on current use lands and resources for traditional purposes by Aboriginal peoples in areas such as hunting, fishing, trapping and gathering.	EIS 4.5.1
	Arrangement of the generation station including locations on the river.	EIS 4.5.1.1
	Dyking arrangements	EIS 4.5.1.7
	Reservoir options and generating station size (i.e. production capacity).	EIS 4.5.1.1
	Hydroelectric technologies considered (i.e. including number and types of turbines).	EIS 4.5.1.4

Final Guideline Section	Final EIS Guideline Requirements Heading	Where Addressed in EIS
	Fish passage upstream and downstream	EIS 4.5.1.5
	Planning for ancillary features such as access roads, borrow sites, etc.	Roads: EIS 4.5.1.8 Borrow: EIS 4.3.2.9
	Operating patterns	EIS 4.5.1.3
	Reservoir preparation strategies	EIS 4.3.3.1, Appendix 4A
5.3	**Description**	
5.3.1	***Location***	
	A description of the Project's site location using maps of appropriate scale. The location map should include the boundaries of the proposed site including, the latitude and longitude coordinates, the major existing infrastructure, adjacent land uses and any important environmental features.	EIS 4.1, Map 4-1 EIS Map 1-1
	Site plans/sketches and photographs showing project location, site features and the intended location of project components should be included.	EIS 4.1, 4.3, Figures 4-1, 4-2, 4-3, 4-4, 4-6, 4-7, Map 4-1 EIS Map 1-1
5.3.2	***Components***	
	Major components of the Project should be described under the following headings: Ice Boom Construction, Coffer Dams, Generating Station, Spillway, Reservoir/forebay, Quarried and Excavated Construction Materials, Worker Accommodation.	EIS 4.1, 4.3.1, 4.3.2
5.3.3	***Activities***	
	The EIS shall include expanded descriptions of activities associated with the construction, operation, maintenance, foreseeable modifications, and where relevant, closure, decommissioning and reclamation of sites and facilities associated with the proposed project.	EIS 4.6

Final Guideline Section	Final EIS Guideline Requirements Heading	Where Addressed in EIS
	This would include detailed descriptions of the activities to be carried out during each phase, the location of each activity, expected outputs and an indication of the activity's magnitude and scale.	EIS 4.6
	Activities and project components associated with fish habitat compensation works must also be detailed.	EIS 4.5.1.5, 4.5.2.1
5.3.4	***Schedule***	
	A detailed schedule for the Project with the time of year, frequency, and duration for all project activities.	EIS 4.6.1, Figure 4-5
6	**SCOPE OF THE ASSESSMENT**	
6.1	**Factors to be Considered**	
	Environmental effects of the project, including effects of malfunctions or accidents.	EIS 4.7.8 EIS Chapter 5 EIS 6.3 through 6.8
	Environmental effects also include any cumulative environmental effects that are likely to result from the Project.	EIS Chapter 7
	The significance of the environmental effects referred to above.	EIS 6.3 through 6.8 EIS Chapter 7
	Comments from the public that are received during the EA.	EIS 3.6 PI SV Appendices 1C, 1D, 2, 3, 4,5
	Comments from Aboriginal groups that are received during the EA.	EIS Chapter 2, 3.4.1, 3.6 PI SV Appendices 1C, 1D, 2, 3, 4, 5
	Measures that are technically and economically feasible and are intended to be undertaken to accommodate any adverse impact of the Project on current use of land and resources for traditional use by Aboriginal persons.	EIS 6.7.3
	Measures that are technically and economically feasible and proposed to mitigate any significant adverse environmental effects of the Project.	EIS 6.3 through 6.8 EIS Chapter 7

Final Guideline Section	Final EIS Guideline Requirements Heading	Where Addressed in EIS
	The purpose of the Project	EIS 4.2
	Alternative means of carrying out the Project that are technically and economically feasible and the environmental effects of any such alternative means.	EIS 4.5
	The need for, and the requirements of, the follow-up program in respect of the Project.	EIS Chapter 8
	The capacity of renewable resources that are likely to be significantly affected by the Project to meet the needs of the present and those of the future.	EIS 6.10 EIS 9.2.3.1, 9.2.3.2
	How traditional Aboriginal knowledge has been integrated in the preparation of the EIS.	EIS 1.4 EIS Chapter 2, Appendix 2A EIS 5.2, 5.3.2, 5.3.3 EIS 6.2.2, 6.2.3, 6.3.2, 6.4.2, 6.5.2, 6.6.2, 6.7.2, 6.8.2 EIS 7.2 EIS 8.2.7, 8.3.1, 8.3.4 EIS 9.2.1 EIS Chapter 10
	The EIS shall include an assessment of the “need for” the project and “alternatives to” the project.	EIS 4.2
6.2	**Scope of the Factors**	
6.2.1	*Determination of Valued Ecosystem Components (VECs)*	
	The EIS will describe the process used for identification of Valued Ecosystem Components (“VECs”). VECs will be selected based on professional judgement interests and concerns raised by the public, Aboriginal groups and government.	EIS Chapter 5 EIS 6.2.3.3.1, 6.2.3.4.1, 6.2.3.5.1, 6.2.3.6.1, 6.2.3.7.1

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	Describe how candidate VECs were evaluated to identify whether there would be an interaction or a cause-and-effect pathway, linking the candidate VEC to the Project.	EIS Chapter 5 EIS 6.4.1, 6.5.1, 6.6.1, 6.7.1, 6.8.1
	Identify concerns specific to any VEC raised during any workshops or meetings held by the proponent or that the proponent considers likely to be affected by the Project.	EIS 3.6
	The proponent must describe any issues raised or comments noted regarding the nature and sensitivity of environmental components within and surrounding the Project and any planned or existing land and water use in the area.	EIS 3.6 EIS 6.4.2, 6.4.3, 6.5.2, 6.5.3, 6.6.2, 6.6.3, 6.7.2, 6.7.3, 6.8.2, 6.8.3
	How ATK has been integrated with western science in the identification and analysis of VECs.	EIS 1.4 EIS Chapter 2, Appendix 2A EIS 5.2, 5.3.2, 5.3.3 EIS 6.2.3.1, 6.2.3.3.1, 6.2.3.4.1, , 6.2.3.6.1, 6.2.3.7.1 EIS 7.2 EIS 8.2.5, 8.2.7, 8.3.1, 8.3.4 EIS Chapter 10
	The specific geographical areas or ecosystems that are of particular concern to interested parties, and the relationship of these areas to the broader regional environment and economy.	EIS 5.3.1 EIS 6.1, 6.2.3.2.1, 6.2.3.3.1, 6.2.3.4.1, 6.2.3.5.1, 6.2.3.6.1, 6.2.3.7.1, 6.3.1, 6.4.1, 6.5.1, 6.6.1, 6.7.1, 6.8.1

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6.2.2	*Spatial Boundaries*	
	Clearly indicate the spatial boundaries (local and regional study areas) that were selected to be examined in order to identify environmental effects. The EIS must contain a justification and rationale for all boundaries chosen including a reference to which models and data are being utilized.	EIS 5.3.1 EIS 6.1, 6.2.3.2.1, 6.2.3.3.1, 6.2.3.4.1, 6.2.3.5.1, 6.2.3.6.1, 6.2.3.7.1, 6.3.1, 6.4.1, 6.5.1, 6.6.1, 6.7.1, 6.8.1
6.2.3	*Temporal Boundaries*	
	The temporal boundaries of the studies should span all components of the Project: construction, operation, maintenance, decommissioning and reclamation of the sites affected by the project. Temporal boundaries shall also consider seasonal and annual variations related to the identified VECs for all phases of the Project, where appropriate.	EIS 5.3.1 EIS 6.3.1, 6.4.1, 6.5.1, 6.6.1, 6.7.1, 6.8.1
7	**CONSULTATION**	
7.1	*Public Participation*	
	The proponent shall describe in its EIS any project-related consultations undertaken with the general public. The proponent shall also describe planned or on-going public consultations relating to the Project.	EIS 3.4.2, 3.5 PI SV 1.1, 2.2.1.5, 2.2.2 Appendices 1A, 1B, 2, 3
	The methods used for the public consultations and relevance to the Project:	EIS 3.5 PI SV 2.1
	The locations;	EIS 3.5.1 PI SV Appendices 1A, 1B, 2, 3
	The persons and organizations consulted;	EIS 3.5.1 PI SV Appendices 1A, 1B, 2, 3
	Concerns raised during the consultations; and	EIS 3.6 PI SV Appendices 1C, 1D, 2, 3

Final Guideline Section	Final EIS Guideline Requirements Heading	Where Addressed in EIS
	The extent to which public concerns were incorporated into the design of the Project or the EIS.	EIS 3.6 EIS 4.5.1
	The resultant changes:	EIS 3.6
	The EIS shall describe outstanding issues identified by the Public during consultation and describe any means, proposed or employed to address the outstanding issues.	EIS 3.6 PI SV Appendix 1D
7.2	***Aboriginal Consultation***	
	The proponent will actively solicit Aboriginal concerns from groups other than the KCNs during the course of the EA.	EIS 3.4.1 PI SV 2.2.1, Appendices 1A, 1B, 4, 5
	Contact information of those groups consulted;	PI SV Appendices 4, 5
	Descriptions of the consultation processes used to identify the factors to be considered in the EIS;	EIS 3.4.1, 3.5
	Lists of factors suggested for inclusion in the EIS, whether or not the factors were included, and the rationale for exclusions;	EIS 3.6
	Descriptions of the traditional territories and potential or established Aboriginal and Treaty rights that were asserted by the groups in relation to the assessment area; and	KCNs Environmental Evaluation Reports PI SV Appendix 4A
	Efforts made to solicit the above information from Aboriginal groups if the proponent is unable to obtain the information.	EIS 3.4.1, 3.5.1, 3.5.2 PI SV 2.2.1.1, 2.2.1.2, 2.2.1.3, Appendices 2A, 3A, 4, 5
7.3	***Government Agency Consultation***	
	The proponent shall provide a summary of any consultations undertaken with provincial, federal or other government agencies or officials during the project planning or environmental assessment.	EIS 3.5.4 PI SV 2.2.3
	Contact information of those consulted;	PI SV Appendix 3B

Final Guideline Section	Final EIS Guideline Requirements Heading	Where Addressed in EIS
	Descriptions of the consultations;	EIS 3.5.4 PI SV 2.2.3
	Lists of all factors suggested for inclusion in the EIS, whether or not the factors were included, and the rationale for any exclusions; and	EIS 3.6
	Any issues relevant to the environmental assessment that were raised in the consultations.	EIS 3.6
8	**EXISTING ENVIRONMENT**	
	Information on the environmental setting will be organized into the following broad topics: Physical environment; Biophysical environment (i.e. aquatic and terrestrial); and Socio-economic environment (including resource use and heritage resources).	
8.1	*Physical Environment*	
	ATMOSPHERE	
	Precipitation, temperature, and wind speed/direction	EIS 6.2.3.2.2
	Trends in climate change	EIS 6.3.12.1
	A description of climate variability and extreme events.	EIS 6.3.12.1
	A description of how on-site data has been utilized in combination with data collected from regional stations to develop the site climatology. This should also include a discussion of uncertainty in the site climatology.	PE SV 2.2.1.1
	Existing air quality and sources of air contaminants, including greenhouse gas emissions.	EIS 6.2.3.2.3
	Information regarding the location of the project and the distance to all potential human receptors for different uses (residential, recreational, traditional etc.) within the area affected by the project specific to air quality effects.	EIS 6.2.3.2.3

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	An inventory of all potential sources of air contaminants and emissions from the proposed project: criteria air contaminants, air pollutants on the List of Toxic Substances in Schedule 1 of the *Canadian Environmental Protection Act*, 1999.	EIS 6.3.4.1, 6.3.4.2
	Existing ambient noise level	EIS 6.2.3.2.4
	The delineation of the distance of the project to all potential human receptors specific to noise effects.	EIS 6.2.3.2.4
	LAND	
	A description of local and regional physiography, geology and soil conditions. For areas to be flooded and eroded, the level of mercury and other potentially toxic metals in soils, in particular for soils with high organic content and indurated soils.	EIS 6.2.3.2.5, 6.2.3.4.2,
	Chemical characterization of soils, including organic matter content, and nutrients.	EIS 6.2.3.2.5
	Physical and chemical properties of rock and borrow material sources, including the Acid Base Accounting.	PE SV 5.3.2.3, 5.4.1.1.5, 5.4.1.1.6
	A description of permafrost conditions that includes a description of the distribution of permafrost, thermal conditions, ground ice, thaw sensitivity and active layer thickness.	EIS 6.2.3.2.5, 6.3.5
	Regional seismicity and seismic activity including an estimate of seismic hazards.	EIS 6.2.3.2.5
	Shoreline characteristic (geologic materials, organic materials, areas of shoreline erosion and recession, locations of instability) and areas of potential reservoir shoreline erosion conditions and the rate of shoreline erosion and recession.	EIS 6.2.3.2.7
	Peatland disintegration along shorelines and inland areas.	EIS 6.2.3.2.7
	Shoreline debris	EIS 6.2.3.2.11

Final Guideline Section	Final EIS Guideline Requirements Heading	Where Addressed in EIS
	SURFACE WATER AND GROUNDWATER	
	Hydrology and spatial extent of the local and regional watersheds in the Split Lake to Gull Rapids reach, Stephen's Lake (Reservoir).	EIS 6.2.3.2.6
	A description of existing water regime, range of flows and water levels shall also include a description of seasonal variability and extreme events.	EIS 6.2.3.2.6
	Existing range of flows and water levels in the context of the operation of the Churchill River Diversion (CRD) and Lake Winnipeg Regulation (LWR).	EIS 6.2.3.2.6
	Longitudinal profiles of water levels and bathymetry of the Nelson River from the outlet of Split Lake to the inlet to Stephens Lake (Reservoir).	EIS 6.2.3.2.6 AE SV 3.3.2.3
	Ice conditions, including changes during the winter and variability from year to year.	EIS 6.2.3.2.6
	Dissolved oxygen and temperature conditions.	EIS 6.2.3.2.10 AE SV 2.4.2.3.1, 2.4.2.4, 2.4.2.5.1, 2.4.2.6, 2.4.2.7
	Groundwater movement, levels and regime.	EIS 6.2.3.2.9
	Nature and extent of suspended sediment transport and deposition.	EIS 6.2.3.2.8
	Hydrologic and hydraulic models, including a detailed assessment of instream flow needs.	EIS 4.7.1, 4.7.2 EIS 6.2.3.2.6 PE SV 4.2.5, Appendix 4B

Final Guideline Section	Final EIS Guideline Requirements Heading	Where Addressed in EIS
	The EIS will provide in detail the hydraulic models that will describe the existing (baseline) hydrological regime and that will be used to predict the potential changes in the hydrological regime as a result of the Project. The EIS will describe the following information for each model used: · Input parameters and assumptions; · Outputs provided by the model; · Basis of the model methodology; and · Purpose for the model.	PE SV 4.2.5, Appendix 4B
	A table of hydraulic models used should be developed and presented in the EIS. This table will have the model name, how the model is used and a description of general purpose.	PE SV 4.2.5, Appendix 4B
	THERMAL AND ICE REGIME	
	The EIS will include a description of the existing water temperature and ice regimes of the Nelson River. Technical study areas for reservoir and river locations will be described	Ice Regime / Technical Study Area: EIS 6.2.3.2.6 Water Temperature: EIS 6.2.3.2.10
	A description of the model, calibration and validation methods and predicted water temperature and ice characteristics in the area of assessment will be provided.	PE SV Appendix 4B PE SV Appendix 9A
	FLUVIAL GEOMORPHOLOGY AND SEDIMENT TRANSPORT	
	The EIS will present information regarding the existing conditions and related changes to fluvial geomorphology and sediment transport in the Nelson River.	EIS 6.2.3.2.8
	Suspended sediment characteristics and transport rates in the Nelson River in the area of assessment.	EIS 6.2.3.2.8
	Bed material characteristics and bedload transport rates in the Nelson River in the area of assessment.	EIS 6.2.3.2.8

Final Guideline Section	Final EIS Guideline Requirements Heading	Where Addressed in EIS
	Historical locations, patterns, and rates of channel erosion and deposition in the area of assessment.	Mineral Sediment Deposition: PE SV 7.3.1.1, 7.3.1.2 Organic Sediment Deposition: PE SV 7.3.1.3, 7.3.1.4 Shoreline Erosion: EIS 6.2.3.2.7
8.2	**Biophysical Environment**	
8.2.1	*Aquatic Environment*	
	WATER QUALITY AND SEDIMENT QUALITY	
	A description of the limnology, including physical and chemical characteristics of the groundwater and surface water quality, with discussion on seasonal variation.	Groundwater Quality: EIS 6.2.3.2.9 Water Quality: EIS 6.2.3.3.2
	Chemical characteristics should include concentrations of water and sediment quality parameters that affect the suitability of the environment for aquatic life.	Water Quality: EIS 6.2.3.3.2 Sediment Quality: AE SV 2.6.4
	A description of the mercury concentrations, mobility and fate within the riparian ecosystem.	EIS 6.2.3.2.5, 6.2.3.4.8
	Identify all sources (surface and groundwater) of drinking water, as well as water used for recreational purposes, within the area of influence of the project.	Groundwater: PE SV 8.0 Water-related infrastructure: SE SV 4.3.3.1. 4.3.3.2 Water and Ice-based Transportation: EIS 6.2.3.5.4 Resource Use: EIS 6.2.3.6

Final Guideline Section	Final EIS Guideline Requirements Heading	Where Addressed in EIS
	The identification of potential human receptors, considering those who may be exposed to contaminants via drinking water sources, and/or recreational waters.	Water and Wastewater Treatment during Project Construction: EIS 4.6.14 Water and Wastewater Treatment during Project Operation: EIS 4.7.9 Water-related infrastructure: SE SV 4.3.3.1. 4.3.3.2 Water and Ice-based Transportation: EIS 6.2.3.5.4 Resource Use: EIS 6.2.3.6
	An indication of baseline levels of naturally-occurring contaminants in drinking water sources (surface and groundwater) in order to access [assess] impact on drinking water.	Groundwater Quality: EIS 6.2.3.2.9 Surface Water Quality: EIS 6.2.3.3.2
	Susceptibility to erosion and sedimentation.	Shoreline Erosion: EIS 6.2.3.2.7 Sedimentation: EIS 6.2.3.2.8

Final Guideline Section	Final EIS Guideline Requirements Heading	Where Addressed in EIS
	The EIS will contain details of methodology, modelling, and analysis used to establish existing sediment load in waterbodies in the area of assessment... Total Suspended Solids (TSS) will be used to describe water quality with respect to sediment.	PE SV 7.2.5.1, 7A.1.1.1, 7B.1.1.3
	The EIS will describe methods/models for describing current levels of sediment deposition within the waterbodies of the study area. A baseline of sediment deposition rates over the area of assessment will be established. Results for sediment loading and sedimentation will be compared to Canadian Sediment Quality Guidelines for the Protection of Aquatic Life (2011) and Manitoba Water Quality Standards, Objectives and Guidelines.	PE SV 7.3.1.1, 7.3.1.2, 7.3.1.3, 7.3.1.4
	The EIS will describe existing water quality conditions in the Nelson and its tributaries in the area of assessment. Water quality parameters recorded during baseline studies (e.g., nutrient and metals concentrations, suspended sediment levels, dissolved gas pressure levels, pH, alkalinity, temperature) will be summarized and compared with provincial and federal guidelines, including: · Manitoba Water Quality Standards, Objectives and Guidelines; and · Canadian Water Quality Guidelines (CCME 2011).	EIS 6.2.3.3.2
	AQUATIC HABITAT	
	Data, models, assessment methods and analysis used to describe baseline conditions for fish will be described in the EIS. Sample design, sampling error and sample bias will be described and considered in the reporting of results. Where samples do not meet a statistically valid sample size the results will be reported as descriptive; aquatic habitat based on water depth, velocity, substratum, and presence of cover.	EIS 6.2.3.3.2 AE SV Appendices 3A, 3B, 3C,3D
	Aquatic habitat classified into categories relevant to use by aquatic biota.	EIS 6.2.3.3.2

Final Guideline Section	Final EIS Guideline Requirements Heading	Where Addressed in EIS
	Quantification of existing habitat, including description of changes due to seasonal and year-to-year variation in water flows.	EIS 6.2.3.3.2
	Description of the biological composition of freshwater aquatic environments, including trophic state and the interactions and relative significance of each trophic level Identified in the food chain.	Algae and Aquatic Plants: EIS 6.2.3.3.3 Aquatic Invertebrates: EIS 6.2.3.3.4 Fish: EIS 6.2.3.3.5
	Characterization of the range of natural variability of populations, including abundance and community composition.	Algae and Aquatic Plants: EIS 6.2.3.3.3 Aquatic Invertebrates: EIS 6.2.3.3.4 Fish: EIS 6.2.3.3.5
	INTACTNESS	
	Fragmentation resulting from human linear features and other human footprints, including dykes and dams throughout the watershed.	Aquatic Habitat: EIS 6.2.3.3.2
	Distribution of linear features by feature type.	Aquatic Habitat: EIS 6.2.3.3.2
	Distribution and abundance of core areas.	Aquatic Habitat: EIS 6.2.3.3.2
	ALGAE AND AQUATIC PLANTS	
	Species composition and biomass of phytoplankton, including seasonal changes and relation to characteristics of the waterbody.	AE SV 4.2.3
	Distribution of attached algae in relation to habitat.	AE SV 4.3.3

Final Guideline Section	Final EIS Guideline Requirements Heading	Where Addressed in EIS
	Species composition and distribution of aquatic macrophytes, in relation to habitat.	AE SV 4.3.3
	Distribution, abundance and habitat associations of invasive aquatic plant species.	EIS 6.2.3.3.3
	AQUATIC INVERTEBRATES	
	Species composition or major taxa and abundance of zooplankton, including seasonal changes and relation to characteristics of the waterbody.	AE SV 4.4.3
	Species composition and abundance of benthic invertebrates, in relation to habitat.	AE SV 4.5.3
	Distribution, abundance and habitat associations of invasive aquatic invertebrate species.	EIS 6.2.3.3.4
	FISH	
	Species composition and relative abundance.	EIS 6.2.3.3.5
	Species of cultural, spiritual, or traditional use importance to Aboriginal peoples and Aboriginal groups.	EIS 6.2.3.3.1, 6.2.3.3.5
	Life history parameters, including spawning and feeding biology.	AE SV Appendices 5A, 6A
	Habitat use	EIS 6.2.3.3.5
	Baseline information on the a) availability of fish habitat, b) use or suitability of fish habitat and c) description of the physical environment associated with observed habitat (at a minimum depth, velocity and substrate).	EIS 6.2.3.3.5
	Where all aquatic habitats cannot be directly assessed the method of extrapolation (modelling) will be described. Extrapolations will be tested for fidelity. Where habitat and their use (suitability) cannot be directly sampled the method of habitat description will be described in detail and extrapolations tested for fidelity. A sensitivity analysis will be conducted on these models to assess strength of the results.	Fish Community: AE SV Appendix 5B

Final Guideline Section	Final EIS Guideline Requirements Heading	Where Addressed in EIS
	Habitat Suitability Indices (HSI) may be used for the description of baseline fish habitat in the Nelson River and its tributaries. The development of Habitat Suitability Indices (HSI) specific to the Nelson River in the area of assessment will be conducted using peer reviewed practices and chosen methods will be described. Modelling of the physical environment and habitat suitability will be described and tested for fidelity.	Lake Sturgeon: AE SV 6.3.2, Appendix 6D
	Aquatic HSI's developed from literature review or professional opinion will be done in consultation with Manitoba Conservation and Water Stewardship and Fisheries and Oceans Canada.	Lake Sturgeon: AE SV 6.3.2, Appendix 6D
	Short-term and long-term patterns of fish movements between and within waterbodies, including spawning migrations and movements over habitat potentially affected by the Project.	EIS 6.2.3.3.5
	Distribution, abundance and habitat associations of invasive aquatic fish species.	EIS 6.2.3.3.5
	MERCURY CONCENTRATIONS AND OTHER CHARACTERISTICS OF FISH QUALITY	
	Mercury levels in key domestic and commercial fish species (e.g., lake sturgeon, walleye, northern pike, and lake whitefish).	EIS 6.2.3.3.6
	Other characteristics of fish quality that affect the commercial sale of fish.	EIS 6.2.3.3.6
	AQUATIC SPECIES OF CONSERVATION CONCERN	

Final Guideline Section	Final EIS Guideline Requirements Heading	Where Addressed in EIS
	The EIS will identify all aquatic species named under the *Species at Risk Act* (SARA) and/or *The Endangered Species Act* (Manitoba), listed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), and identified as S1 and S2 species by the Manitoba Conservation Data Centre. The EIS will include information on composition, distribution, relative abundance, seasonal movements, movement corridors, habitat requirements, key habitat areas, and general life history for the identified species. Identify all species listed on Schedule 1 of SARA and those recognized as "at risk" by COSEWIC that may occur in the project area, and at any project component, using recognized survey protocols to provide current field data.	EIS 6.2.3.3.3, 6.2.3.3.4, 6.2.3.3.5
8.2.2	***Terrestrial Environment***	
	SOIL QUANTITY AND QUALITY	
	Distribution and abundance of soil types classified into soil quality categories.	TE SV 2.9.3.2
	Parameters that affect the suitability of soils to perform ecosystem functions (e.g., primary productivity).	TE SV 2.9.3.2
	Present mercury and methylmercury data and analyses in soil.	EIS 6.2.3.2.5, 6.2.3.4.8
	TERRESTRIAL HABITAT	
	Terrestrial habitat based on vegetation, site conditions, groundwater depth, surface water depth, permafrost, topography and disturbance or instability regime.	EIS 6.2.3.4.2
	Terrestrial habitat classified into upland and wetland categories relevant to use by terrestrial biota.	EIS 6.2.3.4.2
	Quantification of existing habitat, including description of changes due to temporal variations in water levels and flows, historical human impacts, vegetation succession and large fires.	EIS 6.2.3.4.2
	FIRE REGIME	
	Fire history	TE SV 2.5.2, 2.5.3

Final Guideline Section	Final EIS Guideline Requirements Heading	Where Addressed in EIS
	Fire regime parameters relevant for vegetation, wildlife and ecosystem functions.	TE SV 2.3.2, 2.5.1, 2.5.3
	ECOSYSTEM DIVERSITY	
	Distribution and abundance of stand and landscape level ecosystem types.	EIS 6.2.3.4.2
	Distribution, abundance and environmental associations of ecosystem types requiring special consideration such as rare or highly diverse types.	EIS 6.2.3.4.2
	WETLANDS	
	Mapped wetlands in the project area including riparian wetlands and those that may be affected by ancillary features of the project, indicate direction of inflow/outflow, and describe the location, size of wetlands, wetland type, condition, ecological community types, flora and fauna.	EIS 6.2.3.4.2
	Describe the contribution of the wetland to the quantity and quality of surface water and groundwater.	TE SV Appendix 2F (2.19)
	Describe the terrestrial and aquatic habitat functions	EIS 6.2.3.4.2
	Describe the ecological function of the wetland in the surrounding ecosystem and adjacent land use.	EIS 6.2.3.4.2
	Distribution, abundance and environmental associations of peatlands and wetland types making disproportionately high contributions to wetland function such as highly productive types or types that provide high quality habitat for waterfowl or aquatic furbearers.	EIS 6.2.3.4.2
	Parameters that affect wetland functions.	TE SV 2.3.2, 2.8.1.1
	CARBON STORAGE	
	Carbon stored in terrestrial vegetation and soils.	TE SV Appendix 2F (2.19)
	Parameters that affect the ability of vegetation and soils to store carbon.	TE SV 2.3.2
	INTACTNESS	
	Fragmentation resulting from human linear features and other human footprints.	EIS 6.2.3.4.2

Final Guideline Section	Final EIS Guideline Requirements Heading	Where Addressed in EIS
	Distribution of linear features by feature type.	EIS 6.2.3.4.2
	Distribution and abundance of core areas.	EIS 6.2.3.4.2
	TERRESTRIAL PLANTS	
	Species composition, including species of cultural, spiritual, or traditional use importance to Aboriginal peoples and Aboriginal groups, distribution and relative abundance of vascular plants, in relation to habitat.	EIS 6.2.3.4.3
	Species composition distribution and relative abundance of the common ground mosses and lichens, in relation to habitat.	EIS 6.2.3.4.3
	Distribution, abundance and habitat associations of invasive plant species.	EIS 6.2.3.4.3
	TERRESTRIAL INVERTEBRATES	
	The EIS will describe species composition and habitat associations of terrestrial invertebrates (e.g., worms, snails, spiders, insects) in the applicable study area(s).	EIS 6.2.3.4.4
	AMPHIBIANS AND REPTILES	
	· Species composition and distribution of amphibians. · Habitat associations and seasonal use by amphibians. · Species and presence of reptiles (if applicable).	EIS 6.2.3.4.5
	BIRDS	
	Species composition, including species of cultural, spiritual, or traditional use importance to Aboriginal peoples and Aboriginal groups, distribution and relative abundance of songbirds, raptors, upland gamebirds and waterbirds, including migratory birds, in relation to habitat including seasonal changes.	EIS 6.2.3.4.6

Final Guideline Section	Final EIS Guideline Requirements Heading	Where Addressed in EIS
	MAMMALS	
	Species composition, including species of cultural, spiritual, or traditional use importance to Aboriginal peoples and Aboriginal groups, distribution and relative abundance of small mammals, furbearers, large carnivores and ungulates, in relation to habitat including seasonal changes.	EIS 6.2.3.4.7
	A determination of caribou use of the project and surrounding area, movements through or near the project area, and the seasonality of these movements.	EIS 6.2.3.4.7
	MERCURY IN WILDLIFE	
	Mercury levels for key bird species (e.g., Canada goose, mallard); and for key mammal species (e.g., beaver, muskrat, otter and mink).	EIS 6.2.3.4.8 Key bird species: TE SV 8.3.3 Key mammal species: TE SV 8.4.3
	SPECIES OF CONSERVATION CONCERN	
	The EIS will identify all plants and animals named under the SARA and/or *The Endangered Species Act* (Manitoba), listed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), and identified as S1 and S2 species by the Manitoba Conservation Data Centre. The EIS will include information on composition, distribution, relative abundance, seasonal movements, movement corridors, habitat requirements, key habitat areas, and general life history for the identified species. Identify all species listed on Schedule 1 of SARA and those recognized as "at risk" by COSEWIC that may occur in the project area, and at any other project component, using recognized survey protocols to provide current field data.	Terrestrial Plants: EIS 6.2.3.4.3 Terrestrial Invertebrates: EIS 6.2.3.4.4 Amphibians and Reptiles: EIS 6.2.3.4.5 Bird Species at Risk: EIS 6.2.3.4.6 Mammals - Rare or regionally rare species: EIS 6.2.3.4.7

Final Guideline Section	Final EIS Guideline Requirements Heading	Where Addressed in EIS
8.3	*Socio-Economic Environment*	
8.3.1	*Economy*	
	The regional economy, in particular local Aboriginal and non-Aboriginal communities and the regional centre, with an emphasis on the labour force, employment, unemployment, income, and education and training, and with a profile of local business capacity (e.g., goods and services).	Local study area: EIS 6.2.3.5.2 Regional study area: SE SV 3.3.5, 3.3.6
	A profile of key resource use sectors potentially affected by the Project (see Land and Resource Use), with an emphasis on the commercial sectors.	EIS 6.2.3.6
	Cost of living	EIS 6.2.3.5.2
8.3.2	*Population, Infrastructure and Services*	
	Existing population distribution and demographics; including for each of the Aboriginal groups.	EIS 6.2.3.5.3
	Existing infrastructure and services of Aboriginal and other communities, in-vicinity including:	EIS 6.2.3.5.3
	· Housing/accommodation supply;	EIS 6.2.3.5.3
	· Water and sewer infrastructure;	SE SV 4.3.3
	· Education;	EIS 6.2.3.5.3
	· Emergency services;	SE SV 4.3.3
	· Social services; and	EIS 6.2.3.5.3
	· Public health infrastructure and health and social services that may be relied upon during Project construction and operation.	EIS 6.2.3.5.3
8.3.3	*Personal, Family and Community Life*	
	· Public safety · Travel, access and safety · Aesthetics · Health status and health issues · Culture and spirituality; including for each of the Aboriginal groups · Governance, goals and plans	EIS 6.2.3.5.4

Final Guideline Section	Final EIS Guideline Requirements Heading	Where Addressed in EIS
8.3.4	*Land and Resource Use*	
	Land use context (recreation, navigable waters, etc.)	EIS 6.2.3.5.3, 6.2.3.5.4, 6.2.3.6
	Description of lands including:	
	Land acquisition focusing on Crown land requirements and private land acquisition requirements for the Project.	EIS 4.4 EIS 6.2.3.5.3
	Description of Reserve lands and Treaty Land Entitlement.	EIS 6.2.3.5.3 SE SV 4.3.4
	Lands with special designation (proposed and existing), focusing on the following: · Federal and provincial park lands; · Wildlife Management Areas; · Areas of special interest (Manitoba Protected Areas Initiative); · Ecological reserve lands; and · scientific sites.	EIS 6.2.3.6.4
	Based on information provided by Aboriginal groups or, if Aboriginal groups do not provided this information, on available information from other sources, a description of the following:	
	Current and proposed uses of land and resources by each Aboriginal group for traditional purposes, i.e., hunting, fishing, trapping, cultural and other traditional uses of the land (e.g., collection of medicinal plants and uses of sacred sites).	EIS 6.2.3.5.4, 6.2.3.6.2
	Land and water access into the area by Aboriginal people.	EIS 6.2.3.6.2, 6.2.3.5.3, 6.2.3.5.4
	Water and ice routes, modes of transportation, and timing of water/ice route usage.	EIS 6.2.3.6.4, 6.2.3.5.4
	Navigation and navigation safety	EIS 6.2.3.6.2, 6.2.3.5.4

Final Guideline Section	Final EIS Guideline Requirements Heading	Where Addressed in EIS
	Description of commercial resource use and lands including: Commercial use of resources by each Aboriginal group and non-Aboriginal groups, focusing on the following:	
	· Commercial fishing;	EIS 6.2.3.6.3
	· Commercial trapping;	EIS 6.2.3.6.3
	· Resource tourism including lodge and outfitting operations and eco-tourism;	EIS 6.2.3.6.3
	· Navigation and navigation safety;	EIS 6.2.3.5.4
	· Commercial mining activities, leases, licenses and lands; and	EIS 6.2.3.6.3
	· Forestry and forested lands.	EIS 6.2.3.6.3
	Description of recreational resource use including:	
	· Use of lands and waters by non-Aboriginal peoples for the purposes of sports fishing, hunting, recreational cabin uses and associated travel routes and travel safety concerns;	EIS 6.2.3.6.4
	· Navigation and navigation safety; and	EIS 6.2.3.5.4
	· Description of use of potable water for drinking water purposes.	EIS 4.3.2.2 EIS 6.6.5.2
8.3.5	***Heritage Resources***	
	Historical land use and occupancy	EIS 6.2.3.7, 6.2.3.7.1
	Archaeological sites and culturally important sites, focusing on shoreline sites that could potentially be affected by erosion.	EIS 6.2.3.7
	Location of known and potential burial sites (if any).	EIS 6.2.3.7
	Structures, sites or things of historical, archaeological, paleontological or architectural significance that will be affected by the Project.	EIS 6.2.3.7

Final Guideline Section	Final EIS Guideline Requirements Heading	Where Addressed in EIS
8.3.6	*Traditional and Local Knowledge*	
	The proponent must incorporate into the EIS the traditional and local knowledge to which it has access or that it may reasonably be expected to acquire through applying the appropriate due diligence, in keeping with appropriate ethical standards and without breaching obligations of confidentiality, as set out in section 2 of this document.	EIS 1.4 EIS Chapter 2, Appendix 2A EIS 5.2, 5.3 EIS 6.2.2, 6.2.3, 6.3.2, 6.4.2, 6.5.2, 6.6.2, 6.7.2, 6.8.2 EIS 7.2 EIS 8.2.7, 8.3.1, 8.3.4 EIS 9.2.1 EIS Chapter 10 KCNs Environmental Evaluation Reports
9	**ENVIRONMENTAL EFFECTS ASSESSMENT**	
	This section will describe the potential environmental effects of the Project components. The proponent shall identify the Project's likely adverse environmental effects during construction, operation, maintenance, decommissioning and reclamation of sites and facilities associated with the Project, and describe these effects using appropriate criteria.	
9.1	**Assessment Methodology**	
9.1.1	*Precautionary Approach*	
	Describe how implementation of the Project components and activities have been planned in a careful and precautionary manner in order to ensure that significantly adverse or unwarranted environmental effects will not occur, especially with respect to environmental functions and integrity, considering system tolerance and resilience, and/or the human health of current or future generations.	EIS 4.3.3, 4.5.1 EIS Chapter 8 EIS 10.3

Final Guideline Section	Final EIS Guideline Requirements Heading	Where Addressed in EIS
	Outline and justify the assumptions made about the effects of all project components and activities and the approaches to minimize these effects.	EIS 4.3.3 EIS 6.3 through 6.8
	Demonstrate that in designing and operating the Project, priority has been and would be given to strategies that avoid the creation of adverse environmental effects.	EIS 4.5.1 EIS 6.3 through 6.8
	Develop contingency plans that explicitly address accidents and malfunctions of the Project.	EIS 4.7.8, 4.7.8.2
	Identify the proposed follow-up and monitoring activities, particularly in areas where scientific uncertainty exists in the prediction of effects.	EIS Chapter 8
	Present public views on the acceptability of all of the above.	EIS Chapter 2 EIS 3.5, 3.6
9.1.2	*Impact Matrix*	
	An impact matrix methodology in combination with identification of VECs should be used to evaluate the adverse environmental effects of the Project. The assessment should include the following general steps listing the activities and components of the Project; identifying VECs; Identifying the potential interactions between the project activities and components and the environment during all phases of the project. Predicting and evaluating the likely effects on identified valued ecosystem components; Identifying technically and economically feasible mitigation measures for significant adverse environmental effects; Identifying residual environmental effects; Ranking of each residual adverse environmental effect based on established criteria; and Determining the potential significance of residual environmental effect following the implementation of mitigation.	Approach: EIS Chapter 5 Impact Matrix: EIS Appendix 6C Assessment results: EIS 6.3 through 6.8

Final Guideline Section	Final EIS Guideline Requirements Heading	Where Addressed in EIS
	The results of the assessment process should be clearly documented in the text as well as in summary matrices and tables. The analysis must be documented in a manner that readily enables conclusions on the significance of the environmental effects to be drawn.	EIS 6.3, 6.4, 6.5, 6.6, 6.7, 6.8
9.1.3	***Potential Effects on Aboriginal Groups***	
	Potential social and/or economic effects to Aboriginal groups that may arise as a result of the Project.	EIS 6.6, 6.7.3, 6.7.4
	Effects of the Project may have on current use of lands and resource for traditional purposes by Aboriginal peoples, including but not limited to hunting, fishing, navigation, trapping, gathering, cultural and other traditional uses of the land (e.g. collection of medicinal plants, use of sacred sites), as well as related effects on lifestyle, culture and quality of life of Aboriginal groups and measures to avoid, mitigate, compensate or accommodate effects on traditional uses.	EIS 6.6.5.5, 6.6.5.6, 6.6.5.7, 6.7.3
	Effects of alterations to access into the area on Aboriginal groups, including deactivation or reclamation of access roads.	EIS 6.6.4.5, 6.6.5.5, 6.7.3
	Effects of the project on heritage and archaeological resources in the project area that are of importance or concern to Aboriginal groups.	EIS 6.8
	A discussion of any factors that may inhibit or foster the flow of economic and other benefits to Aboriginal communities.	EIS 6.6.3
9.2	**Mitigation Measures**	
	The EIS must consider measures that are technically and economically feasible and that would mitigate any significant adverse environmental effects of the Project.	EIS 4.3.3.2 EIS 6.3 through 6.8
	The proponent shall describe its environmental protection plan and its environmental management system, through which it will deliver the plan.	EIS 4.3.3.3 EIS Chapter 8

Final Guideline Section	Final EIS Guideline Requirements Heading	Where Addressed in EIS
	This section of the EIS describe how potentially adverse environmental effects would be minimized and managed over time.	EIS 6.3 through 6.8 EIS Chapter 8
	As well, the proponent shall describe its commitments, policies and arrangements directed at promoting beneficial or mitigating adverse socioeconomic effects.	EIS 4.3.3.2, 4.6.17, EIS 6.6
	The proponent shall discuss the mechanisms it would use to require its contractors and sub-contractors to comply with these commitments and policies and with auditing and enforcement programs.	EIS 4.7.4 EIS Chapter 8
	This should include monitoring activities that will be undertaken to evaluate the effectiveness of mitigation and the need for management response (adaptive management).	EIS Chapter 8
	The EIS shall provide an analysis of the likely efficacy of the proposed technically and economically feasible mitigation measures, drawing where relevant on experience gained from employing the measures on other similar projects.	EIS 6.3 through 6.8
	The reasons for determining whether the mitigation measure reduces the significance of an adverse environmental effect shall be made explicit.	EIS 6.3 through 6.8

Final Guideline Section	Final EIS Guideline Requirements Heading	Where Addressed in EIS
9.3	**Residual Effects**	
	The EIS shall include a summary of the Project's residual effects, including the temporal and spatial extent of those effects, so that the reader clearly understands the real consequences of the Project, the degree to which adverse environmental effects can be mitigated and which adverse environmental effects cannot be mitigated or compensated.	Text: 6.4.3.1.3, 6.4.3.2.3, 6.4.4.1.3, 6.4.4.2.3, 6.4.5.1.3, 6.4.5.2.3, 6.4.6.1.3, 6.4.6.2.3, 6.4.7.1.3, 6.4.7.2.3, 6.4.7.3.3, 6.5.3.1.5, 6.5.3.2.5, 6.5.3.3.5, 6.5.3.4.5, 6.5.4.2.5, 6.5.5.5, 6.5.6.5, 6.5.7.1.5, 6.5.7.2.5, 6.5.7.3.5, 6.5.7.4.5, 6.5.7.5.5, 6.5.7.6.5, 6.5.8.1.5, 6.5.8.2.5, 6.5.8.3.5, 6.5.8.4.5, 6.5.8.5.5, 6.5.8.6.5, 6.5.8.8.5, 6.5.9.1.5, 6.6.3.1.3, 6.6.3.2.5, 6.6.3.3.5, 6.6.3.4.4, 6.6.3.5.5, 6.6.4.2.5, 6.6.4.3.5, 6.6.4.4.5, 6.6.4.5.5, 6.6.5.1.5, 6.6.5.2.5, 6.6.5.3.5, 6.6.5.4.5, 6.6.5.5.5, 6.6.5.6.5, 6.6.5.7.5, 6.7.3.2.5, 6.7.4.1.5, 6.7.4.2.5, 6.7.4.3.5, 6.7.5.1.5, 6.8.3.3 Summary tables in the following sections: EIS 6.4.8, 6.5.10, 6.6.6.1, 6.6.6.2, 6.6.6.3, 6.7.6, 6.8.4

Final Guideline Section	Final EIS Guideline Requirements Heading	Where Addressed in EIS
9.4	**Determination of the Significance of Residual Effects**	
	The following criteria should be used in determining the significance of residual effects: · Magnitude; · Geographic extent; · Timing, duration and frequency; · Reversibility; · Ecological and social context; · Level of confidence and probability; and · Existence of environmental standards, guidelines or objectives for assessing the impact.	EIS 5.5
	The EIS should contain a section which explains the assumptions, definitions and limits to the criteria mentioned above in order to maintain consistency between the environmental effects.	EIS 5.5
	The proponent will provide a summary of regional, provincial, Aboriginal or national objectives, standards or guidelines that have been used to assist in the evaluation of the significance of the identified adverse environmental effects.	EIS 5.5 EIS Appendix 6B
	For identified significant adverse effects, the proponent shall determine the probability (likelihood) that they will occur. The proponent shall also address the degree of scientific uncertainty related to the data and methods used within the framework of its environmental analysis.	EIS 5.5 EIS 6.4 through 6.8 (Each VEC has concluding paragraph)
	The EIS must clearly explain the method and definitions used to describe the level of the adverse environmental effect (e.g. low, moderate, high) for each of the above categories and how these levels were combined to produce an overall conclusion on the significance of adverse environmental effects.	EIS 5.5
	The EIS will contain a summary of the significance of the residual environmental effects in tabular form.	EIS 6.4.8, 6.5.10, 6.6.6.1, 6.6.6.2, 6.6.6.3, 6.7.6, 6.8.4

Final Guideline Section	Final EIS Guideline Requirements Heading	Where Addressed in EIS
9.5	**Effects of the Environment on the Project**	
	The EIS must predict how local conditions and natural hazards, such as severe and/or extreme weather conditions and external events (e.g., flooding, ice jams, rock slides, landslides, fire, outflow conditions and seismic events) could adversely affect the Project and how this in turn could result in impacts to the environment (e.g., extreme environmental conditions result in malfunctions and accidental events).	EIS 6.9
	The sensitivity of the Project to long-term climate variability and effects must be identified and discussed.	EIS 6.3.12, 6.4.9, 6.5.11, 6.6.7, 6.7.7, 6.8.5, 6.9.1.4
	The EIS must provide details of a number of planning, design and construction strategies intended to minimize the potential adverse environmental effects of the environment on the Project. Potential impacts should be mitigated, as appropriate and/or feasible.	EIS 6.3.13
9.6	**Effects of Potential Accidents and Malfunctions**	
	The proponent must identify a list of, and the probability of potential accidents and malfunctions related to the Project, including an explanation of how those events were identified, potential consequences including the environmental effects, the worst case scenarios and the effects of these scenarios. Examples of events that should be considered include events such as failure of dams and dykes.	EIS 4.7.8
	The geographical and temporal boundaries for the assessment of malfunctions and accidents may be different than those in the scope of factors for each VEC. This analysis must include, at a conceptual level, an identification of the magnitude of an accident and/or malfunction, including the quantity, mechanism, rate, form and characteristics of the contaminants and other materials likely to be released into the environment during the accident and malfunction events.	EIS 4.7.8

Final Guideline Section	Final EIS Guideline Requirements Heading	Where Addressed in EIS
	The EIS must also describe the safeguards that have been established to protect against such occurrences and the contingency and emergency response procedures in place if an accident or malfunction does occur. The EIS must include a list of emergency response plans to be developed and implemented during the life of the project.	EIS 4.6.13, 4.7.8
9.7	**Capacity of Renewable Resources**	
	The EIS must describe the effects of the Project on the capacity of renewable resources to meet the needs of the present and those of the future. The EIS must identify those resources likely to be significantly affected by the Project, and describe how the Project could affect their sustainable use. The EIS must also identify and describe criteria used in considering sustainable use. Sustainable use may be based on ecological considerations such as integrity, productivity, and carrying capacity.	EIS 6.10
9.8	**Cumulative Environmental Effects**	
	Valued environmental components (VECs) specific to the residual adverse environmental effects of the Project shall be identified and described at the outset of the cumulative environmental effects assessment.	EIS Chapter 7
	The proponent shall discuss the data and methodology to be used in the scoping phase of the cumulative environmental effects assessment, including a list of other projects to be considered, a list of the residual adverse environmental effects of the Project to be considered in the assessment, the temporal and spatial boundaries specific to those effects, to ensure that the assessment will meet the needs of the analysis.	EIS Chapter 7
	The proponent shall provide a map showing all past, present and future projects it has considered to be included in the cumulative environmental effects assessment.	EIS Chapter 7, Appendix 7A

Final Guideline Section	Final EIS Guideline Requirements Heading	Where Addressed in EIS
	The EIS must describe the analysis of cumulative effects on identified VECs over the life of the Project, including the incremental contribution of all identified past, current and proposed projects and activities, in addition to that of the Project.	EIS Chapter 7
	The EIS must include different forms of the cumulative environmental effects (e.g. synergistic, additive, induced) and identify impact pathways and trends.	EIS Chapter 7
	Explain the approach and methods used to identify and assess the cumulative adverse environmental effects and provide a record of all assumptions and analysis that support the conclusions, including the level of confidence in the data used in the analysis.	EIS Chapter 7
9.9	**Summary**	
	For all key VECs that were assessed, the EIS should contain a table summarizing the following key information: · concise summary of potential adverse environmental effects; summary of proposed mitigation and compensation measures; · a brief description of potential residual adverse environmental effects; · a brief description of potential cumulative adverse environmental effects; · applicable standards or guidelines; · comments from the public and responses; · comments from Aboriginal groups and individuals and responses; · relationship of the VEC to a identified Aboriginal group's access to lands and resources for traditional purposes; and · a list of proposed commitments, summarizing the timing and responsibility of each of the actions for which a commitment (including special management practices or design features) has been made by the proponent.	EIS 6.4.8, 6.5.10, 6.6.6.1, 6.6.6.2, 6.6.6.3, 6.7.6, 6.8.4, Appendix 6C EIS 3.6 Separate Executive Summary document
10	**ECONOMIC AND SOCIAL BENEFITS OF THE PROJECT**	

Final Guideline Section	Final EIS Guideline Requirements Heading	Where Addressed in EIS
	Information on the predicted economic and social benefits of the Project should be presented including a discussion of any factors that may inhibit or foster the flow of economic and other benefits to Aboriginal communities.	EIS Chapter 2 EIS 6.6 EIS Chapter 9 EIS Chapter 10
11	**BENEFITS TO CANADIANS**	
	For the purpose of the comprehensive study, the proponent will describe how Canadians benefit from the information gathering process undertaken by the proponent as part of the environmental assessment. Factors to be considered may include: · Maximized environmental benefits; · Contribution of the EA to support sustainable development; · Public participation; · Technological innovations; · Increases in scientific knowledge; and Community and social benefits.	EIS Chapters 2, 3, 6, 9, 10
12	**ENVIRONMENTAL MANAGEMENT**	
12.1	**Planning**	
	The EIS shall describe the proposed EMPs for all stages of the Project and include a commitment by the proponent to implement the EMPs should the Project proceed. In accordance with the proposed EMP, monitoring and mitigation plans should be developed, specific to various aspects of the Project and the environment to be incorporated into all project components and activities. These plans would outline how results from monitoring will be used to refine or modify the design and implementation of mitigation measures and management plans.	EIS Chapter 8

Final Guideline Section	Final EIS Guideline Requirements Heading	Where Addressed in EIS
12.1.1	*Decommissioning and Reclamation Plan*	
	The EIS shall provide a preliminary outline of a decommissioning and reclamation plan for any components associated with the Project. This shall include ownership, transfer and control of the different project components as well as the responsibility for monitoring and maintaining the integrity of some of the structures.	EIS 4.6.16, 4.8
12.2	**Follow-Up Program**	
	The EIS shall describe the proposed follow-up program plan in sufficient detail to allow independent judgment as to the likelihood that it will deliver the type, quantity and quality of information required to reliably verify predicted effects (or absence of them), and to confirm both the EA assumptions and the effectiveness of mitigation.	EIS Chapter 8
	The proponent must describe the compliance reporting methods to be used, including reporting frequency, methods and format.	EIS Chapter 8
	Environmental assessment effects predictions, assumptions and mitigation actions that are to be tested in the follow-up monitoring program must be converted into field-testable monitoring objectives.	EIS Chapter 8
	The conceptual-level monitoring design must include a statistical evaluation of the adequacy of existing baseline data to provide a benchmark against which to test for project effects, and the need for any additional pre-construction or pre-operational monitoring to establish a firmer project baseline.	EIS Chapter 8
	The follow-up program shall include, at a conceptual level, a schedule indicating the frequency and duration of effects monitoring. This schedule is to be developed after an evaluation of the length of time needed to detect effects given estimated baseline variability, likely magnitude of environmental effect and desired level of statistical confidence in the results (Type 1 and Type 2 errors).	EIS Chapter 8

Final Guideline Section	Final EIS Guideline Requirements Heading	Where Addressed in EIS
	The description of the follow-up program must include, at a conceptual level, contingency procedures/plans or other adaptive management provisions as a means of addressing unforeseen effects or for correcting exceedances as required to comply or to conform to benchmarks, regulatory standards or guidelines.	EIS Chapter 8
	The EIS must provide the following: · A discussion of the proposed follow-up program and its objectives; · A description of the main components of the program and each monitoring activity under that component; · A discussion of the objectives the monitoring activity is fulfilling (i.e. confirmation of mitigation, confirmation of assumptions; verification of predicted effects); · The structure of the program; · A schedule for the finalization and implementation of the follow-up program; · A description of the roles and responsibilities for the program and its review process, by both peers, Aboriginal groups, and the public; · Possible involvement of independent researchers; · the sources of funding for the program; and · Information management and reporting .	EIS Chapter 8
13	**SUMMARY AND CONCLUSIONS**	
	The EIS must summarize the overall findings of the EA with emphasis on the main environmental issues identified. It should provide a summary on the significance of adverse environmental effects and cumulative environmental effects likely to occur as a result of the implementation of the Project.	EIS Chapter 10 Separate Executive Summary document

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ACRONYMS, ABBREVIATIONS AND UNITS

ACRONYMS AND ABBREVIATIONS

Acronym / Abbreviation	Term
AAC	Annual Allowable Cut
AADT	Average Annual Daily Traffic
AC	Alternating Current
AE SV	Aquatic Environment Supporting Volume
AEA	Adverse effects agreement
AGE	Advisory Group on Employment
AIP	Agreement in Principle
AMEC	An engineering, project management and consulting firm
AMP	Access management plan
AMS	Accelerator Mass Spectrometer
ANFO	Ammonium Nitrate/Fuel Oil
ANOVA	Analysis of variance
AOL	Aski'Otutoskeo Ltd.
ASI	Area of special interest
asl	Above sea level
ATE	Adventure travel and eco-tourism
ATK	Aboriginal traditional knowledge
ATV	all terrain vehicles
BC	British Columbia
BCES	Business Contracting and Economic Strategy Reference Group
BCHCR	Burntwood Community Health Resource Centre
BCMELP	British Columbia Ministry of Environment, Land, and Parks
BCMOE	British Columbia Ministry of the Environment
BFI	Brighter Futures Initiative
BHC	Building Healthy Communities
BNA	Burntwood Nelson Agreement
BOD	Biochemical oxygen demand
BP	Before Present
BRHA	Burntwood Regional Health Authority
CAC	Construction Advisory Committee

Acronym / Abbreviation	Term
$CaCO_3$	Calcium carbonate
CALA	Canadian Association for Laboratory Accreditations, Inc.
CARCNET	Canadian Amphibian and Reptile Conservation Network
CBN	Churchill-Burntwood-Nelson
CCFM	Canadian Council of Forest Ministers
CCME	Canadian Council of Ministers of the Environment
CCREM	Canadian Council of Resource and Environment Ministers
CDA	Canadian Dam Association
CEA	Cumulative effects assessment
CEAA	Canadian Environmental Assessment Agency
CEO	Chief Executive Officer
CETP	Community Employment and Training Program
CFIA	Canadian Food Inspection Agency
CFU	Colony forming units
CHA	Canadian Hydropower Association
CIA	Comprehensive Implementation Agreement
CINE	Centre for Indigenous Peoples' Nutrition and Environment
CISC	Cisco
CI	Confidence limit
CLFN	Cross Lake First Nation
CMHC	Canadian Mortgage and Housing Corporation
CNG	Core Negotiating Group
CNP	Cree Nation Partners
CO	Carbon monoxide
CO_2	Carbon dioxide
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
CPUE	Catch per unit effort
CRCM	Canadian Regional Climate Model
CRD	Churchill River Diversion
CRDAP	Churchill River Diversion Archaeological Project
CWS	Canadian Wildlife Services
d.w.	Dry weight

Acronym / Abbreviation	Term
dBA	Decibels adjusted (noise power)
DBH	Diameter at breast height
Dbs	Depth below surface (note: Heritage Resources)
DC	Direct current
DELT	Deformities, erosion, lesions, and tumours in fish
DFO	Department of Fisheries and Oceans
DIN	Dissolved inorganic nitrogen
DL	Detection limit
DMA-80	Direct mercury analysis (version 80)
DN	Draft note
DNC	Direct negotiated contract
DO	Dissolved oxygen
DOC	Dissolved organic carbon
DP	Dissolved phosphorus
e.g.	example
EA	Environmental assessment
EAPF	Environment Act Proposal Form
EC	Environment Canada
EIA	Environmental impact assessment
EIS	Environmental impact statement
ELARP	Experimental Lakes Area Reservoir Project
EMAN	Ecological Monitoring and Assessment Network
EMP	Ecological monitoring program
EMPA	Excavated Material Placement Areas
EMS	Environmental Management System
ENGO	Environmental non-governmental organizations
EnvPP	Environmental protection plan
EPA	Environmental Protection Agency
EPP	Environmental protection program
ER	Ecological Reserve
ESWG	Environmental Studies Working Group
et al.	and others

Acronym / Abbreviation	Term
ETL	Enviro-Test Laboratories
EUP	Exclusive use permit
FDA&V	Forest Damage Appraisal and Valuation
FEMP	Federal Ecological Monitoring Program
FFMC	Freshwater Fish Marketing Corporation
FL	Fork length
FLCN	Fox Lake Cree Nation
FLRMA	Fox Lake Resource Management Area
FLUDEX	Flooded upland forest experiments
FMU	Forest Management Unit
FNIHB	First Nations and Inuit Health Branch
FP	Fire protection
FRA	Fire regime area
FRC	Forest renewal charge
FRI	Forest resource inventory
FS	Forest Section
FSDA	Federal Sustainable Development Act
FSDS	Federal Sustainable Development Strategy
FSL	Full supply level
GHA	Game Hunting Area
GHG	Greenhouse gases
GIS	Geographic information system
GOT	Generation Outlet Transmission
GPS	Global positioning system
GS	Generating Station
GW	Gigawatt
HBC	Hudson's Bay Company
HFFP	Healthy food fish program
HGD	Harmonized Gillam Development
HHRA	Human health risk assessment
HNTEI	Hydro North Training and Employment Initiative
HRB	Historic Resources Branch

Acronym / Abbreviation	**Term**
HRIA	Heritage resources impact assessment
HRPP	Heritage resources protection plan
HSI	Habitat suitability index
HTFC	Hilderman Thomas Frank Cram
HVDC	High Voltage Direct Current
HZI	Hydraulic Zone of Influence
i.e.	That is
IBA	Important Bird Area
IC	Inorganic carbon
IEZ	Intermittently exposed zone
IHA	International Hydropower Association
IMAC	Interim maximum acceptable concentration
INAC	Indian and Northern Affairs Canada
IPCC	Intergovernmental Panel on Climate Change
ISD	In-service date
ISO	International Organization for Standardization
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),.
KERC	Keeyask External Relations Committee Reference Group
KETA	Keeyask Employment and Training Agency Reference Group
KHLP	Keeyask Hydropower Limited Partnership
KIP	Keeyask Infrastructure Project
KIP EA	Keeyask Infrastructure Project Environmental Assessment
KIRC	Keeyask Internal Relations Committee Reference Group
KPI	Key person interview
KTC	Keewatin Tribal Council
LC50	Concentration at which 50% mortality of a test organism occurs
LCA	Life-Cycle Assessment
LECO	not an acronym – provider of environmental analytic equipment
LEL	Lowest effect level
LFH	Litter, fibric, humic

Acronym / Abbreviation	Term
LGD	Local Government District
LK	Local knowledge
LNR	Lower Nelson River
LUC	Land use categories
LWCNRSB	Lake Winnipeg, Churchill and Nelson Rivers Study Board
LWR	Lake Winnipeg Regulation
MAC	Maximum acceptable concentration
MAI	Mean annual increment
MB	Manitoba
MBCDC	Manitoba Conservation Data Centre
MBESA	Manitoba Endangered Species Act
MCWS	Manitoba Conservation and Water Stewardship
MDMNR	Manitoba Department of Mines and Natural Resources
MEMP	Manitoba Ecological Monitoring Program
MESA	Manitoba Endangered Species Act
MH	Manitoba Hydro
MIT	Manitoba Infrastructure and Transportation
MKO	Manitoba Keewatinowi Okimakanak
MMF	Manitoba Metis Federation
MMMR	Canada-Manitoba Agreement on the Study and Monitoring of Mercury in the Churchill River Diversion
MNS	Manitoba Naturalists Society
MOL	Minimum operating level
MOU	Memorandum of Understanding
MPMO	Major Projects Management Office
MTS	Manitoba Telecom Services
MVA	Megavolt amperes
MW	Megawatt
MWG	Mammals Working Group
MWQSOG	Manitoba Water Quality Standards, Objectives, and Guidelines
MWS	Manitoba Conservation and Water Stewardship
n.d.	No date
N/A	Not available/applicable

Acronym / Abbreviation	Term
NCC	Nature Conservatory of Canada
NCFN	Nisichawayasihk Cree First Nation
NCIS	National Contaminants Information System
NCN	Nisichawayasihk Cree Nation
NCS	Northern Collector System
NFA	Northern Flood Agreement
NFFA	Northern Fishermen's Freight Assistance
NHC	Northwest Hydraulic Consultants Inc.
NLHS	Northern Lights Heritage Foundation
NNADAP	National Native Alcohol and Drug Abuse Program
NPRI	National Pollutant Release Inventory
NRSB	Nelson River Sturgeon Co-Management Board
NRSSA	Nelson River Sturgeon Stewardship Agreement
NSC	North/South Consultants Inc.
NTU	Nephelometric turbidity units
NWPA	Navigable Waters Protection Act
NWT	Northwest Territories
OC	Organic carbon
ON	Organic nitrogen
OWL	Overview of Water and Land
PAL	Protection of Aquatic Life
PD	Project Description
PD SV	Project Description Supporting Volume
PE SV	Physical Environment Supporting Volume
PEL	Probable effect level
PEMP	Physical Environment Monitoring Program
PF	Percent flooded
PIP	Public Involvement Program
PI SV	Public Involvement Supporting Volume
PM	Particulate matter
PPER	Post-Project Environmental Review
ppm	Parts per million

Acronym / Abbreviation	Term
PPT	Pre-Project Training
PR	Provincial Road
PRLC	Partners Regulatory and Licensing Committee
PRSD	Percent relative standard deviation
PTH	Provincial Truck Highway
PWZ	Predominantly wetted zone
PY	Person years
PYLL	Potential years of life lost
RCM	Regional Climate Model
RCMP	Royal Canadian Mounted Police
RI	Rate of infestation
RMA	Resource Management Area
RNFB	Revised Northern Food Basket
ROW	Right-of-way
RRCS	Renewable Resources Consulting Services Ltd.
RTL	Registered Trapline
SARA	Species at Risk Act
SD	Standard deviation
SE	Standard error
SE SV	Socio-Economic Environment, Resource Use and Heritage Resources Supporting Volume
SEIA	Socio-Economic Impact Assessment
SEL	Severe effect level
SEMP	Socio-Economic Monitoring Program
SIL	Southern Indian Lake
SLCPPER	Split Lake Cree Post Project Environmental Review
SLRMA	Spilt Lake Resource Management Area
SLRMB	Split Lake Resource Management Board
SOD	Sediment oxygen demand
sp(p).	Species
SQG	Sediment quality guideline
SRES	Special Report Emissions Scenarios
SS	Switching Station

Acronym / Abbreviation	Term
SSVT	Stand stock volume table
SV	Supporting volume
TBD	To be determined
TC	Tendered contract
TCN	Tataskweyak Cree Nation
TCU	True colour units
TDN	Total dissolved nitrogen
TDS	Total dissolved solids
TE SV	Terrestrial Environment Supporting Volume
TEMA	Tataskweyak Environmental Monitoring Agency
TGH	Thompson General Hospital
TIC	Total inorganic carbon
TK	Traditional knowledge
TKN	Total Kjeldahl nitrogen
TLE	Treaty Lands Entitlement
TN	Total nitrogen
TOC	Total organic carbon
TP	Total phosphorus
TRG	Tissue residue guideline
TSS	Total suspended solids
UCN	University College of the North
UMA	Underwood McLellan and Associates Ltd.
UNESCO	United Nations Educational, Scientific and Cultural Organization
USD	United States dollar
USDA	United Sates Department of Agriculture
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
UV	Ultraviolet
UVA/UVB	Ultraviolet light (type A and B)
VEC	Valued Environmental Component
WHO	World Health Organization
WKTC	Wuskwatim Keeyask Training Consortium

Acronym / Abbreviation	Term
WLFN	War Lake First Nation
WMA	Wildlife Management Area
WMP	Waterways Management Plan
WQG	Water quality guidelines
WRCS	Wildlife Resource Consulting Services
WUA	Weighted usable area
ya	Years ago
YFFN	York Factory First Nation
YFRMA	York Factory Resource Management Area
YOY	Young-of-the-year

UNITS

Abbreviation	Unit
Btu	British thermal unit
cm	centimetre
CFU/mL	coliform forming units per millilitre
cm^3	cubic centimetre
km^3	cubic kilometre
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
fish/h	fish per hour
fish/m/h	fish per metre per hour
fish/s	fish per second
fc	footcandle
GHz	gigahertz
GJ	gigajoule
GW	gigawatt
GWh	gigawatt-hours
g	gram
g/L	grams per litre
g/m^2	grams per square metre
g/t	grams per tonne
> (use only in tables)	greater than
≥	greater than or equal to
ha	hectare (10,000 m^2)
Hz	hertz
h (not hr)	hour
h/d	hours per day
h/wk	hours per week
h/y	hours per year
"	inch
individuals/m^3	individuals per cubic metre
individuals/L	individuals per litre

Abbreviation	Unit
individuals/m^2	individuals per square metre
J	joule
kg	kilogram
kg/m^3	kilograms per cubic metre
kg/h	kilograms per hour
kg/m^2	kilograms per square metre
kJ	kilojoule
km	kilometre
km/h	kilometres per hour
kPa	kilopascal
kV	kilovolt
kW	kilowatt
kWh	kilowatt-hour
< (use only in tables)	less than
≤	less than or equal to
L	litre
L/m	litres per minute
MW	megawatt
MWh	megawatt-hour
m	metre
m/min	metres per minute
m/s	metres per second
t	metric ton (tonne)
µg/g	micrograms per gram
µg/L	micrograms per litre
µm	micrometre
µS/cm	microSiemens per centimetre
mg	milligram
mg/m^3	milligrams per cubic metre
mg/L	milligrams per litre
mL	millilitre
mm	millimetre
M	million
mo	month
ng/L	nanograms per litre
oocyte/L	oocyte per litre
ppb	parts per billion

Abbreviation	Unit
ppm	parts per million
%	percent
plants/m^2	plants per square metre
s	second (time)
cm^2	square centimetre
km^2	square kilometre
m^2	square metre
TWh	terawatt hours
wk	week
yr	year

CHAPTER 1

INTRODUCTION

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1.0 INTRODUCTION

1.1 OVERVIEW: THE PROJECT AND THE PARTNERSHIP

The Keeyask Generation Project (the Project) involves development of a 695 megawatt (MW) hydroelectric generating station and associated facilities at Gull (Keeyask) Rapids on the lower Nelson River, immediately upstream of Stephens Lake in northern Manitoba and between dams developed on the Nelson River from the late 1950s to the early 1970s (see Map 1-1).

By road, the nearest community west of the Project is Split Lake, home of the Tataskweyak Cree Nation, and the nearest community to the east is Gillam, home of a Fox Lake Cree Nation reserve and centre of Manitoba Hydro's northern operations. The Nelson River and the surrounding environment have been greatly altered over the past 50 years by the development of the Lake Winnipeg Regulation Project, the Churchill River Diversion Project and five generating stations. These alterations have replaced large rapids with dams, changed stretches of the river into reservoirs, augmented flows into the river by 30% and reversed the seasonal flow pattern such that higher flows now occur in winter and lower flows in spring and summer.

The energy produced by the Project will be sold to Manitoba Hydro and integrated into its electric system for use in Manitoba and for export. The Project's average annual production of electricity will be approximately 4,400 gigawatt-hours (GWh), enough to power approximately 400,000 homes.

Subject to regulatory approval, construction will begin in 2014. First power will be produced in 2019 and construction completed in 2022. From start to finish, construction will take approximately eight and a half years.

The Keeyask Hydropower Limited Partnership (the Partnership) will own and operate the Project. The Partnership was incorporated under the laws of the Province of Manitoba in 2009. The *Joint Keeyask Development Agreement* (JKDA) signed by the four KCNs and Manitoba Hydro in May of 2009 is the legal framework defining the Partnership, its responsibilities and obligations. The structure of the Partnership arrangement is illustrated in Figure 1-1.

The Partnership is comprised of four limited partners and one general partner.

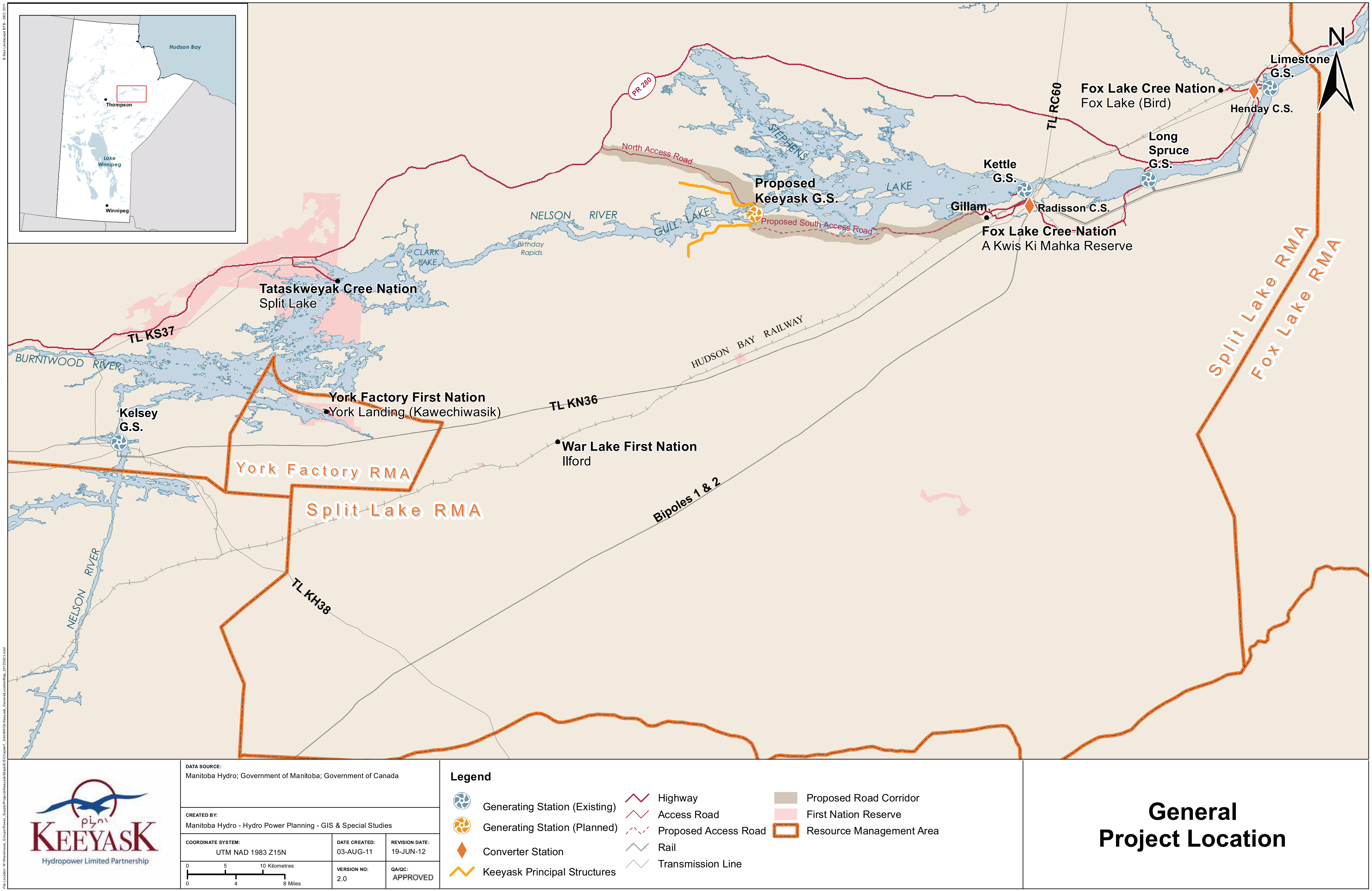
The four limited partners are Manitoba Hydro and three Keeyask Cree Nations (KCNs) investment entities: Cree Nation Partners Limited Partnership, York Factory First Nation Limited Partnership, and FLCN Keeyask Investments Inc. The Cree Nation Partners Limited Partnership is controlled by Tataskweyak Cree Nation (TCN) and War Lake First Nation (WLFN).

The York Factory First Nation Limited Partnership is controlled by York Factory First Nation (YFFN). FLCN Keeyask Investments Inc. is controlled by Fox Lake Cree Nation (FLCN).

The general partner is 5900345 Manitoba LTD., a corporation wholly owned by Manitoba Hydro. The general partner is responsible for the management and operation of the business of the Partnership, and is also liable for all of the debts of the Partnership. The general partner will contract all the planning, construction and operation to Manitoba Hydro, and will contract with Manitoba Hydro to provide all the debt financing required to construct the Project. Manitoba Hydro will subcontract virtually all of the services and supplies required to build the Project to other contractors. A number of contracts for construction work, services, labour, and materials will first be offered to the KCNs or businesses controlled by them. Once the Project is built, the general partner will contract with Manitoba Hydro to provide the necessary services to manage and operate the Project.

Manitoba Hydro, the general partner and each of the KCNs investment entities will invest in the Partnership. Manitoba Hydro and the general partner will own at least 75% of the Partnership and the KCNs, through their respective KCNs investment entities, collectively have the right to own up to 25% of the Partnership. The Partnership will own the Project.

The affairs of the general partner are subject to the direction of its board of directors. The board will include three persons nominated by CNP (two from TCN and one from WLFN) and one person nominated by each of YFFN and 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.


Hudson Bay
Thompson
Lake Winnipeg
Winnipeg
PR 280
North Access Road
STEPHENS
LAKE
Proposed Keeyask G.S.
Proposed South Access Road
NELSON RIVER
GULL LAKE
Birthday Rapids
CLARK LAKE
Tataskweyak Cree Nation
Split Lake
TL KS37
BURNTWOOD RIVER
York Factory First Nation
York Landing (Kawechiwasik)
Kelsey G.S.
York Factory RMA
Split Lake RMA
TL KN36
HUDSON BAY RAILWAY
War Lake First Nation
Ilford
Bipoles 1 & 2
TL KH38
NELSON RIVER
Kettle G.S.
Gillam
Radisson C.S.
Fox Lake Cree Nation
A Kwis Ki Mahka Reserve
TL RC60
Long Spruce G.S.
Fox Lake Cree Nation
Fox Lake (Bird)
Limestone G.S.
Henday C.S.
N
Split Lake RMA
Fox Lake RMA
KEEYASK
Hydropower Limited Partnership
DATA SOURCE:
Manitoba Hydro; Government of Manitoba; Government of Canada
CREATED BY:
Manitoba Hydro - Hydro Power Planning - GIS & Special Studies
COORDINATE SYSTEM:
UTM NAD 1983 Z15N
DATE CREATED:
03-AUG-11
REVISION DATE:
19-JUN-12
VERSION NO:
2.0
QA/QC:
APPROVED
0 5 10 Kilometres
0 4 8 Miles
Legend
Generating Station (Existing)
Generating Station (Planned)
Converter Station
Keeyask Principal Structures
Highway
Access Road
Proposed Access Road
Rail
Transmission Line
Proposed Road Corridor
First Nation Reserve
Resource Management Area
General Project Location

Map 1-1

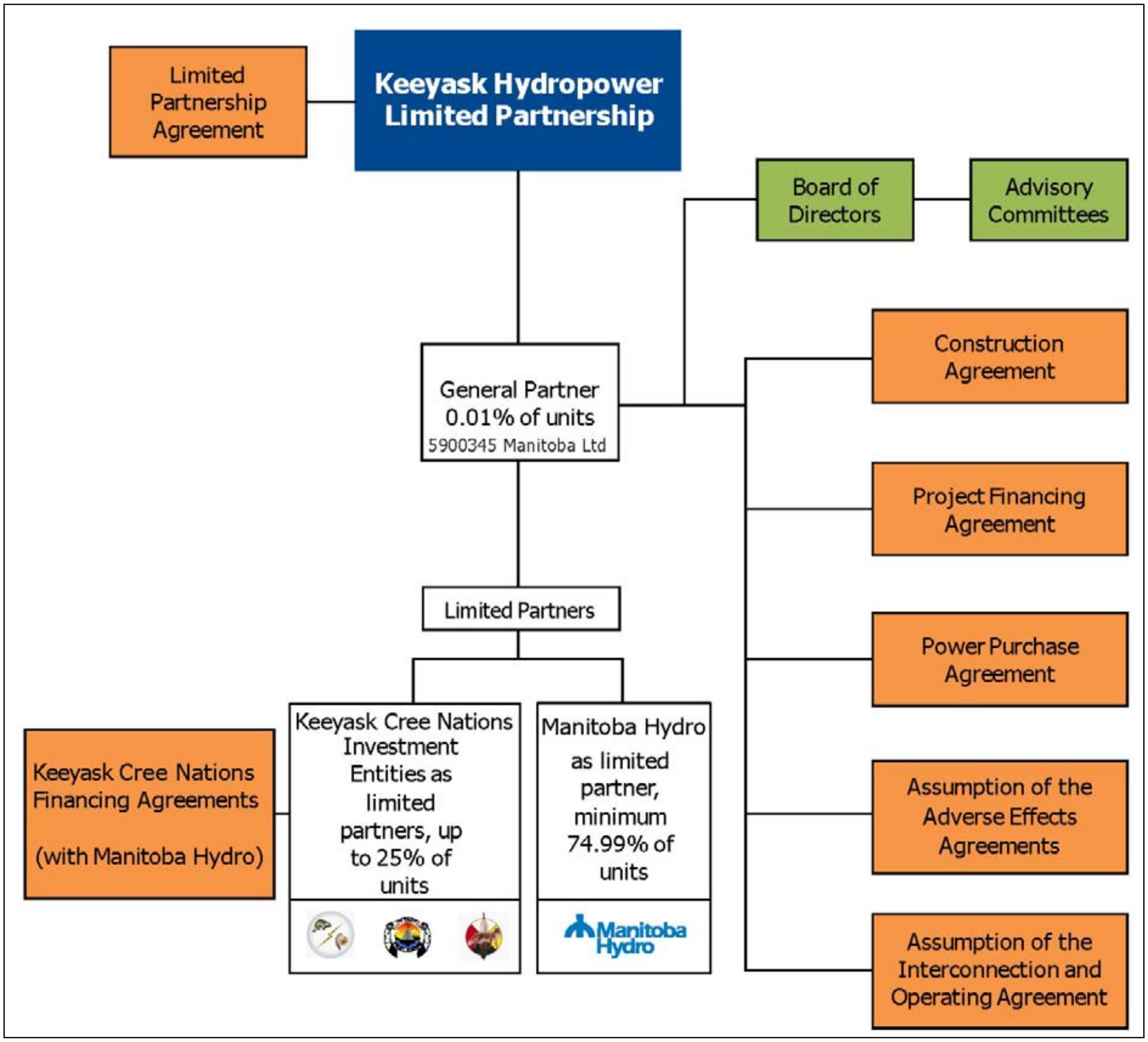


Figure 1-1: Organization Structure of the Keeyask Hydropower Limited Partnership

Manitoba Hydro has also agreed with TCN to construct the Project in accordance with certain fundamental construction features and, similarly, it has agreed with TCN and YFFN to operate the Project in accordance with certain fundamental operating features (see Section 4.1).

The JKDA also includes an Environmental and Regulatory Protocol, setting out roles and responsibilities for the Partnership's environmental assessment. This protocol built upon a similar structure that had been developed and modified since the early years when Keeyask environmental studies began. While Manitoba Hydro is given primary responsibility for many activities, the KCNs have active roles in the assessment. Manitoba Hydro and CNP have the authority to review and approve elements of the assessment and EIS, and YFFN and FLCN to review and comment (see Section 2.3).

A team that includes KCNs Members and their advisors, Manitoba Hydro personnel and various consulting firms has conducted the environmental assessment and participated in drafting and review of the EIS —the list of Key Personnel is provided at the start of this document. Appendix 1A provides a broader list of people that are acknowledged as contributing to the assessment and the EIS.

1.1.1 PROPONENT CONTACT INFORMATION

Contact information for the Keeyask Hydropower Limited Partnership is as follows:

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1.2 SCOPE OF THE PROJECT

The Project will consist of principal structures and supporting infrastructure Figure 1-2 illustrates the principal structures.

The principal structures consist of a powerhouse complex, spillway, dams and dykes, as well as a reservoir. The powerhouse, including a control building and service bay, will house the equipment required to produce electricity. The spillway will manage surplus water flows, and the dams and dykes will contain the reservoir created upstream of the principal structures.

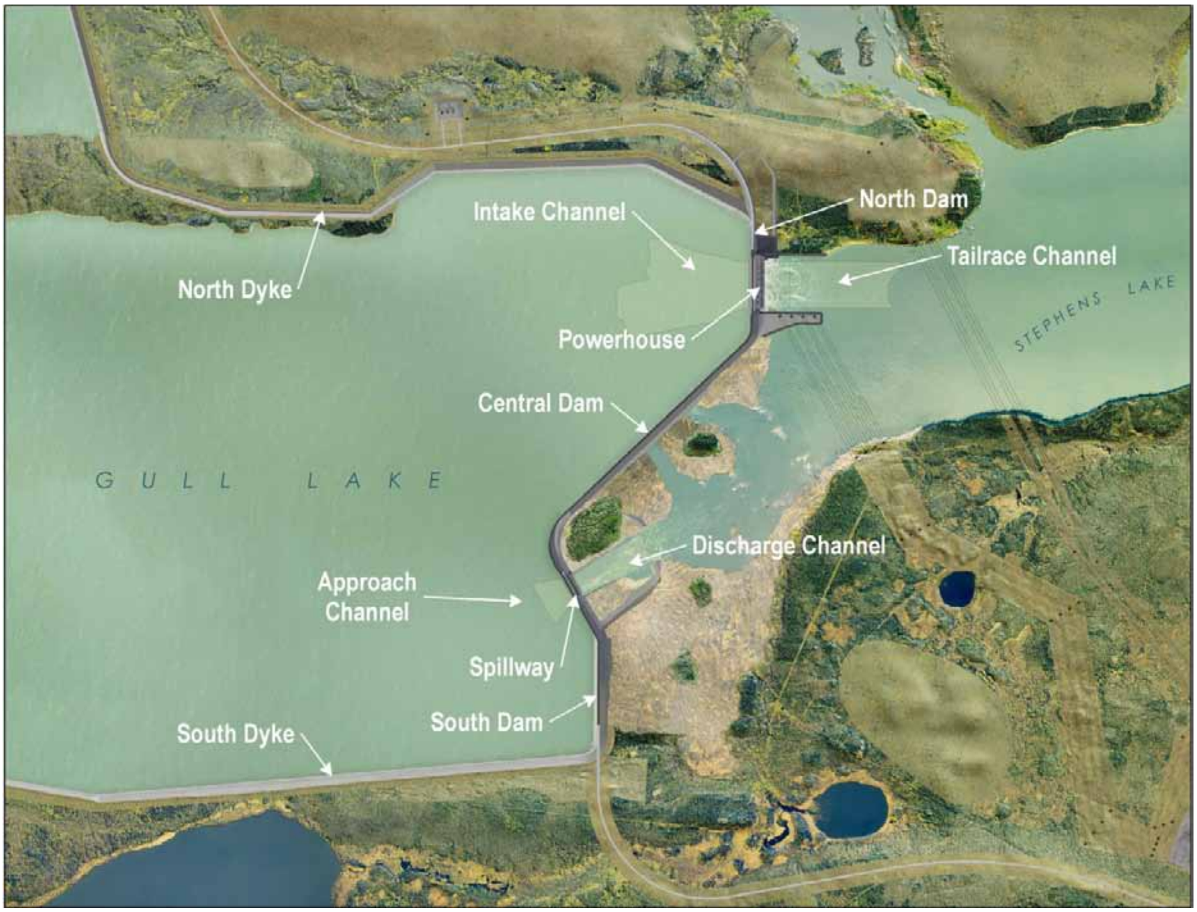

Figure 1-2: Principal Structures

Supporting infrastructure will consist of permanent facilities that will be used to construct and/or operate the Project and temporary facilities required only to construct the principal structures. Permanent infrastructure includes a north and south access road to connect to the provincial highway system; some of the cofferdams; a tower spur; rock groins; communication tower; boat launches and a portage; and some of the borrow areas, including the roads to these areas. Temporary infrastructure includes the main camp and work areas (including landfill, water and sewage treatment facilities); explosives magazine; some of the cofferdams; ice boom; some of the borrow areas, including roads to these areas; and placement areas for excess excavated materials. Some borrow areas will be required for construction and operation; others will be decommissioned and rehabilitated after the Project is constructed. The Project also includes the operation and decommissioning of certain facilities (*e.g.*, camp facilities and a security gatehouse) constructed as part of the Keeyask Infrastructure Project (KIP).

The Project will use approximately 18 m of the 27 m of hydraulic head available between Split Lake and Stephens Lake. About 12 m of this drop in elevation occurs through Gull Rapids. The Project will be operated with a maximum reservoir level (*i.e.*, full supply level) in the immediate forebay of 159 m (521.7 ft) above sea level and a minimum operating level (MOL) of 158 m (518.4 ft) above sea level.

The Project includes activities for the construction and operation of the permanent facilities (the term "operation" also includes maintenance); construction, operation and decommissioning of the temporary facilities (*i.e.*, those required only to construct the Project); operation and decommissioning of the camp and work areas previously licensed and constructed as part of KIP; and operation of the north access road, also licensed and constructed as part of KIP. Chapter 4 provides information on the Project Description.

1.3 REGULATORY FRAMEWORK

This Environmental Impact Statement (EIS) is submitted by the Partnership, and was prepared in accordance with the EIS Guidelines issued in response to an application for environmental approvals.

The Project is subject to an environmental assessment under the *Canadian Environmental Assessment Act* and *The Environment Act* (Manitoba). Before the Project can be built, both federal and provincial regulatory requirements must be met.

The Project is a "project" as defined in the *Canadian Environmental Assessment Act*. The environmental assessment is required due to two triggers under the Law List Regulations; namely, the *Fisheries Act* (Section 32 and 35[2]) and the *Navigable Waters Protection Act* (Section 5). As a hydroelectric generating station with a production capacity of 200 MW or more, it is identified in the Comprehensive Study List Regulations of the *Canadian Environmental Assessment Act*. As this Project will be assessed as a comprehensive study, the Canadian Environmental Assessment Agency will exercise the powers and perform the duties and functions of the responsible authorities during the assessment process until the comprehensive study report is submitted to the Minister of Environment. At the time of writing, following the Minister of Environment's decision, Fisheries and Oceans Canada and Transport Canada will assume their roles as responsible authorities in relation to the Project.

The Project is a "development" as defined in *The Environment Act* (Manitoba). As an electrical generating facility with a generating capacity greater than 100 MW, the Project is designated as a Class 3 development in the Classes of Development Regulations pursuant to that act. The Minister of Conservation and Water Stewardship will require the Partnership to prepare an assessment report and will have the Clean Environment Commission conduct public hearings. The Minister will decide whether to issue a licence for the Project.

As expressed in the Canada-Manitoba Agreement on Environmental Assessment Cooperation (2007), Canada and Manitoba have agreed to carry out a cooperative environmental assessment that will generate the type and quality of information and conclusions on environmental effects required by both orders of government.

Appendix 1B includes a list of licences required for the Project.

1.4 ABORIGINAL TRADITIONAL KNOWLEDGE, LOCAL KNOWLEDGE AND TECHNICAL SOURCES

The Partners agreed early on that there should be two different processes leading to the approval of the Project: the Keeyask Cree Nations process and the government process.

The KCNs process has been underway for more than a decade with the support of Manitoba Hydro. The process assisted the KCNs to understand the Project and its impacts on their communities and Members and to determine the conditions under which they would support the Project. The Project was evaluated in terms of their own worldview, values and experience with past hydroelectric development. Each of the communities led their own consultations with their respective Members resulting in decisions to sign the Joint Keeyask Development Agreement (JKDA) and their respective Adverse Effects Agreements (AEAs). Each of the KCNs defined and presented their own evaluations of the Project based on their worldview of the environmental effects on their communities; and each of the KCNs has made an independent decision to support the Project. The Cree Nation Partners (CNP) has provided its Keyask Environmental Evaluation Report to describe Members' understanding of the expected impacts of the Project on themselves and to explain their independent decisions to be Project proponents. YFFN has provided their evaluation report, Kipekiskwaywinan: Our Voices. FLCN's Environment Evaluation Report is currently in draft form and will be submitted by the Partnership when finalized. These reports contribute substantially to Chapter 2.

A video, *Keeyask: Our Story*, presents the KCNs history and perspectives related to hydroelectric development. Presented through the prism of their holistic Cree worldview, it explains the journey the KCNs travelled in evaluating their concerns about the Project, the nature of their participation as Partners, and the decisions they ultimately made.

The government processes are different from the KCNs process in terms of scope, methods, values and concepts. Consistent with provisions of the *Canadian Environmental Assessment Act* and *The Environment Act* (Manitoba), the KCNs and Manitoba Hydro have agreed that the planning and environmental assessment of the Project under the government legislation will provide that, in addition to local knowledge and knowledge derived from technical science, Aboriginal traditional knowledge (ATK) will be considered to contribute to a better understanding of the specific impacts of the Project. Accordingly, this document uses the following sources of information: ATK, community or local knowledge (including information from the Public Involvement Program – Chapter 3), and knowledge derived from technical sources (*e.g.*, engineering and scientific studies and analysis undertaken by the Partnership, articles and peer-reviewed journals, and government databases).

While the KCNs have led their own evaluation of the effects of the Project on their communities and Members, they have also collaborated in the preparation of this EIS. In particular, ATK gathered by the KCNs in the development of their evaluation on their own communities and Members, as explained in their respective Environmental Evaluation Reports, is also considered in this document.

Indeed, ATK and technical science are used throughout this EIS, from identifying issues to assessing effects and mitigation. Both were, and will continue to be, used by the Partnership to improve the Project (*e.g.*, reservoir clearing, safe trails program, choice of low head design). As a result of the ongoing participation of the KCNs in the Project planning, assessment and regulatory review, ATK, local knowledge and technical science underpin the planning and development of the Project.

Appendix 6A of the EIS provides a list of studies undertaken by the Partners and relied upon for the information provided in the environmental assessment. The references section provides citations for other relevant studies used in the assessment.

1.5 STRUCTURE OF THE RESPONSE TO THE EIS GUIDELINES DOCUMENT

This Response to EIS Guidelines document presents the information required to meet the requirements of the EIS Guidelines. The Response to EIS Guidelines includes the following chapters:

- Chapter 1: Introduction;
- Chapter 2: Partners' Context, Worldviews and Evaluation Process;
- Chapter 3: Public Involvement;

- Chapter 4: Project Description;
- Chapter 5: Regulatory Environmental Assessment Approach;
- Chapter 6: Environmental Effects Assessment;
- Chapter 7: Cumulative Effects Assessment;
- Chapter 8: Monitoring and Follow-Up;
- Chapter 9: Sustainable Development;
- Chapter 10: Conclusions;
- References;
- Glossary; and
- Map and Figure Folio.

APPENDIX 1A

ACKNOWLEDGEMENTS

ACKNOWLEDGEMENTS

The Keeyask Hydropower Limited Partnership wish to acknowledge, with gratitude, the co-operation and assistance received from many sources in the course of conducting the environmental assessment and preparing the environmental impact statement (EIS).

The Keeyask Cree Nations Members involved in the preparation and review of the EIS, along with the technical staff from Manitoba Hydro and the Environmental Assessment Study Team involved in the preparation of the EIS are listed below:

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War Lake First Nation Chiefs and Councils
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Waters Edge Consulting
Campbell Marr LLP
Roger Tassé O.C. Q.C.

YORK FACTORY FIRST NATION

YFFN Members, Elders, Youth, Resource Harvesters and Users, Chief and Council (past and present), York Factory Future Development, Hilderman Thomas Frank Cram and Brad Regehr (D'Arcy and Deacon)

FOX LAKE CREE NATION

Fox Lake community members, Fox Lake Kitayatisuk & Harvester Core Group, Fox Lake Chief and Council, Fox Lake Negotiations office and staff, advisors: Terry Dick (University of Manitoba & Arctic Fish Inc.); Brian Kotak (Miette Enterprises), Grant Wiseman (Wiseman Geomatics), Vince Crichton (V. Crichton Enterprises Ltd.), Kevin Brownlee

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J.D. MOLLARD AND ASSOCIATES (2010) LIMITED

Lynden Penner, Jason Cosford, and Troy Zimmer

APPENDIX 1B

KEEYASK GENERATION PROJECT REGULATORY LICENCES

Keeyask Hydropower Limited Partnership

Keeyask Generation Project Regulatory Licences

Applicable Legislation, Approval Required, Regulation	Activities
FEDERAL	
DFO Operational Statements	Ice bridges, high pressure directional drilling, beaver dam removal, etc.
Canadian Environmental Assessment Act	Town Centre Complex Project
Navigable Waters Protection Act	All in water structures affecting navigation, including GS, cofferdams, dykes causeways, culverts, boat/barge launches, groins, fish habitat compensation works, ice booms, etc.
Fisheries Act (Authorizations)	All in-water structures, including GS, cofferdams, dykes, causeways, culverts, boat/barge launches, groins, etc. Also blasting.
Notification of use of explosives (Federal: Nav Canada - NOTAM)	Blasting
PROVINCIAL	
Environment Act (Environment Act Licence)	Project including all water and wastewater treatment plants
Environment Act (Collection and Disposal of Waste Regulation)	Solid waste disposal
Crown Lands Act (Work permit)	Generation Station site and borrow areas
Dangerous Goods Handling and Transportation Act (Storage and Handling of Gasoline and Associated Products Regulation)	Petroleum storage
Fire Prevention and Emergency Response Act (Occupancy permit for Road Camp)	South access road camp
Forest Act (Permit to cut timber on Crown Lands)	Reservoir clearing, clearing access trails, etc.
The Heritage Resources Act (Heritage resources permit if heritage resources found)	Project

Keeyask Generation Project Regulatory Licences

Applicable Legislation, Approval Required, Regulation	Activities
Highways Protection Act (Permit to connect to highway)	South Access Road construction
Mines and Minerals Act	Quarry use
Public Health Act (Food handling Permit)	All food handling establishments in camps
Environment Act (Onsite Wastewater Management Systems Regulation) (Water and Wastewater Facility Operators Regulation)	Wastewater storage in work areas not connected to the camp, Water and wastewater treatment plants
The Water Rights Act (Water Rights Licence)	Concrete production and other water withdrawal
Water Power Act	Project
Wildfires Act (Work Permit and Burn permit)	Clearing, burning

CHAPTER 2

PARTNERS' CONTEXT, WORLDVIEWS AND EVALUATION PROCESS

CHAPTER 2
TABLE OF CONTENTS

APPENDICES

2.0 PARTNERS' CONTEXT, WORLDVIEWS AND EVALUATION PROCESS

2.1 INTRODUCTION

This chapter presents the context within which the Keeyask Hydropower Limited Partnership (the Partnership) approached and developed the principles and processes that have guided the preparation of this environmental impact statement (EIS).

The Partners agreed early on that there would be a Keeyask Cree Nations evaluation process as well as a government regulatory environmental assessment process. This chapter focuses on the central elements of the Keeyask Cree Nations' (KCNs) worldview and the fundamental values integral to that worldview. This includes the critical importance and function of Aboriginal traditional knowledge (ATK) throughout the multi-faceted process of KCNs engagement in the Keeyask Generation Project (the Project).

Much of the text in this chapter has been prepared by the KCNs, beginning with Section 2.2, which explains their worldview. Section 2.3 provides a chronology of agreements between each Cree Nation and Manitoba Hydro (and, at times, Canada and Manitoba), beginning with those that compensated for damages caused by past hydro projects, and then the Joint Keeyask Development Agreement (JKDA), which marks a new era of collaboration and cooperation before a major new project is undertaken. Sections 2.4, 2.5 and 2.6 are then devoted to the Cree Nation Partners (Tataskweyak Cree Nation and War Lake First Nation working together as the CNP), York Factory First Nation (YFFN) and Fox Lake Cree Nation (FLCN), who each share their goals and objectives, experiences and perspectives about their participation in the Project. This analysis includes a description of the extensive and comprehensive community consultation processes undertaken by KCNs communities respecting their engagement in the Project planning over many years.

After intensive community consultation, each First Nation approved the JKDA and their community-specific adverse effects agreements (AEAs), and their respective Chiefs and Councils subsequently signed the JKDA and AEAs with Manitoba Hydro in 2009. The JKDA and AEAs provide the legally binding framework for the relationship between the KCNs and Manitoba Hydro in the planning, construction, future operations and monitoring of the Project. While the EIS considers the manner in which these agreements influence the design criteria, adverse effects programs, and hiring preferences of the Project, the agreements per se are not within the scope of the Project for which regulatory approval is being sought and are not subject to review in the environmental impact assessment.

CNP, YFFN, and FLCN, with Manitoba Hydro's support, autonomously represented themselves and retained external expertise during the JKDA and AEA negotiations. They directed and managed the evaluation of the environmental impacts of the Project on each of their respective communities and their Members, based on their own worldview. They engaged their own independent professional and technical support and used ATK in their evaluation of the Project impacts.

As a partner, Manitoba Hydro also describes its approach to the initiative by elaborating its mission and commitment to sustainability and to establishing positive, respectful, constructive and mutually beneficial relationships with Aboriginal communities in Manitoba in general, and specifically the KCNs in this initiative.

The final section of the chapter provides a summary of Manitoba Hydro's mandate, goals and sustainable development principles.

2.2 KEEYASK CREE NATIONS WORLDVIEW, VALUES AND ABORIGINAL TRADITIONAL KNOWLEDGE

2.2.1 KEEYASK CREE NATIONS WORLDVIEW AND VALUES

The following consensus respecting how the Ininewak (the Cree people) live and what is true about Askiy (the living earth and all within and upon it) has been developed among and articulated by the Elders and leadership of the KCNs.

Ininewak Askiy Kasikannowapachikatek (How the Ininewak Live and What is True About Askiy)

We are four Cree Nations: Tataskweyak Cree Nation, War Lake First Nation, Fox Lake Cree Nation and York Factory First Nation. We do not speak for others.

The following statements are not a complete description of who we are, how we live and what is true to us, and there are differences between and amongst our communities and our individual members. However, we share the following statements regarding who we are, how we live and what is true to us. These statements provide important guidance for the Keeyask Generation Project.

We, the **Ininewak**[1], were placed here on Askiy by Manitou. We are part of Askiy. We are sustained by Askiy. We care for Askiy. Our language, Kitayamowin, is fundamental to who we are, how we live and what is true about Askiy. It is important that our language is maintained. We highly value our families, communities, and Nations, and these make up who we are as Ininewak.

Askiy is the word used by the Ininewak for the whole of the land, water (nipi), animals (aweassisak), plants including medicines (muskikeya), people (Ininewak), all other creatures and the interrelatedness of all things. All things are alive, have spirit and come from Askiy. Askiy and all things come from something greater than us – Manitou. Our culture, spirituality and history are part of Askiy. Kakenaw kakona ota aski nikanatentennan – everyone and everything on Askiy is sacred to us.

Niwákomákanak (My Relations)[2], all things are related; all things are equal. We are all relations. Our relationships with Askiy are important to our culture, identity, spirituality and history. Our relationships are based upon aspénimowin (trust) and kisténitamowin (respect) for every part of Askiy. Ininewak kistentamok kakenow kakona ota aski – We highly respect everything that is part of Askiy.

Mino-pimatisiwin means living a good and honourable life. Mino-pimatisiwin includes many things such as being a good person, respecting Askiy, harvesting and consuming healthy Ininew foods, and following our values. Kanawécikéwin – we care for Askiy for the Ininewak today and future generations. We pray and give thanks for everything that Askiy provides. Ohcinéwin – if a person harms or abuses anything that is part of Askiy, there will be consequences for oneself and even one's family members. Because this is such a powerful thing, we need to be careful and respect even the use of this word. Pastamowin – if a person slanders another person, there will be consequences for oneself and even one's family members. When we act in a harmful or disrespectful way, we must acknowledge the harm we have created and make sincere attempts to put things right and strive for é-tipápéskopanik (balance) and minonénimowin (harmony). To set things right we use rituals and ceremonies. Matinakéwin - we share with others. We, the Ininewak, maintain our kiskinohamakaywina (teachings) and aniska achimowin (traditions) by living them (pimatisiwin) and teaching them to our youth and future generations.

This is what we know to be true and important. This is how we should conduct ourselves while we are alive.

See Appendix 2B for a syllabic interpretation of the Cree worldview.

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1 Some Members of our communities also refer to who we are as the Muskego Ininuwak and the Nehenow Ininiwak.

2 There are different ways of speaking about relationships in Nehenow ayamowin. Other Cree terms include wakohtinwin (kinship), kiwákomákananak (our relations) and wakoméwéwin (relationship).

2.2.2 ABORIGINAL TRADITIONAL KNOWLEDGE

Joseph Irvine Keeper, a Cree born and raised in Norway House, has worked with Cree communities for much of his life. He was involved in the Community Development movement of the 1960s, which had as its objective the involvement of the Cree people in developing self-reliant, self-governing First Nations. He participated in the organization of the Northern Flood Committee and its role in the landmark Northern Flood Agreement (NFA) (1977), which created the basis for the TCN Implementation Agreement (1992) and subsequent agreements. Joe has contributed the following text, extracted from the CNP Keeyask Environmental Evaluation Report, as description of the Cree historical relationship to the land that the KCNs continue to live and experience today:

> Since time immemorial, we have had a relationship to our lands and waters that was inextricably linked to our existence and survival. We saw ourselves as interrelated to the land and all parts of the land, both animate and inanimate. We believed that for our continued existence and survival as Cree it was necessary to live in a way that maintained the harmony and balance of the ecosystem. We believed that if this could not be accomplished we could not survive. Our ecosystem would then begin to unravel and eventually disappear. Therefore, over the millennia, we developed within our culture the spiritual beliefs, customs, values and practices that would serve to ensure harmony and balance within our world.
>
> Our ancestors believed in a Creator or Great Spirit who had provided a land with all the requirements that we needed to sustain our identity. As part of this belief, it was necessary for all parts of the lands and waters to relate and interrelate with every other part. It was important for our ancestors to find a way to ensure and enhance these relationships. This was accomplished through particular practices which showed respect and gratitude to animals and plants and to all other parts of our world, as provided by the Creator. There were particular ceremonies, rituals and practices, such as the vision quest for youths, to enhance their relationship with the other beings in our world.
>
> Inherent in the Cree culture is how we placed ourselves in our relationship to the land and all of nature. It was a reciprocal relationship - nature contributed by caring for the Cree and the Cree contributed by caring for nature.
>
> Within our culture, spiritual life, family life, and livelihood activities are not separated. These values and beliefs become an integral part of an individual's personality. When TCN and War Lake Members look at the purpose of our resource area, they see it from within the spectrum of our value and belief system. It is seen as part of the gift from the Creator from which we obtain our livelihood and reason for being. It is also part of our value and belief system that we must treat all parts of his world with the respect and care consistent with the spiritual beliefs of our culture.
>
> As we became involved with the white man and adapted Christianity into our spiritual beliefs, certain practices changed, but the basic beliefs, values, traditions and customs have been retained.

ATK, then, is a cumulative body of knowledge, practice and belief about relationships among living beings that is handed down by Elders in each generation and is a way of life continuously adapted and added to by each generation.

The principles, which have guided the sourcing, use and incorporation of ATK into this EIS are included as Appendix 2A to this chapter.

2.3 HISTORY OF AGREEMENTS BETWEEN KEEYASK CREE NATIONS AND MANITOBA HYDRO

The KCNs have lived for centuries in their ancestral homeland, which is today at the very heart of Manitoba Hydro's northern generating system. In the experiences between the Cree and non-Aboriginal people since first contact with Europeans in the 17th century, there have been interactions of various types, including negotiations and oral or written agreements. These experiences form an integral part of their approach to participation in the Project.

Over the centuries, the Cree experienced a gradual loss of control and power in decisions affecting major aspects of their lives. The increased need for land and hydroelectric resources by the larger Canadian society resulted in greater intrusion in their ancestral homeland and the culture of the Cree. Hydroelectric developments in northern Manitoba, which began about 50 years ago, became the largest factor in reducing the capacity of their homeland **ecosystem** to sustain them physically and culturally.

The first indication of a project that would affect the flows and levels of the waters on the lower Nelson River happened in 1957 with the start of construction of the Kelsey Generating Station. Two decades later, it was followed by the **Lake Winnipeg Regulation** and **Churchill River Diversion** (LWR and CRD) Projects. Construction of this massive regulation and diversion scheme began in 1970, with LWR completed in 1976 and CRD operational in 1977. During that same era, two large generating stations were developed: Kettle Generating Station, which inundated surrounding land and lakes to create Stephens Lake, was completed in 1974, and Long Spruce Generating Station was completed in 1979. From the Cree perspective, CRD, LWR and the two additional generating stations caused the most severe effects on their culture by seriously limiting the use of their homeland ecosystem.

In December 1977, the landmark Northern Flood Agreement was signed by Canada, Manitoba, Manitoba Hydro and the Northern Flood Committee, which represented five Cree Nations: Split Lake First Nation now called Tataskweyak Cree Nation (TCN); York Factory First Nation; Norway House Cree Nation; Cross Lake First Nation; and Nelson House First Nation (now called Nisichawayasihk Cree Nation [NCN]). The NFA was one of the first agreements of its type in Canada. It provided a range of remedial and compensatory measures to address the effects caused by hydroelectric development, including compensation programs and remedial measures for trappers and fishermen.

Four of the NFA communities have since signed agreements with Canada, Manitoba and Manitoba Hydro to implement their respective obligations: TCN in 1992, YFFN in 1995, NCN in 1996, and Norway House in 1997. In 2004, FLCN signed an agreement with Manitoba and Manitoba Hydro that recognized and resolved adverse effects of past projects on the natural environment in FLCN's traditional territory and related socio-economic impacts, including land use issues. In 2005, WLFN signed the War Lake Past Adverse Effects Agreement with Manitoba and Manitoba Hydro, which recognized WLFN's use of their traditional resource area in the southern portion of the Split Lake Resource Management Area (SLRMA) by payment of compensation for damages caused by previous hydroelectric development.

The following initiatives designed to analyze the effects from previous projects and the potential effects of the Keeyask Generation Project were undertaken and ultimately led to the signing of the JKDA, the environmental assessment and this resultant EIS and the KCNs' Environmental Evaluation Reports:

- **Joint Studies on the Impact of Past Hydro Developments in the Split Lake Area:** TCN and Manitoba Hydro undertook a number of studies from 1992 to 1996 to analyze the impacts on the community of Split Lake due to the potential development of hydroelectric generating stations on the Nelson River between Split Lake and Stephens Lake. These studies culminated in the publication of the Split Lake Post-Project Environmental Review. In response to a request from TCN, the community and Manitoba Hydro examined the impacts of Manitoba Hydro project initiatives that had occurred within the SLRMA between 1957 and 1996. It reviewed the impacts of Manitoba Hydro development in the SLRMA from both Aboriginal traditional knowledge and technical scientific perspectives, and identified baseline research requirements for developing a hydroelectric project at Gull Rapids. The review generated five separate reports documenting outcomes.
- **Agreement-in-Principle (AIP) and Process Agreements:** In 1996 following the completion of the Post-Project Environmental Review, Manitoba Hydro suggested that TCN and Manitoba Hydro continue consultations commensurate with the scope and timing of a potential development of Gull Rapids which, at that time, was contemplated to be 20 to 25 years away. TCN responded favourably, proposing that the best way forward would be to negotiate the terms of a business agreement in which TCN and Manitoba Hydro would be co-proponents for any such future development. As a result, discussions between TCN and Manitoba Hydro were held from 1998 to 2000, culminating in an AIP which was ratified by the community and signed in October 2000. *The Agreement-in-Principle Regarding the Potential Future Development of the Gull Rapids Hydro-Electric Generating Station* (AIP) sets out the fundamental principles and understandings that would govern the new relationship between TCN and Manitoba Hydro with respect

to the potential development of the Project. This AIP provided a framework to guide the negotiation of the JKDA and the AEA. In signing the AIP, TCN believed its rights and interests could be better advanced by being a participant in the Project and by building upon the terms of its past agreements.

The AIP made provisions for involving other First Nations with the agreement of Hydro and TCN. In late 2000, TCN, with the agreement of Hydro, invited FLCN, YFFN and WLFN to become signatories to the AIP. WLFN subsequently signed the AIP in 2003.

- **Gull (Keeyask) Negotiating Principles and Process Proposal:** YFFN's and FLCN's formal involvement in the planning for the Project began in 2001, some months after Manitoba Hydro and TCN signed the AIP. In September 2001, Manitoba Hydro, TCN, WLFN, YFFN and FLCN signed the Principals' Memorandum setting out the negotiating principles for concluding the JKDA, and a year later, in October 2002, they signed the Negotiating Principles and Process Proposal, which set out in more detail, the negotiating principles and process for concluding the JKDA.
- **Joint Keeyask Development Agreement (JKDA):** The KCNs and Manitoba Hydro negotiated the JKDA between 2002 and 2008. These negotiations shaped the key features of the Project and the terms of the Partnership between the KCNs and Manitoba Hydro, including governance of the Partnership and financing and management of the Project. Among other matters, the JKDA also addresses the KCNs' potential income opportunities, training, employment, business opportunities, and involvement in the Partnership's environmental and regulatory affairs. The JKDA was signed in May 2009 by representatives from each of the KCNs and Manitoba Hydro.
- **Keeyask Environmental and Regulatory Protocol:** Given the implications of their different worldview, TCN concluded at an early point that they should determine and present their own evaluation of the environmental impacts of the Project on their own community. This was accepted by Manitoba Hydro under a protocol reached in 2001 to guide them in the preparation of the environmental assessment required under the *Canadian Environmental Assessment Act* and the *Environment Act* (Manitoba). The protocol subsequently incorporated WLFN, YFFN and FLCN. Each of the communities led the consultations with their respective Members, while Manitoba Hydro took the lead for facilitating consultation processes with other communities. It was also agreed that for all components of the assessment, study methods for collecting, organizing and evaluating information would need to be compatible with each other and be capable of being integrated into the EIS.

- The protocol was adjusted over the years with the current version being incorporated into the JKDA. Through the protocol, a number of committees and processes have been established for the environmental assessment. They include the following:
  - **Partners' Regulatory and Licensing Committee (PRLC):** The PRLC is composed of nine Members from the KCNs (three from TCN and two each from WLFN, FLCN and YFFN) and three staff from Manitoba Hydro, who collectively govern the Partnership's environmental activities. TCN and Manitoba Hydro co-chair the committee.
  - **EIS Coordination Team:** While the PRLC is the senior body overseeing the environmental assessment, the Coordination Team manages the environmental studies, including final coordination and preparation of the EIS and the environmental protection plans. CNP and Manitoba Hydro each have two voting members on the Coordination Team, and FLCN and YFFN each have one non-voting representative on the Coordination Team (decisions to date have been by consensus).
  - **Key Issues Working Groups:** Beginning in June 2007, the EIS Coordination Team established a series of multilateral working groups to address key issues and to act as a forum for discussion of concern to the KCNs communities. The KCNs and Manitoba Hydro planned, organized and held workshops on important environmental assessment topics such as ATK, scoping of valued components, and cumulative effects assessment.
  - **Environmental Studies Working Groups:** Manitoba Hydro has established bilateral working groups with each of the KCNs to review issues of importance to each community, including a review of annual field plans for environmental studies and sharing results of the studies.

2.4 CREE NATION PARTNERS' INVOLVEMENT IN THE PROJECT

As noted previously, Manitoba Hydro projects have had a severe impact on the Cree Nations on the lower Nelson River, but by 1998, when TCN proposed a partnership with Manitoba Hydro for the potential Project at Gull Rapids, TCN and its Members had slowly regained power and authority over decisions that affect their lives. They believed their rights were sufficiently recognized to give them enough confidence to begin negotiations with Manitoba Hydro. They believed that such negotiations held the potential for restoring some of the capability of their homeland ecosystem that had been lost over time and for returning some of the influence and control they had lost over the years. They entered the discussions with two principles in mind: first, they would not oppose the Project if satisfactory partnership arrangements could be negotiated; second, they would use their own worldview to assess the potential environmental effects of the Project on themselves and their communities.

CNP undertook extensive consultation processes with their Members to articulate the Cree worldview and, from this perspective, considered all aspects of the Project. This consultation process was highly inclusive and consistent with traditional CNP decision-making. The consultation provided opportunities to shape the Project in a variety of meaningful ways and guided the negotiations which led to the AEAs and the JKDA.

2.4.1 Evaluation Based on the Cree Nation Partners' Worldview

The CNP undertook the evaluation of the Project's potential effects on its communities and Members based on their worldview. In undertaking this evaluation, which is recorded in the CNP Keeyask Environmental Evaluation Report, CNP developed a model – the Mother Earth Ecosystem Model – through extensive discussions among TCN Elders and Members in workshops and community meetings. The process included the development of a vision statement, a set of core beliefs, land use planning objectives, and a description of their relationships with Mother Earth. The model was accepted through consensus of TCN Members and later adopted by WLFN. It conveys the interconnectedness of all facets of their homeland ecosystem.

The CNP describe this interconnectedness in terms of their relationships with Mother Earth. These relationships are the basis of CNP social organizations and of the customs, practices and traditions that are integral to their distinctive cultural identity.

These relationships are as follows:

- Spiritual relationships;
- Historical relationships;
- Life sustaining relationships;
- Caregiver relationships and the duty of respect;
- Hunting, fishing and gathering relationships;
- Trapping relationships;
- Educational relationships;
- Physical relationships – travel, camping, meetings and burials;
- Emotional relationships;

- Social relationships within the community;
- Socio-political relationships with other First Nations and outsiders;
- Knowledge of ecological relationships among non-human beings; and
- Personal property and community infrastructure relationships.

The Cree worldview identifies them, as a group and individually, to be Members of the natural world. The Cree, with their own beliefs, values, practices and traditions, have established relationships and obligations with all the other parts of the natural world as an integral part of that world. The foundation of the Cree relationship is spiritual. They believe that all parts of nature, animate and inanimate, have a spirit or a soul and are worthy of respect. Thus, when one part of nature is impacted all the other parts are also impacted, which creates an imbalance that must be remedied.

The evaluation of the Project, conducted by the CNP and based on their worldview, is an evaluation of the ability of their homeland ecosystem to sustain them physically and culturally. In their view, this is a state of harmony and balance, accompanied by strong relationships with Mother Earth.

2.4.2 CNP Coordination and Consultation Processes at Key Stages in the Environmental and Planning Phase

Based on traditional Cree decision-making, CNP utilized a comprehensive and inclusive process to inform and consult with Members during the AIP, AEA and JKDA negotiations. This included a variety of committees, types of meetings and forms of media. In the following sections, a listing is provided of the methods CNP employed from 1998 to 2009.

2.4.2.1 Committees and Reference Groups

- The Council and Elders Gull Planning Committee: This committee was formed in July 1998. It led to the drafting of a joint development work plan and timetable. Over the following two years, TCN undertook an intensive schedule of work to define and understand the nature of the Project and bring that understanding to the community so that Members could make informed decisions on the proposed Project. This committee was responsible for the establishment of a set of Reference Groups to develop negotiating positions and consult with Members, particularly about the benefits and risks of the potential new business relationship. Appointments to the Reference Groups were made by Chiefs and Councils, who also participated in the Groups along with Elders, Members, support staff and outside strategic, technical and legal advisors. Presentations at these meetings typically involved each Reference Group's subject area, but also served to inform Members of the progress in negotiations and the latest information on the Project. From 2001 to the referenda in 2009, 134 Reference Group meetings were held.

The Council and Elders Gull Planning Committee were also responsible for the initiation of the OWL process.

- **The Overview of Water and Land (OWL) Process and OWL Reference Group:** In 1998, the Council and Elders Gull Planning Committee adopted a framework to look at land and environmental planning and assessment issues. They appointed a Working Group which developed a process for Members to identify the foreseeable effects from the construction and operation of the Project. Later, TCN hired four staff to manage the OWL process.

  In parallel with the activities carried out by TCN, WLFN established its own OWL process to address their own unique adverse effects. TCN and WLFN Members also attended joint meetings to consider broader issues of interest to both communities and to form a common understanding as to the overall approach for assessing the predicted impacts. Appointments were made to the OWL Reference Group and the following responsibilities were assigned:

  - Participate in the process of developing detailed negotiating positions and consulting with Members about the Project;
  - Ensure that all questions raised by Members concerning the benefits and risks of the potential new business relationship were answered;
  - Identify potential adverse effects on TCN Members; and
  - Identify any programs or actions that could be implemented to reduce or offset the identified adverse effects.

- **Keeyask Employment and Training Agency Reference Group (KETA):** KETA was responsible for maximizing attainment of employment and business opportunities, including the JKDA target of 110 operational jobs with Manitoba Hydro over 20 years. Once training funding was secured, under the Community Employment and Training Program (CETP), the title of this Reference Group was changed to the CETP Reference Group.

- **Keeyask External Relations Committee Reference Group (KERC):** Beginning in 2000, KERC assisted in managing the relationships between CNP and other First Nations, environmental groups, Churches and other religious organizations. KERC focussed on developing and implementing responses to protect CNP rights and interests from undue interference from external groups. The most significant opposition was focused in the states of Wisconsin and Minnesota and stemmed from American Tribes, governmental bodies and regulatory agencies.

- KERC was responsible for monitoring activities and indentifying the proliferation of inaccurate and out-dated information. As a tool to better inform concerned opposition, KERC developed presentations which told the story of CNP's involvement in the Project from their own perspective, including information about Project planning and CNP future goals. Over the past decade, relationships were managed with Church groups and ENGOS resulting in greater public understanding of the Project.
- **Keeyask Internal Relations Committee Reference Group (KIRC):** KIRC was responsible for developing the legal, financial, and operational requirements of the Project ownership structure, including decision making and management powers, and the nature of TCN governance requirements to enable effective ownership, control, and management.
- **Business Contracting and Economic Strategy Reference Group (BCES):** BCES was formed to maximize the business opportunities associated with the Project, including considerations with respect to the Hydro Northern Purchasing policy, required training and related support, joint ventures, and regional economic development.
- **Expert Committee on Adverse Effects:** This joint CNP-Manitoba Hydro committee, established in December 2003, was required to review all information relating to potential Project adverse effects as determined through the OWL process and the environmental assessment process, and identify, evaluate and recommend potential mitigation measures. The committee did some initial work related to preventing, avoiding and lessening adverse effects, but the majority of its work focused on replacements, substitutions, and offsetting opportunities.

2.4.2.2 MEETINGS

- **Meetings Preceding Ratification of the AIP:** TCN community meetings were held between November 1998 and May 1999 to discuss different aspects of the potential partnership with Manitoba Hydro, including the concept of working in cooperation with Manitoba Hydro, and to provide information to Members about matters ranging from budget to potential adverse effects, and included details and documents that were tabled at meetings by either TCN or Manitoba Hydro.
- **Roundtable Meetings:** To ensure the exchange of Project information and provide a forum for discussion of issues and concerns being expressed by Members, Roundtable meetings, where the five Reference Groups met as a large group, were scheduled periodically.
- **General Membership Meetings:** These meetings were held in the CNP communities, in Thompson and in Winnipeg, to provide the opportunity for all interested Members to hear presentations on various subjects and to voice their opinions and concerns. The meetings were announced in advance and advertised through the radio, strategically

placed posters, and by word of mouth. From 2001 to the 2009 referenda, 30 General Membership meetings were attended by CNP Members.

- **Information and Planning Meetings:** Information and Planning meetings were held to brief the CNP leadership and Members on the progress of negotiations with Manitoba Hydro and to present issues that required discussion and decision. Typically, these were meetings between advisors and Chiefs and Councils, Elders, Reference Groups, support staff and interested Members to plan for the negotiations with Manitoba Hydro, or following negotiations, to provide a briefing on the discussions. From 2001 to the 2009 referenda, 1455 Information and Planning meetings were attended by CNP Members.
- **Negotiation Meetings with Manitoba Hydro:** The Core Negotiating Group (CNG), various technical committees (on Project Description, Commercial Terms and Business Opportunities), and the Expert Committee on Adverse Effects conducted the negotiations. From 2001 to the 2009 referenda, 456 Negotiation meetings were attended by CNP Members, supported by their own strategic, technical and legal advisers.
- **Youth Meetings:** Separate meetings with the youth of TCN and WLFN were held so that their voices would not be lost in the larger public forums. Presenters at the meetings stressed the importance of hearing from the people who would be the leaders of tomorrow and the people charged with managing the consequences as well as the benefits of the Project. The youth were also encouraged to attend General Membership meetings. One survey was conducted with students at the school using hand-held voting devices to collect their views about what mattered most to them personally and as Members of their communities. From 2001 to the 2009 referenda, seven Youth Meetings were attended by CNP Members.
- **Consultations Leading to the Ratification Vote:** During the community consultation phase leading to the vote on the JKDA and AEAs, 15 meetings were held in Split Lake, Ilford, Thompson and Winnipeg to review all aspects of the proposed agreements with TCN and WLFN and their Members.

2.4.2.3 OTHER COMMUNICATION MECHANISMS

- **Community Questionnaires:** In May 1999, TCN administered a community questionnaire regarding potential development of the Project to ensure that the opinions of as many Members as possible would be heard and considered. Five hundred and thirty-five people completed and returned the questionnaire.

  Some questions were formulated to elicit answers regarding Cree culture, the natural environment, resource development and traditional skills and lifestyles. Other questions asked participants about their priorities ranging from low to very high regarding possible development in the areas of local business opportunities, ownership of the generating station, training and the opportunity to conduct a community environmental review. Finally, the questionnaire asked Members to respond to questions as if TCN were a part owner of the Project.

The first step of the WLFN process was a cultural component that involved 44 interviews. The report on that process, prepared in May 2002, notes that WLFN Members endorsed an approach to assessing the environmental effects of the Project based on Aboriginal traditional knowledge within a holistic worldview.

A Project adverse effects questionnaire was distributed to the TCN community in March 2003. The purpose of this questionnaire was to get feedback on how important specific adverse effects might be to Members if the Project were built. Seven hundred questionnaires were distributed, of which 555 were completed and returned. The results from the 555 completed questionnaires provided guidance to the Chief and Council of TCN in relation to the adverse effects and other negotiations with Manitoba Hydro.

- Newsletters/Journals: The *Tataskweyak Journal* began as a newsletter in 1998, reporting to the community on the potential business relationship with Manitoba Hydro. Two newsletters were published in 1998, five in 1999 and another two in 2000. Between 2001 and 2008, the *Tataskweyak Journal* published 27 issues and two special editions. The *Tataskweyak Journal* reported on the progress of the main JKDA negotiating issues with Manitoba Hydro in addition to announcing community meetings, publishing survey results and commenting on current issues under discussion in Split Lake.

  WLFN's community newspaper, the *Mooseocoot Times*, began publishing in 2004. It was utilized to report on the progress of JKDA and AEA negotiations, community announcements, and materials relevant to WLFN. Between 2001 and 2008, the *Mooseocoot Times* was published six times.

- Radio Broadcasts: The local radio station was used to announce the schedule of community meetings during the JKDA community consultation phase, to hold call-in programs to answer Members' questions on adverse effects and generally to promote an understanding of the JKDA and AEAs.

- Websites: In 2001, TCN established a website (www.tataskweyak.mb.ca) to express its voice in hydroelectric development matters, its history, its people, and a description of its lands and waters in the SLRMA. It continues to be a useful source of information for Members and the general public.

  The CNP established a website in 2008 (www.creenationpartners.ca) to provide information for the community consultation process leading to the referendum on the JKDA and the AEAs. The website included major Project updates, full digital copies of the *Tataskweyak Journal* and the *Mooseocoot Times*, complete digital copies of the JKDA and the AEAs, a section on "Frequently Asked Questions," and technical information on the proposed project description, including maps and satellite images.

2.4.3 CNP Concerns Prior to Project Improvements and Mitigation

As noted previously, CNP Members were engaged early in the process to identify their issues so their negotiating team could work with Manitoba Hydro and the other KCNs to address potential Project impacts through changes in the Project design, mitigation measures and programs in their AEAs.

In this section, the issues identified by TCN Members and endorsed by WLFN Members are listed. Since originally developed, this list has evolved to include other issues that arose during the negotiations. The wording of the following issues has been modified to remove duplication.

- Over 17 square miles of land will be flooded, Gull Rapids will be lost, and Birthday Rapids will be affected.
- Potential effects on the Cree language, our worldview, our Aboriginal traditional knowledge and seasonal movements are specific concerns.
- Our families will lose their historical connection to the land that will be flooded.
- Our emotional well-being will be harmed, since it will be disrespectful to the land, and indicates a failure to properly care for the land and for fellow beings of Mother Earth, by allowing the Project to be built and flooding to take place. It could also disrupt the harmony and balance amongst all Mother Earth's beings—human and non-human. The Project will also damage our spiritual connection with the land.
- Many of our relationships with and among other beings will be changed by the Project.
- Opportunities to teach and learn traditional lessons will be lost.
- Opportunities to live a traditional lifestyle will be lost.
- Relationships with other First Nations will be affected, as will our inherent right to self-government, as the Project has caused Hydro and Manitoba to become involved in relations between and among TCN, WLFN and other First Nations and has had an effect on our traditional decision-making.
- Fiduciary relationships between our First Nation and the Crown could be affected and we are concerned that Canada and Manitoba honour and respect them.
- Relationships with Manitoba Hydro could be affected because of differing interpretations of the NFA, the 1992 Agreement and the AIPs.
- Noise from construction of the roads and dam will scare animals away from the Keeyask area.

- Construction workers will fish and hunt animals, resulting in fewer fish and animals being available to Members.
- More policing and security will be required due to the presence of construction workers in the area.
- The risk of death and injury to CNP Members will increase, due to increased traffic on PR 280 associated with the construction.
- More drugs and alcohol will be used by the youth because of the presence of construction workers.
- There is a risk that construction workers will abuse women from the communities.
- There will be an increased demand for housing as Members come home to seek work on the Project.
- Shorelines will be subject to erosion, thus putting more sediment into the water. Moreover, the Project will create many miles of unsightly new shoreline, due to erosion, slumping, and debris.
- Daily water levels will fluctuate.
- While engineering studies show that water levels on Split Lake will not be affected during the open water season, some Members are concerned that there may be a greater risk of flooding in the community of Split Lake, as occurred in 1997 and 2005.
- While engineering studies show that no further changes will be caused to the seasonal flow in the Nelson River, some Members think there will be further changes once the Project is operational.
- While the timber will be salvaged from the flooded areas, once it is flooded the area will never again produce trees for firewood or building materials.
- It will be more difficult to catch fish, because of debris, sediment, altered habitat and dangerous boating conditions. Fishing with nets will be more difficult because of silt. Consequently, fish will make up a smaller part of our diet.
- The dam will block fish movement upstream and downstream.
- Changes in winter water levels will cause suffering and deaths of muskrats and beavers.
- The increase in mercury levels in some fish species, especially jackfish and pickerel will pose a health hazard.
- Traditional hunting, fishing and trapping grounds will be altered or destroyed.
- There will be fewer animals such as moose, waterfowl, muskrat and beavers to harvest.
- Caribou habitat will also be lost due to the flooding.

- Waterfowl nesting habitat will be damaged by the flooding and nests will be destroyed by daily water fluctuations.
- Sturgeon spawning areas will be lost at Keeyask (Gull) and Birthday Rapids.
- Travelling by boat will be less safe due to floating debris and to the creation of new and unfamiliar reefs.
- Travel over ice may be more dangerous. In particular, travelling by snowmobile over the ice will be more difficult due to increased slush ice.
- Medicinal plants will be lost due to flooding.
- There will be less traditional food because of fewer animals and mercury in some fish species.
- Recreational opportunities presently available will be lost.
- Traditional camp sites and trappers cabins will be destroyed.
- Some archaeological objects such as ancient tools and pottery will be lost forever when land is flooded.
- Despite efforts to identify burial sites before the Project is constructed, it is possible some unknown sites will be flooded.
- Known sacred sites will be lost due to flooding.
- There will be stress in the community because of uneven distribution of costs and benefits amongst CNP members arising from the Project. For example, the most direct losses suffered from flooding may be experienced by different people than those who may get the greatest benefits from jobs and businesses.
- The loss of traditional hunting and fishing grounds may have a negative effect on various species and also may cause overcrowding and tension among some of the resource harvesters.
- CNP Members who trap in the Keeyask area will suffer lost revenue because there will be fewer fur-bearing animals to trap due to flooding caused by the Project.
- There may be increased encroachment by outsiders on lakes in the eastern part of WLFN's Traditional Use Area.
- The Western science-based regulatory processes have not properly considered our worldview and our inherent right to make our own decisions.

These issues have been addressed in a number of ways through changes in the design of the Project (Section 5.3.4); adverse effects agreements (Section 5.3.5); training, employment and business opportunities (Section 5.3.6); and other mechanisms, such as studies undertaken for the environmental impact assessment. For example, the issues regarding the loss of burial and sacred sites were identified in the AIP, which stated all such known sites will be protected or moved, if necessary, and appropriate spiritual ceremonies will be performed. Studies led by CNP have been undertaken to identify these sites, and plans have been drafted to manage heritage resources and burial sites that may be affected by the Project. The plans are consistent with Cree traditional wisdom, practices and governance and with provincial legislation regarding found human remains and heritage resources.

2.4.4 CHANGES TO IMPORTANT ASPECTS OF THE PROJECT

The issues raised by CNP Members during the consultation process were concerns about foreseeable environmental effects based on their 50 years of experience with previous hydroelectric developments. The issues informed the CNP negotiators about aspects of the Project that they would work with Manitoba Hydro and the other KCNs to address. The issues also informed the CNP negotiators working on the AEAs.

First, aspects of the Project were modified in important ways, including the Project's size, location, name (from "Gull" to "Keeyask," which means gull in Cree) and the associated benefit arrangements, including training, employment preferences and business opportunities. The following fundamental features related to the design, construction and operation of the Project cannot be changed without CNP's agreement:

- The north and south access road will be routed within specific corridors;
- The intake, powerhouse complex, spillway and main construction camp will all be at the locations shown in the Project description;
- The construction and operation of the Project will not require any changes to the CRD Licence, as modified by the Augmented Flow Program, or the LWR Licence;
- The operation of the generating station will not affect water levels on Split Lake during open water conditions; and
- The full supply level of the reservoir will be 159 m (521.7 ft) and the minimum operating level will be 158 m (518.4 ft), and the reservoir will be higher or lower than these elevations only under special or emergency conditions, which are described in the JKDA.

As well, in response to concerns raised by the Cree, improvements were made to plans for clearing the reservoir, water management, ice monitoring, navigation and hazard marking, and reclamation of disturbed sites.

2.4.5 CNP Adverse Effects Agreements

The CNP AEAs encompass agreed upon mitigation measures, the purpose of which is to address and resolve all present and future Project adverse effects on TCN and WLFN, all impacts of the Project on their collective rights and interests, and all impacts of the Project on the exercise of Aboriginal and Treaty rights by their Members which arise from the development and operation of the Project within the Agreed Water Regime, and which, as of the date of signing of the Agreements, are foreseen or are foreseeable with the exercise of due diligence.

The core of each Agreement is a set of Offsetting Programs. The overall purpose of the Offsetting Programs is to provide appropriate replacements, substitutions or opportunities to offset unavoidable Project adverse effects on the practices, customs and traditions integral to their distinctive cultural identity. The AEAs also deal with compensation for residual effects. There are other provisions for dealing with Manitoba Hydro's on-going liabilities, and in the case of TCN, certain provisions if water levels in the Project reservoir exceed defined limits. For both TCN and WLFN, compensation for residual effects was a one-time cash payment.

Every Offsetting Program will be operational by 2013 in the case of TCN and 2014 in the case of WLFN. They will be in effect as long as the Project is operational. As of 2009, the net present value of CNP AEAs was $45 million.

2.4.5.1 Tataskweyak Cree Nation Adverse Effects Agreement

The Offsetting Programs, residual compensation and other aspects of the TCN AEA are as follows:

- The Creation of a Keeyask Centre: The objective is to provide space and facilities in Split Lake, as well as office functions for the management and administration of the Offsetting Programs. It also includes space for conducting educational and learning programs. Two $2 million payments have been made to fund the Keeyask Centre.
- The Access Program: The objective is to provide Members with substitute opportunities to hunt, fish and trap for food and to carry out associated customs, practices and traditions integral to their distinctive cultural identity within the SLRMA.
- The Healthy Food Fish Program: The objective is to provide opportunities for Members to continue to fish and to provide a supply of wholesome fish to Members in order to replace fish that may no longer be safe to consume as a result of increased methyl-mercury levels caused by the Project.

- **The Land Stewardship Program:** The objective is to provide opportunities for TCN Members to show respect for the land in a manner consistent with their traditional values and to assist them in caring for the land within the area.
- **The Traditional Lifestyle Experience Program:** The objective is to provide opportunities for young adult Members to experience a traditional lifestyle during one cycle of seasonal activities on the land.
- **Traditional Knowledge Learning Program:** The objective is to replace opportunities for traditional learning that will be lost due to the development of the Project.
- **Traditional Foods Program:** The objective is to provide opportunities to gather and share traditional foods.
- **The Cree Language Program:** The objective is to strengthen the cultural identity of the Members by creating opportunities for adults to learn to speak Cree or to improve their Cree language skills.
- **Museum and Oral Histories Program:** The objective is to provide a substitute opportunity for TCN Members to maintain their historical connection to the land.
- **Pre-Determined Compensation:** In the interest of ensuring to the best of their abilities that future problems and potential misunderstandings are avoided, pre-determined compensation will be paid in the unlikely event that the Project reservoir exceeds 159.05 m or falls below 157.95 m. Compensation will also be paid to TCN when the reservoir is intentionally drawn down for maintenance, inspection or emergency purposes.
- **Residual Compensation:** Compensation for residual effects is a one-time cash payment for all adverse effects that were not addressed by the Offsetting Programs and the pre-determined compensation for extreme water levels in the Project reservoir. The residual compensation of $3 million, in 2008 dollars, was a negotiated amount and was paid upon the signing of the TCN AEA.
- **Funding Features:** The Partnership is obligated to assume direct responsibility for the construction and costs of cabins, docks, ice houses, ramps and storage sheds at each of Pelletier, Waskaiowaka, Limestone, Recluse and Myre lakes. It must also fund the guaranteed annual amount, which is the annual amount to be used to operate the Offsetting Programs and maintain and replace capital items. The guaranteed annual amount will be paid annually for the life of the Project. TCN will have the flexibility to reallocate funds between the Offsetting Programs or to reallocate funds to new agreed programs. All programs are to be fully funded by 2013.
- **Adverse Effects Agreement (AEA):** Manitoba Hydro made its settlement offer, and the AEA was concluded prior to completion of the Keeyask environmental assessment and EIS. The AEA provides for the compensation proposal to be reviewed and

modified as may be required to accommodate changes in the proposed Project resulting from federal or provincial environmental review and licensing processes.

- The AEA also includes provisions to review and modify the agreement if the environmental assessment identifies new information about adverse effects, if the Project is altered by regulators, or if the conditions attached to the Project approval by regulators affect an offsetting program. In such circumstances, changes may be made to the AEA or offsetting program if there is a material change in an adverse effect or if the effectiveness of an offsetting program or other mitigation measure is materially changed.
- **Continuing Obligations:** In addition to the Offsetting Programs, Manitoba Hydro and/or the Partnership will retain certain ongoing obligations with respect to the Project. These include the responsibility to compensate TCN Members who are licensed trappers for loss of net income and/or direct loss of property and the responsibility for personal injury or death unless the event occurs in a pre-designated area in the vicinity of the Project. Compensation is also required for illness resulting from methyl-mercury contamination of food and for unforeseen adverse effects.

2.4.5.2 War Lake First Nation Adverse Effects Agreement

The Offsetting Programs, residual compensation and other aspects of the WLFN AEA are as follows:

- **The Creation of a Distribution Centre:** The objective is to provide space and facilities related to fish processing, storage and distribution.
- **Community Fish Program:** The objective is to provide a supply of wholesome food fish from War Lake and Atkinson Lake in order to replace fish that may no longer be available to consume as a result of increased methyl-mercury levels caused by the Project.
- **Improved Access Program:** The objective is to provide Members with substitute opportunities to fish, hunt, gather and trap, and to carry out other customs, practices and traditions integral to their distinctive cultural identity in their homeland ecosystem.
- **Traditional Learning/Lifestyle Program:** The objective is to provide opportunities for young adult Members to experience a traditional lifestyle at Atkinson Lake.
- **Cree Language Program:** The objective is to strengthen cultural identity by creating an opportunity for adult Members to learn to speak Cree, or to improve their Cree language skills.
- **Museum and Oral Histories Program:** The objective is to provide a substitute opportunity for Members to maintain the historical connection to the land that will be lost when the Project is built.

- **Residual Compensation:** Compensation for residual effects is a one-time cash payment for all adverse effects that were not addressed by the Offsetting Programs. The residual compensation of $255,000 was a negotiated amount and was paid upon the signing of the WLFN AEA.
- **Funding Features:** The Partnership must fund the guaranteed annual amount, which is the annual amount to be used to operate the Offsetting Programs and maintain and replace capital items. The guaranteed annual amount will be paid annually for the life of the Project. The WLFN will have the flexibility to re-allocate funds between the Offsetting Programs or to re-allocate funds to new agreed programs. All programs are to be fully funded by 2014.
- **Adverse Effects Agreement (AEA):** Manitoba Hydro made its settlement offer, and the AEA was concluded prior to completion of the Keeyask environmental assessment and EIS. The AEA provides for the compensation proposal to be reviewed and modified as may be required to accommodate changes in the proposed Project resulting from federal or provincial environmental review and licensing processes.

  The AEA also includes provisions to review and modify the agreement if the environmental assessment identifies new information about adverse effects, if the Project is altered by regulators, or if the conditions attached to the Project approval by regulators affect an offsetting program. In such circumstances, changes may be made to the AEA or offsetting program if there is a material change in an adverse effect or if the effectiveness of an offsetting program or other mitigation measure is materially changed.
- **Continuing Obligations:** In addition to the Offsetting Programs, Manitoba Hydro and/or the Partnership will retain certain ongoing obligations with respect to the Project. These include the responsibility to compensate WLFN Members who are licensed trappers for loss of net income and/or direct loss of property and the responsibility for personal injury or death unless the event occurs in a pre-designated area in the vicinity of the Project. Compensation is also required for illness resulting from methyl-mercury contamination of food and for unforeseen adverse effects.

2.4.6 PROJECT TRAINING, EMPLOYMENT AND BUSINESS OPPORTUNITIES

Beginning in late 2000, a number of programs were established to provide training, employment and business opportunities to CNP Members. They include the following:

- An allocation of up to $19.6 million has been made to train CNP Members.
- A total of 642 individual CNP Members participated in one or more training activities. This is approximately 17% of their on-Reserve populations. The training activities can

be divided into three general occupational categories: Designated Trades; non-Designated Trades; and Business and Administration.

- During the Project construction, a target of 630 person-years of employment for KCNs Members has been planned for the construction of the Project. If the number of person-years is below the target, additional dollars up to a maximum of $3 million will be extended to the joint KCNs/Manitoba Hydro working groups on operational jobs. The employment and training opportunities during the construction include trades and management work that will be available through different contracts and related employment.
- Manitoba Hydro has agreed to an operational jobs target for KCNs over the next 20 years. The JKDA outlines an annual budget of $900,000, adjusted for inflation, to support the KCNs work with Manitoba Hydro on designing and implementing a successful employment framework to meet the operational jobs target. The CNP share of this annual budget is $540,000 and the CNP operational jobs target is 110 jobs over the next 20 years.
- The Project will also provide opportunities to expand the number, capacity, diversity and viability of KCNs businesses. The JKDA identifies 15 work packages on Project construction for direct negotiation with KCNs-controlled businesses. The total value of KCNs contracts is estimated by Manitoba Hydro to be $203 million in 2007 dollars. The total value of CNP contracts is estimated by Manitoba Hydro to be $122 million in 2007 dollars.
- AMISK Construction is a joint venture between CNP and Sigfusson Northern. The joint venture has been formed to carry out Project-related construction activities that will be available to CNP as construction on the Project proceeds. Through AMISK, CNP communities will receive numerous benefits throughout the Project development including training and employment, equipment and tools, profits and other lasting benefits for the CNP communities.

2.4.7 CNP REFERENDUMS

Referendums were held in CNP communities on February 5, 2009 to determine the level of support for the ratification of the JKDA and the AEAs by the Chiefs and their respective Councils.

TCN answered question 1: “Do you support the Chief and Council of TCN signing the proposed Joint Keeyask Development Agreement?” by a vote of 421 “Yes” votes and 273 “No” votes. Question 2: “Do you support the Chief and Council of TCN signing the proposed Keeyask Adverse Effects Agreement?” was answered by 427 “Yes” votes and 267 “No” votes.

WLFN answered question 1: "Do you support the Chief and Council of WLFN signing the proposed Joint Keeyask Development Agreement?" by a vote of 65 "Yes" and 4 "No" votes. Question 2: "Do you support the Chief and Council of WLFN signing the Keeyask Adverse Effects Agreement?" was answered by 61 "Yes" votes and 8 "No" votes.

The Chief and Council of both TCN and WLFN approved the signing of both the JKDA and the AEAs.

2.4.8 CNP Conclusions

The evaluation conducted by CNP, as part of the extensive consultation process, identified many important potential adverse effects of the Project on their communities and Members. However, based on improvements to the design of the Project and provisions in their AEAs and the JKDA, CNP Members supported the Project through positive votes in their referenda.

The CNP believe that their homeland ecosystem was in a state of harmony and balance prior to first contact with non-Aboriginals. The state of harmony and balance was gradually diminished with the changes brought by non-Aboriginals, most significantly, hydroelectric development. From the beginning of their negotiations with governments and Manitoba Hydro, CNP leaders were determined that their homeland ecosystem would once again provide for them physically and culturally— essentially to attain a new state of harmony and balance.

Like previous hydroelectric development projects, the Project will have certain major, unavoidable effects. Knowing this, CNP nevertheless are hopeful the Project will actually enhance their culture by providing opportunities to engage in the customs, practices and traditions integral to their distinctive Cree cultural identity. Similarly, they are hopeful that the benefits that are associated with the JKDA—training, employment, business opportunities, and potential income opportunities from the sale of the Project's power—will sustain them physically. By providing for them culturally and physically, their homeland ecosystem, transformed by the Project, can be in an enhanced state of harmony and balance.

The CNP analysis of the Project is available as a separate report, the CNP Keeyask Environmental Evaluation Report, which is included with the Project EIS.

2.5 York Factory First Nation Involvement in the Project

YFFN's involvement and role as a partner in the Keeyask Generation Project must be understood in the broader context of its history on the Hudson Bay coast; the community's relocation to Split Lake; the appearance and growth of Manitoba Hydro in the north; the development of various legal agreements between YFFN and Manitoba Hydro, including the Joint Keeyask Development Agreement (JKDA) and YFFN Adverse Effects Agreement; and finally looking to the future of the Keeyask Partnership.

2.5.1 YORK FACTORY FIRST NATION HISTORY

The following is YFFN's own account of their history. The Ininiwak ancestors of YFFN lived along the coast of Hudson Bay (Kîhcikamîy) for a long time. So long ago in fact, that long ago (Kuyas) is remembered only through Kuyas Achimowina, the oral tradition and Kapesiwin, the scattered remains of former campsites. There are well over 200 ancient and historical sites, some up to 5,000 years old, identified to date across the Hudson Bay coastal area of Manitoba. Many of these are associated with the Ininiwak ancestors of YFFN.

In 1668, three separate European exploratory parties arrived at the estuaries of the Nelson and Hayes Rivers. The next 25 years saw a flurry of activity as both French and English built a series of forts and trade posts. The York Factory post – also known as the "Big House' (Kischewaskahekan) – of the Hudson's Bay Company (HBC) began operations in 1684, and soon became the central hub in the North American fur trade. Throughout the following period of wars, economic rivalry and peace treaties between England and France, YFFN ancestors continued to move throughout and occupy the Hudson Bay coast and further inland bringing furs to trade for European goods such as metal tools and implements at York Factory (Kischewaskahekan). As word of the European presence progressed further south, many other First Nations formed trade alliances with the Ininiwak, and by this means, the Cree became middlemen in the fur trade.

In 1875, the Crown signed Treaty 5 with the Saulteaux and Cree at Berens River. Treaty 5 covered the area south of the Hudson Bay Lowland and an adhesion was signed in 1908 by Split Lake (Tataskweyak) and Nelson House. It was not until August 10, 1910 that YFFN signed an adhesion to Treaty 5 that included, amongst other things, provision of reserve land for YFFN.

In 1933, the York Factory post lost its status as a customs port of entry, leading to a reduced level of traffic and trading. As well, Port Nelson (Pawinakaw) was abandoned and many of our relatives moved to Split Lake (Tataskweyak), Shamattawa, Churchill (Mantayo Seepee) and other sites along the railway line. In 1947, two different groups of Cree people from York Factory resulted in the Shamattawa and Fox Lake Bands. We continue to share a common history, even common grandparents, with Cree families in Shamattawa, Churchill, Bird, Ilford (Moosecoot), Split Lake (Tataskweyak) and Gillam (Akwayskimakuk).

YFFN Members were the last of the Ininiwak at York Factory. Five family groups continued to spend the summers at York Factory (Kischewaskahekan) – one from Port Nelson

(Pawanikaw), another from Crooked Bank (Wanatawahak), another from Ten Shilling Creek (Seepastik), another from Kaskatamakan and the remainder from Shamattawa.

In the fall of 1956, representatives from Indian Affairs traveled to York Factory (Kischewaskahekan) and told the remaining YFFN Members of plans to close operations at the fort and move the community inland to the southeast side of Split Lake. While the relocation to York Landing (Kawechiwasik) was an unwelcome experience, YFFN Members have now lived in York Landing (Kawechiwasik) for more than 50 years. Younger YFFN Members were born in York Landing (Kawechiwasik) and take occasional trips to York Factory, Ten Shilling Creek, Port Nelson, and Kaskatamakan to conduct traditional activities such as hunting and fishing. York Landing (Kawechiwasik) has become YFFN's home. It was not until 1990 that a small area of reserve land was established for YFFN at York Landing (Kawechiwasik).

In 1957, the year YFFN Members arrived in York Landing (Kawechiwasik), Manitoba Hydro began construction of the Kelsey Generating Station. YFFN was not consulted about the project, although it was built just kilometres from York Landing and would forever change the waters and land. In the 1970's, the Lake Winnipeg Regulation (LWR) and Churchill River Diversion (CRD) proceeded, again without any prior consultation with Cree communities and without any environmental assessment and licensing. The Kettle Generating Station was completed downstream of York Landing (Kawechiwasik) in 1974, followed by the Longspruce Generating Station in 1979. Finally, the Limestone Generating Station was completed in 1990.

The relationship between YFFN and Manitoba Hydro is shaped by a number of legal agreements that have been negotiated over the last 35 years. Although hydroelectric development began on the Nelson River in the 1950's, it wasn't until 1977 when Canada, Manitoba, Manitoba Hydro and five First Nations (Split Lake, Nelson House, York Factory, Norway House and Cross Lake) signed the Northern Flood Agreement. This agreement put a framework and processes in place to address adverse effects of Lake Winnipeg Regulation, the Churchill River Diversion, the Augmented Flow Program, and hydroelectric development on the Nelson and Burntwood Rivers. In 1995, YFFN entered into a second agreement called the Comprehensive Implementation Agreement (CIA), with Canada, Manitoba, and Manitoba Hydro to implement the NFA.

2.5.2 YFFN Worldview, Values, and Traditional Knowledge

Throughout time, YFFN's understanding of the world, its values, and its traditional knowledge have been central to the survival of the YFFN people and the continued respect and stewardship of the land and waters. This was the case several hundred years ago and it remains the case today. So, YFFN's worldview, values and traditional knowledge are rooted in the community's history, culture, and relationship to the land on the coast, and now in the Split Lake and Aiken River area.

YFFN's teachings (*kiskinohamakaywina)* have been handed down through the generations, and continue to be passed on today. These teachings embody the values of YFFN ancestors and today's Elders giving guidance to their community members. These teachings are relevant and applicable to the Keeyask environmental assessment process and the planning, construction and operation of the Keeyask dam.

To YFFN, it is important to show respect (*kistaynitamowin*) when speaking and acting towards *Askiy*, which is the Cree term for the whole of the land, water, people, plants, animals and all things. YFFN is affected by even the smallest changes to *Askiy*. YFFN Members are part of *Askiy* having relied on *Askiy* for as long as they have existed.

For YFFN, it is also important to honour (*kistaynitakosewin*) life and Askiy. These are special gifts that must not be forgotten. YFFN honours life and Askiy through ceremonies since the YFFN members are inherently spiritual people. YFFN believes that everything in life comes from *Munito*. YFFN believes that all things in nature must be respected – that relationships with living and nonliving things are two-way relationships. To live a good life YFFN respects and cares for *Askiy*, other people, and all things in this world for its ancestors and for future generations. This is called *minopimatisiwin* (living the good life).

With the arrival of Europeans many YFFN Members accepted Christianity and Christian beliefs. Today, diverse spiritual beliefs and practices are found among community Members that could be called traditional, Christian or more blended forms of spiritual belief. Regardless, spirituality is very important in YFFN's culture and world view. YFFN's spirituality informs stewardship of the land and YFFN feels that it is important to acknowledge spirituality in the Keeyask Generation Project.

It is very important to YFFN Members to speak truthfully (*tapwaywin*) based on one's knowledge and experience. The truth isn't always pleasant, but by acknowledging the truth it is possible to move forward and build trust with others and come to terms with one's actions and feelings. Trust (*aspehnimowin*) is also important to YFFN Members' relationships with family, friends and working partners. Trust is developed over time through experience with other individuals or groups of people. *Ohcinewin* is a very important Cree concept, which is not easily translated into the English language. Because of the interconnectedness of *Askiy*, if you harm anything, including the land, water, people, plants, and animals, you will experience equally harmful consequences. These repercussions can also come back to those around you, your children or your children's children. This concept applies to all aspects of life. This is a powerful thing, so it is very important to be careful and respect even the use of the word.

It is important to consider one's actions carefully and with caution (*ayakohmisewin*) because of the possible consequences of those actions. When caution is not exercised, mistakes are made. Caution is important so that individuals and our community can avoid disrespectful and harmful actions to others and *Askiy*.

YFFN's traditional knowledge (*ininiwi-kiskénihtamowin*) is held by its Elders and passes from generation to generation. It is a dynamic, living process that is added to and adapted in the lives of successive generations of Cree people. To YFFN, traditional knowledge is more than just information. It lives within YFFN's way of life.

YFFN Elders, Members and resources users continue to maintain their worldview, values and *ininiwi-kiskénihtamowin*. Some of YFFN's traditional knowledge has been documented in community reports. However, YFFN's traditional knowledge isn't just information to be recorded and included in the Environmental Impact Statement (EIS); rather YFFN considers it as an ongoing process of sharing and participating in the partnership. Because traditional knowledge lives within the community's way of life, the process of engaging community Elders, Members and resources users is the most important way that its traditional knowledge, values, and worldview enter the Environmental Impact Assessment (EIA). For this reason, it is crucial that our community representatives, Elders, youth, resources users, and knowledge holders continue to participate in the Keeyask Generation Project's next phases including construction, operation, environmental monitoring and adaptive management.

2.5.3 YFFN Involvement in the Keeyask Process

YFFN's formal involvement in the planning for the Keeyask Generation Project began in 2001, some months after Manitoba Hydro and Tataskweyak Cree Nation (TCN) signed the "Agreement-in-Principle Regarding the Potential Future Development of the Gull Rapids Hydro-Electric Generating Station" (AIP). On September 14, 2001, YFFN, Manitoba Hydro, TCN, War Lake First Nation (WLFN) and Fox Lake Cree Nation (FLCN), signed the Principals' Memorandum setting out the negotiating principles for concluding the JKDA.

On October 15, 2002, YFFN, Manitoba Hydro, TCN, WLFN, and FLCN signed the Negotiating Principles and Process Proposal, which set out, in more detail, the negotiating principles and process for concluding the JKDA. The Negotiating Principles and Process Proposal provided for reimbursement of YFFN's costs to participate in project negotiation, planning and implementation activities. Subsequently, YFFN established the York Factory Future Development office and hired community Members to staff the office and participate in project negotiations, planning and implementation. The funding was also used by YFFN to retain legal and technical advisors to assist the First Nation in the negotiation, planning and implementation activities.

Between 2002 and 2008 YFFN participated with Manitoba Hydro, Cree Nation Partners (CNP – representing TCN and WLFN) and FLCN in the negotiation and drafting of the JKDA. YFFN also participated with the Project partners in various multi-party committees and working groups responsible for considering specific aspects of the Project (*e.g.,* the Keeyask Project Description Committee).

From late 2005 until the spring of 2008, YFFN and Manitoba Hydro negotiated the YFFN Keeyask Adverse Effects Agreement (AEA), which is the compensation package for Project adverse effects on YFFN. The Keeyask AEA emerged out of Article 9 of the 1995 CIA, which states that YFFN and Manitoba Hydro must develop a proposal to compensate YFFN for "known and foreseeable" adverse effects of any Future Development, including the Keeyask Generation Project.

In April, 2008, Hydro presented an offer to YFFN with respect to the total monetary value for compensation. The monetary compensation is provided to YFFN to finance programs to offset Project adverse effects and to compensate for residual adverse effects. The AEA also includes commitments related to monitoring of Project adverse effects.

Manitoba Hydro made its settlement offer, and the AEA was concluded prior to completion of the Keeyask environmental assessment and EIS. The CIA provides for the compensation proposal to be reviewed and modified as may be required to accommodate changes in the proposed Future Development resulting from federal or provincial environmental review and licensing processes.

The AEA also includes provisions to review and modify the agreement if the environmental assessment identifies new information about adverse effects, if the Project is altered by regulators, or if the conditions attached to the Project approval by regulators affect an offsetting program. In such circumstances, changes may be made to the AEA or offsetting program if there is a material change in an adverse effect or if the effectiveness of an offsetting program or other mitigation measure is materially changed.

2.5.4 JKDA AND AEA RATIFICATION

Before YFFN Chief and Council could sign the JKDA, the First Nation was required to hold a referendum to determine whether its Members supported the signing. At the same time that the referendum on the JKDA was held, YFFN Members were also asked to vote on whether they supported Chief and Council signing the AEA. In the period leading up to the referendum poll, between April 2008 and early March 2009, YFFN conducted six rounds of information meetings for Members of the First Nation in each of York Landing, Thompson, Churchill and Winnipeg.

In addition to information meetings, YFFN used several methods to communicate to Members about the JKDA and AEA. A website was set up where Members could access documents and other information about the JKDA and AEA. Full copies of the JKDA and AEA were distributed to Members. A newsletter (in Cree and English) and a plain language summary of the JKDA were prepared and distributed to Members.

The YFFN referendum polls for the JKDA and AEA were held on March 29th, 2009, with advanced polls on March 9th, 2009. The YFFN polls took place seven weeks after the TCN and WLFN referendum polls, which determined a "KCN Majority" in support of the Keeyask Generation Project.

The referendum question asked each YFFN Member if they would support Chief and Council in signing the JKDA—Yes or No and the AEA—Yes or No. In the referendum, YFFN applied the minimum threshold required by the JKDA Ratification Protocol for the poll. A sufficient level of support for Chief and Council to sign the JKDA and AEA required: participation by a minimum of one third of all Members eligible to vote and a majority of votes cast being in favour of the referendum question.

Of 713 eligible voters on- and off-reserve, 261 cast ballots (36.6%). There were 216 "yes" votes in favour of signing the JKDA (83% of valid ballots) and 220 "yes" votes in favour of signing the AEA (84% of valid ballots).

In May 2009, YFFN Chief and Council signed the JKDA and AEA on behalf of YFFN.

2.5.5 YFFN's Decision to Become a Partner in the Keeyask Generation Project

The signing of the JKDA and AEA marked YFFN's decision to become a partner and co-proponent in the Keeyask Generation Project. This decision was not an easy decision for the community to make given the circumstances and the diversity of views held by community Members regarding the Keeyask Generation Project. YFFN Members were faced with a deep moral dilemma in terms of assessing the potential environmental impacts, both negative and positive, that would affect the community. Even with the best planning, mitigation and monitoring programs, YFFN feels that there will still be substantial adverse effects to the land and YFFN's way of life. YFFN has had to try to come to terms with this new role they have adopted in the Keeyask Generation Project.

For YFFN, the decision to sign the JKDA and become a partner in the Keeyask Generation Project was based on wanting to ensure that their youth and future generations will benefit from the prospective revenues, jobs, training, and capacity-building opportunities. Equally important to YFFN has been the ability to participate in the Project and the environmental impact assessment. For YFFN, it is very important to be at the table and participate in the planning, mitigation, monitoring and follow-up, and the adaptive management of the Project. By adding their voices, values, and traditional knowledge to the Keeyask Generation Project, YFFN Members hope to positively impact the Project, reduce adverse effects and contribute to their ongoing role as stewards of the land and waters.

2.5.6 YFFN Involvement in the Keeyask Environmental Impact Assessment

YFFN is involved in the Keeyask environmental assessment through representation on the various key issues working groups mentioned in Section 2.3 (*e.g.*, Mercury and Human Health Working Group, Aquatics Working Group, Mammals Working Group). Also, as mentioned in Section 2.3, YFFN is a member of the Partners Regulatory and Licensing Committee (PRLC) and has one non-voting representative on the EIS Coordination Team. YFFN also participates in the Environmental Studies Working Group (ESWG), on a bilateral basis with Manitoba Hydro, to examine and discuss environmental issues of particular importance to YFFN.

Between 2002 and 2010, YFFN undertook a number of community-based studies to examine environmental and socio-economic issues of specific importance to the community. Studies were undertaken to examine: existing socio-economic and environmental conditions; potential environmental and socio-economic impacts of the Project; socio-economic baseline and sustainability indicators; community goals and future priorities; traditional economic and land based activities; and community history. Community Members were involved in the studies through meetings, workshops, interviews, surveys and field trips. Study reports were provided to Manitoba Hydro and its environmental management team.

The York Factory Future Development office has informed Members about the Keeyask Generation Project and the environmental assessment process through periodic newsletters, community meetings, and workshops, including special meetings and workshops with Elders, resource users, and youth. Cree translation has been provided at meetings and in newsletters. YFFN has communicated the views, concerns and knowledge of its members about Keeyask, and their expectations for the future, through its reports and participation in the project planning and assessment processes.

YFFN continues to keep Members informed about the Keeyask Generation Project by holding community meetings in York Landing and through its website. YFFN has also been involved with Manitoba Hydro and the other Keeyask Cree Nations (KCNs) in the process of preparing the EIS for the Keeyask Generation Station by participating in the working groups, attending issue specific workshops, reviewing and commenting on various EIS volumes and writing its own EIS evaluation report.

YFFN has produced its own evaluation report for the Keeyask EIS called *Kipekiskwaywinan* (Our Voices). *Kipekiskwaywinan* has become a very important document to the community because of how it tells YFFN's story of Keeyask and expresses the concerns, experiences and priorities of Members.

Kipekiskwaywinan is not a tidy, coordinated written account that tries to make community concerns, experiences and priorities sound objective, balanced, certain, predictable and manageable. Rather, the report is full of many contradictions, uneven treatment, bias, fear, anger, wariness, resignation, yet hope. YFFN has stated that its aim was to communicate the impact of this project and partnership on the community and people. YFFN Members have differed with each other in meetings and workshops; some YFFN Members have shed tears while trying to describe the pain of changes to their way of life and the threats to their cultural survival. *Kipekiskwaywinan* has been very important for YFFN Members in terms of reflecting upon, discussing and beginning to come to terms with the effects of past hydro-electric development and the potential effects of the Keeyask Generation Project.

2.5.7 YFFN CONCLUSIONS

Through its participation in the Keeyask Generation Project and the Environment Impact Assessment, YFFN has been acutely aware of the role it will play in the potential environmental impacts, both positive and negative, as well as the mitigation measures, monitoring and follow-up programs, and adaptive management of the Keeyask Generation Project.

YFFN's history and experience with past hydro-electric development has understandably led to a level of distrust and skepticism of some of the scientific predictions. YFFN, however, is optimistic and hopeful moving forward in partnership with Manitoba Hydro and the other KCNs. Moving forward in partnership is very important to YFFN in terms of building a better relationship with its partners, continuing to learn about and manage the environmental impacts of the Keeyask Generation Project, maintaining its cultural values, practices, and traditional knowledge through the Keeyask Generation Project, and ensuring various economic benefits for its youth and future generations.

It is important to YFFN to work together as a partnership to continuously reconcile their role in the partnership, heal past wounds related to hydro-electric development, and build trustworthy relationships, through processes, programs and decision-making, for the life of this project and partnership. YFFN especially wants their children and future generations to know that they entered into this partnership with these feelings and deep misgivings, insisting on a long term, ongoing commitment to healing, reconciliation, mutual respect and self-determination.

YFFN's worldview, values, and traditional knowledge inform and adapt along with the Keeyask Generation Project. YFFN believes the only way they can succeed in this partnership, and the partnership can succeed, is to hold onto and apply their worldview, values, and traditional knowledge (*ininiwi-kiskénihtamowin*) of the Elders, resource users, youth and community members to the Keeyask Generation Project. YFFN feels that this will be crucial if their community is to continue to adapt, maintain their way of life, and achieve positive outcomes in the Keeyask partnership.

YFFN is cautious (*ayakohmisewin*) for what lies ahead, but as YFFN has had to do many times since first contact with European colonizers, YFFN sees the need and importance in adapting while maintaining their culture, teachings, and way of life. YFFN is approaching the Keeyask partnership with hope and determination to keep their values, participate in mitigation, monitoring and follow-up, and adaptive management, and provide opportunities for their youth and future generations. It is YFFN's future generations who will inherit the outcomes of this project and partnership.

2.6 FOX LAKE CREE NATION INVOLVEMENT IN THE PROJECT

2.6.1 FLCN HISTORICAL CONTEXT

Fox Lake people have lived for generations in the northeast region of Manitoba, embraced by rivers, lakes, and muskeg. The *Kischi Sipi*, or "Great River" (Nelson River), is the largest water system to flow through the Fox Lake people's territory. Fox Lake people's history is rooted in stories, landmarks, relationships among land, people and animals, and through *Inninimowin*[1] (translates to: "the language we speak"). Fox Lake *Ininewak* are descendants of the peoples who inhabited the boreal forest east of the *Kischi Sipi* for centuries prior to the fur trade. Like the other First Nations involved in Keeyask, our history is multifaceted - Fox Lake peoples' ancestors can be traced to York Factory, Fort Severn and even as far as Big Trout Lake Ontario. Today our relations can be linked to York Factory First Nation, Tataskweyak Cree Nation, War Lake First Nation and Shamattawa First Nation.

More specifically, Fox Lake peoples' relationship to the land and waters can be viewed as complex. This relationship is reflected in the oral tradition (stories, legends) about *Askiy* (the Inninimowin word for the people and their interconnections with the land, water, resources, animals and fish); the naming and remembering of places and landmarks; the use and navigation of the local landscape and waterways; important events and the maintenance of Nation-to-Nation relationships such as Treaty (*Ininewak*– Crown), hunting alliances, and marriage. Embedded within *Ininewak* society is a philosophy referred to as *mino pimatisiwin*. *Mino pimatisiwin*, which is the overall health of a people and *Askiy*, is a fundamental *Ininewak*

1 Note on Inninuw terminology – it should be emphasized that there is no standardized spelling formats for Inninuw in English. The spelling of place names in this document has incorporated the Roman Orthography approach in an attempt to duplicate the First Nation verbal pronunciation into an English sounding word. Another point to remember is that there can be additional place names with First Nations with a different spelling. Makeso Sakahikan Ininewak Kitayatisuk, hunters, trappers and fishers, have generally accepted the Inninuw place names noted in this document and its interpretation. For FLCN, the accepted spelling of several Inninuw terms is slightly different – for example, FLCN spell Ininewak as Inninuwak and Askiy as Aski.

value. Human well-being is dependent upon the well-being of *Askiy*, including our perceptions of the well-being of *Askiy*. It is our responsibility to care for and nurture the well-being of *Askiy*, so that it can provide for the future *Inninuwak*.

It is important for Fox Lake Cree Nation that both Manitoba Hydro and the Regulators understand FLCN's relationship to the lands and waters within areas to be affected by the Keeyask Project. Areas traditionally used by Fox Lake members have been greatly impacted by fifty years of dam building. Fox Lake's Core *Kitayatisuk* (Elders) and Harvester Group have indicated that some Members have used and still use the lands and waters along the *Kischi Sipi* between Gull and Conawapa Rapids, including inland areas along streams and creeks.

Fox Lake views all Hydro projects, including Keeyask, as one continuous staged process of development with long-term and cumulative impacts. Unlike in the past, Fox Lake now has an opportunity to participate as a partner and to educate, inform and influence the Keeyask Project. This partnership serves as a way to ensure the protection of *Askiy*. *Askiy* is the foundation of the Cree worldview and embodies the cultural, spiritual, and physical well-being - it must be protected, both now and into the future.

2.6.2 LAYING THE FOUNDATION FOR DIPLOMATIC RELATIONSHIPS: FORGOTTEN NATION IN THE SHADOWS OF THE DAMS

To understand the Keeyask Project from the issues and perspectives of FLCN, it is important that Fox Lake reminds the reader that the early interactions with Manitoba Hydro have not been pleasant. *The Forgotten Nation in the Shadows of the Dams* (1997) is based on the oral tradition, the available written record, and academic studies and examines the benefits and disparities caused by the project as a result of lack of consultation, relocation and destruction of people's homes in Gillam, inadequate adjustment measures, adverse effects to *Askiy,* socio-economic impacts, lack of access to Manitoba Hydro jobs, and non-participation in the Northern Flood Agreement. As the population of Gillam area grew from a few hundred to several thousand in less than two years, FLCN homelands were bombarded with migrant workers, and the *Askiy*, upon which Fox Lake members relied for hunting, fishing, trapping and gathering, was flooded and forever transformed. Hydro development was an instrumental reason for the failure to have land set aside for a Reserve in Gillam. All of these factors are documented in this report to demonstrate the abrupt, forced transition for Fox Lake peoples from a self-sustaining and self-determined community, to a community rife with social issues and despair. This report sets out the basis of Fox Lake Cree Nation's grievances concerning the effects of past hydroelectric projects on *Askiy*. The concluding chapter in this document offers ideas for change. Seven years later, the Impact Settlement Agreement was achieved.

2.6.3 COMMUNITY HISTORY DOCUMENT: NINAN AND COMMUNITY HISTORY VIDEO

Ninan (draft) is a compilation of oral histories about a wide range of themes, including: Cree legends and stories, livelihoods and family life, community values and norms, and institutional experiences such as the forced-enrolment of children to residential schools, hydroelectric development, denial of a reserve, and other systematic means of discrimination. The draft history document illustrates inherent *Ininewak* values that are embedded in Fox Lake Cree society, such as living *mino pimatisiwin*, caring for *Askiy* and other philosophical values and perspectives. The data collected in this project was digitally archived. The community video illustrates the human impacts of hydro development in FLCN traditional territory and how the community expresses their story of the Keeyask Project.

2.6.4 FLCN TRADITIONAL KNOWLEDGE PROGRAM

The Fox Lake Traditional Knowledge Program emerged at a later stage of the environmental assessment process. FLCN asserts that if any TK or *Askiy Keskentamowin* (AK) work is to be done with its Members, then it must be led and directed by Fox Lake. The project commenced in January of 2009, in a team meeting to seek guidance and advice from key Elders and harvesters, as well as to identify key individuals for map biographies. The study team recruited individuals through *Fox Tracks* (FLCN's newsletter), posters and leaflets, as well as through word of mouth. The communication literature emphasized the importance of protecting and preserving Fox Lake peoples' knowledge for the young people and for the future generations.

Research methods included: in-depth, in-person, open-ended interviews. Elders and *Kitayatisuk* participated in interviews. After each interview, the TK facilitators transcribed the interviews, a time-consuming and demanding undertaking. Many Elders speak 'High Cree', which is an older dialect of Cree and in order to extract the messages being shared, collaboration with other Cree speakers and references to a dictionary prepared by missionaries at York Factory was undertaken.

Fox Lake people were also invited to participate in community mapping sessions specifically related to Cree place names and caribou, fish, moose migration patterns. Along with providing valuable traditional knowledge, the sessions provided an opportunity for participants to socialize and learn from one another, especially between Elders and the younger generation.

The study team and several key Elders and harvesters spent several days visiting key sites between July and December 2009, to ground-truth the results of the interviews and mapping sessions. Global positioning system (GPS) points were recorded at each location of interest, and detailed field notes were recorded. Once the report was drafted, interviewees also had an opportunity to meet with the principal author and a facilitator to review the draft report and clarify their main points.

The study report findings assert:

1. Importance of Cree language;
2. Former and ongoing resource use within the Keeyask area;
3. Perceptions of water, fish (sturgeon, whitefish, brook trout, suckers, jackfish, walleye, fish preparation and perception of fish);
4. Perceptions of land;
5. Waterfowl (Geese and Ducks);
6. Furbearers (Muskrat, beaver, rabbit, fisher, martin and lynx);
7. Caribou – including caribou crossings, types of caribou and caribou preparation;
8. Moose;
9. Wolves;
10. Other Animals;
11. Medicine and berry harvesting;
12. Honouring the Ancient Ancestors though Archeology; and
13. Overall changes to *Askiy*, including flooding, animal sickness, and reminiscence of a better time (i.e. life before the flood).

The traditional knowledge program team was then tasked with analyzing those findings to identify themes, and to determine the potential Keeyask Project impacts facing FLCN, based on the experience and historical knowledge of its citizens. The team identified four themes.

- Aquatic Environment:
  - Keeyask Generating Station Project impacts;
  - Water quality;
  - Sedimentation;
  - Fish quality;
  - Sturgeon; and
  - Brook Trout.
- Terrestrial Environment:
  - Keeyask Generating Station Project impacts;
  - Wildlife;
  - Caribou;
  - Erosion;
  - Access; and
  - Resource use.
- Importance of Traditional Knowledge Programs or what FLCN Elders now refer to as *Askiy Keskentamowin* (AK).
- Stephens Reservoir as a model for the Keeyask Reservoir, as far as applicable, to understand potential physical and biological effects and possible ways of mitigating those effects.

The Fox Lake Traditional Knowledge draft report produced the following recommendations on 12 topics. These recommendations are not all Keeyask specific.

2.6.4.1 Cree Language or Inninimowin (the language we speak)

A recurrent theme, specially held by the *Kitayatisuk* (Elders), was the importance of Inninimowin to FLCN, due to the implications inherent for an intact *Ininewak* society. Participants strongly recommended that FLCN pursue measures to revitalize the language, and to continue to re-establish and affirm the original place names. This has started with programs in Fox Lake's AEA.

2.6.4.2 Traditional Knowledge or Ininewak Askiy Keskentamowin Programs

FLCN has taken significant steps to direct who, what and how research is conducted involving the documentation of its traditional knowledge/*Askiy* knowledge. The draft report recommended that Fox Lake people lead and advance the research of their community, which will foster the ability to build capacity on many levels. The draft report further notes that traditional knowledge programs require contributions from the whole community; that traditional knowledge programs need to be integrated into the initial planning stages of development. FLCN asserts that traditional knowledge studies need to be a continuous process, since it is a dynamic, evolving knowledge system. In line with this recommendation, FLCN has stressed the inclusion of traditional knowledge programs as part of its long-tem community monitoring associated with the Keeyask Generation Project and other developments in areas traditionally used by FLCN Members.

2.6.4.3 Cree Foods Initiatives

FLCN identified the need for a community-wide assessment of wild food consumption due to concerns about contaminants, particularly mercury.

2.6.4.4 Cache Lake

Butnau River and Cache Lake were important to FLCN members prior to the development of the Kettle Generating Station in the 1970s, and continue to be used today.

2.6.4.5 Importance of Ground Truthing

The draft report affirms the importance of the involvement and participation of local resource users in ground-truthing traditional knowledge and recommends more ground-truthing by experienced local resource users in future studies and monitoring programs.

2.6.4.6 Gravesite Protocol

Noting impacts of past projects on ancient graves, FLCN is currently involved in internal discussions to develop a FLCN protocol for identifying, protecting and addressing the burials and gravesites of its Members in the Fox Lake RMA and the Gillam area.

2.6.4.7 Holistic Kischi Sipi (Nelson River) Management

Noting changes occurring in concepts of land ownership and management since colonization, FLCN encourages a greater understanding of this concept to the region's

Indigenous, and more specifically Cree, peoples. Such an undertaking could foster genuine working relationships concerning river management. Historically the river was shared by all of the communities and continues to be used today and based on *Ininewak* time-honoured philosophy, *Askiy* cannot be owned.

2.6.4.8 Resource Use

The traditional use study revealed that the resource users will be affected by the Keeyask Project to a greater extent than initially understood. Therefore, FLCN will continue to discuss ways to implement the alternative resource use (or off-set) program that is included in FLAEA.

2.6.4.9 Lake Sturgeon Mitigation

FLCN, as a Partner, has stated that it must continue to be involved in any and all Partnership plans to mitigate the effects of the Keeyask Project on sturgeon. Collecting sturgeon eggs and stocking programs require protocols that reflect FLCN values and knowledge system; FLCN has been part of these discussions.

2.6.4.10 Erosion

FLCN recommends long-tem monitoring of erosion on Stephens Lake, which FLCN refers to as Stephens Reservoir.

2.6.4.11 Water Regime Changes

FLCN noted that its members are concerned about the cumulative and on-going effects of past projects on the *Kischi Sipi* (Nelson River).

The draft Fox Lake Cree Nation Traditional Knowledge study report indicates that historically the Keeyask area was used by KCNs Members and continues to be used today. The draft report concludes that the Fox Lake people are resilient, and continue on their journey to foster the Ininewak concept of how traditional knowledge can inform and improve the quality of environmental studies being conducted in preparation for future hydroelectric development. Not only is the collection of time-honoured traditional knowledge important, it is essential to collect and preserve such knowledge while key knowledge-holders are still with us.

2.6.5 FLCN INVOLVEMENT IN THE ENVIRONMENTAL ASSESSMENT AND REGULATORY PROCESSES

Through the Keeyask environmental assessment process, FLCN participates diligently in both multilateral and bilateral tables concerning the protection of *Askiy*. These tables include: the Environmental Studies Working Group, Environment Impact Statement Coordinators Group, Partners Regulatory and Licensing Committee, Mammals Working Group, Aquatics Working Group, Mercury and Human Health Technical Working Group and various aquatic and mammals subgroups with the other Keeyask partners. FLCN ensures that members are informed about the Project though community meetings, website, community newspaper – Fox Tracks, and memos. Informational literature is often translated into Cree syllabics. FLCN also participates as a Partner in reviewing and commenting on the various Environment Impact Statement (EIS) documents and writing of its own environment evaluation report.

2.6.6 INVOLVEMENT IN THE KEEYASK GENERATION PROJECT: JKDA AND FOX LAKE ADVERSE EFFECTS AGREEMENT

Through the signing of the JKDA in May of 2009, Fox Lake Cree Nation (FLCN) decided to engage in the Keeyask Partnership to maximize benefits for the people of FLCN. Before FLCN Chief and Council could sign the JKDA and FLAEA, FLCN leadership held a referendum on March 11, 2009, to determine whether they had permission to sign the Joint Keeyask Development Agreement (JKDA) and the Fox Lake Adverse Effects Agreement (FLAEA). In the period leading up to the referendum, the Fox Lake Future Development team hosted a series of thirty community information sessions in Bird, Gillam, Thompson, Churchill and Winnipeg. Also, copies of the JKDA and FLAEA were mailed to all identified Fox Lake members.

The results of this referendum are as follows:

Out of 726 eligible voters, 268 ballots, or 36.9% of eligible voters were cast. Of those, 87% voted in favor of the JKDA and 91% voted in favour of the FLAEA. Because Council had earlier decided to include as many members in the voting process as possible, a second referendum was held resulting in 345 FLCN voters participating (47% of those eligible). Of those, 92% voted in favour of the JKDA and 94% voted in favour of the FLAEA.

2.6.6.1 THE FOX LAKE ADVERSE EFFECTS AGREEMENT: PROTECTING ASKIY AND DEALING WITH KEEYASK EFFECTS BEFORE THEY OCCUR

The signing of the JKDA and the AEA by FLCN leadership, exemplifies a position to ensure that our needs and interests are looked after and we are not left behind, again forgotten in the shadows of the hydroelectric development. Being a partner in the Keeyask Project is based on our needs and desire to look out for the youth and future generations of Fox Lake.

FLCN negotiated monies for programs such as the following:

1. Gathering Centre;
2. Youth Wilderness Traditions Program;
3. Cree language program;
4. Gravesite Restoration Program;
5. Lateral Violence;
6. "Where do we go from Here" Program; and
7. Alternative Resource Use Program.

It is important to illustrate that the FLAEA notes that the Keeyask Environment Assessment and some of FLCN's own assessment studies were not complete at the time of the signing of the AEA and FLCN negotiated provisions for possible amendment to the agreement in the future. However, even within this partnership, FLCN is aware that *Askiy* will forever be altered, and therefore will make every effort to ensure that *Askiy* is protected. FLCN's priority was to prevent, avoid, or lessen the adverse effects and then to provide appropriate replacements, substitutions or opportunities to offset any remaining adverse effects. Many of the adverse effects address the influx of migrant workers to FLCN local area.

Through this involvement, FLCN hopes to be better prepared to work toward the mechanisms needed to mitigate the negative impacts of the project. FLCN intends to take full advantage of any positive opportunities that result from the project while ensuring our treaty and Aboriginal rights are protected and maintained. Manitoba Hydro (acting on behalf of the Keeyask Hydropower Limited Partnership) remains responsible for negotiating the compensation to commercial trappers for direct losses or damages originating from the Project. In signing the agreement, FLCN provided releases concerning impacts of the Project on its treaty and Aboriginal rights.

2.6.7 FLCN CONCLUSIONS

FLCN is in the midst of rebuilding its community from the devastating effects of past projects, while at the same time trying to prepare for the oncoming projects such as South Access Road, BiPole III, Keewatinoow Converter Station and Conawapa, to ensure that a repeat of the past will never occur. FLCN and its Members are continuing to grow and move forward, while maintaining our culture, and ways of knowing. Through a further understanding of and reuniting with our history, values and language, we are better able to take control and to self-determine of our future. FLCN remains committed to the Keeyask Partnership, but will also ensure that the voice of its people continues to be heard.

2.7 MANITOBA HYDRO

2.7.1 MISSION AND SUSTAINABILITY GOALS

Manitoba Hydro is the province's major energy utility. It serves over 525,000 electricity customers throughout Manitoba and exports electricity to utilities through its participation in three wholesale markets in Canada and the mid-western United States. Nearly all electricity generated by Manitoba Hydro is from self-renewing water power from 14 hydroelectric generating stations, primarily on the Winnipeg, Saskatchewan and Nelson rivers. It is also the major distributor of natural gas in the province, delivering natural gas to 265,000 customers in nearly 100 communities in the province.

With assets approaching $13 billion it has grown to become one of Canada's largest public utility companies servicing the electricity needs of all Manitobans and contributing to the economic development of the province and Canada. Its domestic electricity rates are among the lowest in North America.

The corporation is governed through the Manitoba Hydro-Electric Board. Members are appointed by the Lieutenant-Governor in Council. The vision of the corporation is: "To be the best utility in North America with respect to safety, rates, reliability, customer satisfaction, and environmental leadership, and to always be considerate of the needs of customers, employees, and stakeholders." The corporation seeks to enact this vision through its mission statement and a comprehensive and measureable set of specific goals which have been incorporated into its strategic plan. The mission of the corporation is: "To provide for the continuance of a supply of energy to meet the needs of the province and to promote economy and efficiency in the development, generation, transmission, distribution, supply, and end-use of energy."

The corporation's strategic plan for 2011/2012 identifies nine specific goals as follows:

- Improve safety in the workplace;
- Provide exceptional customer value;
- Strengthen working relationships with Aboriginal peoples;
- Maintain financial strength;
- Extend and protect access to North American energy markets and profitable export sales;
- Attract, develop, and retain a highly skilled and motivated workforce that reflects the demographics of Manitoba;
- Protect the environment in everything that we do;
- Promote cost effective energy, conservation and innovation; and
- Be recognized as an outstanding corporate citizen and a supporter of economic development in Manitoba.

Of particular importance to the Keeyask Generation Project and, in this instance, the KCNs, is the commitment Manitoba Hydro has made to sustainable development. In 1993, the corporation adopted a sustainable development policy and 13 complementary guiding principles based on the principles and guidelines of sustainable development adopted by the Manitoba Round Table on Environment and Economy. The policy and the 13 principles represent a guiding influence for the corporation's decisions, actions, and day-to-day operations.

These principles have been applied in developing the Partnership with the Keeyask partners and in advancing the Keeyask Generation Project through to fruition. A further elaboration of these principles and their relationship to the Project can be found in Chapter 9.

As a means of putting into practice Manitoba Hydro's commitment to sustainable development, the corporation has developed and implemented an environmental management system (EMS) that meets international standards. As a set of tools and processes used to realize environmental goals, an EMS enables Manitoba Hydro to identify its environmental impacts, set goals to manage them, implement plans to meet those objectives, evaluate performance, and make continual improvements to the system.

Manitoba Hydro has exercised a strong leadership role in both formulating and advancing sustainability principles within the Canadian Hydropower Association (CHA), the national trade association dedicated to representing the interests of the hydropower industry whose members represent more than 95% of the hydropower capacity in Canada. As well, in a similar leadership capacity with the UNESCO-based International Hydropower Association (IHA), Manitoba Hydro has contributed to and supported the development of a

Sustainability Assessment Protocol. The protocol has enjoyed wide acceptance from the hydropower industry, non-government organizations and international financial institutions. The use of the protocol is voluntary and is not required by Canadian regulation. However, applying the protocol could obtain international recognition of Keeyask's sustainability attributes. Subjected to an independent audit assessment, the Partnership will participate in the IHA process to assess the Project using the new protocol.

As a demonstration of its commitment to furthering the sustainability goals and standards of both of these organizations, senior executives at Manitoba Hydro have been and continue to be involved in the governance and direction of the CHA and IHA.

Manitoba Hydro is also a member of the Canadian Electricity Association (CEA) and an active participant in its Sustainable Electricity program. Sustainable Electricity is an industry-wide sustainability initiative that addresses the three components of sustainability: environment, society, and the economy. The program enables the electricity industry to take a holistic approach to managing its impacts and securing a collective energy future.

Manitoba Hydro understands that the future of hydroelectric generation in northern Manitoba must include Aboriginal peoples. This recognition extends beyond meaningful consultation and appropriate accommodation to enabling Aboriginal communities to share in the wealth and opportunity arising from the development of the water power resources in their traditional territory. Manitoba Hydro would be among the first to acknowledge that such has not always been the case and that Aboriginal people in northern Manitoba have been negatively impacted by hydroelectric developments in the past.

Through a deliberate, concerted and concentrated effort, the corporation has worked diligently in recent decades and taken steps toward reconciliation. It has endeavoured to repair damaged relationships, to acknowledge and compensate for past damages from hydroelectric development, and to build positive and durable relationships with Aboriginal people who live in the vicinity of northern hydroelectric developments. This has extended to include participation in new hydroelectric developments. Difficult legacies take time and trust to overcome and despite obstacles, representatives from First Nations communities and senior officials with Manitoba Hydro and their professional representatives have worked constructively to improve relationships and create business partnerships that accommodate the social and economic aspirations of First Nations people in a manner which also allows their vital cultural and spiritual traditions to strengthen and flourish.

The Partnership announced in June 2011 that it is planning to proceed with the Keeyask Generation Project. The Premier, the Chiefs of the four Keeyask Cree Nations, and then President and CEO of Manitoba Hydro, Mr. Bob Brennan, spoke at the announcement. Mr. Brennan stated:

> I am extremely proud to participate in the launch of Keeyask with our partners. Manitoba Hydro's approach today to developing new generation facilities in a close working relationship with Aboriginal communities ensures local people share in the immediate and long-term benefits. Working together on project planning and

environmental studies has helped to increase local benefits and reduce and manage environmental impacts, with mitigation and compensation addressed before development proceeds.

APPENDIX 2A

ABORIGINAL TRADITIONAL KNOWLEDGE PRINCIPLES WITHIN THE KEEYASK ENVIRONMENTAL IMPACT STATEMENT

KEEYASK
Hydropower Limited Partnership

Common Principles Regarding Inclusion of Aboriginal Traditional Knowledge in the Keeyask Environmental Assessment

The principles set out here have been developed by Manitoba Hydro with TCN, WLCN, YFFN and FLCN (the Keeyask Cree Nations) to reflect how their Aboriginal traditional knowledge is being and will be included in the Environmental Assessment for the Keeyask Generation Project.

1. **Giving Equal Weight**

   The EA process honours and respects ATK and the Cree worldview. The EA aims to give equal weight to ATK and western science. It is recognized that ATK has value in and of itself.

2. **Ensuring Visibility**

   ATK will have a distinguishable voice in the Environmental Impact Statement (EIS), and will not be melded with western science so as to become invisible.

3. **Maintaining Authority and Confidentiality**

   Aboriginal people have authority and control over their traditional knowledge. Each KCN, together with its knowledge holders, will choose whether the source of its knowledge is to be acknowledged in the EIS document, or to remain confidential.

4. **Leading Documentation - Rigorous and Defensible Methods**

   Each KCN is taking the lead role in collecting and documenting their ATK. Rigorous and defensible methods will be used to collect and document ATK.

5. **Acknowledging Worldviews**

   The EA process and the EIS document recognize Cree knowledge and western science as distinct worldviews. ATK is more than just information about resources and resource use. There is a role for ATK in each step of the EA process.

6. Building and Sustaining Respectful Relationships

The EA process aims to foster communication and knowledge-sharing, and to build and sustain respectful relationships between Manitoba Hydro and the KCN communities.

7. Acknowledging the Past

Acknowledge the past in the EA process as providing context for the assessment (including temporal context).

8. Reflecting Cultural Values and Spirituality

Cree spirituality and cultural values are being and will be reflected in the EA process.

9. Acknowledging Caution and Addressing Uncertainty

Acknowledge and respect the caution that many KCN members have about predictions of environmental effects of hydro-electric development (*e.g.*, uncertainty associated with predictive models). It is important to employ a precautionary approach that identifies knowledge gaps and recognizes the uncertainty of predictions.

APPENDIX 2B

CREE WORLDVIEW SYLLABICS

Keeyask Hydropower Limited Partnership

The following Cree syllabic translation is provided by York Factory First Nation as their interpretation of the KCNs Cree worldview found in Chapter 2. It should be noted that Cree syllabics differ amongst Cree Nations across Canada.

ᐃᐣᓂᓂᐤ ᑲᑭᓯᐱᒪᑎᓯ ᐊᐢᑭᐣᓄᐤ ᑲᓯᑲᐣᓇᐤᐊᐧᐸᑕᑭᐠ

Ininewak Askiy Kasikannowapachikatek

ᑭᓇᐣ ᑲᓄᐤ ᑲᓀᓯᔭᐠ ᐃᓂᓂᐊᐠ, ᑕᑕᐢᑫᔭᐤ ᐃᓂᓂᐊᐠ ᒧᓯᑯᒥᓯᐤ ᐃᓂᓂᐊᐠ, ᒪᑫᓯᐤᓴᑲᐃᐧᑲᐣ ᐃᓂᓂᐊᐠ ᒥᓇ ᑭᒋᐊᐢᑲᐃᑲ ᐃᓂᓂᐊᐠ, ᐁᑯᐣᓂᐠ ᐅᑯ ᑲᐃᐧᐃᒣᐊᐧᑲᐣᓂᒪᒋᐠ ᐅᓂᐢᑯᐳᒋᑫᐧᐊ ᐊᐣᑕ ᑭᔭᐢᑯ ᐸᐤᐢᑎᑯᐠ.

ᐁᑯᒪ ᑲᔭᑎᒪᓯᓇᐃᑲᑌᐠ ᒧᓇ ᒥᑐᓂ ᑭᑭᓯᑕᓂᐊᐣ ᐊᐁᐧᓂᑭ ᑭᓇᓇᐠ ᑕᓂᓯ ᑲᑭᓯᐱᒪᒍᐅᔭᐠ. ᒥᓇ ᐊᐣᓂᑭ ᑲᓯᐸᐯᔭᐠᑯᒋᐠ ᑭᑎᐯᓂᒪᑲᐣᓇᓇᐠ ᐁᑯᐤ ᐊᑕᐃᓇ. ᒪᑦᒪᐤ ᐅᒪ ᑲᑎᒪᓯᓇᐃᑲᑌᐠ ᐅᑦᒪᒋ. ᐊᐁᐣᓂᑭ ᑭᓇᐣᓇᐣ ᒥᓇ ᑲᑭᓯᐱᒪᒍᐅᔭ ᒥᓇᐁᑕᐯᒪᐠᑲᐠ. ᑭᐢᑌᑕᑯᐣ ᑕᑐᑕᒪᐠ ᑕᐃᐧᒋᐃᑯᔭᐠ ᐅᒪ ᑭᔭᐢ ᑭᐸᐃᑲᐣ.

ᐃᓂᓂᐊᐠ - Ininewak[1]

- ᑭᓇᓇ ᐃᓂᓂᐊᐠ, ᒪᓂᑐ ᑲᑭ ᐊᓂᑯᔭᐠ ᐅᑕ ᐊᐢᑭᐠ. ᑭᑕᓇᓇᑲᒋᑕᔭᐠ ᐊᐢᑭ ᑕᑲᐣᓇᐁᐣᑕᒪᐠ ᑯᔭᐠ ᐊᐢᑭ.
- ᑭᑕᔭᑦᒧᐃᐧᓇᐣ ᑭᑎᓂᓂᒧᐤᐃᓇ ᑭᐢᑌᑕᑯᐣ ᐊᐧᐁᐧᓂᑭ ᑭᓇᓇᐣ ᑲᓯᐱᒪᑎᓯᔭᐠ ᒥᓇ ᑲᑐᑕᒪ ᐅᑕ ᐊᐢᑭᐠ ᐁᑯ ᒥᓇ ᐅᒪ ᑲᓯᐊᔭᒥᔭᐠ ᑕᑲᓇᐁᐧᐣᒋᑲᑌᐠ.
- ᒥᑐᓂ ᑭᑕᔭᐣᓇᐤ ᑕᐃᐧᒋᐊᐠᑯᐠ ᑲᑎᐯᓂᒪᑯᐠ ᑭᑎᑕᐃᓇᐠ ᒥᓇ ᑲᑭᓇᐧ ᐃᓂᓂᐃᐠ. ᐁᑯᑕ ᑕᐤᒋᑭᐢᑫᑕᒪ ᐁᓂᓂᐃᐧᔭᐠ.

ᐊᐢᑭ - Askiy

- ᐊᐢᑭ ᐁᑯᒪ ᐃᐧᑌᐤᐃᐣ ᑲᔭᐸᒋᑕᔭᐠ ᑭᑭᓇᐣ ᐃᓂᓂᐊᐠ ᒥᓯᐁ ᐊᐢᑭ, ᓂᐱ, ᐊᐃᐧᔭᐢᓯᓴᐠ ᑲᐣᑕᑭᐠ ᐊᐢᑭᐠ ᒪᐢᑭᑭᔭ ᐃᓂᓂᐊᐠᑲᑭᓇ ᒥᓇ ᑲᐣᑕᑭᒪᑲᐠ ᑫᑯᐣᓇ.
- ᑲᑭᐣᓇ ᑫᑯᐣᓇ ᐱᒪᑕᓄ, ᐊᒐᑯᐊᐣᓄ, ᐊᐢᑭ ᑲᒋᒪᑲᐠ.
- ᐊᐢᑭ ᒥᓇ ᑲᑭᓇᐤ ᑫᑯᓇ ᑲᒋᒪᑲᐠ ᑭᐢᒐᐃᐧᐊᓄ ᐃᓂᑯ ᑭᓇᓇᐣ ᒪᓇᑐ.
- ᑭᑭᐢᑫᑕᒧᐃᓇᓇ ᐊᒐᑯᐱᒪᑎᓯᐃᐧᐣ ᒥᓇ ᐊᒋᒧᐃᓇ ᑲᓯᑭᐢᑫᑕᒪᐠ ᐁᑯᒪ ᐊᐢᑭ ᐅᒋ.
- ᑲᑭᓇᐤ ᑫᑯ ᐅᑕ ᐊᐢᑭ.
- ᑲᑭᓇᐤ ᐊᐁᐧᓇ ᒥᓇ ᑲᑭᓇᐧ ᑫᑯ ᐅᑕ ᐊᐢᑭ ᑭᑲᓇᐁᐧᑕᒪᑲᐃᐧᓇᐣ.

ᑭᐊᐠᑯᑌᐣᓇ - Niwakomakanak[2]

- ᑲᑭᓇᐤ ᑫᐠᑯᐣ ᑭᐊᐠᑯᑌᐣᓇᐤ ᑲᑭᓇᐤ ᑫᑯᐣ ᐯᔭᐠᑯ ᑭᑎᓯᐊᑐᑲᑌᓇ ᑲᑭᓇᐤ ᑭᐊᐧᑯᒥᑎᓇᐤ
- ᑲᓯᐊᐠᑯᑕᒪᐠ ᐊᐢᑭ ᑭᐢᑌᑕᑯᓄ ᑲᓯᐱᒪᒋᐤᐅᔭᐠ ᐊᐁᓇᑭᓇ ᐊᒐᑯᐱᒪᑎᓯᐃᓂᐠ ᒥᓇ ᐁᑐᑕᒪ ᑫᑯᓇ.

- ᑲᓯᐊᐠᑯᑕᒪᐠ ᐊᐢᑭ ᑭᐢᑌᓂᑕᑯ ᐁᔭᐢᐯᓂᒧᑐᑕᒪᐠ ᒥᓇ ᑭᑌᑕᒧᐃᐧᓂ ᑲᑭᓇ ᑫᑯᐣ ᐊᐢᑭ ᐅᒋ.
- ᐃᓂᓂᐊᐠ ᑭᐢᑌᑕᒡᒧᐠ ᑲᑭᓇ ᑫᑯᓇ ᐅᑕ ᐊᐢᑭᐠ.

ᒥᓄᐤ ᐱᒪᑎᐢᓯᐃᐧᐣ – Minopimatisiwin

- ᒥᓇ ᐱᒪᑎᓯᐃᐣ ᐁᑯ ᑯᐧᔭᐢᑕᓯᐱᒪᑎᓯᔭᐠ, ᐁᑯ ᒥᓇ ᒥᒣ ᑫᑯᓇᐊᓯᒋ, ᑕᐱᐢᑯ ᑯᔭᐢ ᑕᓂᓂᐃᔭᐠ, ᑲᑭᐢᑌᑕᒪᐠ ᐊᐢᑭ ᒥᓇ ᐁᒥᓄᐢᑲᑯᔭᐠ ᓇᑐᒥᒋ, ᒥᓇ ᑲᑭᓇᐧ ᑫᑯᐣ ᑲᑐᑕᒪᐠ ᑫᓯᐸᒋᑕᔭᐠ.
- ᑲᓇᐁᓂᒋᑫᐃᐧᐣ ᑭᑲᓇᐁᑌᓇᐤ ᐊᐢᑭ ᐃᓂᓂᐊᐠ ᐅᒋ ᐊᓄᐧ ᑲᑭᓯᑲ ᑭᔭᐱᐧ, ᒥᓇ ᐊᓂᑭ ᑫᐊᑎ ᐊᐣᓂᐢᑫ ᐱᒪᑎᓯᒋᐠ.
- ᑭᑕᔭᒥᐊᐣᓇᐤ ᒥᓇ ᑭᓇᓇᐢᑯᒧᓇᐣ ᑲᑭᓇᐤ ᑫᑯ ᐊᐢᑭ ᑲᒋᒥᓂᑲᐤᐃᐧᔭᐠ.
- <u>ᐅᒋᓄᐤᐃᐣ</u> - ᑭᓱᐱᐣ ᐊᐤᐁᓇ ᐊᐣᓂᓯᓂᐤ ᐁᑲ ᑯᐤᔭᐢ ᑲᑐᑕᐠ ᑫᑯᐣ ᐊᐢᑭ ᑲᒋᒪᐠᑲᐠ, ᐁᑯᓂ ᐱᑯ ᓇᐣᑕ ᐃᓇ, ᐊᐦᐳ ᓇᐣᑕᐤ ᑲᓯᑎᐯᑕᐠ ᐊᐦᐳ ᐅᑎᐯᓂᒪᑲᓇ, ᒋᑫᒪ ᒥᑐᓂ ᒪᐢᑲᐤᐊᐢᑌᐤ ᐅᒪ, ᑕᑭᐢᐸᓂᐃᑯᒋ ᐊᐁᓇᒥᑐᓂ ᑕᔭᑯᒣᑕᐠ, ᒥᓇ ᑭᐢᑌᑕᒪᐠ ᑫᓯᐊᐸᒋᑕᔭᐠ ᐅᒪ ᐁᑌᐤᐃᐣ (ᐅᒋᓄᐤᐃᐣ).
- <u>ᐸᐢᑕᒧᐃᐣ</u> - ᑭᑐᐱᐣ ᐊᐁᓇ ᑫᑯᐣ ᑲᒪᒋᐊᓂᒧᒪ ᐃᐧᒋ ᐃᓂᓂᐊ. ᐊᐦᐳ ᐁᑲ ᑯᐤᔭᐢ ᑲᑐᑕᐊ. ᑭᑭᐢᑫᑌᓇᐣᓇᐤ ᐊᑕ ᑕᐯᒋ ᑭᐁᓇᑎᑯᔦᐠ.
- ᑭᓴᐱ ᑭᑎᑐᑌᓇᓇᐤ ᐁᑲᑫᑯᐣ ᐁᒪᓇᒋᑕᔭᐠ ᐊᐦᐳ ᐁᑯ ᐁᒪᓇᒋᑐᑕᒪᐠ ᐅᒋᑕᐤ ᑕᒥᓄᐢᑕᔭᐠ ᐊᓂᒪ ᑫᑯᐣ ᑲᑭᑐᑕᒪᐠ ᒥᓇ ᐁᑲ ᑫᑯᐣ ᑕᐢᐸᓂᐃᐧᑯᔭᐠ ᐁᑯᒪ ᐅᒋ ᑕᑕᐱᑕᐤᐸᓂᐠ ᒥᓇ ᒥᓄᐸᓂᐠ.
- ᑯᐤᔭᐢ ᑫᑯᐣ ᑲᐃᑐᑕᒪᐠ ᑭᑕᔭᒥᐊᐣᓇᐤ
- ᒪᑎᓇᒪᑫᐤᐃᐣ
- ᑭᓇᐣ ᐃᓂᓂᐊᐠ ᑭᑎᑕᑌᐣᓇᓇᐤ, ᑭᑭᐢᑭᓄᒪᑫᐃᓇᐣ ᒥᓇ ᐊᓂᐢᑫ ᐊᒋᒧᐃᐣᓇ, ᐁᑐᑕᒪᐠ ᐱᒪᑎᐢᓯᐃᐣ ᒥᓇ ᐁᑭᐢᑭᓄᒧᐊᐠᔭᑯᐠ ᐅᐢᑲᑎᓴᐠ ᒥᓇ ᐊᓂᑭ ᑫᑎᐊᐢᓂᐢᑫ ᐱᒪᑎᓯᒋᐠ

ᐁᑯᒪ ᐁᓯᑭᐢᑫᑕᒪᐠ ᐁᑕᐯᔦᓂᒥᓱᔭᐠ ᒥᓇ ᐁᑭᐢᑌᑕᑯᐠ. ᐁᐢᑯᒪ ᑫᑐᑕᒪᑯᐤᐸᐣ ᐁᐢᑯᐧᐱᒪᑎᓯᔭᐠ

[1]ᐊᑎ ᐊᐣᓂᓯᓂᐊᐠ ᑭᑎᓯᐊᔭᒡᒧᐃᓇᐣ ᐃᑭᐢᑫᑕᒡᒧᐠ ᐊᐁᐣᓂᑭ ᑭᓇᐣᓇ, ᒪᐢᑫᑯ ᐃᓂᓂᐊᐠ ᒥᓇ ᐊᓂᑭ ᒐᐃᐧᔭᐤ ᐃᓂᓂᐊᐠ
[2]ᐱᑐᐢ ᐊᐱᓯᐢ ᐃᑌᐁᐧᐸᓄᐤ ᐅᒪ ᐁᔭᔭᒥᔭᐠ ᒐᐱᐸᐤ ᐊᔭᒧᒡᐃᐣ ᐊᐠᑯᑐᐃᐣ, ᑭᐊᐠᑯᒪᑲᓇᐣᓇᐠ, ᒥᓇ ᐊᐠᑯᒥᐁᐧᐃᐣ

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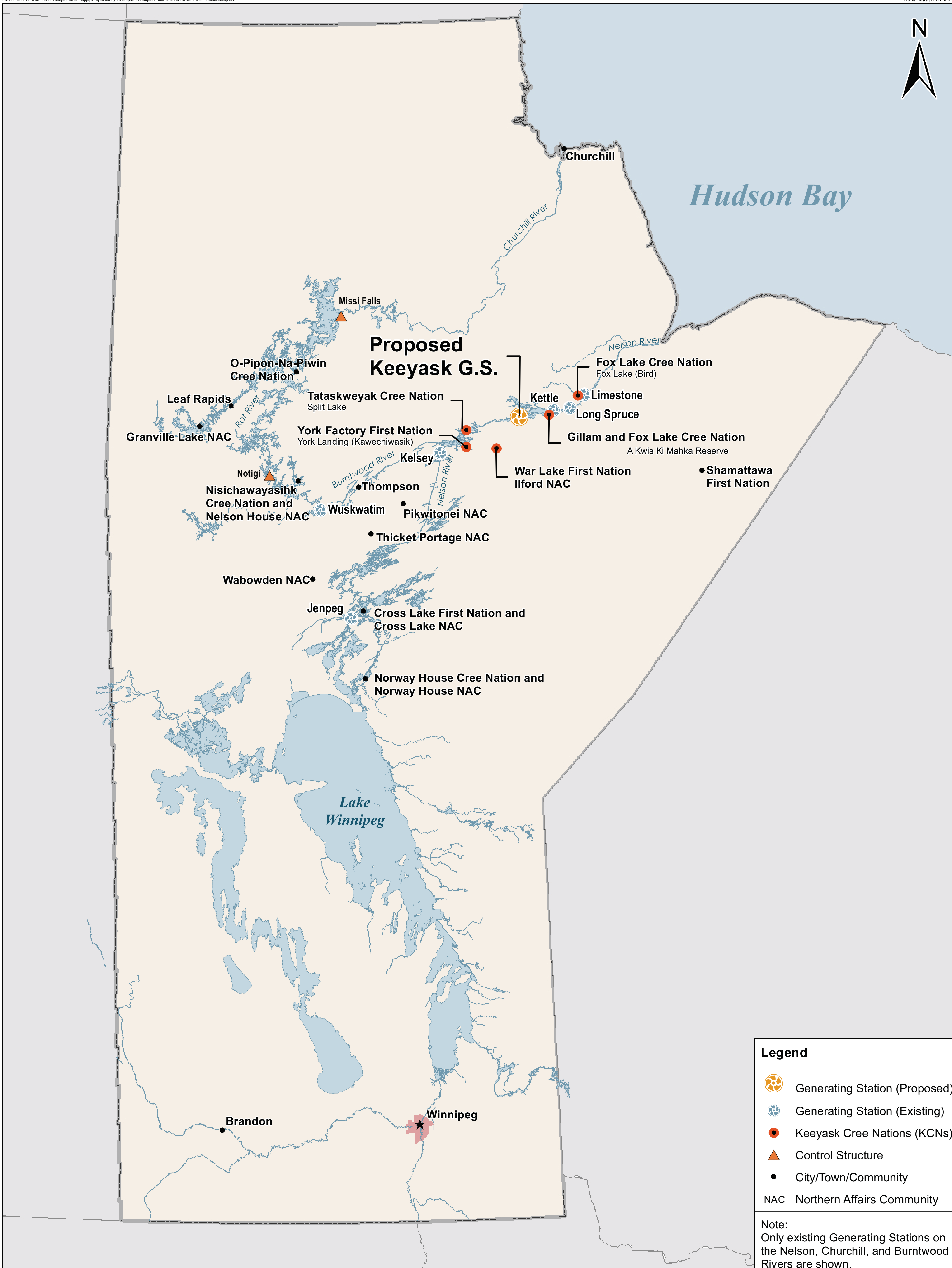

KEEYASK
Hydropower Limited Partnership

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

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

COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	02 MAY 12	21-JUN-12
0 40 80 Kilometres / 0 30 60 Miles	VERSION NO: 1.0	QA/QC: APPROVED

Communities Invited to Participate in the Public Involvement Program

Map 3-1

CHAPTER 4

PROJECT DESCRIPTION

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4.0 PROJECT DESCRIPTION

4.1 PROJECT OVERVIEW

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Table 4-1: Keeyask Generating Station Design Parameters

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

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

4.2 NEED FOR AND ALTERNATIVES TO

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

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

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

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

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

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

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

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

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

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

4.3 PROJECT COMPONENTS

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

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

4.3.1 PRINCIPAL STRUCTURES

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

4.3.1.1 POWERHOUSE COMPLEX

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

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

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

4.3.1.2 SPILLWAY

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

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

4.3.1.3 DAMS

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

4.3.1.4 DYKES

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

4.3.1.5 RESERVOIR

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

4.3.2 SUPPORTING INFRASTRUCTURE

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

4.3.2.1 MAIN CAMP AND WORK AREAS

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

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

4.3.2.2 ADDITIONAL TEMPORARY WORK CAMP

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

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

4.3.2.3 Communications Infrastructure

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

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

4.3.2.4 Temporary Explosives Magazine

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

4.3.2.5 Construction Power

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

4.3.2.6 Roads

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

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

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

4.3.2.7 COFFERDAMS, ROCK GROINS AND TOWER SPUR

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

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

4.3.2.8 ICE BOOM

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

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

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

4.3.2.9 SOURCES OF ROCK, GRANULAR AND SOIL MATERIALS

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

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

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

4.3.2.10 PLACEMENT AREAS FOR EXCESS EXCAVATED MATERIAL

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

4.3.2.11 INFRASTRUCTURE OF OTHER PROJECTS / FACILITIES

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

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

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

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

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

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

4.3.2.12 BOAT LAUNCHES, BARGE LANDINGS AND PORTAGE

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

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

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

4.3.3 ENVIRONMENTAL MITIGATION / COMPENSATION

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

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

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

These measures are summarized in the following sections.

4.3.3.1 Measures in Joint Keeyask Development Agreement

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

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

4.3.3.2 Biophysical and Socio-Economic Mitigation Measures

4.3.3.2.1 Physical Environment

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

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

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

4.3.3.2.2 Aquatic Environment

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

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

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

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

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

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

4.3.3.2.3 Terrestrial Environment

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

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

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

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

4.3.3.2.4 SOCIO-ECONOMIC ENVIRONMENT

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

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

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

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

4.3.3.2.5 RESOURCE USE

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

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

4.3.3.2.6 HERITAGE RESOURCES

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

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

4.3.3.3 ENVIRONMENTAL PROTECTION PLANS

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

4.4 LAND REQUIREMENTS

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

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

4.4.1 ABORIGINAL AND RESERVE LANDS

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

4.4.2 PROJECT FOOTPRINT

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

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

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

Notes:

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

4.5 PROJECT PLANNING, ALTERNATIVE MEANS AND MITIGATION MEASURES

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

4.5.1 PROJECT PLANNING

4.5.1.1 GENERATING STATION SITE SELECTION AND RESERVOIR LEVELS

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

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

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

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

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

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

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

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

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

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

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

4.5.1.2 General Arrangement of Primary Structures

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

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

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

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

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

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

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

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

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

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

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

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

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

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

4.5.1.3 RESERVOIR OPERATING RANGE AND MODE OF OPERATION

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

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

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

4.5.1.4 TURBINE DESIGN

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

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

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

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

4.5.1.5 FISH PASSAGE

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

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

4.5.1.6 TRASH RACKS

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

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

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

4.5.1.7 DYKES

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

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

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

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

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

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

4.5.1.8 SOUTH ACCESS ROAD

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

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

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

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

4.5.1.9 EXCAVATED MATERIAL PLACEMENT AREAS

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

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

4.5.2 ALTERNATIVE MITIGATION MEASURES

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

4.5.2.1 AQUATIC ENVIRONMENT

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

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

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

4.5.2.2 TERRESTRIAL ENVIRONMENT

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

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

4.5.2.3 SOCIO-ECONOMIC ENVIRONMENT

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

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

4.6 PROJECT CONSTRUCTION

4.6.1 CONSTRUCTION SCHEDULE

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

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

4.6.2 INSTALLATION OF ICE BOOM

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

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

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

4.6.3 RESERVOIR CLEARING

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

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

4.6.4 SITE PREPARATION AND SUPPORTING INFRASTRUCTURE

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

4.6.5 EXCAVATIONS

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

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

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

4.6.6 ACCESS ROADS DURING CONSTRUCTION

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

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

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

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

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

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

4.6.7 CONSTRUCTION OF COFFERDAMS

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

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

4.6.8 PRODUCTION OF CONCRETE AND AGGREGATE

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

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

4.6.9 CONSTRUCTION OF POWERHOUSE

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

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

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

4.6.10 CONSTRUCTION OF SPILLWAY

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

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

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

4.6.11 Construction of North and South Dykes

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

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

4.6.12 Construction of North, Central and South Dams

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

4.6.13 Public Access and Site Security

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

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

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

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

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

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

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

No personal firearms will be permitted on the Project site.

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

4.6.14 WATER AND WASTEWATER TREATMENT

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

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

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

4.6.15 RESERVOIR IMPOUNDMENT

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

4.6.16 DECOMMISSIONING OF TEMPORARY INFRASTRUCTURE

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

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

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

4.6.17 CONSTRUCTION WORKFORCE AND CONTRACTS

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

4.6.17.1 EMPLOYMENT, HIRING AND TRAINING

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

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

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

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

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

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

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

Notes:

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

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

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

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

Notes:

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

4.6.17.2 Construction Work Packages and Types

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

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

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

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

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

Source: JKDA, Schedule 13-1, 2009.

4.6.17.3 WORKFORCE OVERVIEW

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

4.6.17.4 WORKFORCE SIZE AND COMPOSITION

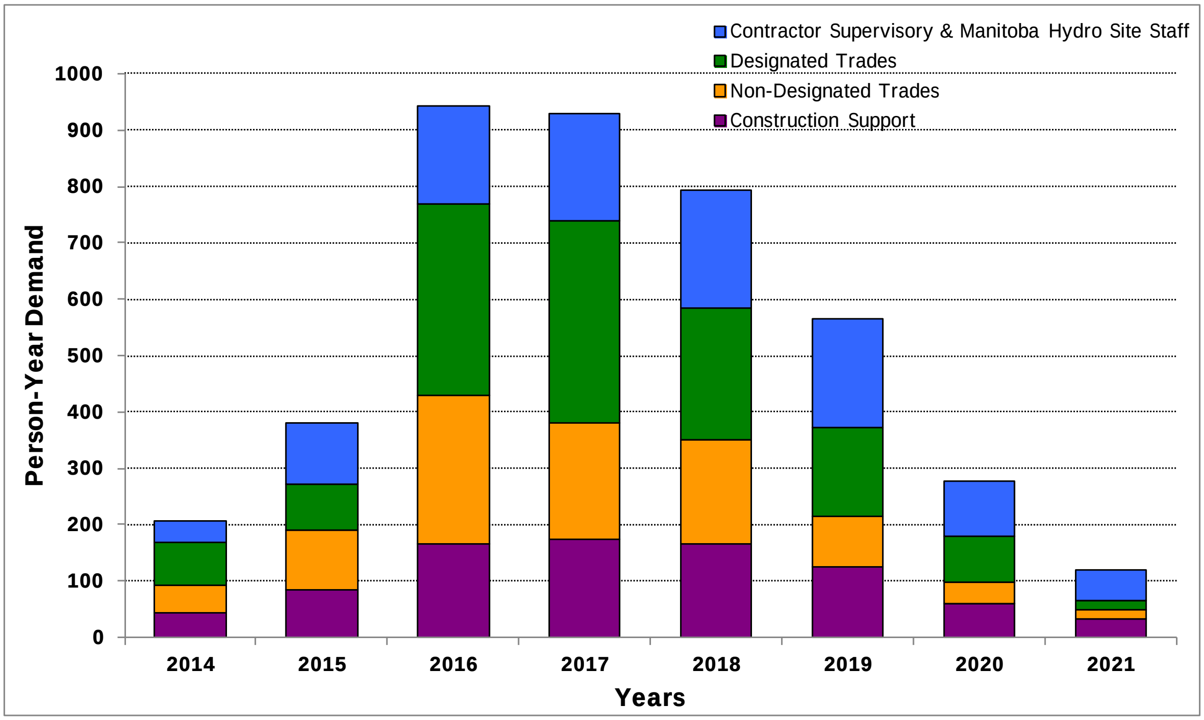
Workforce size and composition will change continually throughout the construction stage. The construction workforce size and composition are commonly measured by the following two criteria:

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

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

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

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



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

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

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

4.6.17.4.1 Workforce Volume (Person-Years Analysis)

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

Table 4-6: Construction Workforce Requirements by Job Category

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

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

4.6.17.4.2 CONSTRUCTION PHASE ESTIMATED GROSS EMPLOYMENT INCOME ANALYSIS

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

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

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

Sources:

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

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

4.7 PROJECT OPERATION

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

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

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

4.7.1 MODES OF OPERATION

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

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

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

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

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

4.7.2 HYDRAULIC ZONE OF INFLUENCE

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

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

4.7.3 VEGETATION AND DEBRIS MANAGEMENT

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

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

4.7.4 OPERATING AND MAINTENANCE PROCEDURES AND REGULATORY COMPLIANCE

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

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

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

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

4.7.5 MAINTENANCE OF ROADS AND STREAM CROSSINGS

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

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

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

4.7.6 ENVIRONMENTAL MONITORING

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

4.7.7 Operation Workforce

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

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

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

Source: Data provided by Manitoba Hydro in 2009.

4.7.8 SAFETY, SECURITY AND EMERGENCY RESPONSE

4.7.8.1 PUBLIC SAFETY AND SECURITY

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

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

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

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

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

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

4.7.8.2 EMERGENCY RESPONSE

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

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

Elements of the program include:

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

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

4.7.9 WATER AND WASTEWATER TREATMENT

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

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

4.8 DECOMMISSIONING

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

KEEYASK Hydropower Limited Partnership

DATA SOURCE:
Manitoba Hydro Artist Concept Rendering - November 2011

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

NOTE(S):
Artist's Rendering - Concept Only

DATE CREATED: 03-AUG-11

REVISION DATE: 13-FEB-12

VERSION NO: 1.0

QA/QC: APPROVED

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

General Arrangement
Looking North

Figure 4-1

KEEYASK Hydropower Limited Partnership

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

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

General Arrangement
Looking Upstream

Figure 4-2

KEEYASK
Hydropower Limited Partnership

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

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

Powerhouse Complex

Figure 4-3

KEEYASK
Hydropower Limited Partnership

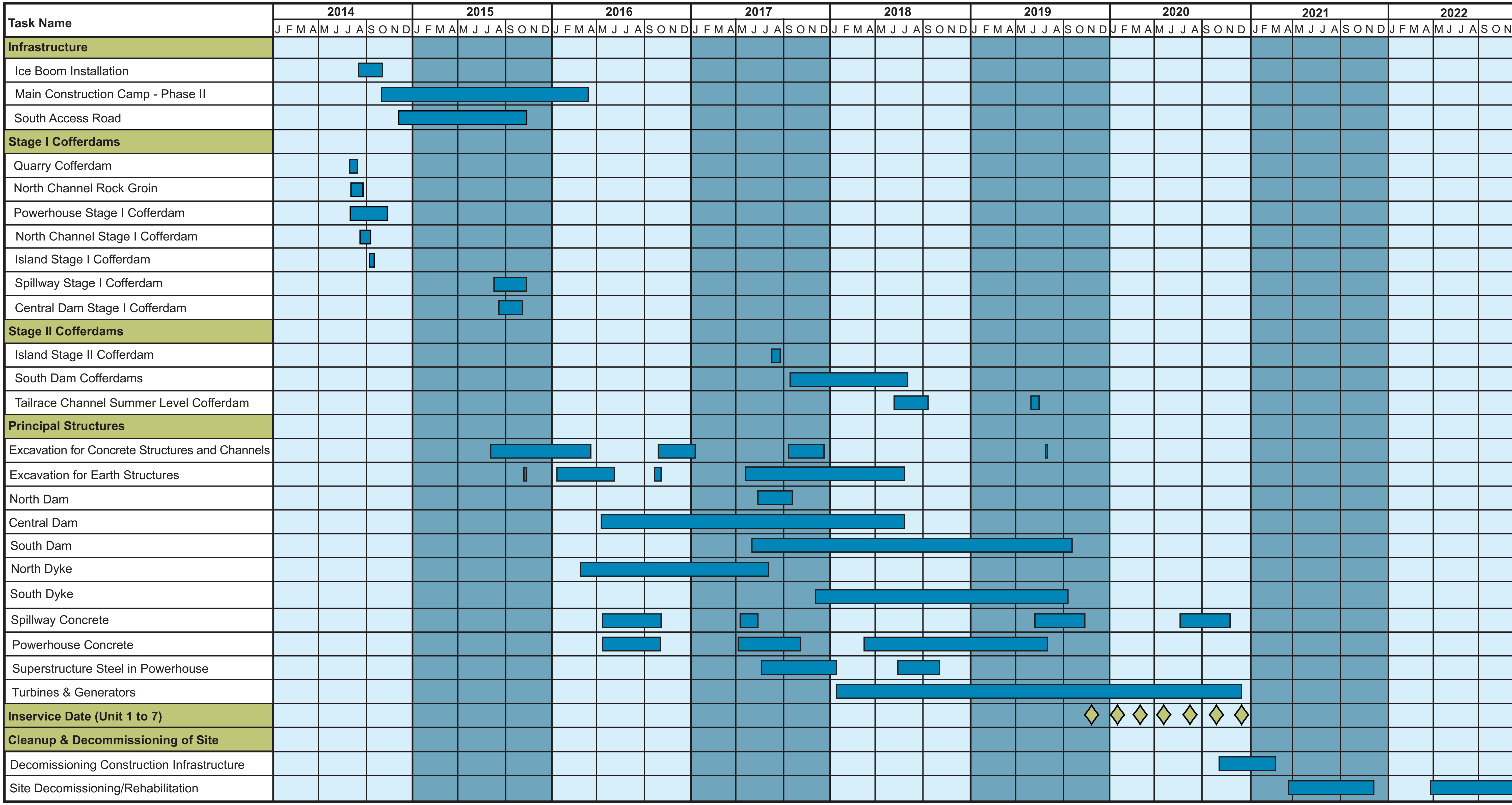
DATA SOURCE:
Manitoba Hydro Artist Concept Rendering - September 2011

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

NOTE(S):	DATE CREATED:	REVISION DATE:
Artist's Rendering - Concept Only	04-SEP-11	11-APR-12
	VERSION NO:	QA/QC:
	2.0	APPROVED

Spillway

Figure 4-4



KEEYASK
Hydropower Limited Partnership

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

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

Note(s):

DATE CREATED: 16-APR-12

REVISION DATE: 15-JUNE-12

VERSION NO: 2.0

QA/QC: APPROVED

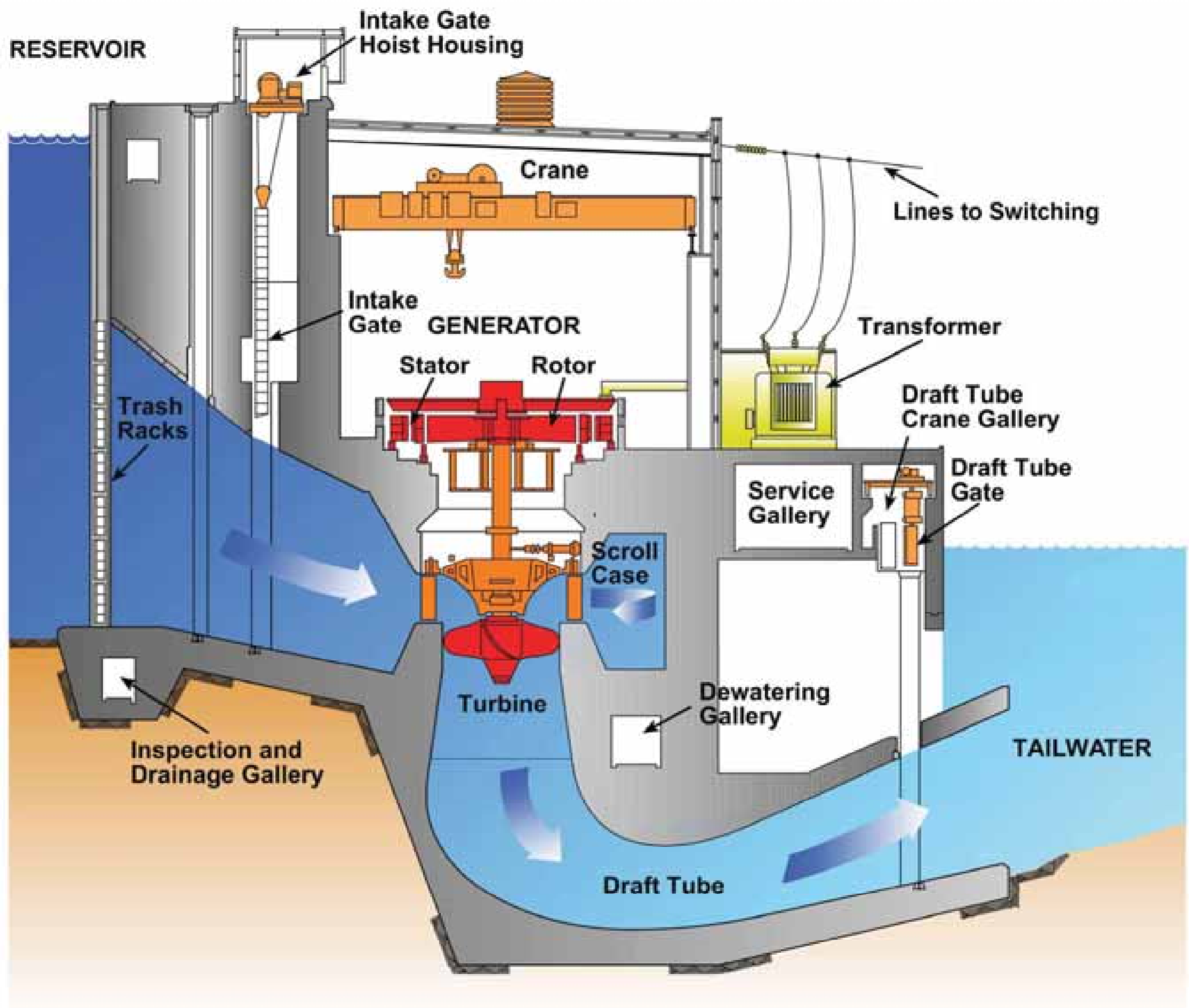
Legend

Task

Milestone

Preliminary Construction Schedule

Figure 4-5



KEEYASK
Hydropower Limited Partnership

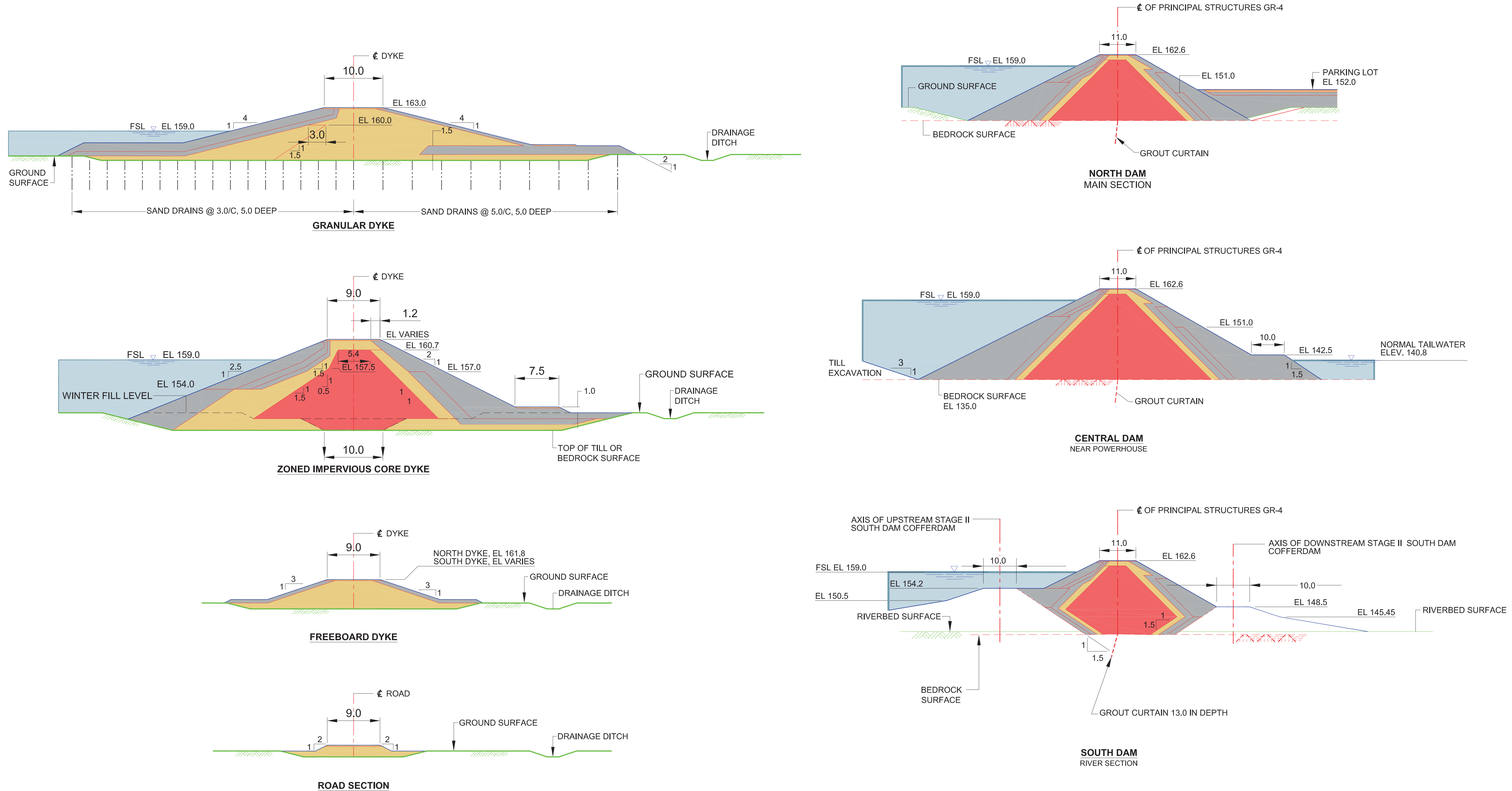
DATA SOURCE:
Manitoba Hydro

CREATED BY:
Manitoba Hydro - Hydro Power Planning - Keeyask & Burntwood Planning

NOTE(S):	DATE CREATED:	REVISION DATE:
Artist's Rendering - Concept Only	17-JAN-12	23-APR-12
	VERSION NO:	QA/QC:
	2.0	APPROVED

Typical Powerhouse Cross Section
Vertical Shaft Turbine

Figure 4-6



KEEYASK Hydropower Limited Partnership

DATA SOURCE:
Memorandum GN-4.2.2.2, Rev. 0, Figure 5

CREATED BY:
KGS Acres

COORDINATE SYSTEM	DATE CREATED:	REVISION DATE:
Not Applicable	12-APR-12	12-APR-12
SCALE: NTS	VERSION NO: 1.0	QA/QC: APPROVED

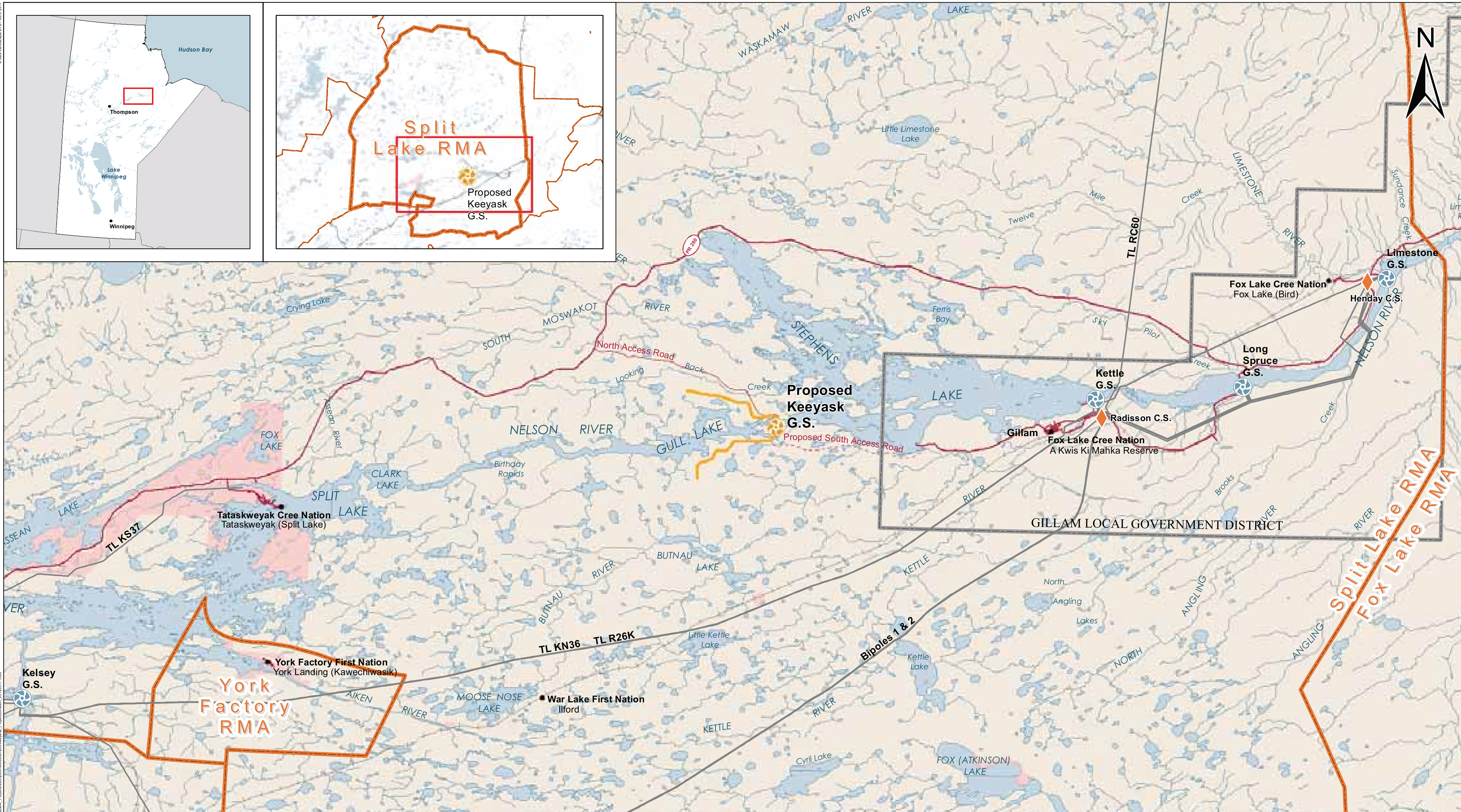
Legend

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

Dykes and Dams

Typical Cross Sections

Figure 4-7



KEEYASK
Hydropower Limited Partnership

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

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

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

Legend

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

Project Location

Map 4-1

KEEYASK
Hydropower Limited Partnership

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

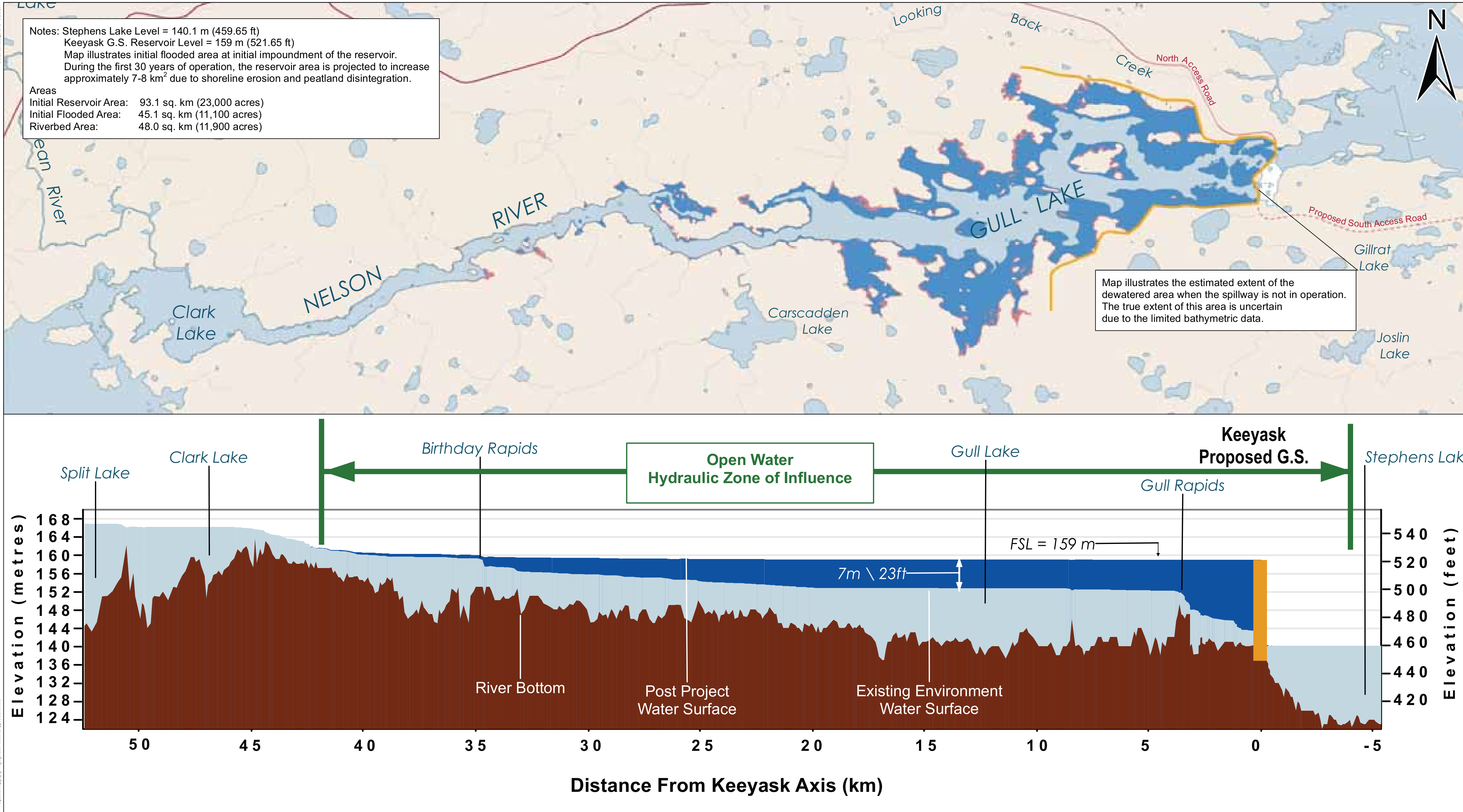
CREATED BY:
Manitoba Hydro - Hydro Power Planning - GIS & Special Studies

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

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

Principal Structures

Map 4-2



KEEYASK Hydropower Limited Partnership

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

CREATED BY:
Manitoba Hydro - Water Resources Engineering Department

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

Legend

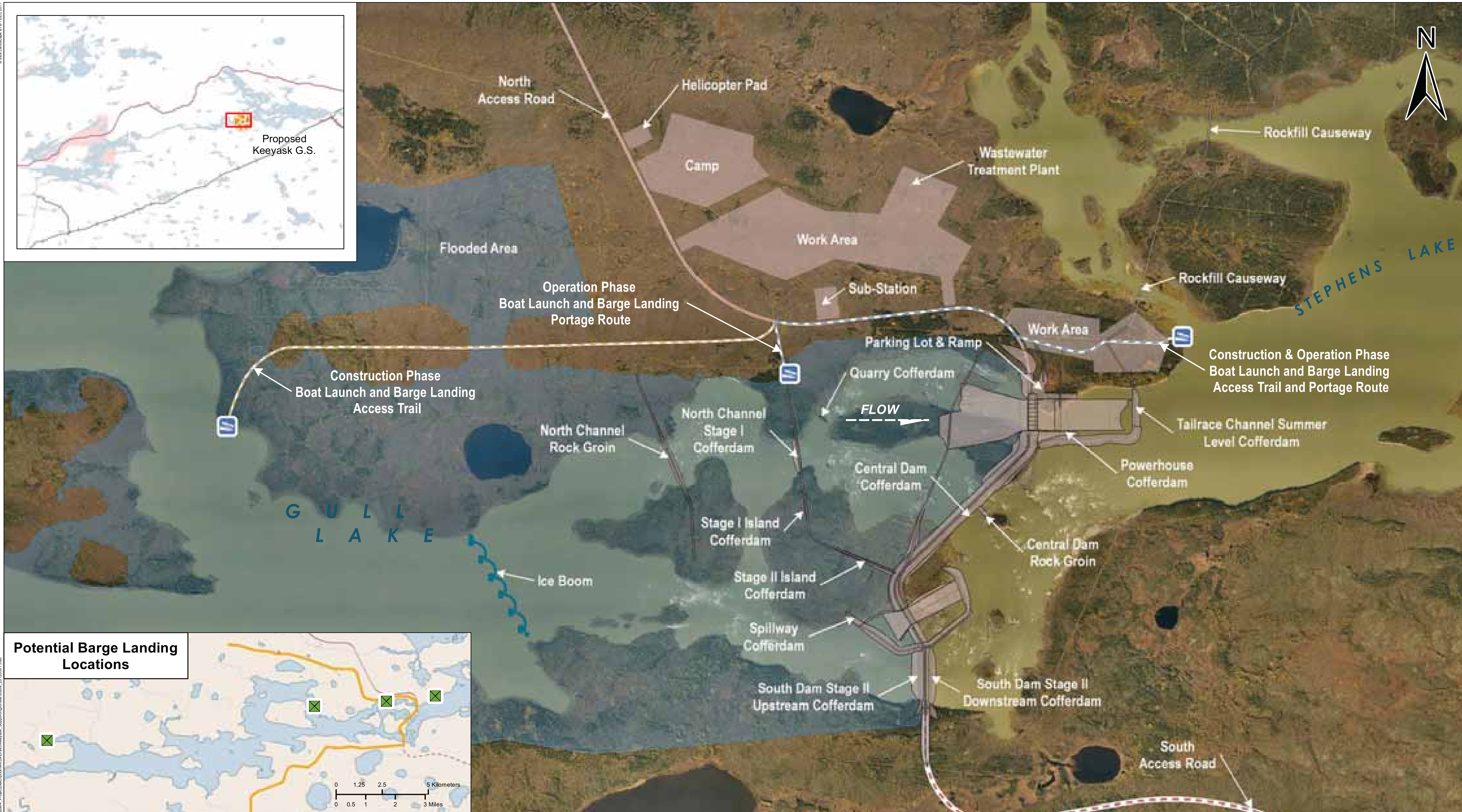
- Existing Water Surface Area
- Initial Flooded Area (159 m)
- Reservoir Expansion During First 30 Years
- Keeyask Principle Structures

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

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

Water Surface Profiles and Flooded Area

Map 4-3



KEEYASK
Hydropower Limited Partnership

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

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

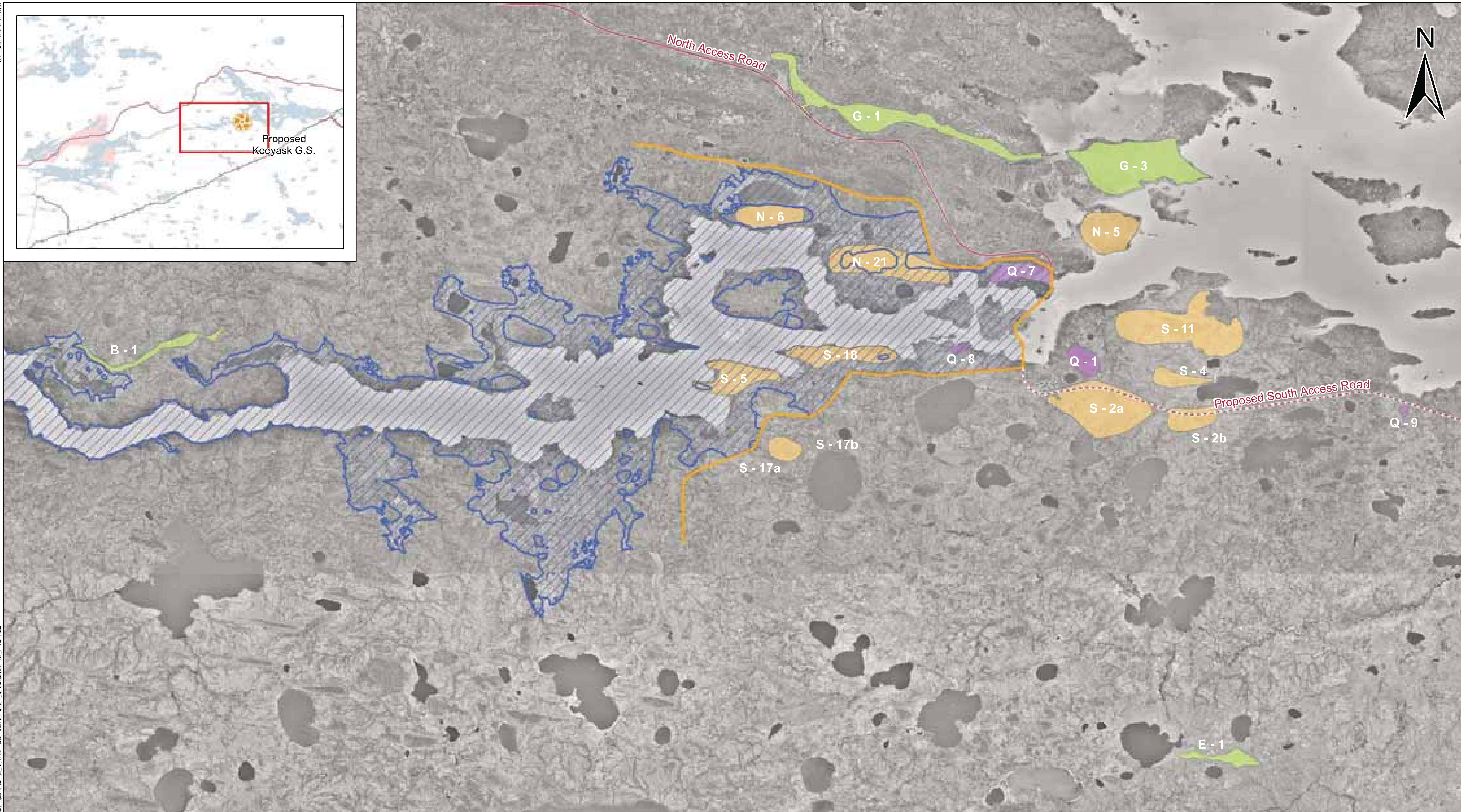
COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	03-AUG-11	01-MAY-12
0 0.3 0.6 Kilometres / 0 0.25 0.5 Miles	VERSION NO: 2.0	QA/QC: APPROVED

Legend

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

Supporting Infrastructure

Map 4-4



Keeyask Hydropower Limited Partnership

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

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

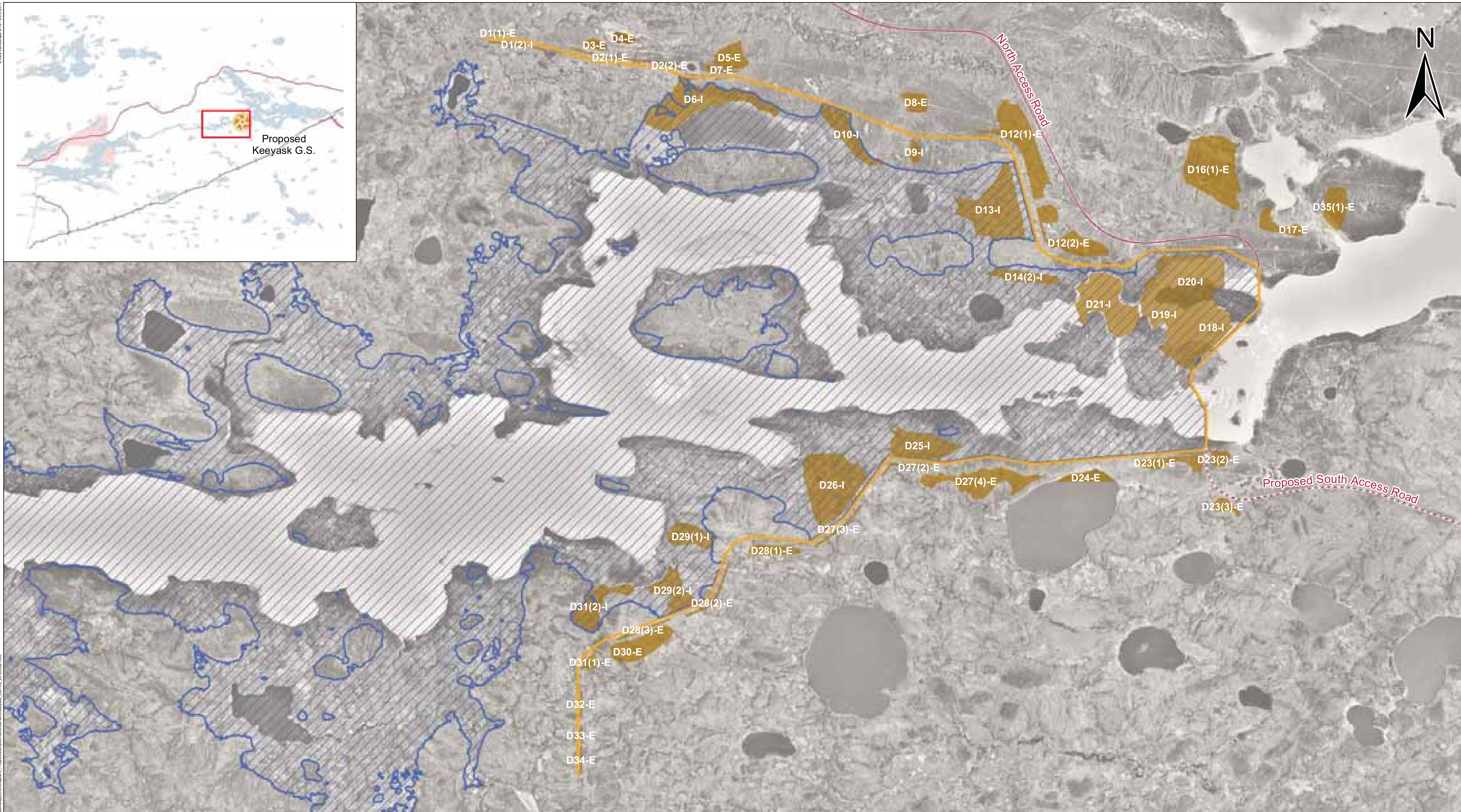
COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	09-FEB-12	22-MAY-12
0 1 2 Kilometres / 0 0.85 1.7 Miles	VERSION NO: 3.0	QA/QC: APPROVED

Legend

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

Borrow Sources and Quarries
Potential

Map 4-5



KEEYASK
Hydropower Limited Partnership

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

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

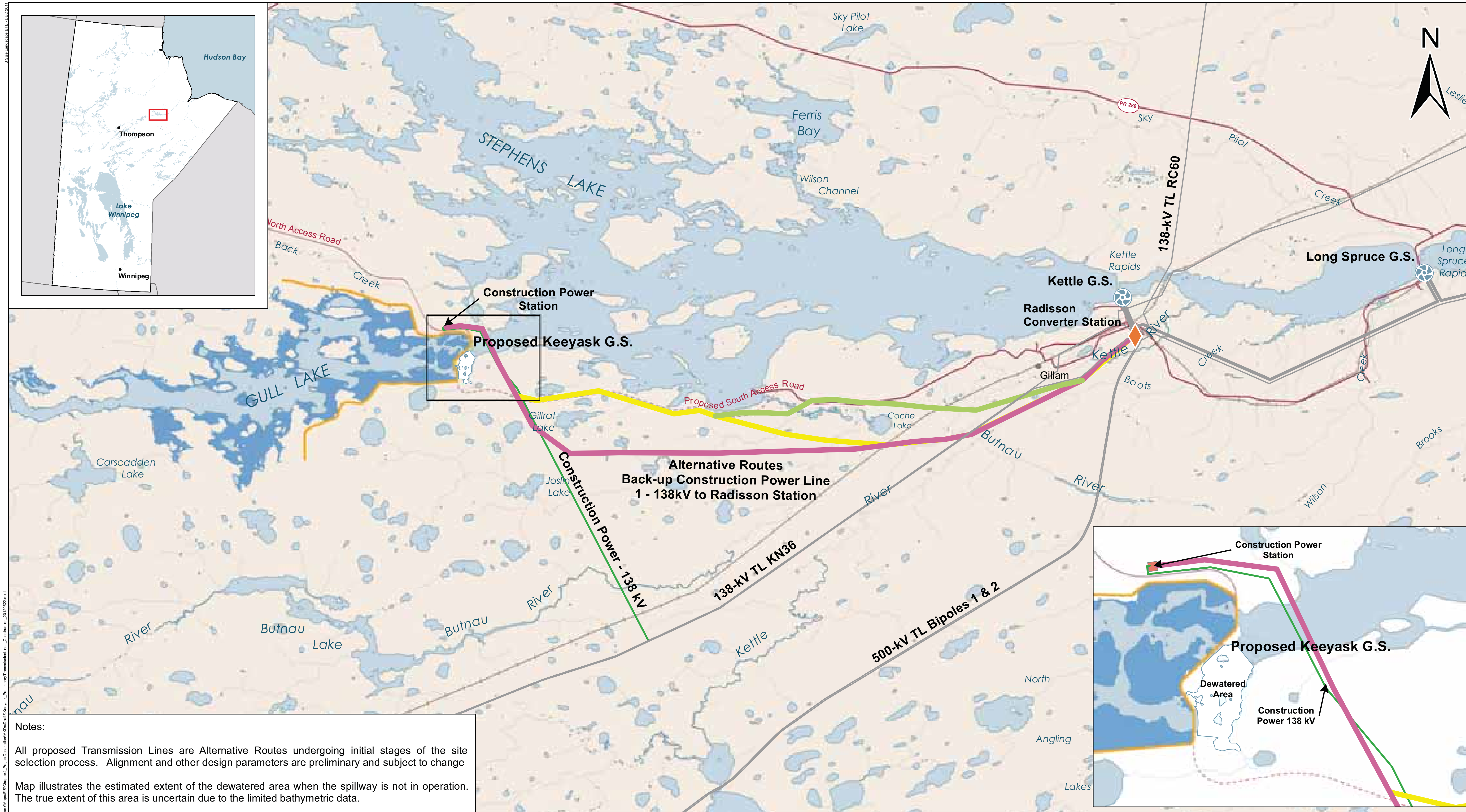
COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	09-FEB-12	22-MAY-12
0 0.55 1.1 Kilometres / 0 0.45 0.9 Miles	VERSION NO: 2.0	QA/QC: APPROVED

Legend

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

Excavated Material Placement Areas

Map 4-6



Notes:

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

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

KEEYASK
Hydropower Limited Partnership

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

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

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

Legend

- Transmission Line (Existing)
- Construction Power Line (Proposed)

Back-up Construction Power Transmission Line

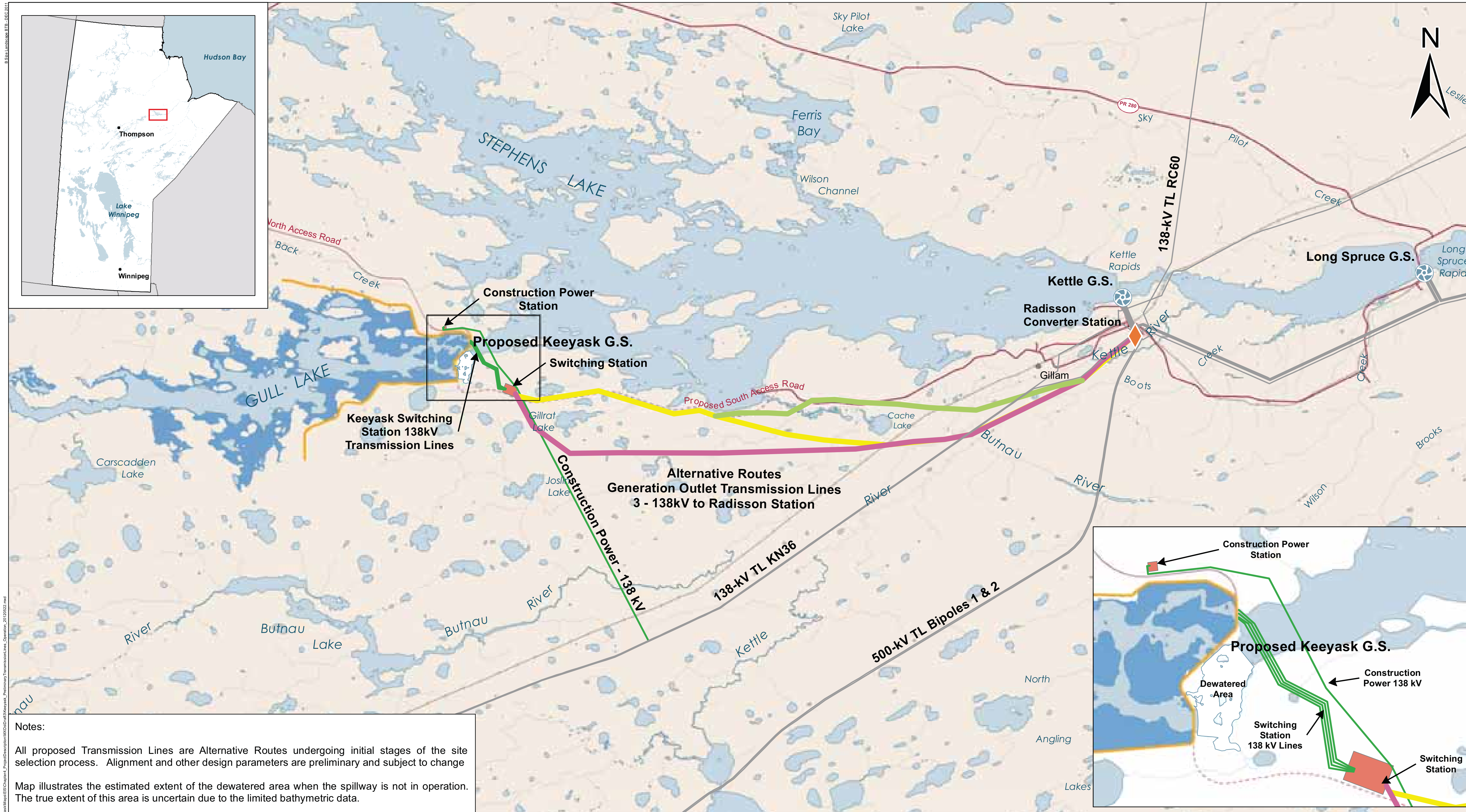
- Route Alternative Option A
- Route Alternative Option B
- Route Alternative Option C
- Generating Station (Existing)
- Converter Station (Existing)
- Keeyask Principal Structures
- Transmission Substation (Proposed)
- Potential Dewatered Area
- Initial Flooded Area (159 m)
- Exisiting Water Level
-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

Keeyask Transmission Project

Preliminary Transmission Corridors

During Keeyask Generation Project Construction Phase

Map 4-7



Notes:

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

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

KEEYASK Hydropower Limited Partnership

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

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

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

Legend

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

Keeyask Transmission Project

Preliminary Transmission Corridors

During Keeyask Generation Project Operation Phase

Map 4-8

KEEYASK Hydropower Limited Partnership

DATA SOURCE: Manitoba Hydro; Government of Manitoba; Government of Canada			
CREATED BY: Manitoba Hydro - Hydro Power Planning - GIS & Special Studies			
COORDINATE SYSTEM: UTM NAD 1983 Z15N		DATE CREATED: 25-MAR-12	REVISION DATE: 10-MAY-12
0 0.1 0.2 Kilometres / 0 0.1 0.2 Miles		VERSION NO: 1.0	QA/QC: APPROVED

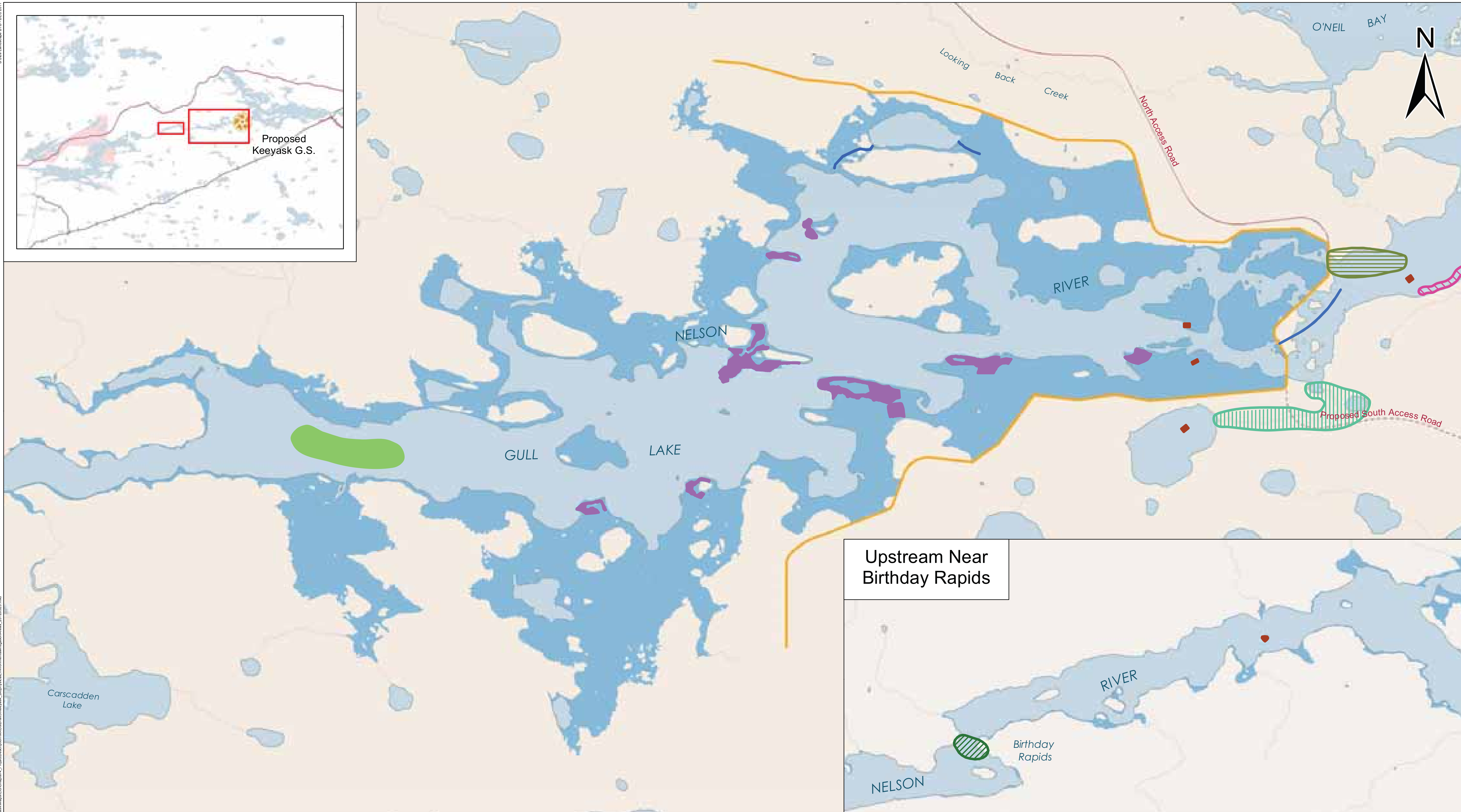
Legend

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

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

Boat Launch and Access Routes

Map 4-9



KEEYASK
Hydropower Limited Partnership

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

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

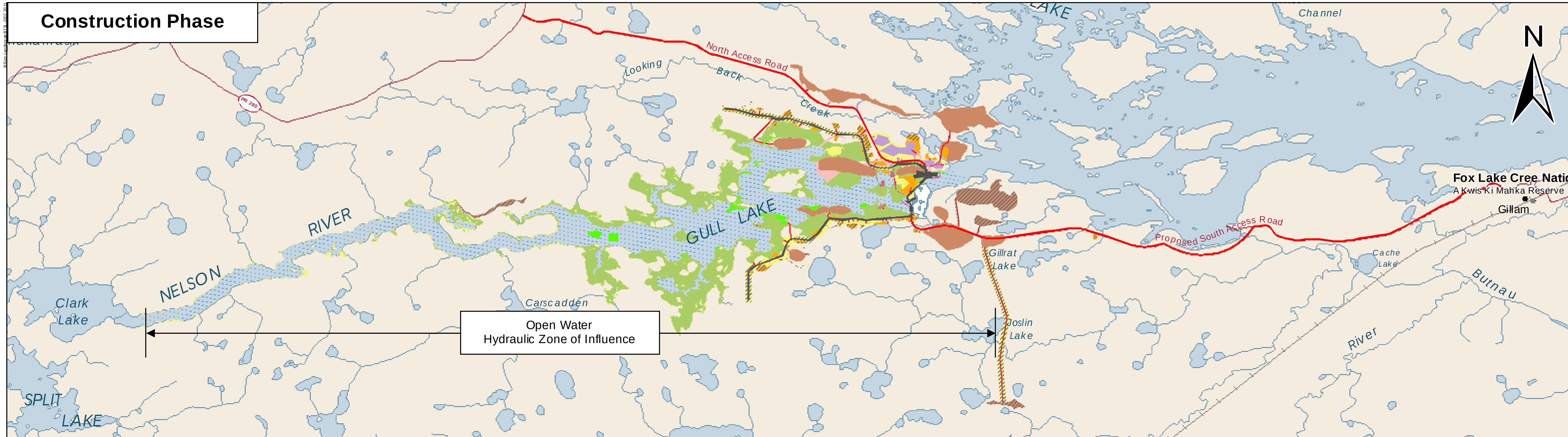
COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	12-APR-12	23-MAY-12
0 0.7 1.4 Kilometres 0 0.55 1.1 Miles	VERSION NO: 4.0	QA/QC: APPROVED

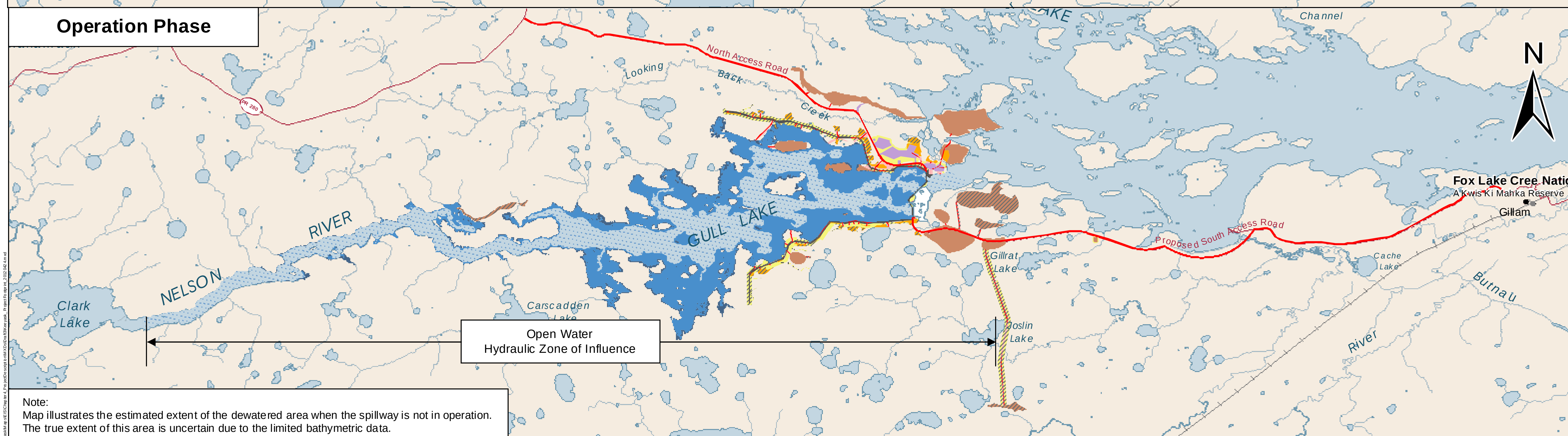
Legend

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

Biophysical Environmental Mitigation Areas
General Locations

Map 4-10





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

DATA SOURCE: Manitoba Hydro; Government of Manitoba; Government of Canada; ECOSTEM		
CREATED BY: Manitoba Hydro - Hydro Power Planning		
COORDINATE SYSTEM: UTM NAD 1983 Z15N	DATE CREATED: 18-JAN-12	REVISION DATE: 25-APR-12
0 3 6 Kilometres / 0 2 4 Miles	VERSION NO: 3.0	QA/QC: Approved

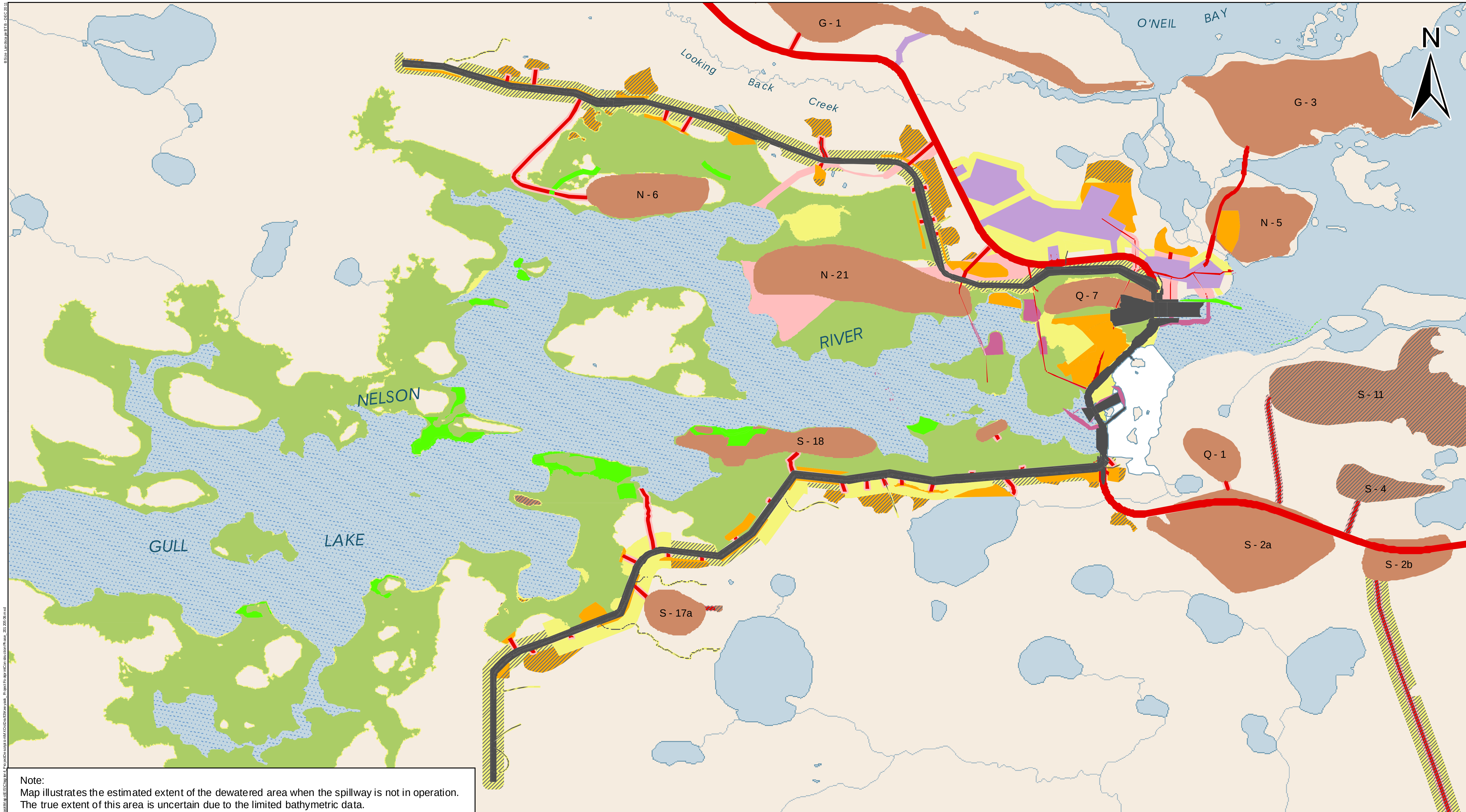
Legend

- Road
- Road Corridor
- Infrastructure
- River Management
- Borrow Area
- Camp and Work Area
- Excavated Material Placement Area
- Mitigation Area
- Possible Disturbed Area
- Reservoir Clearing
- Initial Flooded Area (159 m)
- 30-year Reservoir Expansion Area (159 m)
- Altered Water Level or Flow
- Potential Dewatered Area
- Existing Water Surface Area
- Areas Unlikely to be Used

KEEYASK Hydropower Limited Partnership

Project Footprint Overview
Construction and Operation Phase

Map 4-11



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

KEEYASK
Hydropower Limited Partnership

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

CREATED BY:
Hydro Power Planning - Keeyask & Burntwood Planning Section

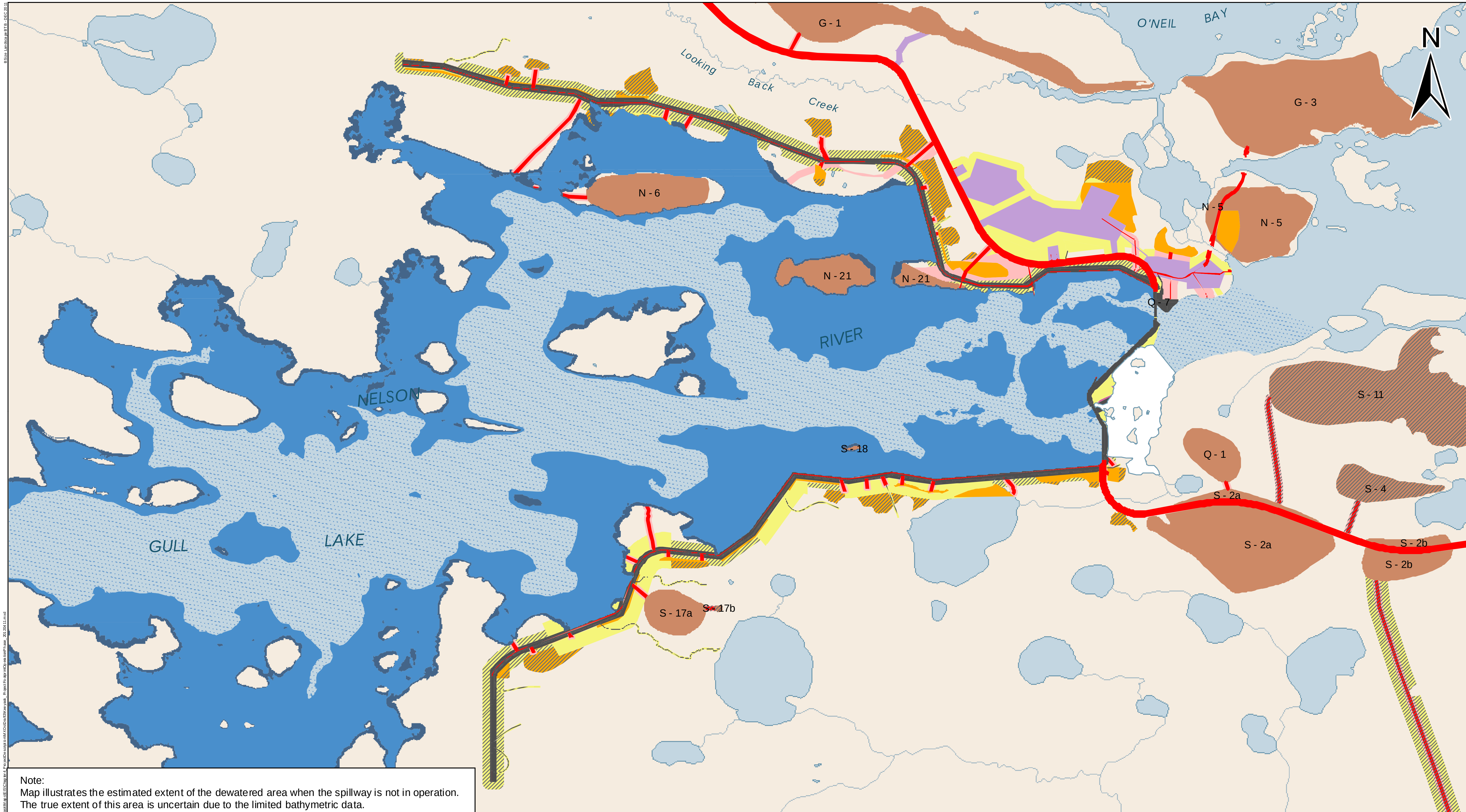
COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	18-JAN-12	09-MAY-12
0 0.55 1.1 Kilometres / 0 0.45 0.9 Miles	VERSION NO: 3.0	QA/QC: Approved

Legend

- Road
- Road Corridor
- Infrastructure
- River Management
- Borrow Area
- Camp and Work Area
- Excavated Material Placement Area
- Mitigation Area
- Possible Disturbed Area
- Reservoir Clearing
- Altered Water Level or Flow
- Potential Dewatered Area
- Existing Water Surface Area
- Areas Unlikely to be Used

Project Footprint Construction Phase
Site Level

Map 4-12



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

Keeyask Hydropower Limited Partnership

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

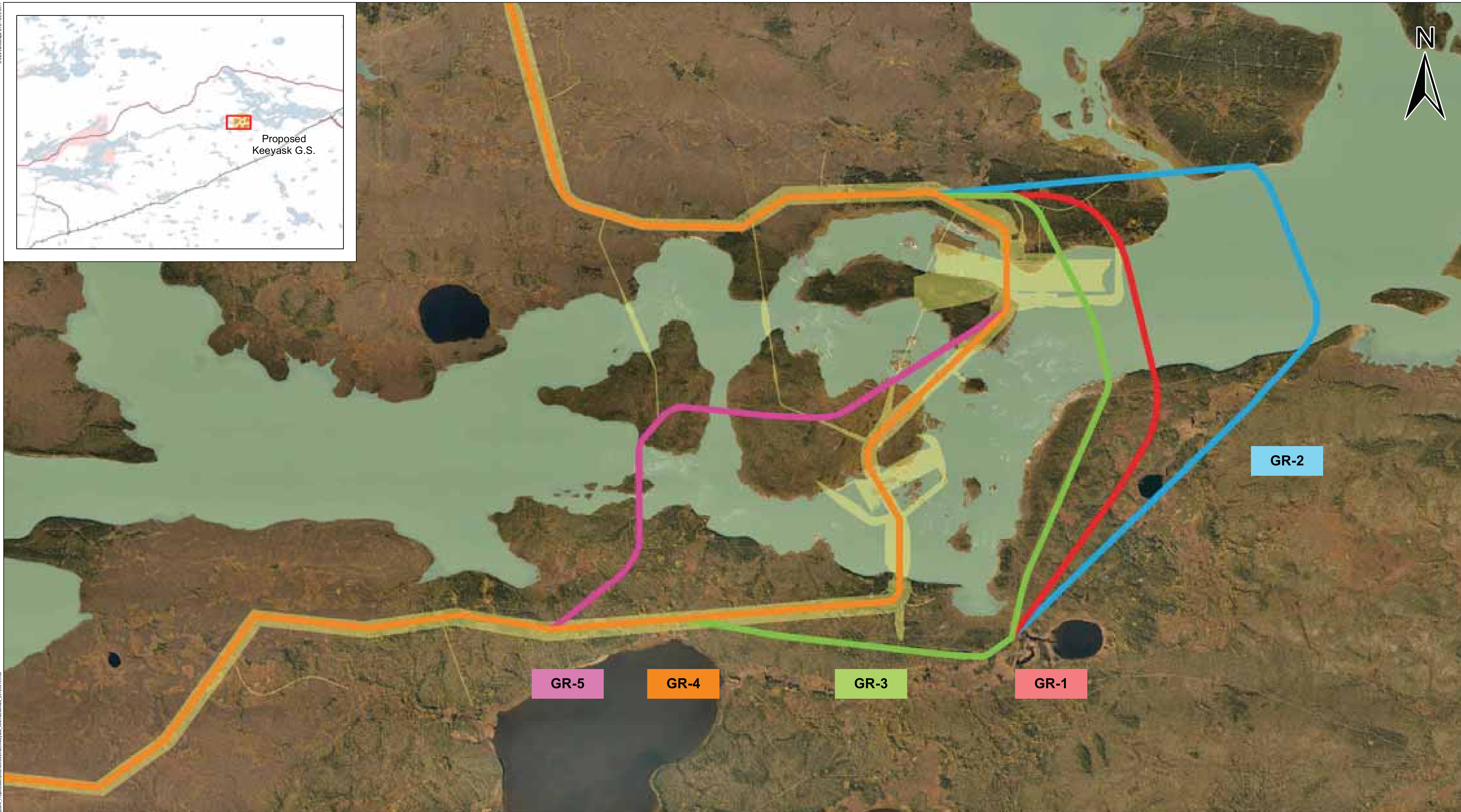
CREATED BY:
Hydro Power Planning - Keeyask & Burntwood Planning Section

COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	18-JAN-12	18-APR-12
0 0.55 1.1 Kilometres / 0 0.45 0.9 Miles	VERSION NO: 3.0	QA/QC: Approved

Legend

- Road
- Road Corridor
- Infrastructure
- River Management
- Borrow Area
- Camp and Work Area
- Excavated Material Placement Area
- Mitigation Area
- Possible Disturbed Area
- Initial Flooded Area (159 m)
- 30-year Reservoir Expansion Area (159 m)
- Altered Water Level or Flow
- Potential Dewatered Area
- Existing Water Surface Area
- Areas Unlikely to be Used

Project Footprint Operation Phase
Site Level



KEEYASK
Hydropower Limited Partnership

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

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

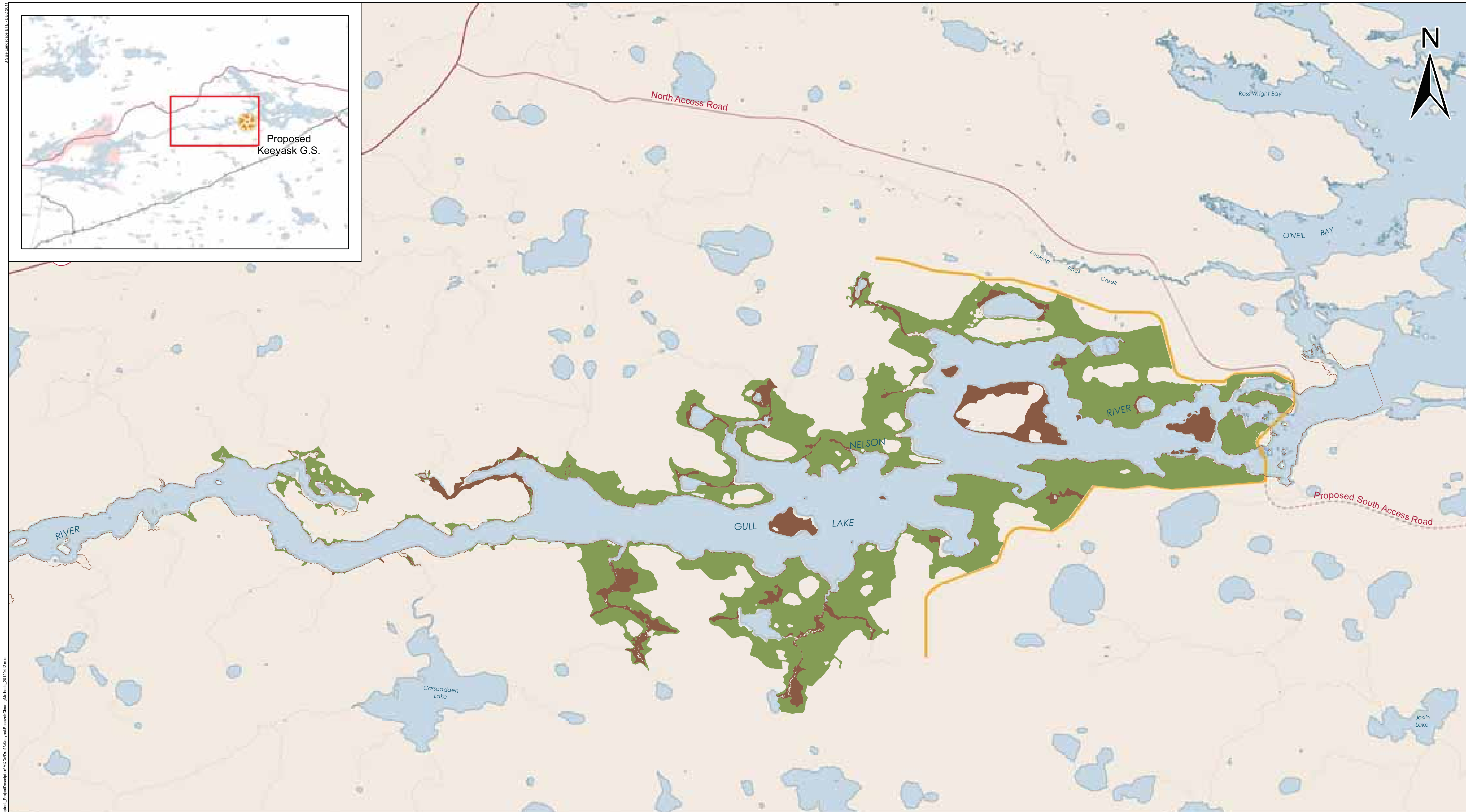
COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	12-APR-12	18-APR-12
0 0.25 0.5 Kilometres / 0 0.2 0.4 Miles	VERSION NO: 1.0	QA/QC: APPROVED

Legend

Alternative Axis
- GR-1
- GR-2
- GR-3
- GR-4
- GR-5
- Proposed Infrastructure

Keeyask Alternative Axes

Map 4-14



KEEYASK
Hydropower Limited Partnership

DATA SOURCE:
Manitoba Hydro; Government of Manitoba; Government of Canada; Plus 4 Consulting & ECOSTEM Ltd Clearing Plan published 2011-12-02; Manitoba Hydro Best Available Water (2010_WRE_QBird_CanVec50k_2012_02_16)

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

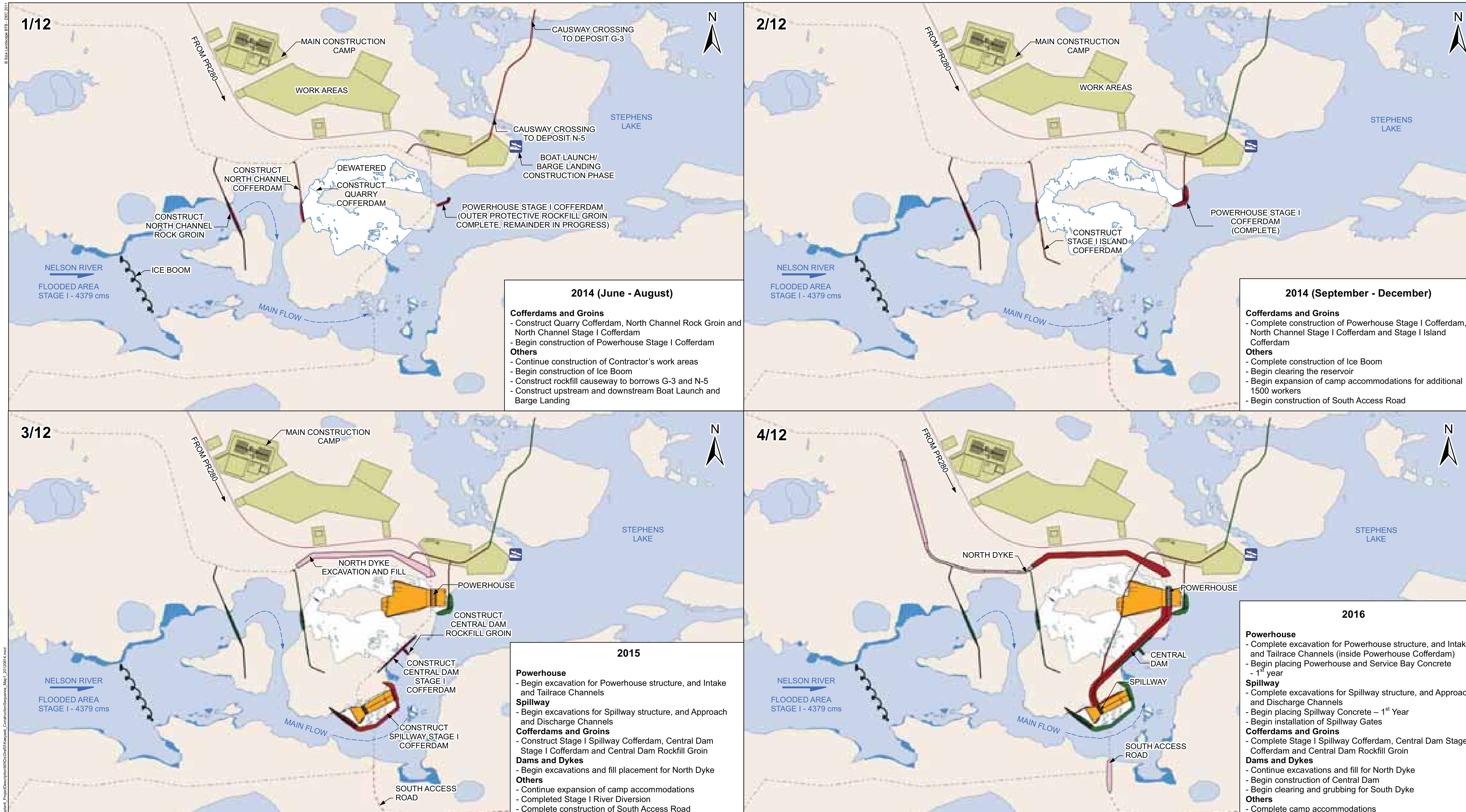
COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	16-FEB-12	12-APR-12
0 1 2 Kilometres / 0 0.9 1.8 Miles	VERSION NO: 2.0	QA/QC: APPROVED

Legend

Type of Clearing
- Hand Clearing
- Hand or Machine Clearing
- Keeyask Principal Structures
- Highway
- Access Road
- Proposed Access Road

Proposed Reservoir Clearing Methods

Map 4-15



KEEYASK Hydropower Limited Partnership

DATA SOURCE:
Manitoba Hydro, KGS Acres, Government of Manitoba

CREATED BY:
Manitoba Hydro - Hydro Power Planning Department

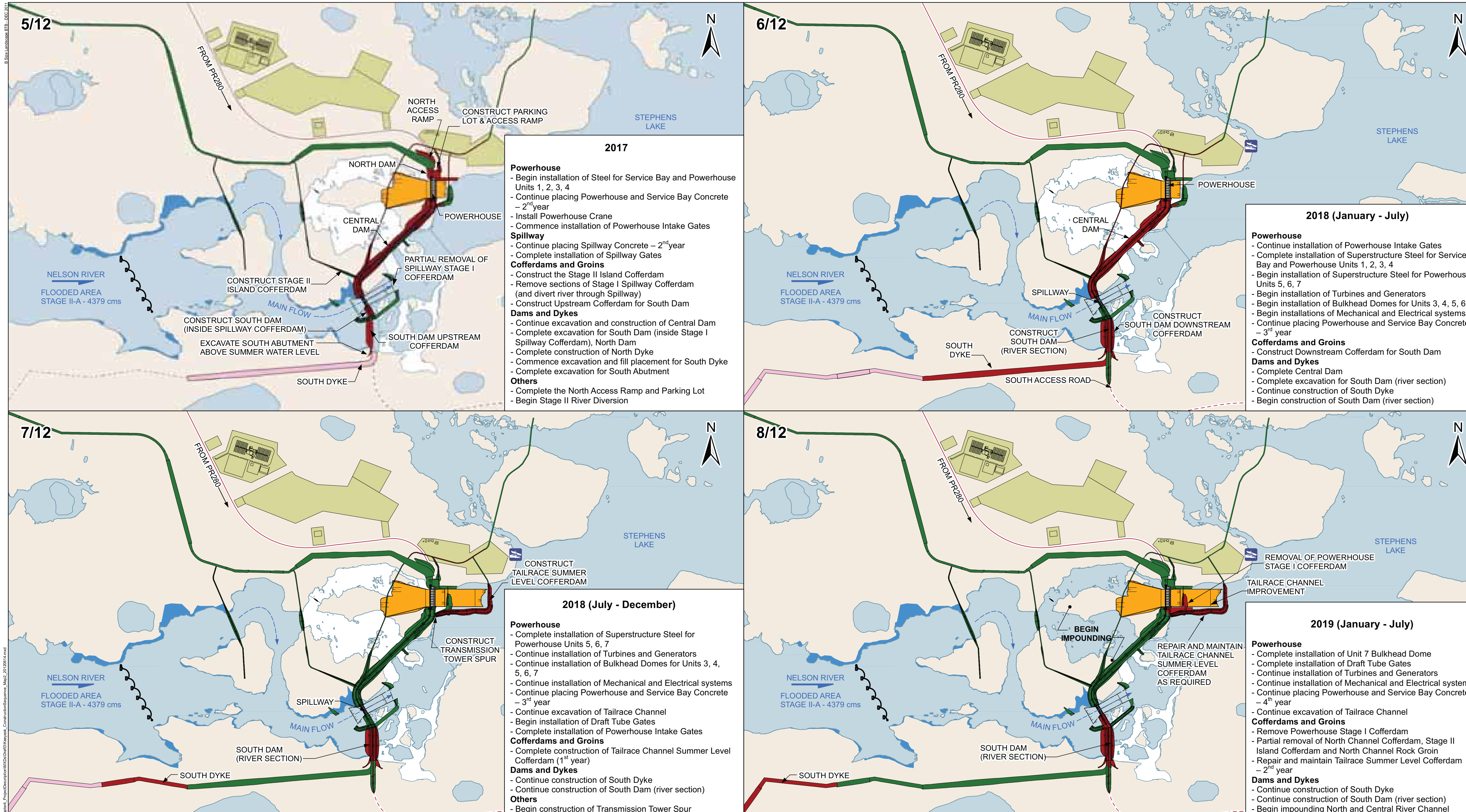
COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	14-FEB-12	14-JUN-12
0 0.5 1 Kilometres / 0 0.4 0.8 Miles	VERSION NO: 3.0	QA/QC: APPROVED

Legend

- Planned/Removed Feature
- Proposed Access Road
- Access Road
- Work Area and Construction Camp
- Structure in Progress
- Earthfill Structure (Complete)
- Excavation Area
- Bedrock Excavation Area
- Concrete/Steel Structure
- Boat Launch & Barge Landing
- Existing Water Surface Area
- Stage I Flooded Area
- Potential Dewatered Area

Construction Sequence
Years 2014 to 2016

Map 4-16



KEEYASK Hydropower Limited Partnership

DATA SOURCE:
Manitoba Hydro, KGS Acres, Government of Manitoba

CREATED BY:
Manitoba Hydro - Hydro Power Planning Department

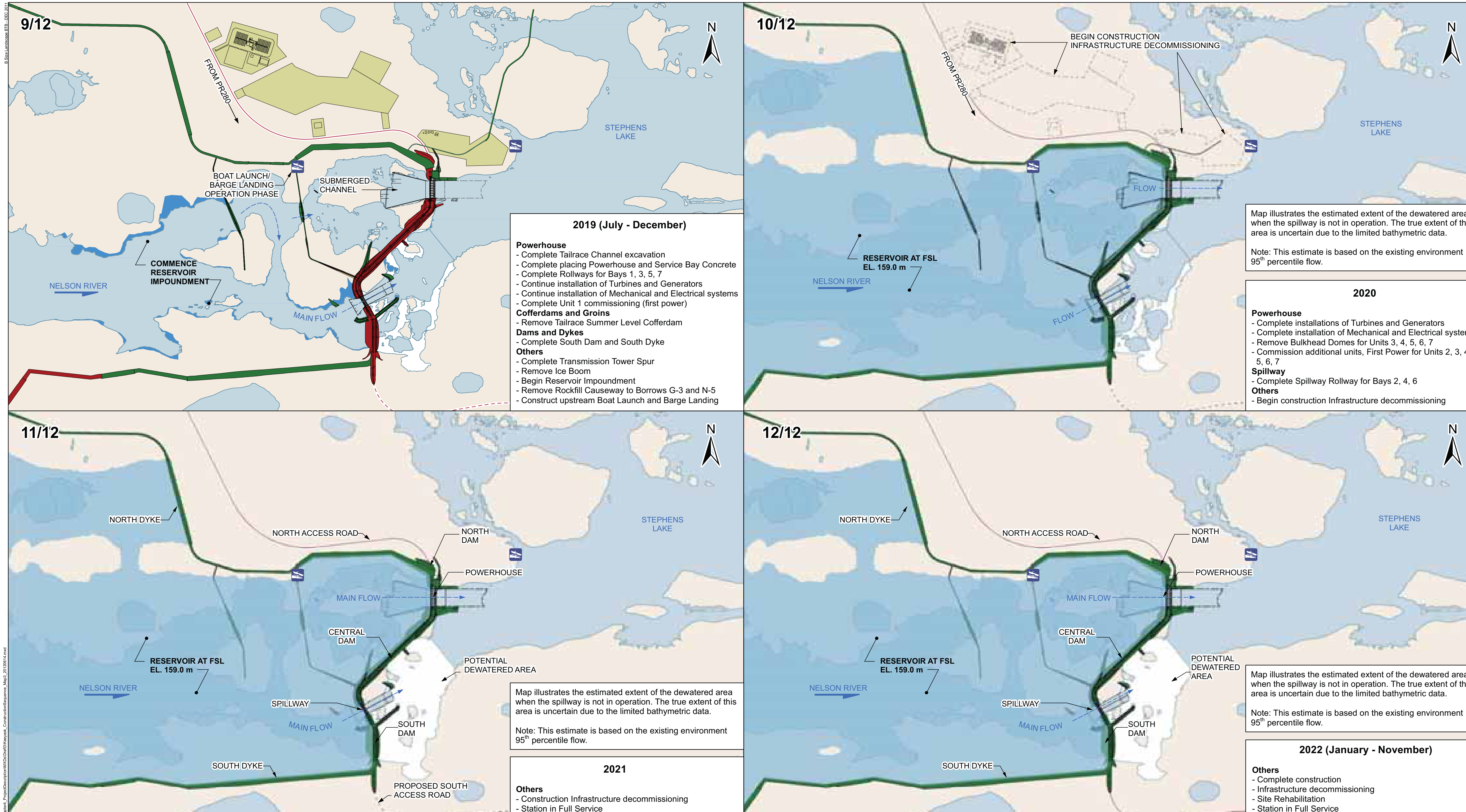
COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	14-FEB-12	14-JUN-12
0 0.45 0.9 Kilometres / 0 0.4 0.8 Miles	VERSION NO: 3.0	QA/QC: APPROVED

Legend

- Planned/Removed Feature
- Proposed Access Road
- Access Road
- Work Area and Construction Camp
- Structure in Progress
- Earthfill Structure (Complete)
- Excavation Area
- Bedrock Excavation Area
- Concrete/Steel Structure
- Boat Launch & Barge Landing
- Existing Water Surface Area
- Stage II Flooded Area
- Potential Dewatered Area

Construction Sequence
Years 2017 to 2019

Map 4-17



KEEYASK Hydropower Limited Partnership

DATA SOURCE:
Manitoba Hydro, KGS Acres, Government of Manitoba

CREATED BY:
Manitoba Hydro - Hydro Power Planning Department

COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	14-FEB-12	14-JUN-12
0 0.45 0.9 Kilometres / 0 0.4 0.8 Miles	VERSION NO: 2.0	QA/QC: APPROVED

Legend

- Planned/Removed Feature
- Proposed Access Road
- Access Road
- Work Area and Construction Camp
- Structure in Progress
- Earthfill Structure (Complete)
- Excavation Area
- Bedrock Excavation Area
- Concrete/Steel Structure
- Boat Launch & Barge Landing
- Existing Water Surface Area
- Stage II Flooded Area
- Initial Reservoir Area (159 m)
- Potential Dewatered Area

Construction Sequence
Years 2019 to 2022

Map 4-18

APPENDIX 4A

JOINT KEEYASK DEVELOPMENT AGREEMENT
SCHEDULE 11-1:
RESERVOIR CLEARING PLAN

Keeyask Hydropower Limited Partnership

SCHEDULE 11-1

KEEYASK HYDROPOWER LIMITED PARTNERSHIP

RESERVOIR CLEARING PLAN

DATED .

SCHEDULE 11-1

KEEYASK HYDROPOWER LIMITED PARTNERSHIP

RESERVOIR CLEARING PLAN

This **Reservoir Clearing Plan** reflects current conditions in the area of the **Keeyask Project**. Conditions can change quickly, as has been evidenced by numerous forest fires over the last decade, affecting the northeast part of the reservoir area, Caribou Island and most of the south of the **Keeyask Project**.

This **Reservoir Clearing Plan** is subject to the provisions of any license issued by a **Regulatory Authority** affecting the **Keeyask Project**, including the **Closing Licenses**, and will be modified, as necessary, in order to comply with the terms of any such license.

1. OBJECTIVES

The objectives of the **Reservoir Clearing Plan** for the **Keeyask Project** are as follows:

(a) minimize impacts of reservoir creation and operation on the fishery by minimizing the effects of standing trees and shrubs on fishing in selected areas within the reservoir;

(b) minimize the impacts of reservoir creation and operation on human access to shore locations by creating shore access locations through selective clearing of trees and shrubs;

(c) minimize hazards to boating safety and fishing resulting from large floating debris by minimizing the source of such debris; and

(d) minimize aesthetically offensive landscapes.

2. RESERVOIR CLEARING

The clearing of vegetation from the reservoir area is divided into two phases:

(a) pre-flooding, which affects the area within the 159 meters (521.7 feet) ASL flood elevation at the dam; and

(b) post-flooding, which includes areas that may be affected by erosion or peat land disintegration after the reservoir has been filled with water.

These two phases are discussed in greater detail and are accompanied by separate Figures 1 and 2, attached.

2.1 Pre-Flooding

Clearing of the reservoir area prior to flooding will address many of the goals for safety and environmental sustainability. Recommended clearing methods and associated activities include areas for hand clearing, areas where hand or machine clearing are suitable, and the creation of access and safe landing sites along the reservoir shoreline. Consideration is given to both wood salvage and environmentally sensitive areas that may require specific treatment during clearing operations. Flagging of clearing boundaries and on-site supervision are critical to the successful implementation of all aspects of the reservoir clearing plan (Figure 1).

2.1.1 Areas to be Cleared

The surface elevation of the reservoir up to at least 159 metres (521.7 feet) **ASL**, and some level above as a buffer, will be surveyed and staked to define the extent of area to be cleared. This area is shown on Figure 1.

2.1.2 What is to be Cleared

All standing woody material, which includes dead and living trees and shrubs 1.5 metres (5 feet) tall or taller, as well as all fallen trees 1.5 metres (5 feet) or more in length with a diameter of 15 centimeters (6 inches) or greater at its largest point will be cleared.

2.1.3 Timing of Clearing Activities

Reservoir clearing will be undertaken in the three (3) years preceding reservoir impoundment, except for areas that will be underwater as a result of coffer dam construction. These areas will be cleared prior to the flooding caused by these works.

2.1.4 Methods of Clearing

2.1.4.1 <u>Mechanical Clearing</u>

The preferred method of clearing is mechanical clearing by shear blading during the winter when the ground is frozen. Using this method, the cleared material is deposited in windrows or piles and left to dry. Cleared material is burned during the following winter season.

Machine clearing has the advantage of shearing stumps off at ground level, along with all other vegetation that is there. It also accumulates all of the loose and dead woody debris that is on the forest floor, along with hummocks of sphagnum moss, making for a very efficient and effective operation. Maximizing machine clearing will minimize the amount of woody and organic debris that would remain on site and enter the water following flooding.

All areas designated for mechanical clearing on Figure 1 will be cleared using this method, with the following exceptions:

(a) cultural or heritage sites known or discovered to exist within the areas identified for mechanical clearing will receive special treatment, as appropriate, as determined on a case by case basis;

(b) selected mainland locations as may be designated by the **Project Manager**, where practical, for tree salvage (for use as firewood, saw-logs, cabins, etc.) will be hand cleared; and

(c) selected locations as may be identified by the **Project Manager**, where tree and shrub density is sufficient to reduce wave energy, may not be cleared, leaving trees and shrubs standing in shallow water to provide protection to the shoreline from wave energy, thereby reducing erosion rates and providing a more stable shoreline for the new growth of riparian shrubs and trees.

2.1.4.2 <u>Hand Clearing</u>

The areas requiring hand clearing are approximately as shown on Figure 1. Clearing will be done using chain saws and brush cutters and other tools as may be appropriate in the circumstances.

Generally, hand clearing will take place at locations within 10 metres (33 feet) of the existing normal high water mark on the Nelson River and within 5 metres (16 feet) of tributary stream banks, due to the higher potential for disturbance of sensitive sites in these areas (for example, riparian areas and heritage sites).

In addition, hand clearing methods will be used where it is not possible to operate mechanical clearing equipment because of site location (inaccessible islands) or condition (steep slopes).

Typically, areas cleared by hand will contain stumps of trees and shrubs approximately 6 inches (15 cm) in height. In addition, most of the smaller shrubs and forest floor debris (if covered by snow) will remain on site.

The final extent of each area to be cleared using hand clearing methods will be determined in the field and will be clearly marked, within one kilometer (0.6 miles) of the area to be cleared by hand, prior to mechanical clearing taking place.

2.1.5 Landing (Access) Sites

There will be an on-going need for user access to the reservoir area from land and access to land from the reservoir for reasons of resource harvesting, recreational enjoyment or emergency purposes. A number of landing sites will be identified along the future reservoir shorelines and these sites will be cleared pursuant to the **Waterways Management Program**. Clearing at these sites may consider the removal of stumps and peat, along with the above ground vegetation, to ensure safe access/egress to the shoreline. Hand clearing will be considered at landing sites above the high water mark to minimize environmental effects and maximize recreational, aesthetic and cultural opportunities.

2.1.6 Consideration of Environmental Sensitivities/Valuable Sites

Information is still being collected and analyzed to identify very specific environmental sensitivities and environmentally valuable sites that may be managed to support the protection of the environment. It is anticipated that such sites will be relatively small in size, possibly experimental in nature and may require long-term study. Consideration of these issues will be undertaken in the environmental protection plan for the **Keeyask Project**.

2.2 Post-Flooding

Areas beyond the initial impoundment of 159 metres (521.7 feet) ASL are at risk of erosion and peat land disintegration after flooding (Figure 2). It is also anticipated that erosion and peat land disintegration will continue over a prolonged period of time after reservoir impoundment and if left unchecked has the potential to contribute substantial amounts of woody debris into the reservoir, thereby jeopardizing human safety and resulting in negative impacts to the **Keeyask Cree Nations**.

Areas that will convert from land to water over time as a result of peat land 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** 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.

APPENDIX 4B

JOINT KEEYASK DEVELOPMENT AGREEMENT SCHEDULE 11-2: WATERWAYS MANAGEMENT PROGRAM

Keeyask Hydropower Limited Partnership

SCHEDULE 11-2

KEEYASK HYDROPOWER LIMITED PARTNERSHIP

WATERWAYS MANAGEMENT PROGRAM

DATED .

SCHEDULE 11-2

KEEYASK HYDROPOWER LIMITED PARTNERSHIP

WATERWAYS MANAGEMENT PROGRAM

1. INTRODUCTION

The **Keeyask Project** will alter the water regime and associated aquatic and terrestrial ecosystems on the Nelson River upstream of Gull Rapids to Clarke Lake and downstream of Gull Rapids to Stephens Lake. Upstream of the **Keeyask Project**, the water levels on some water bodies will increase significantly and will inundate initially forty-five (45) square kilometres (17.4 square miles) of land.

It is expected significant amounts of floating debris will be generated by the initial impoundment of the reservoir. Floating islands and bogs are expected to exist for some time after initial impoundment. Thereafter, other floating debris is expected to be generated as shorelines erode around the reservoir's perimeter. The impoundment and resulting debris will create navigation hazards.

This **Waterways Management Program** describes the agreed programs and plans discussed in section 7 of the **Project Description** that will be implemented by the **Limited Partnership** to reduce potential impacts and accommodate users of the waterway, as well as manage associated safety liabilities for the **Keeyask Project**. This **Waterways Management Program** will be reviewed from time to time by the **Limited Partnership** to ensure that it continues to meet its objectives.

Hydro will implement this **Waterways Management Program**, using existing **Hydro** management and field supervisory staff, as a service to the **Limited Partnership**, and the costs of the program will be included in annual operation and maintenance budgets and reports provided to the **Limited Partnership**.

2. OBJECTIVE

The objective of the **Waterways Management Program** is to contribute to the safe use and enjoyment of the waterway from Split Lake to Stephens Lake throughout the pre-flooding and operational stages of the **Keeyask Project**, in a manner consistent with sections 7.2.1 through to 7.2.7 of the **Project Description**.

3. PROGRAM

3.1 Phase One (1) – Pre-Flooding

The first phase of the **Waterways Management Program** will consist of implementing the measures outlined in section 7.2 of the **Project Description** 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** to identify and contribute to impact management measures at high priority spiritual and heritage sites that will be flooded.

3.2 Phase Two (2) – Post Flooding

The second phase of the **Waterways Management Program** will consist of implementing waterways management activities after flooding. The **Waterways Management Program** will deliver the services outlined in sections 7.2.2 to 7.2.7 of the **Project Description** and also will provide support services, as required, for reclamation of disturbed sites along shorelines.

4. PROGRAM ACTIVITIES

4.1 Program Activities: Phase 1

In each year of the four (4) year period after construction start and before impoundment, two (2) boat patrols, four (4) persons in total employed as **Hydro** seasonal employees, supplemented as required with local labour, including two (2) persons required for a winter ice trail crew, hired on a short-term basis through a local **KCN Business**, will:

(a) operate a multi-purpose boat patrol, monitor waterway activities and liaise with individuals and groups using the Nelson River;

(b) stabilize shoreline at sensitive streams using low impact techniques;

(c) 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;

(d) assist with the relocation of graves to sites not affected by Keeyask, in cooperation with involved **Members**;

(e) construct and maintain a safety cabin;

(f) cut and maintain trails and portages; and

(g) 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 (2) boats, motors and a trailer, two (2) snow machines, sleighs and trailers and safety clothing and equipment, chainsaws, a GPS, ice auger and related equipment.

Low impact techniques include hand placement of field stone and planting of willows to protect a site.

4.2 Program Activities: Phase 2

The activities to be undertaken, in different time periods after impoundment, include the following:

(a) collecting floating debris;

(b) monitoring waterway activities and liaising with individuals and groups;

(c) preparing forebay depth charts and travel routes;

(d) marking safe travel routes, by installing and maintaining navigation and hazard markers;

(e) installing and maintaining water level staff gauges;

(f) constructing and maintaining safe landing sites and required docks and shelters;

(g) installing and monitoring regularly the condition of safe ice trails and the nature and extent of their use;

(h) planning and implementing the remaining protection and preservation measures at spiritually and culturally significant, historical or heritage sites using low impact techniques;

(i) monitoring and maintaining shoreline stabilization measures previously installed at sensitive streams;

(j) maintaining trails and portages.

4.3 Years One (1) to Five (5) Following Impoundment

In each year from years one (1) to five (5) following impoundment, a crew of up to twenty-five (25) workers, configured as two (2) primary boat patrols and three (3) supplementary work crews, will operate five (5) multi-purpose boats for one hundred (100) days in each open water season for the first three (3) and potentially five (5) years. A two (2) person ice trail crew would also operate in this period.

The four (4) persons making up the two (2), two (2) person primary boat patrol crews will be employed as **Hydro** seasonal employees. The workers making up the supplementary work crews and the ice trail crew will be hired on a short term basis through a local contractor.

Below the powerhouse of the **Keeyask Project**, it is expected that concerns will arise with respect to the unknown effects of powerhouse flows. To help manage downstream issues one of the boat patrol crews will operate as a temporary boat patrol for the first three (3) years. The primary function of this boat patrol will be to implement safety measures, deliver information to downstream resource users, and help people become accustomed to the powerhouse's operating mode. The future requirement for this measure would be evaluated thereafter.

4.4 Years Six (6) to Ten (10) Following Impoundment

In each year from years six (6) to ten (10) following impoundment, it is expected that during the open water season, one (1) or more maintenance crews of up to twelve (12) local workers in total, hired on a short term basis through a local contractor, may be required. The maintenance crews would work in conjunction with two (2) person making up a boat patrol crew who will be employed as Hydro seasonal employees. During the ice covered season, when it is safe to travel, a two (2) person ice trail crew will be hired on a short term basis through a local contractor.

4.5 Following Year Ten

In each year after year ten (10), it is expected two (2) persons, making up a boat patrol crew, will be employed as **Hydro** seasonal employees during the open water season and two persons making up a two (2) person ice trail crew will be hired on a short term basis through a local contractor during the ice covered season.

5. SELECTION OF PROGRAM PERSONNEL

5.1 Factors to be Considered on Hiring

The following factors will be considered by **Hydro** in its selection of **Waterways Management Program** personnel:

(a) direct experience and familiarity with open water and winter travel conditions on the Nelson River and Gull Lake;

(b) satisfactory safety record in operating watercraft;

(c) demonstrated safety skills and competencies for working in challenging environmental conditions;

(d) previous work experience in performing required Waterways Management Program tasks;

(e) proven wilderness survival skills; and

(f) personal relationship to Gull Lake.

CHAPTER 5

REGULATORY ENVIRONMENTAL ASSESSMENT APPROACH

KEEYASK
Hydropower Limited Partnership

CHAPTER 5
TABLE OF CONTENTS

LIST OF FIGURES

5.0 REGULATORY ENVIRONMENTAL ASSESSMENT APPROACH

5.1 INTRODUCTION

This Chapter describes the approach taken by the Keeyask Hydropower Limited Partnership (the Partnership) for the regulatory environmental assessment of the potential effects associated with the Project. It provides an overview of the framework, contribution of Aboriginal traditional knowledge (ATK), local knowledge and technical science to the environmental assessment; the approach to assessing effects of the Project and cumulative effects (CEA); and the approach to determining the significance of residual effects.

5.2 OVERVIEW OF APPROACH

The Project is the subject of two evaluations[1], the first of which was conducted by the Keeyask Cree Nations (KCNs) for their internal purposes and the second of which is a public review currently being conducted by federal and provincial environmental regulators:

- KCNs Evaluation Process:

  The KCNs evaluation process has been underway for more than a decade with the support of Manitoba Hydro. The process assisted the KCNs to understand the Project and its impacts on their communities and Members and to determine the conditions under which they would approve the Joint Keeyask Development Agreement and support the Project. The Project was evaluated by each of the KCNs in terms of their own worldview, values and experience with past hydroelectric development, as well as their relationships with *Askiy* (Mother Earth) (see Chapter 2 and the KCNs' Environmental Evaluation Reports, which are provided to assist other people to understand their independent decisions to be Project proponents).

- Government Regulatory Assessment Process:

  Work by Manitoba Hydro and the KCNs on the government regulatory assessment process has also been underway for many years. The Keeyask Generation Project

[1] In addition to the two evaluations cited above, the federal and provincial governments have responsibilities under Section 35 of the Constitution regarding Aboriginal consultations; and Manitoba Hydro will be required to fully explain its decision to contract for Keeyask production before an independent panel on the need for and alternatives to major new projects and export contracts (see Section 4.2).

environmental impact assessment is in accordance with the regulatory framework outlined in Section 1.3, guidance provided by federal and provincial regulatory agencies, and standard environmental assessment practice. The existing environment and the manner in which it functions was studied and analyzed using the scientific method (referred to as "technical information" in the environmental impact statement (EIS), ATK and local knowledge. The assessment then predicted the effects on this environment if the Project is developed, and mitigation was identified to reduce the severity of adverse effects as much as possible. A monitoring program will determine if the prediction of effects are accurate and if mitigation measures are working as expected; and, if not, will assist in identifying new mitigation measures to apply.

ATK played an important role in planning the Project as well as the conduct of the KCNs evaluations and the regulatory environmental assessment.

Through bilateral and multilateral planning processes involving the KCNs and Manitoba Hydro, the Project was shaped to reduce adverse effects. Since the 1990s, Manitoba Hydro has worked with TCN (and later also with WLFN, YFFN and FLCN) in joint planning committees to improve the Project itself (*e.g.*, choice of a lower-head option, development of a Reservoir Clearing Plan [Appendix 4A], Waterways Management Program [Appendix 4B] and other measures) by drawing on the ATK of Members of the KCNs. This meant that there were fewer effects to be assessed.

ATK played a role for each of the KCNs in coming to conclusions about their participation in the Partnership. Each of the KCNs did its own studies to evaluate the Project and the Partnership. An understanding of the worldview of the KCNs, the evaluation process that they undertook, and their conclusions about the Project and the Partnership are found in Chapter 2.

The KCNs also agreed to contribute ATK to the government regulatory assessment process.

The Partnership, through its regulatory assessment, has:

- Examined and planned the Project in a careful and precautionary manner (Chapter 4, Chapter 8, and Chapter 10);
- Identified potential environmental effects of the Project, including the environmental effects of malfunctions or accidents that may occur in conjunction with the Project (Chapter 6), and cumulative effects likely to result from the Project in combination with other projects or human activities that have been or will be carried out (Chapter 7);
- Developed technically and economically feasible measures to mitigate adverse environmental effects (Chapters 4 and 6);
- Evaluated whether the Project, following the application of mitigation measures, is likely to result in significant adverse environmental effects (Chapter 6); and furthermore,

whether cumulative adverse environmental effects that are likely to result from the Project are significant (Chapter 7);

- Considered the capacity of renewable resources that are likely to be significantly affected by the Project to meet the needs of the present and the future; and
- Evaluated whether the Project is consistent with sustainable development (Chapter 9).

Chapter 4 describes the construction and operation of the permanent facilities (the term “operation” also includes maintenance); construction, operation and decommissioning of the temporary facilities (*i.e.*, those required only to construct the Project); operation and decommissioning of the temporary infrastructure previously licensed and constructed as part of the Keeyask Infrastructure Project (KIP); and operation of the north access road, also licensed and constructed as part of KIP.

Given the exceptionally long life of a hydroelectric generating station, it is not practical to describe in detail the manner in which the Project’s permanent facilities will be decommissioned. However, in the event decommissioning is required at some future date, Chapter 4 includes the Proponent’s commitment to comply with legislated and licensing requirements, existing agreements, and industry standards prevalent at that time.

5.3 ASSESSMENT FRAMEWORK

Project effects are predicted by comparing the biophysical and human environments between:

- The predicted future conditions without the Project in place; and
- The predicted future conditions with the Project in place.

The assessment recognizes that the lower Nelson River and adjoining waters, including areas affected by Lake Winnipeg Regulation (LWR) and the Churchill River Diversion (CRD), has been and continues to be an altered environment as a result of the initial diversion and regulation of waters in the early 1970s, as well as ongoing regulation and hydroelectric development, as approved under the *Water Power Act* (Manitoba). For the purpose of assessing the effects of the Project, the existing environment without the Project is considered the environmental setting. This environmental setting is reviewed in Section 6.2 of Chapter 6.

Sections 6.3 to 6.8 identify the expected positive and adverse environmental effects of the Project following the application of proposed mitigation measures for each environmental component in the EIS Guidelines. Expected effects that remain after the application of mitigation measures are considered to be residual effects of the Project. The assessment concludes in Sections 6.4 to 6.8 by determining whether expected residual adverse environmental effects on each valued environmental component (VEC) will be significant (as defined according to the methodology set out for the assessment); and whether the effects assessment conclusion is sensitive to climate change (including Section 6.3 Physical Environment).

The cumulative effects assessment is in Chapter 7 and monitoring and follow-up programs are discussed in Chapter 8.

5.3.1 ASSESSMENT FRAMEWORK STEPS

The assessment employs a series of steps to develop conclusions on the effects of the Project. Key steps include the following:

STEP 1: PROJECT DESCRIPTION

The project description (see Chapter 4) defines the Project components and activities required to construct and operate the Project's permanent facilities and to decommission infrastructure not required for operations. This includes measures to mitigate potential adverse effects and specific programs developed to provide appropriate replacements, substitutions or opportunities to offset adverse effects and enhance benefits of the Project.

STEP 2: SCOPE OF ASSESSMENT

Spatial boundaries define the areas where the biophysical and socio-economic studies were conducted (*i.e.*, the study areas). The study area for each environmental component (*e.g.*, the physical environment, aquatic environment, terrestrial environment) is defined by the geographic extent of the direct and indirect effects of the Project. Where required, the study areas extend beyond the zone of impact to provide context for the studies.

Study areas vary between environmental components to appropriately reflect the extent of Project effects on that component (*e.g.*, the study area for socio-economic effects is larger than the study area for physical effects). Similarly, the study areas for individual VECs and supporting topics within each environmental component also vary as the study area for a species with a large home range need to be larger than the study area for a more sedentary species. The study areas selected are large enough to capture the effects of the Project, but not so large as to mask the effects of the Project (by making the effects of the Project as a percent of the area appear unreasonably small).

The majority of studies focused on the areas where the main impacts would occur. For example, while the regional study area for heritage resources is quite large, the heritage resource studies focus on the reach of the Nelson River between the outflow at Clark Lake and the inflow into Stephens Lake (including the north and south access roads, north and south dykes, and most borrow areas) where the majority of disturbances would occur.

Detailed descriptions of the study areas and related temporal scope for each environmental component are provided in Section 6.2.3.2 (Physical Environment); Section 6.2.3.3 (Aquatic Environment); Section 6.2.3.4 (Terrestrial Environment); Section 6.2.3.5 (Socio-Economic Environment; Section 6.2.3.6 (Resource Use); and Section 6.2.3.7 (Heritage Resources).

During the scoping step, key issues of importance to regulatory authorities and people who may be affected by or have an interest in the Project were identified. From these issues, VECs were selected to focus the assessment of the significance of adverse effects. Selection of VECs was based on the following criteria:

- Overall importance/value to people;
- Key for ecosystem function;
- Umbrella indicator;
- Amenable to scientific study in terms of the analysis of existing and post-construction conditions;
- Potential for substantial Project effects; and
- Regulatory requirements.

VECs selected for each environmental component are listed in the subsequent sections of Chapter 6.

Step 3: Environmental Setting

The existing environment, including the past, the present and the future environment without the Project, is described. This requires a description of the existing environmental setting of the study area, including trends, conditions, and the major influences of past and present projects and activities, in shaping the current and future environmental setting without the Project. The description of the environmental setting includes a discussion of the physical, aquatic, terrestrial, socio-economic, resource use and heritage environments.

Step 4: Identification of Potential Effects

The potential effects of the Project on the existing environment is identified. This step requires a comparison of the existing and future environments with and without the Project, as established in Step 2; potential effects of the Project are identified separately during the Project's construction and operation phases.

Step 5: Mitigation of Adverse Effects

Mitigation measures to reduce adverse effects are also identified. These are proposed measures to avoid, prevent or reduce adverse effects and enhance positive effects.

STEP 6: ASSESSMENT OF RESIDUAL EFFECTS

The effects that would remain after the application of mitigation measures are identified. These residual effects are assessed in terms of their nature, magnitude, and spatial and temporal extent.

STEP 7: REGULATORY SIGNIFICANCE OF RESIDUAL EFFECTS

The regulatory significance of residual effects on each VEC is evaluated according to criteria set out in the EIS Guidelines (see Section 5.5).

STEP 8: CUMULATIVE EFFECTS

Cumulative environmental effects are assessed that are likely to result from the Project in combination with other projects or human activities that have been or will be carried out. The cumulative effects assessment focuses on VECs (as described in Step 2) that may be adversely affected by the Project (after mitigation) and considers likely adverse effects caused by the other projects or human activities that overlap in space and time with those of the Project. After considering proposed mitigation and using the same criteria as in Step 7, the regulatory significance of any such residual effects of the Project is determined.

STEP 9: MONITORING AND FOLLOW-UP

The final step is the development of an environmental protection program for monitoring and managing the effects of the Project during construction and operation. The program will be finalized once regulatory requirements are known.

The monitoring programs will help to determine the actual effects of the Project, including:

- Whether they are consistent with the analysis in the environmental impact assessment;
- The effectiveness of mitigation measures; and
- Whether any adaptive management and mitigation measures need to be implemented if unforeseen impacts occur.

5.3.2 SOURCES OF INFORMATION

The partners worked together to conduct and document this environmental assessment. ATK, local knowledge and technical science were used to inform the assessment. As both proponents of the Project and as affected in-vicinity First Nations, the KCNs played an integral role, along with Manitoba Hydro, in directing and shaping the assessment.

5.3.2.1 Aboriginal Traditional Knowledge

ATK is a cumulative body of knowledge, practice and belief about relationships among living beings that is handed down by Elders to each generation and is a way of life continuously adapted and added to by each generation (as taken from Berkes 2008). ATK is broad and holistic and also includes more specific knowledge. All of the KCNs' ATK is grounded in the Cree worldview. Each of TCN, WLFN, YFFN and FLCN took its own approach to applying their ATK to their respective evaluations of the Project; therefore, different sources of ATK were brought into the process.

ATK played a role in the scoping and conduct of the environmental assessment. A major ATK workshop was held by the partners in June 2008; from there, they established ATK principles to guide how ATK would be brought into the process (see Chapter 2, Appendix 2A). ATK helped to identify issues, effects, mitigation and monitoring. The KCNs brought their ATK to the processes, which guided the environmental assessment (*e.g.*, through the Partners Regulatory and Licensing Committee, EIS Coordination Team, bilateral environmental studies working groups, and multilateral working groups dealing with the aquatic environment, mammals and mercury and human health). In addition, extensive community-based consultation was undertaken by each of the KCNs with its Members. Finally, the KCNs will play a role in monitoring and follow-up plans (including ATK) through mechanisms established through the governance structures of the JKDA.

The more specific ATK of the KCNs, also grounded in their worldview, is reflected in Chapter 6, Environmental Effects Assessment. ATK that contributes to the understanding of the environmental setting is included in Section 6.2, and ATK that contributes to the understanding of effects of the Project is described in Sections 6.3 through 6.8. Where ATK identifies uncertainty regarding conclusions reached through technical science, this is addressed through monitoring and follow-up in Chapter 8.

5.3.3 Technical and Local Information

Technical sources of information include engineering and scientific studies and analyses undertaken by the Proponent, articles in peer-reviewed journals and "grey" literature (*i.e.*, not published in peer-reviewed journals), and existing government databases. Local knowledge came from the Public Involvement Program, including open houses and meetings with local officials, and less formally through interactions between the scientific team and local workers.

Keeyask-specific studies have been undertaken for the assessment for several decades. The studies covered the range of topics required for the environmental assessment, as set out in the Guidelines. Over the past decade, study plans were produced each year by the study team and reviewed and revised in consultation with the KCN communities.

The study program was designed to achieve the following:

- Address concerns and issues identified by the locally-affected KCNs communities and Manitoba Hydro with respect to the proposed developments;
- Provide information that assisted the KCNs and Manitoba Hydro in making their respective decisions regarding the proposed developments;
- Identify opportunities for the KCNs associated with the developments;
- Assist in the planning of the developments by identifying and assessing impacts of alternatives identified by the KCNs and Manitoba Hydro;
- Identify environmental issues that need to be considered during planning of the developments (*e.g.*, identify possible negative effects so they can be avoided or mitigated wherever possible);
- Provide information for the environmental impact assessment and prepare the EIS in accordance with regulatory requirements;
- Provide baseline information to allow for future monitoring studies to determine the environmental effects of the Project and, if necessary, to apply adaptive management strategies; and
- Develop data reports and technical memos for field studies. These technical reports and memos were used as primary sources of information for the analysis documented in each of the supporting volumes. The findings in the supporting volumes, as well as the KCNs' Environmental Evaluation Reports, are the sources of primary information for the EIS.

The following are other sources of information, in addition to the field studies undertaken by the technical study team:

- Statistical data sources including data obtained from Statistics Canada, Manitoba Bureau of Statistics, Aboriginal Affairs and Northern Development Canada (previously INAC), Health Canada First Nation and Inuit Health Branch (Health Canada), Manitoba Health, Canadian Food Inspection Agency, Freshwater Fish Marketing Corporation, Fisheries and Oceans Canada (DFO); Manitoba Conservation and Water Stewardship, Environment Canada, and Manitoba Infrastructure and Transportation;
- A program of key person interviews, workshops and focus groups;
- Discussions with known experts in specific areas;
- Datasets and other information obtained from Manitoba Conservation and Water Stewardship , Manitoba Land Initiative, Committee on the Status of Endangered Wildlife in Canada, Agriculture and Agri-Food Canada and Canadian Forest Service;

- Monitoring studies conducted on Manitoba Hydro projects in northern Manitoba, which provide an understanding of both the short-term and long-term effects of similar projects in similar environments; historical studies; and EISs of other relevant projects, particularly large-scale projects in Canada;
- Meetings with regulatory agencies to discuss the status of the environmental studies and provide information to assess ongoing changes to the Project;
- Issues and concerns identified through the Public Involvement Program; and
- Use of both published and unpublished information (a list of the documents depended upon in this assessment is provided in the References section of each supporting volume of the EIS or associated reports).

5.4 APPROACH TO CUMULATIVE EFFECTS ASSESSMENT

The cumulative effects assessment (CEA) assesses the cumulative environmental effects likely to result from the Project in combination with other projects or human activities (as listed in Chapter 7) that have been or will be carried out. After considering proposed mitigation and using the criteria in Section 5.5, the CEA determined if any such residual effects of the Project on VECs are significant from a regulatory perspective.

The CEA focuses on VECs determined in Chapter 6 to be adversely affected by environmental effects of the Project that overlap in space and time with the effects of other projects or human activities.

Chapter 6 assesses adverse effects of the Project on the existing environment, the condition of which is affected by past and current projects and human activities.

Chapter 7 addresses the CEA. The adverse effects of the Project that overlap with the effects of other past and current projects and activities are summarized (based on Chapter 6), and then the adverse effects of the Project that overlap with the potential effects of other future projects and activities are assessed.

5.5 APPROACH TO DETERMINATION OF REGULATORY SIGNIFICANCE

The assessment predicts environmental effects that are both positive and adverse after mitigation measures have been applied (*i.e.*, residual effects). It also evaluates the regulatory significance of adverse residual effects on VECs that are likely to occur.

The regulatory significance of predicted residual adverse environmental effects on each VEC is assessed using a two-step process. In assessing regulatory significance, where possible the Chapter 6 analysis uses relevant regulatory documents, environmental standards, guidelines, or objectives such as prescribed maximum levels of emissions or discharges of specific hazardous agents in the environment.

STEP 1

Each VEC is initially evaluated using the following criteria as provided in the EIS Guidelines:

- Direction or nature (*i.e.*, positive, neutral or adverse) of the effect;
- Magnitude (*i.e.*, severity) of the effect;
- Spatial boundaries (*i.e.*, geographic extent); and
- Temporal boundaries (*i.e.*, duration).

To apply these criteria in the EIS, each is defined as follows:

- **The Direction or Nature of the Effect** describes the nature of the residual effect and the difference or trend of the effect compared with existing baseline or pre-project conditions. Direction is described as:
  - Positive – A beneficial or desirable effect on the environment;
  - Neutral or negligible – No measurable change in the environment[1]; or
  - Adverse – An undesirable effect on the environment.

  The overall direction of change (positive, neutral or adverse) is typically clear for a specific VEC. However, issues can arise when a specific species or habitat has positive effects in some areas and is harmed in other areas. Issues can also arise when considering differing perceptions, perspectives and values among different groups of affected people about their community and region. For example, the assessment of overall direction of change for socio-economic effects also considers the following:

  When assessing effects of the Project on people, it is recognized that there are problems inherent in assessing separately effects on different VECs that contribute to overall personal, family and community life. Effects may be either positive or negative, depending on the people affected. Effects may also be both positive and negative when different groups are affected differently, when different elements of a VEC are affected differently, or when different VECs are considered for the same group.

- **Magnitude** describes the predicted severity or degree of disturbance the residual effect has on a component of the biophysical or socio-economic environment. Where relevant,

[1] Neutral or negligible effects were considered in the EIS to be equivalent to no residual effect.

this criterion takes into consideration the extent to which a VEC is vulnerable (including a species at risk) to any detectable adverse effect. Magnitude is described as:

- Small – No definable, detectable or measurable effect; or below established thresholds of acceptable change; or within the range of natural variability; or minimum impairment of an ecosystem component's function;
- Moderate – Effects that could be measured and could be determined within a normal range of variation of a well designed monitoring program; or are generally below or only marginally beyond guidelines or established thresholds of acceptable change; or are marginally beyond the range of natural variability or marginally beyond minimal impairment of ecosystem component's function; or
- Large – Effects that are easily observable, measured and described (*i.e.*, readily detectable without a monitoring program), and well beyond guidelines or established thresholds of acceptable change; are well beyond the range of natural variability; or are well beyond minimal impairment of an ecosystem component's functions.

- Geographic Extent describes the spatial boundary within which the residual environmental effect is expected to occur. Geographic extent is described as:
  - Small geographic extent – Effects that are confined to a small portion of one or more small areas where direct and indirect effects can occur (*e.g.*, rights-of-way or component sites and adjacent buffer areas);
  - Medium geographic extent – Effects that extend into local surrounding areas where direct and indirect effects can occur; or
  - Large geographic extent – Effects that extend into the wider regional area where indirect or cumulative effects may occur.
- Duration describes the temporal boundary or length of time within which the predicted residual environmental effect would last. Duration is described as:
  - Short-term – Effects that generally occur within the construction period or initial period of impoundment or that occur within only one generation or recovery cycle of the VEC;
  - Medium-term – Effects that extend through a transition period during the operation phase or that occur within one or two generations or recovery cycles; or
  - Long-term – Effects that extend for a long-term during the operation phase, or that are permanent, or that extend for two or more generations or recovery cycles.

All VECs are examined using the above four criteria (see Figure 5-1). VECs that have an adverse effect and meet the criteria for Step 2 (see below) are examined further. The effects of the Project on VECs that do not proceed beyond the above Step 1 assessment are determined to be not significant for the purposes of this regulatory assessment.

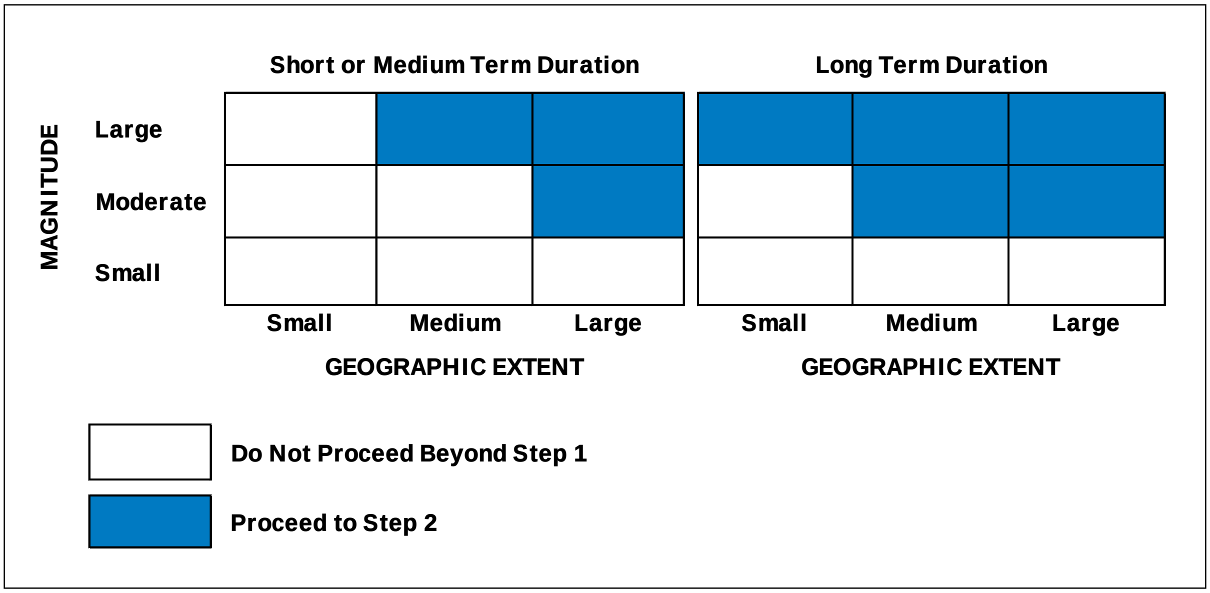


Figure 5-1: Regulatory Significance Step 1 Assessment

STEP 2

VECs that have an adverse effect and meet the following criteria are examined further:

- A species at risk listed as threatened or of special concern under SARA (or is being considered for such listing today based on a COSEWIC recommendation); or
- Small in geographic extent, large in magnitude and long-term in duration; or
- Medium in geographic extent and either large in magnitude (regardless of duration) or moderate in magnitude and long-term in duration; or
- Large in geographic extent and either moderate or large in magnitude (regardless of duration).

In Step 2, additional criteria that may be considered are as follows:

- **Frequency** describes how often the predicted residual environmental effect would occur. Frequency is described as:
    - Infrequent – Effects that occur only once or seldom during the life of the Project (*e.g.*, initial clearing of right of way);
    - Sporadic/Intermittent – Effects that occur only occasionally and without any predictable pattern during the life of the Project (*e.g.*, wildlife – vehicle collisions, bird strikes with transmission lines); or
    - Regular/Continuous – Effects that occur continuously or at regular periodic intervals during the life of the Project.
- **Reversibility** describes the potential for recovery from an adverse effect. Reversibility is described as:
    - Reversible – Effect that is reversible during the life of the Project; or
    - Irreversible – A long-term effect that is permanent.
- **Ecological and Social Context** describes whether the VEC is particularly sensitive to disturbance and has the capacity to adapt to change. This includes where relevant the rarity, uniqueness and fragility of the VEC within the ecosystem (*e.g.*, rare species/habitats, critical habitats, breeding areas). Ecological and Social Context is described as:
    - Low – The VEC is not rare or unique, is resilient to imposed change, or is of minor importance to ecosystem functions or relationship;
    - Moderate – The VEC has some capacity to adapt to imposed change, is moderately/seasonally fragile, or is somewhat important to ecosystem functions or relationship; or
    - High – The VEC is a protected/designated species or fragile with low resilience to imposed change or part of a very fragile ecosystem.

Following Step 2 analysis for a VEC, a determination is provided on whether the adverse effects of the Project on the VEC are significant for the purposes of this regulatory assessment.

For example, if an environmental VEC is known to be highly resilient (*i.e.*, adaptable and recovers well from disturbance), effects that could otherwise be considered significant may, for the purposes of regulatory determination of significance, be determined as insignificant. Conversely, where the loss of even a few individuals may affect the long-term viability of a population, the effect on a VEC may be significant, even where the magnitude and geographic extent are otherwise considered to be in the medium range. For socio-economic VECs, additional factors that may need to be considered include concurrent effects on other socio-economic VECs affecting the same group of people or others in the same community or region, or the degree to which the affected people have control over mitigation (which may affect "vulnerability" in socio-economic terms), and overall confidence in the assessment after consideration of proposed mitigation measures.

The assessment where relevant also addresses the certainty/uncertainty (*i.e.*, level of confidence) of the analysis/prediction. The Canadian Environmental Assessment Agency's guidance document explains that the level of uncertainty is a condition resulting from the adequacy of scientific information. Some effects are predicable with a high level of certainty while other effects may be unknown until they occur. Sources and degrees of uncertainty for each of the biophysical and socio-economic analyses are identified where relevant and feasible in Chapter 6 (Environmental Effects Assessment). Chapter 6 also notes a number of instances where ATK predicts that the effects will be greater than those predicted by technical science. In cases such as these, monitoring will be undertaken to measure the actual effects of the Project and, if necessary, implement adaptive management measures.

Proposed monitoring and follow-up activities as described in Chapter 8 address, among other matters, management plans to deal with instances where conclusions about whether the Project will cause an effect and/or the extent of such effect differ when based on ATK as compared to technical science. These differences, where known, are reported in the EIS and considered to reflect uncertainty that will require resolution in the monitoring and follow-up in Chapter 8.

In the event that significant adverse effects are predicted for residual effects on VECs, the likelihood is discussed in terms of both the probability of occurrence of the significant adverse effect and the degree of uncertainty. Based on this, a conclusion is made as to whether a significant adverse environmental effect is likely.

Cumulative effects assessment is addressed in Section 5.4 above and in Chapter 7. The significance determinations in Chapter 6 for adverse environmental effects in the context of effects from other past and current projects are reviewed where relevant in Chapter 7 for cumulative effects related to reasonably foreseeable future projects.

If it is determined that the Project will likely cause a significant residual adverse effect on a VEC(s) that is a renewable resource, the EIS further considers the capacity of the VEC(s) to meet the needs of the present and those of the future.

CHAPTER 6

ENVIRONMENTAL EFFECTS ASSESSMENT

KEEYASK
Hydropower Limited Partnership

CHAPTER 6
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In print version, Chapter 6 Maps can be found in the accompanying Map and Figure Folio.

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6.0 ENVIRONMENT EFFECTS ASSESSMENT

6.1 INTRODUCTION

The Partners agreed there would be a Keeyask Cree Nations (KCNs) evaluation process as well as a government regulatory environmental process. Chapter 2 of the EIS focused on the central elements of the KCNs' worldview and the fundamental values integral to that worldview.

The intent and scope of this chapter is to describe, particularly for provincial and federal regulatory agencies, the expected effects, mitigation and residual effects related to the construction and operation of the Keeyask Generation Project on components of the environment. Chapter 6 addresses Sections 8 (Existing Environment) and 9 (Effects Assessment) of the Final Environmental Impact Statement Guidelines for the Keeyask Generation Project prepared by the Canadian Environmental Assessment Agency (CEAA 2012).

As set out in Chapter 5, (Regulatory Environmental Assessment Approach), the effects of the Project were predicted by comparing what is expected to happen with the Project during the construction and operation phases, with what would be expected to happen in the future without the Project. To focus the assessment, and aligned with the scope of assessment in Section 6 of the Federal EIS Guidelines, valued environmental components (VECs) and relevant supporting topics were identified for the aquatic, terrestrial, resource use, socio-economic and heritage resources components of the environment. For the physical environment component a series of key topics were identified for analysis which supported analyses in other components. Chapter 6 presents the results of analysis of these effects, mitigation of adverse effects or enhancement of positive effects, and residual effects (after mitigation has been considered). It also presents conclusions with respect to the significance of residual effects on VECs and a brief description of monitoring needs (with cross-reference to Chapter 8: Monitoring and Follow-Up). Finally, it describes the sensitivity of these effects when climate change is considered.

The environmental assessment (EA) studies, which underpin these results, drew on both technical science and Aboriginal traditional knowledge (ATK). Appendix 6A provides a list of environmental study reports and technical memos by environmental discipline (*e.g.*, physical, aquatic, terrestrial *etc.*) used in the preparation of, and as background support to, the environmental assessment of the Project. In addition, Appendix 6B provides a list of policies, standards and guidelines used by the environmental assessment study team to assist in their effects assessment. Appendix 6C includes an Impact Matrix table that identifies the potential interaction between the Project activities and components of the environment during all phases of the Project. In particular, potential interactions with VECs are illustrated. Effects, mitigation, residual effects and significance are described in Section 6.3 though 6.8. Manitoba Hydro and the Keeyask Cree Nations (KCNs) worked jointly through a series of committees and working groups to oversee the EA and to address potential effects, mitigation and residual effects. In addition, the KCNs undertook their own studies and set out their results in the Cree Nation Partners Keeyask Environmental Evaluation Report, the York Factory First Nation Evaluation Report (*Kipekiskwaywinan*) and the Fox Lake Cree Nation Evaluation Report (draft). In addition to the KCNs Evaluatioon Reports, the Executive Summary and this EIS, there are a series of supporting volumes (*e.g.*, physical environment, aquatic environment *etc.*).

ATK is presented throughout this EIS. Chapter 2, in particular, presents the KCNs' worldview and evaluation of the Project. In addition, a video entitled, *Keeyask: Our Story*, which expresses the views of the KCNs about the Project and their participation in it, forms part of this filing.

In this chapter, results are presented by each broad component of the environment (*i.e.*, physical, aquatic, terrestrial, socio-economic, resource use and heritage resources). Technical science results are presented using the methodology steps set out in Chapter 5 (Regulatory Environmental Assessment Approach), which are consistent with federal and provincial legislation and guidance documents. Where available, ATK specific to each component is also presented. It is important to note that ATK that is presented in this chapter should be considered within the KCNs' worldview, which is described and set out in Chapter 2, (Partners' Context, Worldviews and Evaluation Process).

As described in Chapter 5, (Section 5.3.1), spatial boundaries were established to define the areas where the biophysical and socio-economic studies and the Project effects assessment were conducted (*i.e.*, the study areas). Component-specific maps (*e.g.*, physical environment, terrestrial environment habitat) with the appropriate regional and/or local study areas were developed. Table 6-1 lists all the study area maps that are included in the Map and Graphic Folio. Further descriptions of the study area boundaries can be found in the introductory section of each specific environmental component.

Table 6-1: Study Areas

Component	Sub-component	Title of Map	Map Number
Physical Environment	Physical	Physical Environment Local Study Area	Map 6-2
	Physiography	Local and Regional Physiography Study Areas	Map 6-3
Aquatic Environment		Aquatic Environment Study Area	Map 6-18
Terrestrial Environment		Geographic Zones Used for Terrestrial Study Areas	Map 6-28
Socio-Economic Environment	Socio-Economic	Socio-Economic Local Study Area	Map 6-1
		Socio-Economic Regional Study Area	Map 6-41
	Resource Use	Resource Use Local and Regional Study Areas	Map 6-42
	Heritage	Heritage Resources Study Areas with Registered Archaeological Sites	Map 6-46

Chapter 6 is organized into the following sections:

- Section 6.2 (Existing Environment), includes the regional setting, a summary of the past (from the pre-contact period including the recent period of hydroelectric development) and a profile of the **existing environment** and future trends without the Project.
- Each of the sections that follows present effects and mitigation, residual effects, determination of regulatory significance and sensitivity of effects to climate change for the following components of the environment:
    - Section 6.3 Physical Environment;
    - Section 6.4 Aquatic Environment;
    - Section 6.5 Terrestrial Environment;
    - Section 6.6 Socio-economic Environment;
    - Section 6.7 Resource Use; and
    - Section 6.8 Heritage Resources.

Chapter 7 (Cumulative Effects Assessment) and Chapter 8 (Monitoring and Follow-Up) are important companion chapters in presenting the full conclusions of this component of the environmental assessment.

6.2 EXISTING ENVIRONMENT

6.2.1 REGIONAL SETTING

The Project is located in northeastern Manitoba within the Boreal Shield Ecozone (Smith *et al.* 1998). The general topography of the Project area has been influenced by glacial activity and is characterized by gently sloping terrain with peat of varying thickness overlying fine-grained clay and sand.

The Project is within the northern Manitoba boreal ecosystem with discontinuous permafrost contained in various types of peatlands that support relatively young vegetation. Land cover and terrestrial habitat are dominated by sparsely to densely treed black spruce vegetation on peatlands. Bogs, fens, shallow water and marsh wetlands typically occur along waterbody shorelines, with shallow water habitat the most common along the Nelson River — the Nelson River being the major feature in the general physical landscape.

The Nelson River and the surrounding environment have been greatly altered over the past 50 years by the development of the Lake Winnipeg Regulation, the Churchill River Diversion Project and five generating stations. These alterations have replaced large rapids with dams, changed stretches of the river into reservoirs, augmented flows into the river by 30% and reverse the seasonal flow patterns such that higher flows now occur in winter and lower flows in early spring (see Section 6.2.2.3 for further details). For example, Stephens Lake was created by the construction of the Kettle Generation Station in the early 1970s and is managed as a reservoir.

The aquatic environment consists of lacustrine habitat in shallow lakes (Split, Clark, Gull and Stephens lakes) and riverine habitat of the Nelson River, typically in one swiftly flowing channel (though a few islands and off-current bays are present). The Nelson River is the receiving stream of an extensive watershed stretching across Alberta, Saskatchewan and Manitoba, east into Ontario and extending southerly into North Dakota and Minnesota in the United States. The widespread watershed results in substantial water flows that represent major hydroelectric generating potential.

People have occupied the region for thousands of years with enormous changes occurring since the 1600s when Europeans began to arrive. The region's original inhabitants were Aboriginal groups who lived off the land and typically followed a seasonal cycle, timing their movements to take advantage of where natural resources were abundant. These groups eventually became several Cree Nations, some of whom currently live in the vicinity of the Project. They continue to be a key part of the region's population and economy and adhere to the Cree worldview that emphasizes respect for and stewardship of *Askiy* (Mother Earth)(the land, water and living things). Traditional resource use, including hunting, fishing, trapping, and gathering for both domestic/subsistence and commercial purposes, continues to be important to the Cree people who live in this region.

Government services and programs, mining exploration, Manitoba Hydro development and operations, forestry and commercial and domestic resource use are the main drivers of the region's economy. The majority of the region's population of about 84,300[1] lives in communities, with a very small proportion of people living in more remote areas (Statistics Canada 2007). The region's communities are comprised of First Nation reserves, Northern Affairs communities and industrial towns and cities. The largest portion of the population (*i.e.*, about 72%) has self-identified as being of Aboriginal descent. The City of Thompson is the main regional service center, the transportation hub for the region and its largest community.

Six of the region's communities are located in the vicinity of the Project: Split Lake (home to Tataskweyak Cree Nation), Ilford (home to War Lake First Nation), York Landing (home to York Factory First Nation), Fox Lake/Bird (home to Fox Lake Cree Nation), Gillam (Manitoba Hydro's key operations and service center and home to FLCN Members and their urban reserve) and Thompson (see Map 6-1). Populations of these First Nation and industrial communities are shown in Table 6-2.

Table 6-2: In-Vicinity Community Population (2006)

	Tataskweyak Cree Nation[1]	War Lake First Nation[1]	Fox Lake Cree Nation[1]	York Factory First Nation[1]	Gillam[2,3,4]	Thompson[2,3,5]
On-Reserve and Crown Land	2,169	125	273	452		
Total First Nation population	3,020	235	1,019	1,072		
Community population					1,210	13,445

Sources: Statistics Canada 2007; Indian and Northern Affairs (INAC) First Nations Population Profiles 2006.

Notes:

1. INAC data represent the population as of December 31, 2006 (date chosen to match Statistics Canada data).
2. Statistics Canada data represent the population during the Census of Canada on May 16, 2006.
3. Statistics Canada data are subject to random rounding procedure; population totals and individual cells are rounded.
4. 580 persons self-identified as Aboriginal out of the total population.
5. 4,915 persons self-identified as Aboriginal out of the total population.

[1] The 2006 total population for the overall northern region is based on Statistics Canada Census Divisions 19, 21, 22 and 23.

6.2.2 THE PAST

Through their own words, each of the KCNs has documented the history and present situation of their people who have inhabited the Keeyask area for thousands of years. The Cree people of TCN, WLFN, YFFN and FLCN have shared their stories, culture and history in Chapter 2 and in their evaluation reports. The KCNs' stories illustrate how changes over the past 200 years have had a profound effect on their relationships with the environment, changing their way of life and culture. The most profound of these changes took place over the past 55 years with the onset of hydroelectric development, which greatly altered their environment.

Section 6.2.2 summarizes key drivers of change and notable developments in the history of the KCNs from the pre-contact period, the pre-hydroelectric period focusing on contact with European explorers and the fur trade, and the hydroelectric period focusing on the most recent history. Figure 6-1 presents a visual timeline of these periods in history (see SE SV for further details).

Understanding the KCNs' past is important context to understand today's existing environment and future trends without the Project. In the sections that follow, emphasis is placed on key drivers of change since European settlement and industrial development. Context is provided in the Pre-Contact and Pre-Hydroelectric sections.

The most detailed information is provided for the hydroelectric development era between 1957 and the present in order to depict how the construction and operation of these northern hydroelectric projects resulted in life-altering changes to the water, land and traditional way of life of First Nation members living in the Keeyask area (CNP Keeyask Environmental Evaluation Report; YFFN Evaluation Report (*Kipekiskwaywinan*); FLCN Environment Evaluation Report (Draft); FLCN 2009 Draft; Split Lake Cree – Manitoba Hydro Joint Study Group 1996a, 1996b). The Socio-Economic Supporting Volume (SE SV, Section 2) provides a more detailed review of recent and past historic events that shaped the human history of northeastern Manitoba and includes discussion of the ATK and perspectives of the KCNs. Chapter 2 of this document provides historical context and details about the Cree worldview.

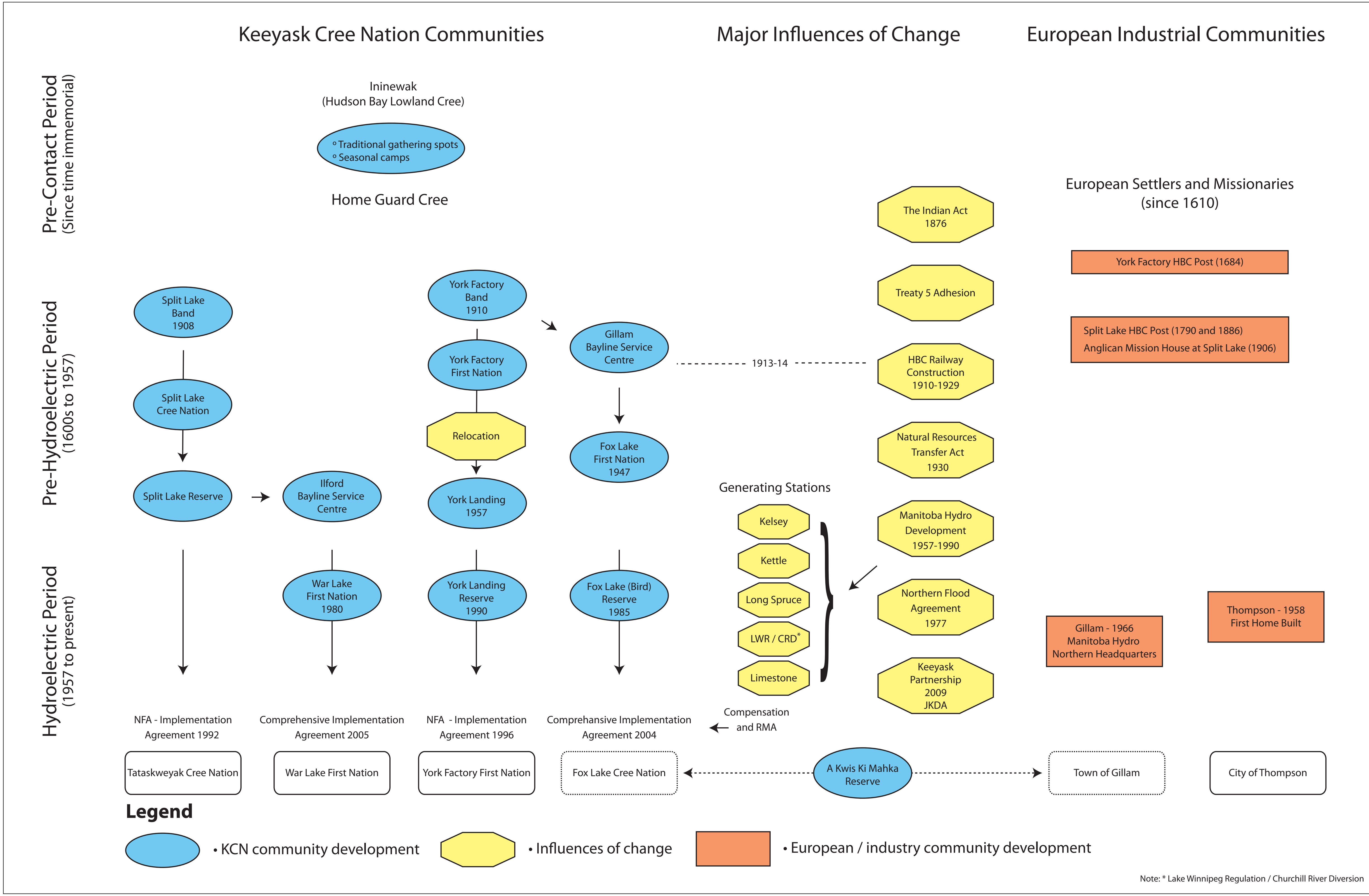


Figure 6-1 Historical Influences of Change and Development of Current Day Communities in the Keeyask Area

6.2.2.1 PRE-CONTACT PERIOD

The KCNs traditional territory is part of a much larger Cree homeland that extends from Northern Quebec into Alberta. As noted above, the Cree people have been part of northern Manitoba since time immemorial and ancestors of the KCNs have lived in and around the Keeyask area for thousands of years. Prior to first contact with European explorers and traders, the KCNs people had a long history of living off the land in areas along the coast of the Hudson Bay and in the interior northern region. Their territory covered the land and waterways surrounding the Nelson River and Hudson Bay Coast (Split Lake Cree – Manitoba Hydro Joint Study Group 1996b; WLFN 2002; FLCN 2009 Draft; YFFN 2010a). Many lived in scattered hunting clans and followed a seasonal round, which was an annual cycle of migration prescribed by the natural yearly cycle of the waters and lands in northern Manitoba. They were not associated with a specific First Nation but referred to themselves as *Ininewak*[1]. In historical documents, the Cree name Muskego-Ininuwak (meaning Swampy Cree) is given to this group of Ininewak who lived in the Hudson Bay Lowlands (for greater detail on the cultural chronology, please see Section 6.2.3) (Split Lake Cree – Manitoba Hydro Joint Study Group 1996a; WLFN 2002; FLCN 2009 Draft; YFFN 2010a).

6.2.2.2 PRE-HYDROELECTRIC PERIOD

The period of time between first contact with Europeans and before industrial development in the region is documented by the KCNs as a time of adapting to newcomers while maintaining their traditions, culture and way of living in harmony with their surroundings. As the 20th century progressed, the drivers of change and influences on the way of life of the KCNs became more difficult to adapt to and feelings of loss of their traditional way of life began to be prevalent. The following is a summary of the key drivers of change having affected the northern Manitoba Cree way of life before 1957. More details about how these key drivers of change have affected the Cree communities are reflected from a more personal perspective in each of the KCNs' Environmental Evaluation Reports.

The first Europeans to arrive to what is now the Province of Manitoba were fur traders in the 1600s. With them came new external economic and social influences to the Aboriginal people who had occupied the area for thousands of years. Between the 1600s to early 1900s, the fur trade expanded and many Aboriginal people were introduced to external economic and social influences to the northern region. Although colonization of the southern regions of Manitoba began in the 1800s, it was not until the late 1800s that increased interest in northern Manitoba occurred.

Within eight years of Canada's confederation, Treaty 5 was negotiated (in 1875), and adhesions to the treaty were signed in 1908 and 1910 by Split Lake and York Factory First

[1] Several spelling variations exist; however, the KCNs have agreed to *Ininewak* for this document (Section 2.2.1 provides the KCNs' worldview statement).

Nations respectively. In 1912, Manitoba's political boundaries were extended northward to include the entire northern area of what is known today as the Province of Manitoba (Manitoba Historical Society 2010). Among the many other external forces that followed were the *Natural Resources Transfer Act* of 1930, the registered trapline system, residential schools and the development of transportation and communication infrastructure. The Hudson Bay Railway, which has been under construction off and on since 1910, was completed in 1929 (Malaher 1984). Ilford and Gillam were among the communities established along the rail line. Roads, air strips and snowmobiles expanded the transportation network. (For greater explanation, see Section 2 of the SE SV). These forms of infrastructure opened the north for further industrial expansion related to mining, commercial forestry and hydroelectricity. All of these changes profoundly affected the way of life and culture of the Keeyask area's Aboriginal population, transforming their migratory way of life, responding to seasonal change, to a more sedentary way of life based in communities.

6.2.2.3 HYDROELECTRIC PERIOD

From the late 1950s to the present, more than 35 major generation, conversion and transmission projects have been undertaken by Manitoba Hydro in northeastern Manitoba affecting the traditional territories of the KCNs, their communities and Members. Specifically, between 1957 and 1995, four large hydroelectric generating stations and associated transmission lines were constructed within the Split Lake Resource Management Area, in addition to works associated with the Lake Winnipeg Regulation project (LWR) and the Churchill River Diversion (CRD) water management system (see Map 6-1[1] for the location of these generating stations described in detail). Kelsey Generating Station (GS) (1961) was the first of the four generating stations built along the Nelson River, followed by Kettle GS (1974); these projects both pre-dated the Lake Winnipeg Regulation and the Churchill River Diversion projects (1976). The Long Spruce GS was officially opened in 1979 and the Limestone GS in 1991. In conjunction with the hydroelectric projects on the Nelson River, the Town of Gillam was expanded in the mid-1960s with a sudden influx of non-local workers to serve as the operations and administration base for Manitoba Hydro's Nelson River generation, conversion and transmission activities. Construction and operation of these northern hydroelectric projects resulted in life-altering changes to the water, land and traditional way of life of First Nation Members living in the Keeyask area (FLCN 2009 Draft). In the words of Cree Elder, Joe Keeper, "The Cree world had completely changed, yet they hadn't moved". The KCNs' Environmental Evaluation Reports (as well as Chapter 2) describe how hydroelectric development in northern Manitoba has resulted in the profound changes to the way of life of their people. Through necessity of articulating and advocating for their rights and perspectives to those outside their homeland, the KCNs have spent much effort documenting how the effects have dramatically changed their physical and

[1] In print version, Chapter 6 Maps can be found in the accompanying Map and Figure Folio.

cultural surroundings. The above-noted documents provide additional detailed understanding of these effects. These generation stations and associated works have added to the changing character of land used by community Members and added to the area's workforce and population.

These direct effects have, in turn, resulted in changes to the surrounding environments and their use, including the following broad categories of environmental and socio-economic effects (Split Lake Cree – Manitoba Hydro Joint Study Group 1996b, 1996c):

- Physical environment: water levels and flows, debris, erosion, ice and land area affected;
- Biological environment: vegetation, wildlife, fish and associated habitats;
- Resource use patterns: trapping, hunting, fishing, gathering; and
- Socio-economic environment: economy, population, social and cultural well-being, way of life, governance, navigation and travel, and community infrastructure.

Particularly influential have been the construction and operation of the four generating stations and the substantial water management projects of LWR and CRD noted above, which taken together, have substantially adversely affected the land, water and traditional way of life of the KCNs. The following sections provide a summary of the most direct and obvious effects on water (change in levels and flows), land (area disturbed) and workforce (peak and total workforce) associated with these developments.

6.2.2.3.1 KELSEY GENERATING STATION

The Kelsey GS is located on the upper Nelson River close to where it enters Split Lake. It is at the southern edge of the Split Lake Resource Management Area (RMA), several kilometres upstream from York Landing and 40 km southwest of the reserve community of Split Lake. The Kelsey GS was the first hydroelectric generating station developed on the Nelson River, built in response to the request of INCO for the Manitoba Hydro-Electric Board to provide over 100 MW of power to serve the new nickel mining and smelting operations and associated town site development now known as Thompson. The main construction took place over four years between 1957 and 1961, beginning with the building of an airstrip and rail spur line from the construction site to the Hudson Bay Railway line used for transporting the construction workforce and materials to and from the site. The town site of Thompson, 90 km from the western edge of the Split Lake RMA, was constructed during this time. Thompson did not exist prior to its development as the INCO workforce town site (Fraser 1985).

The Kelsey reservoir raised water levels by approximately 9.5 m above natural levels and flooded approximately 58 km^2 of land for 150 km along the upper Nelson River from the Kelsey GS to Sipiwesk Lake. No shoreline was cleared in advance, leading to considerable debris in the river along with flooding, erosion, mercury contamination and large-scale changes in the landscape on the upper Nelson River (Split Lake Cree – Manitoba Hydro

Joint Study Group 1996a, 1996b). Kelsey GS did not result in any measurable changes in the water flows downstream along the Nelson River due to its operating parameters[1]. A fire at the dam site in 1968 caused a release of stored water, causing slush ice with effects felt at the nearby communities of Split Lake and York Landing.

The direct effects of transmission projects in the vicinity of the Kelsey GS were initially limited to a 93 km transmission line from the Kelsey GS to Thompson with about 50 km traversing the southern edge of the Split Lake RMA. In addition, a rail spur was built from the Hudson Bay Railway to the construction camp at the Kelsey GS. Over subsequent years, several additional transmission projects expanded the station's role (Split Lake Cree – Manitoba Hydro Joint Study Group 1996b). The influence of the Kelsey GS construction workforce on local communities was restricted due to lack of access between the construction site and the communities (Split Lake Cree – Manitoba Hydro Joint Study Group 1996b). By 1965, Thompson was incorporated as a town with a population of 8,500 and was connected to Winnipeg, through the extension of Provincial Trunk Highway #6 from Grand Rapids.

6.2.2.3.2 KETTLE GENERATING STATION

The Kettle GS, located at Big Kettle Rapids (the Kitchi Askiko Powstik) site, is within the eastern part of the Split Lake RMA and is about 7 km north-east of Gillam (Split Lake Cree – Manitoba Hydro Joint Study Group 1996b; FLCN 2009 Draft). The Kettle GS is about 16 km upstream from the Long Spruce GS and 80 km downstream of Split Lake. At the time of construction, the vast majority of the approximately 300 people living at Gillam and the surrounding area were Fox Lake Cree Nation Members (FLCN 2009 Draft). Development of the Kettle GS was the first of four projects outlined in Phase I of the framework for northern hydroelectric development recommendations submitted by the Nelson River Programming Board in 1965. Demand for electricity in Manitoba was forecast to exceed available supply by the winter of 1970/71, thus providing the rationale for developing the Kettle GS (Split Lake Cree – Manitoba Hydro Joint Study Group 1996b).

The main construction activities took place over seven years from 1966 to 1974. Construction involved several large, related projects above and beyond the generating station, which had lasting direct effects on the surrounding area. Particular effects were experienced by FLCN Members living in and around Gillam. These related projects included the construction of the Radisson Converter Station, transmission lines from the Kelsey GS to Radisson, electrification and expansion of Gillam to accommodate the construction workforce (and later operations personnel), a new airstrip and a road. Work camps to house project workers were also constructed and both the Gillam town site and nearby work camps housed well over 1,000 workers from outside the area during peak periods. Shortly after 1966, 24 km of dyke were constructed along with a cofferdam, borrow pits and

[1] Downstream effects are a result of future projects such as Lake Winnipeg Regulation and the Churchill River Diversion.

quarries, and the Butnau River dam. The reservoir was completed in 1970 allowing the Kettle GS to begin producing power. It was fully operational by 1974.

Closure of the river resulted in water levels at the structure being raised by about 30 m, tripling the size of Moose Nose Lake. The reservoir, renamed Stephens Lake, flooded over 220 km^2 of land and inundated the traditional uses by in-vicinity Cree of the Moose Nose Lake and Butnau River areas. The diversion of water from the Butnau River into the Kettle River resulted in increased flows between Cache Lake / Butnau River, adding to the flooding and erosion.

Large tracts of land were used, with approximately 130 km^2 used for related projects including the expansion of Gillam and the Radisson Converter Station. This included the Kelsey-Kettle transmission lines, the Kettle-Radisson transmission lines, the Bipoles I and II (HVDC) transmission lines (with a cleared right-of-way totalling 895 km in length from the Radisson Converter Station to the Dorsey Converter Station northwest of Winnipeg), and telecommunication towers. The Bipoles I and II traverse south of Ilford and cross over land used by WLFN (see Map 6-1).

Gillam changed in population from 300 in 1913 to over 2,000 people in the early 1970s in order to accommodate project workers and their families as well as workers needed to service the added population in Gillam. In addition to the population boom of Gillam, the construction camp at the site resulted in an additional influx of over 1,500 workers into the town of Gillam at times (Split Lake Cree – Manitoba Hydro Joint Study Group 1996b). Following construction, the demographics of Gillam changed from the predominantly First Nation and Metis community to a larger industrial town comprised mainly of Manitoba Hydro operation and administration staff and their family members who moved to the community from elsewhere (Split Lake Cree – Manitoba Hydro Joint Study Group 1996b; FLCN 2009 Draft).

6.2.2.3.3 LONG SPRUCE GENERATING STATION

The Long Spruce GS is located 16 km downstream of the Kettle GS and approximately 27 km east of Gillam (see Map 6-1). It is located between the communities of Bird (now known as Fox Lake) and Gillam on the Nelson River and is approximately 96 km northeast from Split Lake (Split Lake Cree – Manitoba Hydro Joint Study Group 1996b; FLCN 2009 Draft). Long Spruce was the next set of rapids downstream from Kettle Rapids and was flagged for hydroelectric development to meet growing electricity demands in Manitoba. The main construction activities for the Long Spruce GS took place over seven years from 1972 to 1979.

When the Long Spruce reservoir was created in 1977, water levels rose at the structure by about 26 m resulting in approximately 14 km^2 of land flooded upstream. For FLCN, flooding meant that the "inundation of tributaries... as well as the estuaries of smaller rivers destroyed important habitat for fish and wildlife that were primary harvesting areas used by the Fox Lake people”(FLCN 2009 Draft). Related project activities including roads, converter station and transmission projects affected over 93 km^2 of land during this era.

Among the related infrastructure built during this time was an all-weather road from Thompson to Split Lake, which was the first phase of an all-weather road from Thompson to Gillam. By the onset of Long Spruce construction, Gillam had already changed into a Manitoba Hydro industry town site and had experienced the boom-bust of the Kettle construction phase. Long Spruce construction employed more than 2,000 workers at its peak, virtually all of whom were from outside the area (Split Lake Cree – Manitoba Hydro Joint Study Group 1996b). Most of the construction workers were housed at the project construction camp. Operation and maintenance of the Long Spruce GS resulted in additional personnel living in Gillam as part of Manitoba Hydro’s northern operation and maintenance workforce.

6.2.2.3.4 Lake Winnipeg Regulation and Churchill River Diversion

The regulation of Lake Winnipeg (the LWR project) and operation of the CRD altered the Nelson River and its tributaries in the area by reversing the seasonal water level highs and lows and changing the natural cycle of flows (Split Lake Cree – Manitoba Hydro Joint Study Group 1996a; FLCN 2009 Draft). In the case of LWR, this project allowed Manitoba Hydro to control the natural flow of water into the Nelson River from Lake Winnipeg in order to make more outflow available in the fall and winter when demand for electricity is at its highest. It also created a flood control mechanism for communities around Lake Winnipeg by allowing lake outflows to be increased, if needed, to lower flood water levels. The LWR and CRD projects were the result of a 1966 agreement between the federal and provincial governments, which enabled Manitoba Hydro to regulate Lake Winnipeg outflow and divert portions of water from the Churchill River into the Nelson River at Split Lake. The diversion involved constructing channels to allow water from the Churchill River to be stored in South Indian Lake and released through the Rat and Burntwood rivers to Split Lake to increase the power-producing capacity of the lower Nelson River generating stations (Manitoba Hydro 2011c; Bateman 2005). In association with CRD, there is provision of an Augmented Flow Program that allows the diversion of more water from the Churchill River into the Nelson River on an annual basis at the request of Manitoba Hydro[1]. The CRD augmented Nelson River flows and added between 0.5 and 1.0 m of water to the level of Split Lake, depending on the outflow of the Notigi control structure. These projects were undertaken with the knowledge that growth in demand for electricity would require new capacity.

There was no construction of physical works related to either of these water management projects in the Keeyask Regional Study Areas. The major physical components outside the

[1] A fundamental feature of the Keeyask JKDA is that “no change to the CRD Licence, as modified by the Augmented Flow Program, or to the LWR Licence, will be required to operate the Keeyask Project” (JKDA Section 7.2.2).

Keeyask area included control dams at Missi Falls and Notigi, the Jenpeg Generating Station, a dam at Kiskitto Lake, and several control channels. The main construction activities occurred between 1970 and 1977. Although no construction activity occurred within the Keeyask area, the seasonal reversal of water levels, the increased water level and the altered flows resulted in many changes to the environment such as extensive debris, shoreline erosion, altered ice conditions, changes to vegetation, and mercury contamination in the fish (CNP Keeyask Environmental Evaluation Report; YFFN Evaluation Report (*Kipekiskwaywinan*); FLCN Environment Evaluation Report (Draft)). FLCN summarized effects from the seasonal reversal of water levels and "increasing the flows of the river [as]... increased shoreline erosion, turbidity, and ultimately, elevated mercury levels throughout the entire system, particularly in forebays and downstream from disturbances"(FLCN 2009 Draft).

The diversion of water flows from the Churchill River into the Nelson River resulted in dewatering of approximately 69 km^2 of lakes and waterways, exposing new land, particularly on the lower Churchill River in the northern part of the Split Lake RMA.

6.2.2.3.5 LIMESTONE GENERATING STATION

The Limestone GS is located approximately 25 km downstream from the Long Spruce GS, at the eastern edge of the Split Lake RMA near the border with the Fox Lake RMA (see Map 6-1). The Project is six km east of Bird, and 50 km northeast of Gillam (Manitoba Hydro 1986). The original start of construction for the Limestone GS began in 1976 with the development of a road, rail spur and the construction of the Sundance town site. In 1979 construction was suspended as growth in electricity demand dropped, limiting the need to expand generating capacity. Major construction commenced after a sale of power to the Northern States Power Corporation was in place. The main construction activities took place over seven years from 1985 to 1990.

Even though an environmental license was not required for the Limestone project, for the first time Manitoba Hydro produced an environmental assessment for a hydroelectric project (Manitoba Hydro 1986). First power from Limestone occurred in 1990 and, once fully operational in 1992, the water levels at the GS were raised by about 33.5 m. The Limestone GS was built as a run-of-the-river project so minimal upstream effects occurred, with increases in water levels largely contained within the Nelson River banks resulting in two km^2 of flooding. FLCN has noted that directly downstream of the Limestone GS, within their traditional territory, there was a drop in water levels resulting in exposure of a new riverbed and rocks and dewatering of at least one tributary of the river (FLCN 2009 Draft)[1]. Transmission projects associated with the Limestone GS took up approximately 11 km^2 of surface land. At the same time, the road from Split Lake to Long Spruce (about seven km^2 of land) completed the all-weather road system from Thompson to Gillam. The

[1] Manitoba Hydro has noted the dewatering effects are short-term as the Limestone GS is a run-of-the-river station, not a store and release station.

construction workforce peaked at between 1,500 and 1,800 workers. The construction camp at the Limestone GS accommodated 1,400 workers with an additional 400 workers and their families accommodated at Sundance, a temporary community developed at the north end of the construction site. Very few construction workers and their families moved to Gillam because the Sundance community was an attractive residential option and was much closer to the Limestone GS.

6.2.2.3.6 AGREEMENTS

From the late 1950s through to the 1970s, these developments were planned and implemented with no involvement or consultation with nearby communities whose traditional lands and ways of life were to be substantially altered. In 1974, TCN and YFFN joined together with three other First Nations to form the Northern Flood Committee as a political alliance through which they began to assert their rights, and create systems and processes to protect the use of their land and water, and to regain components of their traditional way of life. In 1977, the Northern Flood Agreement (NFA) was signed but the agreement was difficult to implement (Split Lake Cree – Manitoba Hydro Joint Study Group 1996a).

After much delay and well after LWR and CRD had been planned, built and began operations, TCN and YFFN were able to negotiate and enter into individual comprehensive implementation agreements with Canada, the Province of Manitoba and Manitoba Hydro. These agreements address adverse effects caused by past Manitoba Hydro projects and implement the NFA. TCN signed a comprehensive implementation agreement in 1992; and YFFN signed their comprehensive implementation agreement in 1995. Those KCNs who were not a party to the NFA began independent negotiations with the Manitoba government and Manitoba Hydro after the NFA was signed. FLCN finalized an agreement addressing past adverse effects in 2004 (FLCN 2009 Draft) while WLFN, who became a First Nation in 1980 (after the 1977 NFA), reached an agreement for past damages in 2005.

Manitoba Hydro has developed programs promoting the safe navigation of waterways affected by LWR and CRD. Measures related to providing boat patrols, debris clearing, shoreline stabilization (and clean-up) and safe ice trails are implemented through the existing Waterways Management Program (WMP).

These agreements set the stage for a new era of local First Nation involvement in hydroelectric development, which is exemplified in the Keeyask Project. TCN, WLFN, YFFN and FLCN have become partners with Manitoba Hydro in the Keeyask Project, and have participated jointly with Manitoba Hydro in Project planning and the environmental assessment. Chapter 2 of this document, as well as the KCNs' Environmental Evaluation Reports, provide extensive information on how the involvement of the KCNs has shaped the Project (see also Chapter 4, Section 4.3.3.1 for ways the KCNs have shaped the Project).

6.2.3 Existing Environment and Future Trends

6.2.3.1 Aboriginal Traditional Knowledge Overview

As noted in Chapter 2 (Partners' Context, Worldviews and Evaluation Process) as well as Section 2 of the SE SV, the KCNs have had a long and interdependent relationship with *Askiy* (Mother Earth) and with each other in the northeastern portion of northern Manitoba. Archaeological evidence shows that the area has been occupied for at least 6,000 years (Heritage Resources Section 3 of the SE SV; CNP Keeyask Environmental Evaluation Report). The histories of the KCNs communities are also interrelated, with many sharing a common history on the Nelson River and York Factory coastal area. "It is our belief that we have lived here since time immemorial in an organized society that hunted, fished, trapped and harvested, governing ourselves according to our own laws, customs and beliefs" (CNP Keeyask Environmental Evaluation Report). YFFN's early history was primarily tied to the Hudson Bay (*Kihcikamiy*) coast and, as for the other First Nations, included experiences related to support of the fur trade: "Through many years of observation and experience our ancestors became experts in reading the lands and waters that they used and occupied since as long as they could remember" (YFFN Evaluation Report (*Kipekiskwaywinan)*). FLCN ancestors had deep ties and relationships to the land and waterways of the Hudson Bay region, particularly relying on the lower Nelson River and the surrounding area "since time immemorial" (FLCN 1997). FLCN also notes the importance of adapting to change over time to keep resources sustainable. Chapter 2 provides greater depth on each of the KCNs' involvement in the Project; and each of the KCNs' Environmental Evaluation Reports includes more in-depth ATK. The following section provides some highlights of the KCNs' ATK perspectives on past hydroelectric development.

6.2.3.1.1 Keeyask Cree Nations' Perspectives About Effects of Past Hydroelectric Development

The KCNs have extensive knowledge of the effects of hydroelectric development from past experiences, beginning with when the first project in the area (the Kelsey GS) was constructed, and including development of subsequent projects over the past 45 years. As noted in Section 2 of the SE SV, past experiences living and depending on the land (including experiences with past hydroelectric development) have shaped the ATK of the KCNs; which has, in turn, informed the planning, development and environmental assessment of the Project.

The following section provides some insights of each of the KCNs (further detail can be found in each of the KCNs' Environmental Evaluation Reports and the SE SV).

PERSPECTIVES FROM THE CREE NATION PARTNERS

The hydro dams, reservoirs and the resultant altered water regime (particularly of the Nelson River) have substantially affected the Split Lake Cree homeland (*e.g.*, more than 70% of Manitoba's electricity is generated within the Split Lake RMA). Other infrastructure includes converter stations and high voltage transmission lines including Bipoles I and II. CNP indicated that these projects have combined to have "devastating effect(s) on our customs, practices and traditions" (CNP Keeyask Environmental Evaluation Report). As of 1996, Manitoba Hydro's footprint in the Split Lake RMA totalled about 50,139 ha (123,899 acres) (Split Lake Cree – Manitoba Hydro Joint Study Group 1996b). This footprint is slightly larger than the size of Winnipeg (46,400 ha or 115,000 acres). A sizeable portion of CNP's major waterways in their homeland ecosystem are no longer able to sustain their traditional ways due to alterations from hydroelectric development.

The CNP have a duty of caring for the land and waters so that those waters and land will provide for the people in return. This sense of duty, including honouring and observing proper relationships based on respect, has been challenged by the changes that have happened to the waterways.

PERSPECTIVES FROM YORK FACTORY FIRST NATION

As Cree people, YFFN Members have their own way of knowing, experts, and understanding of a highly complex and interconnected world. YFFN has described their *ininiwi-kiskenihtamowin* (traditional knowledge) as "fundamental and central to who we are as a people and culture" (YFFN Evaluation Report (*Kipekiskwaywinan*)). It is held by community Elders and passes from generation to generation. It is also a "dynamic, living process that is added to and adapted in the lives of successive generations of Cree people" (YFFN Evaluation Report (*Kipekiskwaywinan*)). To YFFN, *ininiwi-kiskenihtamowin* is a "way of life".

YFFN Members have lived at York Landing on Split Lake since 1957, prior to the Lake Winnipeg Regulation, Churchill River Diversion, and the construction of the present day dams. YFFN Elders remember the conditions and characteristics of the water, land, fish and wildlife in that period and they have observed and experienced changes to all these aspects of the environment following the development of the Kelsey Generating Station and subsequent hydroelectric developments on the Churchill, Burntwood, and Nelson River systems. YFFN's traditional way of life and relationships with the land, water and wildlife have been eroded by hydroelectric development. The land, waters, and YFFN Members continue to adjust to the ongoing and cumulative effects of past development.

Over the last several decades, fluctuating water levels have continued to erode all shorelines near York Landing (Kawechiwasik) even though the Lake Winnipeg, Churchill and Nelson Rivers Study Board predicted that shorelines would stabilize within 10 years of the Lake Winnipeg Regulation project. Shoreline erosion has resulted in the loss of boat launches, beaches, camps and scenic places important for family and community gatherings and social wellbeing. YFFN's experience with past hydroelectric development and scientific predictions has led to skepticism about the predictions related to current and future projects.

Water quality is a key topic of concern since the "quality of water affects everything" (YFFN SV). Since the development of Kelsey, YFFN Members have experienced changes in the water, in the stability of ice, and in the numbers of numa'o (sturgeon) and other fish in Split Lake. YFFN Members have indicated that water quality has steadily declined to, where today, Members don't drink from Split Lake; fish are no longer considered healthy to eat – their taste and texture have changed.

YFFN is particularly concerned about travel safety – a constant concern due to the isolation of the community and lack of all-weather road access. Travel is part of daily life. Without all-weather road access, YFFN Members cross Split Lake by boat, ferry, skidoo and winter ice road to access banks and grocery stores, visit family members, and attend gatherings outside the community. In their view, travel has become more dangerous. The reversal of seasonal flows and frequent fluctuations of water levels on the Nelson River system (including at Split Lake) have increased travel risk in open water conditions. Winter roads and trails have become more dangerous and unpredictable due to the formation of weak ice and slush ice as well as hanging ice along shorelines.

YFFN knows that its *ininiwi-kiskenihtamowin* is central to the success of the Keeyask project in terms of the environmental impact statement, mitigation measures, monitoring and adaptive management. It is very important to YFFN to hold onto and apply the values, teachings and traditional knowledge of community Elders and resource users to the Keeyask Project. This will contribute to YFFN's ongoing adaptation and maintenance of its Cree identity. For more detailed perspectives and *ininiwi-kiskenihtamowin* from YFFN Members, please see YFFN's report, *Kipekiskwaywinan* (Our Voices).

PERSPECTIVES FROM FOX LAKE CREE NATION

As with the other KCNs, FLCN values taught respect for the land and water; this included teachings that FLCN should not destroy the land and animals because if they did, that harm would come back to the people. FLCN Members have indicated that, over the years, past hydroelectric development has caused great damage to the land, the water, the animals and cultural heritage – all of which FLCN people depended upon for their food, and their social and cultural well-being. For example, changing water levels and the unpredictable nature of the river caused river travel to become dangerous, resulting in reduced levels of travel for traditional pursuits. The hydroelectric projects of Kettle, Long Spruce and Limestone were built within FLCN's traditional resource use area, resulting in cumulative impacts felt by the FLCN people. Hydroelectric development has resulted in the loss of readily accessible resource use areas in the vicinity of where FLCN people live, including fishing, hunting, trapping, berry picking and medicinal plants.

FLCN indicated that past hydroelectric development, that included an influx of non-local construction workers changed the quiet nature of their community; and also brought increased abuse of alcohol, family violence and the rejection of traditional values and the Cree language: “street parties, brawls and violence were commonplace” (FLCN 2009 Draft; see Section 6.2.3). They also indicated that they have had to contend with racism and discrimination in Gillam during past hydroelectric development (further details are found in Section 5.3.4 of the SE SV).

Mercury levels in fish in Stephens Lake increased to the point where fish were no longer safe to eat. The perception that the Nelson River and Stephens Lake were no longer a safe provider of healthy food has persisted to today, even though mercury levels have declined to safe levels.

6.2.3.2 PHYSICAL ENVIRONMENT

6.2.3.2.1 INTRODUCTION

The physical environment in the general region of the Keeyask Generation Project (the Project) has been altered in the past by both human and natural activities, particularly by the changes resulting from the operation of the Churchill River Diversion (CRD) and the Lake Winnipeg Regulation (LWR). These influences continue today.

The proposed Keeyask Generation Project will change this physical environment. The alterations to the physical landscape form the pathways of effects to the aquatic, terrestrial and socio-economic components of the environment described in subsequent sections. These pathways include the following:

- Construction of the Project will involve extraction of material such as rock, granular material and impervious clays; and generation of dust and noise;
- During operation, Gull Rapids will be almost completely submerged. The reservoir will involve the flooding of about 45 km2 of land. In the upstream open water Hydraulic Zone of Influence of the Project, some areas will be converted from riverine to a reservoir environment in the vicinity of Gull rapids and upstream of Gull lake to Birthday rapids. Water velocities upstream of the Project will be reduced from present conditions, and water levels will fluctuate over a smaller range;
- Ice formation patterns will change; and
- Shoreline erosion and sediment deposition patterns will change.

The pathways and linkages among physical environment components and other components are shown in Figure 6-2. The figure also reflects the ecosystem approach used in the scientific analyses and assessment.

The various attributes of the current and evolving physical environment setting were studied so as to understand the potential effects that the Project will bring about to the physical environment. The existing environment was characterized using available historic data and results obtained from field studies. Where trends were observed and could be projected into the future, these were used to describe the future environment without the Project. It is assumed that there is no difference in hydrology and climate for the existing environment and the future environment with and without the Project. The sensitivity of effects assessment conclusions to potential climate change was considered separately (Section 6.3.12).

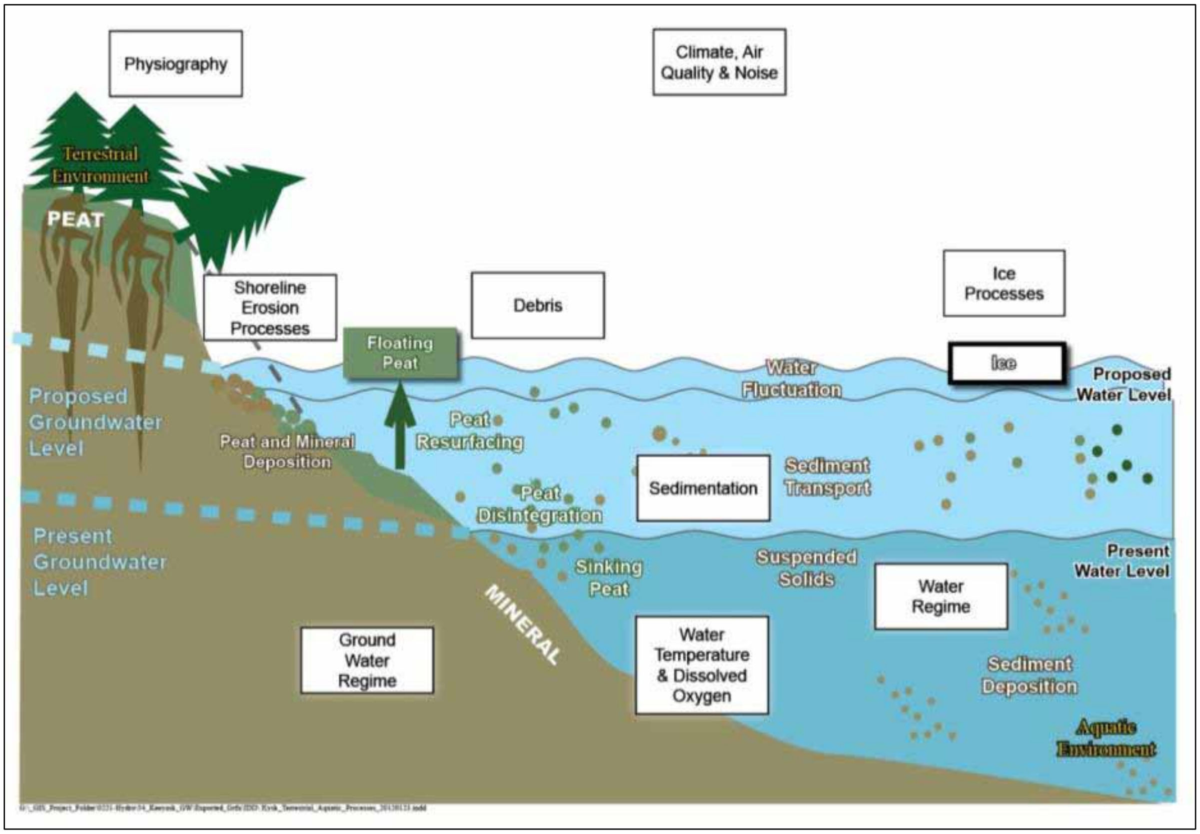


Figure 6-2: Physical Environment Studies and How They Interact

The components of the physical environment include the following:

- Climate;
- Local Air Quality;
- Noise;
- Physiography;
- Surface Water andIce Regime;

- Shoreline Erosion Processes;
- Sedimentation;
- Groundwater;
- Surface Water Temperature and Dissolved Oxygen; and
- Debris.

Map 6-2 for the physical environment includes the open water hydraulic zone of influence, (*i.e.*, the reach of the river over which water levels and water level fluctuations caused by the operation of the Project are measurable within the accuracy required for operation and licence compliance). Most of the physical environment studies focused on the open water hydraulic zone influence. The Local Study Area conforms to Zone 4 of the terrestrial environment studies (Map 6-28). It also includes the areas affected by roads, borrow areas and camps. Studies also occurred in a broader region to consider comparison areas for potential effects for selected parameters. Greater detail on the environmental setting is found in the Physical Environment Supporting Volume (PE SV).

6.2.3.2.2 CLIMATE

The Project is located within the sub-arctic climate zone, which is characterized by long, usually very cold winters, and short, cool to mild summers (Smith *et al.* 1998).

Temperature, precipitation and wind speed climate normals were obtained from Environment Canada's Gillam Airport meteorological station for the 1971-2000 period, which is the current climate normal period set by the World Meteorological Organization.

The average annual temperature is approximately −4.2°C (24.4°F). Average daily temperatures range from −25.8°C (-14.4°F) to −22.0°C (-7.6°F) during the winter months (December, January and February) and from −15.1°C (4.8°F) to +4.4°C (39.9°F) during spring (March, April and May). The summer months (June, July and August) range from +11.4°C (52.5°F) to +15.3°C (59.5°F), while autumn (September, October and November) range from −12.1°C (10.2°F) to +7.0°C (44.6°F). Records indicate historic maximum and minimum extreme temperatures of +36.8°C (98.2°F) in June 2002 and −46.1°C (-51°F) in January 1975. It is not uncommon for temperatures to approach these extremes for days or even weeks at a time during extended cold snaps or warm spells. For the 1971-2000 period, the average number of frost-free days is 91.9 days. This value falls into the frost-free range reported for the northern forest zone of Canada, which is between 60 to 110 days.

The average total annual precipitation is approximately 500millimetres (mm) (20"). Of the total annual precipitation, rainfall accounts for approximately 63% while snowfall accounts for 37%. Precipitation over the months of November through March is mainly in the form of snow, while July and August precipitation is in the form of rain. During the transitional months of April, May, September and October precipitation can fall as either rain or snow, depending on the air temperature. The average total annual snowfall is 229 centimetres (cm) (90") and the average March snow depth is 56 cm (22"). The maximum daily rainfall event occurred in July 2000 at about 64 mm (2.5"), while the maximum daily snowfall event occurred in May 1988 at about 37 cm (15").

The average monthly wind speeds range between 14.0 kilometres per hour (km/h) (8.7 miles per hour (mph)) to 17.8 km/h (11.2 mph). The winter months are most frequently comprised of the lowest wind speeds between 14.0 km/h (8.7 mph) to 14.8 km/h (9.2 mph) with a frequent wind direction of west. Wind speeds in the spring months are slightly higher than winter months and range between 14.0 km/h (8.7 mph) to 15.4 km/h (9.6 mph) with a frequent direction from the northeast. The summer months experience wind speeds that range between 15.1 km/h (9.4 mph) to 15.8 km/h (9.8 mph) and are most frequently from the northeast. The average wind speeds in autumn range between 16.4 km/h (10.2 mph) to 17.8 km/h (11.1 mph) and are most frequently from the west.

Future potential changes in climate are discussed in Section 6.9.

6.2.3.2.3 Local Air Quality

The Project is located in the boreal forest region of northern Manitoba, approximately 180 km (112 miles (mi.)) northeast of the City of Thompson. There are no ambient air quality data monitored for Gillam. An air quality monitoring station is operated at Thompson; however, air quality data for Thompson can be influenced by the emissions resulting from the operation of one of the largest point source emitters in the province, the Vale Smelter.

Existing air quality in Manitoba is considered by Manitoba Conservation to be “good to excellent in general” (1997), and therefore, it is reasonable to believe that air quality in the Local Study Area is good to excellent. The existing air quality at the proposed Project site is consistent with remote, rural, non-industrialized land, typically considered to be of good to excellent quality and in compliance with all Manitoba’s Ambient Air Quality Guidelines.

Ice fog forms when a cold, dry air mass passes over relatively warmer water. Water evaporates from the water's surface but condenses back into tiny suspended droplets as the cold air becomes saturated. If the air temperature is cold enough, the suspended droplets may freeze to form ice fog, thus forming a micro-climate. This phenomenon occurs every fall and winter along the open water areas of the Nelson River, including at Birthday Rapids and Gull Rapids.

The local air quality is not expected to change without the Project.

6.2.3.2.4 Noise

No data are available within the Local Study Area for ambient noise levels; consequently, data was obtained from sources in available literature.

The Local Study Area lacks concentrated urban development and does not contain existing industrial facilities. Sources of noise from human activitiesare expected to be sparsely distributed and intermittent in their occurrence. Noise generated in the area consists of intermittent road traffic near Provincial Road (PR) 280, noise from personal transport vehicles on trails (such as snowmobiles and ATVs), and occasional airplane or helicopter traffic. The acoustic ambient pre-Project environment is expected to experience a noise burden in the range occasionally above that found in a natural undeveloped setting.

In addition to intermittent human-based sources of noise known to occur near the Project site *(e.g.*, motor boats, snowmobiles, aircraft, *etc*.), natural sources of noise include localized noise from the waterfall within Gull Rapids, which trappers say they can hear from as far away as 18 km (11 mi.) on a quiet night (Beardy Pers. Comm., November 18, 2011). It is considered a good natural sound by them. There are numerous trapper cabins in the Local Study Area. The closest cabin to Gull Rapids is about 4km (2.5 mi.) downstream of the Rapids. Current noise levels within the vicinity of the Project are considered to be sparsely distributed and intermittent in occurrence, and consistent with relatively undisturbed, undeveloped northern lands.

The local noise environment is not expected to change without the Project.

6.2.3.2.5 PHYSIOGRAPHY

The Project is located within the Boreal Shield Ecozone (Map 6-3). The Nelson River bisects the Regional Study Area and lakes of various sizes are densely scattered across this area. Many lakes have shorelines composed of unconsolidated materials and often lie between drumlins and eskers *(i.e.*, long ridges of sand and gravel deposits). Drainage is generally eastward along terrain that slopes approximately 0.6 metres per kilometre (m/km) (3.2 feet per mile (ft./mi.)) (Smith *et al.* 1998).

The physiography of the Local Study Area is generally that of a plains landscape, with undulating loamy moraines that erode into drumlin crests and ridges. Elevations range from 150 metres (m) (492 feet(ft.)) to 213 m (699 ft.) above sea level in the lowlands near Stephens Lake, with drumlins and eskers providing local relief to heights of 20 m (66 ft.) to 30 m (98 ft.) (Smith *et al.* 1998). Peatlands occur on gentle slopes and throughout much of the glaciolacustrine lowlands in the area.

The Local Study Area topography is dominated by gently sloping terrain with peat of varying thickness overlying fine-grained glaciolacustrine clay and silt. Steeper slopes are found on the flanks of elongated drumlins that formed in an approximate east-west orientation due to movement of the advancing continental glacier. Because gentle slopes surround most of the proposed Keeyask reservoir, relatively low bluffs and gently sloping nearshore slopes characterize the shore zone. Steeper nearshore slopes and higher bluffs are found where steeper sloping drumlins and glaciofluvial ridges flank the shore zone.

Past hydroelectric and other forms of development have altered physiography of the Local Study Area. The Terrestrial Habitat and Ecosystems discussed in Section 6.2.3.4 of this document and in the Terrestrial Environment Supporting Volume (TESV) describe the extent of terrestrial losses. Total historical land losses due to permanent human features, including their zone of influence on habitat composition, was estimated to be approximately 39,200 hectares (ha) (96,865 acres (ac.)), or 3.2%, of the Local Study Area. The indirect effects of human development are estimated to have altered an additional 22,000 ha (54,360 ac.), or 1.7%, of the Local Study Area. During a recent 45-year period, approximately 20% of the area in ground ice peatlands have converted to open water and other peatland types due to permafrost melting.

In general, the physiography in the Local Study Area is not expected to change substantially, with the possible exception of peatland abundance and permafrost, which are subject to changing climate conditions.

Bedrock and Surficial Geology

The glacial and post-glacial geological overburden thickness is estimated as being as much as 30 m (98 ft.) over the Precambrian bedrock (Betcher *et al.* 1995). The Precambrian bedrock generally consists of greywacke gneisses, granite gneisses and granites. Some preglacial sands and silty sands are found immediately above the bedrock formation but generally the overburden consists of a thick layer(s) of deposited glacial material (till) overlain by postglacial deposits in the form of alluvium (cobbles and boulders overlying sands and gravels) and Lake Agassiz silts and clays; the latter are commonly varved and relatively thin in nature (except in topographic lows) or absent *(e.g.*, on nearby ridges and knolls).

After Lake Agassiz drained to the Hudson Bay and the Beaufort Sea, peat veneer and peat blanket deposits formed on the poorly drained flatlands and depressions, over the postglacial alluvium and clays. Peat deposits have become the most widespread and abundant surface materials in the Local and Regional Study Areas (Map 6-3).

In terms of stratigraphy, postglacial peat and clay have an average thickness ranging between 0.6 m (2.0 ft.) and 1.3 m (4.3 ft.) (Manitoba Hydro 1993). Three separate till and/or till-like (intertill) horizons, which range in thickness between 2 m (6.6 ft.) and 10 m (33 ft.) (Manitoba Hydro1993), have been identified as comprising the underlying deposited glacial material.

Because a wide range of glacial and post-glacial deposit types are present in the Keeyask reservoir area, materials along the predicted shoreline include peat, clay and silt, till, sand and gravel, boulders and bedrock depending on the position of the shoreline in relation to the local stratigraphy at that location.

The essential granular deposits identified for the Project are present along the riverbank and in the esker regions within the Local Study Area. This includes borrow areas such as the areas immediately north of the riverbank, Gull Esker, Limestone Esker, and Birthday Esker on the north side of the Nelson River; and the areas south of the riverbank as well as the Ilford-Butnau Esker (including Deposit E-1 (see Chapter 4, Project Description) on the south side of the Nelson River.

SOILS AND PEATLANDS

Cryosols are widespread in the Regional Study Area, being most commonly associated with permafrost peatlands (Smith *et al.* 1998). Organic Cryosols, the most common soil great group, cover 73% of the Regional Study Area, being considerably more abundant here than in northern Manitoba as a whole. Organic Cryosols are even more abundant in the Local Study Area than the Regional Study Area. Exposed granitic bedrock occurs sporadically throughout the Regional Study Area. Mineral soils also occur throughout the Regional Study Area.

Peaty phase mineral soils and shallow organic soils typically form the transition between upper slope mineral soils and down slope organic soils (Map 6-4). Peatlands dominate the Local Study Area. Veneer bogs and blanket bogs are the most common peatland types covering approximately 62% of the land area. Veneer bogs are thin peats *(i.e.*, less than 1.5 m (5 ft.) thick) that primarily occur on slopes. Blanket peatlands are thicker than veneer bogs and occur on lower slopes, valleys and level areas. Peat plateau bogs are ice-cored bogs with a relatively flat surface that is elevated from the surroundings and has distinct banks. Peat plateau bogs and associated peatland types cover 16% of the land area. The peatland types that cover the remaining land area are horizontal peatlands, riparian peatlands, thin wet peatlands and deep wet peatlands. These peatlands are generally found in lower slope and depressional locations; aquatic peatlands occur along the shorelines of water bodies.

PERMAFROST

National mapping by the Geological Survey of Canada (2005) indicates that the distribution of permafrost is discontinuous in the general region (Map 6-5). Permafrost thickness within the Regional Study Area ranges from less than 10 m (33 ft.) to between 10 m (33 ft.) and 50 m (164 ft.). Extensive discontinuous and sporadic discontinuous surface permafrost is widely distributed throughout the area, occurring in 78% of the Local Study Area (Map 6-5). The types of permafrost range from cold soil temperatures only to ice crystals, ice lenses or thick ground ice. Surface permafrost is uncommon in mineral soils. Surface permafrost generally occurs in all peatland types except for horizontal and aquatic peatlands. Peat plateau bogs contain thick, continuous ground ice. Collapse scars, which are essentially water-filled craters with floating peat, result from ground ice melting in peat plateau bogs.

SEISMIC ACTIVITY

Manitoba, in general, is an area of very low seismicity. In particular, the Precambrian Shield, within which the Project is located, is also of very low seismicity. It is evident from the historical records since the 1600s and relatively recent seismic monitoring), which presents the distribution of magnitude 3 and greater earthquakes in Canada since 1627 (Natural Resources Canada 2008), that no major earthquakes, and hence no important earthquake-generating fault movements, have occurred in Manitoba (Map 6-6).

6.2.3.2.6 SURFACE WATER AND ICE REGIMES

The environmental setting has been influenced by past hydroelectric development in northern Manitoba. In 1970, Manitoba Hydro was granted an interim license to regulate Lake Winnipeg, which stipulates conditions under which Manitoba Hydro is allowed to adjust the outflows for power production purposes along the Nelson River. This allows Manitoba Hydro to store water in Lake Winnipeg, and intra-annually release this water during higher power demand periods such as fall and winter or dry years. Lake Winnipeg Regulation (LWR) has resulted in a shift in seasonal patterns of lake outflows, which results in a winter flow increase on the Lower Nelson River and an associated summer flow decrease. KCNs communities call this the “seasonal reversal” of flows (CNP Keeyask Environmental Evaluation Report).

In 1977, the Churchill River Diversion (CRD) was constructed, diverting water from the Churchill River into the Burntwood River and eventually into Split Lake and the lower Nelson River. The amount of water diverted into Split Lake fluctuates monthly and annually between 400 cubic metres per second (m^3/s) (14,130 cubic feet per second (cfs) and 1,000 m^3/s (35,315 cfs). While the estimated current flow conditions between Split Lake and Gull Rapids are within the range of flows experienced in this reach of the Nelson River prior to LWR and CRD, their seasonal pattern has changed. In the unregulated state, the highest flows of the lower Nelson River typically occurred in mid-summer and reduced to the lowest flows in mid-winter. With LWR and CRD, the highest peak Nelson River flows still typically occur in mid-summer. Typical flows, however, are higher during the winter compared to the summer due to regulation. The difference between the winter and open water flows is generally less than would occur without regulation. The pattern of discharge flows from Split Lake for the 1977-2006 period is shown on Figure 6-3.

Discharges from Split Lake after 1977 have been used to describe the water and ice regime for the existing environment of the EA. River flow to the Local Study Area originates from the upper Nelson River (Kelsey GS outflows–68%), the Burntwood River (29%) and local inflow (3%). The relative contributions from the above sources to the Local Study Area inflow do not change appreciably between the open water and winter seasons. While peak flows generally occur in the spring and summer, typical flows are higher during the winter compared to summer due to the regulation of Manitoba Hydro’s system to meet the higher winter energy demand. Flows are quite variable from year to year but generally do not fluctuate greatly on a daily basis. A typical open water surface profile is shown on Map 6-7.

Existing hydrologic conditions are considered to be representative of future conditions without the Project. The potential effects of climate change were considered separately as described in Section 6.3.12.

OPEN WATER CONDITIONS UPSTREAM OF PROJECT

The upstream extent of the Local Study Area starts at Split Lake. The lake is relatively large with numerous small islands and an approximate surface area of 300 square kilometres (km^2) (116 square miles (sq. mi.)). Water levels are influenced by the amount of water flowing into the lake and the narrow constriction at the outlet that controls the lake's discharge. The levels on Split Lake typically fluctuate between 166.0 m (545 ft.) and 168.0 m (551 ft.) in any given year, but water levels may vary greatly from one year to the next, depending on the water supply from the Nelson River drainage basin and CRD. Water velocities are typically low (less than 0.5 metres per second (m/s) (1.6 feet per second (ft./s)) throughout Split Lake but increase to more than 1.5 m/s (4.9 ft./s) at the outlet. From the outlet of Split Lake to Clark Lake, there is typically less than 1.0 m (3.3 ft.) of head loss.

Clark Lake has a surface area of approximately 11 km^2 (4.3 sq. mi.) and contains several areas greater than 12 m (39 ft.) deep. Much of the area outside of the main flow channel is less than 4 m (13 ft.) deep. Generally, the velocities are low throughout this lake environment (less than 0.5 m/s (1.6 ft./s)).

The 10km (6.2 mi.) reach between the outlet of Clark Lake and Birthday Rapids is approximately 600 m (1,970 ft.) wide and is characterized by a turbulent continuous series of rapids with a drop of approximately 3 m (13 ft.) in water levels. This relatively narrow, long set of rapids (called Long Rapids) and the drop in water level creates very high velocities (more than 1.5 m/s (4.9 ft./s)) and standing waves through much of this reach. Depths range from less than 4 m (13 ft.) in the upper end of the reach and increase to more than 15 m (49 ft.) toward Birthday Rapids. The water level drops approximately 7 m (23 ft.) along the reach from Clark Lake to Birthday Rapids. At the end of this reach, the river narrows to just over 300 m (980 ft.) wide, resulting in Birthday Rapids, a single set of rapids with a drop of 1.8 m (5.9 ft.) to 2.0 m (6.6 ft.) and high velocities (more than 1.5 m/s (4.9 ft./s)).

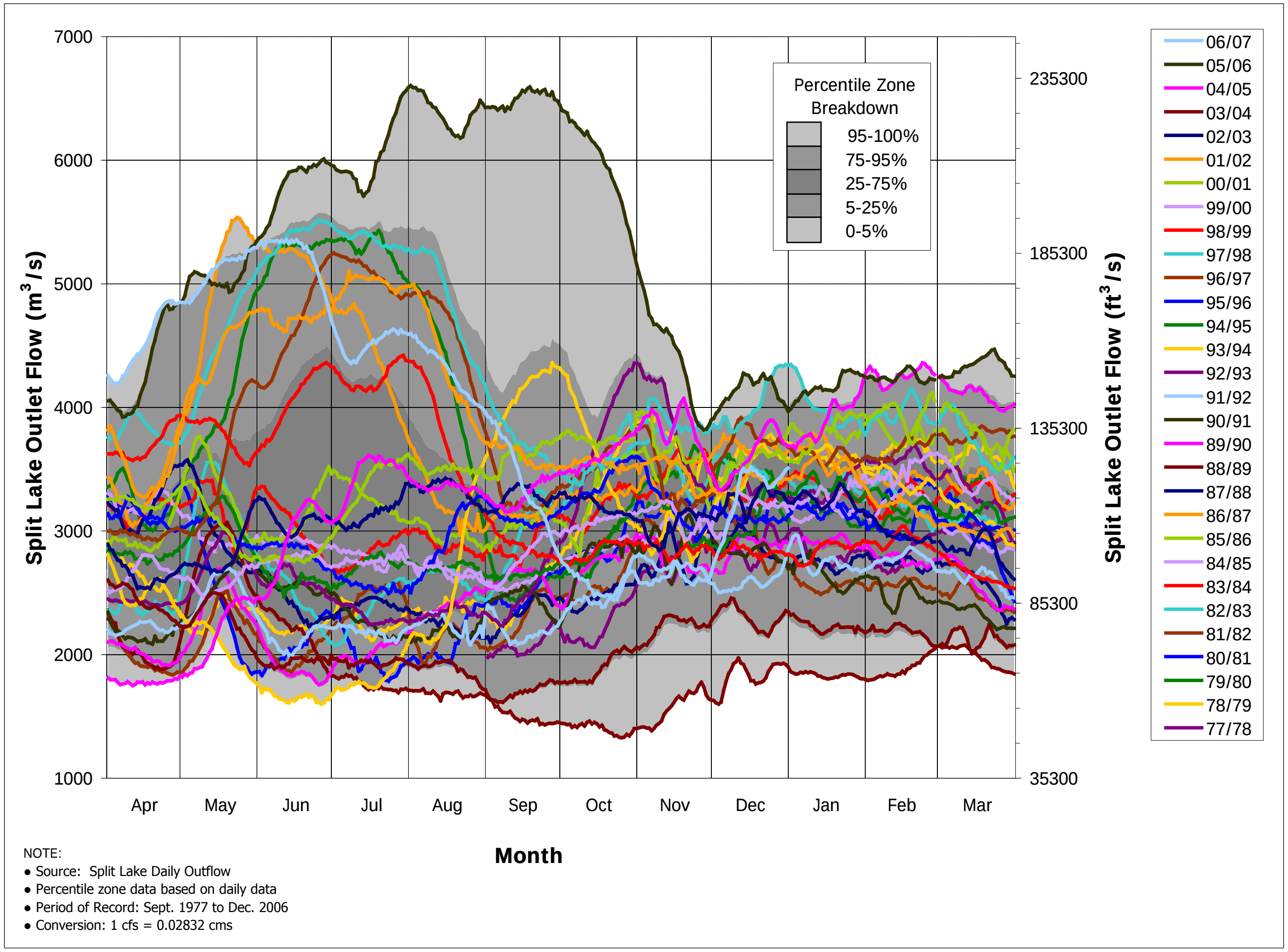
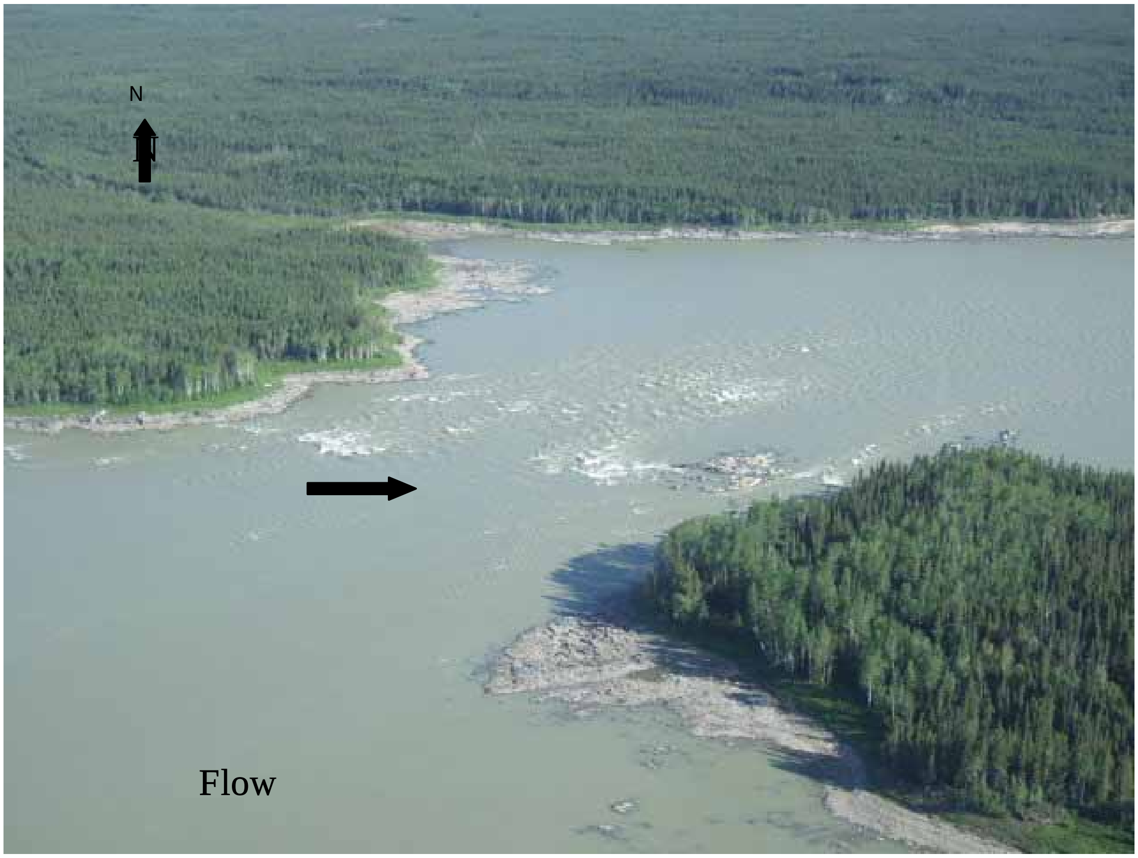


Figure 6-3: Split Lake Outflow (1977-2006)



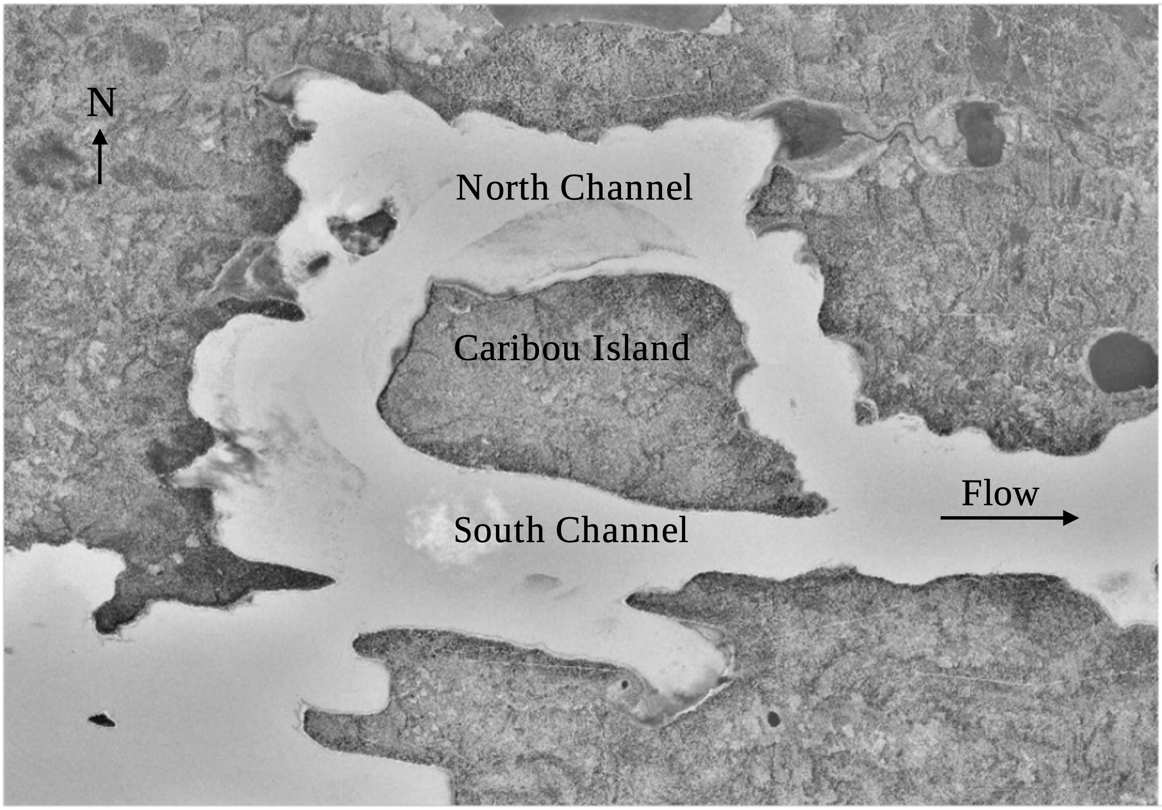
Source: Manitoba Hydro, 2003/07/09.

Photo 6-1: Aerial View of Birthday Rapids During Low Flows Looking Downstream

The 15km (9.3 mi.) reach between Birthday Rapids and Gull Lake is approximately 600 m (1,970 ft.) wide with a moderate gradient, moderate velocities (often less than 1.5 m/s (4.9 ft./s)) and relatively consistent depths (less than 8 m(26 ft.)). There are several small sets of rapids in this reach as well as several small islands. Within this reach, water from Two Goose Creek and Portage Creek discharge into the Nelson River. The drop in water level from the base of Birthday Rapids to the upstream end of Gull Lake is about 5 m (16 ft.) on average.

The Gull Lake portion of the reach is best described as a lake environment where wind and waves dominate shoreline processes. The lake is generally a very wide channel with several islands and bays. Depths along the center portion of the lake are greater than 7 m (23 ft.), with several areas as deep as 20 m (66 ft.). Depths around the islands and in the bays are considerably shallower (less than 3 m (10 ft.)). Due to the wide and deep sections of the lake, velocities are relatively low (less than 0.5 m/s (1.6 ft./s)). Several creeks, including Rabbit Creek and Seebeesis Creek flow into Gull Lake.

Between Gull Lake and Gull Rapids, the river splits into two main channels around Caribou Island. Deep sections exist in the deepest portion (thalweg) of both channels (Photo 6-2).

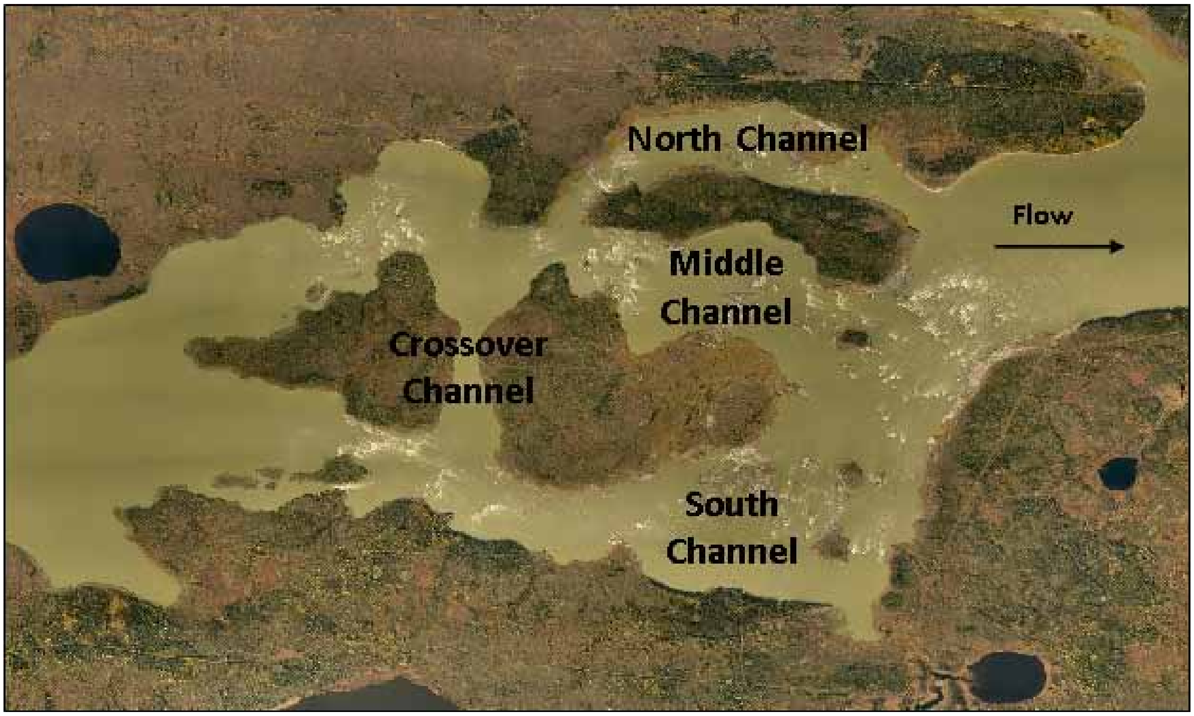


Source: Manitoba Hydro, Gull 1999 Black and White 1 metre Digital Ortho Imagery.

Photo 6-2: Nelson River Flow Split around Caribou Island

The northern channel around Caribou Island is generally wider, shallower and longer than the south channel. As a result, approximately 75% of the river flows are passed in the south channel. Velocities in both channels are moderate (0.5 m/s (1.6 ft./s) – 1.5 m/s (4.9 ft./s)). Several small creeks also discharge into this portion of the river.

With an average drop of approximately 12 m (39 ft.) across its length, Gull Rapids is the largest set of rapids in this reach. The numerous rock outcrops create multiple channels of flow through this section of the river. These include a north channel, a middle channel, a south channel and a crossover channel (Photo 6-3).The majority of the flow (75-85%) passes through the south channel of Gull Rapids, with the north channel passing little to no flow during low Nelson River flow conditions. These channels, and especially the crossover channel, are very dynamic and constantly changing (particularly during winter conditions) due to the nature of the existing ice and water processes occurring in this area. Ongoing erosion of the channels occurs and may ultimately affect the flow distribution within Gull Rapids in the future without the Project.



Source: Manitoba Hydro, Keeyask 2010 Colour 10 centimetre Digital Ortho Imagery.

Photo 6-3: Flow Channels through Gull Rapids on the Nelson River

All channels include rapid and turbulent flow with the highest velocities (more than 1.5 m/s (4.9 ft./s)) occurring in this portion of the reach. Gull Rapids under typical open water conditions is shown in Photo 6-4.

Downstream of Gull Rapids is the inlet to Stephens Lake, which is also the Kettle GS reservoir. There is little drop in water level between Gull Rapids and Stephens Lake. The water level in the reservoir fluctuates within a 3.0 m (9.8 ft.) range due to operations of the Kettle GS. The average open water level of Stephens Lake is about 140.2 m (460 ft.).

Source: Manitoba Hydro, 2003/07/09.

Photo 6-4: Gull Rapids during Open Water Conditions (Looking from South to North)

A systematic method to gather depth information was developed for the Project assessment. Depth grids developed for 5th, 50th and 95th percentile flows for steady-state conditions (*i.e.*, flows held constant) are presented in Map 6-8. The deepest areas (greater than 18 m (59 ft.)) are found in the four lake sections of the reach (Split, Clark, Gull, and Stephens lake) and just upstream of Birthday Rapids. The shallowest portions of the study reach (less than 4 m (13 ft.)) occur in the Birthday and Gull Rapids sections and in the numerous bays along the existing shorelines. Water depths through the rapid sections are often much less than 4 m (13 ft.). The section of the reach just downstream of the Clark Lake outlet is also shallow (less than 4 m (13 ft.)) and steep.

Velocity grids developed for the 5th, 50th and 95th percentile flows for steady-state open water conditions (*i.e.*, flows held constant) are presented in Map 6-9. Information is organized into standing water (0 – 0.2 m/s (0 ft./s-0.7 ft./s)), slow (0.2 - 0.5 m/s (0. ft. /s-1.6 ft./s)), moderate (0.5 – 1.5 m/s (1.6 ft./s –4.9 ft./s)) and high (greater than 1.5 m/s (4.9 ft./s)). Based on the results of open water hydraulic modelling, the estimated travel times for flows along the mainstem of the Nelson River from Split Lake to the proposed Keeyask

GS, under existing environment conditions, ranges from approximately 10 hours to 20 hours for flows between the 5th and 95th percentile values.

The peak monthly flows at all of the creeks occur in May during the spring melt period with the lowest flows estimated to be in March near the end of winter season. The amount of flow in each of these creeks varies throughout each month as these smaller basins typically respond quickly to local rainfall events.

OPEN WATER CONDITIONS DOWNSTREAM OF PROJECT

The reach downstream of the Project includes the upper portion of the Kettle GS reservoir (Stephens Lake) and most of the water level fluctuation here is due to the operation of the Kettle GS. There is little head loss between Gull Rapids, the location of the Keeyask GS, and Stephens Lake. The 50th percentile water level for Stephens Lake is 140.2 m (460 ft.) with an operating range of 3 m (9.8 ft.).

WINTER CONDITIONS UPSTREAM OF PROJECT

The Nelson River drops about 14 m (46 ft.) from Split Lake to Gull Lake. The majority of this drop in elevation occurs over a relatively steep section of the river located between the outlet of Clark Lake to a location, approximately 10 km (6.2 mi.) upstream of Gull Rapids. The higher velocities in this reach have a substantial impact on overall ice formation processes.

Map 6-10 provides an overview of the ice processes observed along this section of the lower Nelson River. Each year, a competent ice cover forms on Split Lake relatively quickly, usually beginning sometime between mid-October and mid-November. This cover then gradually thickens over the winter period, depending on the air temperature and the snow cover. The thickness of ice on the lake can range from 0.8 m (2.6 ft.) to 1.2 m (3.9 ft.).

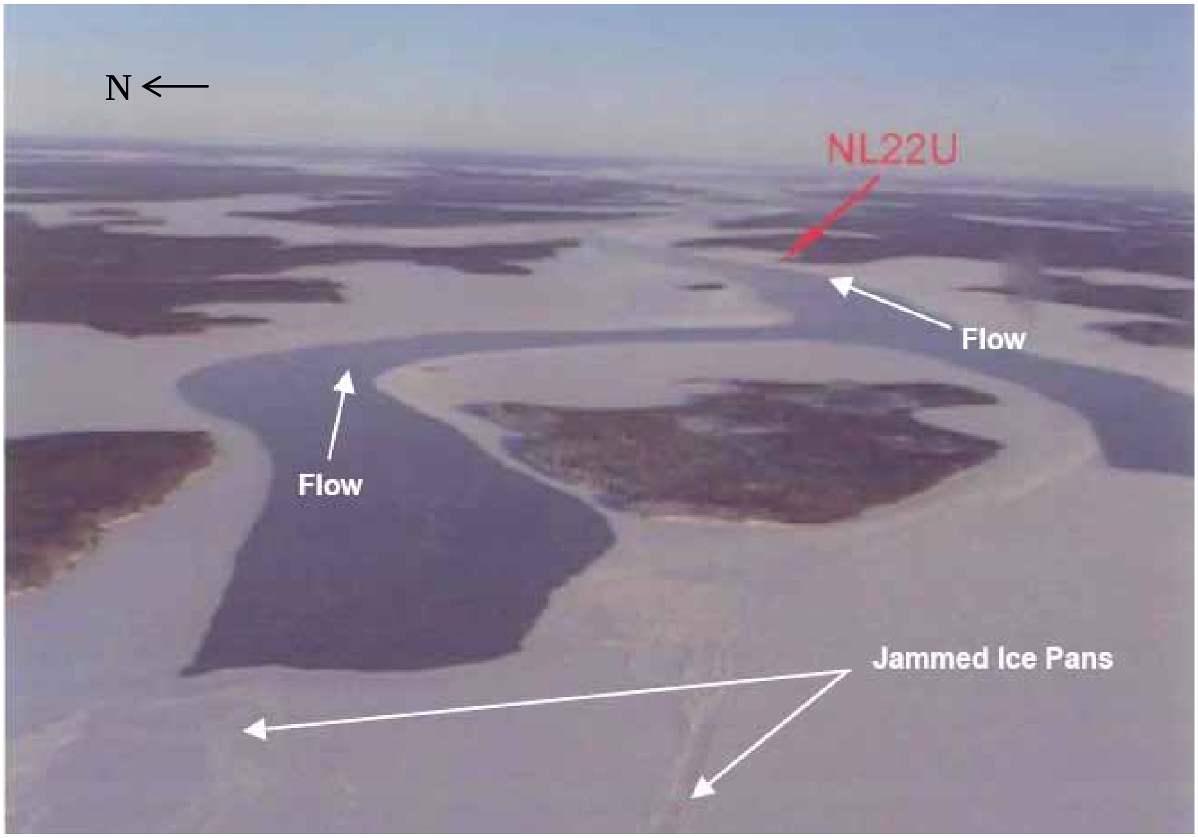
Downstream of Split Lake, ice initially forms as a thin strip of border ice along each bank, and where velocities are relatively low, such as in Clark Lake, border ice growth can cover a large portion of the lake. In the relatively steep reach between the outlet of Clark Lake and Birthday Rapids, higher velocities typically limit the growth of border ice to thin strips along the shoreline. At the same time, frazil ice particles (floating suspended ice crystals) are generated in the open water sections of the river once the water temperature drops below 0˚C. These particles are very adhesive (to surfaces and each other) and accumulate into ice floes and eventually into larger ice pans and sheets. These pans gradually grow in size and strength with time of exposure and distance travelled downstream. Photo 6-5, which shows a reach of the river near Gull Rapids, gives an indication of the density and size of some of these pans.

Source: Manitoba Hydro, 2004/12/16.

Photo 6-5: Typical Ice Pan Density Upstream Of Gull Rapids (Looking Downstream)

As the generated ice pans become larger and stronger, they normally begin to jam at a narrow section of the river, creating an ice bridge. This bridge typically forms at one of three locations all within the vicinity of Gull Lake. Map 6-10, and thus permits the progression or advancement of an upstream ice cover.

Photo 6-6 shows the ice cover at a bridging point located near Gull Lake. The date at which this ice bridge may form is quite variable. Typically, bridging occurs by mid-December, but it has been known to occur as early as mid-November, and in other years, has not been observed to occur at all. The size of the hanging ice dam downstream of Gull Rapids is much larger in years where ice bridging does not occur or it occurs extremely late in the season.



Source: Manitoba Hydro, 2002/02/12.
Note: NL22U is Manitoba Hydro Monitoring Site.

Photo 6-6: Typical Ice Bridging Point near Gull Lake (Looking Downstream)

Once bridging is initiated, this ice cover advances upstream. The typical ice cover in the downstream reach of the lake (up to 10 km (6.2 mi.) upstream of Gull Rapids) is relatively thin and smooth, as the cover is able to advance fairly quickly and easily against the lower velocities in this area. However, the cover in the upstream reach of the lake is considerably thicker and rougher, as it must periodically shove and thicken.

The advancing ice cover typically stalls either temporarily or for the season at the foot of Birthday Rapids, due to the higher velocities present at this location. These high velocities cause ice pans to submerge and be carried under the leading edge of the ice cover, leading to the formation of a hanging ice dam downstream of the rapids. The formation of the hanging ice dam can result in a considerable accumulation of ice in a very local area. This congestion restricts the conveyance capacity of the channel below Birthday Rapids, and can lead to substantial local staging (rising water levels). If the accumulation of ice in the hanging ice dam is large enough, it can also result in some redirection of flow along the riverbanks as the main channel conveyance capacity drops. This redirection of flow can have a substantial impact on bank erosion processes.

As the hanging ice dam grows downstream of Birthday Rapids, it initially leads to increases in water levels at the foot of Birthday Rapids. Eventually, water levels can rise to a point that is high enough to “flood out” the rapids, lowering flow velocities, and allowing the cover to begin advancing upstream again. This does not occur every year, but if it does, the cover eventually stalls at a location, approximately 5 km (3 mi.) upstream of Birthday Rapids. The cover advancement stalls at this point due in part to the steepness of the reach, in part due to the warming of air temperatures and increased solar radiation in late winter, and in part due to a reduction in the upstream open water area (in which frazil ice is generated) as the cover advances.

Anchor ice (ice that attaches to the riverbed bottom) also typically forms just downstream of the outlet of Clark Lake and also at the immediate outlet of Split Lake. These accumulations slowly restrict the conveyance of the channel in this area, leading to staging upstream on Clark Lake and Split Lake. Historical records on Split Lake have shown that this increase in stage may range from as little as 0.3 m to as much as 1.2 m over the course of a winter. The average winter increase in water level on Spilt Lake is approximately 0.6 m. On average, water levels begin to exceed open water stages at the beginning of November, when air temperatures begin to fall. These stages typically reach a maximum in late January/early February, and begin to fall again to open water levels later in the winter as these anchor ice accumulations begin to detach and release from the streambed. Over the course of the winter, the anchor ice may release due to thermal gain from the sun, and then subsequently reform later at night resulting in fluctuations in upstream water levels.

WINTER CONDITIONS DOWNSTREAM OF PROJECT

The existing winter surface profile for an average flow year is shown in Figure 6-4. In the downstream reach of the river (Gull Rapids to Stephens Lake), an ice cover initially forms on Stephens Lake in the early fall, typically by November 1, although these formation dates may vary somewhat depending on the fall air temperatures. Historical observations have shown ice formation dates on Stephens Lake falls within a window between mid-October and mid-November. Due to the low flow velocities in the reach between the foot of Gull Rapids and the inlet to Stephens Lake, much of this reach also freezes over quickly in early fall as lake ice.

Once Stephens Lake freezes over, and before the upstream cover can bridge at one of the three locations on Gull Lake (Map 6-10), all ice generated in the upstream reach passes through Gull Rapids, collects on the leading edge of the cover, and causes the cover to begin to advance upstream. However, the opportunity for upstream progression is limited and the ice front typically stalls at the site of the proposed Keeyask GS due to the high velocities present. Any incoming ice is submerged and deposited under the ice cover resulting in the formation of a large hanging ice dam downstream of Gull Rapids (Photo 6-7). The growth of this ice dam is initially very rapid, but slows considerably when and if an ice bridge forms upstream in Gull Lake.

Source: Manitoba Hydro, 2003/02/03.
Note: 05UF672 is Manitoba Hydro Monitoring Site.

Photo 6-7: Typical Hanging Dam Downstream of Gull Rapids (Looking Upstream)

The hanging ice dam continues to grow throughout the winter. However, the ice cover does not progress through Gull Rapids, even under an extremely cold winter. The formation of the hanging ice dam can result in a considerable accumulation of ice in a very local area, as shown in Photo 6-7, which was taken just downstream of Gull Rapids during the winter of 2004/05. This congestion restricts the conveyance capacity of the channel below the rapids, and can lead to substantial local increases in water level (7 m (23 ft.) to 8 m (26 ft.) above open water levels have been observed). As the cover grows over the winter, substantial internal stresses and pressures develop, and the cover can shift often as the matrix of ice fragments and floes grows. A portion of these loads can be transferred to the banks, due to lateral pressure exerted by the accumulation. In this environment, the banks become susceptible to erosion when ice is pushed up against the bank, or moves directly along the shoreline, abrading the river bank. This can lead to additional scour or to the formation of beach ridges due to the build-up of coarse material (cobbles and boulders) over time.

SPRING BREAK UP ON THE NELSON RIVER

Breakup of the river ice in the Local Study Area in spring is preceded by the release of anchor ice at the outlet of Split Lake and Clark Lake. This usually begins to occur in late

February and as a result, water levels on Clark Lake and Split Lake begin to drop in these latter winter months. The river ice then begins to deteriorate in late March and throughout April, as the sun's stronger solar radiation begins to weaken the ice, and snowmelt runoff begins. Open water leads *(i.e.,* initial open water areas formed due to the deterioration of a previously existing ice cover) then begin to form throughout the main cover. In tandem with this, rising flows cause water levels along the river to increase and, with this rise in water level, the cover eventually loses its bank resistance against the shorefast ice. The leading edge of the cover then begins to retreat down river as the cover progressively breaks and reforms, at times resulting in a temporary ice jams. In areas where the pack ice is contained by wider border ice reaches, the border ice tends to remain in place slightly longer, and the pack ice retreats in the center of the river. The resulting dropping water levels can cause grounding of the shorefast ice. Eventually, the leading edge retreats to the location of the stronger lake ice, leaving open water in upstream areas. The reduction of winter water levels in the reach typically begins in March and continues through until mid-May, at which time levels return to open water levels throughout most of the reach.

Ice remnants located along the shore zone downstream of Birthday Rapids continue to melt and deteriorate, typically into June. Photo 6-8 illustrates typical remnants of shorefast ice that have become grounded along the river reach and are melting *in situ*. This is a typical process in an area of heavy pack ice. As ice remnants melt, they may collapse, pull away and/or slide down the banks of the river, pulling some shore material with them.

Downstream of Gull Rapids, the large hanging ice dam also begins to deteriorate, leading to the development of open leads within the cover. The cover begins to melt and, with the onset of higher flows associated with the spring freshet, flush out into Stephens Lake.

Source: Manitoba Hydro, 2006/05/17.

Photo 6-8: Remnants of Pack Ice on the Shore

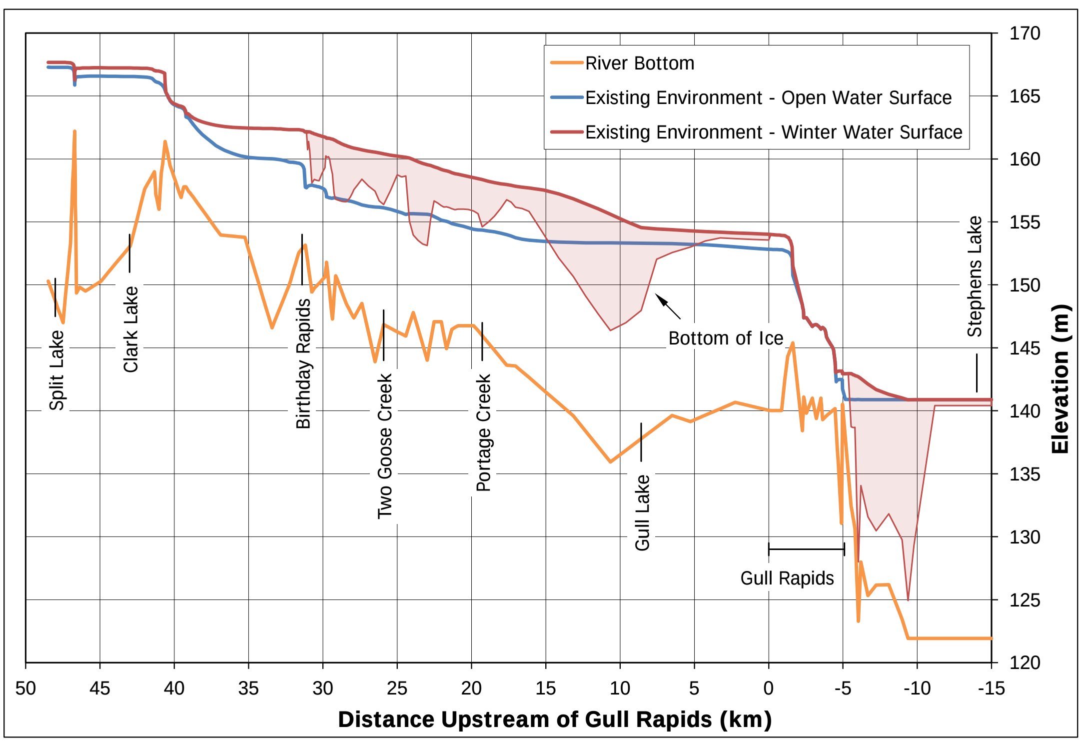


Figure 6-4: Existing Environment Winter Water Surface Profile - Average Flow Year (1999/2000)

6.2.3.2.7 Shorelines and Erosion Processes

Approximately 205 lineal km (127 mi.) of the Nelson River shoreline was mapped and classified in the affected reaches of the Local Study Area that are likely to be affected by the Project (Map 6-11 and Map 6-12). Bank material along the Nelson River shoreline is dominated by mineral material, peat and mineral overlain by peat. Mineral and peat banks dominate shorelines (46% and 32% of shoreline length, respectively). Mineral bank overlain by peat and bedrock comprise the remainder of the shoreline banks. More than three-quarters of the peat shoreline is non-eroding since the peat bank rests on underlying mineral material near or above the 95th percentile of water elevations. The majority of the shoreline has banks that are less than 1.25 m (4.1 ft.) high and only 5% of the shoreline has banks higher than 2.5 m (8.2 ft.). All of the shoreline with banks higher than 3 m (9.8 ft.) are mineral.

Mineral shorelines and shoreline peatlands are subject to erosion processes in the current environment. Shoreline peatlands are either riparian peatlands or are the edges of inland peatlands abutting the shoreline. Riparian peatlands are common in off-system lakes, streams and rivers but uncommon in the Gull Lake reach of the Nelson River. Peat banks on the existing Nelson River shoreline are formed by inland peatlands that extend to the river. These peat banks are currently stable in sheltered locations. The Physiography section of the PE SV contains further details on inland peatlands.

Mineral banks on the existing Nelson River shoreline consist mainly of low to moderately high (0 m (0 ft.) to 3 m (9.8 ft.)) steep banks that have formed in coarse-textured clay till and glaciofluvial (sand and gravel) sediments and, in places, fine-textured clay and silt sediment which were deposited in glacial Lake Agassiz. Gently sloping beaches and nearshore slopes extend out into the lake from the toe of steep shoreline banks. In some places, mineral shorelines consist of non-erodible river-washed bedrock, and in other places very gently sloping non-eroding mineral slopes that are overlain by thin peat and vegetated to just above the normal high-water elevation. Many of the banks along the Nelson River are ice scoured for a short distance above the normal open water elevation, and in places ice has shoved coarse gravel, cobbles and boulders onto the shore, effectively protecting these shorelines from erosion. Overall, mineral erosion rates in the study area are relatively low under existing conditions as compared to other lakes and rivers in northern Manitoba.

Shorelines upstream of Birthday Rapids vary from erosion-resistant bedrock where the bedrock surface elevation is above the high-water level, to discontinuous mineral material over bedrock, to continuous mineral material where the bedrock elevation is below the minimum water level. Historical bank recession rates in this reach are very low, ranging from approximately 0 metres per year (m/y)(0 feet per year (ft./y))to 0.25 m/y (0.8 ft./y) at most locations.

Shorelines at Birthday Rapids consist of wave-washed, erosion-resistant bedrock overlain by thin glacial drift. There is no peat or mineral overlain by peat material in this reach. In most locations, bank recession is negligible. Historical recession rates range from stable bedrock shores to maximum rates of about 0.25 m/y (0.8 ft./y) where erosion is occurring. Any shore erosion in this area likely occurs during the winter period.

Shorelines between Birthday Rapids and the inlet to Gull Lake are characterized by relatively steep ice-scoured banks with low rates of bank recession in most locations. Peat and mineral overlain by peat shorelines are more common in this reach than further upstream accounting for 3% and 24% of the shoreline respectively.

Wave energy throughout Gull Lake is relatively low except for points of land exposed to long fetches parallel to prevailing wind directions. Historical erosion rates are low (less than 0.25 m/y (0.8 ft./y)) along most shoreline reaches. Somewhat higher recession rates (0.25 m/y (0.8 ft./y) to 0.75 m/y(2.5 ft./y)) occur in localized areas that are exposed to prevailing northwest winds.

Low gradient shorelines represent the majority of the shoreline length in Gull Lake. These shorelines typically consist of peat overlying glaciolacustrine sediment or till. Wave energy reaching the shore is usually low, resulting in low to negligible erosion rates.

Effects of ice movement and ice scour can be seen at a number of locations along the Gull Lake shoreline. Most noticeable are areas where cobbles and boulders are pushed up onto the shoreline effectively armouring the beach and bank against wave erosion. In many cases, effects of ice shove can also been seen in tilted and fallen trees and disturbed peat and surface mineral soil.

The shorelines most susceptible to ice abrasion and channelling of river flow by ice are located below Birthday Rapids, in the Nelson River near the inlet to Gull Lake and in the west end of Gull Lake, along narrow reaches of shoreline near Caribou Island, in Gull Rapids and immediately below Gull Rapids.

Bank erosion on the south side of Caribou Island likely has resulted largely from diversion of river flow against erodible banks due to rising water levels that accompany the formation of an ice cover in this reach.

Shorelines in the immediate vicinity of Gull Rapids show the greatest amount of change over time compared to other locations in the Local Study Area and have historical bank recession rates exceeding 1 m/y (3.3 ft./y) in some locations. Bedrock-controlled shorelines in the Gull Rapids area may experience little bank recession during ice-free conditions; however, increasing water levels on the river due to ice formation can result in considerable recession of thin mineral deposits and peat that overlie the bedrock. Channelling of flow due to ice build-up can also result in formation of new channels. Channelized flow under winter conditions also causes increased bank recession rates where bank materials adjacent to Gull Rapids consist of erodible glacial sediments.

The large hanging dams that form each winter downstream of Birthday or Gull rapids have a high potential to abrade and erode the underlying channel and river banks. If the accumulation of ice in the hanging dams is large enough it can also result in a redistribution of flows within Birthday or Gull rapids. This can result in a redirection of flow along the river banks as the main channel conveyance capacity drops. If local velocities increase considerably, any erosion-susceptible material may begin to move. Heavy pack ice in this area, for example, led to the formation of a new cross over channel through the central island during the 2000/2001 winter. These types of episodic events are likely the leading cause of erosion in this reach of the river. Peat shore is virtually absent in this reach.

Measurable peat bank recession in shore segments subject to peatland disintegration processes was not observed for the 41-year period extending from 1962 to 2003.From a comparison of air photos from 1986 and 2006, it was observed that nearly half of all shorelines did not erode from 1986 to 2006; approximately 43% of eroding shorelines eroded less than 0.25 m/y (0.8 ft./y) and less than 10% eroded between 0.25 m/y (0.8 ft./y) to 1.0 m/y (3.3 ft./y). These erosion rates are considered to be relatively stable in the future without the Project.

A review of bank recession rates from a large number of lakes and reservoirs in southern Saskatchewan and Manitoba indicate average annual bank recession rates typically range from 0.25 m/y (0.8 ft./y) to 3 m/y (9.8 ft./y) in large relatively new reservoirs and 0.25 m/y (0.8 ft./y) to 1 m/y (3.3 ft./y) in more mature reservoirs (Penner and Boals 2000). Therefore, long-term rates used for this analysis are consistent with the lower range of rates that have been measured in other lakes and reservoirs of comparable size.

Based on historical recession rates between 1962 and 2003, it is estimated that about 9,100 cubic metres per year (m^3/y) (11,940 cubic yards per year (yd^3/y)) of organic sediment is input into the Nelson River in the upstream reaches of the Local Study Area Map 6-11 and Map 6-12. Similarly, it is estimated that about 28,600 m^3/y (37,400 yd^3/y) of mineral material is input to these reaches of the river.

6.2.3.2.8 SEDIMENTATION

The sedimentation assessment deals with the transport and deposition of sediments in the Local Study Area from the outlet of Clark Lake to Stephens Lake. The analysis of mineral sedimentation included consideration of suspended sediment concentrations in deep water as well as nearshore areas, bedload transport (*i.e.*, movement of material along the bottom) and estimation of the sediment budget. The description of organic sedimentation included consideration of peat transport and organic suspended solids. River and lake bed substrates were also considered.

Sediment data for the Keeyask Project has been collected in the Local Study Area since 2001. An intensive program of open water monitoring was undertaken by Manitoba Hydro from 2005 to 2007. Overall, this monitoring showed that the suspended sediment concentrations in the Nelson River between Clark Lake and Gull Rapids are consistently within the range of 5 to 30 mg/L with the mean in the range of about 13 to 19 mg/L.

Analysis of the particulate size of suspended material collected in the open water periods reveals that the suspended sediments are generally composed of clay and silt as well as some fine sand particles. This is true for both the riverine reach downstream of Split Lake, as well as the lacustrine locations in Gull Lake and Stephens Lake.

Near shore suspended sediment concentrations in the Local Study Area from 2005 to 2007 typically varied from about 2 mg/L to 35 mg/L. However, a few high concentrations (60 mg/L to 125 mg/L) were observed in nearshore areas. This likely results from local disturbances that do not last for a long period of time (*e.g.*, local bank failure). Photo 6-9 shows an example of higher suspended sediment near a shoreline.

Source: Lynden Penner, 2004.

Photo 6-9: An Example of High Suspended Sediment Concentration in Near Shore Areas

There is little correlation between suspended sediment concentrations and water depth, which is an indication that the sediment is not bed material suspended and transported near the river bottom. Similarly, concentrations do not vary substantially across the width of the river. Field data also demonstrate that as the flow in the Nelson River increases, the suspended sediment concentration tends to increase. In addition to field sampling, sediment modeling was performed for existing conditions based on the field data. In the river reach from Clark Lake to Birthday Rapids, at the 50th percentile flow, suspended sediment concentrations rangedfrom 5 mg/L to 25 mg/L. This sediment primarily originates from upstream of the Local Study Area. In the reach from Birthday Rapids to the entrance of Gull Lake the concentration also ranged from about 5 mg/L to 25 mg/L. As the flow enters Gull Lake the velocity dissipates. Within Gull Lake to Gull Rapids, the suspended sediment concentrations ranged from 5 mg/L to 30 mg/L at the 50th percentile flow. At higher 95th percentile flow the ranges of suspended sediment concentrations were similar but average concentrations were higher. Map 6-13 provides a summary of calculated sediment concentrations in the Local Study Area for existing conditions at the 50th percentile flow.

Bed load (the movement of particles along the riverbed) sampling was performed in 2006 and 2007. At the majority of the sampling sites no bed load was measured and where samples were obtained they included sand and fine gravel. These results showed that very low or no bed load was present in the Local Study Area. Based on the 2005 to 2007 sampling, the total mineral sediment load passing through the Local Study Area from downstream of the Clark Lake outlet to Gull Rapidswas estimated to range from about 1.5 to 3.1 million tonnes per year. The estimated load at the 50th percentile flowis aboutone million tonnesper year. Consideration of the sediment data collected along with the low rates of shoreline erosion indicated that suspended sediment in the flow was not predominantly resulting from shorelines within the Local Study Area. A sediment budget analysis based on observed data and flowsindicated that the sediment load was transported through the Local Study Area from downstream of the exit of Clark Lake to Gull Rapids and no substantial deposition or accumulation occurred in the Local Study Area.

Field observations indicate that small amounts of organic sediment and floating peat are generated in the Local Study Area. Water sampling test results indicate that suspended organic carbon is typically low (less than 1 mg/L), which indicates that organic material comprises a small part of the suspended sediment. Little organic deposition occurs.

Downstream of Gull Rapids, Stephens Lake, suspended sediment concentrations during open water conditions in 2006 and 2007 were typically low, ranging from about 3 mg/L to 15 mg/L. Concentrations decrease in the downstream direction from Gull Rapids to the Kettle GS. Coarser sediment transported from upstreamis deposited as the Nelson River flows into Stephens Lake due to reduced velocities. Higher concentrations were observed in the winter in 2008 and 2009, ranging from 5 mg/L up to 156 mg/L. High concentrations are likely due to shoreline erosion resulting from increased water levels caused by the hanging ice dam at the entrance to the lake, as described in the previous section.

Total annual suspended sediment load upstream of the Kettle GS in 2005 and 2006was estimated to be 1.2 and 0.8 million tonnes respectively. Total sediment loads entering Stephens Lake in 2005 and 2006 were estimated to be 3.1 and 1.9 million tonnes respectively. This shows that approximately 1.9 and 1.1 million tonnes of sediment were deposited in Stephens Lake in 2005 and 2006 respectively. Sediment cores from Stephens

Lake (up to 200 m offshore) indicated sedimentation rates of 0 centimetres per year (cm/y) to 2.4 cm/y (0 in./yr to 1 in./y) in the 35 years since the lake (*i.e.*, the Kettle reservoir) was impounded, with most of the sediment coming from shorelines adjacent to the coring sites.

Substrates in the Local Study Area are varied, depending on the location. In the reach from downstream of the outlet from Clark Lake to Birthday Rapids the substrate is largely bedrock and boulder/cobble (Map 6-14). Over about the next 15 km below Birthday Rapids the substrates are primarily bedrock, boulder, and cobble, with some fine sediment in areas with reduced current in shallow water. Gull Lake substrates are predominantly cobble and boulder in areas with flow, and soft in off-current areas. Within Gull Rapids the substrate is comprised of bedrock and boulders. Downstream of Gull Rapids, where the Nelson River flows into Stephens Lake, the substrate changes from cobble/boulder closer to the rapids, to gravel/sand and sand at the entrance to the lake. Further downstream the substrate is finer silt material.

The sedimentation processes in the existing environment are relatively stable.

6.2.3.2.9 GROUNDWATER

Both an upper groundwater table located near the ground surface within the peat (perched above the clay layer), and a lower groundwater table between 5 m (16 ft.) and 10 m (33ft.) below grade (in the underlying till deposits) have been identified in some areas of the Local Study Area. For the most part, however, the local stratigraphy suggests that these two aquifers are connected, (*i.e.*, there is no continuous confining layer separating the two according to the boreholes drilled in the Local Study Area).

The inconsistent relationship between water levels in the adjacent lakes and in the groundwater at several locations suggests some, but not a complete, connection between the groundwater and surface-water systems within the Local Study Area. Alternatively, this inconsistency may reflect the presence of clay or permafrost underlying the lakes, which may act as a barrier to hydrologic flow between the lakes and groundwater.

The overburden and bedrock hydraulic conductivity for the different soil and rock strata within the Local Study Area has been measured to be between 1×10^{-4} m/s to 1×10^{-8} m/s (3.3×10^{-4} ft./s to 3.3×10^{-8} ft./s). Precambrian igneous and metamorphic rocks form the bedrock basement of the Local Study Area, which is generally impermeable to groundwater, except where the bedrock has been fractured by tectonic movement (Betcher *et al.* 1995). The permeability of the bedrock units within the study area is reported to be varied based on the location of local bedrock positions (Manitoba Hydro 1993).

The LWR and CRD have caused river water levels and adjacent groundwater levels to rise along the shoreline. The groundwater level under post-LWR and CRD conditions is likely higher, *i.e.*, closer to the surface than it was under pre-LWR and CRD conditions. It is also expected that the range of variation would be smaller under post-LWR and -CRD conditions since the difference between high and low flows has been generally reduced.

The general groundwater conditions in the Local Study Area appear to be stable.

Natural groundwater recharge occurs throughout the Local Study Area at variable rates depending on factors such as ground-surface topography, subsurface soil materials and natural processes *(i.e.,* precipitation and melting of snow). Based on these factors, groundwater recharge occurs predominantly in the western portion of the Local Study Area (in the vicinity of Birthday Rapids) and where there are more permeable glacial deposits *(e.g.,* Gull Esker). In the eastern portion of the Local Study Area, where ground-surface elevations are lower and the groundwater table is near to the ground surface, less groundwater recharge occurs. In both areas, however, the subsurface presence of clay, till and/or permafrost (depending on the nature and extent of these deposits/features) may limit groundwater recharge by slowing or completely impeding the downward water movement.

Groundwater elevations within the Local Study Area range between approximately 120 m (390 ft.) and 200 m (650 ft.) from west to east across the Local Study Area. This is displayed on Map 6-15 Groundwater Regime - Simulated Groundwater Level – Existing Environment wherein the colours depict groundwater-elevation differentials. Levels are highest in the northwestern and southwestern portions of the Local Study Area and lowest in the east. These groundwater levels are in direct correspondence with area surface topography. Groundwater flows from topographic highs to topographic lows. Accordingly, across the Local Study Area, groundwater flows towards the surface-water network *(i.e.,* into the Nelson River; see Map 6-15 Groundwater Regime - Simulated Groundwater Level – Existing Environment wherein the arrows depict general groundwater-flow direction).

The differences between groundwater levels at any single time and specific location, under different river-flow conditions *(i.e.,* typical, high or low flows) or meteorological conditions *(i.e.,* typical, wet and dry periods), are between 0 m (0 ft.) and 0.8 m (2.6 ft.). However, these relatively small elevation-changes can substantially affect the amount of area where water is at the ground surface due to the generally flat topography of the area.

Year-to-year river-flow and variations in meteorological conditions over the Local Study Area appear to have little effect on the groundwater flow directions, recharging-discharging areas and groundwater hydraulic gradients. Under typical meteorological and typical river-flow conditions, the groundwater velocities range from 0 m/d metres per day (0feet per day (ft./d))to 7.5 m/d (25 ft./d) over the Local Study Area. Zero-velocity conditions occur adjacent to surface-water bodies, where groundwater elevations match the surface-water elevation.

Depth-to-groundwater *(i.e.,* distance from the ground surface to the water table) is particularly important as subtle changes can have implications for the terrestrial environment. These indirect effects are addressed in the Terrestrial Environment Supporting Volume (TE SV). The 50th percentile simulated depth-to-groundwater results for typical conditions in the existing environment are shown in Map 6-16. Depth-to-groundwater varies from the ground surface (or immediately below it) to approximately 7.5 m (25 ft.) below the ground surface. Hydrologically, areas with water at surface and areas with water near surface represent the discharge zones in the Local Study Area. The areas with the deepest groundwater coincide with topographic highs in the Local Study Area, which are also the expected recharge zones within the study area. Overall, the discharge areas occupy a much greater area than the recharge zones for wet meteorological and river-flow conditions (95th percentile groundwater levels), and vice versa for typical and dry 50th percentile groundwater levels.

Under typical meteorological and Nelson River flow conditions at 50th percentile groundwater levels, approximately 1% or 5 km^2 (2 mi^2) of the 566 km^2 (218 mi^2) Local Study Area is occupied by groundwater at the ground surface, excluding the open water of the Nelson River and adjacent lakes, which occupy approximately 18% of the study area (Map 6-16). Approximately 3.5 % or 19.3 km^2 (7.4 mi^2) of the Local Study Area is occupied by groundwater between 0 m (0 ft.) and 0.5 m (1.6 ft.) below ground level *(i.e.,* water near surface).

The groundwater quality in the Local Study Area is described as slightly alkaline, typified by calcium, magnesium and bicarbonate components, with total dissolved solid (TDS) concentrations from 400 mg/L to 450 mg/L (Betcher *et al.* 1995). Recent groundwater analyses generally confirmed the findings. Zinc concentrations were above Canadian Council of Ministers of the Environment water quality guideline for the protection of aquatic life (CCME 1999).

There are no anticipated changes to the driving factors affecting groundwater processes *(i.e.,* river flows, water levels, recharge and stratigraphy) and groundwater quality in the future without the Project.

6.2.3.2.10 SURFACE WATER TEMPERATURE AND DISSOLVED OXYGEN

For the surface water temperature and dissolved oxygen (DO) study, information is organized into an upstream study area encompassing the reach of the river upstream of Gull Rapids where temperature and DO effects are likely to be greatest; and a downstream study area encompassing Stephens Lake where effects are likely to be limited. There is little data available for water temperature and DO conditions in the study area prior to LWR and CRD. However, it is expected that water temperatures prior to LWR and CRD remained relatively unchanged as water flowed between Clark Lake and Gull Rapids since water flowed quickly through the area. Additionally, thermal stratification (top to bottom temperature differences) would not have occurred along the river mainstem because the water column is well mixed. Similarly, it is expected that DO would typically have been high (at or near saturation) due in part to good mixing.

Under current conditions, water temperatures on or near the mainstem are typically uniform through the depth of the water column with no indication of stratification because the river is fully mixed (Figure 6-5). Generally, water temperatures follow short-term (*e.g.*, seven day average) trends in ambient air temperature. For example, when air temperature is elevated for seven days or more the water temperature also warms. Based on monitoring data and an understanding of the processes involved, DO would be expected to remain above 6 mg/L in and near the mainstem at all depths in all seasons throughout the reach between Clark Lake and Gull Rapids. Concentrations of DO are typically at or above saturation in the reach between Clark Lake and Birthday Rapids and remain near saturation downstream to Gull Rapids.

In areas away from the mainstem, such as backbays where less mixing occurs and the river is not as deep, water temperatures are fairly uniform from top to bottom for typical weather conditions. Weak stratification occurs over short periods (one to two days) from time to time when wind speed is extremely low (less than 5 km/h), Localized lower DO concentrations also occur in isolated backbays during periods of very low wind in summer. Concentrations are typically high with average percent saturation levels close to 100%, or more than 8 mg/L for the majority of the time.

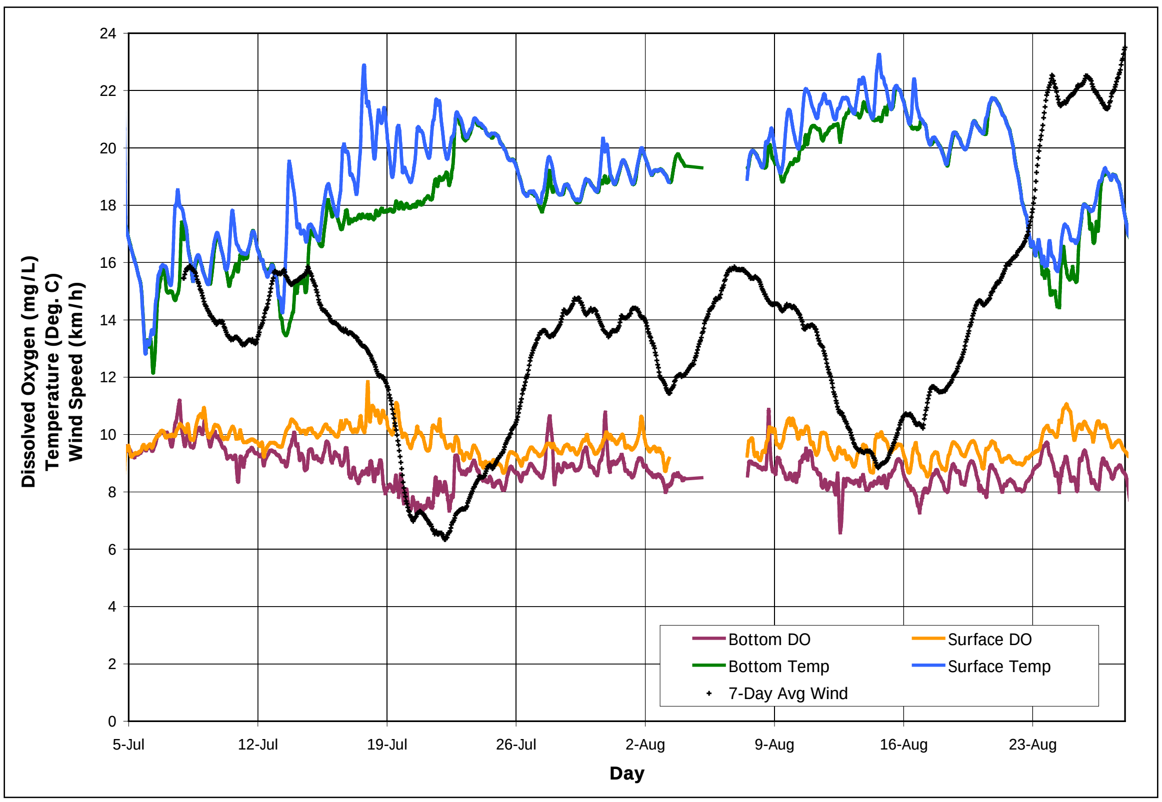


Figure 6-5: 2008 Continuous Water Temperature and Dissolved Oxygen Data in John Garson Bay on Gull Lake

Although there is limited winter data for the area upstream of Gull Rapids, data collected in Stephens Lake indicate that upstream water temperatures with minimum values of 0.1ºC to 0.2ºC likely occurring each winter. In addition, temperatures have some vertical differential (weak stratification) in backbays with warmer water at the bottom (3ºC to 4ºC) than at the top (less than 1ºC).

In the southern part of Stephens Lake, water temperatures are typically relatively uniform through the depth of the water column. Several sites along the main flow path Stephens Lake showed a decreasing temperature gradient in late spring, but this did not indicate a strong thermal stratification and the condition did not persist into the summer.

During typical weather conditions there are no substantial spatial or depth related variations in water temperature or DO among downstream monitoring sites. Continuous monitoring in 2008 in a sheltered, poorly mixed area in a part of Stephens Lake that was flooded 30 years ago, showed that these parts of the lake can develop a large DO between the surface and bottom during low-wind conditions. During an extended low wind period DO percent saturation values were measured as low as 1%, or less than 1 mg/L.

Dissolved oxygen is one component of the total dissolved gases in the water. Total dissolved gas pressure in the water was also measured in the existing environment on October 12 and 13, 2011 from approximately 900 m upstream to 1,200 m downstream of Gull Rapids at 1 m and 4 m depths (Jansen and Cooley 2012). At both depths, the mean total dissolved gas pressure as a percent of local atmospheric pressure upstream of the rapids was 100% and downstream was 102%, or slightly super-saturated. Outflow from Split Lake at this time averaged about 5,550 cms, which exceeds the 95th percentile flow for open water conditions.

It is expected that the future water temperature and DO environment without the Project would continue to be the same as the existing environment.

6.2.3.2.11 DEBRIS

Major factors that contribute to debris processes in the Local Study Area are shoreline erosion, peatland disintegration, ice, river flow and water level, and forest fires. Shoreline erosion and peatland disintegration are the primary factors because the resulting shoreline recession allows new debris to become available to the waterbody. Ice, river flow and water level, and forest fires are important factors in the debris process because they may affect both shoreline recession and the mobilization and transport of debris. Other sources of debris such as timber harvesting (*e.g.*, for firewood) and beaver activity on the water body or tributary streams are deemed to be minor based on boat patrol surveys conducted as part of Manitoba Hydro's Waterways Management Program (Appendix 4B).

Shoreline recession results from breakdown of peat shorelines and erosion of mineral shorelines. Vegetation growing on upland areas adjacent to eroding banks fall onto the shoreline, resulting in debris that may mobilize and move into the waterbody. Localized slope failures also generate debris that enters the river. In addition to current flow, ice scour along shorelines during the spring break-up period is one of the dominant processes that removes vegetation from the ice-scoured area creating a potential source of debris. Many of the banks along the Nelson River are ice scoured for a short distance above the normal open water elevation. In some places, the ice shoving pushes over trees and other vegetation, which may become mobilized in the river. There are some areas of Gull Lake where the shores may be protected by border ice that remains attached to the shore, thereby acting as a buffer to ice shoving. Border ice, however, may create new debris if it causes woody or peat material to be pulled away from the shore when the ice recedes in spring.

With the build-up of a large hanging dam downstream of Birthday Rapids and the collapse and shoving action expected within the rapids if the ice cover advances through them, flows can be temporarily redirected under the ice cover, leading to high-flow velocities over erosion-susceptible shore zone areas. This can lead to the mobilization of woody debris into the waterway both during spring and during the later months if ice abrasion makes a shoreline more susceptible to erosion.

From time to time, forest fires have burned tracts of land right up to the shoreline of the Local Study Area, resulting in standing dead trees along the shoreline that can become debris. Loss of vegetation cover due to fire may also cause underlying permafrost to start melting. The melting permafrost can cause shoreline bank failures, which may cause trees and other material to fall into the river.

While a variety of factors contribute to the creation of debris, once it becomes debris it may be classified as either mobile, because it is floating in the water column or immobile because it is beached above the waterline or it is embedded in bottom sediments. Debris may go through many cycles of being mobilized and immobilized as conditions on the waterway change over time. For example, beached debris may be immobilized for years before it is remobilized due to an event that moves it off the beach. Once mobilized, debris may move around the waterbody, it may move downstream, it may sink or it may subsequently become immobilized again at a different location.

Manitoba Hydro has a waterways management team that performs boat patrols in the local study area, removing hazardous debris from the waterway. The local study area covers the open water hydraulic zone of influence from just downstream of Clark Lake to the inlet of Stephens Lake. The team has been involved in the tracking and removal of mobile debris that poses a risk to navigation safety and, since 2003, has categorized and counted the pieces of debris removed. The number of pieces of woody debris removed in the years 2002 to 2008 ranged from 13 to 177 per year. Small amounts of organic sediment and floating peat are generated in the existing environment from shore erosion processes within the area between Birthday Rapids and Gull Rapids. Based on the field observations, this area does not generate measureable mobile peat from the shore erosion processes under present conditions.

Mapping of 2003 debris conditions encompassed the Local Study Area from Clark Lake to Stephens Lake while the 2008 mapping only covered part of Gull Lake and Gull Rapids. The bulk of the shorelines in the Local Study Area were classified as having no debris in 2003. Among shorelines noted as having debris in 2003, the majority had low density and sparsely distributed debris along with some areas of moderately dense debris. Only two locations had high-density debris. In the Clark Lake to Gull Lake reach, the majority of classified debris was beached woody debris and standing dead trees, although leaning trees were not uncommon and often associated with beached debris. The majority of classified debris in the Gull Lake to Stephens Lake reach was standing dead trees and beached debris, although the shores downstream of Gull Rapids area were characterized by leaning trees Map 6-17 Shoreline Debris.

Debris was also classified for the year 2008, but only in a portion of the Local Study Area (Gull Lake, Gull Rapids). The 2008 classification showed greater densities of debris as compared with 2003. A substantial amount of submerged and floating debris was identified in 2008, which was a very high flow year. It is believed that debris that might be classified as standing dead or beached during a low-flow period like 2003 may have become submerged or floating debris during a high-water period like 2008.

Future debris conditions without the Project are expected to remain similar to existing conditions; specifically, most of the shorelines would have either no debris or low-density debris that is sparsely distributed. Areas of dense debris would remain few and localized. Beached, floating, standing dead and leaning trees would remain the dominant types of debris.

6.2.3.3 AQUATIC ENVIRONMENT

6.2.3.3.1 INTRODUCTION

The aquatic environment of the Nelson River where the Project will be constructed has been substantially altered by hydroelectric developments, in particular the Churchill River Diversion (CRD) and Lake Winnipeg Regulation (LWR), and the construction of the Kettle GS. Effects of the Project will be super-imposed on this disrupted environment.

Project effects will arise as a result of changes to the physical environment, as well as due to the presence of the generating station (GS) and associated structures. An ecosystem-based approach was used to conduct the environmental assessment (AE SV Section 1.2). This approach recognizes that the aquatic environment is a complex system. Key points recognized in this approach are: that different levels of the ecosystem should be assessed; that changes in one component can directly and/or indirectly affect other components; that the spatial scale of effects and scales at which specific components use the environment must be considered; and that the system is subject to considerable temporal variation (*i.e.*, seasonally, between years, and in the long-term).

The following components of the aquatic ecosystem were studied and provide the basis for evaluating effects to VECs:

- Water quality is of fundamental importance to the aquatic ecosystem, as it determines the suitability of the environment for aquatic biota. Variables measured as part of water quality include dissolved oxygen (DO), organic carbon (OC) and inorganic nutrients, which are measures of the major cycles within the ecosystem.

- Aquatic habitat provides the environment in which aquatic organisms live. For aquatic organisms, the structure of the habitat is provided by water depth and velocity, bottom type, and the presence or absence of cover (*e.g.*, aquatic vegetation, terrestrial debris, and riparian vegetation).

- Aquatic plants and algae are the primary producers within the ecosystem. These groups use energy from the sun to create both oxygen and OC, which is consumed either directly by herbivores or, after death, enters the detrital food web.

- Aquatic invertebrates comprise herbivores, detritivores and predators. This assessment considered zooplankton and benthic macroinvertebrates, which form an important part of the aquatic food web.

- Fish form an important part of the aquatic ecosystem as they occupy many different trophic levels and a range of habitats in the aquatic ecosystem.

As discussed in Chapter 5, VECs were selected to focus the assessment and prediction of Project effects. The rationale for the selection of the five aquatic VECs is provided in the text and tables of AE SV Section 1.2, and is briefly summarized as follows:

- Water quality – is a major pathway by which Project effects are linked to other portions of the aquatic ecosystem. The KCNs and Manitoba Hydro recognize water for its importance to all living things, and changes to water quality are subject to regulatory guidelines and restrictions. Water quality affects the suitability of the aquatic environment to support life, and variables are indicative of many of the major pathways of energy and nutrient transfer within the ecosystem.

- Lake whitefish – are negatively affected by hydroelectric development due to environmental changes such as sedimentation in spawning areas and overwinter drawdowns in reservoirs. This species is important to the KCNs for domestic use, is harvested commercially, and, due to its sensitivity to adverse environmental conditions (*e.g.*, water quality), position in the mid-level of the food web, and use of open water lacustrine habitats, provides a good indicator of conditions in this portion of the ecosystem. As with other fish species, lake whitefish and their habitat are protected under the federal *Fisheries Act*.

- Northern pike (locally known as jackfish) – are sensitive to changes in littoral habitats and small tributary streams, which are the environments most vulnerable to effects of hydroelectric operations (*e.g.*, water level fluctuations). This species is harvested in domestic and recreational fisheries. As a top level predator utilizing nearshore, vegetated habitats, changes to northern pike can be indicative of productivity of the littoral environment.

- Walleye (locally known as pickerel) – use a variety of habitats that will be substantially altered by the Project. This species is harvested in domestic, commercial, and recreational fisheries. As a top-level predator using both nearshore and offshore habitats, it provides a general indication of the condition of the aquatic ecosystem.
- Lake sturgeon – are particularly vulnerable to effects of hydroelectric development as a result of their low population numbers and specific habitat requirements. They are culturally and spiritually important to the KCNs and as domestic harvest. They have special status as a heritage species in Manitoba, are designated as endangered under the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), and are being considered for protection under the federal *Species at Risk Act* (SARA). Lake sturgeon is one of the species of greatest concern for the Project and, as such, has been the focus of considerable study and mitigation. Effects to lake sturgeon may also be indicative of effects to other species dependent on riverine environments.

The use of ATK and technical analysis in the environmental assessment are discussed in Chapter 5. Methods and general conclusions related to the ATK-based worldview are provided in Chapter 2, and a description of the existing environment based on the holistic approach of ATK is provided in Section 6.2.3.1.

This section provides a description of the existing aquatic environment based on the technical studies, and with local knowledge from resource users and others, as referenced in the CNP Keeyask Environmental Evaluation Report, YFFN Evaluation Report (*Kipekiskwaywinan)*, FLCN Environment Evaluation Report (Draft) and other supporting materials. A detailed description of the methods and results of the technical data collection programs is provided in the AE SV. Other technical studies used to describe the existing environment and predict Project effects are listed in AE SV Section 1.5.

The existing environment includes historic conditions, in particular as they relate to the current condition of the environmental component of interest. Current conditions are generally described for the period of 1997–2006, based on work done under various technical programs, in particular field studies for this assessment that were initiated in 1999. Additional information was collected after 2006 where analysis indicated data gaps, in particular in relation to lake sturgeon. An analysis of on-going change has also been conducted to determine whether there are clear trends that could continue into the future and markedly change baseline conditions as they exist today.

The Aquatic Environment Study Area includes the reach of the Nelson River from downstream of the Kelsey GS to the Kettle GS, as well as waterbodies immediately adjacent to the Nelson River (Map 6-18). Environmental studies were focused on the reach of the river from approximately 3 km (1.9 miles) downstream of the outlet of Clark Lake to the inlet of Stephens Lake approximately 3 km (1.9 miles) downstream of Gull Rapids, within which direct changes to water levels and flows are expected (Chapter 4). Studies were also conducted upstream of this reach in Split Lake and adjacent waterbodies because fish may move between this area and the area directly altered by the Project. Additionally, Stephens Lake was studied because fish in Stephens Lake use aquatic habitat within the river reach up to Gull Rapids, and a few may move upstream into the habitat above Gull Rapids. The Split Lake, Clark Lake to Stephens Lake, and Stephens Lake reaches each comprise individual local study areas, and together form the regional study area. Sample collection for the water quality component extended downstream to the mouth of the Nelson River to address concerns that inputs to the water at the Project site could be carried downstream (Map 6-19).

Infrastructure associated with the Project, such as the north and south access roads and borrow areas, will affect several small streams and ponds. Existing conditions and Project effects to these waterbodies are discussed in the AE SV. In addition, the AEAs (Section 4.8) will result in increased harvest of fish in off-system lakes and rivers. The effects of harvest on fish populations are described within the domestic fishing analysis (Section 6.7.3.1).

6.2.3.3.2 AQUATIC ECOSYSTEMS

The aquatic ecosystem of the study area is in many ways typical of that which is found in northern boreal environments in Canada. Hydroelectric development has imposed an artificial regime of water levels and flows that, on average, varies little over the year and that is markedly different from a natural cycle of higher water levels in spring and summer and lowest levels in winter. Stephens Lake, located immediately downstream of the Project, is the reservoir of the Kettle GS and was created by the flooding of a section of the Nelson River mainstem, several lakes, and considerable terrestrial area. The Kelsey GS, on the Nelson River upstream of Split Lake, forms the upstream boundary of the study area. Despite these anthropogenic changes, many of the other components of the aquatic ecosystem are similar to undisturbed off-system waterbodies.

WATER QUALITY

Data collection methods for water quality are provided in AE SV Section 2.2 and a detailed description of the existing environment is provided in AE SV Section 2.3. Sediment quality is typically considered in conjunction with water quality and is described in AE SV Section 2.6, but is not considered further in this document. Map 6-19 provides the locations of place names and sampling sites referred to in this section.

Specific observations with respect to changing water quality have been noted by KCNs Members since the completion of the Kelsey GS in 1961, followed by the CRD/LWR which became operational in 1977 (Split Lake Cree – Manitoba Hydro Joint Study Group 1996c; FLCN 2009 Draft; YFFN Evaluation Report [*Kipekiskwaywinan*]). Historically, FLCN Members took their drinking water directly from the Nelson River, but the colour and clarity of the water changed and its quality declined following construction of the Kelsey GS, and continued to decline after each successive dam was built (FLCN 2008 Draft; FLCN Environment Evaluation Report (Draft)). Today, water throughout the system, including Stephens Lake (the reservoir of the Kettle GS), is stated to be murky and undrinkable (FLCN 2008 Draft; YFFN Evaluation Report [*Kipekiskwaywinan*]; FLCN Environment Evaluation Report (Draft)). KCNs Members who have observed that water upstream of beaver dams becomes stagnant and undrinkable suggest that water retained within reservoirs undergoes similar declines in water quality (CNP, YFFN, and FLCN 2011). No technical studies were conducted prior to construction of the Kelsey GS. Techncial studies conducted prior to and after CRD/LWR reported various changes in water quality, the long-term effect being associated with the greater inflow of softer, more turbid water from the Burntwood system (see AE SV Section 2.3 for more details).

Water quality conditions were measured during field studies conducted from Split Lake to the Nelson River estuary from 1999–2006 (Map 6-19). Overall, water in the mainstem of the regional study area (*e.g.*, along the main flow of the Nelson River to the estuary) is moderately nutrient-rich, well-oxygenated, moderately soft to hard, and has a slightly alkaline pH (additional details contained in text and tables of AE SV Section 2.4). Alkalinity, largely comprised of the bicarbonate ion, is moderate, as is typical of Canadian surface waters (Canadian Council of Resource and Environment Ministers [CCREM] 1987). On the basis of alkalinity and pH, the area would be considered “least sensitive” to acidification and most sites would also be classified as of “least sensitivity” on the basis of calcium concentrations. On the basis of total dissolved solids (TDS), the sensitivity to acidification ranges from “least” to “moderate”.

Water quality is relatively similar across the mainstem in the study area. However, water quality in Split Lake varies spatially according to the locations of tributary inflows, as the quality of water varies between the three main tributaries (the Burntwood, Nelson, and Aiken rivers). The Burntwood River near the inlet to Split Lake (which includes inflow from the Churchill River upstream) is typically more turbid, softer, contains higher concentrations of total suspended solids (TSS) and lower fractions of phosphorus in dissolved form, and is characterized by lower alkalinity, total Kjeldahl nitrogen (TSN), and TDS/specific conductance than either the Nelson or Aiken rivers. The Nelson River, where it enters Split Lake, has a higher alkalinity and specific conductance/TDS, and is harder than the Burntwood or Aiken rivers. The Aiken River is more coloured, has a lower pH, is clearer, has lower concentrations of total phosphorus (TP), and contains higher concentrations of OC and total Kjeldahl nitrogen than the Burntwood or Nelson rivers.

Local First Nation Members report that water quality near York Landing is poorest in late winter and early spring, but many residents state that their drinking water is not suitable for consumption year-round due to colour and taste/smell. At times the colour of the water is so pronounced that it changes the colour of their laundry (YFFN and HTFC 2004a, 2004b; YFFN Evaluation Report [*Kipekiskwaywinan*]). Residents have observed that water quality is getting worse each year with the dams (YFFN Evaluation Report [*Kipekiskwaywinan*]), and that turbidity has increased in Split Lake in the post-2005 period (CNP 2010c).

Water quality in Stephens Lake also varies spatially. Conditions in the southern area of Stephens Lake resemble those observed in the main flow of the Nelson River upstream and downstream of the lake. This area is generally more nutrient-rich, more turbid, does not stratify and is more oxygenated over winter than the north arm of the lake. Like turbidity, TSS concentrations in the southern area of the lake decrease from west to east (PE SV Section 7.3). The north arm can stratify in winter and in summer under atypically low wind conditions. DO is lower in the north arm in winter, most notably at depth and in flooded backbays. Temporary depletion of DO at depth can also occur when transient thermal stratification occurs in backbays under low wind conditions. Changes in some water quality conditions are also evident in the Nelson River from Stephens Lake to the estuary. Specifically, TSS and turbidity decrease along the flow of the Nelson River downstream of Stephens Lake, increasing again at the lower end of the Nelson River (downstream of the Angling River). A similar trend is observed for TP, which is not unexpected because TP is correlated to TSS. Other routine variables are generally similar along the length of the lower Nelson River.

Concentrations of ammonia and nitrate were consistently within the Manitoba Water Quality Standards, Objectives and Guidelines (MWQSOGs) for the protection of aquatic life (PAL) during the studies conducted from 1999–2006. The pH (laboratory and *in situ* measurements) was also within the Manitoba guideline for PAL (6.5–9) at all sites and times. In general, TP concentrations at lake sites exceeded the MWQSOG of 0.025 milligrams per litre (mg/L) for lakes, whereas mainstem sites and tributaries to the Nelson River were typically below the MWQSOG of 0.050 mg/L for rivers and streams.

Along the mainstem of the Nelson River, DO was consistently within water quality objectives for PAL in the open water and ice-cover seasons. Conversely, water quality objectives were not always met at some sites located off the main flow of the Nelson River. Specifically, several sites in the north arm of Stephens Lake and some sites in the vicinity of York Landing exhibited low DO in winter either across depth or at depth *(e.g.,* near the sediment-water interface). Data collected in summer 2008 also indicated DO objectives may not be met near the sediment-water interface in isolated backbays in Stephens Lake during periods of atypically low wind and subsequent transient stratification (Section 6.2.3.2).

On the basis of TP, the mainstem would be classified as mesoeutrophic to eutrophic, using the Canadian Council of Ministers of the Environment (CCME) phosphorus guidance framework (CCME 1999; updated to 2012). However, application of trophic categorizations suggested in the scientific literature indicates that on the basis of chlorophyll *a*, the mainstem lakes would be considered mesotrophic. The differences in classification based on TP and chlorophyll *a* suggest that factors other than phosphorus *(e.g.,* light) limit algal growth in the area and/or that the bioavailability of phosphorus may be limited. Concentrations of total nitrogen and TP in the mainstem of the Nelson River are in the lower range of concentrations measured in other streams and rivers in Manitoba.

Of the 34 metals and metalloids analysed, only beryllium was never detected in surface water samples. Several trace elements were either infrequently detected (*e.g.*, less than 10% of samples) or typically present in very low concentrations (*e.g.*, at or near the analytical detection limit), including: antimony; bismuth; cadmium; caesium; lithium; mercury; selenium; tellurium; and thallium.

Most metals were consistently below MWQSOGs for PAL (Manitoba Water Stewardship [MWS] 2011a), including: arsenic; boron; cadmium; chromium; lead; molybdenum; nickel; thallium; uranium; and zinc. Several trace elements occasionally exceeded MWQSOGs for the PAL including: copper; mercury; selenium; and silver. Aluminum and iron exceeded PAL guidelines in the majority of samples collected, but such elevated levels have been observed at many locations in northern Manitoba and elsewhere in western Canada (AE SV Section 2.4).

Total mercury (organic and inorganic) was occasionally detected and, when detected, the concentrations exceeded the current guideline for inorganic mercury.[1] Thirteen percent of samples collected along the Nelson River system in the open water season contained detectable concentrations of mercury. However, most of these measurements were less than twice the analytical detection limit and therefore there is a high level of uncertainty associated with them. All measurements of total and methylmercury (organic) made at the Limestone GS from 2003 to 2007 reported by Kirk and St. Louis (2009) were well below the current MWQSOGs for PAL.

Fecal coliform bacteria were detected at relatively low concentrations (less than or equal to 40 coliform forming units per 100 millilitres) in less than half of the water samples collected over the course of the sampling programs and were below the Manitoba water quality guideline for recreation (200 coliform forming units per 100 millilitres).

A comparative evaluation of water quality during 1987–2006 was undertaken to determine if conditions have been undergoing recent change that could in turn affect the impact predictions and/or descriptions of the existing environment based on the period of baseline studies (see details in AE SV Section 2.4.). Overall, the trend analysis indicates that water quality may vary in the future in relation to discharges, in particular the relative contribution of flow from the Nelson River versus the Burntwood River, and that TSS and turbidity may be increasing over time, at least in Split Lake. Water quality has been generally stable along the mainstem of the Nelson River over the last several decades and conditions appear to have been stable in the north arm of Stephens Lake since the 1980s. The occurrence of water quality PAL guideline exceedances has been consistent over the last

[1] The guideline was revised in July 2011 to a lower concentration. The mercury analyses completed prior to this date used an analytical method for which the detection limit was too high to assess compliance with the revised guideline.

20 years, indicating that water quality has not notably changed in terms of its suitability to support aquatic life. Therefore, water quality has been relatively stable over the last several decades, although year-to-year changes may occur in relation to changes in the discharge of the Nelson and Burntwood rivers. This pattern of variability is expected to continue to the future. The potential effect of climate change is considered separately as described in Section 6.4.9.

AQUATIC HABITAT

The term aquatic habitat is used to describe the structure of the environment within which fish and other aquatic biota live. Typically, aquatic habitat is classified based on four components: water depth; velocity; substrate type; and cover (*e.g.*, the presence of aquatic plants, debris and riparian vegetation).

Aquatic habitat is intrinsically linked to water levels and flows (Section 6.2.3.2.6), and the processes of erosion (Section 6.2.3.2.7) and sediment deposition (Section 6.2.3.2.8). Variations in seasonal phenomena such as ice formation and ice scour (Section 6.2.3.2.6) can also alter the suitability of existing habitat.

A more detailed description of aquatic habitat in the existing environment is provided in AE SV Section 3.3, and data collection methods for the components of aquatic habitat are provided in AE SV Section 3.2.

The Nelson River mainstem has been altered for more than 50 years by the regulation of flows for hydroelectric generation (Section 6.2.2). During this period, several changes to aquatic habitat have been observed by local Cree Nation Members. Beginning with CRD/LWR, seasonal flows and water levels changed such that high flows generally occur in the winter instead of the spring (CNP Keeyask Environmental Evaluation Report; FLCN Environment Evaluation Report (Draft)), and flooding has created some islands while destroying others (FLCN Environment Evaluation Report (Draft)). A visible reduction in the beaches on Split Lake has occurred (YFFN Evaluation Report [*Kipekiskwaywinan*]), shoreline erosion has been observed on Split, Clark, Gull and Stephens lakes (Split Lake Cree – Manitoba Hydro Joint Study Group 1996c; YFFN Evaluation Report [*Kipekiskwaywinan*]; FLCN Environment Evaluation Report (Draft)), and increased levels of sedimentation have been reported in Split, Clark, and Gull lakes (Split Lake Cree – Manitoba Hydro Joint Study Group 1996c). Finally, an increased amount of debris has been noted in the water and in fishing nets (Split Lake Cree – Manitoba Hydro Joint Study Group 1996a; FLCN 2008 Draft; CNP Keeyask Environmental Evaluation Report; YFFN Evaluation Report [*Kipekiskwaywinan*]; FLCN Environment Evaluation Report (Draft); SE SV), and deadheads and logs have settled on lake and river bottoms, further changing the nature of the bottom type (FLCN 2010 Draft).

The reach of the Nelson River between the Kelsey GS and the Kettle GS can be described as a series of inter-connected riverine and lacustrine reaches (Map 6-18) that each contain both lotic (water flowing at 0.2 metres per second [m/s] or greater) and lentic (standing water with a velocity of less than 0.2 m/s) aquatic habitats. Four large lakes, including Split, Clark, Gull and Stephens are found in this reach. The total area of large river and lake habitat in this reach is 65,322 ha; the upstream boundaries occur at barriers resulting from First Rapids on the Burntwood River and the Kelsey GS on the Nelson River, and the downstream boundary is the Kettle GS at the outlet of Stephens Lake.

Split Lake is a large waterbody that contains a wide array of aquatic habitats. At numerous locations within the lake, water depth exceeds 10 m (33 feet). Detectable water velocities can be found at the west end of the lake where the Nelson and Burntwood rivers enter the lake, and at the east end of the lake where the river flows into Clark Lake. Clark Lake is located immediately downstream of Split Lake and is approximately 6 km (3.7 miles) long. Both Split and Clark lakes contain off-current bays that support large aquatic macrophyte beds. The effect of continued sedimentation on these macrophyte beds is of concern to TCN Members (Whitaker, *pers. comm.* 2012b).

The reach of the Nelson River that will form the Keeyask reservoir *(i.e.,* from downstream of Clark Lake to Gull Rapids) contains a diversity of aquatic habitats. Immediately downstream of Clark Lake is Long Rapids which is approximately 3 km (1.9 miles) in length, fairly shallow (Map 6-8), fast-flowing (Map 6-9), and turbulent (AE SV Section 3.3). The substrate is largely bedrock, large cobbles and boulders (Map 6-14). From the downstream end of Long Rapids to the upstream end of Birthday Rapids, the river widens and deepens, and water velocities are moderate (0.5–1.5 m/s [1.6–4.9 feet/s]). Substrate continues to be predominantly cobble/boulder.

Birthday Rapids, situated approximately 10 km (6.2 miles) downstream of Clark Lake, is a constriction in the Nelson River that is characterized by a short, steep drop of about 2 m (6.6 ft.) (Map 6-7, AE SV Section 3.3). The next 12 km (7.5 miles) of the Nelson River downstream of Birthday Rapids is characterized by a relatively uniform mainstem channel with moderate to high water velocity (0.5 to greater than 1.5 m/s [1.6 to greater than 4.9 feet/s]) and bedrock, boulder and cobble substrates (Map 6-8, Map 6-9 and Map 6-14). There are a few large bays located off the mainstem channel with fine sediments that support rooted aquatic (Map 6-20). Several small tributaries, most of which are ephemeral, enter the Nelson River in this reach.

Gull Lake is located approximately 22 km (17 miles) downstream of Clark Lake. This section of the Nelson River is approximately 15 km (9 miles) long and is comprised of three distinct basins with numerous islands and embayments. Both lotic and lentic habitat characteristics are common in Gull Lake. Lotic habitat is located in the main channel where water depths often exceed 10 m (33 feet), water velocities measure 0.2–0.5 m/s (0.7–1.6 feet/s) and bedrock, boulder, and cobble substrates predominate (Map 6-8, Map 6-9 and Map 6-14). Lentic habitats are found in off-current areas where water depths typically range between 0–5 m (0–16.4 feet), and fine sediments predominate. Aquatic vegetation is also common in the lentic habitats where water depths are less than 3 m (9.8 feet); however, the presence, abundance and distribution of aquatic plants is strongly influenced by water levels and therefore, varies among years.

Gull Rapids is located at the downstream end of Gull Lake and is approximately 2 km (1.2 miles) long. Gull Rapids is the largest set of rapids in the Clark Lake to Stephens Lake area, with a drop of approximately 11 m (36 feet) across its 2 km (1.2 miles) length (Map 6-7, AE SV Section 3.3). There are several islands and channels located in Gull Rapids. The substrate is comprised of bedrock and boulders. A very small tributary (Gull Rapids Creek) enters the river within the rapids. Just below the rapids is a short uniform section of river channel that leads into Stephens Lake.

Present day Stephens Lake is a large reservoir formed in 1970 by construction of the Kettle GS. Water depths in the old Nelson River channel are often greater than 20 m (65 feet) and water depths greater than 40 m (131 feet) can be found immediately upstream of the Kettle GS. With the exception of the 4 km (2.5 miles) long reach of Nelson River immediately downstream of Gull Rapids, the habitat is lentic with a predominantly soft, silt substrate. Additional information on habitat in Stephens Lake, including maps, can be found in AE SV Section 3.3. Lotic habitat remains in the 4 km (2.5 miles) long reach immediately downstream of the rapids where in the thalweg depths exceed 15 m (49 feet), water velocities are low (0.2–0.5 m/s [0.7–1.6 feet/s]) to moderate (0.5–1.5 m/s [1.6–4.9 feet/s]) and substrates are composed of bedrock, boulder, cobble and gravel. Several tributaries, including the South Moswakot and North Moswakot rivers, enter into the north arm of Stephens Lake.

Apart from the effect of inter-annual variations in flow, aquatic habitat has been relatively stable over the recent past, given that analyses of the water regime and sedimentation (Section 6.2.3.2.6 and Section 6.2.3.2.8) do not identify any pronounced trends. However, the formation of large ice dams at Gull Rapids has created and would continue to create new channels, due to water level staging and redirection of flows, and may cause changes to the river bottom such as the movement of substrate (*e.g.*, boulders) (Section 6.2.3.2.8). The potential effects of climate change were considered separately as described in Section 6.4.9.

6.2.3.3.3 ALGAE AND AQUATIC PLANTS

The methodology for the collection of information on phytoplankton (microscopic algae in the water column), aquatic plants and periphyton (attached algae) is presented in AE SV Section 2.3 and Section 4.2. A detailed description of the existing environment and available historic information for algal and plant communities is provided in AE SV Section 4.2.

A list of all phytoplankton species identified is provided in the AE SV Section 4.2. None of the identified species are listed as invasive on the Invasive Species Council of Manitoba website (ISCM 2012a).

Phytoplankton biomass was at the lower end (oligotrophic to mesotrophic) of the general range reported for temperate zone waterbodies (AE SV Section 4.2). TCN Members indicated that the effects of hydroelectric development included more common occurrences of algae in the Burntwood River and Split, Clark and Gull lakes (EE Hobbs and Associates Ltd. 1993 in Split Lake Cree – Manitoba Hydro Joint Study Group 1996c; SE SV), and Members of FLCN have observed increased amounts of algae in their nets, which hinders their fishing catch (FLCN 2008 Draft).

A list of all vascular aquatic plant species identified is provided in the AE SV Section 4.3. No species are listed on Schedule 1 of SARA and none have been assessed as "at risk" by COSEWIC. The Manitoba Conservation Data Centre lists *Nymphaea tetragona* as an S2 species (rare in province, maybe vulnerable to extirpation) in the Churchill River Upland ecoregion, but its distribution does not extend into the area directly affected by the Project (Manitoba Conservation Data Centre 2012a; Manitoba Conservation Data Centre 2012b). None of the identified species is listed as invasive on the Invasive Species Council of Manitoba website (ISCM 2012a). The status of emergent species is discussed within the terrestrial analysis (Section 6.2.3.4.3).

In Split, Gull and Stephens lakes, aquatic plants were most common in bays and channels between islands that are shallow (generally less than 2 m [6.5 feet] water depth), with standing water and soft, mineral-based sediments. Pondweeds were typically the most common plants observed.

In the Nelson River mainstem, aquatic plants were restricted to the shallow margins of tributary mouths and to a few small bays (Map 6-20). The majority of aquatic plant growth was typically within the backwater inlets with reduced water velocities, relatively shallow water depths, and soft, mineral-based bottom sediments. Aquatic plants were most abundant in the intermittently exposed zone of the backwater inlets. The plant community in this type of habitat was dominated by northern water milfoil (*Myriophyllum sibiricum*). In shallow water habitat that was predominantly wetted, the community was dominated by pondweeds, particularly *Potamogeton* spp.

6.2.3.3.4 AQUATIC INVERTEBRATES

The methodology for the collection of information on zooplankton and aquatic benthic macroinvertebrates is presented in AE SV Section 4.4 and Section 4.5, respectively. A detailed description of the existing environment and historic conditions for aquatic invertebrate communities is provided in AE SV Section 4.

A list of all zooplankton species identified is provided in the AE SV Section 4.4. None of the identified species are listed as invasive on the Invasive Species Council of Manitoba website (ISCM 2012a).

Zooplankton abundance was higher at standing-water sites (secluded bays relatively isolated from the flow in the Nelson River) than at flowing-water sites (mainstem) (AE SV Section 4.4). Mean zooplankton abundance was highest in Assean Lake, a waterbody not influenced by the Nelson River, followed by Split, Clark, Gull and Stephens lakes.

Copepods were more abundant than cladocerans in the spring and dominated the community. In early summer, cladoceran densities tended to increase and they often predominated throughout the remainder of the open water season.

A list of all benthic invertebrate species identified is provided in the AE SV Section 4.5. No species are listed on Schedule 1 of SARA and none have been assessed as “at risk” by COSEWIC. The Manitoba Conservation Data Centre does not list any S1 or S2 species for the area (Manitoba Conservation Data Centre 2012a; Manitoba Conservation Data Centre 2012b). None of the species identified is listed as invasive on the Invasive Species Council of Manitoba website (ISCM 2012a).

Common benthic macroinvertebrates include bivalves (clams), aquatic insect larvae, and oligochaetes (aquatic earthworms). Elders from TCN have stated that they have noticed a decrease in the number of mayflies since the implementation of CRD/LWR and that aquatic insects are emerging earlier, possibly due to climate change (Split Lake Cree – Manitoba Hydro Joint Study Group 1996c).

Abundances of benthic invertebrates were within the range observed for waterbodies along the Churchill and Rat/Burntwood river systems (AE SV Section 4.5). With the exception of Split Lake, shallow water habitats supported a higher mean abundance of benthic macroinvertebrates than deep water ones. Shallow areas with aquatic plants typically contained a greater abundance of benthic macroinvertebrates compared to areas devoid of vegetation. Chironomids (non-biting midges), aquatic earthworms and amphipods (scuds/water lice) were commonly associated with sediments and plants.

6.2.3.3.5 Fish

A detailed description of the existing environment for the fish community, with emphasis on the VEC species, walleye, northern pike and lake whitefish, is provided in AE SV Section 5.3. Lake sturgeon are described in the AE SV Section 6.3. Methods for data collection for the fish community and lake sturgeon are provided in the AE SV Section 5.2 and Section 5.3, respectively.

A total of 37 fish species was captured during environmental surveys conducted post-1997 (Table 6-3). No species are listed on Schedule 1 of SARA, but lake sturgeon in the Nelson River have been assessed as endangered by COSEWIC and are currently being assessed for listing under SARA. The Manitoba Conservation Data Centre does not list any S1 or S2 species for the area (Manitoba Conservation Data Centre 2012a; Manitoba Conservation Data Centre 2012b). The Invasive Species Council of Manitoba website (ISCM 2012a) lists common carp and rainbow smelt as invasive species.

Table 6-3: Fish Species Captured in the Keeyask Study Area (1997–2008)

Species	Scientific Name
Blacknose dace	*Rhinichthys atratulus*
Blacknose shiner	*Notropis heterolepis*
Brook stickleback	*Culaea inconstans*
Burbot (maria)	*Lota lota*
Common carp (carp)	*Cyprinus carpio*
Cisco	*Coregonus artedi*
Emerald shiner	*Notropis atherinoides*
Fathead minnow	*Pimephales promelas*
Finescale dace	*Phoxinus neogaeus*
Freshwater drum	*Aplodinotus grunniens*
Goldeye	*Hiodon alosoides*
Iowa darter	*Etheostoma exile*
Johnny darter	*Etheostoma nigrum*
Lake chub	*Couesius plumbeus*
Lake sturgeon	*Acipenser fulvescens*
Lake whitefish (whitefish)	*Coregonus clupeaformis*
Logperch	*Percina caprodes*
Longnose dace	*Rhinichthys cataractae*
Longnose sucker (red sucker)	*Catostomus catostomus*
Mooneye	*Hiodon tergisus*
Mottled sculpin	*Cottus bairdii*
Ninespine stickleback	*Pungitius pungitius*
Northern pearl dace	*Margariscus nachtriebi*
Northern pike (jackfish)	*Esox lucius*
Northern redbelly dace	*Phoxinus eos*
Rainbow smelt (smelt)	*Osmerus mordax*
River darter	*Percina shumardi*
Sauger	*Sander canadensis*
Shortheadredhorse	*Moxostoma macrolepidotum*

Table 6-3: Fish Species Captured in the Keeyask Study Area (1997–2008)

Species	Scientific Name
Silver lamprey	*Ichthyomyzon unicuspis*
Slimy sculpin	*Cottus cognatus*
Spoonhead sculpin	*Cottus ricei*
Spottail shiner	*Notropis hudsonius*
Trout-perch	*Percopsis omiscomaycus*
Walleye (pickerel)	*Sander vitreus*
White sucker (mullet)	*Catostomus commersonii*
Yellow perch (perch)	*Perca flavescens*

WALLEYE, NORTHERN PIKE, LAKE WHITEFISH AND OTHER SCALE FISH

The fish community has been affected by previous hydroelectric developments, including the construction and operation of the Kelsey GS, the Kettle GS and CRD/LWR (Section 6.2.2). An increase in walleye populations in Split Lake during the early 1970s was attributed to a reduction in fishing pressure resulting from the 1971 closure of the Split Lake commercial fishery for walleye and northern pike due to elevated mercury concentrations (unrelated to hydroelectric development; Ayles *et al.* 1974). Operation of the CRD has been linked to a reduction in walleye and an increase in sauger in Split Lake from 1973 to 1980 (Split Lake Cree – Manitoba Hydro Joint Study Group 1996c). FLCN Members reported that prior to construction of the Kettle GS, Gull Rapids was a good location to harvest walleye and lake whitefish (FLCN Environment Evaluation Report (Draft)). In Stephens Lake, construction of the Kettle GS combined with the CRD are thought to have disturbed fish migration patterns and to have resulted in an increase in sucker populations (Split Lake Cree – Manitoba Hydro Joint Study Group 1996c). Members of TCN and YFFN reported that hydroelectric development has resulted in fewer fish in Split and Clark lakes (except for sucker) and the Burntwood and Aiken rivers (Split Lake Cree – Manitoba Hydro Joint Study Group 1996c; YFFN Evaluation Report [*Kipekiskwaywinan*]). YFFN Members also noted a general decline in mooneye populations (YFFN and HTFC 2002).

For most waterbodies, the most common large-bodied species are northern pike, walleye and white sucker. Rainbow smelt, an invasive species, were first reported in Split and Stephens lakes in 1996 and is now among the most abundant small-bodied species. Other common small-bodied species include spottail shiner, trout-perch, and emerald shiner.

The catch-per-unit-effort (CPUE) of experimental gillnet gangs set in Gull and Stephens lakes is comparable, but about a third lower than at Split and Clark lakes (Table 6-4). Walleye and lake whitefish were about twice as abundant in Gull Lake compared to the Nelson River mainstem. Experimental gangs set in the north arm of Stephens Lake caught about twice as many fish compared to nets set in the southern part of the lake. Lake whitefish and walleye are particularly abundant in the north arm. Compared to other study area lakes, Assean Lake has a considerably higher CPUE and a substantially different fish community composition. In particular, lake whitefish and cisco are prevalent and rainbow smelt are absent from the lake. The CPUE in the study area lakes falls within the range observed in other waterbodies along the Burntwood and Nelson River systems.

Table 6-4: Comparison of Mean Catch-Per-Unit-Effort (Number of Fish per 100 m of Net per 24 Hours) for Large-bodied Fish in Selected Northern Manitoba Waterbodies

Waterbody	Study Year	Lake Whitefish	Northern Pike	Walleye	Total Catch
STUDY AREA					
Split Lake	1997–2002	1.9	6.0	9.9	35.0
Clark Lake	1997–2004	1.4	9.6	6.2	31.8
Assean Lake	2001–2002	10.3	7.9	26.9	57.7
Nelson River	2001–2002	0.7	9.4	3.1	19.7
Gull Lake	2001–2002	1.8	8.7	6.3	24.8
Stephens Lake	2002–2003	1.8	7.9	7.9	23.5
OTHER					
Notigi Lake	1999–2001	1.0	3.9	3.5	18.4
Leftrook Lake	1999–2001	10.6	14.3	40.6	112.8
Wuskwatim Lake	1998–2002	4.1	4.4	11.4	68.1
Cross Lake:					
East Basin	1992–2006	1.9	16.0	14.7	54.7
West Basin	1992–2006	1.1	10.3	10.9	50.1
Limestone Reservoir	1992–2003	0.8	1.9	2.1	17.9

Domestic fishing occurs throughout the area, although KCNs Members have indicated that they prefer to harvest in waters other than those along the Nelson River. Members reported greater numbers of fish with external lesions and growths and an increase in parasites following northern hydroelectric development (Split Lake Cree – Manitoba Hydro Joint Study Group 1996a, 1996c; YFFN and HTFC 2002; FLCN 2010 Draft; YFFN Evaluation Report [*Kipekiskwaywinan*]; FLCN Environment Evaluation Report (Draft)).

Split Lake is commercially fished and TCN Members stated that fishing on Split Lake has become increasingly difficult due to high water levels and debris that fouls the nets (Split Lake Cree – Manitoba Hydro Joint Study Group 1996c). A walleye fishery operates under special permit on Stephens Lake (Section 6.2.3.6). Recreational fishing occurs in locations that are easily accessible by boat or road *(e.g.*, on Stephens Lake by the Gillam marina, North and South Moswakot rivers by the highway).

Mark-recapture studies (Photo 6-10) have shown that there is substantial movement of the VEC species within, but little movement among, the local study areas *(i.e.*, Split Lake and its tributaries, the Nelson River between Clark Lake and Gull Rapids, and Stephens Lake and its tributaries). All three species are capable of moving upstream and downstream over the major rapids *(e.g.*, Long, Birthday, and Gull rapids) (Map 6-18), but the incidence of such movements is low. Fish from Gull Lake do not appear to migrate downstream to access spawning habitat in Gull Rapids. Likewise, the studies did not record spring or fall spawning migrations of fish moving from Gull Lake to Split Lake, or from Stephens Lake to Gull Lake.

Source: North/South Consultants Inc., 2009.

Photo 6-10: Walleye with a Floy®-Tag Inserted Below its Dorsal Fin during Mark-Recapture Studies

Habitat use in the existing Nelson River environment upstream of the Keeyask GS by different life stages of VEC species is illustrated in Map 6-21, Map 6-22 and Map 6-23.

The Aiken and Assean river systems and First Rapids on the Burntwood River provide important spawning habitat for walleye and lake whitefish in the Split Lake area. Birthday Rapids and the constriction at Morris Point are important spawning areas for walleye and lake whitefish in the Nelson River between Clark Lake and Gull Rapids. Walleye also spawn in off-current areas in this reach, wherever suitable substrate is located. Northern pike spawn in small tributaries and in off-current bays along the shore of Gull Lake. Gull Rapids is an important spawning area for the VEC species, as well as numerous other fish species inhabiting Stephens Lake. Resource users and Elders from the KCNs have highlighted the importance of Gull Rapids as spawning habitat (FLCN 2010 Draft; CNP Keeyask Environmental Evaluation Report; FLCN Environment Evaluation Report (Draft)). Within Stephens Lake, FLCN resource users report that walleye and lake whitefish (a fall-spawning species) likely spawn in Ferris Bay and lake whitefish may also spawn along reefs and islands throughout the lake (FLCN 2010 Draft). Spawning northern pike and walleye have been observed in Looking Back Creek and all three VECs are thought to use the North and South Moswakot rivers for spawning (FLCN Environment Evaluation Report (Draft)).

The VEC species differ in their use of foraging habitat. Walleye were captured foraging in both nearshore and offshore habitat in study area lakes. They were also frequently captured in riverine habitat below Gull Rapids. Northern pike generally showed a preference for foraging habitat characterized by shallow, low velocity water with structure (woody debris, aquatic plants). Lake whitefish were more abundant in deep, open waters; they were rarely captured in riverine habitat. In Stephens Lake, all three species were more abundant in the north arm of the lake compared to the southern portion.

Fish use low water velocity areas in off-current bays for overwintering. During winter, walleye and northern pike were frequently detected in bays on the north side of Gull Lake. One walleye was tracked above Birthday Rapids during winter, suggesting that the area may also provide suitable overwintering habitat. Due to the relatively high water velocities within and immediately downstream of Gull Rapids, it is thought that fish generally overwinter downstream in Stephens Lake. Walleye were located in Stephens Lake during winter in bays and near islands along the south shore. One lake whitefish was located in Stephens Lake during winter approximately 5 km (3.1 miles) upstream of the Kettle GS.

An evaluation of temporal changes in the fish community was undertaken to determine if recent changes could affect the impact predictions and/or descriptions of the existing environment based on the period of field studies. The fish community may still be responding to habitat alterations caused by previous hydroelectric development, as well as undergoing other changes in response to variations in fishing pressure, the introduction of smelt, and climate change (see Section 6.4.9 for a discussion of climate change). Comparison of historic (1983–1989) and recent (2002–2003) CPUE values shows a decline in the total catch at both Split and Stephens lakes. Text and tables that provide detailed CPUE data can be found in AE SV Section 5.3. Whether this difference is due to variations in sampling methodologies or changes in fish populations is unknown. There also appears to have been a shift in the fish communities in both lakes since the 1980s, with an increase in the relative abundance of species that prefer lacustrine conditions *(e.g.*, walleye and northern pike) and a reduction in species that are adapted to riverine conditions *(e.g.*, longnose sucker). The fish community has more recently been affected by the arrival of rainbow smelt in the 1990s; this species is increasing both in abundance and in the diet of predatory fish, and the long-term effects will not be known for many years. The effects of this change, in combination with the on-going effects of climate change (see Section 6.4.9), are likely contributing, and will continue to contribute, to gradual changes in the fish community.

LAKE STURGEON

The lake sturgeon is a long-lived species that was historically abundant and widespread in Manitoba. Lake sturgeon currently inhabit the section of the Nelson River that will be impounded by the Keeyask GS, as well as areas immediately upstream to the Kelsey GS, including the Grass, Burntwood, and Odei rivers, and downstream to the Kettle GS (Map 6-18). The lake sturgeon's unique life history characteristics (late sexual maturity and infrequent spawning), in conjunction with a slow growth rate, made this species particularly vulnerable to over-exploitation by the commercial fishing industry during the late 19th and 20th centuries. Commercial fisheries for lake sturgeon severely depleted and, in some cases, eliminated populations throughout their range in North America.

Commercial harvest of lake sturgeon began in Manitoba during the late 1800s, with initial effort focusing on Lake Winnipeg. Commercial fishing for lake sturgeon in the Nelson River began in 1907 (summary of Nelson River commercial lake sturgeon harvest provided in MacDonell 1997). By 1917, the Nelson River lake sturgeon fishery accounted for 57% of the total Manitoba harvest. Peak annual captures during the 1940s were only about 12,000 kilograms (kg) (26,400 pounds) as compared to peak captures of 66,000 kg (145,200 pounds) in the 1920s. The fishery would undergo three more temporary closures between 1917 and 1970, after periods of high exploitation followed by collapse. The lake sturgeon commercial fishery in Manitoba was closed permanently in 1992. In the eighteen years between 1970-1987, based on the total weight of catch, an estimated 250-500 lake sturgeon were harvested between the Kelsey and Kettle GSs.

In addition to over-harvest, lake sturgeon in the Nelson River have been affected by hydroelectric development at rapids that were historic spawing sites, including the construction and operation of the Kelsey GS, the Kettle GS and CRD/LWR (Section 6.2.2). FLCN Members stated that prior to hydroelectric development lake sturgeon were plentiful and were harvested by Cree Nations along the entire stretch of the lower Nelson River system, particularly at the mouths of the larger tributaries (FLCN 2008 Draft). Notable fishing locations included Kettle Rapids (now the site of the Kettle GS; FLCN 2008 Draft), a former creek called Oskotowi Sipi (Moose Nose Lake area; FLCN 2009 Draft), and former rapids at "Indian Grave Channel" (FLCN 2009 Draft), which is located near the Moswakot rivers/Nelson River junction in Stephens Lake (FLCN 2010 Draft). Rapids between Gull Rapids and the Kettle GS (now flooded) were also important fishing areas for lake sturgeon (FLCN 2010 Draft). Lake sturgeon spawned at Kettle and Gull rapids, and the Butnau River provided important lake sturgeon habitat (FLCN 2009 Draft).

TCN Members reported that both CRD and LWR caused a decline in lake sturgeon abundance (Split Lake Cree – Manitoba Hydro Joint Study Group 1996c). FLCN Members stated that critical habitats were lost with each dam and fish could no longer move as freely within their natural habitat as they were able to prior to dam construction (FLCN 2009 Draft). As each successive dam was built, there were fewer lake sturgeon (FLCN 2009 Draft), and populations downstream of generating stations declined sharply following impoundment (FLCN 2010 Draft). Overall, there are now fewer lake sturgeon in Stephens, Gull, and Clark lakes (Split Lake Cree – Manitoba Hydro Joint Study Group 1996c). In response to directions from WLFN Elders, lake sturgeon are now harvested in lower quantities to preserve their populations (CNP, YFFN and FLCN 2011), and only the occasional lake sturgeon is captured and used by the York Factory community (SE SV).

Lake sturgeon in the study area (Kelsey GS to Kettle GS reach) are organized into three sub-populations based on the utilization of distinct spawning areas and limited movements among the groups. These groups occupy the following areas:

- The Split Lake area, which includes the Nelson River downstream of the Kelsey GS, the Grass River, the Burntwood River downstream of First Rapids, and Split and Clark lakes;
- The Clark Lake to Stephens Lake area, which includes the mainstem of the Nelson River from Clark Lake to Stephens Lake; and
- Stephens Lake.

Population estimates for adult lake sturgeon were developed from mark/recapture studies during spring in the Burntwood River between First Rapids and Split Lake, the Nelson River between Kelsey GS and Split Lake, and the Nelson River between Clark Lake and Gull Rapids. With sufficient numbers of tagged lake sturgeon and study duration, population models could estimate the proportion of lake sturgeon that were not returning to these reaches each year but were present elsewhere in the range of the population to provide an estimate of the total population in each area. Population estimates in the Split Lake area range from 183 to 654 adult lake sturgeon with the most recent estimate (2009) at 585; population estimates in the Clark Lake to Stephens Lake area range from 344 to 1,275 with the most recent estimate (2008) at 643 adult lake sturgeon (Table 6-5). Catches were too low in Stephens Lake to provide an estimate. The variability among annual population estimates and the wide confidence range are due to several factors. The variable spawning interval for lake sturgeon results in many fish that are not captured during every sampling period; this effect is compounded by different spawning intervals between males and females. Given that the population estimate is only for adult-sized lake sturgeon, the annual population estimate fluctuates based on the recruitment of new individuals which relates to spawning success and juvenile survival 20 to 30 years in the past when spawning populations were still changing in response to the commercial fishery. Finally, erratic return of tags from fish harvested in the domestic fishery and incomplete information on harvest records results in episodic updates to mortality estimates that can result in a disproportionate amount of mortality being recorded in one year.

Table 6-5: Adult Lake Sturgeon Population Estimates for the Clark Lake to Stephens Lake and Split Lake Areas

Study Area Location	Year	Estimate	95% Confidence Limits	
			Lower	Upper
Clark Lake to Stephens Lake Area	2001	406	330	638
	2002	344	246	666
	2003	550	429	861
	2004	481	316	876
	2005	-	-	-
	2006	1,275	875	2,078
	2007	-	-	-
	2008	643	384	1,178
Split Lake Area	2001	183	122	576
	2002	228	106	735
	2003	-	-	-
	2004	-	-	-
	2005	592	245	1,815
	2006	505	325	947
	2007	654	527	975
	2009	585	478	824

During recent field studies, the highest average CPUE for lake sturgeon was in the Nelson River between Clark Lake and Gull Rapids and the lowest average CPUE was in Stephens Lake and in the Nelson River downstream of the Kelsey GS. Habitat suitable for all life history stages of lake sturgeon can currently be found in each of the three aforementioned areas.

Lake sturgeon spawn in the spring, generally in a range of water depths in areas of swift current or rapids over gravel, cobble, and boulder-sized substrates. The only location that was confirmed as a spawning site in the Split Lake area during the environmental studies was First Rapids on the Burntwood River. CNP resource users reported that lake sturgeon also spawn below First Falls on the Odei River (CNP Keeyask Environmental Evaluation Report). Historical spawning grounds that may still be used include Witchai Lake Falls in the Grass River and the Nelson River downstream of the Kelsey GS (formerly Kelsey Rapids). Lake sturgeon in the Nelson River between Clark Lake and Gull Rapids spawn primarily at Birthday Rapids and less frequently (and in much smaller numbers) further upstream at Long Rapids. In Stephens Lake, lake sturgeon spawn at Gull Rapids. Gull Rapids is reported to be one of the last lake sturgeon spawning areas on the lower Nelson River (CNP, YFFN and FLCN 2011).

After hatching, larval lake sturgeon are dispersed downstream by the water current before settling on the substrate (Photo 6-11). Because young-of-the-year (YOY) lake sturgeon are difficult to capture, relatively little is known about this life stage. However, studies conducted in other river systems suggest that suitable rearing habitat consists of gravel, sand, or silty sand substrate in areas of low velocity. Habitat in the Split Lake area is very diverse and appears to contain suitable conditions for YOY lake sturgeon. Although rearing sites have not been located in the Split Lake area, the capture of sub-adults indicates that successful recruitment is occurring.

In the Clark Lake to Stephens Lake area, rearing habitat has been identified in a deep, low velocity, sandy area north of Caribou Island in Gull Lake where several YOY were captured during fall gillnetting studies (Map 6-24). Similar habitat has also been identified in the western portion of Stephens Lake north of Cabin Island (approximately 5 km downstream of Gull Rapids); however, the youngest lake sturgeon captured there were two years old (see below for more details). To date, YOY lake sturgeon have only been captured in the vicinity of Caribou Island in Gull Lake (15 fish) and approximately 1.5 km (0.9 miles) downstream of Gull Rapids along the south shore (two fish).

Source: North/South Consultants Inc., 2003.

Photo 6-11: Floating Drift Trap Used to Capture Newly-Hatched Larval Lake Sturgeon as They Drift Downstream

Sub-adult (juvenile) lake sturgeon prefer main channel, deep water areas with low to moderate velocities and gravel, cobble, or sand substrate. Maps showing detailed lake sturgeon capture results overlaying depth, velocity and substrate data can be found in AE SV Section 6.3. Sub-adult lake sturgeon have been captured in all three areas, but are most abundant between Birthday and Gull rapids and in a relatively small area near Cabin Island in Stephens Lake. Within the Clark Lake to Stephens Lake area, sub-adult lake sturgeon appear to favour an area of Gull Lake with low to moderate velocity and a gravel/cobble/boulder substrate south of a small island, as well as the lower velocity, sandy habitat north of Caribou Island (Map 6-25). Sub-adult habitat in Stephens Lake is deep, of low velocity, and consists of a mixture of sand, gravel/sand and silt substrates.

Adult lake sturgeon use a wide variety of habitat for foraging and can move freely throughout the Kelsey to Kettle reach. Adults have been captured throughout the reach of the Nelson River between Clark Lake and Gull Rapids (Map 6-26 and Map 6-27).

With the exception of the Kelsey GS and perhaps First Rapids in the Burntwood River, there are no barriers to the upstream movement of large lake sturgeon within the Kelsey GS to Kettle GS reach. Nevertheless, movements of lake sturgeon between the Split Lake area and the Clark Lake to Stephens Lake area are relatively infrequent, and studies indicate that lake sturgeon from these two areas are genetically distinct (AE SV Section 6.3).

Movements of lake sturgeon through Gull Rapids are relatively more frequent than movements upstream into Split Lake, but it is not known whether populations upstream and downstream of the rapids are genetically distinct. Analysis of additional genetic material in 2012 will address this information gap. Based on tagging studies completed to date, adult lake sturgeon from Gull Lake do not appear to move downstream into Gull Rapids to spawn, nor do fish from Stephens Lake appear to move upstream to spawn at Birthday or Long rapids. Preliminary results from additional studies initiated in 2011 show movement patterns similar to those observed in the studies described above.

The information collected during field and traditional knowledge studies was evaluated to determine whether conditions have been undergoing recent change that could in turn affect the impact predictions. Certain characteristics of the lake sturgeon's life history, such as a variable spawning interval for males and females, long time to maturity, and longevity (greater than 60 years), make it difficult to determine current population trends over the relatively short period during which investigations were conducted. The presence of young fish indicates that recruitment is occurring. Although habitat in the Clark Lake to Stephens Lake area currently supports all the life history requirements for lake sturgeon, population estimates are low, and the long-term sustainability of this population is uncertain. Numbers may be increasing in the Split Lake area, increasing the likelihood of the continuation of this population, if other factors (such as mortality) remain constant. The extremely small number of spawning lake sturgeon at Gull Rapids makes it unlikely that the Stephens Lake group is presently a self-sustaining population.

The potential effect of climate change on lake sturgeon populations is discussed in Section 6.4.9.

6.2.3.3.6 MERCURY, PALATABILITY AND CYSTS IN FISH

Fish quality studies focused on attributes that affect the suitability of fish for human consumption, including: the concentration of trace metals; palatability; and rates of *Triaenophorus crassus* (*T. crassus*) infections resulting in intra-muscular cysts in lake whitefish. A detailed description of fish quality study methods and results are available in AE SV Section 7.

In response to concerns over increased levels of mercury in fish as a result of hydroelectric development, many Members of the KCNs no longer consume fish from the Nelson River mainstem (FLCN Environment Evaluation Report (Draft)), Split Lake (Split Lake Cree – Manitoba Hydro Joint Study Group 1996c; YFFN Evaluation Report [*Kipekiskwaywinan*]; SE SV), or Stephens Lake (Split Lake Cree – Manitoba Hydro Joint Study Group 1996c; FLCN 2008 Draft; FLCN 2009 Draft; FLCN Environment Evaluation Report (Draft)).

MERCURY

Flooding of soil and vegetation due to reservoir creation introduces inorganic mercury and organic nutrients to the water, which leads to increased microbial production of methylmercury. This form of mercury is readily taken up by organisms at low trophic levels and, subsequently, bioaccumulated up the food chain. With the exception of mercury, hydroelectric development generally does not result in increased accumulation of trace elements in fish.

Mean mercury concentrations in predatory fish species (northern pike and walleye) from Split Lake fluctuated greatly over the 20-year period from 1970–1990, without showing any trends that could be attributed to the operation of either LWR or CRD (Figure 6-6). The maximum concentrations for non-commercial samples (*i.e.*, excluding 1970) reached in 1982 for both species, were not significantly different from means recorded in many sampling years between 1973 and 1990. The high variability in mercury concentrations during this time-period can be partially attributed to the often low (five to 12 fish) sample size. In 1992, concentrations in northern pike and walleye were significantly lower than maximum levels, and they continued to decline until 2005 (last sampling date reported herein). Mercury concentrations of northern pike and walleye from Stephens Lake were highest when first sampled in the early 1980s (Figure 6-7); as this was more than 10 years after impoundment, maximum post-flooding concentrations may have been even higher. Concentrations in northern pike and walleye decreased almost continuously until 2005. Lake whitefish from both Split and Stephens lakes had a much smaller range of mercury concentrations than walleye and northern pike, but also declined over the historic record to minimum concentrations in 2005.

Historic data from Gull Lake and other study area waterbodies are limited. Mean concentrations in northern pike (0.51 parts per million [ppm]) and walleye (0.78 ppm) from Gull Lake in 1982 were higher than those from Assean Lake in four years between 1981 and 1996.

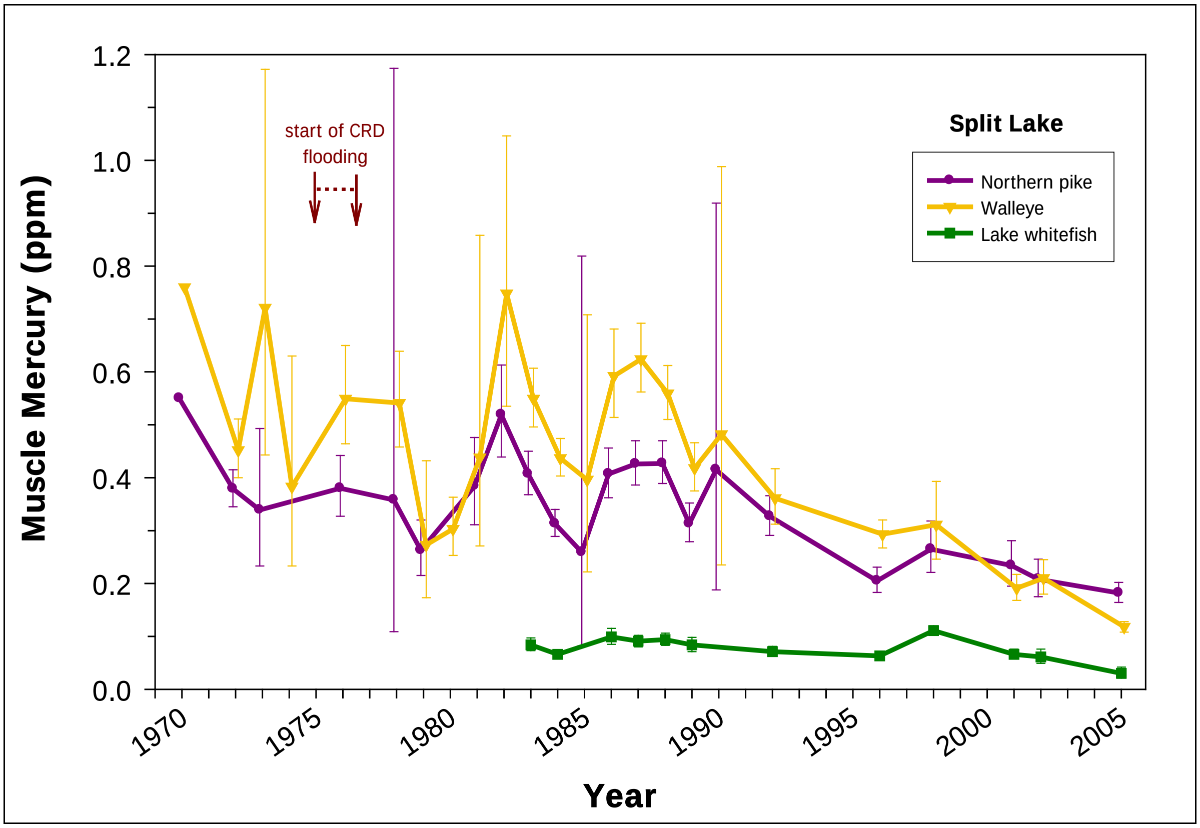


Figure 6-6: Mean (Plus or Minus 95 % Confidence Level) Standardized Mercury Concentrations in Fish from Split Lake

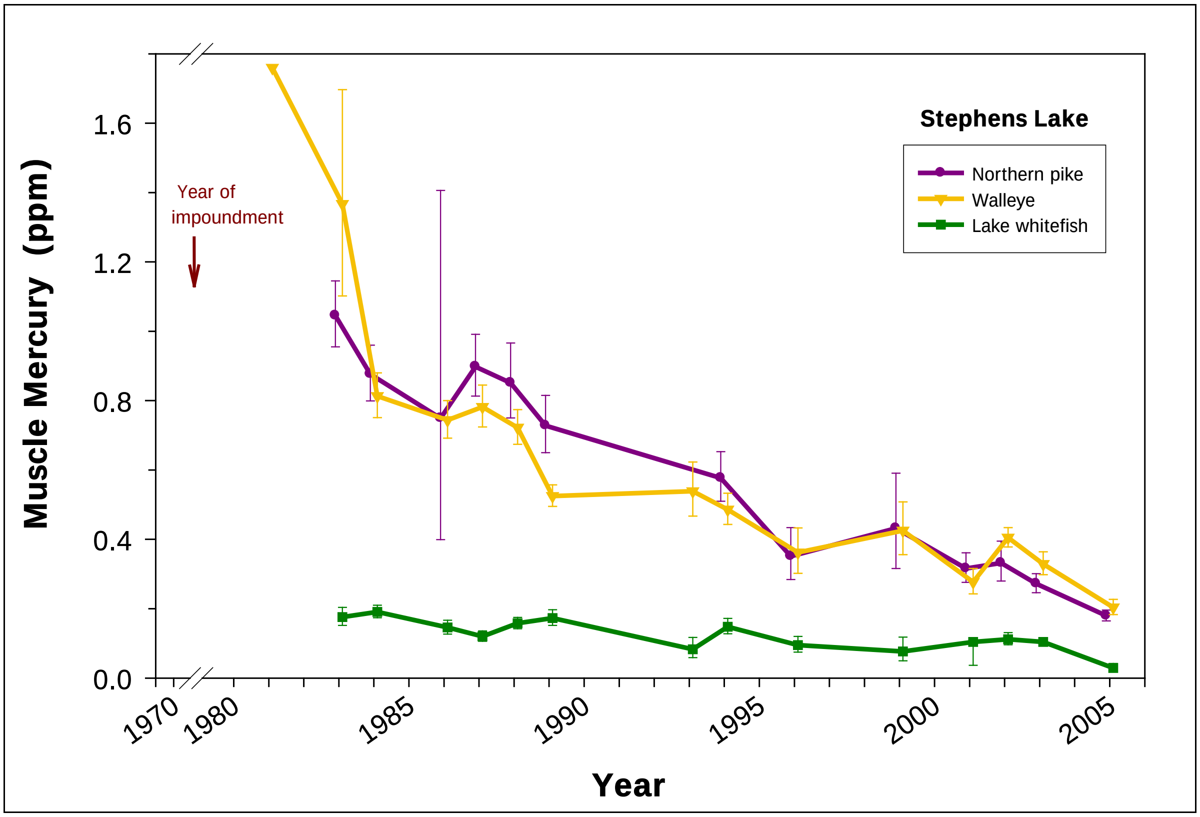


Figure 6-7: Mean (Plus or Minus 95 % Confidence Level) Standardized Mercury Concentrations in Fish from Stephens Lake

From 1999–2006, mean mercury concentrations in all fish species, including lake sturgeon from Gull Lake, were below the Health Canada 0.5 ppm standard for commercial marketing. Given that sturgeon samples were donated by domestic harvesters, the mean total length (1,280 mm [50.4 inches]) of the 13 sturgeon analyzed was relatively large, and mercury concentration were relatively high, ranging from 0.04–0.67 ppm, with a mean of 0.20 ppm. Mean concentrations in lake whitefish never exceeded the 0.2 ppm threshold for safe consumption for persons eating large quantities of fish. However, individuals of all large-bodied species sampled from any waterbody and year frequently exceeded the 0.2 ppm threshold.

Mercury levels currently vary year to year and without any further hydroelectric development are expected to remain within the range of concentrations reported for 1999–2005 in the near future. The potential effects of climate change are described in Section 6.4.9.

Palatability

Members of the KCNs report that the colour, taste and texture of fish were negatively affected by hydroelectric development (discussed in AE SV Section 7.5). As a result of this decline in quality, many KCNs Members will not eat fish captured from the Nelson River mainstem, including Split (YFFN Evaluation Report [*Kipekiskwaywinan*]) and Stephens lakes (FLCN 2008 Draft; FLCN 2010 Draft; FLCN Environment Evaluation Report (Draft)). Blind taste tests to assess the palatability of lake whitefish, northern pike and walleye from study area lakes were conducted in the communities of Bird, Split Lake and York Landing in April/May 2002 and October 2003. Amongst waterbodies, rating of the three species was not entirely consistent. Panellists from all three communities generally preferred fish from lakes that had not been affected by hydroelectric development.

T. crassus Cysts

Between 2003–2006, lake whitefish were sampled from Split, Gull and Stephens lakes (sampling was conducted in each lake for a minimum of two years) and analyzed for infection with *T. crassus*. All fish samples had cyst counts of less than 50 per 100 pounds (23 per 46 kg) of flesh and were therefore of export quality, the highest grade assigned by the Freshwater Fish Marketing Committee.

6.2.3.4 Terrestrial Environment

6.2.3.4.1 Introduction

A terrestrial ecosystem is the living and the non-living things in a land area and the relationships between all of these things. This functional unit has structures (*e.g.*, food web, trophic structure), dynamics (*e.g.*, cycling of energy, nutrients and matter) and performs functions (*e.g.*, converts carbon dioxide into plant material, creates soil).

An ecosystem-based approach was used to understand the terrestrial environment and to evaluate the potential effects of the Project on it. The ecosystem-based approach recognized that the terrestrial environment is a complex, hierarchically organized system in which changes to one component directly and/or indirectly affect other components (see TE SV Section 1.1 for a complete description of the ecosystem-based approach). A key element of the ecosystem-based approach was identifying the ecosystem components (*i.e.*, elements, patterns, linkages, processes and functions) that are particularly important for maintaining terrestrial ecosystem health.

As discussed in Section 5.3, valued environmental components (VECs) were used to focus the assessment. Terrestrial VECs were the ecosystem components that were of particular interest for evaluating effects on terrestrial ecosystem health and/or were of particular social interest. In addition to the VECs, supporting topics were identified to represent the remaining important ecosystem components that, with the VECs, collectively indicate how the Project is expected to affect terrestrial ecosystem health. The sustainable land use framework developed by CCFM (1995) was the basis for identifying the key components of terrestrial ecosystem health (see TE SV Section 1.3.4 for details).

Priority species were established to define the species or species groups that are particularly important for ecological and/or social reasons, including importance to the Keeyask Cree Nations (KCNs; *e.g.*, for food and cultural importance). Some priority bird and mammal species were of sufficient interest to become individual species VECs (*e.g.*, caribou is particularly important both scientifically and to the KCNs). The priority bird and mammal species that were not elevated to VECs were grouped and discussed as the other priority bird and mammal supporting topics.

Table 6-6 lists the 13 VECs and nine supporting topics selected for the terrestrial environment assessment. The rationale for including each is summarized in the relevant sections below and detailed in the TE SV.

Table 6-6: Study Zones Used as the Local and Regional Study Areas for each of the Valued Environmental Components and Supporting Topics

EIS Section and Topic	**Study Zone in Map 6-28**				
	Zone 2[1]	**Zone 3**	**Zone 4**	**Zone 5**	**Zone 6**
TERRESTRIAL ECOSYSTEMS AND HABITAT					
Terrestrial habitat	LSA			RSA	
Fire regime		LSA			RSA
Ecosystem diversity (VEC)	LSA			RSA	
Intactness (VEC)		LSA		RSA	
SOIL QUANTITY AND QUALITY	LSA			RSA	
Wetland function (VEC)	LSA			RSA	
TERRESTRIAL PLANTS					
Priority plants[2] (VEC)	LSA			RSA	
Invasive plants	LSA			RSA	
AMPHIBIANS AND REPTILES					
Priority amphibians[3]	LSA		RSA		
BIRDS					
Canada goose (VEC)		LSA		RSA	
Mallard (VEC)		LSA	RSA		
Bald eagle (VEC)		LSA		RSA	
Olive-sided flycatcher (VEC)		LSA	RSA		
Common nighthawk (VEC)		LSA	RSA		
Rusty blackbird (VEC)		LSA	RSA		
Other Priority birds[4,5]					

Table 6-6: Study Zones Used as the Local and Regional Study Areas for each of the Valued Environmental Components and Supporting Topics

EIS Section and Topic	Study Zone in Map 6-28				
	Zone 2[1]	Zone 3	Zone 4	Zone 5	Zone 6
MAMMALS					
Caribou (VEC)			LSA		RSA
Moose[6] (VEC)		LSA		RSA	
Beaver (VEC)		LSA	RSA		
Other priority mammals[5,7]					
Mercury in wildlife			LSA	RSA	

Notes:

1. Codes in the table indicate which of the study zones shown in Map 6-28 were used as the Local Study Area (LSA) and Regional Study Area (RSA) for each VEC and supporting topic.
2. Priority plant species include those native species that are highly sensitive to human features, make high contributions to ecosystem function and/or are favoured for use by local people. A species was considered to be highly sensitive to human features if it is globally, provincially or regionally rare, near a range limit, has low reproductive capacity, depends on rare environmental conditions and/or depends on the natural disturbance regime. Rare species that are endangered or threatened are of particularly high concern.
3. Includes Species at Risk.
4. Includes other Species at Risk, colonial waterbirds and species at the edge of their known breeding range.
5. Study areas vary too greatly by species to generalize in this table.
6. The Moose Local Study Area also includes the offset areas where individual moose are harvested (see the off-set harvest program description in the SE SV, Resource Use). Assumes that a moose population residing in an area approximating the size
7. Includes endangered, threatened, provincially rare and regionally rare species, small mammals and large carnivores as high contributors to ecosystem function and furbearers highly valued by local people.

A Local Study Area and a Regional Study Area were identified for each VEC and supporting topic. For wildlife species, potential direct and indirect Project effects on individual animals defined the spatial extent of the Local Study Area while potential effects on populations defined the spatial extent of the Regional Study Area. For the other VECs and supporting topics, potential direct and indirect Project effects on individual ecosystem elements (*e.g.*, jack pine stands) defined the Local Study Area while potential effects on the relevant regional entity (*e.g.*, ecosystem diversity) defined the Regional Study Area. Species with large home ranges (*e.g.*, caribou) and the topics relating to ecosystem processes that occur over large areas (*e.g.*, fire regime) had the largest Local and Regional Study Areas.

Map 6-28 shows the six nested study zones that were used as the Local and Regional Study Areas for many of the VECs and supporting topics. Table 6-6 identifies which of these study zones were used as the Local and Regional Study Area for each VEC and supporting topic.

This section provides the environmental setting for the terrestrial ecosystem organized into the following seven subsections:

- Terrestrial ecosystems and habitat;
- Terrestrial plants;
- Terrestrial invertebrates;
- Amphibians and reptiles;
- Birds;
- Mammals; and,
- Mercury in wildlife.

As discussed in Chapter 5, this environmental assessment was based on both Aboriginal traditional knowledge and scientific analysis. Chapter 2 provides the methods and general conclusions related to the ATK-based worldview. A description of the environmental setting based on the holistic approach of ATK is provided in Section 6.2.3.1.

A wide range of Project studies, which included a large number of locations sampled between 2001 to 2011, provided most of the technical information used for the terrestrial assessment. Many of the Project studies examined conditions at existing hydroelectric generation projects, particularly the Kettle Generating Station reservoir (Stephens Lake), to provide examples of how the Project is expected to affect the terrestrial ecosystem. Some studies included sample locations in undisturbed lakes and rivers to improve understanding of natural shoreline wetland conditions and dynamics.

Other important environmental setting information sources were ATK, scientific literature and existing published information. ATK played an important role in both technical data collection and describing the existing environment. The Keeyask Cree Nations (KCNs) Partners provided ATK through the KCNs' Environmental Evaluation Reports and community-based studies; and individual KCNs Members provided ATK and/or local knowledge that helped inform the design of technical studies (*e.g.*, the location and timing of caribou surveys). The KCNs were involved in reviewing annual fieldwork plans through the Environmental Studies Working Groups and individual KCNs Members participated in field data collection. For the past two years, the KCNs were active participants in the Mammals Working Group (primarily focused on caribou and moose). In addition, ATK of historic and current conditions as gathered through community-based research and workshops was incorporated into the detailed VEC and supporting topic descriptions that are presented below and in the TE SV (*e.g.*, FLCN's Traditional Knowledge Report 2010; YFFN Evaluation Report (*Kipekiskwaywinan*)). FLCN's TK Report as well as each of the KCNs' Environmental Evaluation Reports also document how the terrestrial ecosystem was affected by past hydro development.

The Keeyask region (Study Zone 5 in Map 6-28) has been altered in the past by human developments and activities such as hydroelectric development and natural processes such as climate change (TE SV Section 2.3.3). The effects of these past influences on terrestrial ecosystems continue today and are anticipated to continue into the future. For the ecosystem components of interest, the analysis includes projecting current trends in the existing environment into the future using models and available information.

6.2.3.4.2 TERRESTRIAL ECOSYSTEMS AND HABITAT

This section describes current conditions and trends for terrestrial ecosystems and habitat. The TE SV Section 2.3 provides further details regarding the terrestrial habitat assessment methods and results.

Due to dramatic differences in the dominant drivers for change, terrestrial ecosystems and habitat were classified into two major ecological zones: shoreline wetlands and inlands. Wildfire is the dominant driver for inlands whereas surface water level fluctuations and flows are the dominant drivers for shoreline wetlands. Ice scouring is also important influence on Nelson River shoreline wetlands. Inlands were subdivided into uplands and inland wetlands to account for the strong influence of depth to groundwater on vegetation, soils and other ecosystem attributes.

At any given shoreline location, different plant species are typically arranged into bands that reflect a transition in the typical water depth (Photo 6-12). To capture this strong influence on shoreline wetland ecosystems, the shore zone was subdivided into the following water depth duration zones using the number of days that water depths occur over a particular depth range: sub-littoral, lower beach, upper beach, inland edge and inland (Photo 6-1). The inland edge is often called the riparian zone.

As described in Section 6.2.3.4.1, the terrestrial ecosystems and habitat assessment used the ecosystem diversity, intactness and wetland function VECs and the terrestrial habitat, fire regime, and soil quantity and quality supporting topics (Table 6-6) to collectively represent the condition of terrestrial ecosystems and habitat.

Terrestrial habitat was identified as a supporting topic because it is the foundation for understanding and predicting potential Project effects on the terrestrial ecosystem. For example, plants and animals use habitat for survival and reproduction. Due to its high importance to all ecosystem components, terrestrial habitat is the only supporting topic addressed at length in this chapter.

Fire regime was included as a supporting topic because wildfire and climate change have been and continue to be the dominant natural drivers for changes to inland ecosystems throughout most of the Canadian boreal forest, including the Keeyask region (Study Zone 5 in Map 6-28). The TE SV Section 2.4.6 describes the fire regime.

Soil quantity and quality was included as a supporting topic because the maintenance of soil quality and quantity is a key element of sustainability reporting. The TE SV Section 2.9 addresses soil quantity and quality.

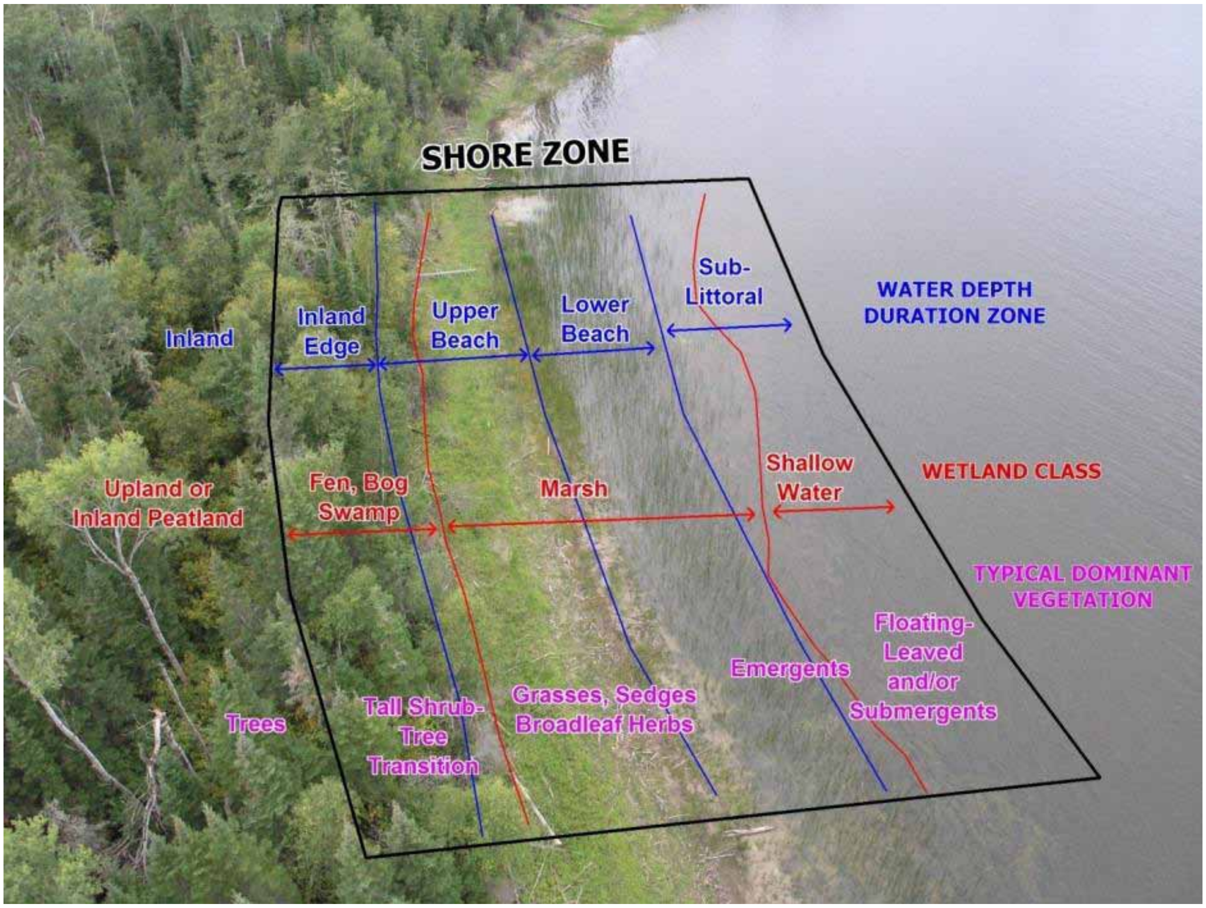


Photo 6-12: Shore Zone Photo Illustrating Water Depth Duration Zones, Vegetation Bands and Wetland Classes

TERRESTRIAL HABITAT

Habitat is the place where an organism or a population lives. Because all natural areas are habitat for something, the term "habitat" is used to refer to terrestrial habitat for all species. Habitat for a particular species is identified with a species prefix, such as moose habitat.

The attributes used to classify and map terrestrial habitat were vegetation type, vegetation age class (where this could be determined), ecosite type, topographic position and either recent disturbance type (*e.g.*, large fires, ice scouring) or water depth duration zone. Ecosite type is a classification of soil, surficial material, surface water, groundwater and permafrost conditions that are associated with substantial differences in vegetation composition and/or structure.

The Habitat Local and Regional Study Areas were Study Zones 2 and 5 in Map 6-28 respectively. The Regional Study Area was an area that was that was large enough to capture a region level ecosystem. That is, a relatively homogenous area in terms of its ecological context (*e.g.*, climate, surface materials) that was large enough to capture the key ecological processes operating at the regional ecosystem level (such as the fire regime) and populations of most of the resident wildlife species (see TE SV Section 1.1 for details).

An ecological land classification that reflected the hierarchical structuring of ecosystems was developed to provide a framework for characterizing terrestrial ecosystem relationships at multiple scales. From largest to smallest, the ecosystem levels relevant for the terrestrial habitat and ecosystems assessment were region, subregion, landscape, landscape element, stand and site (see TE SV Section 1.1 for details). The region ecosystem level corresponds with Zone 5 in Map 6-28. The region ecosystem level is the appropriate level to evaluate terrestrial ecosystem health (Miller and Ehnes 2000).

A hierarchical habitat classification was applied to all of the ecosystem levels. From most general to most detailed, the levels in the habitat classification were land cover, coarse habitat, broad habitat and fine habitat. The categories within each classification level were combinations of vegetation type and ecosite type. Ecologically relevant habitat types were defined through multivariate analysis of field data.

Stand level terrestrial habitat mapping was used as a proxy for stand level ecosystem mapping. Detailed habitat mapping (*i.e.*, at the fine habitat level) was completed for Study Zone 4 (Map 6-28) using large-scale stereo air photos. Generalized land cover mapping was completed for the rest of the Regional Study Area using classified satellite imagery. The habitat composition of the Regional Study Area was assumed to be similar to Study Zone 4 since the generalized land cover and soil landscape composition of these were similar for Study Zone 5.

The characteristics of each habitat type, as well as relationships between habitat components (*e.g.*, soils and vegetation) and drivers such as wildfire or flooding, were derived from vegetation, soil and environmental data collected at over 500 habitat plots, along over 540 km of habitat transects and at over 4,000 soil profile sample points.

Information regarding historical changes in habitat was primarily obtained from the existing environment habitat map, large-scale historical stereo air photos and the Split Lake Post-Project Environmental Review (Split Lake Cree – Manitoba Hydro Joint Study Group 1996a, 1996b, 1996c). Current trends in habitat composition were estimated by extrapolating observed historical changes in the context of published scientific literature for northern Manitoba.

Habitat Composition

Based on the habitat mapping and field studies, land accounted for approximately 76% of the 2,215 km^2 encompassed by Study Zone 4. Land cover in 2010 was dominated by sparsely to densely treed needleleaf vegetation on mineral or thin peatland, and on shallow peatland (about 80% of the land area combined; Map 6-28). Broadleaf treed land cover accounted for approximately 1% of the land area, typically occurring on upland mineral soils, in richer riparian areas and near the Nelson River (Map 6-29). Tall shrub and low vegetation on mineral or peatland ecosites covered 16% of land area, primarily occurring along streams and rivers, other wet areas and poorly regenerating burned areas (a substantial proportion of the low vegetation on mineral, thin peatland and shallow peatland was treed vegetation prior to burning in wildfires during the 1980s and 1990s). Shoreline wetlands other than shallow water wetlands accounted for less than 1% of land area. Human infrastructure comprised approximately 2% of the existing land area.

Black spruce (*Picea mariana*) on thin peatlands and black spruce on shallow peatlands were the two most abundant coarse habitat types by far, with each covering approximately one-third of land area (Table 6-2). The other needleleaf coarse habitat types were jack pine (*Pinus banksiana*) and tamarack (*Larix laricina*) types. The overstorey species included in the broadleaf treed and mixedwood coarse habitat types were trembling aspen (*Populus tremuloides*), balsam poplar (*Populus balsamifera*) and white birch (*Betula papyrifera*). Black spruce and jack pine typically were the needleleaf species in the mixedwood types.

Because of frequent large fires (see TE SV Section 2.3.3), approximately one-quarter of inland terrestrial habitat in Study Zone 4 was less than 50 years old in 2010. Most of the mature forest in the Local Study Area was approximately 70 years old.

Shoreline wetland coarse habitat types comprised less than 1% of land area (shallow water wetland class not included in land area or as a type since bathymetry data were not available to separate shallow from deep water throughout Study Zone 4). Shrub and/or low vegetation on upper beach on the Nelson River was the most abundant of these types (0.6% of the land area). The nature of shoreline wetlands along the Nelson River was considerably different from those in off-system waterbodies, presumably due to the substantial differences in water and ice regimes (see Section 6.2.3.2.6 for Nelson River water and ice regimes). During the study period, vegetated upper beach was only observed on the Nelson River while virtually all of the sub-littoral and lower beach marsh was in off-system waterbodies (Table 6-7). Upper beach peatlands on the Nelson River were periodically flooded while those in off-system waterbodies appeared to float up and down with water fluctuations. Additionally, ice scoured uplands were only observed on the Nelson River. Shoreline wetlands are further described in the wetland function section (Section 6.2.3.4.5).

Compared with Study Zone 4, the 130 km^2 Local Study Area had higher proportions of the broadleaf treed, jack pine treed on mineral or thin peatland and tall shrub on peatland coarse habitat types (Table 6-7). Due to the presence of the Nelson River, shore zone habitat types were proportionately more abundant in the Local Study Area, increasing to a total of 3.1%. Shrub and/or low vegetation on upper beach remained the most abundant shore zone type in the Local Study Area (1.4% of the land area), followed by Nelson River shrub and/or low vegetation on ice scoured mineral or Nelson River shrub and/or low vegetation on sunken peat.

Table 6-7: Coarse Habitat Composition of Study Zone 4 and the Local Study Area, as a Percentage of Total Land Area

Land Cover Type	Coarse Habitat Type	Study Zone 4	Local Study Area
Broadleaf Treed on All Ecosites	Broadleaf treed on all ecosites	0.6	1.4
	Broadleaf mixedwood on all ecosites	0.5	1.2
Needleleaf Treed on Mineral and Thin Peatland Ecosites	Black spruce mixedwood on mineral or thin peatland	0.3	0.3
	Jack pine mixedwood on mineral or thin peatland	0.3	0.5
	Jack pine treed on mineral or thin peatland	1.8	3.1
	Black spruce treed on mineral soil	8.2	12.0
	Black spruce treed thin peatland	32.6	31.3
Needleleaf Treed on Other Peatlands	Jack pine treed on shallow peatland	0.1	0.2
	Black spruce mixedwood on shallow peatland	0.0	0.0
	Black spruce treed on shallow peatland	32.2	23.6
	Black spruce treed on wet peatland	2.1	0.9
	Tamarack- black spruce mixture on wet peatland	0.9	0.3
	Tamarack treed on shallow peatland	0.4	0.7
	Tamarack treed on wet peatland	0.2	0.0
	Black spruce treed on riparian peatland	0.7	0.4
	Tamarack- black spruce mixture on riparian peatland	0.0	0.0
	Tamarack treed on riparian peatland	0.0	-
Tall Shrub on Mineral or Thin Peatland Ecosites	Tall shrub on mineral or thin peatland	0.2	0.6
Tall Shrub on Inland	Tall shrub on shallow peatland	0.3	0.3

Table 6-7: Coarse Habitat Composition of Study Zone 4 and the Local Study Area, as a Percentage of Total Land Area

Land Cover Type	Coarse Habitat Type	Study Zone 4	Local Study Area
Peatlands	Tall shrub on wet peatland	0.1	0.3
Low Vegetation on Mineral or Thin Peatland Ecosites	Low vegetation on mineral or thin peatland	4.5	3.6
Low Vegetation on Inland Peatlands	Low vegetation on shallow peatland	6.8	5.4
	Low vegetation on wet peatland	1.5	1.1
Tall Shrub or Low Vegetation on Riparian Peatlands	Tall shrub on riparian peatland	0.6	1.8
	Low vegetation on riparian peatland	1.8	1.7
Shore Zone (Includes shoreline wetlands and ice-scoured uplands)	Nelson river shrub and/or low vegetation on ice scoured upland	0.1	0.9
	Nelson river shrub and/or low vegetation on upper beach	0.6	1.4
	Nelson river shrub and/or low vegetation on sunken peat	0.1	0.6
	Nelson river marsh	0.0	0.1
	Off-system marsh	0.1	0.1
Human Infrastructure		2.0	6.1
Unclassified		0.5	0.0
All		*100.0*	*100.0*

Notes: Values that round to 0 are shown as "0" while absences are indicated by "–". The unclassified type identifies recently burned areas where vegetation type could not be determined.

Habitat Type Descriptions

This section describes the most common habitat types. Map 6-29 includes aerial photo examples of these and other coarse habitat types.

The black spruce on mineral soil or thin peatland coarse habitat type typically occurred on sloped or elevated well drained mineral deposits. The surface organic layer thickness was highly variable, averaging 23 cm, and was derived from peat mosses (*Sphagnum* spp.) and feathermosses. The vegetation was characterized by a black spruce dominated overstorey with occasional tamarack on moister sites and occasional jack pine, white birch and/or trembling aspen on drier sites. Green alder (*Alnus viridis* ssp. *crispa*) usually occurred in the tall shrub layer, often accompanied by willows (*Salix* spp.). Typical species in the lower understorey were Labrador tea (*Rhododendron groenlandicum*), rock cranberry (*Vaccinium vitis-idaea*), Schreber's moss (*Pleurozium schreberi*), stair-step moss (*Hylocomium splendens*), knight's plume moss (*Ptilium crista-castrensis*), reindeer lichens (*Cladina* spp.) and cup lichens (*Cladonia* spp.). Reindeer lichen cover was more abundant in the northern portion of the Regional Study Area where the tree canopy was more open (CNP Keeyask Environmental Evaluation Report).

The black spruce on shallow peatlands coarse habitat type typically occurred on flat to gently sloping areas with very moist or poorly drained peatlands. The surface organic layer thickness was highly variable, averaging 71 cm, and was derived from peat mosses. Compared with black spruce on mineral soil or thin peatlands habitat type, the vegetation generally had a shorter, more open overstorey and tall shrubs were scarce. The lower understorey layer had more small cranberry (*Vaccinium oxycoccos*), reindeer lichen, peat mosses and feathermosses.

Vegetation in the Nelson River shrub/low vegetation on upper beach coarse habitat type was dominated by either tall shrubs or low vegetation mixed in with graminoids, with the characteristic plant species being different in the Keeyask and Stephens Lake segments of the Nelson River. For the tall shrub vegetation types, flat-leaved willow (*Salix planifolia*) and marsh reed-grass (*Calamagrostis canadensis*) occurred in both segments of the Nelson River, while bog bilberry (*Vaccinium uliginosum*) and sweet gale (*Myrica gale*) cover occurred only in the Stephens segment. For the low vegetation types, the vegetation cover commonly consisted of silverweed (*Argentina anserina*) and marsh reed-grass in the Keeyask segment, while common horsetail (*Equisetum arvense*), marsh -five-finger (*Comarum palustre*) and sedges (*Carex* spp.) were more common in the Stephens Lake segment. Nelson River sub-littoral or lower beach marsh was dominated by water horsetail (*Equisetum fluviatile*).

In contrast, off-system sub-littoral or lower beach marsh on mineral substrates tended to be dominated by either viscid great-bulrush (*Schoenoplectus tabernaemontani*) or creeping spike-rush (*Eleocharis palustris*) and spiked water-milfoil (*Myriophyllum sibiricum*). Water horsetail occurred in shallower water on organic and mineral substrates, while floating-leaved species such as small yellow pond-lily (*Nuphar variegata*) and narrow-leaved bur-reed (*Sparganium angustifolium*) often occurred in deeper water.

Historical Change and Future Trends

Human impacts, climate change and fire regime changes have been the primary factors driving habitat and ecosystem changes in the Regional Study Area over the past few hundred years (see TE SV Section 2.3.3.2). Human infrastructure (*e.g.*, settlements, roads and transmission lines) and hydroelectric development have removed and altered inland and Nelson River shoreline ecosystems. Total historical inland habitat loss and alteration was estimated to be approximately 611 km^2 or 4.8%, of Regional Study Area inland habitat area. Nelson River shoreline wetlands have been substantially altered by water regulation and its indirect effects.

Natural climate warming that began about 150 years ago has already dramatically altered some peatland types, (Vitt *et al.* 1994), primarily through permafrost melting and fire regime changes (see TE SV Section 2.3.3.2). Thie (1974) estimated that about 75% of the permafrost in peatlands in an area between Lake Winnipeg and the Regional Study Area has degraded since the end of the Little Ice Age. Analysis of historical air photos from the Regional Study Area indicated that permafrost melting in peatlands between 1962 and 2006 eliminated approximately 20% of the total area of peat plateau bogs, the most pronounced permafrost peatland type (see TE SV Section 2.3.3.2). Most of this area was converted to very wet peatland types and the rest to open water. Throughout much of the boreal forest, past climate change also altered the fire regime so that the average annual area burned is higher, which is thought to have shifted habitat composition towards younger vegetation and vegetation types with higher components of plant species that regenerate quickly after fire and reduced proportions of permafrost peatland ecosite types.

Past and existing human impacts and past climate change are expected to continue to drive future habitat change in the Regional Study Area even if the Project does not proceed. Ongoing shoreline erosion initiated by hydro-electric development will continue to remove and alter inland and shoreline wetland habitat. For example, it is estimated that approximately 1.2 km^2 of inland habitat would be lost to ongoing mineral bank erosion in the Keeyask reach of the Nelson River between 2006 and 2047 (equivalent to 30 years post-Project; see Section 6.2.3.2.7). By extrapolating the measured ground ice peatland loss over the past 20 years or so, it is estimated that delayed permafrost responses to past climate change will convert at least one-quarter of the remaining inland peat plateau bog to other peatland types and open water by 2047.

ECOSYSTEM DIVERSITY

Maintaining native biodiversity is fundamental to maintaining overall ecosystem function and ecosystem health. Ecosystem diversity, species diversity and genetic diversity are the three components of biodiversity. Ecosystem diversity refers to the number of different ecosystem types and the distribution of area amongst them at various ecosystem levels. Maintaining ecosystem types that are particularly important in the regional context (*e.g.*, types that are species rich, structurally complex or rare for the Regional Study Area) is key to maintaining regional ecosystem health.

The ecosystem diversity VEC evaluates inland ecosystem diversity. Shoreline wetland ecosystem diversity is addressed by the wetland function VEC (see Section 6.5.3.4).

The Ecosystem Diversity Local and Regional Study Areas were Study Zones 2 and 5 in Map 6-28, respectively. The TE SV Section 2.4.3 provides a detailed description of methods and results.

The detailed habitat mapping (Section 6.2.3.4.1) was used as a proxy for stand level ecosystems because habitat includes most of the major ecosystem components, biomass and controlling factors. Measurable indicators used for ecosystem diversity were the number of native **broad habitat types**, the distribution of area amongst the native broad habitat types, the number of stands representing each native habitat type (ecosystem types represented by only a few stands in the Regional Study Area are more vulnerable to disappearing) and the area of **priority habitat types** (which represented the particularly important ecosystem types). Priority habitat types were those inland broad habitat types that were regionally rare or uncommon, had high plant species richness, were structurally complex, had high potential to support rare plant species and/or of particular interest to the KCNs. The wetland function VEC addresses shoreline wetland habitat types (Section 6.2.3.4.5). The wildlife sections address habitat types that are particularly important to wildlife.

The Regional Study Area included 53 native inland broad habitat types. The distribution of area amongst these was very uneven (Map 6-29; TE SV Table 2.6-1, Table 2.7-2). Three black spruce habitat types (black spruce dominant on thin peatland, black spruce dominant on shallow peatland, and black spruce dominant on ground ice peatland) accounted for nearly 65% of the total land area. In contrast, the 42 least abundant inland broad habitat types covered less than 9% of land area.

The four broad habitat types represented by less than ten stands included balsam poplar dominant on all ecosites, balsam poplar mixedwood on all ecosites, jack pine dominant on shallow peatland, and jack pine mixedwood on shallow peatland. The four broad habitat types represented by ten to 20 stands included white birch dominant on all ecosites, white birch mixedwood on all ecosites, tamarack dominant on mineral and black spruce mixedwood on shallow peatland.

Due to the highly uneven distribution of area amongst the broad habitat types, 43 inland broad habitat types met the regional rarity priority habitat criterion while 28 satisfied at least two priority habitat criteria (TE SV Table 2.7-2). The two rarest habitat types in the Regional Study Area were balsam poplar mixedwood and balsam poplar dominant on all ecosites. Many of the regionally rare and uncommon habitat types were more abundant in the Local Study Area portion of the Regional Study Area, generally located on the esker and along the Nelson River.

The most structurally and/or plant species diverse priority habitat types were tall shrub on shallow peatland, tall shrub on thin peatland, balsam poplar mixedwood on all ecosites trembling aspen mixedwood on all ecosites, black spruce mixedwood on thin peatland, jack pine dominant on mineral, jack pine dominant on thin peatland, jack pine mixedwood on thin peatland, jack pine mixture on shallow peatland, tamarack dominant on mineral, tamarack mixture on mineral, tamarack dominant on thin peatland and tamarack mixture on thin peatland.

Priority habitat types with the highest potential to support rare plant species were jack pine, trembling aspen mixedwood and balsam poplar mixedwood on all ecosites, tamarack on mineral or thin peatland, black spruce mixture and mixedwood on thin peatland, and tall shrub types.

As described in the terrestrial habitat section, past climate change and past human developments have altered habitat composition, which means that ecosystem diversity was also altered. Area losses have been relatively high for the upland priority habitat types, as these are the typical locations for roads, settlements and other infrastructure. Priority habitat types that tend to occur along the Nelson River were also disproportionately affected by the direct and indirect effects of hydroelectric development. While these ongoing adverse terrestrial habitat responses to past human developments are locally important, their magnitude at the regional scale is very small for the native broad habitat types.

Future adjustments in response to past climate and fire regime changes could increase the proportions of the priority habitat types with jack pine, black spruce, aspen and white birch overstories as well as the tall shrub and low vegetation types, while decreasing the proportions of tamarack on thin and shallow peatland types.

INTACTNESS

Intactness is the degree to which an ecosystem remains unaltered by human development and activities that remove habitat and increase fragmentation. Fragmentation is a landscape-level process in which human features progressively subdivide habitat blocks into smaller and more isolated fragments. Fragmentation affects ecosystem processes as well as species. Among other things, fragmentation reduces the size of interior areas, isolates habitat and creates edges. In the context of intactness, edges are the peripheral areas of intact habitat blocks that are adjacent to human features, where the adjacent human features create conditions (*e.g.*, noise) that cause some animals to either partially or completely avoid areas that would otherwise be habitat for them (*i.e.*, reduced effective).

A core area is the interior area of an undisturbed habitat patch that remains after removing the edge area (*e.g.*, the area of reduced effective habitat for animals). Some wildlife species are sensitive to human disturbance and require large core areas (*e.g.*, caribou).

The intactness VEC provides an overall evaluation of intactness for species and ecosystems. Highly sensitive species are addressed separately in the relevant wildlife sections of the TE SV.

The Intactness Local and Regional Study Areas were Study Zones 3 and 5 in Map 6-28, respectively. The TE SV Section 3.2.4 provides a detailed description of methods and existing environment conditions.

Linear feature (*e.g.*, road, transmission line) density and core area percentage were the primary indicators used to evaluate intactness. Evaluations of the spatial and size distribution of linear features and core areas complemented these indicators.

Linear feature density was measured as the number of kilometres of linear features per square kilometre of land area in the Regional Study Area. Core areas were the residual areas left after buffering linear features and other human footprints. Low use linear features (transmission lines, trails, dykes and cutlines) were buffered 200 m while high use linear features (railways and all types of roads) and settlements were buffered 500 m.

Linear Feature Density

The Regional Study Area included 5,628 km, or 0.45 km/km^2, of mapped linear features in 2010. Per lineal kilometre, roads are the linear feature type that has the highest adverse effects on ecosystems and species, especially those that are passable all year. The 738 km of existing roads created a road density of 0.06 km/km^2 in the Regional Study Area, with PR 280 making the largest contribution. The remaining roads occurred around small communities, such as York Landing and Ilford, with about half of these being winter roads (Map 6-30).

Roads and rail lines combined to create a regional transportation density of 0.13 km/km^2. Transmission line density was 0.06 km/km^2.

At 0.30 km/km^2, cutlines made the highest contribution to total linear feature density in the Regional Study Area. The ecological effects of cutlines are expected to be lower than those of other linear features for a variety of reasons (*e.g.*, narrower footprint, lower habitat disturbance). Regarding the access function of linear features, it is likely that portions of cutlines and transmission line rights-of-way are not used as human or wildlife corridors because they are partially overgrown, distant from any current human uses and/or are accessible only in winter due to natural barriers. For example, of the 883 km of cutlines surveyed for vegetation regeneration and game trails in 2011, approximately 35% had regenerated to the degree that they no longer functioned as travel corridors. To illustrate the effect of cutlines on linear density, total linear feature density declined from 0.45 km/km^2 to 0.15 km/km^2 when cutlines were not considered.

There was a very high concentration of linear features near Thompson (Map 6-30), which skewed the linear feature densities for the rest of the Regional Study Area. Whereas the Thompson area comprised only 15% of the Regional Study Area, it included 38% of the linear features. Total linear feature density in the Thompson area was 1.27 km/km^2 compared with only 0.32 km/km^2 in the rest of the Regional Study Area.

Core Areas

Core areas larger than 200 ha accounted for 84% of Regional Study Area land area in 2010. If the minimum core area size is increased to 1,000 ha, then core area percentage only dropped to 83% because almost 98% of total core area occurs in core areas that are larger than 1,000 ha.

The three largest core areas contribute over half of the total core area. The largest core area (270,769 ha) was located north of PR 280 between Split Lake and Long Spruce Generating Station (Map 6-30). The second largest core area (181,147 ha) was located north of PR 280 between Split Lake and Thompson.

While seven islands in the Nelson River had core areas larger than 200 ha, none of these islands had core areas larger than 1,000 ha.

Current Trends

With the exception of the conversion of terrestrial to aquatic areas, the intactness measures capture the cumulative effects of past and existing human developments on intactness. Ongoing Nelson River shoreline erosion resulting from hydroelectric development and natural processes would further reduce core area. Portions of existing cutlines will become overgrown with time, which would increase intactness by reducing total linear feature density and increasing core area. While these ongoing adverse core area responses to past human developments are locally important, their magnitude at the regional scale is very small since they are typically located on the fringes of existing core areas.

WETLAND FUNCTION

Wetland functions are the natural properties or processes that are associated with wetlands, independent of the benefits those functions provide to humans. Among other things, wetlands convert sunlight into biomass, store carbon, create soil, moderate groundwater flows, protect shorelines, contribute to biodiversity and provide high quality habitat not otherwise available for some plant and animal species. Wetlands also provide services to people such as recreational opportunities, hunting areas and drinking water purification. Several medicinal and country food plant species used by Members of the KCNs are exclusively or most commonly found in wetlands (*e.g.*, sweet flag, tamarack).

Due to the high ecological and social importance of wetlands, there are provincial and federal policies related to wetland conservation (Sustainability Manitoba undated; Government of Canada 1991). These policies are particularly focused on regions where wetland losses have already been severe and wetland functions have been dramatically affected. In regions where wetlands are abundant and remain in a relatively pristine condition, it is anticipated that some degree of area loss can be absorbed without adversely affecting wetland function (see TE SV Section 2.8.1).

Focusing on particularly important wetlands for evaluation and mitigation is an appropriate approach for this Project assessment since the Project is located in a region with extensive wetlands that are in a relatively pristine condition except along the Nelson River. The overall Project approach to effects on wetland function was to minimize wetland area loss and alteration, avoid globally, nationally or provincially significant wetlands and achieve no net area loss for other particularly important wetlands.

The Wetland Function Local and Regional Study Areas were Study Zones 2 and 5 in Map 6-28, respectively. Since water regime is the key driver for shoreline wetlands (Section TE SV Section 2.3.2.2), the Regional Study Area was subdivided into shoreline wetland study zones to capture the dramatic differences in water regimes on the Nelson River compared with off-system waterbodies, as well as between segments of the Nelson River (Section 4.3). The Regional Study Area was sub-divided into the Nelson River and off-system zones while the Nelson River was subdivided into the shoreline wetland study zones that coincided with the Split Lake, Keeyask, Stephens Lake and Long Spruce segments of the river (TE SV Nelson River shoreline wetland study zones).

Wetland function was evaluated by assigning an overall wetland quality score to each mapped wetland based on its wetland type. This overall wetland quality score was a combined rating of wetland condition and the anticipated degree to which a particular wetland type normally performs various wetland functions. Since Nelson River shoreline wetlands have been highly disrupted by hydro-electric development in terms of a number of attributes (*e.g.*, reduced native species diversity and peat volume), the evaluation includes consideration of the degree to which the functions normally performed by that wetland type have been adversely affected by human development and activities (*i.e.*, wetland condition).

A particular wetland performs multiple wetland functions to varying degrees. The broad and specific wetland functions used to calculate the overall wetland quality scores were:

- Biogeochemical functions:
    - Carbon storage;
    - Nutrient and organic export;
    - Water quality treatment;
    - Hydrological functions;
    - Climate regulation;
    - Groundwater recharge;
    - Shoreline and erosion protection; and
    - Water flow moderation.
- Biodiversity functions:
    - Regional wetland rarity;
    - Diversity of vegetation types within the wetland;
    - Plant species richness;

- o Habitat for focal wetland wildlife species (waterfowl, muskrat, caribou, moose, olive-sided flycatcher); and
- o High quality habitat for species of concern (caribou, olive-sided flycatcher).

Since wetlands account for most of the terrestrial area in the Local and Regional Study Areas and both study areas were large, it was neither necessary nor practicable to undertake a field evaluation of each individual wetland. Each wetland patch in the habitat map (Section 6.2.3.4.1) was assigned an individual score that reflected the anticipated degree of contribution to wetland function provided on a per hectare basis for each of the above functional components based on its wetland type. The scores for specific wetland functions were derived from Hanson *et al.* (2008), results from Project studies and the scientific literature. These specific wetland function scores were adjusted for wetland condition. For each wetland patch (*i.e.*, each wetland polygon in the terrestrial habitat map), the adjusted individual wetland function scores were summed to produce an overall wetland quality score. Since some species such as caribou select habitat at the wetland complex level rather than the wetland patch level, wetland patches that were part of a caribou calving and rearing complex received an increment to their overall wetland quality score.

Wetlands were classified into a wetland type using the Canadian Wetland Classification System (National Wetlands Working Group 1997) with enhancements to reflect local conditions, including water regulation on the Nelson River. Detailed wetland mapping was completed for Study Zone 4 (Map 6-28) and for off-system waterbodies outside of this study zone that were used as benchmark areas. It was assumed that the wetland composition of the Regional Study Area and Study Zone 4 were similar (see Section 6.2.3.4.1 for rationale). The TE SV Section 2.8.1 provides details on wetland function methods and results.

Wetlands accounted for approximately 90% of the land area in the Regional Study Area in 2010. The Regional Study Area is essentially one large wetland complex that is dotted with mineral-capped ridges and hills (Map 6-31). Bog comprised 91% of the wetland area (Table 6-8), followed by fen (8% of wetland area) and marsh (1% of wetland area). Swamp occurring in patches large enough to map was virtually absent, with none occurring in the Local Study Area.

Shoreline wetlands consisted of lacustrine marsh, stream marsh, riparian fen, riparian bog and shallow water (shallow water was only mapped for portions of the Keeyask shoreline wetland study area where bathymetry data were available to separate shallow from deep water). As noted in Section 6.2.3.4.1, the nature and composition of Nelson River and off-system shoreline wetlands were considerably different. Virtually all of the sub-littoral and lower beach marsh was in off-system waterbodies. Nelson River shoreline wetlands are highly disrupted by water regulation and associated ice scouring, which presumably is why vegetation and plant species diversity in these wetlands were lower than in comparable off-system wetlands.

Approximately 163 ha of Nelson River marsh, which consisted of disturbed, non-native wetland types, were mapped in the Keeyask shoreline wetland study zone during the 2003 to 2005 period. It appeared that extremely high flows and water levels on the Nelson River from 2005 to 2011 eliminated this marsh. Because shoreline wetlands are highly dynamic ecosystems, marsh is expected to redevelop over time once water levels drop to median levels for several growing seasons

Study Zone 4 included 193 ha of off-system marsh, 80% of which was lacustrine bay marsh while the rest was riparian stream marsh. Off-system waterbodies with relatively high amounts of marsh were located along waterways and tended to be situated in the valleys formed by pronounced drumlins, presumably receiving additional nutrient inputs from surface and groundwater flow.

Half of the off-system marsh was growing on the sunken fringes of floating riparian peatlands. Most of the remaining marsh was located in the lower beach and sub-littoral water depth zones, typically growing as a narrow band along the margin of a floating peatland or as patches further away from the water's edge. Patches of floating-leaved plants tended to occur in the sub-littoral zone. Photo 6-13 shows a typical off-system marsh growing on the lake bottom.

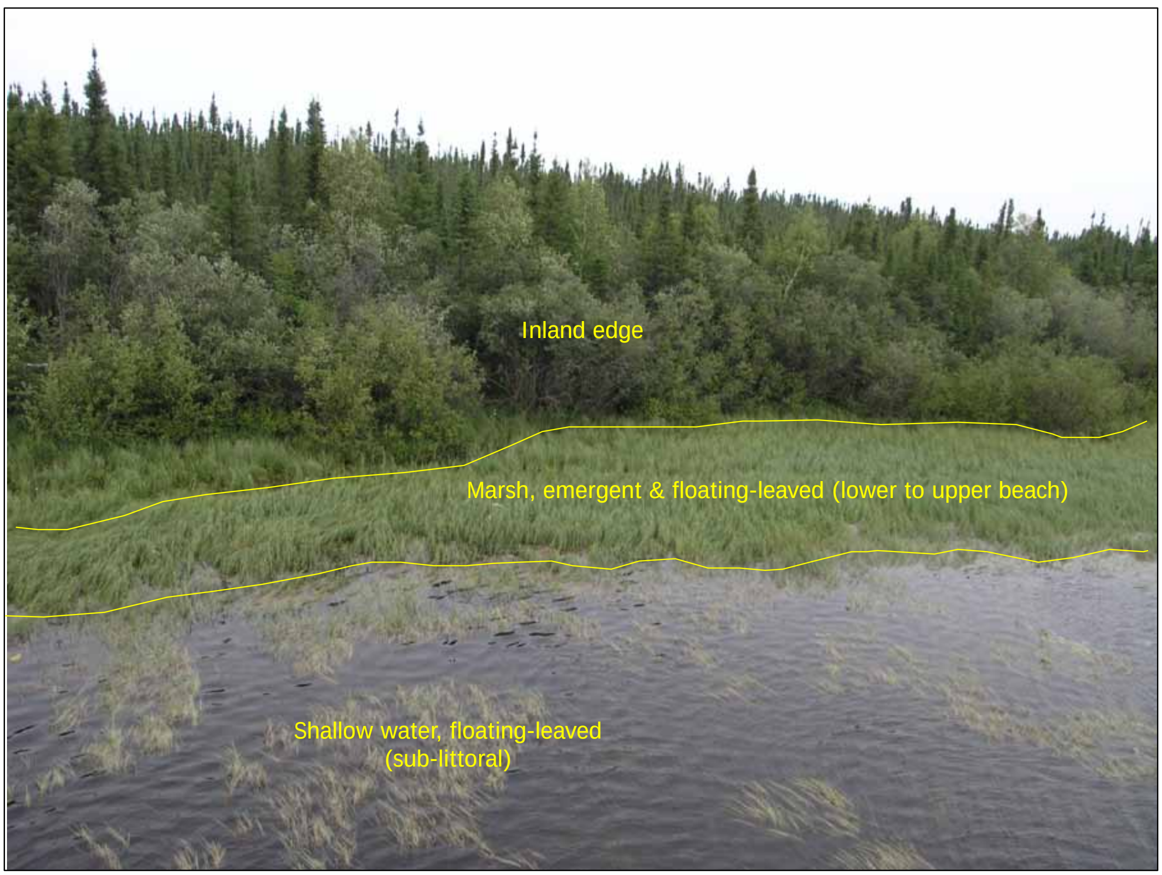


Photo 6-13: Typical Off-System Marsh Growing on the Lake Bottom

Table 6-8: Composition of Existing Wetlands by Wetland Class and Form

Wetland Class	Wetland Form	Study Zone 4	Wetland Function Local Study Area
Swamp	Flat	0.0	–
Bog	Veneer	46.9	50.9
	Slope	1.6	0.6
	Blanket	23.3	22.7
	Peat plateau	5.5	5.0
	Collapse scar	0.2	0.3
	Peat plateau bog/collapse scar mixture	11.0	9.6
	Blanket bog/collapse scar mixture	1.6	–
	Flat	0.7	0.6
	Riparian	0.2	0.1
Fen	Basin	0.0	–
	Slope	0.2	0.2
	Collapse scar	0.0	0.1
	Horizontal	4.4	2.3
	String	0.0	–
	Riparian	3.3	4.9
Fen/Bog mixture	Horizontal fen and blanket bog	0.2	–
Marsh	Lacustrine and stream	1.0	2.8
All		100.0	100.0
Total Area (ha)		*147,566*	*10,461*

Notes: Reported areas are land area only.

As described above, combined ratings for individual wetland functions adjusted for wetland condition were summed to obtain an overall wetland quality score for each wetland type. The off-system marsh wetland types attained the highest overall standard wetland quality scores, which ranged from 60 to 62 (TE SV Section 2.8.3.2.3). Off-system riparian fen types had the next highest overall wetland quality scores (51), but their scores were substantially lower than the off-system marsh scores. The next highest scoring wetland types were the inland swamp types (ranging from 43 to 47). All of the Nelson River shoreline wetland types had low wetland quality scores (ranging from 14 to 18). These disturbed marshes were non-native wetland types for which water regulation has reduced their ability to perform wetland functions.

Study Zone 4 included 193 ha of wetlands scoring at least 60 (*i.e.*, off-system marsh), 12 ha of which were situated in the Local Study Area (Table 6-9; Map 6-32). Over 100,000 ha, or 68%, of wetlands had relatively low wetland quality scores (*i.e.*, less than or equal to 20), primarily due to the high contribution of inland bog types to total wetland area.

The spatial distribution of wetlands scoring at least 60 within Study Zone 4 was the same as that described for off-system marsh in the previous section, since this was the only wetland type falling into the highest score class (even after adjustments for caribou calving and rearing habitat). Wetlands scoring between 42 and 51 (classes 40-49 and 50-59; Table 6-9) were associated with riparian areas, along streams, and were most frequent north and south of Gull Lake and south of Stephens Lakes (Map 6-32).

Table 6-9: Existing Wetland Area by Wetland Quality Score Class

Wetland Quality Score Class	Area (ha)		Percentage of Wetland Area	
	Study Zone 4	Local Study Area	Study Zone 4	Local Study Area
60 - 70	193	12	0.1	0.1
50 – 59	4,255	288	2.9	2.8
40 – 49	168	-	0.1	-
30 – 39	7,387	290	5.0	2.8
20 – 29	34,615	1,826	23.5	17.5
10 – 19	100,947	8,045	68.4	76.9
All	*147,566*	*10,461*	*100.0*	*100.0*

Ongoing responses to past and existing human impacts and past climate change are expected to continue to drive future changes in wetland function and wetland condition in the Regional Study Area even if the Project does not proceed. Ongoing shoreline erosion (TE SV Section 2.2.4) will continue to remove and alter off-system wetlands. There may also be lagged effects on wetlands where human infrastructure such as roads have altered hydrology. While these ongoing adverse wetland area responses to past human developments are locally important, their magnitude at the regional scale is very small since the amounts of area affected are relatively small.

Future adjustments in response to past climate change are expected to lead to the disappearance of the ground ice peatland types, which are likely to be replaced by wet peatland types and open water. While effects on overall wetland function should be relatively low since these types have similar overall wetland quality scores, there may be changes to total contributions for specific wetland functions.

6.2.3.4.3 TERRESTRIAL PLANTS

Terrestrial plants perform key functions in Keeyask ecosystems. Among other things, they provide food and shelter for wildlife, contribute to soil development, store carbon and ultimately are the source for most life because they convert solar energy to biomass. Some plant species are particularly important for ecological reasons (*e.g.*, they are rare species) and/or social reasons such as food and cultural importance to KCNs. In contrast, invasive and non-native plants are considered a threat to other plant species and to ecosystems because they can crowd out native species and alter ecosystems.

This section of the EIS describes the existing environment for terrestrial plants, focusing on invasive plants as the supporting topic and priority plants as the VEC. Invasive plants are defined as plant species that are growing outside of their country or region of origin and are able to out-compete or replace native plants (ISCM 2012b). Priority plants are the native plant species that are particularly important for ecological reasons and/or social reasons. Specifically, priority plants are plant species that are highly sensitive to human features, make high contributions to ecosystem function and/or are of particular interest to the KCNs. A plant species was considered to be highly sensitive to human features if it is globally, provincially or regionally rare, near a range limit, has low reproductive capacity, depends on rare environmental conditions and/or depends on the natural disturbance regime.

Study Zones 2 and 5 in Map 6-28, respectively, were used as the Terrestrial Plants Local and Regional Study Areas.

Project effects on invasive plants were evaluated in terms of the risk of the Project increasing the rate at which invasive plants are introduced and/or spread.

The assessment approach for each priority plant was based on the degree of concern regarding potential Project effects. Each of the globally rare, nationally rare and provincially very rare plant species were assessed individually, with particularly high emphasis on those that are endangered, threatened, globally rare (*i.e.*, ranked G1 to G2 by MBCDC) or provincially rare (*i.e.*, ranked S1 to S2 by MBCDC). Too many plant species met the remaining priority plant criteria to assess each of them individually. These remaining species were assessed in groupings that reflected their reasons for inclusion as priority plants.

Indicators for priority plants varied with the degree of concern related to the species and the availability of sufficient local information to evaluate the distribution, abundance and habitat associations of a species. Depending on the species, indicators included distribution, abundance, number of known locations and/or amounts of available habitat. The TE SV Section 3 provides further details regarding methods and results for the terrestrial plant assessment.

Vascular and Non-Vascular Plants

The plant species found in the Regional Study Area are typical of the central Canadian boreal forest, consisting primarily of species that are tolerant of the cold, harsh climate and can grow in peatlands. Available information indicated that over 750 vascular terrestrial plant species could potentially occur in the Regional Study Area. Of this total, 304 species and 46 species groups (*e.g.*, species only identified to the genus level in the field) were detected in the Regional Study Area during field studies. Project studies only attempted to identify the most common and abundant ground mosses and lichens in the field. Based on field data and ground layer samples collected at the terrestrial habitat plots, 88 mosses, six lichens and two liverworts were identified to either a species or a broader taxon. Appendix 3B of the TE SV (Section 3) provides species lists with common names, scientific names, MBCDC conservation concern ranking (*i.e.*, G-Rank and S-Rank) and the number of locations where the species was found during the terrestrial habitat and plant studies.

In descending order, the most widespread and abundant inland plant species recorded during field studies were black spruce (*Picea mariana*), green alder (*Alnus viridis*), Bebb's willow (*Salix bebbiana*), myrtle-leaved willow (*S. myrtillifolia*), flat-leaved willow (*S. planifolia*), bog willow (*S. pedicellaris*), swamp birch (*Betula pumila*) Labrador tea (*Rhododendron groenlandicum*) and rock cranberry (*Vaccinium vitis-idaea*). The most widespread shoreline wetland plants were marsh reed-grass (*Calamagrostis canadensis*), common horsetail (*Equisetum arvense*) and water sedge (*Carex aquatilis*). More beach and sub-littoral zone species occurred in off-system waterbodies. Species only found in off-system waterbodies included bitter-cress (*Cardamine pensylvanica*), wooly sedge (*Carex pellita*), thread rush (*Juncus filiformis*), small yellow pond-lily and several pondweed species.

INVASIVE PLANTS

Invasive plants are widely considered to be a threat to species and ecosystems. Highly invasive plants can crowd out other plant species and, in extreme cases, extirpate species and alter vegetation composition, ecosystem diversity and other ecosystem attributes.

Invasive plants are introduced and spread by human activities and natural dispersal mechanisms. Invasive plants are spreading in Manitoba.

Field studies detected all of the 19 invasive plants known to occur in the Regional Study Area. The majority of these species generally occurred in disturbed areas, such as along PR 280 or in borrow pits, or along Nelson River shorelines having substrates similar to those in human-disturbed inland areas.

Reed-canary grass (*Phalaris arundinacea*), the only detected invasive plant that is currently classified as highly invasive, was found at 27 locations in the Regional Study Area, primarily along Nelson River shorelines. Purple loosestrife (*Lythrum salicaria*) and leafy spurge (*Euphorbia esula*), the other species classified as being highly invasive, have not been recorded in the Regional Study Area to date. Purple loosestrife has been extending its range northward in Manitoba.

Moderately invasive species found at 39 locations (primarily along roadsides) included smooth brome grass (*Bromus inermis*), Canada thistle (*Cirsium arvense*) and yellow and white sweet-clover (*Melilotus officinalis* and *M. albus*).

The risk that any of these invasive plants will become a problem in the Local Study Area is likely low, particularly over the short-term. Field studies conducted near existing developments in northern Manitoba indicated that invasive plants have been largely confined to human-disturbed areas and have not been crowding out native plant species in adjacent native habitat.

PRIORITY PLANTS

The priority plant list consisted of 101 vascular plants. See TE SV Section 3 Table 3.7-20 for the species list, their MBCDC conservation concern ranking (G-Rank and S-Rank), their reasons for inclusion as a priority plant species, the number of sample locations where the species was found at in the Local and Regional Study Areas, and very general habitat associations from MBCDC and the literature.

None of the endangered, threatened or globally rare species were found or are expected to occur in the Regional Study Area. All of these species are prairie species except for flooded jellyskin lichen (*Leptogium rivulare*). Flooded jellyskin lichen is not expected to occur in the Local Study Area because the Project is not near an existing known flooded jellyskin location, water levels on the Nelson River are highly variable, shorelines along the Nelson River are subject to water currents and ice scouring, its required microhabitat is rare in waterbodies off the Nelson River (*i.e.*, rock outcrop or broadleaf tree trunks located in the water fluctuation zone), and lichens were generally not observed along the waterline of the waterbodies that could be affected by the Project. A representative from the Canadian Wildlife Service confirmed that flooded jellyskin is not likely to occur in the Project area for these reasons (Bazin *pers. comm.* 2012).

None of the 13 provincially very rare species that could potentially occur in the Regional Study Area were found during field studies. One species with an uncertain rare or very conservation concern ranking, elegant hawk's-beard (*Crepis elegans*), was found at nine roadside locations.

Field studies recorded seven of the 45 provincially rare to uncommon plant species that could potentially occur in the Regional Study Area, including small pondweed (*Potamogeton pusillus* ssp. *tenuissimus*), Robbin's pondweed (*Potamogeton robbinsii*), shrubby willow (*Salix arbusculoides*), rock willow (*Salix vestita*), horned pondweed (*Zannichellia palustris*), oblong-leaved sundew (*Drosera anglica*) and American milk-vetch (*Astragalus americanus*). All species except for American milk-vetch were more regionally common than suggested by their provincial conservation concern rank, being found at more than 25% of locations sampled in appropriate habitat. American milk-vetch, which was recorded in a few locations at the eastern end of the Regional Study Area, was found at a larger number of locations to the northeast of the Regional Study Area.

Of the remaining 42 priority plants, 27 were regionally rare and/or near a range limit. Range limit species included jack pine (*Pinus banksiana*), shrubby willow, rock willow, northern Labrador tea (*Ledum palustre* ssp. *decumbens*), wolf-willow (*Elaeagnus commutata*), elegant hawk's-beard, hairy goldenrod (*Solidago hispida*), arctic wintergreen (*Pyrola grandiflora*) and small yellow pond-lily (*Nuphar lutea* ssp. *variegata*).

Plants of particular interest to the KCNs were sweet flag (*Acorus americanus*; locally known as ginger root in English; *wekes*, *wekas* or *wihkis* in Cree), white birch (*Betula papyrifera* and *B.neoalaskana*; *asatee* in Cree), strawberries (*Fragaria virginiana*; *odahihminah* in Cree), northern Labrador tea, currants and gooseberries (*Ribes triste or R. lacustre*; *ekomina* or a*nikimina* in Cree), cloudberries (*Rubus chamaemorus*; *ostikonihminah* in Cree), red raspberry (*Rubus ideaus*; *anouskanuk* in Cree), dewberry (*Rubus pubescens*; *ooskeesihikoominh* in Cree), blueberries (*Vaccinium uliginosum*; *niskeminah* in Cree) and cranberries (*Vaccinium vitis-idaea*; *wesahkeminah* in Cree). Most of these species are common in their preferred habitats. Exceptions are ginger root and northern Labrador tea. Ginger root was not found during field studies. Northern Labrador tea was recorded at seven locations in the Regional Study Area.

6.2.3.4.4 Terrestrial Invertebrates

Invertebrates comprise 97% of all known animal species in the world. Invertebrates are currently classified into 30 phyla, many of which occur in aquatic environments (TE SV Chapter 4). Terrestrial invertebrates (those that spend their adult life on land) are represented within four phyla:

- Nematoda (unsegmented worms, *e.g.*, roundworms);
- Annelida (segmented worms; *e.g.*, earthworms);
- Mollusca (*e.g.*, snails); and
- Arthropoda (*e.g.*, spiders, insects, crayfish).

Both the terrestrial and aquatic habitats present within the Terrestrial Invertebrate Regional Study Area (Study Zone 4 in Map 6-28) provide important habitat for terrestrial invertebrates. The diversity of plant communities in the boreal forest zones, including the Regional Study Area, gives rise to equally diverse terrestrial invertebrate communities.

Such invertebrate communities include species living in the soil (nematodes, earthworms), on the ground (beetles, spiders), in the air (butterflies, moths, flies), and within the vegetation canopy (spiders, aphids, beetles). Terrestrial invertebrates are ecologically important for their role as nutrient cyclers and decomposers (*e.g.*, earthworms), as predators of pest species, as pollinators of flowering plants (*e.g.*, bees) and as food for other animals (*e.g.*, birds).

None of the invertebrate species listed as rare by the Manitoba Conservation Data Centre (MBCDC) or those listed under the *Manitoba Endangered Species Act* (MESA) or the federal *Species at Risk Act* (SARA) are expected to occur within the Regional Study Area, or were found incidentally during several years of field studies. Given this, no invertebrate-targeted field studies were conducted for terrestrial invertebrates. Terrestrial invertebrate communities are therefore described and assessed based on existing literature for boreal ecosystems, which are considered representative to the Regional Study Area (TE SV Section 4).

Without the Project, terrestrial invertebrates will continue to be affected by changes in habitat availability resulting from a number of factors including: fire, forest succession, beaver activity and disease. Current trends for terrestrial invertebrates inhabiting the boreal forest include greater occurrences of insect outbreaks and changes in spring hatch times (Fleming and Candau 1998).

6.2.3.4.5 AMPHIBIANS AND REPTILES

None of the reptile species native to Manitoba are known to have breeding ranges that extend as far north as the Keeyask region, and none were observed during environmental baseline studies. CNP's ATK has noted some reptile species in habitat such as northern ribbed fens (CNP Keeyask Environmental Evaluation Report). As reptile species are not readily found in the Keeyask region, they are not discussed any further in this document (see TE SV for details).

The Amphibian Regional Study Area (Study Zone 4 in Map 6-28) supports two species of amphibians, the boreal chorus frog (*Pseudacris triseriata maculate*) and wood frog (*Rana sylvatica*). Both species are considered common and widespread throughout the Regional Study Area, concentrating in areas where suitable breeding habitat exists (*e.g.*, small ponds, marshes).

While the historical breeding range for the northern leopard frog (*Lithobates pipiens*) includes part of the Regional Study Area, none were detected during environmental studies. During the mid-1970s, the breeding range of this species contracted following severe population declines across much of the prairie provinces (Koonz 1992). FLCN's ATK indicates that northern leopard frogs have declined in the Keeyask area since hydro development; and have not been seen for many years (FLCN Environment Evaluation Report (Draft)). The northern leopard frog is a priority amphibian as it is classified by SARA (*Schedule 1*) and the Committee on the Status of Endangered Wildlife in Canada (COSEWIC 2007) as being of special concern due to population declines throughout most of Western Canada. Since this species was not observed over the course of the 10-year baseline sampling period, and has little potential to be affected by the Project, it was not selected as a VEC for this assessment.

Boreal chorus and wood frog breed in localized populations throughout the Regional Study Area. Breeding commences soon after ponds thaw, usually in May. After the courtship and egg laying period, adult frogs generally spend their time foraging in adjacent areas, usually within 100 m of water (Gibbs 2000). Juvenile frogs can disburse far from water, up to one kilometre when searching for new breeding areas (Berven and Grudzien 1990). Wood frogs and boreal chorus frogs spend winters on the forest floor, under leaf litter and woody debris at or near the ground surface, while northern leopard frogs hibernate in lake-bottom mud. Frogs emerge from hibernation in the early spring (March–April), often moving short distances to breeding areas, which may include seasonal pools, shallow ponds and lake edges (Preston 1982; Government of B.C. 2002).

Without the Project, frog populations within the Regional Study Area are anticipated to continue to be affected by changes in breeding habitat quality and availability resulting from natural variations in seasonal precipitation and/or climate change. Over time, the northern leopard frog populations may repopulate parts of its former range, including the Regional Study Area.

6.2.3.4.6 BIRDS

Approximately 178 bird species potentially breed within or migrate through the bird Local and Regional Study Areas (Study Zones 3 and 4 in Map 6-28). Of these 178 species, 155 are migratory, overwintering in southern areas and breeding in the Regional Study Area and/or in areas further north. The remaining 23 species are residents, which breed and overwinter within the Regional Study Area. Between 2001 and 2011, 124 different species were observed during the ground-based, boat-based and helicopter-based bird surveys (further detail on methods used to gather bird-related information is provided in the TE SV, Appendix 6.10.1).

Shallow bays, inlets and creek mouths of the Nelson River (including Gull Lake), and off-system (*i.e.*, not part of the Nelson River) inland lakes, together provide waterbirds (*e.g.*, ducks, geese, swans, grebes, herons, rails, cranes, shorebirds, kingfishers) with staging habitat during the migration seasons. Inland lakes, creeks and wetlands provide key breeding habitats for many waterbirds including ducks, shorebirds and sandhill cranes *(Grus canadensis)*.

Within the Regional Study Area, the diverse terrestrial habitats and abundant food sources (*e.g.*, insects, seeds) support several landbird species (*e.g.*, songbirds, woodpeckers, upland game birds, raptors, nighthawks), including resident species (*e.g.*, gray jay [*Perisoreus canadensis*], ruffed grouse [*Bonasa umbellus*], and boreal owl [*Aegolius funereus*] that inhabit the Regional Study Area year-round.

Birds are a key food source for the KCNs, with spring and fall hunts important community events. For FLCN, the spring goose hunt has become increasingly important both for the food harvested and as a tradition that welcomes and celebrates the spring season (FLCN

2012). YFFN Community Members travel within the Split Lake and York Landing area, as well as to the coastal area for their spring goose hunt (YFFN 2012; See the Resource Use section of the SE SV for further details on importance of bird species as a food source).

A number of factors, including fire, weather, disease, insect populations, human development, hunting, and climate change, affect bird communities inhabiting the area. Some of the bird species at risk (*e.g.*, rusty blackbird [*Euphagus carolinus*] have been and will likely continue to experience population declines due to loss of overwintering habitats (COSEWIC 2006). Other species (*e.g.*, turkey vulture [*Cathartes aura*]) have increased in abundance and have been expanding their range into northern areas because of climate change, increased availability of food sources and loss of habitat (Cox 2010).

The following section provides a brief overview of the bird community, first by bird group, and then more specifically into priority birds that includes the six bird VECs (mallard [*Anas platyrhynchos*], Canada goose [*Branta canadensis*], bald eagle [*Haliaeetus leucocephalus*], olive-sided flycatcher [*Contopus cooperi*], rusty blackbird [*Euphagus carolinus*] and common nighthawk [*Chordeiles minor*]), as well as other priority birds (*i.e.*, species highly sensitive to human features and/or favoured for use by local people; Section 6.2.3.4). Species highly sensitive to human developments are those species that are globally, provincially or regionally rare, are near a range limit, have low reproductive capacity and/or depend on rare environmental conditions/features (*e.g.*, rare habitats). Twenty-six priority bird species have been identified and are discussed within their respective bird groups.

BIRD GROUPS

Waterbirds

Colonial Waterbirds

Seven species of colonial waterbirds occur within the Regional Study Area: ring-billed gull (*Larus delawarensis*), herring gull (*Larus argentatus*), Bonaparte's gull (*Chroicocephalus philadelphia*), common tern (*Sterna hirundo*), black tern (*Chlidonias niger*), Caspian tern (*Sterna caspia*), American white pelican (*Pelicanus erythrorhynchos*) and double-crested cormorant (*Phalacrocorax auritus*). Herring gull, ring-billed gull and common tern are the most abundant and widespread colonial waterbird species known to breed in the area (Map 6-33). These three species are priority birds due to their use of rare environmental features (*e.g.*, rocky reefs and islands) for breeding. While less common than other gulls, Bonaparte's gulls are also found along the Nelson River, often nesting alone or in small groups on the tops of spruce trees near the river and/or along the edges of inland lakes. Nesting habitat for this species is abundant and widespread throughout the Regional Study Area. Less common species include American white pelican, Caspian tern, black tern and double-crested cormorant, all of which are considered priority birds due to their range limitations.

Waterfowl

Waterfowl observed in the Regional Study Area include 23 species of ducks, four species of geese, and one species of swan (*i.e.*, tundra swan). Common waterfowl observed using Gull Lake and the surrounding area included Canada goose, mallard, American wigeon (*Anas americana*), common goldeneye (*Bucephala clangula*), lesser scaup (*Aythya affinis*), common merganser (*Mergus merganser*) and white-winged scoter (*Melanitta fusca*). The KCNs place considerable value on Canada geese and mallards as both species have and continue to be harvested locally from the Nelson River, including portions of Gull Lake as well as inland lakes (*e.g.*, Cache Lake) and rivers (*e.g.*, Kettle River; FLCN 2010 Draft). Canada goose and mallard are VECs, and as such are discussed further in the bird VEC section.

Uncommon waterfowl species include those at the edge of their range relative to the Regional Study Area: redhead (*Aythya americana*), canvasback (*Aythya valisineria*) and gadwall (*Anas strepera*), all of which are discussed under priority birds.

Rails and Cranes

The yellow rail (*Coturnicops noveboracensis*), sora rail (*Porzana carolina*), and sandhill crane all have breeding ranges that include the Regional Study Area. During the breeding period, sandhill cranes were observed along the edges of inland lakes and in bogs, while sora rails were noted using densely vegetated ponds. Yellow rails, a priority bird due to its regulatory status, were not observed in the Regional Study Area, despite the nocturnal surveys carried out in sedge-dominated peat bogs and extensive early morning breeding bird surveys carried out between 2001 and 2011. Lack of suitable water levels is one factor affecting the suitability of these areas as breeding habitats.

Shorebirds

Twenty-one shorebird species are expected to breed within or migrate through the Regional Study Area. Of these 21 species, killdeer (*Charadrius vociferus*), greater and lesser yellowlegs (*Tringa melanoleuca* and *Tringa flavipes*), spotted sandpiper (*Actitis macularius*), solitary sandpiper (*Tringa solitaria)* and Wilson's snipe (*Gallinago delicata*) were the most common shorebirds observed during field studies. The red knot (*Calidris canutus*) is a priority bird listed as endangered under COSEWIC. Although it was not observed during the 2001–2011 field investigations, it may occur in the Regional Study Area during migration.

Kingfishers

The belted kingfisher is the only kingfisher species with a breeding range that overlaps with the Regional Study Area. A consumer of small fish, the belted kingfisher nests in earthen banks along the Nelson River and forages in clear water found in creeks and inland lakes. Recent Breeding Bird Survey (BBS) data (Kelly *et al.* 2009) noted slight increases in belted kingfisher populations in Manitoba. Otherwise, populations of belted kingfishers are known to be declining in other parts of their range due to loss and degradation of riparian nesting and foraging habitat, exposure to pollutants, and human disturbance (COSEWIC 2012).

Landbirds

Songbirds

Of the 76 songbird species that breed within the Regional Study Area, 66 are migratory and 10 are permanent residents (*e.g.*, boreal chickadee [*Poecile hudsonicus*]). Most of these songbird species breed in the coniferous forests, bogs and riparian habitats that are widespread and abundant throughout the Regional Study Area. Some species are generalists, occurring in almost all boreal habitats where coniferous trees are present (*e.g.*, yellow-rumped warbler [*Dendroica coronata*]), while others are more specific in their habitat needs (*e.g.*, yellow warbler [*Dendroica petechia*], olive-sided flycatcher [*Contopus cooperi*]).

Six songbird species were designated as priority birds. They include regionally rare and/or listed species (*i.e.*, olive-sided flycatcher and rusty blackbird [*Euphagus carolinus*]) and species at the edge of their breeding range (*i.e.*, pine siskin [*Carduelis pinus*], ruby-throated hummingbird [*Archilochus colubris*], clay-colored sparrow [*Spizella pallida*], and blue-headed vireo [*Vireo solitarius*]). Olive-sided flycatcher and rusty blackbird are VECs due to their regulatory status under SARA.

Woodpeckers

Six species of woodpecker occur within the Regional Study Area: hairy woodpecker (*Picoides villosus*), downy woodpecker (*Picoides pubescens*), three-toed woodpecker (*Picoides tridactylus*), black-backed woodpecker (*Picoides aroticus*), yellow-bellied sapsucker (*Sphyrapicus varius*), and northern flicker (*Colaples auratus*). Within the Regional Study Area, the yellow-bellied sapsucker is considered the least common of the woodpecker species due to limited habitat availability. As a range limited species, the yellow-bellied sapsucker is discussed further as a priority bird under “other priority birds”.

Based on field studies, woodpeckers were most common in areas supporting mature deciduous trees (*e.g.*, *Populus* spp.) and in areas of regenerating forest where dead standing trees remain. Dead or dying trees provide most woodpecker species with a source of food (*e.g.*, insects) and nesting habitat.

Woodpeckers are important for their role in creating cavities or holes in dead or dying trees. Various bird species (*e.g.*, common goldeneye [*Bucephala clangula*], boreal chickadee, and tree swallow [*Tachycineta bicolor*]), including woodpeckers, use these tree cavities for nesting and/or as cover when escaping predators.

Raptors

Nineteen raptor species (eagles, hawks, falcons, ospreys and owls) potentially occur within the Regional Study Area. Fifteen of these raptor species are expected to breed within the Regional Study Area, with four species migrating through the area to northern breeding grounds. The most common raptor observed during environmental studies was the bald eagle, a migratory bird that was designated as a VEC in part due to it being highly valued by the KCNs (see discussion of this species under bird VECs). Red-tailed hawk (*Buteo jamaicensis*) and northern harrier (*Circus cyaneus*) were common in inland habitats, with harriers most often observed in open bogs. Northern hawk owl (*Surnia ulula*), boreal owl (*Aegolius funereus*) and great grey owl (*Strix nebulosa*) were the most common owl species detected in the Regional Study Area.

Osprey (*Pandion haliaetus*) is a fish-eating bird that forages in clear water lakes and rivers found throughout the Regional Study Area. Within the region, osprey were most often observed foraging in inland lakes and rivers and along parts of the Nelson River upstream of Birthday Rapids (TE SV, Section 6). Between 2001 and 2011, 15 observations of osprey occurred within the Regional Study Area. Two of these observations included nests: one osprey nest was located on the north side of Gull Lake and one was on the edge of the Regional Study Area, just southwest of Gillam.

Although considered uncommon in the Regional Study Area, turkey vultures (*Cathartes aura*) have recently been observed in areas along the Nelson River (in the town of Gillam). This scavenger has been expanding its range northward due to the availability of food sources (*e.g.*, road kill, garbage dumps).

Upland Game Birds

Three species of upland game bird have breeding ranges that overlap with the Regional Study Area: ruffed grouse (*Bonasa umbellus*), spruce grouse (*Falcipennis canadensis*), and sharp-tailed grouse (*Tympanuchus phasianellus*). Willow ptarmigan (*Lagopus lagopus*) occur within the Regional Study Area as a winter resident. All four species are harvested in the local area and provide an important food source for KCNs and other local resource users.

Spruce grouse is the most common of the three grouse species inhabiting the Regional Study Area. Their preferred breeding habitat, coniferous forest, is abundant and widespread throughout the area. Sharp-tailed grouse, a priority bird, is at the northern extent of its breeding range relative to the Regional Study Area (Manitoba Naturalists Society 2003). Their populations are not widespread or abundant due to the limited availability of their preferred breeding habitat, open treeless bogs or fens with limited shrub growth.

Like sharp-tailed grouse, ruffed grouse are also a priority bird due to range limitations. Ruffed grouse require specific breeding habitats that are not widespread or abundant throughout the Regional Study Area (TE SV, Section 6). Ruffed grouse require mature broadleaf forests (or deciduous dominated forests) that contain downed woody debris (for drumming) and dense tall shrub understories (for concealment cover; TE SV, Section 6). While preferred foods include buds from aspen, the buds from birch, willow and alder are also consumed. Other summer foods include seeds, fruits, berries and leaves, with buds and twigs taken in winter (Rusch *et al.* 2000). Plant material taken depends on location within geographic range and local and seasonal availabilities.

Willow ptarmigan overwinter in the Regional Study Area and breed in areas further north (*e.g.*, tundra). During the winter they use forest and wetland edges where food (*e.g.*, willows) and shelter (*e.g.*, deep snow) is abundant. Due to their value as an important winter food source by the KCNs, ptarmigan are discussed further as a priority bird under "other priority birds".

Nighthawks

Common nighthawk nest on bare ground found in open woodlands and forage on flying insects in open areas, including recent burns, wetlands, beaver floods and lakeshores (Map 6-34). Common nighthawk is a VEC primarily because it is listed as threatened under SARA due to marked population declines since the 1970s (Peterson 2002). Population declines have been observed over most of the common nighthawk range, including the Regional Study Area. Common nighthawks were known to be more abundant within the Regional Study Area but have since declined in recent years (FLCN 2010 Draft).

BIRD VALUED ENVIRONMENTAL COMPONENTS

Approximately 178 bird species were observed in the Regional Study Area. To focus the assessment to those species most vulnerable to Project features and/or valued by people, a listing of priority birds was developed based on the following criteria:

- Species listed as rare by Manitoba Conservation Data Centre (MBCDC);
- Species listed under MESA, SARA and/or by COSEWIC;
- Species at the edge of their breeding range relative to the Regional Study Area;
- Species dependent upon rare environmental features (*e.g.*, rocky reefs, rocky islands); and
- Species valued by KCNs.

Six of the 27 priority birds met the criteria to be selected as VECs (TE SV, Section 6.2.3.4 and Appendix 1.8) while the remaining 21 are discussed as 'other priority birds'.

All six bird VECs are migratory. Two are waterfowl (mallard and Canada goose) one is a raptor (bald eagle), two are songbirds (olive-sided flycatcher and rusty blackbird), and one is a nighthawk (common nighthawk). The olive-sided flycatcher, rusty blackbird and common nighthawk have federal protection under SARA.

Canada Goose

The Canada goose is most abundant along the Nelson River and Gull Lake during the spring and fall migration periods. During years with low water levels, the bays, inlets and creek mouths associated with these reaches can provide suitable forage, shelter and cover for large flocks of migrant geese. These bays and inlets are not only important to Canada geese but also to the KCNs Members and other local resource users that use them during the spring and fall goose hunts (TCN *pers. comm*. 2011). Off-system lakes (*e.g.*, small lake south of Gull Rapids), creeks and rivers are also used by geese during the migration period, especially in the spring when larger waterbodies are still ice covered and unavailable to geese. Many of these inland areas (*e.g.*, Cache Lake, Butnau River, Kettle River) are important hunting areas, and serve as traditional goose hunting sites used by the KCNs during the spring and fall bird migration periods (CNP Keeyask Environmental Evaluation Report; FLCN 2010 Draft). Both the YFFN and FLCN evaluation reports also refer to Members hunting geese in the spring (YFFN Evaluation Report (*Kipekiskwaywinan*); FLCN Environment Evaluation Report (Draft)). The FLCN Environment Evaluation Report recognizes that waterfowl and other migratory birds use environments other than the Keeyask area; and are only present in the Keeyask area for a limited timeframe (*e.g.*, spring and fall migration) (FLCN Environment Evaluation Report (Draft)).

The Canada goose is a grazer of upland plants (*e.g.*, grasses) and occasionally emergent (*e.g.*, sedges) and submergent plants and seeds (Prevett *et al.* 1985; Godfrey 1986). They migrate through the Regional Study Area in May, stopping over on Gull Lake and parts of the Nelson River before making their way northward to their preferred breeding grounds (*e.g.*, the Hudson Bay Lowlands). Between 2001 and 2003, the average density of Canada geese using Gull Lake in May was 3 birds/km^2 and 6 birds/km^2 in September (TE SV). While some Canada geese breed in the Local Study Area (often on islands located in inland lakes supporting sedge), they are relatively uncommon during the breeding and brood-rearing period. Optimal Canada goose breeding habitat (*e.g.*, floating/anchored bog/fen) is rare in the Regional Study Area and availability of adequate forage (*e.g.*, sedge) along the Nelson River is limited, especially in years when river water levels are above average.

Without the Project, the availability of suitable goose staging habitat along the Nelson River and Gull Lake will continue to be influenced by changes in river water levels. Goose harvest by local First Nation communities is expected to continue during the spring and fall migration periods.

Mallard

Mallards are dabbling ducks that feed on plant material (*e.g.*, pondweed and sedges) and aquatic insects (*e.g.*, amphipods) in shallow water (Bartonek 1972; Bellrose 1976; Godfrey 1986). They are highly valued by the KCNs as a traditionally hunted species that not only migrates through but also breeds within the Regional Study Area. In the Regional Study Area, suitable mallard foraging and brood-rearing habitat (*i.e.*, concealment cover) is associated with inland lakes and creeks that support marsh habitat. CNP Members have noted the importance of inland wetlands such as fens for ducks and migrating birds (CNP 2012). In boreal regions, including the Regional Study Area, mallards generally nest within 270 m of water (Ducks Unlimited 2010; Bellrose 1976; Godfrey 1986).

While Gull Lake provides mallards with limited brood-rearing habitat, it does provide suitable staging habitat during the spring and fall migration seasons. Based on results from 2001–2011 environmental field studies, the average density of mallards on Gull Lake in the spring and fall was 2.3 birds/km^2 and 7 birds/km^2, respectively. This is high relative to fall mallard densities observed on the north arm of Stephens Lake (0.6 mallards/km^2) and other boreal lakes such as Wuskwatim Lake (0.5 mallards/km^2) (Manitoba Hydro and Nisichawayasihk Cree Nation 2003).

The results of field studies indicate that water levels appear to have a large influence on the abundance and distribution of waterfowl along the Nelson River. YFFN has indicated fewer geese and ducks in the Split Lake area because the shoreline habitat that they use has been flooded and eroded (YFFN Evaluation Report (*Kipekiskwaywinan*)). FLCN states that after hydro flooding and the loss of stable shorelines, the number of nesting waterfowl declined (FLCN Environment Evaluation Report (Draft)). This and other ATK regarding water level effects, further illustrates that waterfowl are influenced by water level changes.

Without the Project, the availability of mallard breeding habitat is not expected to change substantially. The warmer and wetter conditions predicted for the region may benefit mallards through increased stream flows for brood-rearing, however higher water levels may inundate emergent vegetation thereby reducing the availability of brood concealment cover. Climate change scenarios are described in Section 6.3.12.1 (the sensitivity of effects to climate change). The quality of inlets and bays along the Nelson River and Gull Lake as staging habitat for mallards will continue to vary depending upon river water levels. Loss of wetland habitat on the prairies (due to potential factors such as climate change and wetland changes related to agriculture) may lead to an increased use of boreal habitats (including the Regional Study Area) by mallards.

Bald Eagle

The bald eagle is the most common and abundant raptor inhabiting the Regional Study Area. It is also a highly valued species by KCNs Members. Bald eagle diet consists predominantly of fish, but carrion, birds and small mammals are also consumed. Bald eagles typically migrate into the Regional Study Area in March or April and initiate nesting shortly thereafter. While nests are often reused from the previous year, new ones may also be constructed. Nests consist of sticks and commonly occur in tall trees adjacent to water (Godfrey 1986). Most bald eagle nests observed in the Regional Study Area occur along the Nelson River where forage (primarily medium- and larger-bodied fish) is abundant. Based on field observations, approximately 11 eagle nests currently occur along the Nelson River shoreline between and including Split Lake and Gull Rapids (Map 6-35). Five of these nests occur between Birthday Rapids and Gull Rapids. Each year, most of the 11 nests are used by one nesting pair of adult bald eagles. Bald eagles breeding along the Nelson River typically raise two young that leave the nest by mid-August.

Between 2001 and 2011 the average density of bald eagles inhabiting the Nelson River (between and including Split Lake to Kettle Generating Station) was 0.8 birds/km^2. The average density between Birthday Rapids and Gull Rapids was 0.5 birds/km^2. Eagle densities are similar to those observed in other boreal areas including along the Burntwood River near Wuskwatim Lake, which was generally less than 0.7 eagles/km^2 (Manitoba Hydro and Nisichawayasihk Cree Nation 2003). Along the Nelson River, spring densities averaged 0.2 eagles/km^2, increasing to 1.3 birds/km^2 in July with the arrival of non-breeders. Densities remained high through September (average of 1.0 eagles/km^2), declining in October with the onset of migration.

Within the Regional Study Area the highest average bald eagle densities occurred between and including Split Lake and Birthday Rapids (1.1 birds/km^2). Higher concentrations of bald eagles (up to 3 eagles/km^2) have been observed in areas further downstream, near the Kettle and Long Spruce generating stations, as they are often attracted to food sources provided by GS developments.

Without the Project, bald eagle habitat will continue to be influenced by natural changes in habitat that result from factors such as riverbank erosion, fire and diseases affecting trees. These changes are not anticipated to have a notable influence on the distribution and abundance of local bald eagle populations utilizing the Nelson River area.

Olive-sided Flycatcher

The olive-sided flycatcher, a neotropical migrant songbird listed as threatened by SARA (Schedule 1) and COSEWIC, breeds and nests in coniferous forests, often near forest openings and edges where tall trees are available for perching and where flying insects are abundant (Altman and Sallabanks 2000). This species is associated with mature forest stands with diverse canopy structure, bogs and post-fire habitats (Altman and Sallabanks 2000). Within the Regional Study Area, primary olive-sided flycatcher breeding habitat occurs as coniferous forest or woodland edge adjacent to wetlands, creeks and regenerating forests (Map 6-36).

Bird studies within the Local Study Area revealed variable numbers of olive-sided flycatchers between 2001 and 2003. The majority of olive-sided flycatchers detected were in association with riparian habitat. From 2001-2003, the overall average breeding density of olive-sided flycatchers was 0.03 birds/ha (TE SV Section 6).

Olive-sided flycatcher is considered a VEC due to its regulatory status (listed as threatened under SARA). Low offspring survival may impair this species' ability to maintain viable populations in suitable habitat, thus limiting its ability to recover from reduced habitat availability following environmental change (COSEWIC 2007). As a result, local olive-sided flycatcher populations may be more vulnerable to Project effects.

Without the Project, olive-sided flycatcher populations are likely to continue to decline. Population declines throughout North America have been noted for this species, with possible explanations including habitat loss in wintering grounds, changes in forest structure, urbanization, loss of wetlands and associated edge habitats (Diamond 1991; Petit *et al.* 1993; Altman and Sallabanks 2000). However, data to support these hypotheses are limited enough to make reasons for flycatcher declines inconclusive. On a local level, increased severity of forest fires resulting from factors such as increased frequency and extent of dry periods may benefit this species by creating post fire habitats with dead trees for perching.

Rusty Blackbird

The rusty blackbird is listed as a species of special concern by SARA (Schedule 1, 2009) and COSEWIC. Rusty blackbirds breed in treed wet peatlands, along beaver ponds, fens and slow-moving streams (COSEWIC 2006). These areas occur throughout the Regional Study Area and are considered to be primary breeding habitats for rusty blackbird (Map 6-37). Rusty blackbird diet consists of aquatic insects, snails, small frogs and small fish. Nests are typically constructed within a mass of dense branches in live or dead conifers, hanging over or standing beside wetlands (COSEWIC 2006).

Field observations of rusty blackbirds were made throughout the Regional Study Area with most detections occurring in primary breeding habitat located along creeks, lakes and wetlands (TE SV Section 6).

If the Project were not to go forward, declines in rusty blackbird populations and a noted northerly shift in the distribution of the species (McClure *et al.* 2012) would be expected to continue. The conversion of wetlands to agriculture in southern Canada has been noted as a likely cause of southern breeding population declines (Griffiths and Woynillowicz 2003; Kling *et al.* 2003). Similar loss of wetland forests in their southern wintering grounds has been recognized as a significant threat to the species (Greenberg and Droege 1999).

Common Nighthawk

Common nighthawk is listed as threatened by SARA (Schedule 1) and COSEWIC. Nighthawks forage on flying insects at dusk, usually in forest openings that support aquatic habitat (*e.g.*, wetlands, lakes) and/or regenerating forest where insects are abundant. Nests are constructed on the ground, often on hard, dry mineral substrates including rocky outcrops, forest openings, and regenerating forest supporting little ground vegetation (*i.e.*, primary habitat [TE SV Section 6]). During field studies, one common nighthawk nest was found along a cut-line located on an esker supporting regenerating forest.

During field studies, common nighthawks were observed foraging in habitats considered widespread and abundant throughout the Regional Study Area (*e.g.*, regenerating forests, bogs, wetlands, creeks and inland lakes; (Map 6-34). Suitable nesting habitat, while widespread, is not considered abundant within the Regional Study Area (Map 6-34).

Without the Project, common nighthawk populations may continue to decline. This decline may, in part, be related to general declines in insect populations in common nighthawk breeding and wintering areas. Programs including seasonal mosquito control in North America may be responsible for such declines (Poulin *et al.* 1996; Cane and Tepidino 2001; Conrade *et al.* 2004). On a local level, increased severity of forest fires resulting from factors such as increased frequency and extent of dry periods may benefit this species by creating forest openings for foraging and nesting activities.

Other Priority Birds

Species at Risk

Eight species at risk have the potential to occur within the Regional Study Area (Table 6-10). Three of these species, olive-sided flycatcher, common nighthawk and rusty blackbird are VECs, and as such, are discussed above. All but horned grebe, yellow rail (despite surveys for this species), peregrine falcon and red knot have been observed during field studies. Olive-sided flycatcher, common nighthawk and rusty blackbird are the only species at risk known to breed within the Regional Study Area.

Without the Project, the availability of species at risk habitat will continue to be influenced by fire, insects, creation of habitat through beaver activity (*e.g.*, flooding), seasonal precipitation levels, and climate change. Populations will likely continue to decline due to a variety of factors including habitat loss on both wintering and breeding grounds.

Rare Species

No species designated as rare by the Manitoba Conservation Data Centre (MBCDC) are known to occur within the Regional Study Area.

Birds at the Edge of Their Range

Birds at the edge of their known range are considered to be priority birds as they often occur in low numbers and are vulnerable to environmental change. Fourteen species are considered to be at the edge of their breeding range relative to the Regional Study Area. Four species are colonial waterbirds (American white pelican, double-crested cormorant, Caspian tern and black tern), three are waterfowl (gadwall, redhead, and canvasback), four are songbirds (ruby-throated hummingbird, clay-coloured sparrow, blue-headed vireo, and pine siskin), one is a woodpecker (yellow-bellied sapsucker) and two are upland gamebirds (sharp-tailed grouse, ruffed grouse). All but redhead, canvasback, ruby-throated hummingbird and pine siskin have been observed within the Regional Study Area.

Table 6-10: SARA and MESA-Listed Bird Species at Risk That May Occur within the Bird Regional Study Area

Species	Status	Legislation	Breeding Habitat	Relative Abundance[1]
Olive-sided flycatcher (*Contopus cooperi*)	Threatened	SARA (Schedule 1)	Mature coniferous forest adjacent to beaver floods and other forest openings (*e.g.*, burn)	<3 birds/km^2*
Rusty blackbird (*Euphagus carolinus*)	Special Concern	SARA (Schedule 1)	Riparian areas in wet peatland	<2 birds/km^2*
Common nighthawk (*Chordeiles minor*)	Threatened	SARA (Schedule 1)	Open habitats including rocky outcrops, eskers and ridges	<4 birds/km^2*
Peregrine falcon (*Falco peregrinus*)	Threatened	SARA (Schedule 1)	Not found in Bird Regional Study Area	One observed during migration
	Endangered	MESA		
Short-eared owl (*Asio flammeus*)	Special Concern	SARA (Schedule 3)	Open habitats including low vegetation on peatland	3 birds observed
Yellow rail (*Coturnicops noveboracensis*)	Special Concern	SARA (Schedule 1)	Low vegetation on wet peatland	None observed; quality of habitat fluctuates with precipitation levels
Horned Grebe (*Podiceps auritus*)	Special Concern	COSEWIC	Lakes and ponds	None observed
Red Knot (*Calidris canutus*)	Endangered	SARA (no schedule yet listed)	Intertidal, marine habitats, especially near coastal inlets, estuaries, and bays.	None observed; may occur during migration

Notes:

* Estimated breeding density within the Bird Regional Study Area.

1. Based on field data gathered between 2001 and 2011.

Only the following six of the 14 range-limited species are known to breed within the area (TE SV Section 6):

- Gadwall, like mallard, breeds in upland cover and rears broods on sedge-filled creeks;
- Clay-coloured sparrow is a ground nesting species that breeds in grassy areas found adjacent to roads and along cut-lines;
- Blue-headed vireo breeds in mixedwood forest with tall shrub understory;
- Yellow-bellied sapsucker breeds in mature aspen-dominated forests;
- Sharp-tailed grouse breed in sedge-dominated treeless bogs; and
- Ruffed grouse breed in aspen or birch dominated forest types that are not common or widespread within the Regional Study Area.

Overall, the six range-limited species observed occurred at very low densities. With the exception of blue-headed vireo and ruffed grouse, only a few individuals were detected over the course of the 10-year environmental baseline study period (TE SV).

Without the Project, habitat availability for birds at the edge of their range is anticipated to continue to be influenced by fire, forest succession, linear developments and climate change.

Colonial Waterbirds

Ring-billed gull, herring gull and common tern are priority species due to their dependence on rare environmental features (*i.e.*, rocky reefs and islands). While a number of islands occur in the Nelson River and Stephens Lake, only a small number are suitable for colonial waterbirds. In the Local Study Area, islands utilized as nesting habitat are rocky, support little to no vegetation, have stable banks and limited access by land predators such as fox.

Along the Nelson River, common terns nest on islands in close proximity to foraging areas (*e.g.*, areas of turbulent water). Common terns typically forage up to 9 km from breeding colonies, but foraging distances of up to 20 km are not uncommon (BirdLife International 2011). Gulls are less specific than terns in their nesting requirements and are capable of travelling greater distances in search of suitable forage.

Along the Nelson River, gulls and terns breed within or in close proximity to forage areas. The highest concentrations of gulls were observed breeding on reefs in Gull Rapids and on an island located downstream of Birthday Rapids. ATK provided by FLCN indicates that breeding and nesting islands in Gull Rapids are home to thousands of gulls and terns (FLCN 2012). Field study results revealed that reefs in Gull Rapids have supported between 800–1,500 pairs of gulls and 50–100 pairs of terns; the breeding populations vary annually, potentially in large measure due to water levels. Upstream islands (to Birthday Rapids) typically support 30–100 pairs of terns and over 1,500 pairs of gulls (TE SV Section 6). The CNP Keeyask Environmental Evaluation Report refers to the collecting and eating of gull eggs at nesting colonies as a traditional practice once common for TCN Members. Currently, TCN Members are not as actively engaged in the collection of gull eggs.

Field studies indicate a total of 10 gull and tern nesting sites within the Regional Study Area (Map 6-33). The annual availability of these sites for breeding is largely dependent on the Nelson River water levels. In years of high water, inundation of reefs and islands often reduces the amount of available breeding habitat for colonial waterbirds such as common tern, ring-billed gull and herring gull. YFFN has indicated that island habitat in the Split Lake area has also been flooded, resulting in fewer gulls in the area (YFFN 2012). Competition for breeding sites increases between terns and gulls when suitable breeding habitat is limited. Common terns are at a competitive disadvantage as ring-billed gulls and herring gulls are larger bodied, more aggressive birds that arrive on the breeding grounds earlier than terns; gulls are therefore the first to select and occupy the most optimal sites on suitable nesting islands and reefs. While gulls and terns will often coexist on the same nesting structure, they form separate sub-colonies wherein terns often occupy suboptimal nesting sites often located along the more flood-prone periphery of islands and reefs. In the Regional Study Area, terns generally nest apart from gulls on small reefs in Gull Rapids, and on small rocky islands in Gull Lake and the Nelson River.

Both gulls and terns are valued by the KCNs communities. CNP, YFFN and FLCN have traditionally collected and eaten gull eggs in the past (FLCN 2010 Draft; CNP 2011; YFFN 2012); however, only FLCN continue to harvest gull eggs from areas along the Nelson River (FLCN 2012 Draft). Changes in water levels that alter the availability of suitable nesting habitat for these birds, especially common tern, is a concern expressed by the KCNs.

Without the Project, gulls and terns are expected to continue to be affected by changes in available breeding habitat associated with changes in seasonal water levels.

Willow Ptarmigan

As a traditionally hunted species, the willow ptarmigan is a priority bird due to its intrinsic value to the KCNs (YFFN 2012). It is primarily a winter resident (breeding habitat occurs in areas further north along the tundra), and inhabits areas of the Regional Study Area capable of supporting willows (*e.g.*, in and along forest openings, edges of wetlands, riparian areas and cut-lines; Storch 2000). Willows are crucial for ptarmigan in the winter as they provided both shelter and food (*e.g.*, willow buds). As for all species of grouse, populations of ptarmigan fluctuate substantially and are regionally cyclical (10-year cycles in North America; Storch 2000).

6.2.3.4.7 MAMMALS

Due to the relatively small number of mammal species in the Keeyask region, all mammals were assessed as **priority mammals**, as they address specific issues of scientific and/or social concern and collectively indicate how the Project is expected to affect terrestrial ecosystem health. Priority mammals were categorized further as VECs and other priority mammals to focus the effects assessment. Mammal VECs were caribou (*Rangifer tarandus*), moose (*Alces alces*), and beaver (*Castor canadensis*). Other priority mammals were mammal groups and rare or regionally rare species. Mammal groups discussed in this section consist of the following:

- Small mammals;
- Furbearers;
- Large carnivores; and
- Ungulates.

Mammal groups were based on general characteristics such as rarity, body size, and broad habitat and home range requirements, and not directly on biological taxonomy. As such, mammal groupings were not meant to imply similarity in specific characteristics such as diet (*e.g.*, herbivore or carnivore), or particular habitat preferences (*e.g.*, mature forest or recent burns). While the description of the existing environment begins with an introduction to general mammal groups before focusing on VECs, the effects on mammal groups are discussed under Other Priority Mammals in the Effects Assessment section.

This section provides the environmental setting for mammals based on technical studies and local knowledge from resource users and others, as referenced in the CNP Keeyask Environmental Evaluation Report, YFFN Evaluation Report (*Kipekiskwaywinan*), FLCN Environment Evaluation Report (Draft), Keeyask Traditional Knowledge Report (FLCN 2010 Draft), and other supporting materials. A detailed description of the existing environment for the mammal community with emphasis on the VEC species caribou, moose and beaver is provided in the Terrestrial Environment Supporting Volume (TE SV), Section 7. Methods for data collection are provided in Appendix 7A of the TE SV. VEC habitat models were developed from habitats identified in Section 6.2.3.4, field data, scientific literature, and scientific judgment.

Future trends without the Project are estimated based on the assumption of no further human development in Zone 5 (Map 6-28). However, projects such as the proposed Bipole III transmission line could affect mammal habitat and decrease intactness in the region. The extent of the effects of future projects will be determined in independent assessments, and their cumulative effects with the Project are outlined in Chapter 7.

Study areas specific to a VEC or other priority mammal group are identified in the relevant sections below. All mammal species found in the Keeyask region are valued by the Keeyask Cree Nations (KCNs) (see Chapter 2 on the KCNs worldview including the importance of everything being interconnected). Certain species are important for domestic harvest and furbearers are important for commercial and domestic harvest (see Section 6.2.3.6). The ranges of up to 38 mammal species occur or have occurred in the Keeyask region (TE SV Section 7, Appendix 7B) including small mammals (*e.g.*, red-backed vole, *Clethrionomys gapperi*), furbearers (*e.g.*, American marten, *Martes americana*), large carnivores (*e.g.*, gray wolf, *Canis lupus*), and ungulates (*e.g.*, moose). Twenty-nine mammal taxa were found during environmental studies in the Keeyask region. At least four species or their signs were observed incidentally and outside of formal studies, including woodchuck (*Marmota monax*), northern flying squirrel (*Glaucomys sabrinus*), ermine (*Mustela erminea*), and arctic fox (*Alopex lagopus*). Mammal communities in the Keeyask region consist predominantly of resident species, although a few species such as caribou migrate into the region from Ontario and Nunavut. Resident species rely on a wide variety of boreal forest habitats to support their life functions for breeding, food, and shelter.

Mammal communities have been affected by previous hydroelectric developments including construction and operation of the Kelsey Generating Station (GS), the Kettle GS, and the Lake Winnipeg Regulation and Churchill River Diversion projects (LWR and CRD). While animals were once abundant in the Keeyask region, many were no longer observed in the area following hydroelectric development (YFFN Evaluation Report (*Kipekiskwaywinan*); FLCN Environment Evaluation Report (Draft); FLCN 2010 Draft). Species such as moose have since begun to recover and their numbers have been increasing and some, such as caribou, have returned only recently (CNP Keeyask Environmental Evaluation Report; YFFN Evaluation Report (*Kipekiskwaywinan*); FLCN 2010 Draft). Mammal community dynamics in the Keeyask region are also influenced by fire, weather, disease, insect populations, other human development, hunting and trapping, and climate change (Fisher and Wilkinson 2005; Murray *et al*. 2006). Linkages, or relationships, among wildlife species in the regional ecosystem and their habitat in the Keeyask region have changed as a result of past developments. The maintenance of these relationships is of particular concern to the KCNs (CNP Keeyask Environmental Evaluation Report; YFFN Evaluation Report (*Kipekiskwaywinan*); FLCN Environment Evaluation Report (Draft)).

MAMMAL GROUPS

Small Mammals

Small mammals are the foundation of the carnivore and omnivore food webs. Small mammals are usually short-lived species that include mice, voles, shrews, squirrels, and chipmunks. They occupy a diverse range of habitats, including riparian and upland areas (CNP Keeyask Environmental Evaluation Report). At least one shrew species uses aquatic habitat. Twelve species were captured in the Small Mammals Regional Study Area (Study Zone 3 in Map 6-28). The Small Mammals Local Study Area was Zone 2 in Map 6-28.

There is little historical information describing small mammal populations and habitats in the Keeyask region. Many species were reported as far north as the Churchill area in the early 1900s (Preble 1902). Although small mammals are predominantly terrestrial, important small mammal shoreline wetland habitat has been affected by hydroelectric development. In the existing environment, canopy cover, shrub density, composition of ground cover, soil moisture, and downed woody debris appear to influence the microhabitat requirements of small mammal species (TE SV Section 7.3.2). As such, habitat preferences are based mainly on site-specific characteristics such as fallen logs, stumps, brush piles, and a nearby source of water for red-backed voles, while masked shrews can occupy a range of habitats from forest to tundra, providing the air is humid and there is sufficient ground cover (Banfield 1987). Currently, small mammals are abundant and widespread in Manitoba (Banfield 1987) and in the Small Mammals Local and Regional Study Areas. Approximately 20 small mammals were captured per 100 trap-nights in the Local Study Area from 2001 to 2004. Populations cycle with relative regularity (Boonstra *et al*. 1998); catch-per-unit-effort peaked in 2003 and was lowest in 2004.

Past and existing human impacts and past climate change could influence future habitat for small mammals in the Regional Study Area even if the Project does not proceed. Habitat composition will continue to be an important small mammal population driver. Predicted trends in habitat composition include the future disappearance of the ground ice peatland types, which will be replaced by wetland peatland types and open water. The predicted habitat composition trend for some species is likely to decline, resulting in further small changes to small mammal community. Vegetation along the Nelson River shorelines will most likely remain as secondary habitat for small mammals due to past and on-going changes in shoreline erosion that continue to affect shoreline cover. Although future habitat adjustments will likely lead to alterations in the composition of the small mammal communities in the Keeyask region, populations are expected to continue to cycle within a natural range of variation.

Furbearers

Aquatic and terrestrial furbearers are important to the KCNs for cultural and economic reasons (Section 3.2.3.6). Aquatic furbearers are medium-sized mammals that rely on water for a large portion of their food or habitat. Aquatic furbearers in the Keeyask region are beaver, muskrat (*Ondatra zibethicus*), mink (*Mustela vison*), and river otter (*Lontra canadensis*). Terrestrial furbearers spend the majority of their time in and acquire most or all of their food from upland habitats. The Furbearers Local Study Area was Zone 3 and the Furbearers Regional Study Area was Study Zone 4 in Map 6-28. As beaver is a VEC, it is described in a separate section below.

While furbearers were once abundant in the Keeyask region, they disappeared from the Gillam and York Landing areas following hydroelectric development (YFFN Evaluation Report (*Kipekiskwaywinan*); FLCN Environment Evaluation Report (Draft)). Effects of hydroelectric development on aquatic furbearers were likely greater than on terrestrial furbearers. Shoreline wetlands have changed, and the seasonal reversal of water flow from system operations affects individual home range reestablishment in the Nelson River. Furbearers are currently widespread and secure throughout their ranges in Manitoba (NatureServe 2011), including the Keeyask region. None of the furbearers in the Regional Study Area are classified as rare by the Manitoba Conservation Data Centre.

Muskrats require a source of permanent water such as marshes, ponds, lakes, streams and rivers for habitat (Boutin and Birkenholz 1998). They generally inhabit the edges of emergent vegetation zones (Banfield 1987) and are absent from large bodies of open water (Errington 1963), where wave action is greater. Although marsh can be important muskrat habitat in southern Manitoba, it accounts for only about 1% of wetland areas in the Keeyask region. During field studies in the Regional and Local Study Areas, muskrat activity was most dense on streams and was common on inland lake perimeters. FLCN noted the past and current importance of the Butnau River and Cache Lake for muskrat habitat (FLCN Environment Evaluation Report (Draft); FLCN 2010 Draft). The highest sample count recorded about 140 push-ups in creeks, ponds, and lakes in the Regional Study Area. Muskrats were sparse to absent on the Nelson River. CNP resource users indicated muskrat inhabit Seebeesis Creek off the Nelson River, about 11 km upstream of Gull Rapids (CNP Keeyask Environmental Evaluation Report).

Mink habitat is also associated with water, including stream banks, lakeshores, forest edges, and swamps (Banfield 1987). River otter select similar areas (Melquist and Dronkert 1998). During field studies in the Local Study Area, signs of mink activity were sparse in upland areas, but were common near lakes and riparian shorelines, while signs of river otter activity were common in upland areas and very common near lakes and riparian shorelines (TE SV).

Terrestrial furbearers found in the Keeyask region include snowshoe hare (*Lepus americanus*), woodchuck, red fox (*Vulpes vulpes*) arctic fox, American marten, fisher (*Martes pennanti*), weasels (*Mustela* spp.), and lynx (*Lynx canadensis*). While woodchucks' range includes the Keeyask region, they were not detected during formal surveys. An individual was observed incidentally along PR 280.

Snowshoe hare select habitat based on cover type rather than vegetative species, inhabiting forests with relatively closed canopies, sufficient herb cover, and dense understory (Ferron and Ouellet 1992). Signs of activity were very common in the Local Study Area during field studies, and tended to be more common in riparian than upland habitats.

Red fox are rarely found in the core area of boreal forests (Eadie 1943; Cook and Hamilton 1944; Banfield 1987) and generally select diverse edge habitat. Signs of activity were common in the Local Study Area during field studies. Arctic fox are not residents of the Keeyask region; they are migrants only seen in winter.

American marten prefer contiguous mature or old forest (Chapin *et al*. 1998), and fishers inhabit mature boreal forest (Banfield 1987). Fisher populations were reduced following hydroelectric development, but may be increasing (Mammals Working Group 2010). Signs of activity were common in the Local Study Area in winter and on lake perimeters during summer field studies. Weasels also select boreal forest habitat, but can be found on lakeshores and riverbanks (Banfield 1987). Signs of weasel activity were generally sparse in the Local Study Area during field studies, but were common on lake perimeters. Lynx inhabit mature boreal forest and prefer dense understory (Banfield 1987). Although signs of lynx activity were generally sparse in the Local Study Area during field studies, because abundances fluctuate over a natural 10-year cycle, this species can be periodically more common than indicated. Lynx have been returning to the area recently (FLCN 2010 Draft).

Past and existing human impacts and past climate change could influence future habitat for furbearers in the Regional Study Area even if the Project does not proceed. Habitat composition and availability of prey species will continue to be important furbearer population drivers. Predicted trends in habitat composition include the future disappearance of the ground ice peatland types, which will be replaced by wetland peatland types and open water. The predicted habitat composition trend for some species is likely to decline, resulting in further small changes to furbearer populations. Vegetation along the Nelson River shorelines will most likely remain as secondary habitat for furbearers due to past and on-going changes in shoreline erosion that continue to affect shoreline food and cover. Future harvest that influences furbearer populations will likely continue to vary with fluctuating fur prices and result in highly variable numbers of animals trapped. Trapline stewardship, policy, and management will continue to influence future furbearer populations. Although future habitat adjustments will likely lead to alterations in the composition of the furbearer community, and of the prey they consume (*i.e.*, small mammals) in the Keeyask region, populations are expected to continue to act within a natural range of variation.

Large Carnivores

Large carnivores are larger-sized mammals that contribute to ecosystem function by preying on other animals. They are important to the KCNs and are harvested in the Keeyask region (Section 3.2.3.6). Gray wolf and black bear (*Ursus americanus*) are found in the Keeyask region. The Large Carnivores Local Study Area was Zone 4 and the Large Carnivores Regional Study Area was Zone 6 in Map 6-28.

Gray wolves are not restricted to a single habitat type, as they typically follow their primary prey (Banfield 1987; Carbyn 1998). They are more likely to occupy mixed conifer-hardwood forests and forested wetlands than other habitat types (Mladenoff *et al*. 1995), and although they prefer to inhabit areas with low densities of roads and human activity (Houts 2001; Larsen and Ripple 2004) these large carnivores often use linear features as travel corridors (Jalkotzy *et al.* 1997). Resident wolves are found year-round and prey primarily on moose, while transient wolves follow migratory caribou into the Regional Study Area during winter. Wolves have been observed at Little Limestone Lake (CNP Keeyask Environmental Evaluation Report) and elsewhere. While wolves are uncommon in Gillam because they stay near caribou, they have been reported in the Gillam garbage dump and in the town (FLCN 2010 Draft). In the mid-1900s, gray wolf numbers decreased from rabies outbreaks and wolf control programs in western Canada (Paradiso and Nowak 1982). The wolf population appears stable in Manitoba (Manitoba Conservation, Wildlife and Ecosystem Protection Branch (n.d.*a*). Signs of activity were sparse to absent (*e.g.*, on islands in lakes) in areas of the Local Study Area and common in others during field studies.

Black bears are common inhabitants of coniferous and deciduous forests, swamps, and berry patches (Banfield 1987). Black bears now occupy approximately 85% of their historic range (Kolenosky and Strathearn 1998), and the Manitoba black bear population is sustainable (Manitoba Conservation, Wildlife and Ecosystem Protection Branch n.d.*b*). Signs of activity were common in the Local Study Area in summer during field studies.

Past and existing human impacts and past climate change could influence future habitat for large carnivores in the Regional Study Area even if the Project does not proceed. The availability of moose and possibly caribou will continue to be an important large carnivore population driver. Because future habitat adjustments are unlikely to lead to alterations in the abundance of moose in the Keeyask region, large carnivore populations are expected to continue to act within a natural range of variation.

Ungulates

Ungulates are hoofed mammals that contribute to ecosystem function by consuming plants and as prey for large carnivores. They are harvested by the KCNs and other resource users in the Keeyask region (Section 6.2.3.6). Ungulates that could occur in the Keeyask region include caribou and moose. Although white-tailed deer (*Odocoileus virginianus*) range does not include the Keeyask region (Banfield 1987), this species may occur incidentally, and is discussed in relation to climate change. Caribou and moose are VECs and are discussed below.

White-tailed deer signs were not observed during field studies. Limited habitat supply and severe winters currently restrict white-tailed deer from becoming established residents of the Keeyask region.

Past and existing human impacts and past climate change could influence future habitat for ungulates in the Regional Study Area even if the Project does not proceed. Important drivers that influence ungulate populations are discussed below. Although future habitat adjustments for some types of peatlands will likely lead to alterations in the composition of habitat in the Keeyask region, these habitats are unsuitable for white-tailed deer. White-tailed deer range expansion to include the Regional Study Area is also unlikely if severe winter conditions persist into the future.

Rare or Regionally Rare Species

Rare mammals are listed by the federal *Species at Risk Act* (SARA), *The Endangered Species Act* of Manitoba (MESA), or by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). Boreal woodland caribou is the only rare species listed by SARA or MESA potentially found in the Keeyask region, and is discussed with caribou in the following section. Due to the wide variation in home range sizes of rare species, the Rare Mammals Local Study Area was Study Zone 4 and the Rare Mammals Regional Study Area was Study Zone 6 in Map 6-28.

Wolverine (*Gulo gulo*) was identified as a rare mammal because of its designation as a species of special concern by COSEWIC. Wolverines inhabit forested areas but are not abundant (Banfield 1987). Field studies indicated that they are sparse in the Rare Mammals Local Study Area, but their numbers have recently increased (FLCN 2010 Draft). No den sites were detected in the Rare Mammals Local Study Area.

Until recently, little brown myotis (*Myotis lucifugus*) was considered widespread and secure throughout its range (NatureServe 2011). This bat is a habitat generalist, occupying a range of habitats (Wund 2006). Little brown myotis hibernate in caves or other shelters, called hibernacula, for the winter (Banfield 1987). They occur throughout much of Manitoba (Humphrey 1982) but the northern edge of their range may not extend to the Keeyask region (Forbes 2012). This species is not yet listed by SARA, but an emergency order to place this and other bat species on Schedule 1 of SARA has been requested (COSEWIC 2012). The primary threat to little brown myotis is the spread of white-nose syndrome, caused by a fungus (*Geomyces destructans*), which is predicted to result in the extirpation of little brown myotis within 16 years (Frick *et al.* 2010; Forbes 2012). While white-nose syndrome has not been identified west of Ontario, it is expected to spread to hibernacula across North America within 11 to 22 years (Frick *et al*. 2010; Forbes 2012).

Little brown myotis appear to be sparse in the Local Study Area. No little brown myotis were positively identified in the Local Study Area during field surveys; however, one bat was detected in late July and August 2001 feeding at Gull Lake camp. Anecdotal reports of bat, possibly little brown myotis, including observations near cabins in the Local Study Area have been made, but not confirmed. Bats have also been observed in and near Gillam, but the species is unknown (FLCN 2010 Draft).

Regionally rare species are rare in the Keeyask region but are common within the majority of their ranges elsewhere in Manitoba. Regionally rare species are American water shrew (*Sorex palustris*), porcupine (*Erethizon dorsatum*), raccoon (*Procyon lotor*), striped skunk (*Mephitis mephitis*), and coyote (*Canis latrans*).

Past and existing human impacts and past climate change could influence future habitat for rare or regionally rare species in the Regional Study Area even if the Project does not proceed. Habitat composition and availability of prey species will continue to be important rare or regionally rare species population drivers. Although future habitat adjustments for some types of peatlands will likely lead to alterations in the composition of habitat in the Keeyask region, high quality habitat is unlikely to be affected for most rare or regionally rare species. Vegetation along the Nelson River shorelines will most likely remain as secondary habitat for American water shrew due to past and on-going changes in shoreline erosion that continue to affect shoreline cover. Future harvest that influences rare or regionally rare furbearer populations (*e.g.*, wolverine and coyote, respectively) will likely continue to vary with fluctuating fur prices and result in highly variable numbers of animals trapped. Trapline stewardship, policy, and management will continue to influence future populations. Future habitat adjustments that influence food and cover are somewhat uncertain, but may lead to small alterations in the abundance and distribution of rare or regionally rare species found in the Keeyask region.

MAMMAL VALUED ENVIRONMENTAL COMPONENTS

Valued environmental components consist of the following species:

- Caribou;
- Moose; and
- Beaver.

Caribou

Caribou are important to resource users, especially the KCNs, and are harvested by KCNs Members (although to a much lesser extent than moose) and other resource users (Section 6.2.3.6). The caribou hunt usually follows the autumn moose, duck, and goose hunt and occurs with the winter arrival of caribou (Section 6.2.6.2). Caribou are also important prey for large carnivores. The Caribou Local Study Area was Zone 4, and the Caribou Regional Study Area was Zone 6 in Map 6-28.

Three groupings of caribou are described for the Regional Study Area: barren-ground caribou (*Rangifer tarandus groenlandicus*), coastal caribou (*R. t. caribou),* which is a forest-tundra migratory woodland caribou ecotype, and summer resident caribou (summer residents), a type of woodland caribou whose exact range and herd association is uncertain.

- Barren-ground caribou from the Beverly-Qamanirjuaq herd migrate from Nunavut in autumn to overwinter in Manitoba's northern forests and then leave the Regional Study Area in spring to calve. On occasion, a small fraction of the Qamanirjuaq herd may reach the Regional Study Area – about 10,000 animals migrated this far south once in the last 10 years, of the total 348,000 animals estimated for the population in 2008.
- Coastal caribou from the Cape Churchill and Pen Islands herds migrate from northern Manitoba and northern Ontario into parts of the Regional Study Area in winter. Historically, they leave the area in spring to calve. Larger groups of Pen Islands coastal caribou, numbering in the hundreds, have been observed in the Regional Study Area on occasion, but there are generally fewer than about 50 individuals in a typical winter.
- Summer resident caribou likely move within and beyond the Regional Study Area, but their core range is uncertain. These caribou remain in the Regional Study Area to calve, but the long-term frequency of calving is uncertain. Summer residents are conservatively estimated to number 20 to 50 individuals.

Habitat is selected by caribou at multiple spatial scales and is based on the level of disturbance present, as human-caused or natural alteration and fragmentation may attract moose, which in turn attract wolves, increasing the predation risk for caribou (Rettie and

Messier 2000). Winter habitat for all caribou groups consists of undisturbed mature coniferous forest composed of black spruce, jack pine, or tamarack-dominated peatland, with a ground cover of lichens. Summer habitat applies only to summer resident caribou, as the other caribou groups do not occupy the region at this time. Summer calving and rearing habitats consist of relatively undisturbed islands in lakes or raised black spruce surrounded by expansive wetlands or treeless areas (peatland complexes). Potential calving habitats are common in the Regional Study Area, and habitat does not appear to be limiting to the summer resident cows and calves (TE SV).

Barren-ground Caribou

In the Keeyask region, barren-ground caribou migrate to the area north of the Nelson River (FLCN 2010 Draft). Previous studies indicated that barren-ground caribou from the Qamanirjuaq herd ranged as far south as Split Lake and as far east as the Hudson Bay railway track running between Ilford and Churchill (Miller and Robertson 1967; Split Lake Cree – Manitoba Hydro Joint Study Group 1996a). Caribou migration began to diminish in the 1950s, reducing hunting activity (Split Lake Cree – Manitoba Hydro Joint Study Group 1996a). According to a FLCN resource harvester, a substantial decline in barren-ground caribou numbers began in the 1950s, and after construction of the Kettle GS, there were virtually none south of the Nelson River (FLCN 2010 Draft). In the 1990s, there was a limited return of caribou (Split Lake Cree – Manitoba Hydro Joint Study Group 1996a) while recently, in the winter of 2004–2005, a large number of barren-ground caribou returned to the Keeyask region (FLCN 2010 Draft; TE SV). Current range data (Map 6 38) for the herd supports this distributional extent, where the southeastern limit is now near Stephens Lake (TE SV). The Qamanirjuaq population was estimated at 348,000 individuals in 2008. Few were observed in Manitoba in 2011, and the population may be in decline (Beverley and Qamanirjuaq Management Board 2011). About 10,000 Qamanirjuaq caribou have been estimated to reach the Regional Study Area, although this type of occurrence is infrequent (TE SV).The Nelson River generally serves as an extralimital boundary for Qamanirjuaq barren-ground caribou in the Keeyask region (Map 6-38). River crossing locations have been reported in the Regional Study Area and on the lower Nelson River (FLCN 2010 Draft). Few river crossing sites are reported from field studies. Genetic studies indicated that most barren-ground caribou genotypes were found north of the Nelson River between 2004-2006.

Coastal Caribou

Coastal caribou behaviour is similar to that of barren-ground caribou, particularly during calving, rutting, and migration (Thomas and Gray 2002). Coastal caribou from the Cape Churchill and Pen Islands herds historically occur within the Regional Study area in winter and leave in spring. The Pen Islands coastal caribou herd migrates from Ontario to the area south of the Nelson River (FLCN 2010 Draft), through Shamattawa to the Atkinson Lake area (WLFN 2002), as far west as the Nelson River at York Landing and as far south as Oxford House (Map 6-38). Animals from the Pen Islands herd were first reported in the Keeyask region in the 1990s (Thompson and Abraham 1994; Abraham and Thompson 1998). In the mid-1990s, the herd-size peaked, and was estimated at 10,800 individuals (Abraham and Thompson 1998; Abraham *et al.* 2012). Although large migrations into the Regional Study Area were observed in the winters between 2001 and 2005, less than 300 animals believed to be Pen Islands caribou are observed in most winters. In the winter of 2011–2012, less than 30 caribou were observed during field studies.

The Cape Churchill coastal caribou herd is currently estimated at 3,500 to 5,000 individuals and indications are that the population is likely stable. Although a large migration into the Regional Study Area was observed in winter 2010 (Manitoba Hydro 2011a), there are generally fewer than 50 animals in most winters.

While the Nelson River serves as a physical boundary for both Pen Islands and Cape Churchill coastal caribou in the Keeyask region, river crossing locations have been reported in the Regional Study Area and on the lower Nelson River (FLCN 2010 Draft). Genetic studies indicated that coastal caribou genotypes were found north and south of the Nelson River between 2004-2006. Recent radio-collaring data indicates that most of the sampled Cape Churchill coastal caribou yearly activity is located north of the Nelson River while Pen Islands coastal caribou activity remains south of the River (Manitoba Conservation unpubl. data; Manitoba Hydro 2011a). Slightly more Pen Islands coastal caribou habitat use is found north of the Nelson River compared to Cape Churchill coastal caribou (Manitoba Conservation unpubl. data; Manitoba Hydro 2011a).

Aerial surveys of known calving grounds along Manitoba's Hudson Bay coastline indicate that summer residency has declined in the province, and some animals may have moved inland (Abraham *et al.* 2012). Summer use of the Keeyask region is described below, including cases where Pen Islands caribou appeared to be calving in the Stephens Lake area.

Summer Resident Caribou

In addition to barren-ground and Pen Islands caribou, some KCNs have identified a third variety of caribou common to the Keeyask region: woodland caribou, which are present year-round and can be distinguished from migratory caribou based on their appearance (FLCN 2010 Draft; FLCN 2012 Draft; YFFN Evaluation Report (*Kipekiskwaywinan*)). This group of caribou has recently been described as migratory woodland caribou (Mammals

Working Group 2012; FLCN Environment Evaluation Report (Draft); Fox Lake 2012 Draft). The exact core range, long-term calving frequency, and herd association of the caribou that remain in the Keeyask region year-round cannot be clearly determined. This group could be coastal caribou, woodland caribou, or a mixture of both, and are referred to as summer resident caribou.

Boreal woodland caribou (*R. t. caribou*), a forest-dwelling woodland caribou ecotype, are listed as threatened under SARA and MESA and occurred historically in the Keeyask region (Manitoba Conservation, Wildlife and Conservation Ecosystem Protection Branch 2005a). They do not tend to form large herds when calving and calve on islands when possible (Thomas and Gray 2002). The Nelson-Hayes boreal woodland caribou herd that once occurred within the Keeyask region blended with the coastal Pen Islands herd and no longer exists as a discrete population (Manitoba Conservation, Wildlife and Conservation Ecosystem Protection Branch 2005a). The current range of boreal woodland caribou (Map 6-38) extends into the southwest corner of the Regional Study Area near Thompson, but not as far as the Local Study Area (Manitoba Conservation, Wildlife and Conservation Ecosystem Protection Branch 2005a; Environment Canada 2011).

The group of summer resident caribou in the Keeyask region (Photo 6-3) has been observed to calve in isolation or make use of island habitat, as is characteristic of boreal woodland caribou in Manitoba and elsewhere (Shoesmith and Storey 1977; Hirai 1998; Rettie and Messier 2000). Concurrently, recent data showed that a few radio-collared Pen Islands caribou cows occupied summer habitat in the Keeyask region over two years. At least one animal occupied summer habit in the Keeyask region, but migrated long distances into Ontario the following spring (Manitoba Conservation unpubl. data; Manitoba Hydro 2011a).

Winter migration distances for several collared caribou were in the order of hundreds of kilometres, separating winter range from summer range, which is uncharacteristic of forest-dwelling boreal woodland caribou in Manitoba and elsewhere (Manitoba Conservation unpubl. data; Manitoba Hydro 2011a). During the winter, the summer residents most likely interact with migrating coastal caribou, which could make it difficult to differentiate among the mixed populations (Mammals Working Group 2012).

It is unclear whether summer residents are coastal caribou that periodically do not return to traditional calving areas in Ontario or northern Manitoba, boreal woodland caribou beyond their current recognized range, or a mixture of both. For the purposes of the assessment of potential Project effects, the group of summer resident caribou, is being treated as an independent population that uses a smaller range than the migratory groups, and is more likely to use calving and rearing habitat that occurs within the Keeyask region. Based on what is known of the area, a conservative estimate for the group of animals residing in the Regional Study Area in summer is 20 to 50 individuals.

Source: WRCS, 2011 Caribou Calving Island Studies.

Photo 6-14: A Summer Resident Caribou in the Keeyask Region

Summer habitat is in peatlands and black spruce-dominated stands. Such habitat is selected for the availability of forage and for protection from predators, particularly during the calving season (Rettie and Messier 2000). When calving, summer residents inhabit calving and rearing complexes, which are clusters of islands in lakes or islands of black spruce surrounded by expansive wetlands or treeless areas (peatland complexes), to avoid predators. Primary calving and rearing habitat is defined as islands in lakes greater than 10 hectares (ha) in size or peatland complexes greater than 200 ha. Secondary calving and rearing habitat is defined as islands in lakes between 0.5 and 10 ha in size or peatland complexes between 30 and 200 ha. Based on field studies, caribou do not appear to be using all of the habitat available in the Local Study Area, with the possible exception of islands in Stephens

Lake, which have become a productive calving and summering area for caribou. Approximately 55% of the islands sampled in Stephens Lake and Gull Lake were occupied by adult caribou during at least one summer between 2003 and 2011. Calving and rearing was documented on 10% of the islands in lakes and 5% of the islands in peatland complexes surveyed in 2010 and 2011. The earliest date that calves were detected on islands in lakes was June 8.

Signs of the fall rut included observations of bulls in pursuit of single cows and harem collections on four large islands in Stephens Lake and in one peatland complex. Rutting habitat usually consists of open habitats, including open and semi-open bogs (Darcy and Pruitt 1984), which are habitats similar to calving and rearing complexes in the Keeyask region.

Historical Change and Future Trends

While caribou have been affected by previous hydroelectric development (YFFN Evaluation Report (*Kipekiskwaywinan*); FLCN Environment Evaluation Report (Draft)), including herd size, migration routes, and river crossings (FLCN 2010 Draft), signs of caribou activity were very common in the Local Study Area in summer, and usually sparse in winter. Large numbers of caribou occur infrequently in the Local Study Area (*e.g.*, the winter of 2004–2005), but they are more common in the Regional Study Area. Extreme annual variability in the number of animals was observed from 2001 to 2011 by the technical study team, likely due to differences in the timing of movements and use of alternate migration routes and winter range. Caribou do not use the same migration routes each year because they use different portions of their winter range, which reduces the possibility of consuming all available food in a localized area. The timing of movements is influenced by snow fall and snow melt patterns, the timing and location of plant growth on the calving grounds, and long-term cycles, among other factors.

Past and existing human impacts and past climate change could influence future habitat for caribou in the Regional Study Area even if the Project does not proceed. Habitat composition, predation, and harvest will continue to be important caribou population drivers. Predicted trends in habitat composition include the future disappearance of the ground ice peatland types, which will be replaced by wetland peatland types and open water. The predicted habitat composition trends for caribou would likely be both positive and negative. Ground ice peatland forms some of the treed calving islands in peatland complexes. Lost calving islands will likely be replaced by wet habitat that provides caribou with protection against predators. Although both habitat components have value as caribou habitat, the net effect is uncertain. Finally, on-going changes in erosion resulting from past and existing projects will continue to reduce the size of future caribou calving islands. Because erosion will also contribute to formation of future islands, the net effect on caribou calving habitat is uncertain.

Recently, population declines have been detected for both barren-ground and coastal caribou, and management actions are being taken to reverse these trends. Qamanirjuaq barren-ground caribou are managed by the Beverly and Qamanirjuaq Caribou Management Board, while Manitoba Conservation and the Ontario Ministry of Natural Resources co-operatively manage and monitor the population of coastal caribou. With appropriate management, no changes to these caribou populations are anticipated due to predation and harvest, and long-term recovery efforts for boreal woodland caribou are also being implemented (Environment Canada 2011).

Moose

Moose are important to resource users, especially the KCNs, and are harvested by residents and non-residents of the Keeyask region (see Section 6.2.3.6). The traditional domestic moose hunt begins in autumn (SE SV). Moose are important prey for large carnivores. Without moose, which represent the primary prey biomass of an area, gray wolf abundance would most likely be much lower in northeastern Manitoba (TE SV). The Moose Local Study Area was Zone 4 and the Moose Regional Study Area was Study Zone 5 in Map 6-28.

Moose inhabit the boreal forest and their distribution follows those of preferred trees and shrubs. In winter, moose ranges are smaller than in summer (Phillips *et al*. 1973). Food availability, thermal cover, and predator avoidance influence habitat selection in winter (Dussault *et al*. 2005). Moose occupy habitat in a wide range of seral stages, riparian and forested areas, and the periphery of burns (Irwin 1975; Coady 1982). Upland and lowland habitats are used throughout the winter and lowland riparian areas are used when snow is deep (Coady 1982).

In summer, moose home ranges expand (Stevens 1970; Phillips *et al*. 1973; Crête and Courtois 1997). Lowland and upland mature stands, shrubs and aquatic areas are commonly inhabited (Irwin 1975; Coady 1982). FLCN resource harvesters note that the shoreline and islands of Stephens Lake are important moose habitat (FLCN 2010 Draft). Burned areas are also used in summer (Irwin 1975), as moose are attracted to areas of fresh growth (CNP Keeyask Environmental Evaluation Report). Deciduous forest stands are preferred (Irwin 1975); primary moose habitat is generally in areas with broadleaf trees, jack pine, tall shrubs, young regeneration, or marsh. Conifer stands may also be used (Irwin 1975), and secondary moose habitat includes black spruce or tamarack-dominated stands and low vegetation (TE SV Section 7, Table 7.3-16). Coniferous trees near shrub stands often create edge effects that allow moose to browse on new growth while utilizing protective cover from the nearby canopy. CNP Members have indicated that veneer bogs (peatlands less than 1.5 m deep that generally occur on slopes; see Section 6.2.3.2) are occupied in wet seasons and are used as calving areas (CNP Keeyask Environmental Evaluation Report). Important calving areas also include islands in lakes such as Stephens Lake where moose seek refuge from wolves and where food is available (FLCN 2010 Draft). Approximately 42% of the islands sampled in

Stephens Lake and Gull Lake were occupied by adult moose in summer. Calving was documented on 21% of islands in lakes and less than 1% of islands in peatland complexes.

Moose have traditional seasonal ranges as well as migratory routes (Goddard 1970; LaResche *et al.* 1974). Moose migrate to locate optimal forage throughout the year. Change in habitats may involve movements that vary in length and elevation. Snow conditions are the prime factor in initiating winter migration, but in other seasons, changes in forage quality or quantity may be responsible for moose movement (LaResche *et al.* 1974). Burned veneer bogs are used for migration routes, as they provide easy passage (CNP Keeyask Environmental Evaluation Report).

Historic evidence of moose suggests that their limit was once in the southern Keeyask region; however, in the past 200 years their range has extended as far north as Hudson Bay (Krefting 1974). Historically moose were present between Split Lake and Stephens Lake. Following hydroelectric development, their presence on the shores of Split Lake was diminished as a result of shoreline habitat loss (Split Lake Cree – Manitoba Hydro Joint Study Group 1996a) and fluctuating water levels (YFFN Evaluation Report (*Kipekiskwaywinan*)). Maps shared by Tataskweyak Cree Nation (TCN 2000a; 2000b) depict moose hunting areas on the south shore of the Nelson River between Split Lake and Birthday Rapids, and on the north and south shores of the Nelson River downstream of Birthday Rapids to Stephens Lake. Furthermore, TCN Members identified areas where moose have been noted feeding and breeding in the Gull Lake area (TCN 2000a; 2000c). Moose are often observed on the shores of Stephens Lake, and the islands in the lake are used by cows for calving (FLCN 2010 Draft).

While moose have always existed in the Keeyask region, populations have been increasing (Split Lake Cree – Manitoba Hydro Joint Study Group 1996a) and they are described as more plentiful than 50 or 60 years ago (FLCN Environment Evaluation Report (Draft)). The moose population in the Split Lake Resource Management area was estimated at 1,600 individuals in the mid-1990s (Split Lake Resource Management Board 1994) and at 2,600 individuals in 2010 (TE SV). Moose activity was very commonly observed in the Local Study Area during field studies. An estimated 125 moose currently inhabit the Local Study Area and the population in the Regional Study Area is estimated at approximately 960 individuals (TE SV).

Past and existing human impacts and past climate change could influence future habitat for moose in the Regional Study Area even if the Project does not proceed. Habitat composition, predation, and harvest will continue to be important moose population drivers. Predicted trends in habitat composition include the future disappearance of the ground ice peatland types, which will be replaced by wetland peatland types and open water. As these peatlands are low quality habitat for moose, the predicted habitat composition trend for moose is likely to be neutral. The quality of habitat along the Nelson River will most likely remain low for moose due to past and on-going changes in shoreline erosion that continues to affect shoreline browse. On-going changes in shoreline erosion that resulted from past and existing projects will continue to reduce the size of future moose calving islands. Because erosion will also contribute to formation of future islands, the net effect on moose calving habitat is uncertain. Although the moose population appears to be stable or possibly has increased in the Regional Study Area, other moose populations in Manitoba are recovering from large declines attributed to increased access and harvest. Future moose populations in the region will continue to be managed on a sustainable harvest basis by Manitoba Conservation, with the first right of harvest belonging to First Nations.

Beaver

Beaver is a keystone species capable of creating aquatic habitats and altering terrestrial habitats for many wildlife species. Beaver are important to the KCNs for cultural and economic reasons (Section 6.2.3.6). The Beaver Local Study Area was Zone 3 and the Beaver Regional Study Area was Zone 4 in Map 6-28.

Beaver inhabit waterbodies in forested areas (Banfield 1987). During field studies, beavers were observed to be most active in streams and ponds in the Regional Study Area, and their presence was seldom detected in upland habitats. They may use ponds in northern ribbed fen habitat, and can be found around willows in glaciofluvial complexes (CNP Keeyask Environmental Evaluation Report; see Section 6.2.3.2 for descriptions of habitats). Primary beaver habitat is generally in broadleaf forests, marsh, and tall shrubs. Secondary habitat is generally in black spruce, jack pine, or tamarack-dominated stands, and areas with low vegetation or young regeneration (TE SV Section 7, Table 7.3-16). FLCN Members have noted beaver in the Butnau River and in Cache Lake (FLCN 2010 Draft), and there are currently beaver at several creeks between Gull Rapids and Birthday Rapids (CNP Keeyask Environmental Evaluation Report). Beaver alter aquatic ecosystems by building dams and through their feeding activities (Naiman *et al.* 1986) and increase the diversity of species and habitat on a landscape (Wright *et al*. 2002; Rosell *et al*. 2005). Muskrat, moose, mallard, and other wildlife rely on beaver for the creation of high quality habitat.

Beaver were heavily trapped in the past for their fur and their populations were depleted in the 1930s (YFFN Evaluation Report (*Kipekiskwaywinan*)). They were the most commonly trapped furbearers at that time, but were scarce in areas other than the vicinity of the Churchill River (Split Lake Cree – Manitoba Hydro Joint Study Group 1996a). Prices for fur, particularly beaver, began to decline in the early 1950s (Split Lake Cree – Manitoba Hydro Joint Study Group 1996a). A recovery in the mid-1970s and early 1980s is reflected in the Split Lake harvesting data (Split Lake Cree – Manitoba Hydro Joint Study Group 1996a). Historically, beaver were present between Split Lake and Stephens Lake. Although all streams were considered important for beaver, nine streams were identified as suitable beaver habitat in the Gull Lake area (TCN 2000a). There are fewer beaver in the York Landing area today than in the past due to water level changes and shoreline habitat changes from hydro development (YFFN Evaluation Report (*Kipekiskwaywinan*)). They were abundant along the shoreline of the Nelson River, and are now rare in these areas (FLCN

2010 Draft) due to previous hydroelectric development (YFFN Evaluation Report (*Kipekiskwaywinan*); FLCN 2010 Draft). Shoreline wetlands have changed, and the seasonal reversal of water flow from system operations impedes individual home range reestablishment in the Nelson River. Off-system creeks and lakes currently provide habitat for many beaver and are important areas for trapping (FLCN 2010 Draft).

Field studies indicated that beaver are very common in Study Zone 1 ponds and creeks. The density of active colonies was low on Gull Lake, Stephens Lake, and the Nelson River downstream of Kettle GS, due in part to water-level fluctuations caused by past hydroelectric development. The high water velocities associated with large northern rivers can also create unsuitable conditions for beaver; there are relatively few on the shorelines of comparison areas unaffected by hydroelectric development (the Gods and Hayes rivers). Beaver are somewhat less common in the Local Study Area than in Zone 1. In addition to water levels and velocity, habitat capacity is also influenced by limited food supply, fire, and harvest, resulting in a moderate to high variation in the distribution and abundance of beaver (TE SV). The current beaver population in the Regional Study Area is estimated at approximately 250 active colonies, and there are 23 active lodges in Study Zone 1.

Past and existing human impacts and past climate change could influence future habitat for beaver in the Regional Study Area even if the Project does not proceed. Habitat composition, predation, and harvest will continue to be important beaver population drivers. Predicted trends in habitat composition include the future disappearance of the ground ice peatland types, which will be replaced by wetland peatland types and open water. As these peatlands are low quality habitat for beaver, the predicted habitat composition trend is likely to be neutral. Future beaver harvest is linked to the market value of beaver pelts (Manitoba Conservation, Wildlife and Ecosystem Protection Branch 2011), and will most likely result in highly variable numbers of beaver trapped. Trapline stewardship, policy, and management will continue to influence future beaver populations. Trappers are stewards of their traplines (Fur Institute of Canada 2003), and are responsible for sustaining local beaver populations. Additionally, the provincial government is reviewing a draft Furbearer Management Policy to maintain sustainable populations of furbearers (Manitoba Conservation, Wildlife and Ecosystem Protection Branch 2009), thus future harvest is not expected to exceed sustainable levels.

6.2.3.4.8 MERCURY IN WILDLIFE

Mercury is a heavy metal that occurs naturally in the environment. It is released when soil and vegetation are flooded, converted to organic methylmercury, taken up by organisms at low trophic levels (see Section 6.2.3.3), and passed up the food chain to invertebrates, fish and finally, to riparian wildlife species such as river otter and osprey. Mercury levels in mammals were measured via tissue samples taken from individuals trapped between 2003 and 2009 and levels in birds were estimated from available literature. A detailed description of mercury study methods and results are available in the TE SV. The Mercury Local Study

Area was Study Zone 4 and the Mercury Regional Study Area was Study Zone 5 in Map 6-28.

Mercury in wildlife is often linked to hydroelectric development and has importance to domestic resource use (see Section 6.2.3.5). Historic records for mercury concentrations in indicator species such as river otter and mink near the Regional Study Area are located in the Split Lake – Stephens Lake areas, the Nelson River towards Limestone GS, near Pikwitonei, and other reference areas from northern Manitoba. Along with fish, these two species were monitored as part of the Canada-Manitoba mercury monitoring agreement. Collections from the Southern Indian Lake area occurred approximately six to eight years after the Churchill River Diversion. Collections from the Nelson House-Burntwood River area occurred approximately two to eight years after the Churchill River Diversion. Collections from the Split Lake-Stephens Lake-Upper Nelson River areas occurred approximately 12 to 15 years after Kettle was built and Stephens Lake was flooded. Current levels in the Stephens Lake area are lower than 20 years ago, and extreme variations have not been measured.

The consumption of fish with elevated mercury concentrations represents a risk to animal health (Scheuhammer *et al.* 2007). Where mercury concentrations in fish increase (see Section 6.2.3.3) and are consumed by wildlife, mercury is transported into animal tissues and biomagnified. Herbivorous animals (*e.g.*, geese, beaver, and moose) are not at risk due to the very low quantities of mercury taken up by plants. Omnivorous species (*e.g.*, common goldeneye, muskrat) tend to accumulate more methylmercury than herbivores, but to a much lesser extent than species whose diet is comprised mainly of fish. The risk of health-related effects is greatest for osprey, mink, and river otter (Wren 1986).

Mercury levels in aquatic ecosystems in the Furbearer Regional Study Area are likely to vary over time and, without hydroelectric development, are expected to remain within the range of baseline concentrations reported from 2003 to 2009 for mammals. Similarly, estimated background levels of methylmercury in birds in the Bird Regional Study Area are also anticipated to remain relatively unchanged (within the range measured from 2002 to 2006) without the Project.

6.2.3.5 Socio-Economic Environment

6.2.3.5.1 Introduction

The socio-economic environmental setting examines the current situation, the past influences that have shaped today's existing environment, and how the existing environment may evolve into the future under baseline conditions (when information is available). The socio-economic environment includes the people and communities in the immediate vicinity of the Project (*i.e.*, the KCNs communities, Gillam and Thompson), as well as the Regional Study Area as a whole and the overall economies of Manitoba and Canada. It takes into account the array of interrelated factors that contribute to the social and economic well-being of individuals, families and communities, including the influence of past hydroelectric development. The socio-economic linkages are through two main pathways:

- Pathways through the physical and biophysical environment; and
- Pathways through Project expenditure and revenues.

These linkages are depicted in Figure 6-8, which presents a general framework to show the main pathways by which a hydroelectric development could affect people. For simplicity, the figure does not include the detailed connections that occur within and among these pathways. Those are discussed in greater detail in Sections 3, 4 and 5 of the SE SV.

The extent to which the Project has an effect on people depends largely on their proximity to and level of involvement in the Project. The socio-economic study areas are as follows:

- The Local Study Area: the four partner communities of TCN, WLFN, YFFN and FLCN, the Town of Gillam and the City of Thompson (see Map 6-39 Socio-Economic Local Study Area map); and
- The Regional Study Area: northern Manitoba defined by the boundary identified under Schedule D of the current Burntwood Nelson Agreement, and which includes Census Divisions 19, 21, 22 and 23 (see Map 6-41 Socio-Economic Regional Study Area map).

The socio-economic environment is organized into three main components, with valued environmental components (VECs) or supporting topics of interest under each component:

- Economy (including the VECs of employment and training; business opportunities; income; cost of living; and the resource economy);
- Population, Infrastructure and Services (including the supporting topic population; the VECs of housing; infrastructure and services; transportation infrastructure; and land); and
- Personal, Family and Community Life (including the VECs of community governance, goals and plans; community health; mercury and health; public safety and worker interaction; travel, access and safety; culture and spirituality; and the way the landscape looks (or aesthetics)).

Further details on the Existing Environment for these topics and VECs can be found in the SE SV, Sections 3.3 (Economy), 4.3 (Population, Infrastructure and Services) and 5.3 (Personal, Family and Community Life).

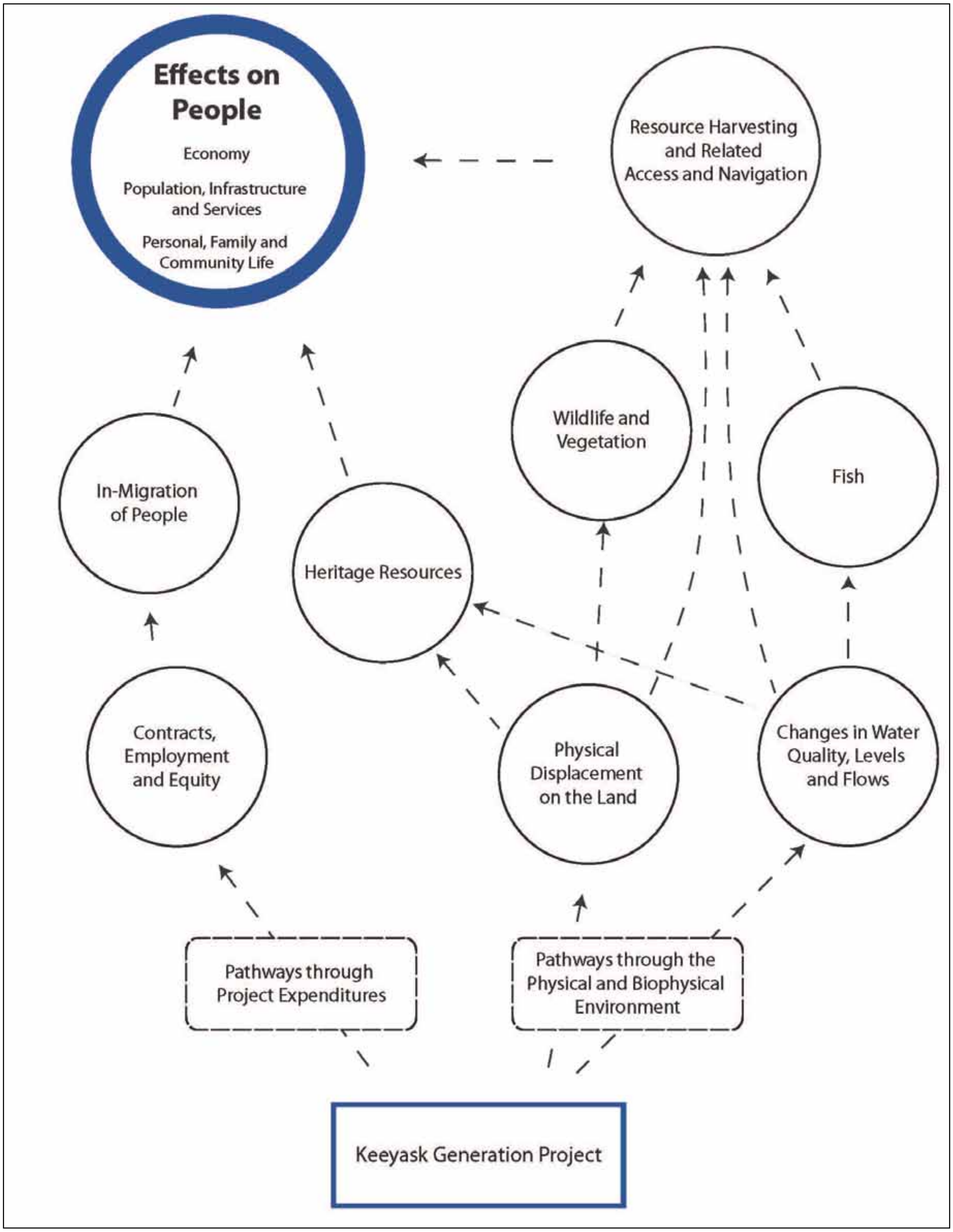


Figure 6-8: Socio-Economic Impact Assessment General Framework

6.2.3.5.2 ECONOMY

EMPLOYMENT AND TRAINING

Employment rates across the Local Study Area are highly variable. According to 2001 Statistics Canada information (the most recent year for which complete employment data is available for all the communities in the Local Study Area), the KCNs communities have young and growing labour forces that currently experience high unemployment rates compared to the northern Aboriginal population or the Regional Study Area as a whole (2001 Statistics Canada data[1]). The high unemployment trend has been consistent between 1991 and 2001. Without sizeable near-by employment opportunities this trend is expected to continue into the future. Factors contributing to the high unemployment rates include lack of full-time job opportunities, inadequate skills, lack of day-care and family responsibilities. Construction of the Project will provide a large number and variety of construction employment opportunities in the region.

A pre-project training initiative, called the Hydro Northern Training and Employment Initiative (HNTEI) 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 sought to add skills to the labour forces of the KCNs and of the Aboriginal labour force of the 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.

HNTEI partners included TCN, WLFN YFFN, FLCN, Nisichawayasihk Cree Nation (NCN), Manitoba Keewatinowi Okimakanak (MKO) and the Manitoba Metis Federation (MMF). These First Nations and Aboriginal organizations were responsible for designing and delivering most of the training, largely through community-based programs. The Wuskwatim and Keeyask Training Consortium (WKTC) acted as the administrative and coordinating body for the HNTEI.

The HNTEI sought to provide educational upgrading, enhance general job readiness, skills development and work experience. Technical pre-project training (PPT) related to construction employment focused on - designated trades (apprenticeable trades like carpentry); construction non-designated trades (non-apprenticeable trades like heavy equipment operator); construction support (*e.g.*, catering); and technical or professional occupations (*e.g.*, administration). The emphasis was on training for occupations that could serve both Project and community needs. Over the life of the initiative, approximately 2,600 training opportunities were provided in communities throughout the Regional Study Area. Of that total, more than 1,070 Aboriginal people were registered in occupational training

[1] 2001 was chosen as a standard reference point for employment analysis because it provides the highest quality and most complete Statistics Canada data for all the communities.

courses or programs[1]. Nearly all of the participants were from communities in the Churchill-Burntwood-Nelson (CBN) area, which includes communities affected by past hydroelectric development and a sizeable proportion from the KCNs. HNTEI also helped place hundreds of trainees into jobs and facilitated several hundred work placements for their trainees. As shown in Table 6-11, there were 595 PPT participants who completed courses and programs. Further detail is provided by occupational category for CNP, YFFN, FLCN, the KCNs as a whole and the Regional Study Area up to the end of March 2010 (see Section 3.3.1 of the SE SV for further detail).

Table 6-11: Hydro Northern Training and Employment Initiative Participants with Completed Courses and Programs by Occupational Category for Keeyask Cree Nations and the Regional Study Area (2009, 2010)

Occupational Job Category	CNP	FLCN	YFFN	Total KCNs	Regional Study Area
Designated Trades	25	5	1	31	101
Construction Support	16	15	16	47	82
Non-Designated Trades	50	38	28	116	345
Business and Management	24	10	14	48	67
Total Graduates	*115*	*68*	*59*	*242*	*595*

Source: Derived from Wuskwatim Keeyask Training Consortium 2009/10 fourth quarter report and other WKTC derived data.

Note:

- Table includes a portion (5%) of apprentices that have achieved less than Level 1 apprenticeship.
- Table includes trainees that have completed courses of programs through the HNTEI in occupational classifications that align with Keeyask workforce estimates as of August 2010.
- Numbers are subject to rounding.
- For greater detail, refer to the SE SV, Section 3.3.1 for a table that also presents other First Nations and Aboriginal organizations.

Labour Force

Labour force characteristics assist in understanding the extent to which Project employment opportunities may be filled by residents of the KCNs and other communities. Key labour force indicators presented include the following:

- Potential labour force (population aged 15 years and older);

[1]Many of the participants in the HNTEI program took more than one course. This skills inventory identifies the estimated maximum number of KCNs Members available to work.

- Participation (proportion of population actively employed, about to be employed or looking for work);
- Employment (proportion of population employed); and
- Unemployment (proportion of population unemployed). Statistics were collected for the KCNs, Gillam, Thompson and the Northern Region.

From 1991-2001 the potential labour force in the KCNs communities experienced a high rate of growth and an increasing participation rate. However, the rate of growth was lower than populations of the Regional Study Area and Manitoba (SE SV Section 3.3.1).

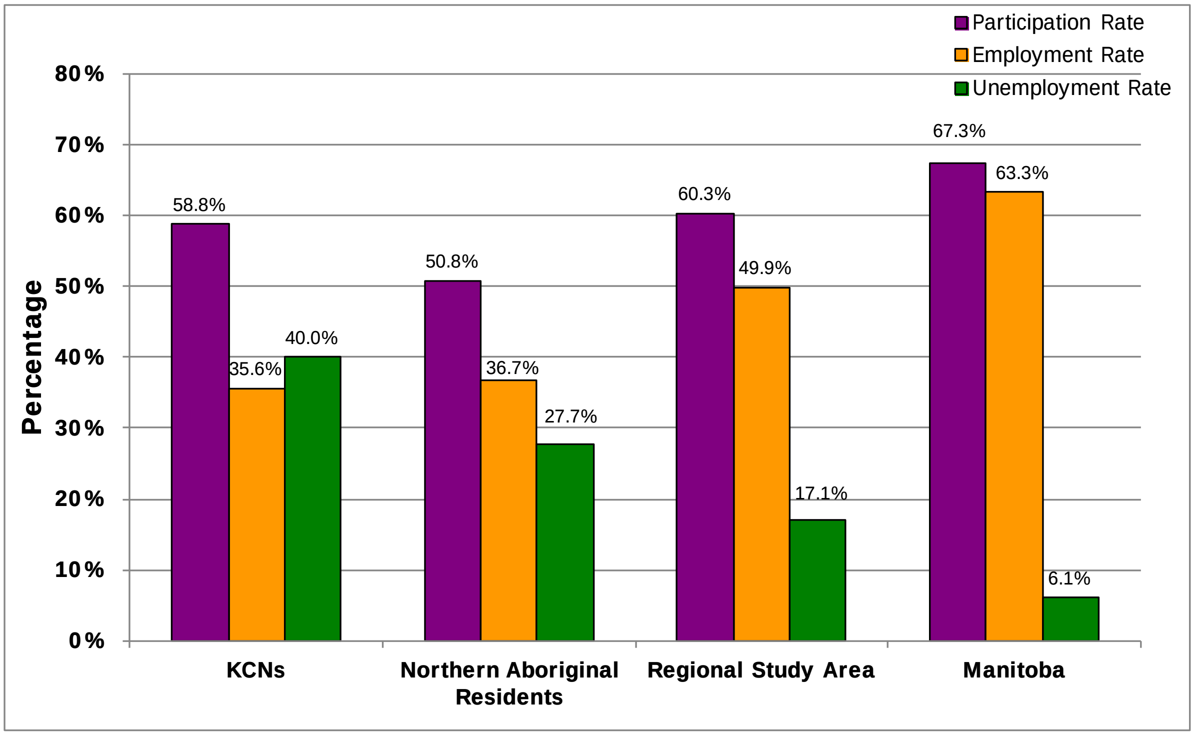
Employment rates across the Regional Study Area are low for Aboriginal people, including in the KCNs communities.

As shown in Figure 6-9, the KCNs employment rate was comparable to that for all northern Aboriginal residents but was well below the rate for the Regional Study Area and Manitoba. The KCNs and northern Aboriginal residents in the Regional Study Area have higher unemployment rates, at approximately 40% and 28% respectively, than the comparison populations of the Regional Study Area and Manitoba.

With rapidly growing labour forces, these unemployment rates have remained high over time; and would be expected to remain high into the future without concerted efforts to address the issue. Efforts are ongoing on the part of communities and governments to enhance the employability of northern Aboriginal residents and develop new employment opportunities in the region. The fieldwork research program (Local Study Area) identified a number of challenges preventing people in the KCNs communities from obtaining employment, including a lack of full-time job opportunities, family responsibilities, lack of day care, availability of housing, and inadequate skills/employment readiness (CNP 2010a, 2010d; FLCN KPI Program 2009-2011; YFFN KPI Program 2009-2010).

The labour force in the Town of Gillam has typically fluctuated following Manitoba Hydro labour force requirements. The town's participation rate in 2001 was higher than that of the comparison populations of the Regional Study Area and Manitoba. The town's employment rate remained relatively stable from 1991 to 2006. Gillam's unemployment rate of 6.4% in 2001 was similar to Manitoba (6.1%) but much lower than the Regional Study Area (17.1%) (Statistics Canada 2002; details are found in the SE SV Section 3.3.1).

Employment in the City of Thompson has traditionally been linked to mining, so that declines in the potential labour force typically corresponded to a reduction in mine employment (*e.g.*, Vale). Despite the decline, the city's participation rate has remained relatively stable over time, greater than that for the comparison populations of the Regional Study Area and Manitoba. The employment rate for this period was also greater than that for the comparison populations. Thompson's unemployment rate in 2001 (7.1%) was comparable to Manitoba and lower than the other comparison populations noted above, reflecting the strong presence of Vale and other associated employers.



Source: Statistics Canada 2002; Statistics Canada 2011.

Notes:

Complete data set provided in SE SV Appendix 3A [Table 3A-2].

KCNs includes Members of Tataskweyak Cree Nation (TCN), War Lake First Nation (WLFN), York Factory First Nation (YFFN), and Fox Lake Cree Nation (FLCN). Statistics Canada refers to these communities as Split Lake, Ilford, York Landing and Fox Lake 2, respectively.

Northern Aboriginal residents defined as Aboriginal Identity Population in Statistics Canada Census Divisions 19, 21, 22 and 23.

Regional Study Area defined as Statistics Canada Census Divisions 19, 21, 22 and 23.

Participation rate refers to the labour force in the week (Sunday to Saturday) prior to Census Day (May 15, 2001), expressed as a percentage of the population 15 years of age and over. The participation rate for KCNs was calculated by InterGroup Consultants as the weighted average of the populations of TCN, WLFN, FLCN and YFFN 15 years and over. All data subject to rounding.

Employment rate refers to the number of persons employed in the week (Sunday to Saturday) prior to Census Day (May 15, 2001), expressed as a percentage of the total population 15 years of age and over. The employment rate for KCNs was calculated by InterGroup Consultants as the weighted average of the populations of TCN, WLFN, YFFN and FLCN 15 years and over. All data subject to rounding.

Unemployment rate refers to the unemployed persons, expresses as a percentage of the labour force in teh week (Sunday to Saturday) prior to Census Day (May 15, 2001). The unemployment rate for KCNs was calculated by InterGroup Consultants as the weighted average of the populations of TCN, WLFN, YFFN and FLCN 15 years and over. All data subject to rounding.

Figure 6-9: Employment, Participation and Unemployment Rates in Keeyask Cree Nations and Comparison Populations (2001)

Education

Education is an important determinant of employability. In 2001, approximately 60% of KCNs Members had an education level of less than a high school certificate or equivalent, which is a considerably higher percentage than the rest of Aboriginal Canadians. This was comparable to northern Aboriginal residents as a whole but much higher than for the other comparison populations (Regional Study Area and Manitoba). In 2001, the year before HNTEI began in these communities, the percentage of KCNs Members over 20 years of age with some post-secondary education or higher, including trades certificates or diplomas, was less than that for the comparison populations of northern Aboriginal residents, the Regional Study Area and Manitoba. Findings indicated that communities were particularly challenged with respect to technical trades, graduation past grade 10 and university or college graduation. Challenges to educational attainment identified by KCNs community Members include teacher retention for on-reserve schools, lack of parental involvement, difficulties of having to access educational services outside of the communities (leading to culture shock, peer pressure and related social challenges), and family responsibilities, including lack of childcare (CNP 2010a, 2010d; FLCN KPI Program 2009-2011; YFFN KPI Program 2009-2010; SE SV Section 3.3.1).

In Gillam, in 2001, education levels were high in comparison to the other populations (*i.e.*, northern Aboriginal residents, the Regional Study Area), and comparable to the Manitoba population, including the categories of university, non-university certificate or diploma; high school certificates; and trades certificates or diplomas. According to local school officials, there has been an increase in high school enrolment in Gillam recently, which has been attributed to the introduction of calculus and university-level mathematics courses as well as internship programs (Gillam KPI Program 2009-2010).

In 2001, about two-thirds of the residents of Thompson over age 20 had a high school certificate or higher education, which was comparable to Manitoba. Thompson also experienced high percentages of residents with trades certificates or diplomas, in addition to post-secondary education certificates, diplomas, degrees or others compared to other populations (Statistics Canada 2011).

In 2001, the proportion of northern Aboriginal residents with a high school certificate, trades or other post-secondary education was lower than in the Regional Study Area and Manitoba. Educational attainment below a high school certificate or equivalent is prevalent in northern Aboriginal communities for a number of reasons; most importantly, a lack of access to high school programs in local First Nations communities (Statistics Canada 2002).

Employment and Occupations

Almost one-quarter of workers in KCNs communities are employed in the sales and service sector (retail, hotel and catering), which was similar to the comparison populations. The second largest sector included occupations in social science, health, education, government service and religion. The trades, transport and equipment operators and related occupations sector is the third largest employer in the KCNs communities, which is also reflected in findings from the community-based research program (Statistics Canada 2002; SE SV Section 3.3.1).

The largest proportion of Gillam's total workforce is employed in the trades, transport and equipment operators and related occupations sector. This disparity (compared to other populations) reflects the extent to which Manitoba Hydro and its contractors are major employers in the community. The sales and services sector along with the management, business, finance and administration sector employs the second largest percentage of the workforce (Statistics Canada 2002).

Occupations in the sales and services sector employed the largest percentage of Thompson's workforce (at nearly 25%) compared to other occupations in 2001. The second largest employers in Thompson were those with occupations related to management, business, finance and administration in 2001 (Statistics Canada 2002).

The largest employers of northern Aboriginal residents are businesses in the sales and services sector. The second largest employers of northern Aboriginal residents are businesses that provide trades, transport and equipment operations and related occupations (Statistics Canada 2002).

Skills Pertinent to Project Construction Employment

An inventory of skills pertinent to Project construction employment was produced to complement the Statistics Canada information that was gathered. For the KCNs, this provides a more direct estimate of individuals who may be qualified for Project construction jobs. Table 6-12 presents estimates of the number of KCNs Members with relevant skills according to broad job categories required for Project construction[1]. KCNs Members are eligible for the preferential hiring provisions that exist for Project construction jobs.

Gillam currently enjoys low unemployment rates, primarily because of the close association with Manitoba Hydro. There are some FLCN Members who live in Gillam who are eligible for the first order hiring preference provisions and may gain employment on the Proejct. Participation by Thompson residents in Project employment opportunities will depend on the state of the city's economy at the time Project construction is underway (for details see SE SV Appendix 4B).

[1] This skills inventory identifies the estimated maximum number of KCNs Members available to work on the Project and includes people who are already employed, may not have the proper qualifications required by hydro projects and who may not be available to secure employment opportunities when they arise. These and other factors are taken into account during the scenario analysis portion of the employment modeling process (see SE SV, Section 3.2).

Table 6-12: Keeyask Cree Nation Estimated Skills by Occupational Category (2014, 2021)

Skills By Job Category[1]	2014[2] (Construction Start)	2021 (Construction End)
Designated Trades	85	90
Non-Designated Trades	165	170
Construction Support	230	255
TOTAL	*480*	*515*

Source: Derived from data provided by Manitoba Hydro based on WKTC (current as of Q4 2009/2010) and other WKTC derived data; analysis prepared by InterGroup Consultants Inc. 2010.

Notes:

1. For greater detail, refer to the SE SV Section 3.3.1 and SE SV Appendix 3A-5.

2. Derived from HNTEI labour supply projection and projection of Statistics Canada occupational data (2001). Analysis by InterGroup Consultants Inc., 20102. Based on project construction start in 2014.

Numbers are subject to rounding.

BUSINESS OPPORTUNITIES

This section characterizes the capacity of existing businesses to participate in opportunities that may arise from the Project. KCNs businesses are of particular interest given the direct negotiated contracts (DNCs) that will be made available to them as a result of the JKDA.

The KCNs have a number of businesses with potential for participating in Keeyask-related contracts. These include businesses that provide engineering, construction, environmental and catering / hospitality services (see SE SV Section 3.3.2.1 for a listing of these businesses). The KCNs communities are also engaged in various business development ventures (*e.g.*, under Aboriginal Business Canada).

As the largest employer in Gillam, the presence of Manitoba Hydro provides a sizeable population base to support local businesses and amenities. A number of construction and contracting, transportation and hospitality businesses have a presence in the town (see SE SV Section 3.3.2.2).

The City of Thompson is the major service centre for the Regional Study Area. The local construction and transport industries have extensive experience in the mining sector and increasing experience working on hydroelectric construction projects in the Regional Study Area (Thompson KPI Program 2008-2010; see SE SV Section 3.3.2.3 for a listing).

INCOME

Disparity in income earnings exists between Aboriginal workers[1] and other workers in the Regional Study Area. On average, Aboriginal workers in the Local and Regional Study Areas earned 68% - 71% of the average earnings of all people employed in the comparison populations (Gillam, Thompson, Regional Study Area and Manitoba). The average Aboriginal annual earnings ranged from approximately $18,000 – $29,000, while the average annual earning for all workers ranged from approximately $26,000 - $41,000. Aboriginal workers in Gillam had higher average annual earnings than Aboriginal workers in the comparison populations. In 2001 and 2006, the KCNs communities experienced a higher reliance on government income than the provincial average (Statistics Canada 2002; see SE SV Section 3.3.3 for further details). This trend is not expected to change unless more employment opportunities are available for people in the KCNs communities.

According to Statistics Canada 2001 data, Regional Study Area residents, including Aboriginal residents, relied on government payments at least two times the national rate.

Because of a high proportion of jobs in mining and electricity production, average income in Thompson and Gillam is higher than the provincial average.

COST OF LIVING

Key cost of living considerations include food and household items, transportation and housing. Living costs are high in the Local Study Area due to the high cost of transporting goods long distances; living costs are expected to remain high into the future. As well, KCNs communities and Gillam have small markets, while York Landing and War Lake lack year round road access.

Residents in the most remote communities experience the highest price index differential. Ranked in order of the percentage difference in prices compared to Winnipeg, York Landing (YFFN) was the most expensive, followed by Ilford (WLFN), Gillam, Split Lake (TCN) and Thompson. A corresponding calculation was not possible for Fox Lake (Bird). As residents of this community buy most of their food and household items in Gillam, their cost of living would be above that of Gillam due to the added cost of travelling to and from Gillam. (Cost of Living Survey 2009) (see SE SV Section 3.2.5 (and Appendix 3B) and 33.4 for methodology and analysis respectively related to cost of living information).

Compared to Thompson, costs for food and household items tend to be high for KCNs residents. All four of the KCNs communities are small markets, with limited purchasing power; and YFFN and WLFN are remotely located with no year-round road access. Transportation to and from the KCNs communities is generally difficult and expensive; much of this cost is attributed to commutes to Thompson and elsewhere for groceries and

[1] Workers in this context refer to people who were employed and earned an income through employment.

other supplies. Housing costs tend to be very low across all four of the KCNs communities as housing is primarily distributed by the band (Cost of Living Survey 2009).

The cost of food and household items tends to be high in Gillam. Costs for housing tend to be low for Gillam residents who are employed by Manitoba Hydro because they are provided with subsidized housing; and for the small portion of FLCN Members who receive band sponsored housing on their new reserve. Other residents, including many FLCN Members not living on reserve, experience much higher housing costs.

The cost of food and household items in Thompson tends to be the lowest of all the communities in the Local Study Area but is still higher than in Winnipeg. House prices tend to be highly volatile in Thompson. With respect to transportation, Thompson is the most accessible community in the Local Study Area, with road access, regular flights, bus and rail service (Cost of Living Survey 2009).

6.2.3.5.3 Population, Infrastructure and Services

The effect that construction and operation of the Project may have on infrastructure and services in communities in the Local Study Area would largely depend on changes in population. An understanding of projected future population is useful in planning for future demands on the VECs of housing, infrastructure and services, which are examined from the perspective of their capacity to handle a Project-induced increase in population.

With support from the federal government, each of the KCNs provides housing, infrastructure and a variety of facilities and services to Members living on-reserve. The Town of Gillam is largely a resource-based community serving Manitoba Hydro as a base of operations for its northern hydroelectric facilities, as well as being the historical and present day home for many FLCN Members and the location of a FLCN reserve. Manitoba Hydro provides housing for its employees and contributes to a range of facilities and services in Gillam although FLCN also provides services for its Members in Gillam. The City of Thompson is the regional centre for northern Manitoba and provides a range of facilities and services for its residents as well as for Members of the KCNs.

Population

The most important factors affecting population growth or decline are births, deaths and migration. Of these factors, migration is the hardest to predict as people migrate to and from communities for a variety of reasons including employment, better housing, access to better health and education services, and various personal reasons. The populations of the communities in the Local Study Area are provided, followed by projected future population independent of the Project. The population projections then provide the driver of change on existing community infrastructure and services (see Section 4.2 of the SE SV for approaches to determining population change in the communities).

Keeyask Cree Nations

The total KCNs Member population in 2006 both on and off-reserve was approximately 5,350 (INAC 2006a, b, c, d). About 43% of the KCNs population lived off-reserve, with a large proportion of these individuals residing in other northern Manitoba communities. The largest of the KCNs communities is TCN, which had a total population of approximately 3,020 people, while WLFN is the smallest with an approximate total population of 235 on- and off-reserve (INAC 2006a and b). YFFN's approximate population was 1,070, while that of FLCN was 1,020 (INAC 2006 c and d). The KCNs population is young (*e.g.*, a large proportion of the overall population is under 25 years of age) (see Figure 6-10) and reflects the overall trend in the Aboriginal population of growth at rates as high as four times greater than non-Aboriginal populations in Canada (CMHC 2008; Steffler 2008). (See the SE SV Section 4.3.1 for additional details on the current KCNs population).

Population projections up to 2023 were calculated for the KCNs in order to understand population growth both with and without the Project. Low, medium and high population projections were modelled and under a medium-growth scenario[1], it is expected that the total population of the four KCNs communities would increase by approximately 39% over 15 years, or 2.6% annually. The average annual growth rate on-reserve would be about 3% and the average annual growth rate off-reserve would be about 2.2% (see Figure 6-11).

Gillam

In 2006, the population of Gillam was approximately 1,200, of which 580 self-identified as being of Aboriginal descent (Statistics Canada 2007). Since 2001, the population has slowly increased at about 0.6% per year, in conjunction with rising Manitoba Hydro employment as well as growth in the community's Aboriginal population[2]. The population of Gillam today and in the near-term continues to be linked primarily to the availability of employment with Manitoba Hydro and associated housing (see section on Housing below). Over the next five to 10 years, Gillam is forecasted to almost double, to between 2,300 and 2,800 people assuming Manitoba Hydro projects move forward (Dillon 2012). This forecast includes growth associated with operation staff of the Keeyask Project, Bipole III / Keewatinoow and the potential Conapawa Generation Project. We assume this also includes other Manitoba Hydro related staff growth, retail and services growth and FLCN population growth (all of which may include families).

Thompson

The 2006 population of Thompson was 13,445 according to Statistics Canada (2007). The Thompson economy has been strongly linked to the mining sector throughout most of its

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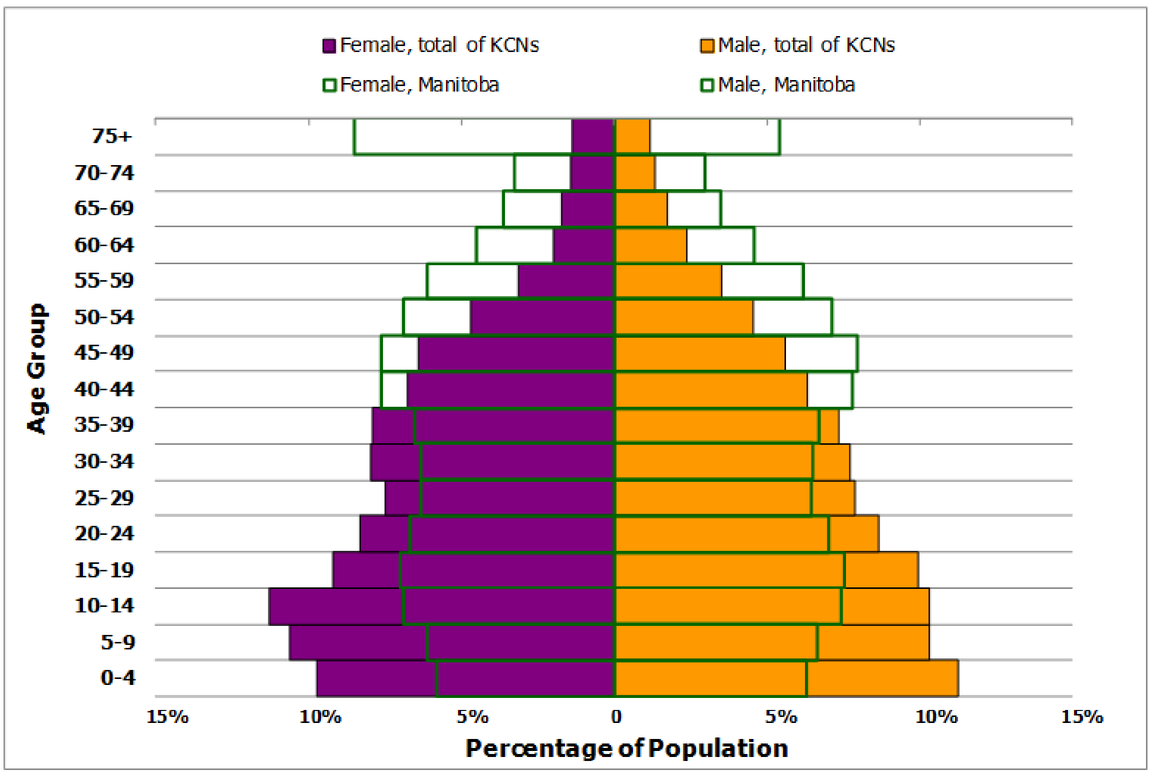
[1]The assumptions used for a medium-growth scenario are presented in Section 4.2.1.2 of the SE SV, while the assumptions and results of low- and high- growth scenarios are in Appendix 4A of the SE SV.

[2]Forty-five percent of Gillam's population self-identified as of Aboriginal descent in the 2006 Census.

history but over the last fifteen years with the increase in government services, post-secondary education and health care services and facilities, Thompson has begun to take on more of role as a regional centre. This changing role has meant that population change is affected by a wider range of factors beyond just mining development. The Aboriginal population in Thompson has also been growing, representing 37% of the overall population in 2006 (Statistics Canada 2007). Using an analysis of the known and potential drivers of change, two scenarios for the potential future population of Thompson were developed (full analysis can be found in Appendix 4C of the SE SV). The two scenarios for population change include: a low growth scenario which maintains growth in the community but at a noticeably lower rate than occurred from 2007 – 2010 (population projection of 14,000 to 17,000); and a suppressed economy scenario similar to stable and sometimes negative growth experienced from 1981 to2006 (population projection of 11,000 to 14,000) (SE SV Section 4.3.1.4).



Sources: Manitoba Health Population Reports 2006; Indian and Northern Affairs, First Nation Profiles 2006a, b, c and d.

Notes:

INAC refers to the communities of Tataskweyak Cree Nation, War Lake First Nation, Fox Lake Cree Nation and York Factory First Nation.

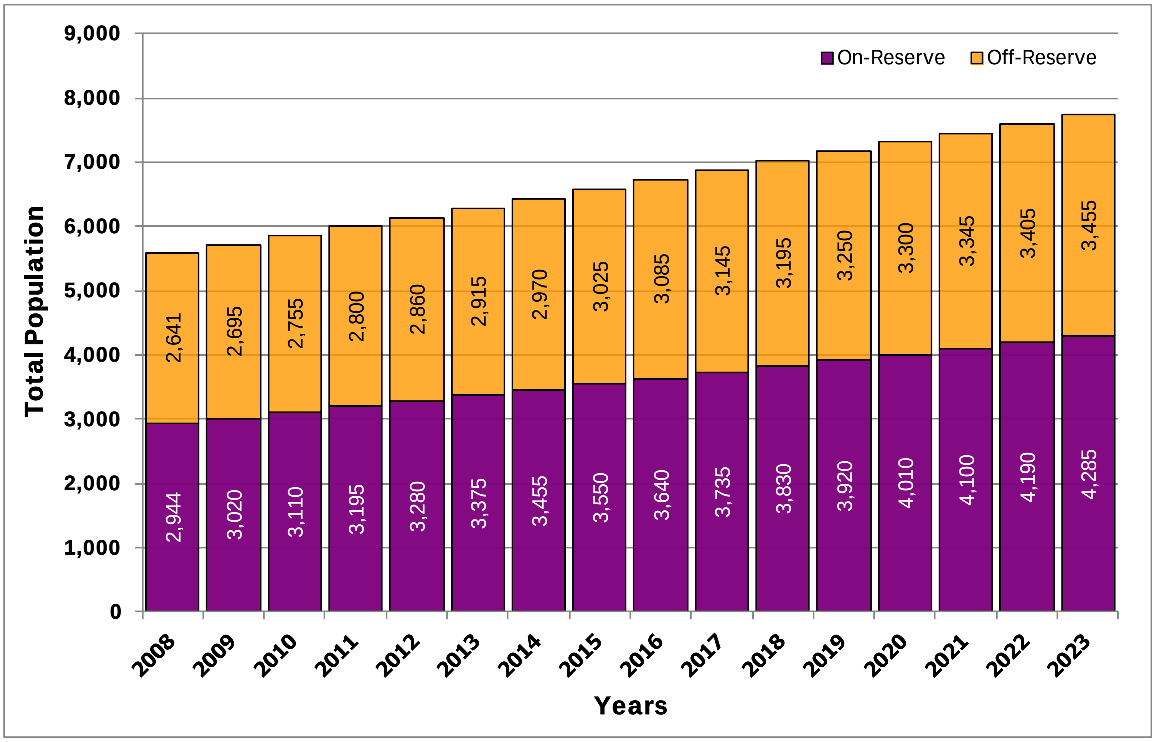
The data are based on a 2006 base year.

INAC data represent the population as of December 31, 2006.

Manitoba Health data represent the population as of June 1, 2006.

75+ population range of KCNs refers to age groups 75-79, 80-84 and 85 years or older in INAC data.

Figure 6-10: Age and Gender Population Distribution of Keeyask Cree Nations (On- and Off-Reserve) versus Manitoba Population (2006)



Source: Analysis prepared by InterGroup Consultants based on Indian and Northern Affairs, First Nations Population Profiles 2008.

Notes:

KCNs data are based on INAC data with a base year of 2008; INAC total population as of December 31, 2008.

INAC data for TCN, WLFN and YFFN are provided by the First Nations and Inuit Health Branch (FNIHB) of Health Canada.

INAC data for FLCN provided by INAC from the Indian Registry System.

The figure above summarizes population projections for TCN, WLFN, FLCN and YFFN.

"On-Reserve" includes individuals living on Crown Land, on other Reserves, and on other lands affiliated with First Nations operating under Self-Government Agreements.

For the Projection, InterGroup used fertility and mortality ratios derived from INAC "The Registered Indian Demography Population, Household and Family Projections, 2004-2029".

The population projection model rounds the calculated totals from the component equation; this figure shows a total of the rounded numbers from each of the individual KCNs projections, which have been rounded to the nearest five.

For FLCN data, the following also applies:

INAC data "On-Reserve" population breakout by gender for all age groups, except 10-14 and 15-19, was prorated based on total "On-Reserve" population (excluding age groups 10-14 and 15-19) gender breakout.

INAC data "On-Reserve" population for age groups above 60 assume Manitoba Health FLCN Population data for the same age groups. Population data for age groups above 75 corrected to be reconciled to total population.

Total population gender breakout for age groups above 65 was prorated based on total population gender breakout.

Off-Reserve population numbers derived as follows: Total population minus "On-Reserve" population (as defined in note above).

Figure 6-11: Keeyask Cree Nations Population Projection (2008-2023 Medium Growth Scenario)

HOUSING

Keeyask Cree Nations

Housing is one of the most basic necessities of life, yet the availability of adequate and affordable housing for First Nations residents is an ongoing concern in northern reserve communities in Canada. A rapidly growing population and limited availability of on-reserve housing are driving the need for more housing in many areas; a trend expected to continue for some time (Steffler 2008; CMHC 2007). The average number of people living in houses in KCNs communities ranges between 2.6 and 4.9 people and is typically higher than the Canadian national average of 2.6 people per household according to Statistics Canada data; some KCNs communities suggest this figure is much closer to six to sometimes 12 people per home (TCN 2010c; FLCN KPI Programs 2009-2010; YFFN KPI Programs 2009-2010). Many First Nation Members who wish to remain in their home communities share accommodations with family members while they are placed on housing waiting lists (thus contributing to crowded conditions) although some leave their communities to find housing elsewhere. In 2010, there were more than 350 KCNs Members on housing waiting lists, and families can wait two years or more to acquire a home in some KCNs communities (TCN 2010c and f; FLCN KPI Programs 2009-2010; YFFN KPI Programs 2009-2010).

Under existing environment conditions, the demand for housing is expected to exceed the supply into the foreseeable future. Contributing to this trend are the following factors: level of federal funding, growing on-reserve population, lack of suitable land for construction (YFFN and FLCN) and seasonal access limiting the timeframe in which building materials can be transported to the community (WLFN and YFFN). A lack of temporary housing is also a problem in KCNs communities. At the time of writing, three of the four KCNs communities had some form of temporary accommodations (see Section 4.3.2 in the SE SV for further details).

Gillam

The majority of homes in Gillam are owned by Manitoba Hydro and rented to employees stationed in the town. During the Gillam KPI program, it was noted that there is a shortage of housing in the community and there were 40 people on Manitoba Hydro's housing waiting list. Housing units are being built to match the expanding needs of Manitoba Hydro in the region and in order to accommodate growth. Manitoba Hydro has plans to build a minimum of 200 houses in Gillam over the next 10 years for staff employed as a result of upcoming projects in the region (Gillam KPI Program 2009-2010). Gillam's new Development Plan recommends developing a multi-stakeholder affordable housing strategy for non-Hydro employees to access a range of housing and living options (Dillon 2012). Manitoba Hydro recently established an alternative housing program, which will help to address home ownership in Gillam, by providing employees with options to purchase their home or to rent accommodation (Manitoba Hydro *pers. comm.* 2012).

Thompson

The 2006 Statistics Canada data indicated that there were 3,355 houses or movable dwellings and 1,465 apartment units (Statistics Canada 2007) in Thompson. In mid-2008, Thompson experienced a peak period of economic growth and it was estimated that the city needed approximately 750 new housing starts to keep up with demand (Service Canada 2009). Since the peak in economic growth, the economic climate has changed with the announced closure of Vale's refinery and smelting plant. It is expected, however, that the current shortage of housing units is likely to continue into the near future under existing conditions. Affordable housing has been identified as a growing need in the community and several housing projects are planned (additional information is available in the SE SV Section 4.3.2).

INFRASTRUCTURE AND SERVICES

In many northern communities including northern First Nation communities, the availability of infrastructure and services is often hampered by limited financial resources. This is often coupled with rapid population growth and increasing demand for services. This section examines the status and capacity of key existing infrastructure and services to accommodate Project-related population change and associated demand. Additional information on existing infrastructure and services including those services not discussed below can be found in the SE SV Section 4.3.3.

Education

Recruiting and retaining teaching staff remains a key challenge in many communities, primarily due to low salaries, lack of housing, and the physical and social isolation. Some KCNs communities experience overcrowded classrooms and a general lack of space and any students wishing to complete their high school education must leave their home communities in three of the four KCNs communities (only TCN has an active community-based high school) (CNP 2010c, 2010f; YFFN KPI Programs 2009-2010; FLCN KPI Programs 2009-2010).

At the time of writing, the schools in Ilford and Fox Lake (Bird) had capacity to accommodate more students; however, the schools in Split Lake and York Landing were operating at or near capacity (CNP 2010c, 2010f; YFFN KPI Programs 2009-2010; FLCN KPI Programs 2009-2010). Given the young and growing on-reserve populations in the KCNs communities, school capacity is expected to be a concern in the future. The Frontier School Division facility in Gillam is currently operating near capacity, and, based on trends over the last five to ten years, there is an expectation that enrolment will increase further. The Town is exploring whether to expand the current school or build a new one since it is expected that enrolment will continue to increase into the future (Gillam KPI Program 2009-2010). A feasibility study to determine the best approach, which included discussions with Manitob Hydro, FLCN, the Town of Gillam and the Gillam School Administration and Committee, is expected to be completed in 2012 (Manitob Hydro *pers. comm.* 2012).

Thompson has six elementary schools and one high school, of which the latter is attended by local students as well as students from First Nation communities that do not have their own high school facilities. All schools in Thompson have well-maintained infrastructure and sufficient space for current programming. The student base has fluctuated over the past several years, with a marginal decline in enrolment in the last few years. The student base fluctuation is expected to continue into the foreseeable future (Thompson KPI Program 2008-2010).

Child Care

In most KCNs communities, child care centres are already operating at capacity, and cannot accept more children. Many communities also experience funding constraints preventing them from hiring additional staff. In most cases, it is a challenge for programs to find and retain qualified child care workers, which can directly affect families that wish to pursue local employment opportunities.

At the time of writing, the child care centre serving TCN was operating at capacity with 16 infants on a waiting list. Equipment in the child care centre was in need of upgrading and funding constraints meant that the centre was unable to hire additional staff (CNP 2010c). The WLFN child care centre has space for up to five children (CNP 2010f). Fox Lake (Bird) currently has no child care facility but is seeking a qualified early childhood educator and discussing options to provide child care services for Members in Fox Lake (Bird) and Gillam (FLCN KPI Program 2009-2011). The YFFN - operated child care program was at capacity and there is a waiting list for the program although the cost of child care is considered to be prohibitive for some families (YFFN KPI Program 2009-2010).

The Gillam child care facility is licensed for 40 children, but typically only accepts between 30 and 35 children due to a lack of space and staffing challenges. At the time of the KPI program, there were 60 children on the waiting list. In 2011/2012, a new child care centre was under construction with capacity for 75 children (including one year olds); this facility is expected to be completed in the summer of 2012 (Gillam KPI Program 2009-2010; Manitoba Hydro, *pers. comm.* 2012).

In 2007, Thompson had 337 child care spaces; however, the city still had a chronic shortage of child care, which was expected to continue into the foreseeable future (Prentice 2007; Thompson KPI Program 2008-2010).

Health Care Services

Health Canada funds several types of programs in the KCNs communities including public education and health awareness programs. Among other things, support is provided for infant care, nutritional awareness, physical activities and diabetes control programs. The First Nations Inuit Health Branch (FNIHB) also works in some communities to deliver primary and emergency care as well as diabetes education.

The facilities and services at the Health Centre used by TCN in Split Lake are described as "inadequate and greatly underfunded" and staff retention, especially for FNIHB public health nurses, is a concern in Split Lake. In order to obtain treatment for diabetes (a major issue) and to access primary care services such as dental care and midwife services many TCN Members must travel to Thompson and Winnipeg (CNP 2010c). For WLFN, the Burntwood Regional Health Authority runs the Community Health Centre in Ilford where a public health nurse provides primary medical care. WLFN Members indicate they have noticed an improvement in basic, primary and emergency health care since the facility opened in 2007 (CNP 2010f). Although Fox Lake (Bird) does not have a nursing station and recruitment and retention of nursing staff for health programs is a challenge, a community health program is in place for FLCN Members in Fox Lake (Bird). Community Members travel to Gillam for nursing and primary health care services (FLCN KPI Program 2009-2011). For YFFN, doctors, dentists and mental health workers visit York Landing's nursing station one or two times per month for three to four days at a time. For illnesses of a more urgent nature, YFFN Members are flown by Medi-Vac to either Thompson or Winnipeg. Community Members have expressed concern regarding the limited nature of health services within their community and have noted that accessing services outside of the community is also challenging due to the lack of an all-weather road (YFFN KPI Program 2009-2010; YFFN 2011).

The 10-bed Gillam Hospital is the primary health centre in the community and has sufficient space to handle the current patient volume, although there have been discussions about expanding the hospital to include a walk-in clinic and to increase the staff to include a second physician or nurse practitioner (Gillam KPI Program 2009-2010).

The 74-bed regional Thompson General Hospital is the largest hospital within the Burntwood Regional Health Authority (BRHA). The Thompson General Hospital provides a wide range of health care services that are used by local residents and by KCNs Members. The Burntwood Community Health Resource Centre is the main health centre in Thompson and provides community health services to Thompson residents. The Centre includes a medical clinic and provides primary medical services, as well as health promotion, education, community outreach and illness prevention programs. Overall, there is a shortage of health services in the community, particularly clinic and walk-in centres, as well as family doctors and other health care professionals. This has led to the use of the hospital emergency room for minor health problems (BRHA 2008).

Social Services

The Awasis Agency of northern Manitoba provides child and family services to the KCNs communities as well as to Members living in Gillam and Thompson. Awasis typically works with other community programs such as National Native Addictions Drug and Alcohol Program (NNADAP), Brighter Futures Initiative, Building Healthy Communities and the Canadian Pre-natal Nutrition Program. In some communities, some KCNs Members have expressed concern that they need additional NNADAP workers to help manage the caseload, and substance abuse treatment programs are also needed within some of communities. Although some social service programs are available in most communities, the programs are not operated or funded on a consistent basis (CNP 2010c, 2010f; YFFN KPI Programs 2009-2010; FLCN KPI Programs 2009-2010; Gillam KPI Program 2009-2010).

LAND

The Project will be built on Crown Land within Split Lake Resource Management Area (SLRMA), which falls within the traditional territory of TCN and covers more than 43,000 km^2. No reserve land or Treaty Land Entitlement land is required for the Project. Reserve and Treaty Land Entitlement land for all of the KCNs is described in the SE SV in Section 4.3.4.

Land in the Town of Gillam is mostly owned by the Town of Gillam and Manitoba Hydro although other land owners include the Provincial Crown, the Federal Crown, FLCN Hudson Bay Railway (Omnitrax), and various private interests (Dillon Consulting Ltd 2011). Based on a range of population growth scenarios, it was determined that there is adequate land available for residential and commercial development in and around the community for the next five to 20 years (HTFC 2008).

The City of Thompson has a limited amount of land available for commercial and residential development; however, the City is exploring development of commercial and residential property north of the Burntwood River and the expansion of the city boundaries in several locations to accommodate future growth.

TRANSPORTATION INFRASTRUCTURE

The three principal all-weather roads that will be used during the construction of the Project are Provincial Trunk Highway 6 (PTH 6), Provincial Road 391 (PR 391) and Provincial Road 280 (PR 280). PR 391 connects Thompson with PR 280, which in turn is used to access the communities of Split Lake, Fox Lake (Bird) and Gillam (Map 6-40 Travel Distances in the Local Study Area). PR 280 is a two-lane, undivided, gravel roadway and is designated as a secondary arterial by Manitoba Infrastructure and Transportation (MIT). PR 280 has been described by many KCNs users as poor in condition and hard on vehicles, with dangerous visibility conditions due to dust. Upgrades to PR 280 between Thompson and Gillam have been initiated by Manitoba Infrastructure and Transportation (MIT) as part of its 2012 infrastructure projects. In conjunction with Manitoba Hydro, MIT identified 45 locations between PR 391 and the Keeyask North Access Road (km 177) that required improvements. The upgrades have been divided into two major components: 1) crushing and stockpiling road aggregates and rock cuts, and 2) re-grading, re-aligning, and re-surfacing. The first component of upgrades between Thompson and Gillam have been completed by MIT and the contract for the second component was awarded in 2012. The upgrades are intended to meet a standard that will improve safety and accommodate increased traffic. The upgrades include widening and curve shaving (Government of Manitoba 2010a). The communities of Ilford (WLFN) and York Landing (YFFN) have no permanent road access but can be accessed by a winter road that connects the communities to PR 280 and is in use from mid-January to mid-April depending on weather conditions. Table 6-13 below shows the various ways by which the KCNs communities can be accessed.

Members of WLFN and YFFN are concerned over not having all-weather road access to their communities, resulting in feelings of isolation and higher costs of goods and services (especially during freeze-up and break-up of the lake). YFFN have expressed concerns about the reliability and safety of the winter road, and have noted that accessing the community, particularly in the shoulder seasons where neither the winter road nor the ferry is capable of operating, is a major concern. These concerns are expected to continue into the future under baseline conditions (YFFN KPI Program 2009-2010).

Table 6-13: Methods of Accessing Keeyask Cree Nations Reserve Communities

	Split Lake (Tataskweyak: TCN)	Ilford (WLFN)	York Landing (YFFN)	Fox Lake (Bird: FLCN)[1]
Rail	No	Yes	No	Yes
Ferry	Yes (to York Landing)	No	Yes (via Split Lake)	No
Road/Bus	PR 280/Bus	No	No	PR 290
Airport	No	Yes	Yes	No
Winter Road[2]	Yes	Yes	Yes	No

Source: YFFN, FLCN and Gillam KPI Programs 2009-2010, CNP 2010c, CNP 2010f.

Notes:

1. FLCN Members living in Gillam have rail, road/bus and air access.
2. Winter roads connect Split Lake to York Factory First Nation at York Landing and War Lake First Nation at Ilford.

6.2.3.5.4 Personal, Family and Community Life

Community Governance, Goals and Plans

Community governance, goals and plans are linked, since it is typically a community's governance structure that is responsible for the execution of activities to achieve its goals and plans.

The primary institution for governance of each of the KCNs is a Chief and Council and their supporting administration, as described in Section 5.3.1 of the SE SV. Over the past four decades, negotiations with Manitoba Hydro and Project planning have placed substantial demands on community leadership in terms of time requirements, decision making and stress in having to balance community and Project needs. At the same time, these activities have increased the communities' capacities to deal with change brought upon by outside influences.

The KCNs share certain common goals, as are reflected in the JKDA and their respective AEAs. Among the common goals are:

- To increase each First Nation's influence over decision making regarding development activities in their respective RMAs;
- To increase the benefits flowing to communities as a result of development activities in their respective RMAs;
- To increase access to financial resources to support community development (both economic and social);
- To increase employment opportunities for their respective memberships; and
- To maintain and renew traditional culture and associated activities (TCN, WLFN, YFFN, FLCN and Manitoba Hydro 2009; TCN and Manitoba Hydro 2009; WLFN and Manitoba Hydro 2009; YFFN and Manitoba Hydro 2009; and FLCN and Manitoba Hydro 2009).

Each of the communities' respective goals and plans are described in Section 5.3.1 of the SE SV.

The Town of Gillam is governed by a mayor and four councillors who are elected for a four-year term. The Town of Gillam operates under an agreement signed with Manitoba Hydro in the 1960s, whereby Manitoba Hydro covers 100% of the Town's capital costs, and operational budgets are negotiated annually. FLCN also has an administrative presence in the community, in addition to the A Kwis Ki Mahka Indian Reserve, established in 2009. Gillam has revised its Development Plan, and has a vision for the future of being "a safe, family orientated, close-knit community where residents and visitors enjoy a vibrant historic full service town, unique natural beauty, and outdoor adventure" (Dillon 2012).

The City of Thompson is governed by a mayor and seven councillors who are elected for a four-year term. The City of Thompson has committed to a sustainable future by developing a sustainable community plan. The plan provides a vehicle through which long-term community sustainability goals can be met, to develop future land use and infrastructure policies and to assist in the coordination of policies and actions (Thompson KPI Program 2008-2010; Thompson and Planning District Sustainable Community Plan 2010).

COMMUNITY HEALTH

The health of individuals, families and communities is shaped by a variety of factors or determinants of health, which include the social and economic environment, the physical environment, and the person's individual characteristics and behaviours (WHO 2009). All of the communities in the Local Study Area are located within the district of the BRHA.

The KCNs understand community health through the Cree concept of living a good and honourable life or *mino-pimatisiwin* (Chapter 2). "From a Cree perspective, health has as much to do with social relations, land and cultural identity as it does with individual physiology" (Adelson 2000). *Mino-pimatisiwin* has strong ties to people's ability to pursue activities on the land, including the ability to hunt, trap, fish and gather food. Traditional foods, which have sustained communities over the centuries, are acknowledged today as providing a better diet than typically is provided from store-bought food (CINE 2006). Traditional foods are also acknowledged as providing for "strengthened cultural capacity and well-being" (ibid, 2006). The ties between health and well-being and the land have been experienced first-hand by the KCNs, who indicated that the advent of hydroelectric development in northern Manitoba resulted in profound changes on peoples' abilities to pursue traditional activities on the land (for further details see the KCNs' Environmental Evaluation Reports).

Health goes beyond the simple absence of disease. A full understanding of community health also requires consideration of a community's social, physical and economic environments as well as individual factors, which contribute to overall health, as described in Section 5.3.2 of the SE SV. Aboriginal status itself is considered by some as one of the key determinants of health in Canada (Raphael 2004) since Aboriginal people are more likely than other Canadians to experience inequalities that act as barriers to overall health (Health Canada 2003). Measuring these determinants of health can be challenging, particularly for the KCNs communities, due to the breadth of factors, and the lack of available data, since much of this type of information is not routinely collected or reported by the various health agencies in a consistent manner.

Health status of the population in the Local Study Area is tracked through many health indicators. An analysis of key health indicators is discussed in Section 5.3.2 of the SE SV. For the KCNs, diabetes, cardiovascular disease, rates of accident and injury, potential years of life lost (PYLL), and mental health are among the key health issues faced in each community.

The KCNs demonstrate the following trends with respect to these indicators (data from Manitoba Health special data run 2011):

- Diabetes among KCNs Members has increased dramatically since the mid 1980s, with a 637% increase in the number of people treated between 1984 and 2006 (27 and 199 people respectively). This represents the highest rate of change in comparison to the BRHA and Manitoba First Nations on-reserve data. Diabetes and related complications were identified by the KCNs as one of the top health concerns.
- Potential years of life lost is a measure that emphasizes causes of death that tend to be more common among younger persons, such as injuries and inherited health issues. For the KCNs, injury and poisoning, accounted for 2,106 or approximately 52% of all PYLL between 1980 and 2005.

Mental health disorders among all KCNs residents increased markedly since the mid 1980s. This rate of change is higher than for the BRHA but lower than for Manitoba First Nations on-reserve population.

The fieldwork research program (Local Study Area) has indicated that some of the KCNs believe that the effects of past hydroelectric developments have influenced community health YFFN KPI Program 2009-2010; FLCN KPI Program 2009-2010). Other community observations have been made regarding current health trends. For example, the KCNs have all expressed concerns about addiction-related issues in their communities, particularly related to alcohol. FLCN has noted an increasing trend in cancer rates, although they recognize that these indicators may reflect factors like the small size of the community, the aging population or improving diagnostics. The KCNs have expressed concerns about water quality in their communities, which has resulted in reliance by some on bottled water for drinking, and is also associated with skin infections (CNP 2010b, 2010e; YFFN KPI Programs 2009-2010; FLCN KPI Programs 2009-2010).

MERCURY AND HUMAN HEALTH

Based on previous experiences with hydroelectric development, including testing through the Federal Ecological Monitoring Program (FEMP), the KCNs became aware of the issue of mercury and human health. Based on this experience, the KCNs identified mercury and health as a key concern in relation to the Project. TCN and WLFN recognized the importance of addressing community concerns with methylmercury through the establishment of a Healthy Food Fish Program and Community Fish Program under their respective AEAs. YFFN and FLCN also have off-system resource use programs in their AEAs to address the concern with methylmercury in fish (see SE SV Section 5.3.3 and Section 5.4.2).

As such, a Mercury and Human Health Technical Working Group was established with representation from each of the KCNs, Manitoba Hydro and supporting specialists (see Section 5.3.3 of the SE SV for details on group composition and activities). The purpose of the group was to better understand mercury in relation to human health today, to understand possible mercury and human health effects of the Project, as well as mitigation to reduce adverse effects. The group also chose to develop communication tools to disseminate this learning to the communities (see Section 5.3.3 of the SE SV for details on the communication strategy).

There are various pathways of human exposure to mercury (Section 5.3.3 SE SV) although country foods, especially consumption of fish, are the primary exposure pathway relative to the Project. Methylmercury is the form of mercury discussed here, as it bio-accumulates through the aquatic food chain, placing people who consume fish at risk (Mergler *et al.* 2007). Fish with the highest methylmercury levels tend to be the large and long-lived predatory fish; however, most fish contain some levels of methylmercury. Various lakes in Canada and lakes in the Keeyask area have fish with naturally occurring elevated levels of methylmercury. However, flooding of soil for new hydroelectric reservoirs can cause mercury to be released from the soil as methylmercury into the aquatic food chain. After flooding, methylmercury levels increase, peak, and then over a period of years return to background levels.

FEMP studies undertaken between 1976 and 1990 to address environmental concerns expressed by residents of northern Manitoba in relation to LWR and the CRD examined the levels of methylmercury present in people. The results of these studies indicated that the vast majority (approximately 98%) of residents of the KCNs *(i.e.*, residents of Split Lake and York Landing) who were tested fell within 0 - 0.019 ppm[1] or what Health Canada defines as the "normal" range. The remainder of those tested fell within concentrations of 0.020 - 0.1 ppm or "at increasing risk range." Women of childbearing age[2] from Split Lake and York Landing fell within the normal range.

Current levels of methlymercury in selected country foods were examined as a part of the Human Health Risk Assessment (HHRA) undertaken by Wilson Scientific for the Project (see SE SV Section 5.3.3). The methods used to estimate human health risks were based on risk assessment procedures cited by Health Canada, the World Health Organization (WHO) and the US Environmental Protection Agency (US EPA). The main items of investigation were consumption of country foods (*e.g.*, fish, game, waterfowl and plants); and the ingestion and direct contact with surface water. The risk assessment is based on relatively high rates of eating fish as well as large portion sizes (*e.g.*, larger than a Health Canada food guide recommendation of 7-8 ounces).

Based on Section 6.2.3 (aquatic environment), the measured current methylmercury concentrations in lake whitefish, jackfish[3] (a.k.a. northern pike), and pickerel (a.k.a. walleye) in Gull Lake and Stephens Lake, lake sturgeon in Gull Lake and the serving sizes and consumption patterns reported by the communities, health risks were calculated.

[1] Ppm means parts per million.
[2] Women of childbearing age are of primary concern to health agencies with respect to mercury exposure due to the risk for fetal exposure.
[3] For the purposes of this document, the KCNs common term for select fish species is used. Jackfish is the common term for northern pike and pickerel is the common name for walleye.

Overall results of the risk assessment for country food items analyzed as well as surface water indicated the following (see the HHRA, Appendix 5C in the SE SV for greater details):

- Due to developmental toxicity risks, groups at increased risk (*e.g.*, women of child-bearing age and young children) need to be more cautious and selective in the types and amount of country foods eaten. Following the consumption guidelines provided in the HHRA will provide protection of these groups at increased risk. Overall however, it is important to maintain eating safe country foods (including fish) as a key contributor to a healthy diet.
- There are no restrictions suggested for eating lake whitefish for any portion of the population.
- The greatest risks were estimated from eating larger jackfish and pickerel (due to their place at the top of the aquatic food chain and thus higher tissue methylmercury concentrations) (see SE SV Section 5.3.3 for specific recommendations).
- Lake sturgeon from Gull Lake that are less than 1,221 mm (48 inches) can be eaten on an unrestricted basis.
- Eating large meals of wild game (*e.g.*, beaver, muskrat, moose and snowshoe hare) does not pose unacceptable health risks under present conditions.
- Eating waterfowl at present concentrations of total mercury is not associated with unacceptable risks.
- Methylmercury concentrations in surface water would not pose unacceptable risks from contact or drinking under present conditions since risks are considered to be negligible.

The Mercury and Human Health Technical Working Group noted the importance of eating fish as part of a healthy, balanced diet and indicated that the communication products are to include the importance of fish as a regular dietary item.

PUBLIC SAFETY AND WORKER INTERACTION

Public safety considers the risks associated with the construction of a major project faced by local communities and/or the general public stemming from an influx of non-local construction workers into communities. It also considers the potential effects of new income associated with employment on the Project.

Overall, most residents of the Local Study Area feel that they live in safe communities (CNP 2010b, 2010e; YFFN KPI Programs 2009-2010; FLCN KPI Programs 2009-2010). The small size of the population may contribute to this feeling of safety. A sense that "everyone knows everyone" provides a feeling of security, particularly outside of Thompson. The two entities responsible for policing in the Local Study Area are the RCMP, with detachments with headquarters in Gillam and Thompson, and First Nation Band constables who provide basic policing services on their respective reserves. An indication of crime rates in the Local Study Area can be found in Section 5.3.4 of the SE SV. The RCMP has not noticed much gang activity in the Local Study Area outside of Thompson at the time of the research program. The gang activity within Thompson tends to affect those directly involved in gangs, and does not extend towards the general public (Thompson KPI Program 2008-2010).

Residents have expressed three main concerns about safety in their communities. The first relates to the misuse of alcohol, which can contribute to domestic violence, accident and injury, and children receiving minimal adult supervision. The second safety-related concern relates to the lack of recreation opportunities and options for youth, which can result in delinquent behaviour and mischief. The third concern is the accelerated rate at which new issues can become apparent in a community – for example, the types and availability of illegal hard drugs (*e.g.*, crystal meth). This is particularly difficult for health and social service providers to manage, as they may not have the capacity or tools necessary to quickly address emerging issues.

The KCNs experiences with past hydroelectric projects, particularly for FLCN, have resulted in a long history of adverse interactions with construction workers because of their proximity to Gillam, beginning with the development of the Kettle Generating Station in the late 1960s. The presence of a large non-local construction workforce, in combination with income-earning opportunities for residents of the Local Study Area, was reported to create interactions with the communities, which were filled with conflict and social dysfunction. FLCN's history noted how Gillam was rapidly changed from a quiet community to one where parties and violence were commonplace (FLCN 2009 Draft). Such situations also made alcohol more readily available to KCNs Members. These experiences were repeated with the construction of each new project, and raise considerable ongoing concerns for the KCNs, particularly FLCN whose close proximity to past projects has shaped the community's history since the 1960s as well as present-day circumstances.

TRAVEL, ACCESS AND SAFETY

Travel, access and safety considers water andice-based transportation, including the land-based trails used to access traditional resource use areas; and road travel in relation to traffic volumes, access and safety.

Water and Ice-based Transportation

Since time immemorial, the KCNs have used the rivers and lakes of the Local Study Area as a travel corridor, as a means of communication and trade, and for gathering food and medicinal plants. Although the Nelson River was known for its swift and fierce rapids, before the river was developed as a part of Manitoba Hydro's generating system, the KCNs people from the Split Lake territory would travel back and forth between Gillam and Split Lake, and further downstream on the Nelson River (FLCN 2010 Draft). Over the course of time, certain land-based trails and paths used to access traditional resources on foot and by dog sled have evolved and are now used as travel corridors for snowmobiles and all-terrain vehicles. Most of the downstream travel to Gull Rapids by TCN Members is by boat and snowmobile. Some of these paths are still used today to access traplines and resource gathering areas.

The Nelson River immediately upstream from Gull Rapids is rarely traveled by boat in the summer time, as the rapids are fast, dangerous and difficult to navigate. Historically, there were portages on both the north and south sides of the river to bypass Gull Rapids, however due to infrequent use these portages have become overgrown and are not currently used. In winter, the way in which ice forms makes the Gull Rapids area dangerous for winter travel, and is avoided. Elsewhere in the Local Study Area winter travel is typically done by snowmobile. Section 5.3.5 of the SE SV contains further details on existing open water and ice conditions.

The KCNs have noted extensive adverse effects from previous hydroelectric projects including concerns over reduced access and less safe access to their traditional territory (Split Lake Cree – Manitoba Hydro Joint Study Group 1996b). Manitoba Hydro has taken responsibility for unpredictable and unsafe boating conditions caused by their projects and have put programs in place to reduce the danger. Many measures are implemented through the Waterways Management Program, which serves the express purpose of improving safety on waterways affected by Manitoba Hydro's LWR-CRD. Section 5.3.5 of the SE SV contains a summary of the KCNs knowledge of travel and safety in the area, and a summary of Manitoba Hydro agreements and programs currently in place.

Road Travel

The Local Study Area encompasses a large geographic area between Thompson and north of Gillam. Prior to 1979-1981 there was no KCNs road access. Today, all-weather roads that are open and maintained year-round provide access to the communities of Thompson, Split Lake, Fox Lake (Bird) and Gillam. Ilford can be accessed year-round by rail line and in the winter by winter road. York Landing is accessible by ferry during the open water season and by winter road for several weeks in the winter, as well as by air year-round (when weather conditions enable landing and takeoff). YFFN Members rely on various transportation modes to travel to Split Lake and Thompson on a regular basis (*e.g.*, weekly and/or daily). YFFN have expressed concerns about the reliability and safety of the winter road which affects overall access to York Landing (see Transportation Infrastructure above) (YFFN KPI Program 2009-2010).

PR 391 and PR 280 are the main roadways in the Local Study Area (see Map 6-40 Travel Distances in the Local Study Area map). The Average Annual Daily Traffic on PR 391 for the years 2003, 2005, 2007, 2008 and 2009 ranges between 760 and 1230 vehicles. Traffic volumes on PR 280 vary, but the average annual daily traffic for the years 2003, 2005, 2007, 2008 through 2010 range between 130 and 186 vehicles depending upon the year and the section of road. KCNs Members have expressed concern over the existing conditions of PR 280, noting high levels of dust and poor road conditions. In addition, vehicle damage (particularly cracked windshields) is a common issue related to PR 280. Over the past several years, the Government of Manitoba through the Department of Infrastructure and Transportation (MIT) has been making improvements to roadways, signage, and pull-offs along PR 280 (see Section 5.3.5 SE SV).

CULTURE AND SPIRITUALITY

Culture and spirituality are dynamic and interactive processes, which are commonly celebrated through the oral tradition as traditional knowledge, and are constantly being shaped and re-shaped through experience, information, knowledge and wisdom. Culture and spirituality are especially relevant to understanding the KCNs worldview as partners in the Project since together they represent their values, beliefs, perceptions, principles, traditions and religion that are based on Cree individual and collective history, experience and interpretation. These cognitive values act as a cohesive force to direct the flow of cultural change. Culture and spirituality are all-encompassing terms that underscore the integral relationship of all things that maintain a way of life. Culture in this discussion can be referred to as socially conditioned assemblages of activities and thoughts that are associated with particular social groups or populations (Harris 1994). Spirituality is descriptive of peoples' relationships with their ecosystems and the awareness that goes beyond the immediate sensible world from which knowledge, ability, or medicine is derived. Culture and spirituality for the KCNs communities inherently places them in a relationship to the land and all of nature. Culture and spirituality for the *Ininewak* are part of *Askiy* (Mother Earth) which represents important relationships that understand that all things come from Manitou (also Munito, Great Spirit or Creator) (see Chapter 2).

A CNP statement regarding Cree worldview is found in the CNP Keeyask Environmental Evaluation Report:

> We have come to realize the importance of articulating and communicating our perspectives to those outside our homeland ecosystem to help others understand our holistic Cree worldview. Assessing the environmental impacts of the Keeyask Project on us required the development of a means of conveying our experience to others…As a people, we are inseparable from our relationship with Mother Earth – relationships that have developed over thousands of years. This is the foundation of our worldview and is integral to our survival. Our relationships with Mother Earth are the basis of our language, history and spirituality – cumulatively, our culture (CNP Keeyask Environmental Evaulation Report).

YFFN's Cree worldview is reflected in YFFN's evaluation report *Kipekiskwaywinan* as expressed by Elder Eric Saunders:

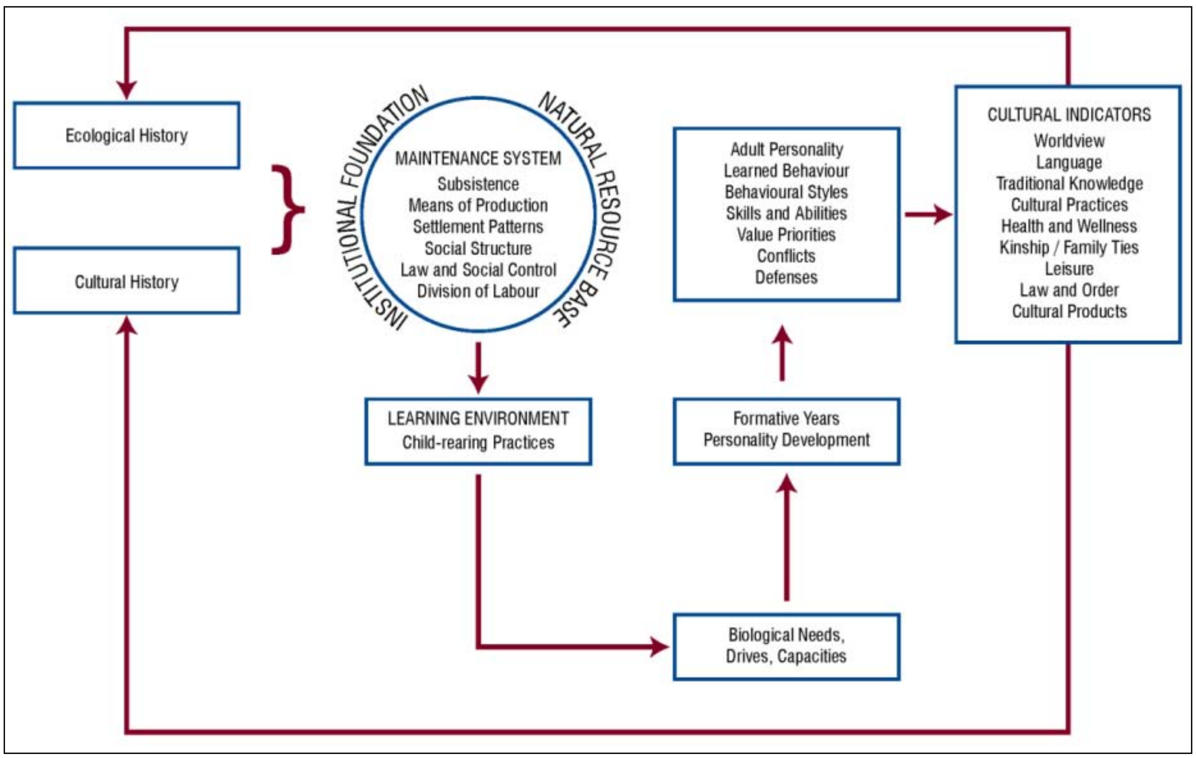
> One of the things really important to me is the Cree worldview. I think it's important to have it in the Environmental Impact Statement because there was a lot of misunderstanding before we started working with Hydro. There was a lack of understanding of the Cree worldview, the things that we do, and why we do them. They are our beliefs, what we were taught when we were growing up. We learned that from our ancestors, our Elders, our parents. But a lot of times it wasn't done orally. A lot of times you learned by observation and that's how I learn a lot of my stuff, just observing what the Elders do. Or when they take you out, they'll say something that you're not supposed to do. That's the only time they'll tell you and you're supposed to learn from this. But a lot of times that's not really understood, where we come from, and I think it's important to have some definition for words that we use (YFFN Evaluation Report (*Kipekiskwaywinan*)).

The FLCN Keeyask Traditional Knowledge Report also reflects the importance of understanding Ininewak worldview:

> Within Euro-Canadian contexts, Pimatisowin is often referred to as "traditional knowledge", but the use of this term tends to gloss over the complexities inherent in the Cree meaning of the word, especially the relationships that people had with their environment, and the "spirituality" that informed their daily lives (FLCN 2010 Draft).

Nine indicators were used to facilitate the description and analysis of change of culture and spirituality in relation to the KCNs (SE SV Section 5.3.6). The indicators highlight the relationships of people to their environmental setting and contribute to assessing cultural values and potential project effects. Systems model showing the interrelationship between the ecological setting and cultural maintenance (based on Whiting & Whiting 1975) Petch 1999©.

Figure 6-12, developed as an adaptation from Whiting and Whiting's 1975 cultural system model (Petch 1999) illustrates all of the components that have been considered in the development of these nine cultural indicators.



Systems model showing the interrelationship between the ecological setting and cultural maintenance (based on Whiting & Whiting 1975) Petch 1999©.

Figure 6-12: Cultural Systems Model

The nine indicators follow similarities with KCNs core values that the communities look to as a guide through their own cultural experiences. The similarities are illustrated in YFFN's statement of fundamental understanding of traditional knowledge (*Ininiwi-kiskénihtamowin*).

It is a dynamic, living process that is added to and adapted in the lives of successive generations of Cree people. It lives within our way of life and it includes many aspects:

- Traditions;
- Cultural identity and activities;
- Language;
- Stories, teachings and legends;
- Humility and listening;
- Spirituality;
- Respect for *Askiy* (Mother Earth) (land, water, people, plants, animals and all things);
- Maintained by older generations (Elders) and taught to our younger generations; and
- On-going process of learning and applying our knowledge and teachings (YFFN Evaluation Report (*Kipekiskwaywinan*)).

The nine cultural indicators and their relevance are as follows:

- Worldview: Encompasses the relationships and interconnectedness of the natural environment, people and spirituality as understood by a given community of people. It provides the ethics for living.
- Language: Provides insight into the daily use of Cree as a means of communication and is critical to the transmission of cultural knowledge. Language can be spoken, written or signed.
- Traditional Knowledge: Reflects the extent to which KCNs Members understand their own traditional practices as transmitted through oral narratives (oral traditions and oral history). This includes the KCNs perspectives on what is considered "specialized knowledge" or "common knowledge" within the communities, and the fact that some knowledge will be held by specific individuals who are qualified to hold and transmit knowledge.
- Cultural Practices: Reflect the extent of traditional practices and cultural activities undertaken by the KCNs. Cultural Practices or "what people within the communities do" is a dynamic process within KCNs communities. The extent of traditional practices and cultural activities was described by KCNs communities as decreasing in frequency when compared within historical contexts.
- Health and Wellness: Includes the physical, emotional, mental and spiritual qualities of life that instil a sense of well being and security. For the KCNs communities, the health and wellness of Members is contingent upon the availability of both western modes of health and wellness programming and traditional health and wellness practices.

Section 6.6.5.2 (Community Health) provides a review of western modes of health and wellness.

- Kinship: Is used to illustrate and discuss existing and historical family patterns in the KCNs communities. Today, kinship incorporates both a western view of the nuclear family (family cohesion), and traditional views about extended families (what or who is family). Kinship as an indicator considers marriage patterns and the understanding that traditional kinship terminology assists with determining the obligatory role and status of individuals in community as well as understanding terms of reciprocity or sharing.
- Leisure: Is free time provided by the cessation of work or dutiful activities and is usually associated with enjoyment or pleasure. For the KCNs, leisure may include the types of activities KCNs Members undertake for relaxation or enjoyment provided during their time free from work or duties. Examples of leisure activities include bingo, skating and baseball.
- Law and Order: Can be viewed as the governance and systematic manner by which social harmony and balance are achieved. This can include customary law and unspoken agreements. The indicator illustrates the historic and current enforcement of western-imposed laws, such as the *Indian Act*, the *Natural Resources Transfer Act*, *Migratory Birds Act*, Registered Trap Lines and the *Family Allowances Act*. Customary laws are those traditional mores and folkways that determine social sanctions. They are the result of certain successful ways of dealing with difference, discrepancies and argument that have maintained social harmony and balance.
- Cultural Products: Can be understood as expressions of culture that represent the essence of self-identity. Included in this theme are various forms of artistic endeavours (painting, music, literature-oral and written), crafts and cultural landscapes; and are illustrative of the number and type of cultural products that KCNs Members produce or create.

The culture of the KCNs is not static but dynamic and this is reflected in the manner in which each First Nation community has adapted to change based on its historical experience and present day circumstances. Adaptation can be due to natural causes, such as forest fire; and to human intervention, such as the registered trap line system and previous hydro development. Each First Nation is a discrete socio-political unit that draws from their own historic experiences, traditions and knowledge of community Elders. However, the historical roots point to a common ancestry and culture core that is strengthened by the many kinship relationships that exist across the communities.

THE WAY THE LANDSCAPE LOOKS (AESTHETICS)

The locations within the Local Study Area considered in relation to the way the landscape looks (or aesthetics) include the area between Gull Rapids and the outlet of Clark Lake where the physical effects of the construction and operation of the Project would arise (including a small inlet into Stephens Lake immediately downstream of Gull Rapids) (see Photo 6-15 below); as well as the community of Gillam.

Source: Manitoba Hydro, 2010.

Photo 6-15: Gull Rapids

This Local Study Area features gently sloping terrain with lakes of various sizes scattered across the landscape. Bogs and peatlands occur throughout much of the area, which is also affected by the presence of discontinuous permafrost. The shorelines around Gull Lake and Gull Rapids are gently sloping with rocky outcroppings in some areas. Between Clark Lake and Birthday Rapids (including Long Rapids) is a series of continuous rapids with about a four m drop. Birthday Rapids consists of a single channel of rapids with approximately a two m drop, while Gull Rapids consists of multiple channels and 11 m of drop before flowing into Stephens Lake.

The KCNs have strong ties to the Nelson River, and their relationship to the land is reflected in statements such as “Locations or features in the landscape, connected by routes travelled historically, act as memory tools for stories about people’s relationships with their environment” (CNP 2010b, 2010e). (See Section 5.3.3 and 5.3.7 of the SE SV for further detail).

The appearance of the town of Gillam has changed over time, as the community evolved from a seemingly-temporary trailer town to a permanent community, housing Manitoba Hydro’s northern operation headquarters and home to many FLCN Members. Long-term residents in the community have noted recent improvements to the town’s appearance through efforts by the town’s beautification committee (*e.g.*, clean-up days). Residents speak of the need to improve certain facilities such as the mall, which is viewed as being outdated. FLCN continues to increase its visual presence within the community through the inclusion of signage and buildings throughout the community.

6.2.3.6 RESOURCE USE

6.2.3.6.1 INTRODUCTION

Resource use is comprised of subsistence and economic activities that make use of the resources derived from the natural environment. These include domestic activities undertaken by Aboriginal peoples such as hunting, trapping and fishing for food in addition to gathering, which involves collecting plants or other natural products for medicinal, dietary or cultural purposes. Resource use also includes: commercial trapping; commercial fishing; forestry; mining; tourism; recreational fishing and hunting; protected areas, such as provincial or federal park lands and wildlife management areas; and scientific sites.

The Project is the subject of two evaluations. The first is referred to as the KCN Evaluation Process which was conducted by the KCNs for their internal purposes and the second, the Government Regulatory Assessment Process, which is a public review currently being conducted by federal and provincial environmental regulators. More detail on these processes is available in Chapter 5.

With respect to the KCN evaluation process, each of the KCNs communities has had the opportunity to present information from their unique perspectives, present their Cree worldview and their evaluation of the Project. The CNP chose to describe the environment and evaluate the Project using their own methodology focusing on their relationships with the land and water that are central to their culture (CNP Keeyask Environmental Evaluation Report). YFFN has participated in community-based studies and key person interview programs (Socio-Economy Section 1.3 of the SE SV). YFFN has also led their own studies and produced their own community volume, which contains information on resource use and provides perspectives on the Project (YFFN Evaluation Report (*Kipekiskwaywinan*)). FLCN has produced a community evaluation (FLCN Environment Evaluation Report (Draft)), the Keeyask Traditional Knowledge Report (FLCN 2010 Draft), the FLCN Preliminary Sturgeon TK Study (FLCN 2008 Draft) and Ninan – The Story of the Fox Lake Cree (FLCN 2009 Draft).

Domestic hunting and gathering, domestic fishing, and commercial trapping have been chosen with KCNs' input as VECs. This section includes both ATK and local knowledge provided by the KCNs. Although all resource use components have been considered, focus has been placed on VECs. An assessment of Project impacts on resource use is provided in Section 6.7 of this document.

The Resource Use Regional Study Area used in this section (hereafter called the "Regional Study Area') includes the Split Lake Resource Management Area (SLRMA), the Fox Lake Resource Management Area (FLRMA) and the York Factory Resource Management Area

(YFRMA) including the YFFN Trapline 13. Focus has been placed on areas within the SLRMA.

The Resource Use Local Study Area, hereafter called the Local Study Area, includes the area encompassed by Trapline 09 and 15 adjacent to the Project, Trapline 25 and the portion of Trapline 07, which will be affected by flooding. The Local Study Area is bounded in the northwest by Provincial Road 280 (PR 280) and the rail line to the southeast. West to east, the Local Study Area stretches from Clark Lake to the town of Gillam. The Local and Regional Study Areas are shown on Map 6-42. Place names and traplines discussed within this section are shown on Map 6-43.

6.2.3.6.2 Domestic Resource Use

Domestic resource use including hunting, fishing, trapping and gathering for food and cultural or ceremonial purposes has been, and continues to be, a vital and substantive way of life for Aboriginal peoples. The products derived from conducting resource use are important but resource use also enables and maintains a care-giving relationship with the landscape (CNP Keeyask Environmental Evaluation Report). As caregivers, the CNP explain that they have a responsibility to care for the land, and in return, the land provides for them (CNP Keeyask Environmental Evaluation Report). For example, respect and honour are displayed to animals that have been killed; harvests are restricted to what can be eaten or shared; and resource use is vital to the transmission of culture, teachings and skills to younger generations.

The existing Aboriginal and treaty rights established through treaties and the *Natural Resources Transfer Agreement* (the *Constitution Act, 1930*) are recognized and affirmed by s.35(1) of the *Constitution Act, 1982*. Aboriginal and treaty rights enable Aboriginal peoples to hunt, trap and fish for food in any season on unoccupied Crown lands and other lands to which they have a right of access. Accordingly, on Crown lands in Manitoba, the hierarchy for resource allocation places Aboriginal domestic harvesting first, followed by Manitoba resident resource allocations and lastly non-Manitoba resident resource allocations. Aboriginal and treaty rights can only be restricted for conservation purposes.

The TCN seasonal pattern of land use, which was recorded by Manitoba Keewatinowi Okimakanak and updated in 2011 with input from other KCNs communities, reflects the Cree seasonal pattern of resource use (Figure 6-13). Early spring trapping of muskrat is generally followed by the spring duck and goose hunt. Summer months consist of duck and gull egg collecting followed by plant gathering, including medicinal plants and berries. Moose hunting is the primary activity in autumn along with duck and goose hunting, followed by the winter caribou hunt. Trapping of furbearers is concentrated in late fall, winter and early spring. Fishing is conducted year round with most activity occurring in spring and early summer, although fishing under the ice also occurs in winter. In addition to these activities, which are often practiced concurrently (*i.e.*, hunting while fishing), small game and plant products are harvested. Grouse, ptarmigan and rabbit are hunted and tea herbs, berries and numerous medicinal plants are gathered.

Safe and economical access to harvesting areas has always been and continues to be critical to resource use. The history of hydroelectric development on the Nelson River (see Section 6.2.2) has substantially altered the patterns of resource use, which the KCNs state have added hidden costs in terms of safety (changes to water and ice conditions) and increased time and effort *(e.g.*, debris in water damaging equipment) required to harvest resources. Water level changes on hydro affected lakes and rivers can cause hanging or suspended ice after drawdowns and flooded ice conditions after water level increases. Less predictable water flows in the open-water season and ice in winter have caused some resource users to reduce or discontinue use of affected waterbodies due to safety concerns (YFFN Evaluation Report (*Kipekiskwaywinan*)). Despite change, the Nelson River is still reported to be the most important travel route in the SLRMA (CNP Keeyask Environmental Evaluation Report).

Roads such as PR 280 improve access to resource harvesting areas such as Assean Lake, the north arm of Stephens Lake and the North and South Moswakot rivers. Roads and subsequent cabin construction have provided access and home bases to KCNs Members. Approximately ten resource user cabins owned or occupied by TCN Members are reported to be along PR 280 between Split Lake and Gillam (CNP 2010b).

Cabins in the Regional and Local Study Areas are used throughout the year and are important for carrying out a traditional lifestyle and also are used as bases for commercial harvesting such as trapping. Known cabins in the Local Study Area include three cabins located on the north side of the Nelson River between Birthday and Gull Rapids, two of which are located on the same site. Four trapper cabins on two sites are located close to PR 280 near the junction of the north access road. Additional cabins located on an island near the inlet of Stephens Lake, approximately 4 km downstream of the Project are used for a small (single license) commercial fishing operation.

Transmission and rail line corridors also provide access for all-terrain vehicle (ATV) and snowmobile travel for both Aboriginals and non-Aboriginals. Open-water boat travel in the Local Study Area is limited due to rapids. Birthday Rapids east of Clark Lake is passable but requires experienced navigators and favourable flow conditions. Gull Rapids is considered impassable. Winter travel on the Nelson River and Gull Lake is affected by hanging ice dams, which can cause a considerable accumulation of ice in very local areas (Section 6.2.3.2). Though the locations of hanging ice dams can be variable from year to year, hanging ice dams which generally form at the foot of Birthday Rapids and downstream of Gull Rapids (Section 6.2.3.2) limit snowmobile access on the Nelson River to the Local Study Area from the west and the east, respectively. Overland travel by snowmobile is more common.

A series of overland trails on both the north and south sides of the Nelson River serve as access corridors to the Local Study Area. Trails were reported to be in "acceptable" condition, though a portage on the north side Gull Rapids was reported to be in an "overgrown" condition (CNP 2010b), which restricts movement into the Local Study Area from the east.

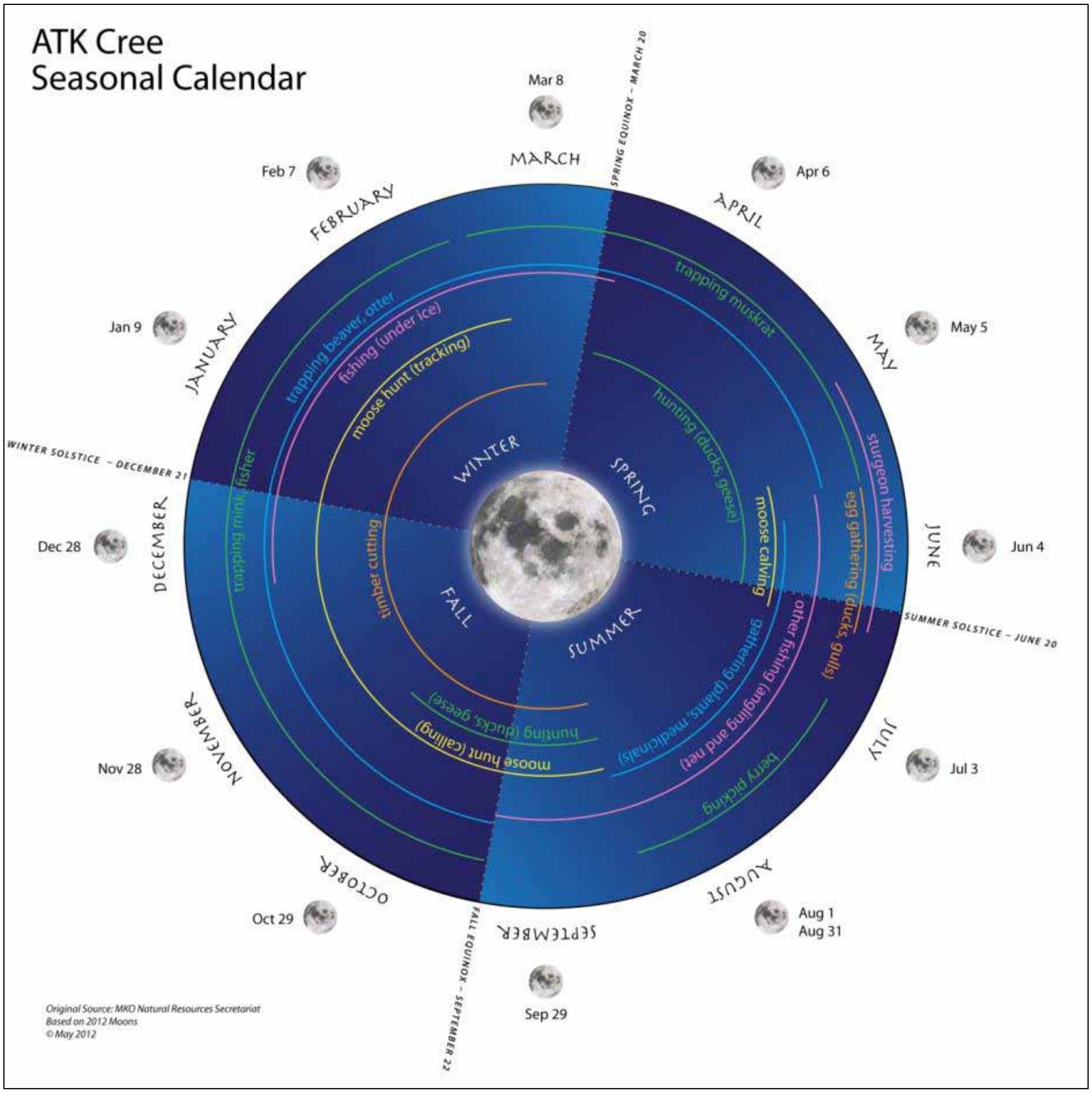


Figure 6-13: The Cree Seasonal Calendar

Although all KCNs report past and FLCN reports present domestic resource use in the Local Study Area, the area is primarily used by TCN Members. Gull Lake and Gull Rapids have been reported as important fishing locations for TCN (CNP, YFFN and FLCN 2011). The Nelson River downstream of Gull Rapids also has been used by the FLCN for fishing now (FLCN 2010 Draft) and in the past (FLCN Environment Evaluation Report (Draft)). Use of the Local Study Area for fishing was not reported by the YFFN or WLFN. Some KCNs Members will not consume fish from Local Study Area waterbodies (*i.e.*, the Nelson River, Split and Stephens lakes) due to concerns of poor quality (taste, texture and colour) (Split Lake Cree – Manitoba

Hydro Joint Study Group 1996b; YFFN Evaluation Report (*Kipekiskwaywinan*); FLCN 2008 Draft; FLCN 2009 Draft; FLCN 2010 Draft; FLCN Environment Evaluation Report (Draft)).

In the Regional Study Area, pickerel (also known as walleye), lake whitefish, jackfish (also known as northern pike) and other species are harvested from numerous waterbodies, which are often close to communities. For example, TCN Members fish Split Lake (Resource Use Section 1.2 of the SE SV); WLFN Members fish Moosenose, War and Atkinson lakes (Resource Use Section 1.2 of the SE SV); FLCN Members fish Stephens Lake, the Kettle River (FLCN 2010 Draft) and the Butnau River (FLCN Environment Evaluation Report (Draft)); and YFFN Members fish the Mistuka (YFFN Evaluation Report (*Kipekiskwaywinan*)), Ripple and Aiken rivers (YFFN 2004a).

In the Local Study Area, lake sturgeon harvest has been documented on Clark and Gull lakes (CNP, YFFN and FLCN 2011) and the Nelson River downstream of Gull Rapids (YFFN 2002; FLCN 2008 Draft; FLCN Environment Evaluation Report (Draft)). Due to interest in conserving lake sturgeon and concerns with respect to its quality as food, KCNs Members have reported reduced lake sturgeon harvest from the Nelson River in recent years (CNP, YFFN and FLCN 2011; FLCN 2008 Draft, FLCN Environment Evaluation Report (Draft)). FLCN has reported that pickerel have replaced lake sturgeon as the most valued fish (FLCN 2010 Draft; FLCN Environment Evaluation Report (Draft)).

In the Regional Study Area, locations such as the confluence of the Churchill and Little Churchill rivers, the mouths of the Weir, Angling and Limestone rivers, Atkinson Lake and the Fox River also have been recorded as TCN and/or FLCN lake sturgeon harvest locations (Resource Use Section 1.2 of the SE SV). YFFN Members reported minimal lake sturgeon harvesting near York Landing and some harvesting in the lower Nelson River near the Hudson Bay coast (YFFN Evaluation Report (*Kipekiskwaywinan*)). Lake sturgeon are highly valued by the KCNs Members as a cultural resource (CNP Keeyask Environmental Evaluation Report; YFFN 2002; FLCN 2008 Draft; YFFN Evaluation Report (*Kipekiskwaywinan*)).

Hunting for moose is known to occur in the Local Study Area, most commonly in the lower reaches of Gull Lake and in the region around Gull Rapids by TCN Members. FLCN report that their Members hunt in the vicinity of the proposed south access road, Stephens Lake (Reservoir), Cache Lake, Moswakot Creek and describe a loss of moose hunting opportunity at Gull Rapids (FLCN Environment Evaluation Report (Draft)). A moose hunting camp is stated to be situated at the mouth of Looking Back Creek (FLCN 2010 Draft; FLCN Environment Evaluation Report (Draft)). Difficult access by boat and swampy terrain is thought to limit moose hunting activity in some local areas, though TCN resource users are known to use this area.

Neither the FLCN or the YFFN have recorded caribou hunting in the Local Study Area in recent years. Caribou are not reported to be plentiful in the Local Study Area, although increasing numbers of caribou have been sighted in the area in recent years (Section 6.2.3.4.7). Caribou numbers in the Local Study Area are highly variable among years (Section 6.2.3.4.7).

In the Regional Study Area, moose hunting is commonly conducted by boat, often along shorelines (such as on Stephens Lake) (FLCN 2010 Draft; FLCN Environment Evaluation Report (Draft)). Moose are reported to be abundant in the Stephens Lake area (Gillam KPI Program 2009-2010; FLCN Environment Evaluation Report (Draft)). The YFFN report caribou and moose hunting based from the Mistuka River (YFFN Evaluation Report (*Kipekiskwaywinan*)) and moose hunting along the PR 280 corridor near the north arm of Stephens Lake (Resource Use Section 1.2 of the SE SV).

The spring and fall goose and duck hunts are important KCNs community events. Typically hunts are conducted close to home communities and outside of the Local Study Area. However, some resource users report taking the train to Churchill and some YFFN Members will travel to Ten Shilling Creek near the mouth of the Hayes River to hunt waterfowl. The FLCN report waterfowl harvest locations at Cache Lake, the Butnau and Kettle Rivers and Stephens Lake (FLCN Environment Evaluation Report (Draft)).

Gathering occurs primarily close to communities or in conjunction with other resource use activities. Berries, Labrador tea leaves and black spruce pitch are collected from various locations for jams and tea and for producing a skin ointment respectively. Wekas[1] root (*Acorus americanus*) is reported by FLCN and YFFN Members to be used as a headache or cough remedy (FLCN 2010 Draft). No gathering activity was documented in the Local Study Area with the exception of Lillian Island, which is used by TCN Members (CNP Keeyask Environmental Evaluation Report). Areas close to the communities are used with greater frequency and intensity than the Local Study Area. Travel barriers such as Birthday and Gull rapids, poor ice conditions in winter, low-lying terrain and distance from communities limit, though do not prevent, opportunities for resource use in the Local Study Area. For example, the Trapline 15 area is used by TCN resource users.

The Local Study Area has an important cultural value to the KCNs communities. Central to the Cree worldview and culture is the understanding of the interconnectedness of the environment where if one area is affected other areas are, in turn affected (CNP Keeyask Environmental Evaluation Report; FLCN 2010 Draft;YFFN Evaluation Report (*Kipekiskwaywinan*); FLCN Environment Evaluation Report (Draft)). Therefore, maintenance of appropriate relationships with the lands and waters and continuation of cultural practices and traditions remain extremely important to KCNs Members.

6.2.3.6.3 Commercial Resource Use

Commercial Fishing

In northern Manitoba, commercial fisheries are important contributors to local economies. From 1997/1998 to 2006/2007, northern Manitoba commercial fisheries employed an average of 760 fishermen and helpers averaging $6,860 per person annually (Resource Use Section 1.3

[1] Cree spelling varies.

of the SE SV). Pickerel is the most valuable species comprising more than 67% of the average landed value of the annual Manitoba catch (approximately $30 million); lake whitefish are second averaging more than 10% and jackfish more than 4%. A small (single license) commercial fishery is conducted on one lake in the Local Study Area (Stephens Lake) and two lakes in the Regional Study Area (Split and Assean lakes) are fished. Gull Lake, which is in the Local Study Area, has a quota assigned to it in the provincial harvest schedule, but has no current license holders and is not fished at the present time.

A small (single license) fishery on Stephens Lake targets pickerel near the lake's inlet. The catch is sold directly to restaurants and individuals in Gillam and Churchill. The operator reported that this fishery produces 100–300 pounds of pickerel fillets per day for 10 weeks with a limit of 500 pounds per day (round weight). The fishery is operated from three cabins located on an island approximately 4 km downstream from the proposed GS. The mean standardized mercury concentration in pickerel (walleye) from Stephens Lake ranged from 0.20–0.41 in four years between 2001 and 2005 (Section 7.2 of the AE SV). These values are below the 0.5 parts per million (ppm) standard at which the Canadian Food Inspection Agency may refuse fish for national sale (Section 6.2.3.3.6). It should be noted that the mean mercury concentrations in pickerel from Stephens Lake are currently at, or even below concentrations observed in natural reference lakes in the general area (Section 7.2 of the AE SV).

The Split and Assean lake fisheries are conducted by up to 20 TCN Members annually, though participation varies on an annual basis. A 59,000 kg round weight quota for Split Lake is allocated for pickerel, goldeye, sauger, whitefish and jackfish. Annual production has been variable (see SE SV Resource Use Section 1.3) but the Split Lake fishery accounts for over 96% of the production (by value and weight) in the Regional Study Area. Split Lake is commercially fished in spring and/or fall depending on water levels, which affect the quantity of debris in the water (Whitaker *pers. comm.* 2012a). Fall fishing for pickerel in 2010 was very good (Whitaker *pers. comm.* 2012a). On average, catch is comprised mainly of jackfish (34%), lake whitefish (22%) and pickerel (22%). The fishery grossed, on average, just under $100,000 per year for 11 years between 1997 and 2008 in years the lake was in production. The Assean Lake fishery grossed on average just over $4,000 per year in the five years the lake was fished from 1997 to 2008.

COMMERCIAL TRAPPING

Commercial trapping is an integral component of the social and cultural environment and economy in the north and it has been identified as a VEC. Commercial trapping is one of the few sectors of the cash economy in which Aboriginal people can participate while maintaining a traditional subsistence lifestyle.

In the Regional Study Area, which includes the SLRMA, the FLRMA and two traplines (13 and 22) from the YFRMA, for the years 1997–2008 inclusive, American marten comprised 68% of the harvest, followed by beaver (13%), both species of fox (5%), mink (5%), muskrat (3%), and otter (2%). During the same time period, trapping in the Regional Study Area (84 traplines) generated a total of more than $2,000,000[1] dollars or over $170,000 and 3,100 pelts per year. Trapping activity engaged over 45 licensed trappers of whom approximately 85% were Aboriginal (as of the 2008/2009 trapping season). Up to two helpers per line can assist the lineholder.

The cost of equipment such as ATVs, snowmobiles, fuel, traps, and cabins and their associated maintenance costs can be prohibitive for trappers or can require an extra source of income. With the exception of marten, pelt prices have also been in decline (1997–2008). Trapping is increasingly becoming a lifestyle choice versus a viable source of income. Though there are some exceptions, road accessible traplines are 145% more productive (in terms of pelts and value) than those with no road access. As of 2008, 23 (27%) of 84 traplines in the Regional Study Area were unallocated. Allocated traplines reported production in less than 60% of years (on average).

The Local Study Area includes Traplines 07, 09, 15 and 25 in the Split Lake Trapping Section. Since 1996, these traplines, which are expected to be affected by the Project *(i.e.*, flooding and/or road construction), have averaged similar production value ($1,908) in comparison to unaffected traplines ($2,142) and the average of all traplines ($2,125). Non-allocation of Trapline 15 since 2001 (annual special permits have been issued to local trappers until 2012 when it was allocated) and intermittent harvest on Traplines 25 (a TCN community line) and 07 have influenced production.

LODGE AND OUTFITTING OPERATIONS AND OTHER TOURISM

Lodges are defined under *the Resource Tourism Operators Act* (Manitoba) as a "facility of a permanent or semi-permanent nature that accommodates nine or more persons" (Manitoba 2002 3(b)). Lodge operators often provide additional services such as equipment (boats and gas) and guides for hunting and/or fishing. Outfitters provide similar services but accommodations are usually at outcamps accommodating less than nine persons. Lodges also may run outcamp facilities under their operations. Lodge and outfitting clientele who hunt are non-residents of Manitoba, typically U.S. residents.

Where non-resident hunting allocations are provided, they are comprised of parcels of land and associated big game tags that give the lodges and outfitters exclusive use for servicing non-Manitoba resident hunters. The moose-hunting season runs for approximately four weeks from mid-September to mid-October and bear hunting is conducted in the spring and/or the fall.

Lodge and outfitting operations in the Regional Study Area bring in more than one million dollars gross income annually. Dunlop's Fly-in Fishing Lodge and Outposts is located on Waskaiowaka Lake with outposts on Campbell and Pelletier lakes. This lodge provides catch and release trophy jackfish and pickerel fishing during the open-water season, and non-resident bear hunts. Holmes Lake lodge, located on Holmes Lake is not currently open but is in the process of refurbishment. Mystery Country Paint Lake Resort's main lodge is located close to

[1] Indexed to 2010 equivalent dollars.

Thompson but two of its four outcamp locations (Goose Hunting Lake and Dafoe Lake) are partially in or just outside the Regional Study Area. One additional lodge, Recluse Lake Lodge, was not in operation in 2008. YFFN owns Silver Goose Lodge at Ten-Shilling Creek at the Hudson Bay coast.

Four outfitting operations are active in the Regional Study Area. Three offer both moose and black bear hunting: All Terrain Bear Hunts based on Wernham Lake; Fox River Outfitters on the Fox River; and Lea Meadows Outfitters on Billard Lake. Ace Wilderness Guiding offers bear hunting based out of Gillam along the PR 280 corridor and on roads south of the Nelson River.

Lodge operators and outfitters collectively hold an estimated total of 52 moose tags and 66 bear tags within the Split Lake RMA, not all of which are filled *(i.e.*, harvested) each year. With assumptions (Resource Use Section 1.8 of the SE SV), non-resident moose and bear harvests might range from 22–33 and 20–26, respectively. Goose and duck harvest is negligible and fishing is mainly catch and release.

Reductions in American tourism due to a weakened U.S. economy since 2008 and a strong Canadian dollar have reduced lodge and outfitting activity in the Regional Study Area (Suffron, *pers. comm*. 2009; see also Resource Use Section 1.8 of the SE SV for additional information). Since 2008, Tourism Manitoba has estimated that visitation from the U.S. (for all Manitoba tourist attractions) declined 13% in 2008, declined further in 2009 by 6.9% and 4.3% in 2010 (Travel Manitoba 2011). The declining trend was predicted to level off in 2011 (Travel Manitoba 2011).

Very limited eco-tourism is undertaken in the Regional Study Area. Little canoe guiding is currently conducted on the Fox and Bigstone rivers and Atkinson (Fox) Lake.

COMMERCIAL FORESTRY AND MINING

Forest resources are predominantly non-commercial in the region with no commercial harvest of timber in close proximity to the Project. Similarly, there are no operating mines or mining claims located in the Local Study Area though limited exploration activity is licensed for the north side of Stephens Lake with no announced metal or mineral discoveries.

6.2.3.6.4 OTHER RESOURCE USE

RECREATIONAL HUNTING, FISHING AND RECREATIONAL CABINS

Sport or recreational fishing is undertaken by non-Aboriginal people. Recreational fishing is very popular in Manitoba attracting an estimated 157,000 resident and visitor fishers per year to Manitoban lakes. On most lakes and rivers, recreational fishing is restricted in the first three weeks of May with further restrictions on brook trout fishing for the Nelson River and its tributaries east of Sundance from September 1–30 annually.

In the Regional Study Area recreational fishing pressures are relatively low but higher in areas accessible by road or trails such as the Assean and North Moswakot rivers for pickerel, and the Limestone River for brook trout. Angling in Stephens Lake also occurs for pickerel and whitefish (Gillam KPI Program 2009-2010). Winter ice fishing is conducted on Atkinson (Fox) and Butnau lakes, generally by non-Aboriginal people living in Gillam (MacDonald *pers. comm.* 2009). In the Local Study Area, very limited fishing occurs on Gull Lake by Gillam residents for pickerel and sauger.

Manitoba resident archery and rifle moose hunting seasons for Game Hunting Areas (GHAs) 1, 2, 3a, 3, 9 and 9a in or partially in the Regional Study Area together last from late August to mid-October annually (depending on GHA). A three-week general rifle season also occurs in December in some GHAs including GHA 9 in the Local Study Area (see Map 6-44). Moose harvest levels in the Regional Study Area are inconclusive due to the voluntary nature of reporting and the intersection of six GHAs in the region. Hunting typically occurs outside of the Local Study Area at locations such as the south side of Limestone Lake, throughout Stephens Lake and on the Fox and Bigstone rivers.

Caribou hunting is limited to GHAs 2 and 3. Seventy-five licences are sold for GHA 3 primarily to Gillam residents, generally selling out in one day. The harvest success rate is estimated to be 50% (Resource Use Section 1.7 of the SE SV). Caribou hunting is generally conducted at locations such as the old Shamattawa winter road, Atkinson (Fox) Lake and on the DC transmission line south and west of Gillam. In GHA 2, located on the north side of the Nelson River and east of the Limestone GS, hunting is limited due to poor access. Recreational caribou hunting is prohibited in the Local Study Area (GHA 9).

Approximately 50 recreational cabins are located on Stephens Lake east of the Local Study Area and are used by Gillam residents. Cabins used by residents of Thompson are located and on Kiask and Dafoe lakes in the western and southern portions of the SLRMA respectively.

PROTECTED AREAS AND SCIENTIFIC SITES

Areas designated by the government can be permanently protected under four Manitoba acts with the following designations: Provincial Parks, Ecological Reserves, Wildlife Management Areas, and Provincial Forests. Land designation affords various levels of protection for conservation or recreational purposes. In addition to the four designations, “park reserve lands” provide interim protection prior to park establishment. Areas of Special Interest (ASIs) identify “candidate sites” for possible future protection. Federally protected areas include national parks such as Wapusk National Park located in the extreme northeast of the Regional Study Area. Protected areas in the Regional Study Area do not infringe on Aboriginal and treaty rights to hunt, fish or trap for subsistence.

There are no protected areas or candidate ASIs in the Local Study Area. The closest Area of Special Interest in the Regional Study Area is the approximately 3,750 km^2 Stephens Lake Area of Special Interest, which is not currently identified as a high priority candidate site for protection. Bounded by PR 280 to the south, it transects Limestone Lake on the west and Myre Lake to the north.

Scientific sites in the Regional Study Area include sites from the Boreal Forest Transect Case Study, the Boreal Ecosystem Atmosphere Study, the Acid Rain National Early Warning System and the National Forest Inventory, which has 2 km x 2 km photo plots throughout Canada to assess forest resources. One National Forest Inventory site is located in the Local Study Area (see Map 6-45).

6.2.3.7 HERITAGE RESOURCES

The VEC of Heritage Resources is based on their status as non-renewable resources; they are tangible[1] objects that provide temporal and spatial evidence of past human activities. The heritage resources environmental setting of the Keeyask Study Area is characterized by a record of human occupation, dating back thousands of years. For the KCNs, heritage resources together with an active oral tradition of long term use and occupancy in the vicinity of the Project provide a vital cultural link between the past and present, and they sustain and support each other. The ATK contributions and cultural knowledge of CNP, YFFN and FLCN were greatly valued in all stages of archaeological investigation. When possible, pre-field engagement with Elders identified areas of landscapes that were remembered from past residency and oral traditions. The reasons provided by Elders as to why certain sites were located in a specific location provided historic context and a better understanding of the decision-making process of historic Cree within the Keeyask Heritage Resources Study Area.

The Heritage Resources Study Area is divided into three geographic areas (see Map 6-46).

Regional Study Area – a broad area that encompasses both the Local and Core Study areas. The south-western extent of the regional study area extends to the junction of the Odei and Burntwood Rivers to the west of Split Lake; the north-eastern extent terminates at Long Spruce GS. This wider geographic area was used in an effort to provide a reasonable boundary that would include a portion of lands used by the local Cree that contained some archaeological record of lengthy use and occupation. Before the Keeyask Project Heritage Resource Investigations 42 archaeological sites were registered in the regional study area with the Province. During Keeyask HRIA-related studies an additional 20 sites were recorded within the regional study area.

Local Study Area – an area that includes Clark, Carscadden, Moose Nose, Stephens, Fox/Atkinson and Kettle lakes and Aiken /Landing River[2]. Also included are the Core Study Area and the reach of the Nelson River from the outlet of Clark Lake to the Kettle GS. The local study area was used for comparative and proxy purposes to determine the range of site

[1] Tangible objects refer to things that can be touched, are substantial and real and have physical existence.

[2] The river is referred to as "Landing River" by War Lake Cree Nation (CNP) while York Factory First Nation refers to it by the provincial toponomic name of "Aiken River".

types that could be located within the more specific Core Study Area along with indicators of seasonal movements of Cree people between the Gull Lake area and connecting waterways. The 100 archaeological sites within the Local Study Area were quantitatively ranked according to a set of values derived from the categories established by the Historic Resources Branch of Manitoba Culture, Heritage and Tourism (HRB 1990) and Northern Lights Heritage Services (2009i); and were then grouped according to high, medium and low archaeological importance. Sites valued as high may contain intact archaeological remains, a burial location or any site with a diagnostic or substantial collection of artifacts or features. These sites would require future mitigation and monitoring. Medium sites may indicate sites that have a considerable assemblage of heritage resources but may be affected by natural erosion or other disturbances. Low ranked sites may represent disturbed sites with minimal or non-diagnostic heritage resources that do not provide elaboration of cultural knowledge. However, these two last categories are valuable in the overall interpretation of past peoples and would require some mitigation and monitoring. The valuation of the 100 archaeological sites within the local study area identified 17 high, 63 medium and 20 low priority sites.

Core Study Area – the reach of the Nelson River between the outflow at Clark Lake and the inflow into Stephens Lake (for greater details, see the Heritage Resources Supporting Volume Section 1.3); this also includes Project components such as the north and south access roads, north and south dykes, and all borrow areas except for G-3, N-5 and S-11. The Core Study Area represents the area of impact expected by the Keeyask Project construction and operation phases.

For the more defined Core Study Area, 50 archaeological sites were recorded, with 29 affiliated with the Pre-European Contact cultural period; nine with the Historic period and 12 multi-component sites with evidence present of both Pre-European Contact and Historical periods. Of these sites, 22 were identified as campsites, 17 as workshops, six were isolated finds and three were recorded as burials. An additional two sites were portage routes.

The Keeyask area is estimated to have been ice-free approximately 8,000 years ago (Nielsen *et al*. 1988; Klassen 1983) and may have been inhabited earlier than the radiocarbon date of 4,300 BP ±40. Archaeological evidence within the local Keeyask Project Study Area includes Middle and Late period Pre-European Contact settlements, activity areas and burials, and historic Cree cabins and monuments; some evidence of European trade goods exists. Traditional knowledge arising from YFFN speaks of a time when the great ice, *Kische Muskomi* covered the land; this was followed by the great flood, *Kischi Niskipewin* and the emergence of land. Ancient people, *Keteyatisak*, immediately began to explore and name all components of the new land according to tradition (YFFN Evaluation Report (*Kipekiskwaywinan*)).

The physical environment consists of an extensive Boreal Forest over Canadian Shield with the soils deposition describing the record of glacial retreat. Some pre-glacial and silty sands lay immediately above the bedrock, but mainly soils consist of a thick layer of deposited glacial material overlain by postglacial deposits in the form of alluvium and Lake Agassiz silts and clays (Keeyask MPMO 2011).

Several major hydroelectric developments along the Nelson River have been constructed in the vicinity of the Regional Study Area over the past 50 years: Kelsey Hydroelectric Generating Station – 1961; Lake Winnipeg Regulation – 1970; Kettle Generating Station – 1974; Churchill River Diversion Project – 1977; Long Spruce Generating Station – 1979; and Limestone Generating Station – 1990 (Manitoba Hydro 2011c). Past project effects have substantially altered the existing environment from that known historically, as such the current heritage resources environment along the river within the open water hydraulic zone of influence may not represent that which was present prior to hydroelectric development. The ATK of the KCNs suggests that many traditionally-used cultural and resource areas have been greatly changed over the years by hydroelectric development. For example, FLCN Elders noted that graves were once present along the Moosecot River which once drained into the Nelson River. The *Neckoway Site* is now an insular outcrop, and the channel referred to as Indian Grave Channel (FLCN 2010 Draft: 73). The confluence of the Moosecot and Nelson rivers was once an important sturgeon fishery with a seasonal settlement nearby.

The existing heritage resources within the Keeyask Regional Study Area were identified using a method of triangulation[1] of oral tradition, archival documents and archaeological records which included literature review, existing archaeological sites inventory, existing TK studies, predictive modeling, and field studies.

Sources of data included the following:

- ATK provided by the KCNs communities through informal engagement and community-published ATK reports added to a greater knowledge of the cultural landscape.
- Historic journals, archival records and photographs obtained through the Manitoba Archives, and the Anglican Church Archives provided background for a historic period characterization of the study area.
- Archaeological site database maintained by the Historic Resources Branch (HRB) was examined and sites plotted for the regional study area, baseline inventory of existing archaeological/geographical spatial data was reviewed, and previous archaeological permit reports examined. Predictive modeling assisted in identifying areas of interest for field investigation.
- Field studies were conducted for the Keeyask Project from 2001 to 2011 and have added valuable technical knowledge to the heritage record.

[1] Triangulation is a technique that aids in validating data by cross verification from two or more sources. Several methodologies are used in combination to study the same subject. For heritage resources, triangulation includes archaeological and historical records and oral narrative.

6.2.3.7.1 ARCHAEOLOGICAL CLASSIFICATION OF THE LOCAL AND CORE STUDY AREAS[1]

Cree people in northern Manitoba are part of a larger Cree cultural group that stretches from northern Quebec to northern Alberta. The cultural group is part of a larger linguistic group called Algonkians. There are many distinct languages within the Algonkian family. For example, the Cheyenne, the Blackfeet, Menominee, Ojibwa and others share common linguistic traits that differentiate their speech from, for example, Dene, Inuit or Siouan neighbours. All share certain core cultural traits that have been preserved through practice and the oral tradition over thousands of years of subsistence living off the land.

Cree people have been part of northern Manitoba since time immemorial and ancestors of the KCNs have lived in and around the Local Study Area for thousands of years. Prior to first contact with European settlers the Cree lived according to the seasonally available resources. They followed an annual round of travel which was highly in tune with optimal timing of resource availability. TCN, WLFN, YFFN and FLCN frequented areas along the coast of the Hudson Bay and well into the interior. Their territory covered the land and waterways surrounding the Nelson River and Hudson Bay Coast (Split Lake Cree – Manitoba Hydro Joint Study Group 1996b; WLFN 2002; FLCN 2009 Draft; YFFN 2010). Many lived in discrete, but kin-related hunting bands and followed a seasonal cycle of movement influenced by the natural yearly cycle of the water and lands in northern Manitoba. While *Keteyatisak* were not associated with a specific First Nation as defined today, the common term for self-identity was, and continues to be, *Ininewak* or *the People*. The *Ininewak* are part of the larger cultural group called Algonkians, which is the linguistic family to which Cree speakers belong. This wide-spread language, which developed well over one thousand years ago, is believed to be associated with the Woodland Period. This period is noted in the cultural chronology chart of northern Manitoba (Figure 6-14). The chronology is loosely tied to diagnostic artifact types that have been dated by past radiocarbon methods. By comparing found artifacts with established typologies a relative time period can be suggested. Other cultural traditions may have influenced the early people within the Regional Study Area as many tools representing these early traditions are to be found on the land. This is consistent with the history and ATK presented by the KCNs (Split Lake Cree – Manitoba Hydro Joint Study Group 1996a; WLFN 2002; FLCN 2009 Draft; YFFN 2010).

Typically, archaeological and heritage resources are classified into cultural chronologies according to certain recurring attributes or traits and by grouping artifact types and designs into traditions[2] and complexes[3] that indicate cultural dynamics.

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[1] For the purposes of this section of the EIS, the archaeological sites, their cultural affiliation and type have been included for the Local Study Area (including the Core Study Area). For the same type of information relative to the Regional Study Area, refer to the Heritage Resources Supporting Volume.
[2] Tradition: Technological or cultural patterns identified by characteristic artifact forms. These persistent forms outlast a single phase and can occur over a wide area.
[3] Complex: All archaeological remains (artifacts, settlement, burials, *etc.*) thought to be reflective of a particular culture.

In the early 1990s the first archaeological survey was conducted in the Gull Lake/Gull (Keeyask) Rapids area; Quaternary Consultants Ltd. (1991) concluded that this did not provide any baseline for past cultural occupation along the Nelson River. No further investigation took place until 2001 when the environmental assessment process was initiated (NLHS 2001a, 2001b, 2002a, 2002b, 2003a, 2003b, 2003c, 2004a, 2005a, 2005b, 2006c, 2006d, 2007a, 2007b, 2007c, 2008a, 2008b, 2009a, 2009b, 2009c, 2009d, 2009e, 2009f, 2009g, 2009h, 2010a, 2010b, 2011a, 2011b, 2011c1).

Between 2001 and 2011, 100 archaeological sites were recorded through Heritage Resources Impact Assessment (HRIA) investigations within the Local and Core Study Areas as part of the Project's environmental assessment; these studies provided a baseline for the heritage record of the Keeyask area (see Figure 6-15).

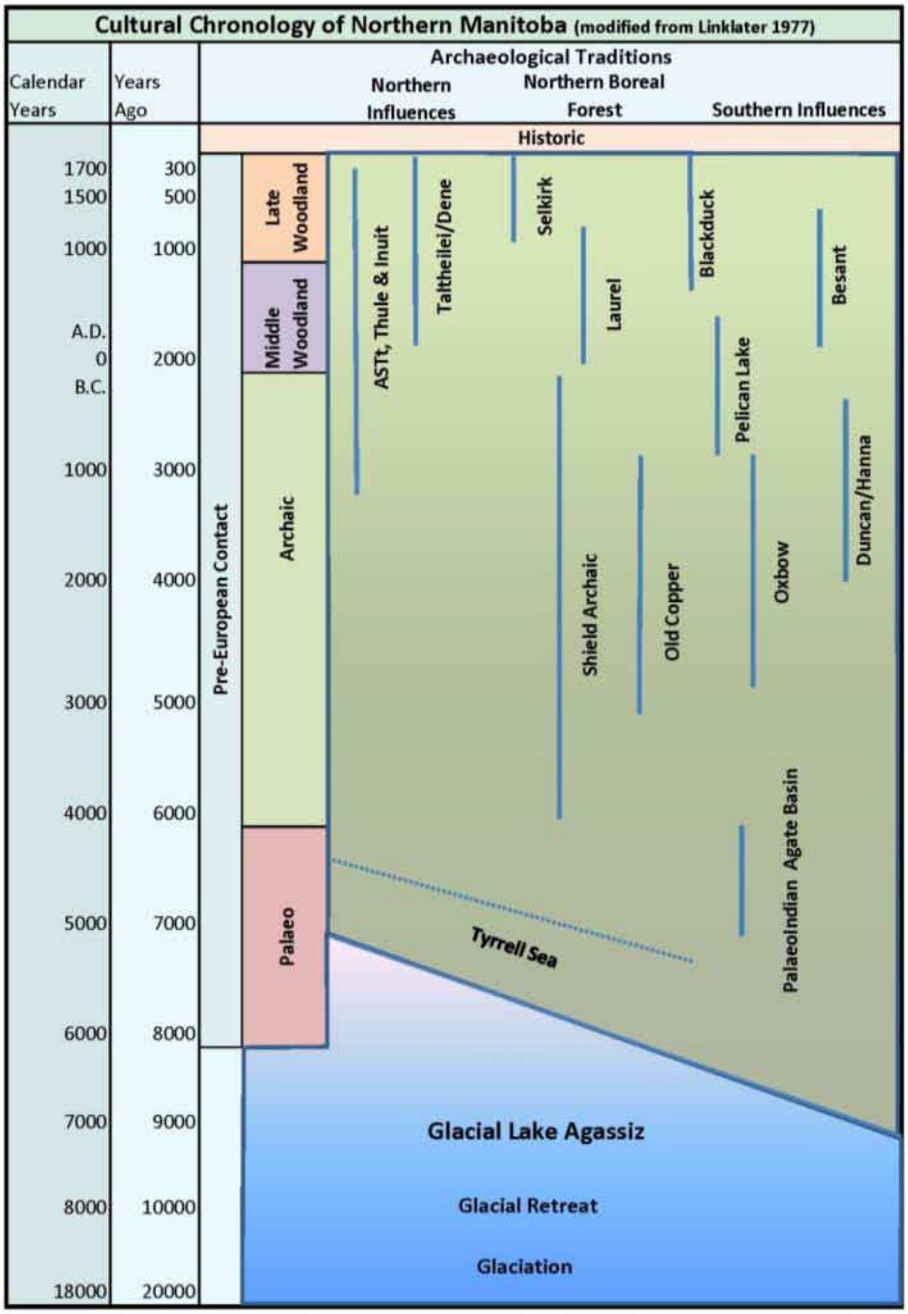

Figure 6-14: Cultural Traditions of Local Study Area with Focus on Pre-European Contact Period

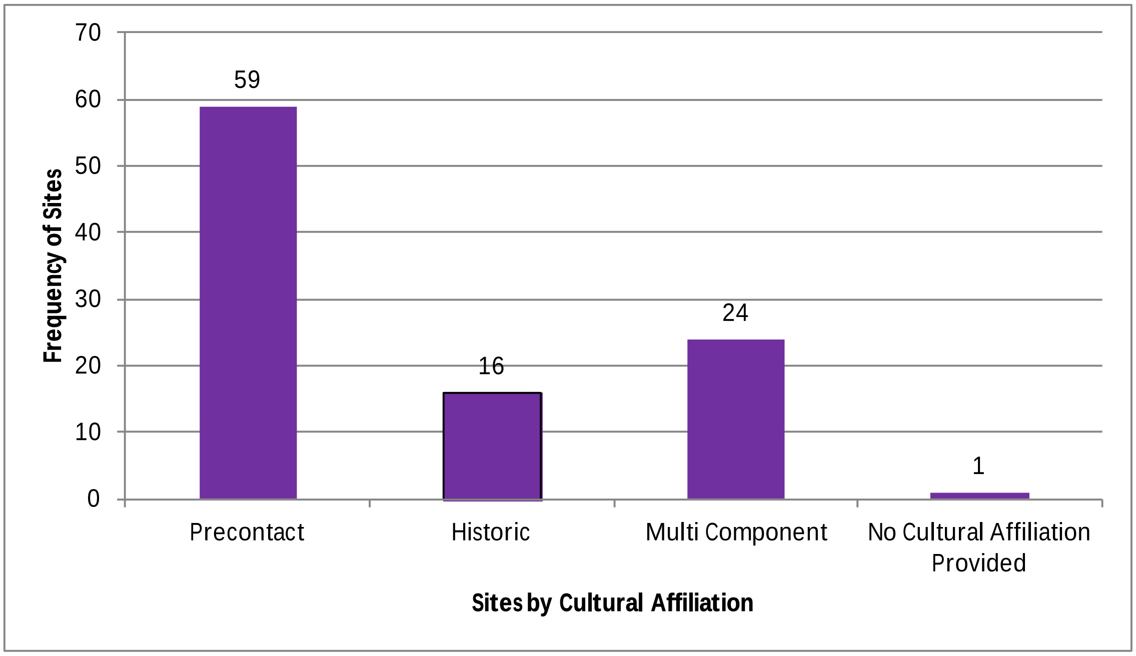

Figure 6-15: Cultural Affiliation of Archaeological Sites within the Local Study Area

These archaeological sites have been documented and where evidence exists, categorized into cultural and chronological distinctiveness based on diagnostic artifacts. Some archaeological sites in the study area did not provide diagnostic materials and therefore can only be generally assigned to a Pre-European or Historic context.

These sites can also be categorized by "Site Type" that indicate the types of activities occurring at a site, or use of a particular area for cultural purposes. Of the 100 recorded archaeological sites noted above, 51 were used as campsites, 31 as workshops, 11 were isolated finds, four contained burials and two were portages.

A total of 25,017 artifacts were recovered during field investigations related to the Project. Further details on sites, cultural affiliation, and description of artifacts are included in the Heritage Resources section of the SE SV.

The following section discusses the heritage resources environmental setting in terms of archaeological identified cultural periods as it may apply to the Local Study Area.

PLANO PERIOD

No evidence of Plano culture (*ca.* 10,000 – 6,000 ya) has been found in the Local Study Area to date. The absence of Plano cultural materials does not rule out the potential for this cultural period. Evidence to the northwest of the Study Area suggests that there is potential for late Plano to be present.

ARCHAIC PERIOD

The earliest evidence of occupation of the Local Study Area dates to the Archaic period (*ca.* 6,000 – 2,000 ya). Two archaeological sites were found on the north shore of Gull Lake. A large, side-notched spear point was found at the site HcKt-01 along with a chert knife and a large side-notched point was recovered from HcKt-05 (NLHS 2003b). No absolute dates for these projectiles were attainable but based on style and construction they are considered to be representative of the Archaic Period. Recently documented found human remains recovered at Gull Lake (HbKu-24) were dated to 4,300 years ±40 BP (Beta Analytic Inc. Beta-284758 2010).

MIDDLE WOODLAND PERIOD

The Middle Woodland Period (*ca.* 2,000 – 1,200 ya) for northern Manitoba is typically associated with ceramic technology, which was introduced via the Eastern Woodland movement. The "Laurel" tradition is the earliest ceramic culture found archaeologically in Manitoba and traces its origins to Early Woodland cultures in Minnesota and Ontario. Various designs were combined to create distinctive motifs, which can be time-marked. The bow and arrow as a new hunting technology appears to have been introduced at this time. One site, HbKu-06, contained ceramics belonging to the Middle Woodland Period. The small fragments showed evidence of coil manufacture with pseudo-scallop design. Laurel pottery was also found at GjLq-03 on Atkinson Lake of similar design. These finds now confirm a wider distribution of Laurel pottery into the Keeyask area which was not previously apparent.

LATE WOODLAND PERIOD

Changes to subsistence and seasonal practices and increases in human population during the Late Woodland Period (*ca.* 1,200 – 400 ya) contributed to the numerous cultural complexes that are reflected in the archaeological record. Changing ceramic-making techniques were also accompanied by changing motifs that archaeologists have identified as Blackduck and Selkirk archaeological phases. Within these phases are numerous derivatives based on attributes and personal motifs that may have acted as a signature of authorship. Sites were identified as belonging to the Late Woodland Period by their fabric-impressed pottery fragments. HbKu-03, 05, 06, 12, 13 and 17 contained pottery associated with the Selkirk Culture. Of great interest was HbKu-06, which contained brushed surface ceramics that were identical to those found in the Local Study Area at Fox/Atkinson Lake at GlKr-03, a distance of some 60 km by water (Petch 2003). The similarities in motif may be a signature of authorship, individual or family group as seen in other parts of the world (Gengenbach 2006).

PROTO-HISTORIC PERIOD

The proto-historic period (400 – 330 ya) refers to that period of first contact between Cree and Europeans where contact took the form of trade goods moving inland along long-established Aboriginal trade routes. This period of indirect trade did not initially involve European traders, only the trade of European goods by Aboriginal people. Along the Hudson Bay coast, in particular the Nelson/Hayes rivers estuaries and Churchill, Cree people hunting and fishing along the coast were the first to come into contact with Europeans and their trade goods. To date, no evidence has been found in the Keeyask Project area that can be linked to this time period.

HISTORIC PERIOD

Cree people within the Local Study Area may have had indirect contact with Europeans as early as 1610, when Thomas Button wintered over at the mouth of the Nelson River, or ten years later when Jens Munk wintered over on the Churchill River. However, for this Project the historic period is considered to commence around 330 ya or A.D. 1682 when the French explorer Pierre Esprit Radisson met Cree hunters on the upper Hayes River near the confluence of the Fox River. By 1684 York Fort I was constructed and many Cree people included annual trading expeditions into their seasonal coastal goose hunt and other resource activities. Missionaries, surveyors, geologists, and fur traders later contributed to the interaction and use of the Local Study Area during the Historic Period. The remains of cabins once occupied by local resource-users contain evidence of the types of materials goods utilized in the Local Study Area at various times in history. Cultural activities and resource-use in this period have been evidenced by modified birch trees (birch bark used for creating containers), tent frames, cabins, and portages. While European trade goods made their way into the interior, bone tools such as the net shuttle below continued as a timeless tool for net-making and possibly babiche for snowshoes (Photo 6-16).

Source: Northern Lights Heritage Services Inc. (2004).

Photo 6-16: Historic Period bone tools found at Effie Bay Site (HcKu-01)

6.3 EFFECTS AND MITIGATION PHYSICAL ENVIRONMENT

6.3.1 INTRODUCTION

This section focuses on effects of the Project on the physical environmental components, mitigation measures (that are technically and economically feasible) to address those effects, and **residual effects** that remain after mitigation. This section will also assess the sensitivity of these effects to possible climate change scenarios.

This section summarizes major changes in physical environment components resulting from the construction and operation of the Project.

The assessment of the Project effects is based on the **existing environment**, as described in the preceding Section 6.2, including the predicted future environmental conditions and trends if the Project were not to proceed. The existing environment was characterized using available historic data and results obtained from field studies. Where trends were observed and could be projected into the future, these were used to describe the future environment without the Project. It is assumed that there is no difference in hydrology and climate for the existing environment and the future environment with and without the Project. The sensitivity of effects assessment conclusions to potential climate change was considered separately (Section 6.3.12).

The existing environment incorporates effects of past projects, most notably past and current projects identified for the **cumulative effects** assessment. This section also notes where there are overlaps or interactions between effects of the Project with potential future projects.

The **Local Study Area** for the physical environment was described in Section 6.2.3.2 and shown on Map 6-2. It includes the open water **hydraulic zone of influence** and the areas involved in construction activities.

As discussed in Section 5, the **environmental assessment** was based on both ATK and technical scientific analysis. Methods and general conclusions related to the ATK-based analysis are provided in Chapter 2, and detailed results are provided in the CNP Keeyask Environmental Evaluation Report, YFFN Evaluation Report (*Kipekiskwaywinan*) and FLCN Environment Evaluation Report (Draft). Detailed results for the technical component of the environmental assessment are provided in the PE SV. This section summarizes the results of the ATK and technical analysis. Given the difference in approach of the Cree worldview and technical science, the assessment of the nature of the residual effects differed for some components; these differences are also discussed (Section 6.4.8). The technical analysis determined effects of the Project on the physical environment by considering the linkages among the physical environment components and changes caused by the Project, both directly (*e.g.*, presence of the dam) and indirectly through changes to the physical environment (*e.g.*, alterations in water levels and flows, inputs of sediments and other substances following flooding). The changes in the physical environment comprise pathways to effects on other aspects of the environment such as aquatic, terrestrial and socio-economic components. The pathways are discussed in Section 6.2.3.2.

The various attributes of the current and evolving physical environment setting were studied so as to understand the potential effects that the Project will bring about to the physical environment. The assessment of the physical environment provides the foundation for assessment of the resulting effects on the aquatic, terrestrial, and, subsequently, the socio-economic environments.

The PE SV provides more detailed descriptions of the changes in the various components in the physical environment and the corresponding pathways to selected VECs.

There is recognition that the climate is changing globally and in the Project region. Incremental changes in climate are not expected as a result of the Project. A separate section (Section 6.3.11) assesses the sensitivity of the Project effects assessment on the physical environment to potential climate change scenarios.

6.3.2 Aboriginal Traditional Knowledge

As part of their historical connection to *Askiy* (Mother Earth), the KCNs have acquired ATK from life experiences and their relationship with the land, water and all living things. They have explained their holistic worldview in Chapter 2 and in more detail in the CNP Keeyask Environmental Evaluation Report, YFFN Evaluation Report (*Kipekiskwaywinan*) and FLCN Environment Evaluation Report (Draft). ATK in this section of the EIS should be understood from the perspective of the Cree worldview. This worldview and knowledge guided the KCNs in their participation in planning the Project with Manitoba Hydro and in providing guidance to the environmental assessment. Many community Members expressed doubt that the effects of past projects were fully understood or accurately predicted and hold similar reservations regarding the current Project.

Some of the ATK observations with respect to physical environment include the following:

- Waterways have been altered very substantially in the region from past hydro projects, making ice and open water conditions uncertain relative to the past and the Project could worsen this;

- There is concern as to whether the engineering calculations of water and ice regimes can be relied upon. Specifically, Members are concerned that the Project may affect water levels on Split Lake;
- Water quality in the waterways, particularly the Nelson River, has been affected from past projects in terms of turbidity, odour, cleanliness and associated drinkability and the KCNs are concerned about the potential for water quality to be further affected by the Project;
- Shoreline erosion in reservoirs like Stephens Lake continues today, and there is concern that the new Keeyask shorelines will be unattractive and that erosion and peat disintegration may continue for decades in the Keeyask reservoir;
- There is concern that Keeyask reservoir levels will reduce caribou calving habitat due to the flooding of islands, and there is uncertainty as to whether new islands will form as replacement calving habitat;
- Ongoing debris generation in the newly flooded reservoir may disrupt resource use activities;
- There is regret about the inevitable loss of Gull Rapids if the Project proceeds; and
- There is concern that climate change will be a major factor in the future physical landscape.

Because ATK has perspectives that differ and doubt some of the results of technical science, an emphasis has been placed on mitigation, adaptive management and monitoring. These topics are covered in Chapter 8.

6.3.3 CLIMATE

The Project's impact on climate change is assessed by determining its greenhouse gas (GHG) emissions. This includes consideration of the emissions of the Project as well as the emissions displaced by the electrical energy produced by the Project. Greenhouse gases include all gases that absorb infrared radiation emitted by the earth's surface. Carbon dioxide (CO_2) and methane (CH_4) are the principal GHGs relevant to the Project.

A Life-Cycle Assessment (LCA) approach was used to estimate the GHG emissions resulting from the manufacture and transport of materials and equipment (*e.g.*, cement, steel), the construction and operation activities, land-use changes and decommissioning of the Project. The LCA was conducted by the Pembina Institute using ISO 14040:2006 "Environmental Management – Life Cycle Assessment – Principles and Framework".

The net implication of the Project on GHG emissions considers both the life-cycle GHG emissions resulting from the construction and operation of the Project, as well as the avoided GHG emissions that result from delivery of the energy (less transmission losses) to markets outside of Manitoba where it will displace alternative fossil-fuel sources of generation.

Manitoba Hydro has established measures and targets related to GHGs that drive strategies and actions to understand, adapt, report and reduce GHG emissions. These are described in Appendix B of the Climate Section of the PE SV. These strategies will apply to the construction and operational phases of the Project.

6.3.3.1 CONSTRUCTION EFFECTS AND MITIGATION

Construction will occur over an approximately 8.5 year timeframe. The LCA considered the GHG emissions from all construction activities. This included GHG emissions from various equipment and vehicles and from the burning of trees/shrubs/organic material that is removed from the reservoir, access roads and borrow areas. Additionally, it considered the manufacture and delivery of construction materials. The LCA also included the GHG impacts associated with the separate Keeyask Transmission Project, which will provide construction power to the project and will transmit production from the project once it in operation(Construction Power transmission line, and the Generation Outlet transmission lines that will run from Keeyask to the Henday converter station).

To quantify the total global warming potential of the different GHGs, gases such as CH_4 are converted to an equivalent amount of CO_2. In total, the construction, operation and eventual decommissioning of the Project will result in life-cycle GHG emissions of approximately 979,000 tonnes CO_2eq or 2.46 tonnes CO_2eq per gigawatt hour (GWh) (CO_2eq/GWh) of electricity produced. These GHG implications are primarily associated with the construction phase and land-use change aspects of the Project. Together, these account for approximately 97% of the total Project GHG emissions.

The construction phase of the Project results in approximately 46% of the Project's total life-cycle GHG emissions. The majority of the construction phase emissions result from manufacture and transport of building materials, namely steel and cement. The quantities of these materials along with the lengthy transportation distances contribute to life-cycle emissions.

GHG implications associated with land-use changes account for 50% of the Project's total LCA emissions. The majority of land-use change implications are associated with the reservoir formation. The methodology used to determine the land-use change implications is considered to be conservative. The methodology assumes that above ground biomass is cleared and burned and that the reservoir itself produces additional emissions based on the 2006 Intergovernmental Panel on Climate Change (IPCC) guidance. Within the first 10 years, the newly established Keeyask reservoir is assumed to increase in its concentration of dissolved gases and associated flux levels relative to levels upstream of the reservoir and pre-project levels. After approximately10 years have passed, the GHG concentrations and fluxes are predicted to approach levels similar to pre-Project and upstream levels, and are also comparable with levels of surrounding natural lakes and rivers in the Keeyask region.

The construction effects are considered small in magnitude, small in extent, short-term in duration and continuous during construction.

There is expected to be a temporal and spatial overlap with the construction effects of the Project with the Keeyask Transmission Project. While these are separate projects they were both included in the Keeyask LCA. Construction of these transmission lines and substations will involve small GHG emissions within the local area. The interaction is not considered substantive.

The construction of the proposed Bipole III transmission line, where it passes through the regional study area, could have some temporal and spatial overlap with the Keeyask Project. The majority of the Bipole III construction activities will be along a linear corridor with no substantive overlap with Keeyask construction activities.

During construction of the proposed Conawapa Generation Project GHG emissions could overlap with the Project but this overlap is not considered substantive as there is no interactive climate change effects expected between the construction of Keeyask and Conawapa projects.

6.3.3.2 OPERATION EFFECTS AND MITIGATION

The LCA includes implications associated with the operation phase of the Project. These are primarily associated with off-site activities such as the production of replacement equipment, recycling of the damaged or worn steel components and concrete replacement. GHG emissions from the reservoir are included in the LCA.

While the construction and operation of the Project will result in short, small increases in regional GHG emissions, the operation of the Project will result in large reductions regionally over the long-term.

The most substantial operational consideration in the LCA is associated with the generation of electricity. Electrical production will increase exports, displacing fossil-fuelled generating stations outside of the province and contributing to substantial emission reduction benefits. The electrical energy from the Project will displace a mixture of generation outside of the province with an assumed emission intensity of 750 tonnes CO_2e/GWh.
It is estimated that the emission reduction benefits in the first year will be nearly 3 million tonnes CO_2eq, more than three times the total 100-year life-cycle GHG emissions of the Project.

The total life-cycle GHG emissions (2.46 tonnes CO_2eq/GWh) are very small compared with other forms of generation. Other methods of meeting energy needs within the province would result in much larger emissions. For example, a comparably sized combined cycle natural gas plant, operating at a 65% capacity factor would produce the same emissions in its first 177 days of operation as Keeyask emissions over a 100-year life.

The net effect of the Project on climate change considers the difference between the total life-cycle GHGs of the Project compared with displaced GHG production elsewhere. The net effect of the Project on climate change is positive within the first year and is estimated to yield a total net benefit of about 747.5 tonnes CO_2eq/GWh. These GHG reductions are considered to be large in magnitude, positive, global in geographic extent, long-term in duration, and a continuous benefit.

Interaction with the Keeyask Transmission Project and this Project in the operation phase with Keeyask is not considered likely. The operation of the potential Conawapa project will likely interact with Keeyask to further displace fossil-fuel generation and provide further reductions in global GHG emissions.

Monitoring will include measuring pre and post-impoundment CO_2 and CH_4 flux concentration at the site of the Keeyask reservoir, and upstream and downstream locations along the Nelson River, as described in the Climate Section of the PE SV.

6.3.4 LOCAL AIR QUALITY AND NOISE

Air quality in Manitoba is rated by Environment Canada as “generally good,” with the exception of local issues relating to industrial sources or vehicle emissions (Krawchuk and Snitowski 2008) Potential air pollutants arising from construction and operation activities in the Local Study Area are expected to include sulphur dioxide (SO_2), carbon monoxide (CO), nitrogen oxides (NOx), volatile organic compounds (VOCs), and total suspended particulate matter (PM, PM10 and PM2.5).

The assessment of noise in the Local Study Area considered activities associated with construction and operation of the Project. There is no noise monitoring data available for Manitoba Hydro GS construction projects. Consequently, noise data used in this discussion is sourced from previous studies, using typical construction noise levels for specific equipment and construction activities, measured outdoor noise levels associated with a range of rural and urban environments, and individual noise exposure patterns. The sources relied upon for noise data include the U.S. Occupational Safety and Health Administration and the U.S. EPA’s Office of Noise Abatement and Control (USEPA 1978).

6.3.4.1 CONSTRUCTION EFFECTS AND MITIGATION

6.3.4.1.1 LOCAL AIR QUALITY

Construction will take place over an approximate 8.5-year period and will involve temporary, localized loadings to the atmosphere. The Project is expected to generate temporary emissions as a result of construction tasks and activities.

These include the following:

- Upgrading existing roads and constructing and maintaining new permanent and temporary access roads;
- Transport traffic involving highway/road shipment, materials and personnel to support construction activities on-site;
- Site clearing activities; and
- Construction of Keeyask dams, dykes, powerhouse and spillway.

Through these activities, the Project will result in the following emissions to the atmosphere.

EMISSIONS FROM UPGRADING ROADS AND BUILDING ACCESS ROADS

The Project is expected to generate temporary emissions as a result of construction tasks and activities related to upgrading roads and building access roads. This activity is expected to cause measurable but small quantities of exhaust gases and dusts, resulting in air contaminant loadings to the local airshed. A large portion of these emissions (NO_x, SO_2, CO and PM) will be from internal combustion gasoline and diesel engines.

Residual effects associated with roadwork activities are predicted to be relatively small in magnitude, medium in geographic extent and short-term in duration.

EMISSIONS FROM TRANSPORT OF EQUIPMENT, MATERIALS AND PERSONNEL

Maximum peak daily emissions resulting from road transport activities were estimated using assumptions regarding final consumption data, estimated fuel requirements and U.S. EPA AP-42 emission factors (USEPA 1995).Estimates for maximum atmospheric annual loadings associated with transport activities were developed using multiple data sources and assumptions, including access road traffic count estimates, and conservative assumptions relating to construction vehicles fleet composition and fuel efficiency rates as reported by Transport Canada (Transport Canada 2011). It was assumed that 15% of transport activities would be by rail as it results in a conservative estimate of emissions because higher levels of shipment by rail would reduce the overall emissions.

In order to provide some context, the highest possible daily total peak emissions resulting from Keeyask road transport of equipment, materials and personnel to and from the Project were compared to total average daily emissions reported for road transportation sector activities for the entire Province of Manitoba for 2009, the most recent year reported in Environment Canada's National Pollutant Release Inventory (NPRI 2009) (Table 6-14).

Table 6-14: Keeyask Road Transport (Equipment, Materials and Personnel) Activities

Air Contaminant	Maximum Peak Daily Emissions (tonnes/day)	Average Daily Emissions for MB Road Transport Sector (tonnes/day)
NO_x	2.0	124.0
CO	0.4	577.0
SO_2	0.1	0.75
PM_{10}	0.1	7.20

It is expected that due to the inherent conservatism in the emissions loading estimate for road transportation for the Project (maximum peak daily trips, conservative fuel efficiency ratings, *etc.*) that actual transport emissions for Keeyask will be smaller than the reported estimates. The maximum potential daily loadings due to Keeyask road transport for each reported air contaminant are orders of magnitude less than the daily emission loadings derived from total emissions reported in the National Pollutant Release Inventory (2009) for total emissions resulting from all road transport activities in Manitoba.

Based on the results of these comparisons, it is not likely that air contaminant emissions from the transport of materials and personnel towards construction of the Keeyask Project will result in exceedances of the ambient air quality objectives and guidelines in the Local Study Area. The effects are considered to be small in magnitude, medium in geographic extent and continuous during construction.

EMISSIONS FROM SITE CLEARING ACTIVITIES

Clearing activities will be required for construction work areas, borrow sources, *etc.*, with the largest clearing associated with reservoir clearing. Reservoir clearing will involve approximately 6 km^2 (2.3 sq mi.) of hand clearing and 34 km^2 (13 sq. mi.) of machine clearing (see Project Description, Chapter 4). Woody debris that is not salvaged will be piled, windrowed and burned after drying and only under acceptable wind conditions. The 40 km^2(15 sq. mi.) of area slated for clearing and debris burning compares to annual burn rate estimates for the region based on available fire history data of approximately 390 km^2(150 sq. mi.) burned per year from existing conditions in the Fire Regime Regional Study Area (see Section 6.2.3.4, TE). Emissions were estimated for site clearing based on fuel requirement estimates (PE SV Section 3) and emission factors from U.S. EPA AP-42 (1995).

The Environmental Protection Plan (EnvPP) for the Keeyask GS outlines details of burning conditions and fire-prevention measures in accordance with provincial permits. Fire prevention measures would include considerations such as supervision of burning, having firefighting equipment, no burning at night among others.

Table 6-15 presents total Keeyask site clearing estimated emissions (over a six-year site clearing program) and annual average estimated emission loadings resulting from Keeyask site clearing work. To provide some context, these values are presented in Table 6-15 for comparison beside a listing of total annual emissions resulting from road transportation activities for the entire Province of Manitoba for 2009, the most recent year reported by National Pollutant Release Inventory (2009 National, Provincial and Territorial Emissions Summaries for Key Air Pollutants, including information on subsectors – January 2011).

Table 6-15: Emission Estimates for Keeyask Site Clearing Compared to Emission Estimates for Manitoba Road Transport (2006)

Air Contaminant	Total Project Clearing Emissions (6 years) (tonnes)	Annual Clearing Emissions (tonnes/y)	Total 2009 Emissions for MB Road Transport[1] (tonnes)
NO_x	275	46	45,101
CO	59	10	210,498
SO_x	18	3	273
PM_{10}	19	3	2,638

[1]Includes heavy-duty diesel vehicles, heavy-duty gasoline trucks, light-duty diesel trucks, light-duty gasoline trucks, light-duty gasoline vehicles and off-road diesel consumption.

Estimated total Project clearing and annual clearing emissions generated by the Keeyask site clearing effort are substantially below the total 2009 atmospheric loadings reported to the National Pollutant Release Inventory for emissions generated by road transport throughout the Province of Manitoba.

The effects of the emissions related to clearing activities on local air quality are considered to be moderate in magnitude, medium in geographic extent, and episodic during the construction period.

EMISSIONS FROM CONSTRUCTION OF KEEYASK PRINCIPAL STRUCTURES AND SUPPORTING INFRASTRUCTURE

Final construction equipment fleet deployment figures will not be available until after contractor selection has occurred. In order to estimate overall emissions associated with this stage of construction, U.S. EPA AP-42 (1995)emission factors were applied to overall fuel requirement estimates prepared for all construction activities occurring under the "Construct Keeyask Dam and Generation Facilities" task (see PE SV, Section 3.0).

Air pollution estimates for construction equipment are based upon emission factors sourced in EPA AP-42 5th Edition, Section 3.3 "Gasoline and Diesel Industrial Engines"(1995).

The nature of emissions resulting from Keeyask dam and GS facility construction activity is such that the sources will often be mobile within the construction zone, stationary for short periods of time and will be intermittent, as not all vehicles in the construction fleet will be operating simultaneously.

Emission estimates are provided in Table 6-16. Total construction emissions over 8.5 years of construction are substantially less than emissions into the atmosphere resulting from a single year of road transport traffic in Manitoba. Annual emissions associated with construction of the dams and GS facilities are estimated to be highest for NO_x at 382 tonnes/y (421 tons/y); however, this is still less than 1% of the annual NO_x loading estimate for road transport within the entire province.

Table 6-16: Emission Estimates for Keeyask Dam and Generation Facilities Construction Compared to Emission Estimates for Manitoba Road Transport (2006)

Air Contaminant	**Total Keeyask Construction** (7 years) (tonnes)	**Annual Keeyask Construction Emissions** (tonnes/y)	**Total 2009 Emissions for MB Road Transport**[1] (tonnes)
NO_x	3,056	382	45,101
CO	658	82	210,498
SO_x	210	25	273
PM_{10}	215	27	2,638

[1] Includes heavy-duty diesel vehicles, heavy-duty gasoline trucks, light-duty diesel trucks, light-duty gasoline trucks, light-duty gasoline vehicles and off-road diesel consumption.

It is not likely that air contaminant emissions from the construction of the Project will result in exceedances of Manitoba ambient air quality objectives and guidelines (Manitoba Conservation, Pollution Prevention 2005) in the Local Study Area.

Dust emissions will vary during the construction period and will be influenced by the level of construction activity, the specific operations and the local weather conditions. The nature of construction is that it consists of a series of different activities and operations, each with its own associated dust emissions. Dust-control measures will be used on roadways, as necessary, to limit the amount of airborne dust. The Keeyask GS EnvPP will provide measures for dust control, requirements for vehicle maintenance, *etc.*, that will mitigate air quality effects.

Considering these mitigation measures, residual effects associated with emissions during construction are small in magnitude, small in geographic extent, and continuous during construction. It is unlikely that these emissions will be detectable beyond the Local Study Area. Monitoring of air quality is not proposed.

While there is temporal overlap and some spatial overlap with the KIP and Keeyask Transmission Project, the interaction with respect to local air quality is expected to be minor.

6.3.4.1.2 NOISE

During the construction phase, the Keeyask Project will involve seven consecutive years of active construction within the Local Study Area. Construction activity will cause elevated noise levels within the immediate construction site, with sound propagating away from the origin of the noise and expected to attenuate with distance back to normal ambient noise levels for the Local Study Area. This increased noise level will be moderate in magnitude, medium in geographic extent, and limited to the duration of construction. It would be similar to other construction activities involving large machinery and traffic, including earthmoving operations. Blasting activities will occur episodically and be short in duration. The majority of construction noise will be generated by sources including earthmoving equipment, materials handling equipment and concrete/aggregate processing operations and clearing operations.

Site preparation will involve the operation of relatively light equipment (trucks, chainsaws, *etc.*) and heavy equipment such as bulldozers, backhoes and large trucks. After the reservoir clearing, there will be haul trucks entering and leaving the site from borrow areas. As the cofferdams are constructed, blasting, usually during the winter period, will occur at the quarry sites. Noise levels will be elevated at the site and along the access roads. Noisy operations such as blasting will follow protocols discussed in the Aquatic Environment Section 6.4 and Terrestrial Environment Section 6.5. Potential effects of noise related to resource use are discussed in the Resource Use Section 6.7.

The worker's camp area is located about 3 km from the main Project construction site. Noise levels from the construction site are not expected to affect worker conditions in the construction camp environment. Related experience from the Wuskwatim Generation Project (currently under construction) indicates that while the Wuskwatim camp is located closer (1.5 km distance) to the construction site than the Keeyask camp will be, no noise-related issues, such as sleep disturbance, have been reported to Manitoba Hydro by workers residing in the worker's camp. Known trappers' cabins are located further away than the main camp and construction noise levels are not expected to affect the use of these buildings. The closest known cabin is about 4 km downstream of Gull Rapids. No chronic construction noise exposure to off-site human receptors and no human health impacts are anticipated.

Workers on-site will be expected to wear hearing protection and other personal protection equipment consistent with best practice on large-scale construction sites utilizing heavy construction machinery on site.

Residual effects associated with construction noise levels are considered to be moderate in magnitude, short-term, medium in geographic extent and continuous during the construction period. Noise monitoring is not proposed.

While there is temporal overlap with other projects, such as KIP operation and the Keeyask Transmission Project, interaction with other projects with respect to noise in the Project vicinity is not expected during the construction phase.

6.3.4.2 Operation Effects and Mitigation

6.3.4.2.1 Air Quality

There are very few air emissions associated with the operation of the Generating Station during operation. There are minor-level emissions associated with activities such as operating backup generators periodically, road maintenance and transport of operators by vehicles to and from the GS. The volume of traffic to the site during operation is considered to be minor.

In the operation phase, ice cover upstream will form earlier than it did prior to the Project, resulting in fewer days of open water, and therefore, fewer days of ice fog formation. There will still be areas between Birthday Rapids and Split Lake that stay open all winter, resulting in similar fog forming days. For about 800 m downstream of the powerhouse, there will be an area that will stay ice-free all year, resulting in ice fog formation all winter. The open water area during operation will be smaller than that which exists in Gull Rapids without the Project. Further downstream an ice cover will still form as it does without the Project and there will be little change in ice fog formation.

Residual effects associated with local air quality during operation are expected to be small in magnitude, small in geographic extent and long-term, with no overlap with other projects (see Chapter 7). Monitoring during the operation phase is not proposed.

6.3.4.2.2 Noise

With respect to the local noise environment the hydroelectric generating station is, by its design, a low-impact facility. The majority of noise is generated by operations taking place inside the principal structure and is mitigated by these operations being contained within the concrete powerhouse. The turbines and generators are housed inside a concrete water passage that is submerged beneath several metres of water, and the noise levels outside of the powerhouse structure are expected to be very low.

Warning sirens will sound prior to operating the spillway to alert potential downstream users of the waterway. This noise is episodic in nature, small in geographic extent and short-term. Noise will also result from the water flowing over the spillway. The noise from the passage of flow through the tailrace or spillway will be similar to the constant sound of a waterfall and is expected to attenuate rapidly with distance from the point of flow. Most of the time, when there is no flow over the spillway, the noise in the area will be reduced from the present conditions due to the absence of the noise associated with the existing rapids. Some KCNs community Members have stated that the sound of the Gull Rapids is considered to be a soothing noise, and local trappers say that it can be heard as far away as 18 km on a quiet night. During operation, the Project is expected to be much quieter than the waterfall sound. A spiritual/religious ceremony is planned close to the time when the rapids will be flooded, as discussed in Section 6.7 (Socio-economic).

Residual effects to the local noise environment are expected to be small in magnitude, small in geographic extent (limited to close proximity to the powerhouse and spillway), and long-term in nature.

While there is temporal overlap of operations with the Keeyask Transmission Project and the Conawapa project, the spatial separation is sufficient that there will be no substantive overlap with respect to noise. No monitoring during operation is planned.

6.3.5 PHYSIOGRAPHY

The environmental physiographic setting is described in Section 6.2.3.2. The effects of the Project on physiography focuses on the direct effects of the proposed Project on the physical land mass in terms of footprint area and use of local materials to build the Project (*i.e.*, borrow areas, rock quarries, *etc.*).

Analysis of Project effects was based largely on synthesis of data collected in the area and facts from a variety of literature sources and personal communications with persons having knowledge of the topography, geology and soils of the Local Study Area. Laboratory tests were also conducted on peat to gain a better understanding of their characteristics and some of the construction materials (*i.e.*, granular material and bedrock). Potential effects on permafrost and the results of testing of materials (*i.e.*, granular and bedrock) to determine their acid-rock leachability potential and suitability for exposure to oxygen and/or for placement in an aquatic environment were also reviewed.

6.3.5.1 CONSTRUCTION EFFECTS AND MITIGATION

The potential effects of the construction work are primarily related to modifications of the local environment surficial soils, geology and permafrost. This is associated with the Project Footprint area of construction and the uses of local borrow material.

Certain components of the Project are expected to result in physical changes to the environment (*i.e.*, access roads, site clearing, off-site materials extractions, GS construction). Details can be found in Chapter 4: Project Description.

During the construction phase, the Project will have a footprint of 13,354 ha (32,998 acres). Area related to altered water level or flow accounts for the highest percentage of this footprint (38.6%), followed by reservoir clearing (27.0%). The construction footprint is shown on Map 4-11 and 4-10, (Chapter 4, Project Description).

Approximately 7,434 ha (18,370 acres) of uplands and peatlands will be affected by clearing activities. Clearing inside the reservoir prior to reservoir impoundment accounts for 3,446 ha (8,515 acres) (46%) of the total clearing.

Earthfill and rock will be removed from the landscape and permanently relocated to construct the Project. Surface permafrost melting will occur in and adjacent to areas where vegetation is cleared and soils are disturbed during construction. Thawing of deep permafrost will occur at a much slower pace over the years as a result of the Project.

Following Project construction, some components of the supporting infrastructure will be removed and areas rehabilitated as defined in a rehabilitation plan.

Residual effects associated with Project construction and its resulting post-construction footprint on the physical landscape (both land and river bottom) will be large in magnitude, small in geographic extent, long-term and continuous on the physical environment.

There is some temporal overlap and spatial overlap with other current and future projects, including the KIP, the Keeyask Transmission Project and, to a lesser extent, Bipole III Transmission Project. There is no spatial overlap with the potential Conawapa station. Potential interactions with soils, peatland and permafrost are discussed in the Terrestrial section and in Chapter 7. The effects of these interactions on the physiography of the Keeyask Project are considered to be minor.

6.3.5.2 OPERATION EFFECTS AND MITIGATION

The effects on the physiography in the Local Study Area during operation relate to the erection of Principal Structures and operation of the reservoir.

The completion of the proposed Project will result in an initial flooding of 45 km^2 in the open water hydraulic zone of influence between the outlet on Stephens Lake to a few kilometres downstream of Clark Lake outlet. The low-head design of the Project results in less flooding than other design options (*e.g.*, high-head design) as described in Chapter 4, Project Description.

Flooding accounts for the highest percentage of Project Footprint. As a result of the Project, Gull Rapids will be almost completely submerged. Approximately 100 ha (247 ac.) of the rapids area downstream of the Project will be dewatered when the spillway is not in operation.

During the first thirty years of operating phase the Project reservoir is predicted to expand by about 7 km^2 (2.7 sq. mi.) to 8 km^2 (3.1 sq. mi.) due to ongoing peatland disintegration and mineral erosion along the shorelines.

Residual effects of the completed Project on the local physiography are large in magnitude, small to medium in geographic extent, long-term and continuous. The significance of these changes to the aquatic, terrestrial and socioeconomic environments and resource use is discussed in those respective sections.

There is temporal overlap of operation with the Keeyask Transmission Project, and the proposed Conawapa project. However, the spatial separation is sufficient that there will be no substantive overlap with respect to the Local Study area.

6.3.6 SURFACE WATER AND ICE REGIME

The construction and operation of the Project will change the surface water and ice regime in the vicinity of the Project, both upstream and downstream of the site. These are major effects of the Project and influential factors regarding effects on the biophysical environment.

The changes in the regimes were estimated using credible open-water hydraulic models, and in the case of the ice behaviour, the use of models developed specifically by Manitoba Hydro and its consultants for northern Manitoba weather and river systems, as discussed in the PE SV.

Manitoba Hydro has collected water level and flow data for more than 30 years along the Nelson River system and also has conducted extensive annual ice condition monitoring. These data were used to calibrate the numerical models. The open-water numerical modeling included one-dimensional, two-dimensional and three-dimensional models. The winter modeling was carried out using a one-dimensional model. These models are described in detail in the PE SV (Section 4.0).

Physical model studies were also used, particularly with respect to the spillway design and associated changes in water level and velocity during the different stages of construction.

It was determined that the flow record from 1977 to 2006, (*i.e.*, post-LWR and CRD projects), was too short to accurately assess long-term inflow variability and associated future system operations. Therefore, for purposes of this assessment, a long-term (94 years) simulated flow record of inflows to Split Lake was used to represent inflows to the Local Study Area in the future, both with and without the Project. It was assumed that CRD and LWR will continue to operate in the future as these operate today. The differences in the surface water and ice regimes were used to describe the effects of the Project.

6.3.6.1 CONSTRUCTION EFFECTS AND MITIGATION

Construction of the Project will involve managing the flow in the river in two stages, as described in detail in Chapter 4 and in the PD SV. During Stage I Diversion, a series of cofferdams and groins will be constructed to direct all river flow into the south channel of Gull Rapids. Cofferdams will permit construction of the powerhouse, spillway and the development of a quarry in the north channel. An ice boom will also be built upstream to facilitate stable ice cover formation on Gull Lake. The ice boom will have no effect on open water levels.

Stage II diversion will involve partial removal of the spillway cofferdams and closure of the river to allow the south dam to be constructed. Towards the end of the Stage II, the reservoir will be progressively impounded to its full supply level.

During the winters of Stage I and the first year of Stage II diversion, an ice cover is expected to bridge upstream of Gull Rapids much earlier in the season than presently occurs due to the presence of the ice boom. This will substantially reduce the volume of ice collecting downstream of Gull Rapids, which will reduce the size of the downstream hanging ice dam. This is expected to reduce the winter water level increases that typically occur at the foot of Gull Rapids by 2 to 3 m (6.6 ft. to 9.8 ft.). This effect is considered to be large in magnitude, medium in geographic extent, long-term and continuous during construction.

Open water levels upstream on Gull Lake during Stage I diversion and the first year of Stage II diversion are predicted to rise by as much as 0.8 m (2.6 ft.). Upstream of Birthday Rapids, open water levels are not expected to change. This effect is considered moderate in magnitude, medium in geographic extent, and short-term.

Earlier initiation of ice bridging upstream of Gull Rapids due to the ice-boom may result in winter water levels upstream of Gull Rapids rising by approximately 0.5 to 1.5 m (1.6 ft. to 4.9 ft.) during Stage I and Stage II diversion. These increases in water levels will be less than the increases expected to occur during the operation phase. These effects are considered moderate in magnitude, medium in geographic extent and short-term.

During the summer and fall of the second year of Stage II diversion, water levels on Gull Lake will rise up to an additional 1 m (3.3 ft.) and an additional 0.2 m (0.7 ft.) near the foot of Birthday Rapids, over the levels expected during Stage I. These effects are considered moderate in magnitude, medium in geographic extent, short-term and low in frequency.

In November of the second year of Stage II diversion, a little before final impoundment to full supply level, water levels may be increased an additional 3 m (9.8ft.) on Gull Lake and 0.6 m (2.0 ft.) near the foot of Birthday Rapids.

Final reservoir impoundment to elevation 159 m (521.7 ft.), Full Supply Level, is expected to occur in November of the second year of Stage II diversion. Regulation of the reservoir will be provided by the use of the spillway gates. The allowable rate of water level rise in the reservoir will be determined by monitoring in order to not adversely affect the principal structures. It is expected the water level increase in the reservoir will be limited to a maximum of approximately 0.5 to 1 m/d (1.6 to 4.9 ft./d). Only a modest cutback in river outflows of 100 to 300 m^3/s (131 to 392 cfs), or about 3 to 10% of the average daily discharge during that time, is expected to be required in order to fully impound the reservoir.

Overall residual effects associated with the surface water and ice regime are expected to be moderate in magnitude, small in geographic extent and continuous during construction.

The construction effects on water and ice regimes will not overlap with other projects, temporally or spatially. Monitoring of water levels and ice conditions will occur during construction (see Chapter 8).

6.3.6.2 Operation Effects and Mitigation

6.3.6.2.1 Open Water Conditions

The characteristics of the future water regime of the Project are based on a peaking mode of operation and a base loaded mode of operation, as discussed in the Project Description (Chapter 4). Extensive hydraulic modeling was conducted for the Nelson River from the outlet of Split Lake to Stephens Lake for post-Project conditions under both modes of operation.

Model calculations for predicted open-water surface profiles (Map 6-47) indicate that the backwater effect of the Project does not extend beyond approximately 41 km (25.5 mi.) upstream of the Project site, or about 3 km (1.9 mi.) downstream of the Clarke Lake outlet. Accordingly, the open water levels on Split Lake and Clark Lake are not expected to be affected by the Project. Effects of the Project on downstream water-level fluctuations and water velocities are predicted to diminish quickly because the Project is close to Stephens Lake. Water levels in the tailrace of the GS will be within the operating range of Stephens Lake and levels in the river channel downstream of the GS are largely controlled by water levels on Stephens Lake. A minimal amount of area along the shoreline will be subject to wetting and drying due to cycling of outflow from the GS. This area is not permanently wetted under existing conditions, as it may be dewatered due to changes in Stephens Lake levels.

The Project's predicted open water hydraulic zone of influence extends from about 3 km (1.9 mi.) downstream of the Clarke Lake outlet to about 3 km (1.9 mi.) downstream of the Project (Map 6-47). At the full supply level of 159 m (521.7 ft.) the reservoir surface area will be approximately 93 km^2 (36 sq. mi.), of which 45 km^2 (17 sq. mi.) is newly flooded land. This area is predicted to increase by about 7 to 8 km^2(2.7to 3.1 sq. mi.) over the first 30 years of operation as the mineral and peatland shorelines erode during the operation phase, as discussed in Section 6.3.7.These effects are large in magnitude, medium in geographic extent, long-term and continuous.

The Nelson River shoreline length and area immediately downstream of the spillway will decrease due to the dewatering of a portion of Gull Rapids when the spillway is not operating.

The creation of the reservoir will almost completely submerge Gull Rapids, with the exception of the dewatered area downstream of the spillway and south dam, and increase upstream water depths (Map 6-48). Water levels immediately upstream will be raised by 10 to 15 m (33 ft. to 49 ft.) above present conditions. The greatest depth of approximately 31 m (102 ft.) will occur in the excavated intake channel leading to the new powerhouse. Increases in water level diminish in the upstream direction. The water level on Gull Lake will be increase by about 6 m to 7 m (20 ft. to 23 ft.), and in the reach between Portage Creek and Birthday Rapids the increase is about 3 to 5 m (9.8 ft. to 16.4 ft.); submerging most of the rapids in this reach. Increases in water level are relatively small above Birthday Rapids. This is a large, medium in geographic extent, long-term and continuous effect.

During a base loaded mode of operation, the reservoir level is kept at full supply level of 159m (521.7 ft.). For all flow conditions, post-Project water level variations under the base loaded mode of operation will be less than those for the peaking mode of operation, and the effects of this mode of operation also diminish moving upstream of the Project site. During the peaking mode of operation, the Keeyask reservoir will fluctuate one meter (between 158 m and 159 m) during a week and may fluctuate up to 1 m in a day. These fluctuations will be greatest immediately upstream of the GS and then diminish moving upstream. These effects are considered moderate in magnitude, medium in geographic extent, long-term and high in frequency.

No changes to the water velocities in Clark Lake or Split Lake during the open water period are expected as theses lakes are upstream of the open water hydraulic zone of influence. Within the open water hydraulic zone of influence velocities will change. The greatest change occurs immediately upstream of the Project where Gull Rapids is flooded out and post-Project velocities are low (Map 6-49). Velocity patterns downstream are also changed by the Project within the open water hydraulic zone of influence.

Residual effects on the surface water and ice regimes during operation are expected to be large in magnitude, small in geographic extent, long-term and continuous. Manitoba Hydro routinely monitors water levels and flows along the Nelson River and this will continue during open water and winter periods, specifically in the reach below Split Lake (see Chapter 8).

Spatial interaction of the operations of the open water regime with other projects is not expected.

6.3.6.2.2 WINTER CONDITIONS

Winter water levels between the outlet of Clark Lake and the Keeyask GS will increase through the creation of the reservoir (Map 6-48).

Ice cover on the river between the Project and Portage Creek will form more quickly than it does presently. It is expected the ice cover will be much thinner (*i.e.*, the average thickness of the reservoir's cover is expected to be 0.8 to 1.2 m (2.6 to 3.9 ft.) by the end of the winter), which is similar to conditions on Stephens Lake. The ice front is expected to advance past Birthday Rapids every year and approximately three weeks earlier than it does currently. At present, the ice front does not always advance through Birthday Rapids. The leading edge of the ice front is expected to be approximately 1 to 2 km (0.6-1.2 mi.) further upstream than occurs currently.

Overall, ice volumes that are generated are expected to be approximately half of what they are without the Project. It is expected that the currents and amount of water level staging associated with spring ice jams will be reduced. Under low-flow conditions that may occur on average once every 20 years, there is a possibility that water levels on Split Lake could be increased by up to 0.2 m (0.7 ft.) above those which occur without the Project due to the change in ice processes in the reach after the Project is built. Split Lake water levels would remain within the range of past winter levels since LWR and CRD. This effect is considered small in magnitude, medium in geographic extent, long-term and continuous in frequency.

Fluctuation of reservoir levels due to peaking operations in the winter may result in increased formation of slush ice conditions. The limited operating range of 1 m will minimize this effect. The effect is considered moderate in magnitude, medium in geographic extent, long-term and of continuous in frequency.

Due to the varying outflow from the Project, the water levels between the station and Stephens Lake will fluctuate a small amount (0.1 to 0.2 m) (0.3 to 0.7 ft.) and will be limited to the immediate tailrace area. The Project will not affect the water level range on Stephens Lake. Winter levels at the location of the tailrace will be much lower than what occurs at present due to tailrace channel improvements and the elimination of the downstream hanging ice dam. Instead of the hanging ice dam, a relatively flat thermal ice cover will form, similar to what currently occurs on Stephens Lake. Immediately downstream of the powerhouse, an area about 800 m (2624 ft.) long is expected to be ice-free all winter. In the spring, the Stephens Lake ice cover will melt in place. When the spillway is not operational, portions of the south channel will be dry.

Overall, the effects associated with winter conditions are predicted to be large in magnitude, medium in geographic extent and long-term and continuous. Water levels and flows will be monitored in the winter.

The open water and winter hydraulic zone of influence of the Project operation does not overlap spatially with other projects, including the potential Conawapa project.

6.3.7 SHORELINE EROSION PROCESSES

The creation of the reservoir upstream of the Keeyask GS will flood land and existing waterways in the Local Study Area. The flooded area is largely comprised of low-lying peatlands. When flooded, this area will rapidly experience a substantial amount of peatland breakdown along new shorelines, mobilization of peat islands, and submerged peat mats floating to the surface (*i.e.*, breakdown of shoreline peatlands and breakdown of resurfaced peat mats). These processes are collectively termed peatland disintegration. Over time, peatland disintegration will expose additional mineral shorelines to wave energy and related erosion.

There is little experience elsewhere with respect to modeling peatland disintegration. Accordingly, the anticipated effects were analyzed by reviewing peatland disintegration in other reservoirs in northern Manitoba such as Southern Indian Lake and Stephens Lake, using aerial photography and other field data. The predicted peatland disintegration is based heavily on the Stephens Lake reservoir, which had similar circumstances and for which good data are available. In addition, extensive shallow borehole investigations were done in the potentially flooded area to characterize the peat and permafrost condition. This information was used to estimate the likely peatland disintegration associated with the Keeyask reservoir. Empirical and process models were developed using this information to estimate the changes in shoreline peatlands (PE SV Section 6.0).

Mineral shoreline erosion was estimated where mineral shoreline material will be present along the initial post-impoundment shoreline and where mineral material will become exposed to erosion over time due to peatland disintegration. A GIS-based wave-energy model was developed from observations and data from a large number of lakes and reservoirs, including those located in northern Manitoba. The model was used to predict post-Project shoreline recession rates in mineral soils. Erodibility coefficients used in the model were developed using historical aerial photo data from representative shoreline sites in Stephens Lake. The mineral shoreline erosion model accounted for water-level fluctuation, erodibility of shore materials, wave erosion of the toe of the exposed shoreline bank, down cutting and flattening of the nearshore slope by wave action, and mass wasting of the shore bank.

Predicted shoreline erosion volumes were used to estimate shoreline recession based on the pre- and post-erosion shoreline profile geometry. Hourly wind data from the Environment

Canada weather station in Gillam were used as inputs to the wave-energy model. Estimates were made of the extent of shoreline recession and volumes of material mobilized into the reservoir for Years 1, 2-5, 6-15, 16-30, 31-50, and 51-100 after operation begins (detailed quantification is provided in the PE SV, Section 6.0). These estimates were compared with similar estimates made for the future environment without the Project to describe the effects of the Project.

6.3.7.1 CONSTRUCTION EFFECTS AND MITIGATION

Erosion during the construction phase relates mainly to river diversion caused by cofferdam construction in the river. The shorelines with the greatest potential for erosion during Stage I diversion are portions of the south shore of the south channel of Gull Rapids due to changes in the flow, water levels and velocity patterns. These effects are considered moderate, medium in geographic extent, short-term, and continuous.

Some minor effects on shoreline erosion could occur during the impoundment phase of construction but will occur over a short duration at the end of Stage II diversion (Section 6.3.6.1).

Cofferdam designs, construction methodology and sequencing have been developed to minimize erosion and sediment inputs during construction. For example, fine cofferdam material exposed to erosion (waves, flow) would be covered with rock to prevent erosion.

The residual construction effects associated with shoreline and erosion processes are expected to be small in magnitude, medium in geographic extent, short-term and sporadic during the construction period.

No overlap of shoreline erosion with known future projects is expected.

A physical environment monitoring program will be prepared to monitor shoreline erosion during the construction period (Chapter 8).

6.3.7.2 OPERATION EFFECTS AND MITIGATION

The creation of the reservoir will have a large effect on shoreline erosion processes. The extent and location of shoreline erosion and peatland disintegration is shown on Map 6-50 and Map 6-51 for the post-Project conditions at Year 30 of operation. Further details on other intervals are found in the PE SV.

The Project will initially flood about 45 km^2 (17 mi^2) of land. Shoreline erosion will expand the reservoir by an additional 7 to 8 km^2 (2.7 to 3.0 mi^2) during the first 30 years of operation due to mineral bank erosion and peatland disintegration. Erosion caused by the Project does not overlap with future projects. Most of the erosion is expected to take place in the first 15 years of operation after which bank recession rates decrease to stable long-term rates that are similar to existing rates.

Of the upstream shoreline length, the percentage of peat shoreline at Year 30 of operation will reduce to 23% from the current 31% due to peatland disintegration. As a result, the mineral shoreline length will increase to 68% from the current 60%. The percentage of bedrock shoreline (about 10%) will not change. The upstream shoreline length is predicted to initially increase from its current length of about 205 km to 264 km (127 to 163 mi.) (62% peatland, 28% mineral and10% dykes/rock) after initial impoundment. It decrease due to erosion of islands and peninsulas to about 244 km (151 mi.) (23% peatland, 68% mineral and9% dykes/rock) during the first 30 years of operation. Without the Project approximately 1% of the shoreline would be expected to recede at least 50 m (164 ft.) over the next 30 years, while about 17% of the shoreline would be expected to recede 50 m (164 ft.) with the Project. These effects are considered to be large in magnitude, medium in geographic extent, long term and continuous.

Future shoreline recession rates over a 30-year period with the Project were estimated for the peaking mode of operation to be as follows:

- 10% will remain stable;
- 25% will recede less than 15 m (49 ft.);
- 48% will recede between 15 m to 50 m (49 to 164 ft.);
- 12% will recede between 50 m to 100 m (164 to 328 ft.); and
- 5% will recede more than 100 m (328 ft.).

Approximately 1% of the shoreline in the open water hydraulic zone of influence would be expected to recede by at least 50 m (164 ft.) in the future without the Project. With the Project, the extent of the shoreline in these reaches that is expected to recede by at least 50 m (164 ft.) is predicted to increase to 17% of the shoreline.

Shoreline recession rates are slightly higher for the base loaded mode of operation due to the wave energy being distributed across a narrower shore zone along reservoir because the water level does not fluctuate. The difference is greatest in the first five years and decreases thereafter. For approximately 95% of the shoreline the difference in total recession for base loaded and peaking modes of operation over 30 years is less than 5 m. Map 6-50 Peatland Disintegration and Erosion in the Western Upstream Reaches and Map 6-51 Peatland Disintegration and Erosion in the Eastern Upstream Reaches show the predicted shoreline recession and reservoir expansion under base loaded mode of operation 100% of the time. Peatland disintegration is expected to be similar under baseloaded and peaking modes of operation primarily for two reasons. First, some peatlands are floating and will move up and down, so they will not be subject to a change in wave energy. Second, for the remaining peatlands, wave energy either has little influence on the peatland disintegration rates or will have little effect on the sheltered locations where these peatlands are found. The different modes of operation will affect mineral erosion because the peaking mode of operation will result in a higher water-level fluctuation range (approximately 1 m) (3.28 ft.) than the baseloaded mode of operation (no fluctuation). This results in greater wave-energy dissipation and decreased erosion. The ultimate total extent of shoreline recession is expected to be similar for both modes of operation. After 30 years of operation, the peatland disintegration processes are expected to be stable. Mineral shoreline erosion is expected to stabilize at or near existing recession rates by Year 15.

The effects of the Project on shoreline erosion are considered to be large in magnitude, medium in geographic extent, and long-term in duration.

Total releases of organic sediments and peat are expected to decline quickly during the first five years of operation. Annual organic sediment released into the aquatic system are predicted to increase from about 1,000 tonnes/year (1,100 tons/y) at present to about 1.3 million tonnes (1.43 million tons) in the first year of operation, then decrease to about 200,000 tonnes/y (220,000 tons/y)in Years 2-5 and about 18,000 tonnes/y (20,000 tons/y) by Year 16-30. The effects of these loadings on suspended organic concentration in water are discussed in Section 6.3.8.

Mineral sediment releases are also expected to decline quickly during the first five years of operation. Mineral sediment released into the aquatic system is expected to increase from about 56,000 tonnes/y (62,000 tons/y) at present to about 600,000 tonnes/y (666,000 tons/y) in the first year, declining to about 230,000 tonnes/y (253,000 tons/y) in Years 2-5 and 160,000 tonnes/y (176,000 tons/y) by Year 16-30 for base loaded mode of operation 100% of the time. Mineral sediment releases will be lower for a peaking mode of operation.

The effects of the Project on mineral and organic sediment releases are considered large in magnitude, medium in geographic extent, long-term and continuous.

Downstream of the Project, mineral shoreline erosion rates and sediment load will decrease because the hanging ice dam below Gull Rapids will no longer form. Peat banks are absent in the downstream reach. The Nelson River shoreline length and water surface area immediately downstream will decrease due to the dewatering of the rapids downstream of the spillway. These downstream effects are considered large in magnitude, medium in geographic extent, long-term and continuous.

Floating peat that may pose a hazard to navigation would be mitigated through the Waterways Management Program (Section 6.3.11). Shoreline erosion will be monitored during at least the initial operating period (Chapter 8).

Overall residual operation effects associated with shoreline erosion processes are expected to be large in magnitude, medium in geographic extent, long-term and continuous.

The effects of shoreline erosion processes resulting from the Project operation are not expected to overlap spatially with proposed projects such as Conawapa, Bipole III or the Keeyask Transmission Project.

6.3.8 SEDIMENTATION

Changes to the water regime and erosion processes will lead to changes in sedimentation processes and changes to river substrates. Sedimentation is a combination of processes including erosion, entrainment, transportation, deposition and compaction of mineral, sediment and peat material. Because the physical properties of mineral sediment differ from those of peat material, they were considered separately in the assessment.

Quantitative sedimentation predictions for the future environment with and without the Project were provided for time intervals following projected impoundment for Year 1, Year 5, Year 15 and Year 30. Two-dimensional numerical modeling using Mike 21 was carried out to assess the mineral sedimentation environment within the Local Study Area. A conceptual model was also developed to study the transport of mineral sedimentation in the near shore areas.

Hydraulic and sedimentation modeling of the existing Project environment, as well as for the different construction stages of the Project, were carried out. The changes in river hydraulics resulting from cofferdam construction and changes in shoreline erosion were calculated. The estimates from shoreline erosion and construction were used to estimate the potential changes to suspended sediment concentrations at a monitoring location located approximately 1 km (0.6 mi.) downstream of Gull Rapids.

A one-dimensional HEC-6 numerical model (US Army Corps of Engineers, 1993) was applied to assess potential changes in the sedimentation environment in Stephens Lake. Numerical modeling techniques were used to predict the volumes of eroded shore mineral material under both baseloaded and peaking modes of operation for the Project. These models are described in more detail in PE SV Section 7.0.

There are no widely used, standard hydraulic models that can be used to predict transport of peat mats or organic suspended solids in reservoirs or rivers. The transport and the general locations of expected deposition of peat material were approximated for post-impoundment conditions using numerical modeling and GIS analytical tools. These tools were developed for this study using data on wind and post-Project flow conditions identified in the Surface Water Regimes Section (Section 4.0 of the PE SV).

A simple analysis was performed to estimate organic suspended sediment concentrations for the future with the Project. Potential organic suspended solids concentrations in the newly flooded bays were estimated based on settling rates for representative samples of peat from the Keeyask area. Qualitative assessments were made for the post-Project peat transport and organic sediment concentration environment downstream of the Project.

Water depths, shorelines and water surface information were used to develop base maps of the post-Project environment (PE SV, Section 4.2.5.4). Results of studies suggested that the changes arising from physical processes in the reservoir will have largely stabilized prior to Year 30; therefore, Year 30 was considered a reasonable model for the long-term condition of the reservoir. Four models were used to estimate substrate distributions for Year 30 (AE SV, Appendix 3B). These models were based on observed conditions in Stephens Lake, which forms a model of a reservoir developed in similar conditions to the proposed Keeyask reservoir 30 years after impoundment. Model results were subsequently used to estimate the areas of each habitat type as described in the Aquatic Habitat Section 6.4.3.2.

6.3.8.1 CONSTRUCTION EFFECTS AND MITIGATION

During Stage I and II river diversions, upstream water level increases are limited, being contained largely within the Gull Rapids area, and affect mostly mineral shorelines. Mineral suspended sediment concentrations are predicted to increase in Gull Rapids and at the inlet of Stephens Lake due to material placement in the river and water level staging that can result in erosion of shorelines. Upstream of Gull Rapids, the sedimentation environment and river/lake substrates are not expected to be affected.

Construction of initial Stage I river diversion works in 2014 (*i.e.*, quarry cofferdam, powerhouse Stage I cofferdam, north channel rock groin, north channel Stage I cofferdam) may increase suspended sediment concentrations by 1 to 4 mg/L (typically about 2 mg/L at a monitoring location K-Tu-02 approximately 1 km (0.6 mi.) downstream) over a two-month period. In 2015, construction of the spillway Stage I cofferdam and central dam Stage I cofferdam is expected to increase suspended sediment over a period of about three months. These increases are less than 5 mg/L most of the time, although an initial peak increase of up to 8 mg/L may occur for about a day, while an increase of more than 5 mg/L may occur for about 4 days. Partial removal of the spillway Stage I cofferdam in 2017, at the end of Stage I diversion, may increase suspended sediment by up to 4 mg/L for about one month.

Stage II diversion will begin immediately following removal of the spillway Stage I cofferdam with flow passing through the spillway and construction of the upstream south dam cofferdam across the south channel to close off the river. This will result in additional water level increases within the Gull Rapids area. This activity will increase suspended sediment over a period of about one and a half months. The increase is less than 10 mg/L most of the time, although a peak increase of up to 15 mg/L may occur for about a day, while an increase of more than 10 mg/L may occur for about four days. Construction of the tailrace summer level cofferdam in 2018 will increase suspended sediment by 1-2 mg/L over a period of about seven weeks. In 2019, removal of the powerhouse cofferdam and tailrace cofferdam will increase suspended sediment by about 3 mg/L and 7 mg/L, respectively, with each increase lasting for about one month.

About 30%of the increased mineral sediment concentrations will be deposited in Stephens Lake. Most of the deposition will occur in a 5km (3 mi.) reach near monitoring location K-Tu-01 downstream of Gull Rapids where coarser particles will settle out as velocities decrease. Additional finer sediments will settle out in the south basin of the lake as the water flows to the Kettle GS. The remaining finer sediment that stays in suspension and will be discharged downstream through the Kettle GS. During entire construction period, it is expected that less than 6 mm of sediment will be deposited near the entrance to Stephens Lake downstream of Gull Rapids and less than 1 mm will be deposited in the vicinity of the Kettle GS.

Based on 2005-2007 data, the mineral suspended solids at various sites in Stephens Lake range from 3 to 15 mg/L during the open water months of 2005 to 2007. Based on data gathered during the winter months of 2008 and 2009, they range from 5 to 156 mg/L. The higher concentrations during the winter months were likely due to active shoreline erosion resulting from the ice dam immediately downstream of Gull Rapids.

The effects on peat are integrated into the assessment of the first year of operation because peat shorelines are not substantially affected until the reservoir is impounded in the latter part of Stage II diversion.

As noted in the Shoreline Erosion section (Section 6.3.7.1), cofferdam designs, construction methodology and sequencing have been developed to minimize the introduction of sediment into the water. For example, cofferdam removal would be done “in the dry” as much as reasonably practical to prevent sediment entering the water.

Sediment will be actively monitored during construction to ensure that instream construction is not causing increases in suspended sediment that exceed limits that may be specified by regulators. A Sediment Management Plan will be in place during construction and will describe where monitoring is to be done and what actions might be taken if suspended sediment increases beyond specified thresholds.

Based on the mitigation measures, residual effects associated with construction on sedimentation and river/lake substrates are expected to be moderate in magnitude, medium in geographic extent, short-term and infrequent during the approximate six years of river diversion activities.

There will be some overlap of in-stream construction activities between Keeyask and the potential Conawapa GS. It is expected that the Keeyask instream work on the tailrace cofferdam (mid-July to mid-September 2018), powerhouse cofferdam removal (July 2019) and tailrace cofferdam removal (September 2019) will increase downstream TSS concentration at the Kettle GS. Suspended sediment increases of about 2 mg/L to5 mg/L (typically less than 3 mg/L) may occur for periods of one to three months (depending on year). These increases will be transported downstream but concentrations will reduce downstream as the river flows towards Conawapa. These effects on the aquatic environment are discussed in Section 6.4.

Monitoring of suspended solids and turbidity will be done at several locations upstream and downstream of the Project as part of physical environment monitoring plan (see Chapter 8). Monitoring under the Sediment Management Plan would only be in place during construction and is separate from the physical environment monitoring.

6.3.8.2 OPERATION EFFECTS AND MITIGATION

The suspended mineral sediment concentrations upstream of Birthday Rapids are not expected to change from present conditions. Mineral suspended solids within the reservoir between Birthday Rapids and the Keeyask GS are expected to reduce from present conditions due to reduced flow velocities within the reservoir compared with existing conditions. Concentrations will be reduced by about 2 to 5 mg/L for average river flows and will generally be below 20 mg/L. The Year 1 sediment concentrations are shown in Map 6-52 Spatial Distribution of Depth Averaged Sediment Concentration. For high river flows, suspended sediment concentrations are predicted to reduce by 5 to 10 mg/L within the reservoir and will generally be below 25 mg/L. Sediment concentrations are predicted to reduce through the reservoir and be lower than the current conditions at Gull Rapids. By Year 15, the sediment concentrations are expected to stabilize and approximate conditions in Stephens Lake, where average open water concentrations are about 9 mg/L. These effects are moderate, medium in geographic extent, long-term and continuous.

Based on extensive modeling and field verification, the majority of the mineral sediments resulting from shoreline erosion are predicted to deposit in near shore areas. After Year 1, the rates of near shore deposition are predicted to be generally in the 0 to 3 cm/y (0 to 1.2 in.)range, depending on the location. These are similar to those in Stephens Lake. The south near shore areas in Gull Lake will likely experience the highest rate (4 cm/y to 6 cm/y(1.6 in./y to 2.4 in/y) for a baseloaded mode of operation) of mineral sediment deposition in the first year. In the offshore area, deposition rates are expected to be 0 to 1 cm/y (0 to 0.4 in/y). These effects are considered moderate in magnitude, medium in geographic extent, long-term and continuous.

Given that the total sediment load entering the Local Study Area from Split and Clark lakes is not expected to change, the sediment load passing through Gull Rapids will be reduced somewhat. After Year 1 of operation, the total sediment load is expected to be about 800,000 tonnes/y (880,000 tons/y) (for avergage flow conditions, a reduction of about 20% entering Stephens Lake). It is expected that the mineral suspended solids concentrations between the generating station and extending downstream about 12 km (7.4 mi.) into Stephens Lake will be reduced by 3 to 5 mg/L under typical-flow conditions. A reduction in the deposition in the upstream end of Stephens Lake is expected due to the upstream deposition of coarse material in the Keeyask reservoir. Additionally, since the large hanging ice dam will no longer form in Stephens Lake, the amount of shoreline erosion resulting from water level increases caused by the ice dam will be reduced, which will reduce associated sediment loads. The average total suspended concentrations at Stephens Lake sites ranged from 5 to 15 mg/L in the open water months of 2005 to 2007. The concentrations in Stephens Lake, particularly in the area immediately upstream of Kettle GS, will likely not be greatly affected. These effects are small in magnitude, medium in geographic extent, long-term and continuous.

A portion of the flooded peatlands may resurface or break down and become mobile. Some peat shorelines will break down and disintegrate into the water. It is predicted that there will be an overall decrease in total average annual organic material disintegrated from the shoreline between Year 1 and Year 15. A small portion (approximately 7 to 15%) of the total area of floating peat mats will likely be mobile, depending upon the material composition of peat and mechanism of disintegration from the shore. The highest maximum total mobile peat mass is predicted to occur in Year 5, with approximately 170,000 tonnes (187,000 tons), decreasing towards Year 15 to approximately 90,000 tonnes (99,000 tons). There is not expected to be any additional mobile peat after 15 years of operation. The total mobile material in the south side of the reservoir is predicted to increase by 60% between Year 1 and Year 5 because of shoreline disintegration and dominant northerly winds. The area surrounding Gull Lake will contribute large amounts of material into the waterbody in Year 1 because of inundation; however, most of the released organic sediments are expected to accumulate in the bays of origin. It is unlikely that there will be any appreciable amount of organic sediment deposition in the main stem of the reservoir.

Total organic material released into the reservoir is predicted to be highest in the large bays on the north and south sides of the new reservoir. These areas have extensive peatlands and creeks. The rate of peatland disintegration will decrease after the first year of operation. These effects are considered large in magnitude, medium in geographic extent, medium term in duration and continuous.

A relatively small amount of material is expected to pass through the spillway when it is in operation. For example, in Year 1 about 10,000 to 13,000 tonnes (11,000 to 14,300 tons) of the total 1.3 million tonnes (1.43 million tons) (about 1%) of peat input to the Keeyask reservoir may pass through the spillway. Accumulations at the generating station and also in the reservoir are expected to be managed under the Waterways Management Program.

In flooded backbays in Year 1 of operation, increases in organic suspended solids may range from 2 to 3 mg/L in the less affected bays to about 8 to 21 mg/L in the most affected bays. These increases are expected to drop substantially in the first few years of operations. By Year 5, these increases are expected to be about 1 mg/L or less on average and decrease in later years as organic loading decreases. These effects are considered to be large in magnitude, medium in geographic extent, short-term and continuous.

While a great deal of organic sediment is expected to be released, there is little effect predicted on organic suspended solids in the reservoir due to the large volume of water in the reservoir. Organic suspended sediment concentrations in Stephens Lake are expected to increase by less than 1 mg/L in the initial year of operation and decrease with time. These effects are considered small in magnitude, medium in geographic extent, continuous, but not long-term.

The effects of reservoir creation on river and lake bed substrates varies in relation to proximity to the generating station. The riverine reach from downstream of the outlet of

Clark Lake to Gull Lake is expected to have minimal changes in erosion and sediment deposition. No substantial change in substrate composition is expected in this reach. The greatest substrate changes occur in the area of Gull Lake to the Keeyask GS. The area is expected to become mainly a depositional environment, given that it has the greatest increases in depth and decrease in velocity. As the reservoir ages, discontinuous deposits of silt will form on existing cobble/gravel/sand substrates in main river channel areas of Gull Lake. However, coarser substrates will be present at some locations with greater exposure to currents and wave action. Over time, continuous deposits of silt will settle and cover much of the flooded terrestrial areas. Downstream of the Keeyask GS, the substrates are expected to remain similar to the existing environment. The post-Project substrate characterization is shown on Map 6-53 Substrate - Post Project – Year 30 Keeyask Area.

There is no expected interaction of sedimentation processes during operation of the Project with other future projects such as Conawapa or Bipole III.

Monitoring of suspended solids in the river will be done at several locations upstream and downstream of the Project. The monitoring program will take place for the first several years of operation (see Chapter 8).

6.3.9 GROUNDWATER

Development of the Project will increase water levels within the Nelson River upstream of Gull Rapids, thereby creating a reservoir, flooding land and changing the position of the shorelines. These changes to the surface water regime will lead to groundwater regime changes, which are important with respect to potential interactions with the terrestrial and aquatic environments. Raising or lowering the groundwater table can affect vegetation or change groundwater contributions to creeks and lakes.

Existing geological and hydrological information was used to characterize the current groundwater flow regime on a regional scale, in addition to available data from various field data gathered during studies of soils, vegetation, peat and erosion throughout the Local Study Area. The future range and temporal variation of groundwater levels, depth-to-groundwater table, extent of groundwater affected by the Nelson River, groundwater quality and groundwater flow direction with and without the Project was then predicted using a groundwater flow model that was built and calibrated for the regional study area. The data put into the model consisted of historic river flow data (1977 to 2007) and meteorological data that could be considered representative of existing conditions (1971 to 2007). Further details on the models and model simulations are provided in PE SV (Section 8.0).

The approach taken to assess the predicted potential Project effects was to determine the difference in groundwater conditions for the future environment with and without the Project. This was carried out by comparing the simulation results (dry meteorological with low river flows, typical meteorological and river flows, and wet meteorological with high river flow conditions) for each of the two scenarios. Differences between the two groundwater regimes (*i.e.*, increase in the groundwater elevations as a result of raising water levels in the reservoir area) were then reviewed and characterized as to potential Project effects.

The predicted effects of the Project on groundwater were used to assess interactions with other aspects of the Physical Environment, as well as the other environments (*i.e.*, aquatic, terrestrial and socioeconomic), as discussed in those respective sections.

6.3.9.1 Construction Effects and Mitigation

During Stage I and Stage II river diversion, the groundwater levels will increase but are expected to stay within levels observed historically during open water. During winter, there is a potential for groundwater levels to rise higher than observed levels. These effects are small in magnitude, small in geographic extent, short-term and continuous.

During reservoir impoundment, it is expected that groundwater levels will steadily change with the changing surface-water regime such that by the end of the construction period, groundwater levels will have risen to the levels predicted for the future environment with the Project during operation. This effect is considered large, medium in geographic extent, long-term and continuous.

Construction plans have considered the existing groundwater regime to address groundwater interferences with construction activities (and construction interferences with groundwater), so that they are minimized. Due to the shallow nature of the groundwater conditions in most areas (including the proposed location of the Keeyask Generating Station), there is a potential risk of groundwater contamination from construction activities (particularly a contingency event such as a fuel spill). Refuelling areas will be sited and mitigation measures enacted to prevent, as much as possible, impacts from contingency events. These measures will be detailed in the Keeyask GS Environmental Protection Plan. Therefore, no residual effects are anticipated.

Based on the mitigation measures, residual groundwater effects associated with construction on groundwater are expected to be small in magnitude, small in geographic extent, short-term and continuous during construction.

The reservoir impoundment and its effects on groundwater are assessed in the following Operation Effects section (Section 6.3.9.2).

Monitoring of groundwater levels in the Project vicinity is not proposed. No spatial overlap of Project effects with other projects is anticipated.

6.3.9.2 Operation Effects and Mitigation

The main aspects of the Project that are predicted to affect the groundwater regime are the development of the north and south dykes; the creation of the reservoir; and the powerhouse, spillway and related structures.

The spillway and powerhouse structures will be constructed so as to be impermeable, preventing the existing groundwater-surface water interactions immediately downstream of the Keeyask Generating Station. The north and south dykes, which will extend on both sides of the river upstream of the Keeyask Generating Station, will consist of impervious materials (till cores) for the purpose of impounding the reservoir (although some seepage is expected). The impoundment of the reservoir and operation of the powerhouse will raise the surface-water level, which will raise the groundwater elevations within existing and newly created islands within the reservoir. Furthermore, in combination with the dykes, the reservoir will create a hydraulic head, that in turn affects the existing groundwater regime in the vicinity of the reservoir shoreline. The Project will cause the groundwater levels immediately adjacent to the new reservoir to rise between 0 and 7.5 m (0 to 24.6 ft.) (depending on soil type), with an average increase of approximately 2 m (6.6 ft.). This will cause the total area width to increase by 13 to 18 km^2 (5 to 7 mi^2). This area does not extend into Clark and Split lakes. The average groundwater level is predicted to rise 0.5 m (1.6 ft.) or more within an 18 km^2 (7 mi^2) area along the reservoir shoreline and within the existing and new islands. Under wet meteorological conditions with high river flows, the predicted increase is about 0.5 m (1.6 ft.) within an area of13 km^2(5 mi^2). The region immediately downstream of the proposed dykes is not expected to be affected. The dykes, which will have small amounts of seepage, and drainage are expected to maintain groundwater levels to pre-Project conditions. The lateral extent of groundwater effects along the affected shoreline is predicted to be as much as 500 m (1,640 ft.) outside the new shorelines. The larger extent occurs in several locations due to a very low topographic gradient. These effects are considered moderate, medium in geographic extent, long-term and continuous.

Groundwater flow directions are not predicted to change with the Project (regardless of meteorological and river-flow conditions), except in the vicinity of the principal structures near Gull Rapids and the south dyke Map 6-54 and Map 6-55. Groundwater movement is expected to remain towards the surface-water network (*i.e.*, Nelson River, its tributaries, and adjacent lakes and streams). When the Project is operating with a baseloaded mode of operation, however, groundwater flows on the south side of Gull Lake (which currently move towards the Nelson River) are predicted to either decrease in velocity or flow away from the flooded zone depending on the water level in the Nelson River. These highly localized alterations to groundwater flow, however, do not occur on the north side of Gull Lake due to topographic differences between the two sides of the lake. On the north side, groundwater flows are expected to continue to be towards Gull Lake. These effects are considered moderate, medium in geographic extent, long-term and continuous.

Groundwater quality is not predicted to change with the Project.

Overall, the residual operation effects associated with groundwater are expected to be moderate in magnitude, medium in geographic extent, long-term and continuous.

While there is temporal overlap of operations with the Keeyask Transmission Project, and potential Conawapa Generation Project, the spatial separation is sufficient that no interaction with respect to groundwater effects is expected.

Monitoring of groundwater levels in the operation phase is not proposed.

6.3.10 Surface Water Temperature and Dissolved Oxygen

Water temperature is an important factor in maintaining healthy oxygen levels. Decay rates of submerged vegetation and peat increases with temperature. Temperature is also a factor in the potential stratification of a reservoir. At present, Gull Lake does not stratify. Shallow backbays created due to flooding and having organic material on the lake bottom may experience elevated water temperatures due to a lack of mixing with the main flow through the reservoir. The assessment considered existing environment water temperature monitoring data collected at sites upstream and downstream of the Project, including data from Stephens Lake, which is the reservoir upstream of the Kettle GS. Climate data used in the analysis, including wind data, was obtained from the Environment Canada Gillam Station. The assessment utilized models (PE SV, Section 9.0 to simulate conditions for different weekly periods for a range of inflows, temperature and wind speeds. These simulations were done for Year 1 and Year 5 of operation.

6.3.10.1 Construction Effects and Mitigation

There are no predicted effects on water temperature or dissolved oxygen during construction because of high levels of mixing upstream of the Project. During the latter part of Stage II river diversion, the upstream water level will approach the full supply level as the spillway rollways are constructed. This will cause initial flooding of approximately 45 km^2 (17.4 mi^2). The increased water levels will affect water temperature and dissolved oxygen. The results of modeling indicated that, because of good mixing along the mainstem, a large part of the reservoir including newly flooded areas, will have high dissolved oxygen and moderate temperatures, similar to the inflow into the reservoir.

The construction effects on dissolved oxygen and water temperature are considered small in magnitude, medium in geographic extent, short-term and continuous.

There is no adverse overlap with other future projects such as the Conawapa Generation Project because the Keeyask Project is not predicted to change the dissolved oxygen and water temperature of the flow discharged downstream relative to conditions without the Project. Dissolved oxygen and water temperature monitoring is not proposed during the construction period.

6.3.10.2 OPERATION EFFECTS AND MITIGATION

6.3.10.2.1 UPSTREAM OF THE PROJECT

Water temperatures in the majority of the reservoir including most of the flooded area are not predicted to be affected by the Project because the mainstem is well mixed and water flows relatively quickly through the mainstem of the reservoir. Stratification of the mainstem of the reservoir is not expected to occur. Stratification of water temperatures is expected to occur in poorly mixed shallow backbay areas for short durations on a regular basis during low wind periods based on measurements in Stephens Lake. Shallow backbay areas that are located further away from the main river flow area do not mix well with the mainstem and will have warmer temperatures approaching peak daytime air temperatures during hot summer days. These effects are considered moderate, medium in geographic extent, long-term and continuous.

Dissolved oxygen concentrations along the mainstem of the reservoir, including the major portion of the flooded area, will remain at or near saturation for all flow and weather conditions and all seasons, and will be greater than 6.5 mg/L.

For typical average summer conditions (*i.e.*, average flows and typical weather conditions having an average wind speed of about 15 km/h (9 mph)), dissolved oxygen in backbays is expected to be reduced by up to 1.5 mg/L relative to the inflow dissolved oxygen, but the dissolved oxygen concentrations are expected to remain above 6.5 mg/L throughout the reservoir.

During critical summer weather conditions (high humidity, high air temperatures, and low winds) the depth averaged dissolved oxygen concentrations in newly flooded backbay areas are expected to be less than 6.5 mg/L. Up to about 1 km^2 of the reservoir area will have a dissolved oxygen concentration of 2-4 mg/L, about 18 km^2 (7 mi^2)will have a concentration between 4-6.5 mg/L and 72 km^2 (27.8 mi^2) has a concentration greater than 6.5 mg/L. Stratification of the mainstem of the reservoir will not occur but stratification in poorly mixed, shallow backbays is expected to occur about 3% of the time during low wind periods. Dissolved oxygen concentrations at the bottom of backbay areas may be below 2 mg/L for short durations, which will affect an area of approximately 1 km^2(0.4 mi^2). Stratification and dissolved oxygen effects during critical summer periods with low wind will be of short duration (likely no more than about two to three days) because typical wind conditions are sufficient to mix the water column and replenish the dissolved oxygen.

Effects on dissolved oxygen concentrations during open water conditions will be greatest during the first year of operation and are expected to gradually improve over time. These effects are considered to be small in magnitude, medium in geographic extent, long-term and will occur occasionally.

In winter the water temperatures drop to less than 1°C (33.8 °F) during most of the season and an ice cover prevents surface reaeration. Dissolved oxygen concentrations will decrease to low levels in backbay areas that are poorly mixed with the mainstem flow, which has a high dissolved oxygen concentration. This also occurs in poorly mixed bays in the existing environment. Depending on the reservoir level, approximately 12-19 km^2 (4.6-7.3 mi^2) of the reservoir area may be completely frozen due to an ice cover of about 1 m thickness. In the remaining reservoir area, dissolved oxygen concentrations of less than 2 mg/L occur in about 5-6 km^2 (1.9-2.3mi^2) of the reservoir. Approximately 62-69 km^2 (24-26.6mi^2)of the reservoir area (about 66-74%), including a large portion of the flooded area, is expected to have higher dissolved oxygen concentrations that exceed 9.5 mg/L. Thermal stratification along and near the mainstem of the reservoir is not expected, but may occur in isolated backbays. These effects are considered large in magnitude, medium in geographic extent, long-term and continuous for winter periods.

6.3.10.2.2 DOWNSTREAM OF THE PROJECT

There is no predicted effect of the Project on water temperature being discharged into Stephens Lake during open water conditions. During the winter, the temperature of water exiting the Powerhouse will be approximately 0.02°C (32°F) and this water will cool back to 0°C (32°F) within 800 m (2,624 ft.) downstream of the Powerhouse. This effect is considered small, small in geographic extent, long-term and continuous. There will be no effect on downstream winter water temperature conditions in Stephens Lake.

There is no predicted effect on dissolved oxygen concentrations in the water being discharged downstream into Stephens Lake; concentrations will remain at or near saturation for all flow and weather conditions in all seasons. There will be no effect on dissolved oxygen in Stephens Lake itself.

Oxygen demands due to organic material in the water being discharged downstream from the reservoir should remain low in the mainstem and are not expected to change by more than 1 mg/L. This change will not exert any measurable oxygen demand downstream of the Project.

Monitoring downstream of Limestone GS and Kelsey GS at high flow (approximately 95th percentile) and spill in 2011 showed that total dissolved gas pressure ranged from 100% to 118% of saturation) with highest pressures within or near the spillway flow(Jansen and Cooley 2012). The design of the Keeyask spillway and tailrace channel reduces the potential to entrain dissolved gasses in the flow discharged downstream. Design features to mitigate the potential of high total dissolved gases include: shallow tailrace channel; the water is discharged toward the surface of the tailrace channel; the upward slope on the downstream end of the tailrace channel should aid in degassing the water by directing the flow towards the surface; and about 2 km downstream of the spillway the flow from the spillway is directed into the flow path of water discharged from the powerhouse, which facilitates mixing of these two flows. In addition to these design features, the operation of the spillway (*e.g.*, height of gate openings, number of gates operating) can be adjusted to further minimize the potential increase in total dissolved gas pressure downstream of the spillway.

Based on the observed conditions at the Limestone and Kelsey generating stations under high flow conditions and considering the design features at Keeyask that reduce the potential entrainment of total dissolved gases, it is anticipated that total dissolved gas pressure downstream of the Keeyask spillway would be within or less than the ranges observed at the Kelsey and Limestone generating stations.

Total dissolved gas pressure is expected to increase above existing environment for several kilometres downstream of the Keeyask GS. Increases in most locations are expected to be less than 110% of atmospheric pressure, although higher concentrations may occur temporarily in some areas during high spill events.

The increase in total dissolved gas pressure downstream of the Keeyask GS is considered to be small in magnitude, medium in geographic extent, long-term and intermittent as it mainly occurs when the spillway is in operation, which is expected to be about 12% of the time.

The effects of the Project on surface water temperature and dissolved oxygen do not overlap spatially with other future projects because the Project is not predicted to change the water temperature and dissolved oxygen of the flow discharged downstream relative to conditions without the Project.

Physical environment monitoring of surface water temperature, dissolved oxygen and total dissolved gas pressure is proposed during the operating period (Chapter 8).

6.3.11 DEBRIS

The Keeyask reservoir will initially flood about 45 km^2 (17.4mi^2) of land comprising of forest and peatlands (Map 6-47). During the construction period, the reservoir will be cleared of trees to avoid mobilization of timber and other woody material that could become debris in the post-impoundment phase. The Project partners have recognized that subsequent peatland disintegration and mineral erosion may result in debris issues (release of woody vegetation and organic material) that could impede the use and/or the aesthetic appreciation of the reservoir and the reaches downstream of the generating station, especially in the early years of operation. The Waterways Management Program has been developed to mitigate these concerns during the construction and operation phases. The Project Description (Chapter 4) provides a detailed description of the program.

Debris referred to in this section is woody vegetation and other organic material (*i.e.*, floating and suspended peat) that impedes the desired use or aesthetic appreciation of a waterway.

The Project will alter the existing natural hydraulic characteristics of the river and reservoir within the Project's open water hydraulic zone of influence, which will affect debris processes. This includes woody debris, as the soils supporting trees, shrubs, *etc.*, are eroded into the water, and peat material, as peatlands are eroded. Debris has the potential to create unappealing landscapes, reduce safety during river navigation, reduce the ability to harvest resources, negatively impact the shoreline environment, and increase operating costs.

Information obtained primarily from the existing Waterways Management Program in the Local Study Area was used to understand the current debris environment, as described in Section 6.2.3.2, and how it might change if the Project is constructed. Minor amounts of organic sediment and floating peat are generated in the current environment.

The amount of peat debris that may result during operation was quantified in the shoreline erosion processes study and the sedimentation study (PE SV, Sections 6 and 7). The amount of woody debris that might result without mitigation is not quantified because plans to manage and minimize the adverse effects of woody debris were developed early in the Keeyask planning process, including clearing the reservoir. Plans to manage and minimize woody debris are fundamental components of the Project design and are detailed in the Joint Keeyask Development Agreement (JKDA, Schedule 11-1, Appendix 4A).

6.3.11.1 Construction Effects and Mitigation

The Project is not expected to affect the generation or accumulation of debris upstream or downstream of Gull Rapids during construction until the reservoir is impounded at the end of Stage II of river diversion.

During Stage I diversion the increased water levels will remain within existing shorelines and will not introduce new debris. During Stage IIA diversion, water level increases during construction will inundate some lower lying shorelines. Areas within Gull Rapids that will be inundated will be cleared of trees according to the Reservoir Clearing Plan (Chapter 4, Project Description), thereby minimizing the potential to generate large woody debris during the construction phase. Almost all of the clearing will be accomplished using mechanical means to level and pile the vegetation, which subsequently will be burned. Because this clearing method strips off a large amount of the surface material (trees, brush, grasses, *etc.*), much of the loose and dead woody debris on the ground will also be removed. This will minimize the potential amount of small woody debris initially entering the reservoir when it is impounded. Some small woody material left over from clearing activities will be mobilized and will move downstream but is not expected to affect navigation or safety.

The pre-flooding phase of the Waterways Management Program will monitor and address this situation by removing debris as needed. The boat patrol crew performing waterway management work will also monitor waterway activities, liaise with individuals and groups using the river, and share information on safety issues. The effect of debris is expected to be small in magnitude and short-term during the construction period.

The reservoir will be impounded at the end of Stage II river diversion bringing the reservoir to the full supply level of 159 m (522 ft.). Impoundment will flood shoreline areas that have been cleared of vegetation under the Reservoir Clearing Plan.

Peatlands within the new reservoir area will be disturbed by construction and reservoir clearing activities, and this disturbed peat may mobilize to become floating organic debris as the reservoir is impounded. This mobilized peat will accumulate in back bays in the new reservoir and some peat will move downstream. Some small-sized remnants left over from clearing will also be mobilized. The quantity mobilized is expected to be small, and the influx of new small woody debris and vegetation will be gradual as water levels rise over time and additional areas are flooded. Debris that enters into the mainstem of the reservoir is not expected to substantially impact navigation or safety downstream, and the effect will likely be small in magnitude, medium in geographic extent and short-termin duration. Much of the small debris in flooded backbay areas that are well removed from the main channel is expected to remain largely within those areas because flow patterns will not move the material out of these bays. The material will likely accumulate on the shore or sink when water logged. In these areas, it is predicted not to substantially affect navigation, safety or operations. Along with removing large woody debris, it is expected that Waterways Management crews will opportunistically remove small woody debris as they currently do within the Local Study Area.

It is predicted that most peat mobilized during impoundment will remain within the reservoir, particularly within Gull Lake, and only a small amount will move downstream of the generating station into Stephens Lake. Most of the resurfaced peat will remain in the area in which it originates for a number of reasons such as subsequent sinking, hanging up along shorelines or grounding in shallow water.

Based on the monitoring and mitigation measures outlined in the Reservoir Clearing Plan and the Waterways Management Program (see Chapter 4), residual effects associated with debris are expected to be small in magnitude, medium in geographic extent, continuous and short-term during construction. Monitoring of debris removal activity and its characterization will occur through the Waterways Management Program (Chapter 8).

No spatial overlap of debris effects is expected with other foreseeable projects during construction (Chapter 7).

6.3.11.2 OPERATION EFFECTS AND MITIGATION

The pre-flooding Reservoir Clearing Plan specifies the removal of trees of 0.15m (0.5 ft.) diameter or larger and/or 1.5 m (4.9 ft.) or more in length (see Chapter 4). It is expected that smaller woody debris will be mobilized in the reservoir due to impoundment, mineral shoreline erosion and peatland disintegration. Compared with large woody debris, the small woody debris is not persistent in the waterway because it easily breaks down and becomes waterlogged and sinks more readily. Smaller woody debris that remains floating and mobile is expected to collect as rafted and beached debris in back bay areas, particularly in bays along the south side of the reservoir, since prevailing wind would tend to move the material to these areas over time in the same manner as floating peat. Debris that accumulates in backbay areas is not anticipated to impact upon navigation or resource use on the reservoir as it will be out of the way from safe travel routes and landing sites. Boat patrols operating under the Waterways Management Program during the operating period will remove large woody debris as required, and it is expected that crews would opportunistically remove small woody debris as they currently do. Rafted debris that accumulates and impacts navigation routes and safe landing sites for boats will be managed and removed under the post-flooding Waterways Management Program. According to the post-flooding Reservoir Clearing Plan shorelines at risk of erosion after flooding will be cleared on an ongoing basis to prevent the creation of new large woody debris. Residual effects are considered small, medium in extent, long-term and continuous.

The rate of peatland disintegration is predicted to be greatest in the early years of operation (Years 1-5) and it is expected to gradually decline over time as shorelines stabilize. Because the breakdown material is generally small, it is not expected to have an appreciable impact in the waterway.

Mobile peat is attributed to resurfaced peat mats and mats due to shoreline peatland breakdown. While peat resurfacing is not anticipated to occur beyond Year 10 following impoundment, some of this peat will remain mobile. By this time, the majority of peat mats generated by shoreline peatland breakdown are immobile because they are generated in very shallow water. No mobile peat is expected beyond Year 15. The majority of potentially mobile peat is expected to sink or become beached near where it originates. Much of the mobilized peat that does move into the reservoir is expected to accumulate in bays along the southern shore of the reservoir because prevailing winds will tend to move the peat in that direction.

Some woody and peat debris generated in the reservoir is expected to move downstream into Stephens Lake; however, this will only occur when the Keeyask spillway is operational, which is expected to be infrequent based on historic flow records. The amount of peat likely to be transported downstream into Stephens Lake is predicted to be small, and the Reservoir Clearing Plan and the Waterways Management Program will serve to limit and remove hazardous debris that could otherwise move downstream of the Project. It is anticipated that neither woody nor peat debris from the upstream hydraulic zone of influence will have a measurable effect on downstream debris conditions during the operating period. The effects are therefore considered to be small, medium in gegraohic extent, long-term and continuous.

Immediately downstream of the Keeyask Generating Station, the amount of shoreline erosion and associated generation of new woody debris is predicted to decrease substantially once the Project is constructed. Debris is currently generated immediately downstream of Gull Rapids due to the hanging ice dam that forms each winter, which can cause substantial erosion of shorelines, causing woody debris to fall in the water. The hanging ice dam will no longer form with the Project in place, which will reduce this source of debris.

Due to changes in the ice regime upstream of the Project, it is expected that physical ice scouring of the shoreline likely will not occur along much of the reservoir shorelines, thus removing this potential source of debris in the Project environment. After mitigation, the effects are considered to be moderate in magnitude, medium in geographic extent and continuous in frequency.

Mitigation measures outlined in the Reservoir Clearing Plan and the Waterways Management Program, residual effects associated with debris are expected to be moderate in magnitude, short-term and reducing during operation.

No substantive overlap of debris effects is expected with other foreseeable projects during operation.

Monitoring of debris removal activity and its characterization will occur through the Waterways Management Program.

6.3.12 SENSITIVITY OF PROJECT EFFECTS TO CLIMATE CHANGE

This section presents on overview of the sensitivity of the physical environment assessments to predictions of future climate change described below in Section 6.3.12.1. The CEAA document, "General Guidance for Practitioners: Incorporating Climate Change in Environmental Assessments" (2003), proposes that the future climate conditions be reviewed to determine if there is a risk to the public or the environment *in situ*ations where the Project is the major factor related to the risk. The physical environment assessments and the conclusions on residual effects described earlier in this section were reviewed to determine if these conclusions would change as a result of climate change effects.

The examination of the sensitivity to climate change focused on the operation phase as the construction period will take place in the near term and climate change is a longer-term phenomenon.

As discussed in the previous physical environment sections, the effects of the Project on the physical environment are largely driven by the changes to the surface water and ice regimes resulting from this Project. Therefore, the approach to the sensitivity considerations began by reviewing the sensitivity of the future surface water and ice regimes to changes in climate. The examination of the other components of the physical environment built on this understanding.

6.3.12.1 FUTURE CLIMATE CHANGE SCENARIOS

Global Climate Models (GCMs) and Regional Climate Models (RCMs) were used to project future climate change considering a range of future greenhouse gas emission scenarios. A number of plausible future climates termed "climate scenarios" were developed for the Project study area following the guidance of the International Panel on Climate Change's Task Group on Data and Scenario Support for Impact and Climate Assessment "General Guidelines on the Use of Scenario Data for Climate Impact Adaptation Assessment" (Carter 2007).

The future climate scenarios in this report are based on an ensemble of GCMs and one RCM. These are described in more detail in PE SV (Section 2.0). In total, the ensemble of GCMs consisted of 139 climate scenarios as projected by 24 GCMs and up to three different emission scenarios ranging from low to high carbon dioxide emissions. The Canadian Regional Climate Model version 4.2.3 (CRCM) uses a higher resolution model for a limited area to better represent the characteristics that control regional climate. It was driven at its boundaries by three different GCMs using two emission scenarios. However, at this time only one RCM is available for this region. In this assessment, all climate scenarios were treated as equally plausible. The range of projected future climate scenarios includes uncertainties in both GCMs and emission scenarios.

The ensemble of climate scenarios were developed for three future time periods; the 2020s (average of 2010-2039), the 2050s (2040-2069), and the 2080s (2070-2099). The average annual temperature in the region is projected to increase with time: 1.5°C (2.7°F) for the 2020s, 2.8°C (5.0°F) for the 2050s and 4.1°C (7.4°F) for the 2080s. Climate scenarios also project an increase in average precipitation. Average annual precipitation is projected to increase by 5% for the 2020s, 10% for the 2050s and 14% for the 2080s. Seasonal projections of future climate showed that both temperature and precipitation will generally increase with time for all seasons. However, some scenarios project a decrease in temperature and/or precipitation in certain months. Furthermore, of the four seasons, winter is projected to experience the greatest increase in mean temperature and total precipitation change. Generally, the CRCM projections of temperature and precipitation fall within the same range as those from the ensemble of GCMs.

The RCM was also used to assess future changes in rates of evapotranspiration. On average, total annual evapotranspiration is projected to increase into the 2020s, 2050s and 2080s. May is projected to have the greatest increase in evapotranspiration while winter months are projected to have minimal change. It is important to note that the projections are from only one RCM and two emission scenarios. The full range of uncertainty from the climate modeling is not captured in the projections for evapotranspiration.

The occurrence of extreme events is difficult to analyze due to the absence of globally distributed, long-term records with sufficient detail. According to the (IPCC) "…the type, frequency and intensity of extreme events are expected to change as Earth's climate changes, and these changes could occur even with relatively small mean climatic changes…a number of modelling studies have also projected a general tendency for more intense but fewer storms outside the tropics, with a tendency towards more extreme wind events…" (Meehl *et al.* 2007).

6.3.12.2 LOCAL AIR QUALITY / NOISE

The effects of the Project on air quality and noise relate mainly to the construction phase. The changes in climate in the relatively near future are not expected to change the effects assessment on air quality and noise in the Local Study Area. The larger open-ice intervals in future winter conditions could result in somewhat greater production of ice fog in the Project area.

6.3.12.3 PHYSIOGRAPHY

There may be changes in the future regional physiography due to climate change (see TE SV), especially with respect to permafrost, but these changes will not be caused by the Project.

6.3.12.4 SURFACE WATER AND ICE REGIME

The approach to judging the sensitivity of the water and ice regime conclusions to climate change considered the following steps:

1. Consider the regional climate change scenarios for the future;
2. Assess how local precipitation and temperature changes might affect water and ice regimes; and
3. Consider changes to water and ice regimes resulting from increased and decreased Nelson River flows.

Higher precipitation usually results in higher runoff and stream flows. Higher local precipitation can increase the flow in the local streams. On a local basis, these effects may somewhat offset the projected higher evapotranspiration rates. The inflows from smaller creeks draining into the Nelson River in the Local Study Area are a very small part of the Nelson River flows (about 3%), given that the Nelson River watershed extends into Alberta, Saskatchewan, Manitoba, Ontario, Minnesota and North Dakota.

Manitoba Hydro is currently conducting a detailed analysis of the overall effect of climate change on the Nelson River flows. Quantitative information is not expected for several years. Since detailed information is not yet available, a precautionary approach was used to test the sensitivity of the effects assessment to potential climate change impacts on Nelson

River flows. This involved consideration of a variability of ±10% across all flow percentiles for the Nelson River post-Project inflows.

The conclusions of residual effects of the Project on the surface water and ice regimes are relatively unaffected by potential climate changes as described in the following observations:

- Upstream water regime:
  - Increased river flows are not expected to change effects of the Project on Split Lake as the open water hydraulic zone of influence remains downstream of the lake;
  - Decreased river flows could result in an increased frequency of very low river flows in winter, which would cause small (about 0.2 m) (0.7 ft.) increases in winter water levels in Split Lake above those which occur without the Project due to the change in the ice processes in the reach after the Project is built(see Section 6.3.6);
  - The reservoir operating range of 158 -159 m (518-521 ft.) is not predicted to change with either an increase or decrease in Nelson River flows. Higher flows would result in a higher frequency of water levels in the upper part of this operating range and reduced daily fluctuations within the operating range, whereas lower river flows could result in more frequent fluctuation within the 1 m operating range;
  - The flooded area of the reservoir is predicted to be slightly larger if high flow events were to increase; conversely, if low flows were to become more prevalent, then the reservoir area is expected to be slightly smaller during these low flow events;
  - There would likely be only minimal changes to backwater effects on local streams from the reservoir either for increased or decreased Nelson River flows. The extent of the hydraulic zone of influence in the creeks would be relatively unaffected by changes in creek flows; and
  - There would likely be only minimal changes to the river velocity patterns with either an increased or decreased river flow scenario.
- Downstream water regime:
  - Use of the spillway could increase from about 11% to 18% of the time with a 10% increase in river flow, resulting in more frequent wetting of the area downstream of the spillway; and
  - Conversely, decreased river flows could result in spillway use decreasing from about 11% to 5% of the time and an associated reduction in the frequency of wetting of the area downstream of the spillway.
- Ice regime:
  - Warmer temperatures are predicted to result in later formation of an ice cover, potentially delaying it several weeks by the 2080s. A similar result could be expected in regard to ice breakup, which could occur up to several weeks earlier, and by the

2050s, the winter ice period may be shorter by two to four weeks and, by the 2080s, by about four weeks;

- The ice that does develop will likely be somewhat thinner and the location of pressure ridges may change;
- Increased snowfall could also result in an increase of slush ice on top of the ice cover; and
- These effects are capable of being mitigated with the use of the safe trails program under the post-flooding Waterways Management Program.

In summary, the residual effects assessment of the surface water and ice regime is not particularly sensitive to likely future changes in climate. This is largely due to the fact the reservoir operating range of 158-159 m (518-521 ft.) remains unchanged, regardless of the Nelson River flows and thus the effects of the Project on the water and ice regimes are relatively unaffected by climate change.

The implications of these potential variations on the water and ice regime as a result of climate change were used to discuss potential associated changes in the residual effects assessments in the other physical environment topics.

6.3.12.5 SHORELINE EROSION PROCESSES

Most of the mineral bank erosion and effects on peatlands are expected to occur early in the operating phase (*i.e.*, Years 1 to 5) of the Project when climate conditions are still similar to the assumed conditions at the start of the Project. This observation, coupled with the fact that the operating range of the reservoir will not change, means that the conclusions regarding the residual effects of shoreline erosion are not substantially affected by climate change.

Some observations with respect to peatland disintegration and mineral erosion include the following:

- Resurfaced peat:
  - There will be little incremental response in this process due to climate change because changes in climate are small in the first few years of operation when most of the resurfacing occurs.
- Shoreline peat breakdown:
  - Small changes in climate at the start of the operating period are not expected to substantively change the predictions for the first five years of operation when the largest effects of peat shoreline breakdown occur.

  - Changes in climate could increase the rates of breakdown of shoreline peat (rates would be relatively low compared with the first few years of operation) and reservoir expansion could increase somewhat.
  - The overall conclusions with respect to the residual effects of shoreline peat disintegration do not change substantially as a result of climate change.
- Floating peat:
  - There could be a slight increase in the number of mobile peat mats if warmer climate conditions increase peat mat buoyancy, but the Waterways Management Program will mitigate such effects.
- Organic sediment:
  - The largest organic sediment loads are predicted to occur within the first five years of operation when climate change is small and loading is not expected to substantively change;
  - Additional peatland breakdown beyond year five of operation could result in predicted organic sediment entering the reservoir sooner;
  - Additional expansion would occur primarily in inland areas in backbays where the peat would not be mobile; and
  - Organic sediment due to potential additional expansion in backbay areas would have negligible effects on the reservoir.
- Mineral shoreline erosion:
  - The range of conditions assumed for mineral erosion studies covers the potential $\pm$10% change in flow and the assessed residual effects of the Project are not changed;
  - Higher flows and more frequent water levels in the upper part of the operating range would result in higher shoreline recession rates closer to the upper end of the predicted range(*i.e.*, predicted effects with base loaded operation) but the overall extent of recession is not expected to change;
  - Additional peatland breakdown in later years could result in mineral shorelines developing sooner in affected locations. Long-term, stable mineral shoreline recession rates could be established sooner at these locations;
  - Higher wave energy caused by increased severity of storms due to climate change would result in higher wave energy during storm events that may occur less frequently. These changes are expected to be most pronounced after long term erosion rates have been established and are not expected to affect long term rates. In localized areas increased storm activity may result in long term rates being established sooner; and

- Increased severity of storms due to climate change would result in higher wave energy during storm events, but a lower storm frequency would reduce the potential effect of this change. These changes are expected to be most pronounced after long term erosion rates have been established and are not expected to affect long-term rates. In localized areas instead storm activity may result in long term rates being established sooner.

- Ice conditions:
  - Longer ice-free conditions could result in more wave-based erosion of mineral shorelines in the reservoir;
  - This potential influence is lowest in the early years of Project operation when erosion rates are highest and changes in climate are smaller;
  - Erosion rates stabilize over time and climate changes are not expected to substantially affect long-term erosion rates; and
  - Climate change would not be expected to affect erosion rates in the riverine reach upstream of Birthday Rapids owing to the largely bedrock-controlled shorelines in this reach.

Overall, the assessment of residual effects of the Project on mineral shoreline erosion and peatland disintegration are not predicted to change as a result of climate change.

6.3.12.6 SEDIMENTATION

Climate change is not expected to substantially change the residual effects assessment for the Project with respect to shoreline erosion and peatland disintegration, primarily because most of these effects occur in the first few years of operation when changes in climate are smaller. Accordingly, this conclusion applies also to sedimentation. Organic suspended sediment concentrations in the first five years of operation would not substantively change. Although peat shoreline breakdown may be larger than predicted after year five of operation, the overall average concentrations of organic suspended sediment are expected to remain very low within the main reservoir area, as predicted without climate change. Areas of potential additional inland expansion could have increased organic suspended sediment concentrations in those areas where breakdown may occur. Long term sedimentation rates could be established sooner if lower, stable, long term mineral shoreline recession rates occur sooner. The creeks do not contribute substantially to the total sediment load in the river, so changes in local runoff due to climate change are not expected to affect turbidity in the reservoir. Overall, the assessment of residual effects for sedimentation and changes to lake/river substrates is not predicted to change as a result of climate change.

The post-Project substrate characterization is not likely to change materially.

6.3.12.7 GROUNDWATER

Increased temperature and/or increased precipitation may result in some melting of permafrost in the area. This could increase recharge rates to the water table and widen the affected groundwater area but probably no more than about 2%.

Overall, the conclusions on residual effects of the Project on groundwater are not predicted to change substantially with additional effects from climate change.

6.3.12.8 DISSOLVED OXYGEN AND WATER TEMPERATURE

The temperature of the water entering the reservoir from upstream could increase due to climate change with or without the Project. Water temperatures along the mainstem are not affected by the Project and this conclusion would apply even with climate change. Water temperatures in the back bays are predicted to be higher than in the mainstem and this differential would continue to occur with climate change as warmer climate conditions increase backbay water temperatures.

Dissolved oxygen along the mainstem is not affected by the Project and this conclusion would apply even with climate change. Increasing temperatures in back bay areas and areas of potential additional expansion could cause dissolved oxygen to decrease further over larger areas during infrequent periods of low wind speeds.

Later ice formation and an earlier thaw due to climate change would correspondingly cause a delay in the winter dissolved oxygen decline and earlier dissolved oxygen recovery in spring. While the duration of low dissolved oxygen conditions in winter would decrease along with the shorter period of ice cover, the extent and severity of low dissolved oxygen concentrations would not change since a relatively stable low dissolved oxygen condition would still develop each winter.

Overall, the residual effects conclusions with respect to dissolved oxygen and water temperature are not predicted to change materially due to climate change.

6.3.12.9 DEBRIS

There will be minimal woody debris caused by the Project due to the clearing of the reservoir in advance of impoundment. Peat is expected to be mobilized into the reservoir, particularly in the early stages of operation. Potential additional expansion of the reservoir could require additional removal of woody vegetation from shorelines. This possibility is considered in the comprehensive Waterways Management Program to manage debris in the operation phase. Climate change does not affect the conclusions regarding debris as effects are mitigated through the Waterways Management Program during the operation phase.

6.3.12.10 SUMMARY/CONCLUSIONS

A review of the conclusions of the Project's residual effects on the physical environment indicates that the assessment is not sensitive to climate change. The robustness of the conclusions is largely due to two factors. First, the water regime within the open water hydraulic zone of influence and the reservoir operating range are not substantially changed when considering climate changes and resulting potential river flows. Second, the largest effects of the Project on the physical environment occur early in the operating period when climate changes are smaller. Overall, the conclusions on the residual effects of the Project are not predicted to be substantially affected as a result of predicted changes in future climate conditions.

6.4 EFFECTS AND MITIGATION AQUATIC ENVIRONMENT

6.4.1 INTRODUCTION AND APPROACH

This section focuses on effects of the Project on the aquatic environment components, mitigation measures (that are technically and economically feasible) to address those effects, residual effects that remain after mitigation, and the regulatory significance of the residual effects on VECs. This section will also assess the sensitivity of these effects to possible climate change scenarios.

The assessment of Project effects was based on the existing environment, as described in the preceding Section 6.2.3, including the predicted future environmental conditions and trends if the Project were not to proceed. This existing environment incorporates effects of past projects, most notably past and current projects identified for the cumulative effects assessment. This section will also note where there are overlaps or interactions between effects of the Project with potential future projects.

Effects of the Project are described for the Aquatic Environment Regional Study Area, which includes the mainstem of the Nelson River from downstream of the Kelsey GS to the Kettle GS, as well as immediately adjacent waters (Map 6-18). The assessment of effects to water quality extends downstream to the Nelson River estuary (Map 6-19).

As discussed in Chapter 5, this environmental assessment was based on both ATK and technical scientific analysis. An evaluation based on the Cree worldview is provided in Chapter 2, and evaluations that are more detailed are provided in the CNP Keeyask Environmental Evaluation Report, YFFN Evaluation Report (*Kipekiskwaywinan*) and FLCN Environment Evaluation Report (Draft). Detailed results for the technical component of the environmental assessment are provided in the Aquatic Environment Supporting Volume (AE SV). This section summarizes the results of the ATK and technical assessments, including a description of potential effects, mitigation measures designed to address these effects, and the residual effects expected after consideration of the mitigation measures. Given the difference in approach of the Cree worldview and technical science, the assessment of the nature of the residual effects differed for some components; these differences are discussed in Section 6.4.1.0.

The technical analysis assessed effects of the Project on the aquatic environment by considering the linkages between the aquatic environment and changes caused by the Project, both directly (*e.g.*, presence of the dam, alterations in water levels and flows) and indirectly (*e.g.*, changes to water quality have subsequent effects on aquatic biota). Changes to function within the ecosystem (*e.g.*, changes in the frequency and magnitude of water level variation, a disturbance present in both natural and regulated systems) were also considered. The main pathways by which the construction and operation of the Project will affect the aquatic environment are described in detail in AE SV Section 1.4.

Several approaches were used in the technical assessment. Generally, potential effects were identified based on scientific knowledge of causal relationships (*e.g.*, effect of low dissolved oxygen [DO] on fish). The magnitude and the spatial and temporal extent of effects were determined through several methods, including: use of Stephens Lake, a reservoir environment similar to the Keeyask reservoir, as a proxy; comparison to empirical data from other reservoirs (*e.g.*, Limestone and Long Spruce reservoirs in Manitoba, the Robert-Bourassa reservoir in Québec, and the lower Churchill River reservoir in Newfoundland and Labrador); and, where applicable, empirical models developed on the basis of observed relationships in the study area and elsewhere. Further details on the assessment methodology can be found in the AE SV Section 1.2 and other specific sections related to each of the aquatic environment components in the AE SV.

The assessment considered all the components of the aquatic ecosystem described in Section 6.2.3.3. However, as described in Chapter 5, the assessment was focussed on the VECs. The aquatic VECs are as follows: water quality; walleye; northern pike; lake whitefish; and lake sturgeon. Rationale for the VEC selection was previously discussed in Section 6.2.3.3.

The following description of effects addresses potential changes to the aquatic environment in Split, Clark and Stephens lakes, and the reach of the Nelson River that will become the reservoir. Changes to smaller waterbodies that do not affect these larger areas are addressed in the AE SV, but not in this volume (*e.g.*, streams crossed by the north and south access roads, small streams entering the Nelson River that will be flooded). In addition, potential effects to fish populations and mitigation measures related to shifts in resource use as a result of the AEAs (Section 4.8) are assessed in Section 6.7.3.1 and not considered in this section. The assessment presented in this volume focuses on major pathways of effects; information on pathways of effects that would have relatively little potential impact is presented in the AE SV.

The KCNs have stated that they expect changes to water levels and flows, with related changes to water quality and other components of the aquatic environment, to extend upstream into Split and Clark lakes. Technical analysis does not predict such changes (Section 6.3.6). The analysis of effects to Split and Clark lakes presented in this section is restricted to potential effects related to the movement of fish from the newly formed reservoir to upstream lakes; uncertainty between the predicted effects based on ATK and technical analysis is addressed through post-Project monitoring (Chapter 8).

6.4.2 ABORIGINAL TRADITIONAL KNOWLEDGE

As part of their historical connection to *Askiy* (Mother Earth), the KCNs have acquired ATK from life experiences and their relationship with the land, water and all living things. They have explained their holistic worldview in Chapter 2 and in more detail in the CNP Keeyask Environmental Evaluation Report, YFFN Evaluation Report (*Kipekiskwaywinan*) and FLCN Environment Evaluation Report (Draft). ATK in this section of the EIS should be understood from the perspective of the Cree worldview. This worldview and knowledge guided the KCNs in their participation in planning the Project with Manitoba Hydro and in providing guidance to the environmental assessment. Many community Members expressed doubt that the effects of past projects were fully understood or accurately predicted and hold similar reservations regarding the current Project.

Some of the ATK observations with respect to the aquatic environment include the following:

- When Keeyask is built, water will be much higher on Split Lake (CNP, YFFN and FLCN 2011; SE SV), which will affect water quality, fish quality and fish abundance near York Landing (YFFN Evaluation Report (*Kipekiskwaywinan*)).
- Water velocity changes, shoreline erosion, the release of peat and sediment, and decaying organic matter that results from flooding will affect water quality (FLCN Environment Evaluation Report (Draft)).
- Shorelines are expected to be subject to more erosion, which will contribute to increases in sediment in Gull and Stephens lakes (FLCN 2010 Draft; FLCN Environment Evaluation Report (Draft)). Sediment in the water is believed to negatively affect fish eggs (FLCN 2010 Draft) and fishing success (CNP Keeyask Environmental Evaluation Report). Erosion monitoring in Stephens Lake is recommended on an ongoing basis (FLCN 2010 Draft).
- The Keeyask dam is expected to negatively affect fish populations by blocking fish movements (CNP Keeyask Environmental Evaluation Report) and causing spillway and turbine mortality (FLCN 2008 Draft; FLCN 2010 Draft; FLCN Environment Evaluation Report (Draft)). Potential mitigation strategies identified during community review meetings in 2009 include incorporating a fish ladder onto future project designs similar in concept and function to those implemented in Washington State (FLCN 2010 Draft).
- Drying of the south channel downstream of the Keeyask GS when the spillway is not in operation is expected to contribute to fish mortality (FLCN 2008 Draft).
- Lake sturgeon populations have decreased downstream of hydroelectric generating stations post-impoundment, and FLCN community Members are concerned that the viability of lake sturgeon populations will be threatened by construction of the Keeyask

GS (FLCN 2010 Draft). If the Keeyask GS is built, FLCN Members expect that there will be no viable lake sturgeon populations left without significant re-stocking efforts. While restocking programs are necessary, FLCN Members are apprehensive of their long-term success (FLCN 2010 Draft). FLCN Elders have communicated that they do not prefer the currently proposed methods for harvesting lake sturgeon eggs, and they believe that if larger lake sturgeon are released, the fish will be more likely to survive (FLCN 2010 Draft).

- Increases in mercury in fish, particularly walleye and northern pike, will affect fish quality and consumption (FLCN 2010 Draft; CNP Keeyask Environmental Evaluation Report; FLCN Environment Evaluation Report (Draft)) and the palatability of fish will continue to decline (FLCN 2010 Draft; YFFN Evaluation Report [*Kipekiskwaywinan*]).

Because ATK has perspectives that differ and doubt some of the results of technical science, an emphasis has been placed on monitoring and adaptive management. These topics are covered in Chapter 8.

6.4.3 AQUATIC ECOSYSTEMS AND HABITAT

6.4.3.1 WATER QUALITY

Water quality is an aquatic VEC. A detailed description of the assessment methods and results for water quality, including results of mass balance models, descriptions of monitoring results from other impounded systems to assist in predicting effects, *etc.*, is provided in AE SV Section 2.5. The general approach used to characterize the effects of the Project on water quality was based on: (i) comparison of predicted changes in water quality to Manitoba Water Quality Standards, Objectives and Guidelines (MWQSOGs; MWS 2011a) and the CCME guidelines for the Protection of Aquatic Life (PAL; CCME 1999; updated to 2012), (*i.e.*, is the Project expected to cause an exceedance of a water quality guideline) ; and (ii) comparison to existing water quality conditions. The magnitude of effects were defined relative to (i) the MWQSOGs and (ii) considering whether changes are expected to be detectable.

6.4.3.1.1 CONSTRUCTION EFFECTS AND MITIGATION

Through the following pathways, the Project has the potential to affect water quality during construction:

- Construction of instream structures, including placement and removal of cofferdams and excavated materials placement areas and diversion of flows through new channels;
- Diversion and impoundment during river management resulting in water flow/level changes and increased erosion of shorelines;

- Point and non-point sources from the sewage treatment plant, processing of aggregate materials and concrete, dewatering of cofferdams, and site runoff;
- Blasting;
- Leachate from stockpiles and structures containing rock exposed to surface waters/drainage (*e.g.*, dam); and
- Accidental spills/releases.

The effects to water quality related to impoundment and flooding, which begin during the construction phase, continue during the operation phase and are discussed in Section 6.4.3.1.2.

As described in Section 6.3.8.1, installation and removal of cofferdams, together with other activities, will generally result in an increase in total suspended solids (TSS) of less than 5 milligrams per litre (mg/L) (*i.e.*, within the Manitoba objectives). Larger increases are expected to be of moderate magnitude and short duration, with peaks of up to 15 mg/L for one day or up to 8 mg/L for one month. Increased TSS concentrations may be detectable in the river immediately below the construction site, but will diminish by approximately 30% through Stephens Lake. During periods of instream construction lasting one to three months (depending on year) the predicted increase in suspended sediment at Kettle GS is less than 5 mg/L (typically less than 3 mg/L), but may be somewhat higher for a few days when the river is closed off. Increases of similar or lesser magnitude would be seen downstream of the Kettle GS. These increases are not expected to result in detectable effects to aquatic biota, as the majority are within the Manitoba objective for suspended sediment (*i.e.*, an increase of less than 5 mg/L for a one day averaging duration) and TSS increases of greater than 5 mg/L would only be for one or a few days.

There are several point and non-point source inputs that will enter the Nelson River including effluent from the sewage treatment plant, concrete batch plant, dewatering of cofferdams and excavations, and site runoff. A detailed assessment of changes to the receiving environment is provided in the AE SV. However, because effluent will meet or exceed provincial standards for discharging into receiving waters (Environmental Protection Plan [EnvPP]) and be rapidly diluted, no marked effect to water quality beyond the immediate receiving environment is expected.

Blasting has the potential to affect water quality when residues from ammonium nitrate fuel oil enter the water and increase ammonia and/or nitrate levels. In accordance with Fisheries and Oceans Canada blasting guidelines (Wright and Hopky 1998), ammonium nitrate fuel oils will not be used where water will contact the blast area; instead, dynamite will be used (EnvPP).

Rock that contains sulphides has the potential to generate acidic leachate when exposed to atmospheric oxygen and water. The risk of acidic leachate generation is low at Keeyask (PE

SV Section 5.4.1.1); therefore, no effect to water quality beyond the immediate receiving environment is expected.

The risk of the contamination of surface water due to accidental spills and/or releases of hydrocarbons and other contaminants is low due to the implementation of safe storage and handling of hazardous materials, and development of spill response plans as described in the EnvPP (Chapter 8).

RESIDUAL EFFECTS OF CONSTRUCTION

In summary, the following mitigation measures will be implemented to address construction effects on water quality:

- Measures to reduce TSS inputs as described in the EnvPP (Chapter 8);
- Treatment of effluents and implementation of management practices to mitigate non-point sources (EnvPP);
- Adherence to Fisheries and Oceans Canada blasting guidelines with respect to the use of ammonium nitrate fuel oils; and
- Procedures for the safe storage and handling of hazardous materials, and a spill response plan (EnvPP, Chapter 8).

A detailed description of expected residual effects to water quality is provided in AE SV Section 2.5. The following are the residual effects on water quality once the appropriate mitigation measures are applied:

- Increased concentrations of TSS during instream construction, with the largest increases occurring immediately downstream of construction; and
- Increased concentrations of substances in effluents in the immediate receiving environment.

Using the criteria established to determine the significance of Project effects for regulatory purposes (described in Section 5.5), the residual effects of Project construction on water quality are expected to be adverse, short-term, and of moderate magnitude over a medium spatial extent and small magnitude over a large spatial extent. Effects are intermittent, based on the specific construction activity, and reversible at the end of construction activities.

6.4.3.1.2 OPERATION EFFECTS AND MITIGATION

Through the following pathways, the Project has the potential to affect water quality during operation:

- Changes in the water regime - changes in water levels, flows, velocities, depths, and residence times may affect mixing, reaeration, accumulation, cycling or losses of substances from the reservoir, and thermal regimes;

- Changes in the ice regime - changes in the spatial extent of open water areas and/or timing of freeze-up and break-up may affect reaeration (and therefore DO concentrations) and light availability;
- Flooding of terrestrial habitat - decomposition of flooded organic materials may affect DO, pH, nutrients (phosphorus and nitrogen), organic carbon (OC,) colour, and metals; and
- Erosion and sediment transport/deposition - hydroelectric development often increases shoreline erosion, thereby affecting TSS and water clarity, but may also lead to increased sediment deposition associated with reductions in water velocities.

Changes in water quality upstream of the GS may also affect water quality downstream. The key water quality variables commonly altered by hydroelectric developments are nutrients (including phosphorus and nitrogen), DO, pH, and TSS/turbidity/water clarity. Other parameters such as metals (including mercury), conductivity/TDS, OC and colour may be altered.

WITHIN THE KEEYASK RESERVOIR

Effects of Project operation on water quality are expected to vary spatially in relation to water depth, mixing/water residence times, and velocities. Water quality effects are described in the following sections based on the distinctions between nearshore, flooded bays (lentic environments) and the deeper, lotic areas of the reservoir. Distinctions are also made on the basis of depth; "shallow" refers to depths of 0–3 m (9.8 feet), and "deep" refers to depths greater than 3 m. Lotic areas (*i.e.*, areas where water currents are apparent), which are composed largely of deep habitat, within the lacustrine portion of the reservoir are also referred to as "mainstem." Water quality parameters discussed below include DO, pH, TSS/turbidity, nutrients (nitrogen and phosphorus), and metals.

Dissolved oxygen – Detailed results of modeling of effects of the Project on DO in water are presented in Section 6.3.10.2. Flooding and peatland disintegration are expected to cause decreases in DO concentrations in the nearshore, lentic areas (*e.g.*, flooded bays) of the reservoir with poor mixing and long residence times in the open water and ice-cover seasons. The duration of effects is expected to be 10–15 years, but in highly isolated nearshore areas where organic substrates persist and/or where floating peat islands are present, it may be longer (*i.e.*, greater than 30 years). In addition, temporary decreases in DO may occur over the long-term in association with fall die-off of aquatic plant beds and/or periodic phytoplankton bloom events.

The majority of the reservoir is expected to remain well-oxygenated year-round due to high volumes/flows and short water residence times. Localized depletion of oxygen may occur in areas with substantive accumulations of peat islands, particularly if they occur in shallow, flooded areas. During low wind events, which are expected to be infrequent, short-term decreases in DO in localized nearshore areas may result in DO concentrations below the instantaneous minimum Manitoba PAL water quality objectives and the CCME PAL guideline. Greater effects to DO will occur in winter. In winter, the most stringent Manitoba PAL water quality objectives and the CCME PAL guideline will be met in 66–74% of the reservoir area, depending on mode of operation. Anoxic and hypoxic conditions are expected to develop in nearshore, lentic areas over flooded terrestrial habitat that have limited mixing with the mainstem in the ice-cover season. As the ice-cover season is long, these low DO conditions will occur for a number of months.

pH – Effects of Project operation on pH are anticipated within nearshore areas of the reservoir, notably shallow, lentic areas, that have long residence times, low mixing, and are located over flooded terrestrial habitat, due to decomposition of flooded organic materials. The pH is expected to decrease in these areas during the initial years following flooding, but is anticipated to remain within Manitoba and CCME PAL water quality guidelines in most or all areas of the reservoir. No effects to pH in the mainstem of the reservoir are expected.

The duration of effects on pH are expected to be similar to those predicted for DO (*e.g.*, 10–15 years). A reduced pH was observed in the north arm of Stephens Lake in the initial years following flooding, although it increased to levels similar to the mainstem of the Nelson River within 15 years post-impoundment. Slightly lower pH continues to persist in isolated backbays in the north arm of the lake in areas with poor mixing, local drainage inflows, and organic substrates, and this may also occur in similar areas of the Keeyask reservoir in the long-term. Monitoring in other boreal reservoirs has indicated that water quality conditions, including pH, typically return to pre-flood conditions within approximately 10–15 years (Hayeur 2001).

TSS and turbidity – TSS and turbidity in the reservoir will be affected by erosion of mineral or organic shoreline materials and resurfacing of flooded peat in combination with changes in the hydraulic regime that affect sediment transport and deposition during Project operation. Predicted changes in TSS during operation were generated separately for mineral erosion (*i.e.*, “inorganic TSS”) and disintegration of peat (*i.e.*, “organic TSS”) and are presented in Section6.3.8.2.

The collective effects of Project operation on TSS (*i.e.*, inorganic and organic materials collectively) are predicted to be dominated by increases in organic TSS in the flooded lentic habitat and effects to mineral TSS in the deeper, lotic areas of the reservoir. TSS will be reduced along the mainstem, most notably under high flow scenarios, and organic TSS will increase in nearshore, lentic areas of flooded bays, most notably in shallow flooded bays off the mainstem of present-day Gull Lake (Section 6.3.8.2). Effects on organic TSS will be greatest in Year 1 (the first year of full impoundment), declining rapidly thereafter. Effects to mineral TSS will be more long-term as the major driver is a reduction in water velocities in the reservoir.

As described in Section 6.3.8.2, mineral TSS is generally predicted to decrease in the shallow and deep areas of the reservoir with the Project, most notably under high flows (95th

percentile), although small increases (1–4 mg/L) are projected in some areas under some conditions (*e.g.*, different flows and years of operation). In general, the predicted decreases (or occasionally increases) in mineral TSS are less than 5 mg/L (*i.e.*, within the chronic Manitoba PAL water quality objective and the CCME PAL guideline) under low, median, and high flows in shallow and deep areas for Year 1 and Year 5 of operation. The major exception will occur under high flows in the areas near the GS where larger TSS decreases (8–14 mg/L) are expected (relative to conditions without the Project).

Over the long-term, TSS is predicted to decrease in most areas of the reservoir. The decreases in TSS are predicted to generally be less than 5 mg/L throughout the reservoir under median flow conditions. Although modeling was not conducted for time-frames beyond Year 5 for the high flow condition, it is expected that the magnitude of changes in TSS for the long-term period will be similar to those predicted for Year 5 (*i.e.*, up to 7–14 mg/L near the GS). Therefore, the long-term effects on TSS (*i.e.*, decreases) are expected to be within the Manitoba PAL objective more than 50% of the time and the largest decreases predicted under high flow conditions will occur in the areas closest to the GS.

As described in Section 6.3.8, although mineral TSS will generally decline in nearshore areas with the Project despite the increase in mineral erosion, episodic resuspension of fine particles may occur in the nearshore areas of the reservoir. Therefore, mineral TSS concentrations may increase during high wind events. Similarly, episodic erosion events may lead to episodic increases in TSS in the nearshore environment. CNP predict that shoreline erosion will increase sediments and debris in water in the operation phase (CNP Keeyask Environmental Evaluation Report).

Effects of the Project on organic TSS (*e.g.*, suspended peat particles and fibres) are not expected to be detectable along the mainstem of the reservoir (*e.g.*, in lotic areas) but will result in detectable increases in the nearshore, lentic areas in Year 1 of impoundment. In addition, organic TSS concentrations will vary across the lentic areas of the reservoir due to spatial differences regarding peatland disintegration, local bathymetry, and the water regime. Overall, the largest increases in organic TSS will occur in flooded, lentic areas.

It is likely that organic TSS will exceed the chronic Manitoba PAL water quality objective and the CCME PAL guideline in Year 1 of full impoundment in some lacustrine portions of the reservoir. As peatland disintegration will decrease notably after Year 1, increases in organic TSS will decline rapidly, thereafter.

Nitrogen and phosphorus – Nutrient concentrations in the Keeyask reservoir may be affected by leaching from and decomposition of flooded organic materials, through changes in concentrations of organic and inorganic TSS (which include nutrients) related to erosion and peatland disintegration, and changes to sediment deposition and the water regime (*e.g.*, increased water residence times in the nearshore areas).

Overall, based on the linkages between the Project and water quality, the quantity of peat that would be flooded by the Project, the predicted effects of peatland disintegration, consideration of observed effects in adjacent Stephens Lake, the wealth of scientific literature on the effects of flooding on nutrients, and modeling results, it is expected that nutrients (nitrogen and phosphorus) will increase in isolated, flooded areas of the reservoir. It is expected that the effects would be greatest in shallow, flooded habitat with long residence times and would exhibit a gradient of decreasing concentrations from shore out into the mainstem of the reservoir. It is also expected that phosphorus and ammonia may be higher in anoxic areas of the reservoir in winter. In addition, localized increases in nutrients may occur in the vicinity of floating peat islands. The increases in nutrient concentrations are expected to be moderate to large and increases in total phosphorus are likely to exceed one or both of the CCME phosphorus management triggers (CCME 1999; updated to 2012) in the nearshore, isolated, flooded bays.

Effects of flooding and peatland disintegration on nutrients in the mainstem of the reservoir are expected to be negligible due to the large volume of flow and short residence times; small reductions in total phosphorus may occur in association with reductions in concentrations of mineral TSS. This is further substantiated by the available information for Stephens Lake which indicates that nutrient concentrations in the mainstem of the reservoir (*e.g.*, the southern riverine portion) were likely largely unchanged with creation of the Kettle reservoir, as conditions were similar upstream and downstream of the reservoir 2–3 years post-impoundment.

Based on decades of research pertaining to reservoirs and nutrients, it is anticipated that increases in nutrients would be most pronounced in the first several years post-impoundment, decreasing thereafter, and likely stabilizing in approximately 10–15 years.

Metals – During operation, metals in the reservoir may increase due to flooding and peatland disintegration, or may decrease due to increased sedimentation.

Total metals will likely increase in flooded bays, largely due to increases in organic TSS and from leaching and decomposition of flooded terrestrial habitat. Most metals are expected to remain within MWQSOGs for PAL; however, flooding and peatland disintegration may cause or contribute to exceedances of the Manitoba and CCME PAL guidelines for iron and aluminum (which are currently well above guidelines[1]) and selenium and silver (which occasionally exceed guidelines). Similarly, the Project is expected to increase the magnitude of exceedances of the aesthetic drinking water quality guideline for iron.

Like other water quality variables, the largest effects to metals are expected in the nearshore areas of flooded bays, most notably in shallow, isolated areas located over flooded peat. Total metal concentrations will increase in these areas due to leaching and decomposition of flooded organic materials and from introduction of eroded mineral and organic materials that will be in suspension. The duration of increases in metals in flooded bays is expected to

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[1] As discussed in Section 6.2.3.3.2, aluminum and iron are above guideline levels in many waterbodies in northern Manitoba and across western Canada.

be similar to that predicted for other water quality variables. That is, effects would persist for approximately 10–15 years and would be greatest during the initial years post-impoundment.

Effects of flooding and peatland disintegration are not expected to cause a detectable increase in metals in the mainstem of the reservoir. Small decreases in total metals are expected in the area immediately upstream of the GS, most notably under high flows, due to Project effects on TSS levels (Section 6.3.8.2). Metals that are positively correlated to mineral TSS (iron, aluminum, barium, chromium, cobalt, manganese, potassium, titanium, and vanadium) will likely be most notably affected.

DOWNSTREAM OF THE KEEYASK GENERATING STATION

Potential effects of the Project on water quality in Stephens Lake, downstream of the GS, relate to changes in the quality of water originating from the reservoir and/or changes in physical environment processes downstream of the GS.

Dissolved oxygen – DO is expected to remain similar to current conditions in Stephens Lake and above PAL water quality objectives and guidelines. Effects to DO are expected to be small in the main flow of the reservoir and DO is expected to remain at or near saturation at the GS in the open water and ice-cover seasons. In addition, estimated concentrations of biological oxygen demand that would arise from peatland disintegration are expected to be less than 1 mg/L, which represents a concentration below the limits of analytical detection, at the outflow of the GS. Therefore, DO conditions in Stephens Lake would not be measurably affected by changes in water quality upstream in the Keeyask reservoir.

Total Dissolved Gas Pressure – Total dissolved gas pressure is expected to increase for several kilometres downstream of the Keeyask GS. Peak levels in most locations are expected to be less than 110% of atmospheric pressure, although higher concentrations may occur temporarily in some areas during high spill events (Section 6.3.10.1.2). The MWGSOGs do not include total dissolved gas pressure. The CCME guidelines indicate a limit of 110% total dissolved gas pressure where the water depth is greater than one metre. Although levels greater than 110% have the potential to result in deleterious effects (*e.g.*, gas bubble disease) on fish (AE SV Section 2.5), given the intermittent nature of spillway discharge, the limited area potentially affected, and the presence of nearby deep waters that allow fish to escape the effects of gas supersaturation, this is not expected to be a marked source of injury or mortality to fish. However, given that little site-specific information exists with respect to the type of facilities and sensitivity of resident species, an assessment of potential effects to fish health will be conducted after the station is in operation.

pH – No effects to pH are expected in Stephens Lake, including in the vicinity of the Gillam drinking water intake, because no changes in pH are anticipated along the main flow of the reservoir upstream and because there will be no flooding downstream of the GS.

Total suspended solids/turbidity – Relative to conditions that would be expected without the Project (*e.g.*, “background” condition), TSS is expected to be lower at the GS during operation. The largest decrease relative to background would occur during high flow conditions (*e.g.*, 95th percentile flows) and the effects would be long-term.

Currently, TSS concentrations decrease from the inlet to Stephens Lake to the Kettle GS. The Project will result in lower TSS concentrations at the inlet to Stephens Lake (downstream of the Keeyask GS) and decreased concentrations, relative to conditions without the Project, are expected to persist along the mainstem in Stephens Lake for 10–12 km (6.2–7.5 miles) from the GS (discussed in Section 6.3.8.2). Further downstream, TSS concentrations are expected to be similar to those that currently occur without the Project.

Nitrogen and phosphorus – As discussed above, combined effects of flooding, peatland disintegration, and enhanced sediment deposition are expected to cause a slight decrease in TP concentrations and a small, likely undetectable, increase in total nitrogen concentrations along the mainstem of the reservoir. TP may decrease due to predicted decreases in mineral TSS in the Keeyask reservoir and over 10–12 km (6.2–7.5 miles) in Stephens Lake downstream of the GS, as TP is correlated to TSS in the study area. Decreases in TP, relative to conditions without the Project, will be greatest under high flows. These effects will be long-term as they result from changes in the hydrological regime and subsequent effects on sediment deposition. In terms of trophic status, Stephens Lake is currently classified as mesoeutrophic to eutrophic and is expected to remain within a similar range of trophic state during operation. As the TP concentrations are currently near the boundary of these categories, phosphorus concentrations are expected to fall within either category from year to year.

Metals – Metals are not expected to measurably increase in Nelson River water flowing out of the Keeyask GS. However, concentrations of metals that are associated with suspended solids may be slightly reduced in the outflow, notably under high flows, due to reductions in TSS. Metals that are positively correlated to mineral TSS (iron, aluminum, barium, chromium, cobalt, manganese, potassium, titanium, and vanadium) would likely be affected most notably. In addition, further reductions in total metal concentrations may occur over the 10–12 km (6.2–7.5 mile) stretch downstream of the GS due to reductions in mineral TSS, relative to current conditions.

RESIDUAL EFFECTS OF OPERATION

A detailed description of expected residual effects to water quality is provided in AE SV Section 2.5. The following are the residual effects on water quality:

- Short-term increases in TSS in nearshore areas and long-term decreases in TSS in most areas of the reservoir and for a number of kilometres downstream of the reservoir;
- Nutrients, metals, OC, true colour, conductivity/TDS will increase and pH and water clarity will decrease in nearshore areas due to flooding and peatland disintegration. Effects will be greatest in Year 1 of full impoundment and will decline thereafter. Effects to the mainstem area of the reservoir and downstream will be negligible to small;

- Dissolved oxygen concentrations will decrease in the ice-cover season in nearshore, flooded areas, and anoxia will develop in some of the shallow, isolated areas over winter. Infrequent periods of low DO will develop in nearshore areas under atypically low wind conditions in summer. The majority of the reservoir will maintain DO concentrations above the Manitoba PAL water quality objective and the CCME guideline year-round. Effects on DO will be greatest in Year 1 of full impoundment and decline thereafter. Downstream effects will be negligible;
- Metals should generally remain within MWQSOGs for PAL in the reservoir and downstream. The key exceptions are iron and aluminum which are currently present at concentrations well above the Manitoba and CCME guidelines, and Project operation will increase concentrations further. However, concentrations are expected to remain within the ranges of aluminum and iron concentrations in other Manitoba rivers or streams; and
- Effects of operation on water quality are generally expected to persist for 10–15 years, with the exception of effects on TSS (*i.e.*, a decrease) which will continue for the life-span of the Project.

Using the criteria established to determine the significance of Project effects for regulatory purposes (described in Section 5.5), the likely residual effects of Project operation on water quality in nearshore flooded areas are expected to be adverse, medium-term, and moderate to large in magnitude over a small geographic extent. In the mainstem of the reservoir and for several kilometres downstream in Stephens Lake, likely residual effects of the Project are expected to be adverse, long-term, and moderate over a medium geographic extent.

6.4.3.1.3 CONCLUSION ABOUT RESIDUAL EFFECTS ON WATER QUALITY

Overall, adverse effects of construction are expected to be short-term and of moderate magnitude at the construction site and in Stephens Lake. Small magnitude effects will extend downstream past the Kettle GS during some instream construction activities. During the initial years of operation, the Project will cause medium-term, moderate to large changes in water quality in nearshore areas of the reservoir. There will be a moderate reduction in TSS in the reservoir and the southern portion of Stephens Lake in the long-term. Effects during operation are continuous/regular as they occur all the time or at regular intervals (*e.g.*, DO depletion each winter). Effects in flooded areas will diminish over time, while the decline in TSS levels is irreversible and will occur for the life of the Project. The ecological context of the predicted change is moderate, reflecting the importance of water quality to the aquatic ecosystem, but also the ability of the aquatic ecosystem to adapt to these changes and the diminishing effect over time. The long-term decline of TSS could be considered a positive effect, given that local resource users report TSS was historically lower in this reach. In general, adverse effects of TSS on aquatic life are associated with increases in TSS. However, increasing water clarity may increase primary production and potentially affect fish behaviour. Due to the predicted magnitude and spatial extent of long-term reductions in TSS, no substantive effect on aquatic biota is anticipated.

The technical water quality assessment is based on models, scientific literature, and information collected from a proxy reservoir (*i.e.*, Stephens Lake) and the overall certainty associated with the predictions is moderate to high. Overall, there is high certainty regarding the nature and direction of all effects and the magnitude of effects predicted for the mainstem of the reservoir, and moderate certainty regarding the magnitude of effects in nearshore areas of the reservoir.

The adverse residual effects of the Project will not overlap or interact spatially and temporally with effects from future Projects, with the exception of a small, short-term increase in TSS during construction, which would overlap with instream construction of the Conawapa GS. Cumulative effects are discussed in Chapter 7.

Monitoring of water quality has continued periodically since the conclusion of the EIS studies and additional sampling will be conducted prior to construction to update the baseline data collected during the EIS studies. Monitoring will include sampling at sites along the Nelson River from downstream of the Kelsey GS to the estuary. In addition, sampling programs will target specific activities (instream construction) and site-specific effects (*e.g.*, inputs from flooded terrain) (see Chapter 8).

6.4.3.2 Aquatic Habitat

A detailed description of the effects of construction and operation on aquatic habitat is provided in AE SV Section 3.4.

6.4.3.2.1 Construction Effects and Mitigation

Through the following pathways, the Project has the potential to affect aquatic habitat during construction:

- Installation of instream structures such as cofferdams will change water levels and flows within and upstream of Gull Rapids; and
- Sediments released during construction will deposit in downstream environments.

Habitat changes related to altered water levels and flows, including dewatering of the riverbed downstream of the south dam, will begin during construction and be a permanent feature of operation. These effects are discussed under operation in Section 6.4.3.2.2.

Cofferdam construction will result in the loss of aquatic habitat in Gull Rapids over the course of the construction period (Chapter 4). Affected habitat includes areas of medium to high water velocity habitat over gravel/cobble and boulder substrate. During Stage I, the majority of flow in the north and central channels of Gull Rapids will be eliminated and flow in the south channel will increase (Section 6.3.6.1). During Stage II, all flows will be diverted through the spillway and flows through the most southern portion of the south channel will cease.

During the instream construction activities, suspended sediments will likely be deposited in the Nelson River as it enters Stephens Lake (Section 6.3.8.1). This sediment will form a layer estimated to be up to 0.6 cm (0.2 inches ["]) thick near the inlet of the river to Stephens Lake, and then diminish to approximately 0.1 cm (0.04 ") over the southern portion of the lake to the Kettle GS. Sediments will remain post construction. Sediment deposition is not expected to change the existing substrate as the size of deposited material is related to water velocity; therefore coarse material (*e.g.*, sand) will settle over areas that are currently coarse, and fine material (*e.g.*, silt) will settle over areas that are currently fine.

RESIDUAL EFFECTS OF CONSTRUCTION

A detailed description of expected residual effects to aquatic habitat is provided in AE SV Section 3.4. The following are the predicted residual effects:

- Installation of instream structures such as cofferdams will change water levels and flows within and upstream of Gull Rapids, resulting in the loss of habitat in the north and middle channels of Gull Rapids in Stage I of construction and loss of remaining habitat in the south channel in Stage II; and
- A thin layer of sediment will deposit in the river and Stephens Lake, but no change in substrate composition will occur.

6.4.3.2.2 OPERATION EFFECTS AND MITIGATION

Through the following pathways, the Project has the potential to affect aquatic habitat during operation:

- Increased water levels as a result of impoundment by the GS;
- Decreased velocity due to increased water levels;
- Flooding of terrestrial areas;
- Changes in erosion and sediment deposition;
- Peat uplift and formation of peat islands;
- Changes in water level fluctuations due to flow regulation by the GS;
- Dewatering in the footprint of the GS and downstream river channel; and
- Changes in the ice regime, including changes in ice cover and timing of ice-on and ice-off.

AE SV Section 3.2 provides detailed methods and results for the aquatic habitat analysis, including methods of habitat classification, a description of models used to predict post-

Project habitat, and summary tables of areas of specific habitat types in the pre- and post-Project environments, including at several time steps during the initial decades post-impoundment as the reservoir evolves. Studies suggest that the changes arising from physical processes in the reservoir will have largely stabilized prior to 30 years after impoundment; therefore, this time span was considered a reasonable model for the long-term condition of the reservoir.

Maps illustrating post-Project water depth (Map 6-48), velocity (Map 6-49) and substrate (Map 6-53) within the open water hydraulic zone of influence are provided in Section 6.3. Illustrations of the relative changes in depth and velocity are provided in AE SV Section 3.4.

As discussed in Section 6.2.3.3.2, the total area of large river and lake habitat in the Kelsey GS to Kettle GS regional study area is approximately 65,000 ha (160,618 acres). Construction of the Keeyask GS will divide this area into an upstream area of approximately 40,000 ha (98,842 acres) (including flooded area of the reservoir) and a downstream area of approximately 30,000 ha (74,132 acres).

WITHIN THE KEEYASK RESERVOIR

The open water area of the reservoir at initial full supply level will increase by approximately 45 km^2 (17 miles^2), resulting in a reservoir surface area of 93 km^2 (36 miles^2) and the reservoir volume will increase. The residence time for water flowing in the mainstem will increase from 10 to 20 hours in the existing environment to 15 to 30 hours post-Project.

The effects of reservoir creation on aquatic habitat vary in relation to proximity to the GS. The riverine habitat from downstream of the outlet of Clark Lake to upstream of Birthday Rapids will be slightly altered due to a relatively small increase in water depth and decrease in water velocity. The river reach extending from Birthday Rapids to Gull Lake will remain as riverine habitat, but will be altered due to a notable increase in depth, decrease in velocity, and a loss of white water habitat in the Birthday Rapids area. Increases in erosion within the riverine portion of the reservoir are expected to be minimal (Section 6.3.7) and sediment deposition is not expected to change (Section 6.3.8). No change in substrate composition of the mainstem habitat is expected (AE SV Section 3.4). Aquatic plant habitat in the existing littoral zone will be lost due to increased water depth. Flooding will create backwater inlet habitat in the lower reaches of Portage Creek and Two Goose Creek. Information on flooded creek habitat, including maps, can be found in AE SV Section 3.4.

The greatest changes will occur in the reach from Gull Lake to the Keeyask GS, where flooding will result in a loss of existing littoral zone habitats, creation of flooded terrestrial habitat, partial or complete flooding of creeks, flooding of most of Gull Rapids, and loss of over 100 ha (247 acres) of habitat located under the principal structures or in the dewatered riverbed at Gull Rapids (the loss of Gull Rapids with respect to effects downstream of the GS is addressed below). As the reservoir ages, discontinuous deposits of silt will form on existing cobble/gravel/sand substrates in main river channel areas of Gull Lake (Map 6-53).

Terrestrial areas flooded as a result of impoundment will consist predominantly of low-lying peatlands that will break down and mobilize to form peat islands in the initial post-impoundment period. Over time, continuous deposits of silt will settle and cover most flooded terrestrial areas. New littoral habitats will evolve in shallow water less than 3 m (9.8 feet) deep. These habitats will have a variety of substrates, depending on site-specific conditions. The lower reservoir is expected to become mainly a depositional environment, given that this area has the greatest increase in depth and decrease in velocity. These predicted changes agree with ATK from the CNP, who expect that shoreline erosion will increase sediments and debris in water in the operation phase (CNP Keeyask Environmental Evaluation Report). However, coarser substrates will be present at some locations with greater exposure to currents and wave action, in particular where coarser substrates are placed to create approximately 3 ha of spawning habitat (see discussion of walleye and lake whitefish below in Section 6.4.6.1.2).

Over time, rooted aquatic vegetation will establish in some shallow areas (Map 6-56). The actual area occupied by plants in the reservoir may vary widely in space and time. When compared to the average area occupied in the existing river from below Clark Lake to Gull Rapids, there would be an estimated loss of approximately 11% of the area occupied by plants under a Base loaded scenario and 49% under peaking scenario in the long-term. This larger loss during a peaking scenario is due to the adverse effect that water level variation has on plant growth in shallow water.

After the Project is constructed, water levels in the reservoir will fluctuate between an elevation of 158 m (518 feet) and 159 m (522 feet), resulting in an intermittently exposed zone that is 1 m (3.2 feet) in depth. This is a smaller total range than in the existing environment, where the intermittently exposed zone is up to 2.1 m (6.9 feet) in depth. However, under a peaking scenario, the intermittently exposed zone will be dewatered on a daily or weekly basis, in contrast to the existing environment where changes in water level occur much more slowly.

A more stable ice cover is expected to form which would decrease winter ice scour in shallow areas.

DOWNSTREAM OF THE KEEYASK GENERATING STATION

Downstream of the main dam, approximately 100 ha (247 acres) of the south channel of Gull Rapids will be dewatered except for a portion that will be periodically watered during operation of the spillway. The downstream portion of the north channel of Gull Rapids will be converted into the tailrace for the GS. The dewatering of Gull Rapids also removes a defined channel for water from Gull Rapids Creek to flow in over Gull Rapids and eliminates a wetted connection passable by fish between Gull Rapids Creek and Stephens Lake or the Nelson River.

The position of the main flow in the 3 km (1.9 miles) river reach downstream of the GS will change as a result of construction of the generating station; changes in flow are not expected to extend into Stephens Lake (Section 6.3.6.2). Given that the elevation of the tailrace of the GS is within the operating range of Stephens Lake, water levels in the river channel downstream of the GS are largely controlled by water levels on Stephens Lake and only a minimal amount of habitat is subject to dewatering due to cycling at the GS. This habitat is not permanently wetted under existing conditions, as it may be dewatered due to changes in Stephens Lake levels. Therefore, no need for minimum discharges from the GS to maintain wetted habitat has been identified, with the exception of measures to provide appropriate flow to habitats constructed as part of the mitigation program (see Section 6.4.6.2.2 for more details).

The loss of Gull Rapids (which provides habitat characterized by turbulent flow, high velocities and coarse substrates) will be mitigated through the creation of habitat at several sites downstream of the GS, as follows:

- Approximately 3 ha (7.4 acres) of habitat consisting of large boulders interspersed with smaller boulders and cobble will be constructed to provide suitable spawning habitat for several fish species in an area of flow along the north shore just downstream of the generating station;
- Coarse materials from the remnants of the tailrace cofferdam will be spread to create conditions attractive to spawning fish in areas where interference with the outflow from the GS will not be a concern;
- A 0.1 ha reef comprised of coarse substrate suitable for lake whitefish spawning will be constructed at the site along the southern river bank near Stephens Lake; and
- During 20-30% of the spring spawning periods, flows from the spillway will be sufficient to wet areas of existing habitat in a portion of the south channel of Gull Rapids.

Additional details and use of these mitigation works are discussed in Section 6.4.6.1.2 and Section 6.4.6.2.2.

The ice dam that currently forms at the inlet to Stephens Lake each winter will not persist in the post-Project environment and the resultant stable ice cover is expected to reduce ice scour in shallow areas. The distribution of water velocity under the ice will also change, and the current large changes in winter water level and the formation of new channels will no longer occur.

RESIDUAL EFFECTS OF OPERATION

In summary, the mitigation measures listed above will mitigate the loss of habitat in the reservoir and Gull Rapids following construction of the GS.

Effects to aquatic life are considered in Sections 6.4.4, 6.4.5 and 6.4.6. A detailed description of expected residual effects to aquatic habitat is provided in AE SV Section 3.4.

The following are the residual effects on aquatic habitat once the appropriate mitigation measures are applied:

- Conversion of river/lake environment to reservoir in an approximately 40 km (25 miles) long reach between the outlet of Clark Lake and Gull Rapids, with associated changes in depth, velocity and substrate;
- Loss of turbulent flow in Birthday Rapids;
- Loss of existing littoral habitat, including areas of macrophyte beds;
- Loss of tributary habitat;
- Deposition of silt over existing sand and hard substrates in deep areas of Gull Lake;
- Creation of new aquatic habitat through the flooding of terrestrial areas;
- A reduction in the range of water level changes in the reservoir but an increase in the frequency;
- At the GS, Gull Rapids will be eliminated and over 100 ha (247 acres) of riverbed will be dewatered or included in the footprint of the GS structures;
- Changes in water levels and flows and minor changes to substrate will occur in the river reach downstream of the GS; and
- A reduction in ice scour and disturbance of aquatic habitat by ice upstream and downstream of the GS.

6.4.3.2.3 Conclusion about Residual Effects on Aquatic Habitat

Overall, considering construction and operation, changes to aquatic habitat will be large and long-term, over a medium geographic extent.

The technical aquatic habitat assessment is based on models, scientific literature, and information collected from a proxy reservoir (*i.e.*, Stephens Lake) and the overall certainty associated with the predictions is moderate to high depending on the habitat characteristic. Monitoring of habitat in the reservoir, the immediate downstream river channel, and at mitigation works will occur periodically until the long-term condition of the habitat has been established (Chapter 8).

6.4.4 ALGAE AND AQUATIC PLANTS

6.4.4.1 ALGAE

A detailed description of the effects of construction and operation on algae is provided in AE SV Sections 4.2 and 4.3.

6.4.4.1.1 CONSTRUCTION EFFECTS AND MITIGATION

The Project has the potential to affect algae during construction through effects to water quality and dewatering of habitat in Gull Rapids. Changes to water quality, such as increases in the concentration of TSS and related variables (*e.g.*, turbidity) and nutrients (Section 6.4.3.1.1) have the potential to affect algae. It is expected that measures to protect water quality will reduce the duration and magnitude of any construction-related effects on the algal community.

Cofferdam placement and dewatering of the area within cofferdams will affect attached algae in the immediate vicinity. The majority of aquatic habitat affected during construction will also be affected by the permanent works of the GS (Section 6.4.3.2.1). This habitat dewatering has the potential to reduce the production of drifting filamentous algae that originate from attached algae growing in Gull Rapids.

RESIDUAL EFFECTS OF CONSTRUCTION

The residual effects of construction on algae include a moderate decrease in the production of filamentous algae in Gull Rapids as the area is progressively dewatered during the construction of cofferdams.

6.4.4.1.2 OPERATION EFFECTS AND MITIGATION

The Project has the potential to affect algae during operation due to changes in water quality and aquatic habitat.

Collectively, there is the potential for small to moderate increases in phytoplankton biomass over the long-term in reservoir bays with longer water residence times, depending on the balance between the positive effect of increased nutrients and the negative effect of reduced light penetration due to increased TSS/turbidity. The reduction in TSS and resulting increase in water clarity in the mainstem of the reservoir and downstream of the GS are expected to result in a long-term, small increase in phytoplankton biomass in the reservoir and southwestern portion of Stephens Lake.

The reduction in high velocity and hard substrate at Gull Rapids due to flooding, dewatering, and/or the GS structures will result in a reduction in the production of drifting, filamentous algae.

Residual Effects of Operation

A detailed description of expected residual effects to algae is provided in AE SV Sections 4.2 and 4.3.

The residual effects of operation on algae include the potential for small increases of phytoplankton in several areas: the off-current, sheltered bays of the reservoir due to the increase in water residence time and nutrients; the mainstem of the reservoir due to increased water clarity; and the southwestern area of Stephens Lake due to increased water clarity. A reduction in the production of drifting, filamentous algae from fast-flowing hard substrate areas of the river will also occur.

6.4.4.1.3 Conclusion about Residual Effects on Algae

The effects of the construction and operation of the Project on algae are expected to be large over a small geographic extent (at the GS site), small over a medium geographic extent (local area with the reservoir and immediately downstream in Stephens Lake), and long-term.

The algal assessments are based on models, scientific literature, and information collected from a proxy reservoir (*i.e.*, Stephens Lake) and the overall certainty associated with the predictions is moderate to high. Overall, there is high certainty regarding the nature and direction of effects and the magnitude of effects predicted for the mainstem of the reservoir (phytoplankton) and the reduction in aquatic habitat that produces filamentous algae. Certainty regarding the magnitude of effects in nearshore areas of the reservoir (phytoplankton) and for the colonization of flooded areas (attached algae) is moderate.

Monitoring of the algal community will occur prior to construction to update the baseline data collected for the EIS. Periodic sampling will occur during the construction and operation period to determine whether responses are as predicted (Chapter 8).

6.4.4.2 Aquatic Plants

A detailed description of the effects of construction and operation on aquatic plants is provided in AE SV Section 4.3.

6.4.4.2.1 Construction Effects and Mitigation

The Project has the potential to affect aquatic plants during construction through effects to water quality and dewatering by cofferdams. There are no beds of aquatic plants in the immediate area of Gull Rapids that would be affected by cofferdams so no effects due to dewatering are expected. The slight increases in TSS predicted in the downstream environment due to construction are not sufficient to affect plant growth in Stephens Lake.

Residual Effects of Construction

No effects are expected.

6.4.4.2.2 OPERATION EFFECTS AND MITIGATION

The Project has the potential to affect aquatic plants during operation due to changes in water quality and aquatic habitat.

As discussed in Section 6.4.3.2.2, the impoundment of the Nelson River at Gull Rapids will produce large changes in the aquatic plant community, predominantly within the more lacustrine downstream portion of the reservoir. Post-impoundment, the vast majority of existing aquatic plant beds will be lost due to flooding. This will also result in a substantial decrease in the production of drifting plant biomass predominantly from within Gull Lake for up to 15 years post-impoundment as new, vegetated littoral habitat is established. Overall, a reduction in occupied aquatic macrophyte habitat (*e.g.*, habitat suitable for plant growth with plants present) is expected in the reservoir in the long-term given that many shallow flooded areas are organic and that plants in the reservoir are expected to colonize and inhabit less of the available habitat (based on a study of Stephens Lake).

Downstream of the GS, no plants are present in the area that would be affected by cycling of the GS. The reduction in TSS and resulting increase in clarity in Stephens Lake is not expected to affect aquatic plant distribution because the reduction will be small, and other factors, such as water level changes on Stephens Lake, will have a larger effect.

RESIDUAL EFFECTS OF OPERATION

A detailed description of expected residual effects to aquatic plants is provided in AE SV Section 4.3. The residual effects of operation on aquatic plants are:

- Loss of existing plant beds in Gull Lake; and
- Establishment of new plant beds 10–15 years post-impoundment, though the total area occupied is expected on average to be less than in the existing environment.

6.4.4.2.3 CONCLUSION ABOUT RESIDUAL EFFECTS ON AQUATIC PLANTS

The effects of the construction and operation of the Project on aquatic plants are expected to occur over a medium extent in the reservoir, and will be large in the short-term, decreasing to small in the long-term.

The technical aquatic plant assessment is based on models, scientific literature and information collected from a proxy reservoir (*i.e.*, Stephens Lake), and the overall certainty associated with the predictions is moderate to high. Overall, there is high certainty regarding the nature and direction of effects and the magnitude of effects predicted for the loss of existing plant beds, and low to moderate certainty regarding the magnitude of effects predicted for the colonization of flooded areas. Monitoring of the aquatic plant community will be conducted prior to construction to update baseline data collected for the EIS. Periodic sampling will occur during the operation period to verify that responses are as predicted (Chapter 8).

6.4.5 Aquatic Invertebrates

6.4.5.1 Zooplankton

A detailed description of the effects of construction and operation on zooplankton is provided in AE SV Section 4.4.

6.4.5.1.1 Construction Effects and Mitigation

Zooplankton could be affected by construction-related changes to water quality. However, given the nature and duration of expected changes to water quality (Section 6.4.3.1.1), no effects to zooplankton are predicted.

Residual Effects of Construction

No effects are expected.

6.4.5.1.2 Operation Effects and Mitigation

The Project has the potential to affect zooplankton during operation due to changes in water quality, reservoir water residence time, and phytoplankton.

Collectively, there is the potential for small to moderate increases in zooplankton abundance over the long-term in portions of the reservoir with longer water residence times, both due to an increase in phytoplankton and due to greater time for zooplankton biomass to accumulate. No change is expected in the mainstem of the reservoir or Stephens Lake as the water residence time is too short for the zooplankton population to increase in response to changes in phytoplankton.

Residual Effects of Operation

A detailed description of expected residual effects to zooplankton is provided in AE SV Section 4.4.

Overall a small to moderate increase in zooplankton biomass is expected in off-current portions of the reservoir.

6.4.5.1.3 Conclusion about Residual Effects on Zooplankton

The effects of the construction and operation of the Project on zooplankton are expected to be small to moderate, and long-term, and to occur over a small geographic extent.

The technical zooplankton assessment is based on models, scientific literature and information collected from a proxy reservoir (*i.e.*, Stephens Lake), and the overall certainty associated with the predictions is moderate to high. Overall, there is high certainty regarding the nature and direction of effects and the magnitude of effects predicted for the mainstem of the reservoir, and moderate certainty regarding the magnitude of effects in nearshore areas of the reservoir. Periodic sampling would occur during the construction and operation periods to determine whether responses are as predicted (Chapter 8).

6.4.5.2 Aquatic Macroinvertebrates

A detailed description of the effects of construction and operation on aquatic macroinvertebrates is provided in AE SV Section 4.5.

6.4.5.2.1 Construction Effects and Mitigation

The Project has the potential to affect aquatic macroinvertebrates during construction through effects to water quality, dewatering of habitat in Gull Rapids, and the deposition of sediments in Stephens Lake.

Changes to water quality, such as increases in the concentration of TSS and related variables (*e.g.*, turbidity) and reduction in DO (Section 6.4.3.1.1), have the potential to affect macroinvertebrates. It is expected that measures to protect water quality will prevent any measureable effects.

Cofferdam placement and dewatering of the area within cofferdams will affect benthic macroinvertebrates in the immediate vicinity (the majority of aquatic habitat affected during construction will also be affected by the permanent works [Section 6.4.3.2.1]). This has the potential to reduce the production of drifting invertebrates originating from Gull Rapids.

Habitat changes related to altered water levels and flows, including dewatering of the riverbed downstream of the south dam, will begin during construction and be a permanent feature of operation. The effect of these alterations on aquatic macroinvertebrates is discussed under operation in Section 6.4.5.2.2.

The deposition of sediments in Stephens Lake is not expected to affect benthic invertebrates because the total amount of deposition is very small (less than 0.6 cm [0.2 "] thickness over the entire construction period) and the substrate composition will not be altered (Section 6.4.3.2.1).

Residual Effects of Construction

The residual effects of construction on macroinvertebrates include losses in Gull Rapids where cofferdams are constructed and a potential reduction in drifting invertebrates downstream into Stephens Lake. This effect would be permanent.

6.4.5.2.2 Operation Effects and Mitigation

The Project has the potential to affect aquatic macroinvertebrates during operation due to changes in water quality and aquatic habitat.

The impoundment of the Nelson River at Gull Rapids will produce large changes in the aquatic macroinvertebrate community. A large increase in the abundance of benthic macroinvertebrates is expected in the reservoir in the long-term in response to the increased availability of aquatic habitat. As aquatic vascular plants are not expected to begin to develop in the downstream portion of the reservoir until five to 15 years after impoundment, plant-dwelling macroinvertebrates will be mostly absent from the reservoir during this time. Overall, there will be a reduction in the abundance of plant-dwelling macroinvertebrates in the reservoir, the extent of which will depend on the mode of operation of the GS.

The reduction in fast-flowing water and hard substrate at the rapids due to flooding, dewatering, and/or footprint of principal structures, and conversion of tributary habitat to bays, will result in a reduction in the abundance of macroinvertebrates favouring this type of aquatic habitat and likely contribute to a moderate decline in the production of drifting macroinvertebrates (predominantly larval insects) from within Birthday and Gull rapids and tributaries.

Downstream of the GS, the loss of Gull Rapids will result in a small to moderate reduction in the numbers of drifting macroinvertebrates in the river immediately below the GS. The aquatic habitat mitigation measures listed in Section 6.4.3.2.2 that will create areas of coarse substrate with flow will provide habitat suitable for invertebrates that previously colonized Gull Rapids.

RESIDUAL EFFECTS OF OPERATION

The mitigation measures for aquatic habitat listed in Section 6.4.3.2.2 will generally improve the diversity of habitat available for benthic macroinvertebrates. A detailed description of expected residual effects to aquatic macroinvertebrates is provided in AE SV Section 4.5. The residual effects of operation on aquatic macroinvertebrates are:

- An overall increase in the total amount of benthic macroinvertebrates in the reservoir due to the doubling of aquatic habitat;
- A reduction in the amount of plant-dwelling macroinvertebrates; and
- A reduction in the amount of macroinvertebrates that inhabit rapids and a reduction in macroinvertebrate drift below the GS.

6.4.5.2.3 CONCLUSION ABOUT RESIDUAL EFFECTS ON AQUATIC MACROINVERTEBRATES

The effects of the construction and operation of the Project on aquatic macroinvertebrates are expected to be moderate to large and long-term, and to occur over a small to medium geographic extent in the reservoir, at the GS site, and immediately downstream in Stephens Lake. As described above, changes involve both increases and decreases in macroinvertebrate abundance, depending on the specific area.

The technical macroinvertebrate assessment is based on models, scientific literature and information collected from a proxy reservoir (*i.e.*, Stephens Lake,) and the overall certainty associated with the predictions is moderate to high. Overall, there is high certainty regarding the nature and direction of effects and the magnitude of effects predicted for the increase in availability of aquatic habitat for benthic macroinvertebrates and reduction in aquatic habitat that produces drifting macroinvertebrates. Certainty regarding the magnitude of effects predicted for the colonization of flooded areas by both bottom- and plant-dwelling macroinvertebrates is moderate. Monitoring of the aquatic macroinvertebrate community will occur prior to construction to update the baseline data collected for the EIS. Periodic sampling will occur during the operation period to verify whether responses are as predicted (Chapter 8).

6.4.6 FISH

Four fish species are aquatic VECs: walleye, northern pike, lake whitefish and lake sturgeon.

6.4.6.1 WALLEYE, NORTHERN PIKE, LAKE WHITEFISH AND OTHER SCALE FISH

A detailed description of the effects of construction and operation on the fish community is provided in AE SV Section 5.4.

6.4.6.1.1 CONSTRUCTION EFFECTS AND MITIGATION

Through the following pathways, the Project has the potential to affect walleye, northern pike, lake whitefish, and other scale fish during construction:

- Disruption of spawning activity due to disturbance by construction activity and habitat loss/alteration;
- Alteration of aquatic habitat in Stephens Lake due to sediment deposition;
- Stranding of fish when cofferdams are dewatered;
- Entrainment of fish in intake pipes for water used for construction;
- Blasting effects;
- Water quality effects from instream activities, malfunctions, or accidental spills; and
- Potential harvest by the workforce.

The effects of habitat alterations related to flooding and loss of Gull Rapids that began during construction, but are permanent changes in operation, are discussed in the operation section.

The construction of cofferdams will result in a sequential loss of aquatic habitat in Gull Rapids and relatively higher velocities in the south channel. Gull Rapids is currently used for spawning by fish, including the VEC species, residing in Stephens Lake. Other spawning habitat is available for these species within Stephens Lake; however, there may be years with reduced recruitment due to the reduction in total available spawning habitat.

Instream construction activities are expected to result in a 0.1–0.6 cm (0.04–0.2 ") layer of sediment to form on the bottom of Stephens Lake (Section 6.3.8.1). Most of the deposition is expected to occur near the entrance of Stephens Lake downstream of Gull Rapids. This amount of deposition is not anticipated to affect fish use of habitat in the lake.

The dewatering of areas within the cofferdams that are constructed in Gull Rapids has the potential to strand fish. Instream construction will be timed generally to avoid spawning periods and thereby minimize the number of mature fish that are in the area being dewatered, as well as the mortality of eggs due to dewatering. Salvage fisheries will be conducted in the areas dewatered by the cofferdams prior to dewatering to minimize the number of stranded fish.

The entrainment/impingement of fish on water intake pipes will be minimized by adhering to guidelines for end-of-pipe fish screening (DFO 1995).

Blasting activities have the potential to cause sensory disturbance, injury, and mortality to fish. Potential effects of blasting will be minimized by adhering to guidelines for the use of explosives near Canadian fisheries waters (Wright and Hopky 1998).

The effects to fish from changes in water quality will be minimized as described in Section 6.4.3.1.1. The increases in TSS predicted in the downstream environment are not expected to have a detectable adverse effect on fish populations.

During construction, there is the potential for an increase in fish mortality due to recreational harvesting by the workforce. As discussed in Section 6.7.5, effects are expected to be negligible given provisions in the Keeyask Generation Project Construction Access Management Plan (Construction AMP) (Chapter 8) and experience from the Wuskwatim Generation Project.

RESIDUAL EFFECTS OF CONSTRUCTION

In summary, the following mitigation measures will be implemented to address construction effects on walleye, northern pike, and lake whitefish:

- Avoidance of instream construction during sensitive spawning periods, where practicable;
- Fish salvage prior to dewatering;
- Application of guidelines for end-of-pipe screening and blasting;
- Measures to reduce effects to water quality; and

- Measures to mitigate effects due to harvest by construction workers.

Detail regarding expected residual effects to VEC fish species is provided in AE SV Section 5.4. The following are the residual effects on walleye, northern pike, and lake whitefish once the appropriate mitigation measures are applied:

- No predicted effects for fish residing in the Nelson River between Clark and Stephens lakes; and
- Year class strength of fish in Stephens Lake that rely primarily on spawning habitat in Gull Rapids is predicted to decrease for the years that the cofferdams are in place during construction; the effect to the population is reversible after the construction of spawning habitat below the tailrace.

Using the criteria established to determine the significance of Project effects for regulatory purposes (as described in Section 5.5), the likely residual effects of Project construction on walleye, northern pike, and lake whitefish are expected to range from none (northern pike) to adverse, moderate, and medium-term over a medium extent (lake whitefish and walleye).

6.4.6.1.2 Operation Effects and Mitigation

Through the following pathways, the Project has the potential to affect walleye, northern pike, lake whitefish and other fish species during operation:

- Reduction in velocity at Birthday Rapids could increase fish movements upstream to Split and Clark lakes;
- Changes in water quality (TSS and DO) in backbay areas of the reservoir, in particular during the first ten years of impoundment;
- Habitat changes in the reservoir due to changes in water levels and flow will result in the loss or alteration of existing habitats (tributaries, rapids, littoral) and creation of new habitats. Some of these habitats (*e.g.*, littoral) will be of lower quality due to the increased frequency of water level fluctuations in the reservoir. These habitat changes will result in changes of the production of aquatic plant, invertebrates and forage fish;
- Changes in downstream movement of larval, juvenile and adult fish due to the creation of the reservoir and presence of the GS structures (*i.e.*, dam, spillway, trashracks and turbines);
- Creation of a barrier to upstream fish movement at Gull Rapids due to presence of the GS;
- Loss of rapids habitat at Gull Rapids in footprint of the GS and dewatered river channel;
- Potential for fish to become stranded after spillway operation; and
- Changes in harvest levels.

All pathways are discussed in the AE SV; key pathways are discussed below.

WITHIN THE KEEYASK RESERVOIR

Changes in aquatic habitat in the Keeyask reservoir and a decrease in water velocity at Birthday Rapids could result in increased movement of fish upstream into Split or Clark lakes. However, it is expected that Long Rapids, which will still have high velocities and white water in the post-Project period (AE SV Section 3.4), will continue to function as an impediment to such movements. Therefore, emigration from the Keeyask reservoir is not expected to cause a measurable decline in fish populations in the reservoir nor an increase in upstream lakes.

As discussed in Section 6.4.3.1, with the exception of sites within backbays that will periodically experience DO depletion (in particular during the winter), water quality in the reservoir will be suitable for aquatic life. In the majority of bays, fish will be able to escape areas of low DO when they develop; however, in one northern bay, formed over the area of present day Little Gull Lake (Map 6-18), fish could become trapped as ice freezes to the bottom over shallow areas. Fish favouring shallow, vegetated habitat, such as northern pike, would be most at risk. To allow fish to escape, two channels, one approximately 400 m long and the other approximately 800 m long, both 5 m wide at the base with a minimum water depth (under ice) of 1.0 m, will be constructed to connect this area to the main reservoir (see AE SV Appendix 1A for more details). The dimensions of this channel were selected based on small tributaries where fish were known to move under ice.

Changes in Habitat

The most prominent effect to the fish community in the Keeyask reservoir will be related to changes in habitat, with an increase in quantity and a decrease in diversity. These changes could result in a shift in species composition. There will be more deeper and slower-moving habitat in the reservoir environment (AE SV Section 3.4), which is expected to result in an increase in species associated with lake-like conditions and a decrease in species that prefer river-like conditions. The flooding of several tributaries to Gull Lake will result in a loss of run and riffle habitat, which are typically highly productive in terms of forage fish. Fish access to the upper portions of tributaries that are not completely flooded will be maintained through a program to remove accumulations of flooded debris from the mouths of these streams (see AE SV Appendix 1A for more details). Information collected on the fish community in Stephens Lake, which is a proxy for the Keeyask reservoir, has shown that all of the habitat requirements of walleye, northern pike, and lake whitefish are met in the reservoir.

To obtain quantitative estimates of changes in fish abundance as a result of habitat alterations, a model was developed to estimate the abundance of fish and available foraging habitat for juvenile/adult fish in the post-Project environment at four time steps after impoundment (Years 1, 5, 15 and 30) for peaking and base load operation modes (see AE

SV Section 5.4 for more details). These estimates were generated using the area of habitat types from existing pre-Project and predicted post-Project habitat maps and habitat-specific catch-per-unit-effort values for fish species or groups.

Based on habitat modelling, the abundance of the large-bodied fish community in the first year after impoundment in peaking mode of operation is predicted to be approximately 7% lower than in the existing environment, and will gradually increase over time as aquatic habitat evolves. However, within the first year of impoundment there will be an almost doubling of the useable foraging area in the reservoir for large-bodied species compared to the existing environment. Text and tables that provide detailed habitat modeling results for scale fish can be found in AE SV Section 5.4. Northern pike populations are predicted to be lower in the first year due primarily to a decrease in the amount of shallow, low-velocity habitats and habitats with standing water and hard substrates. In contrast, the abundance of walleye and lake whitefish could potentially increase in the first year in response to an increase in primarily deep, standing or low velocity habitat with soft silt/clay substrates. However, it should be noted that the model is based on fish production in habitat types, and that the actual fish numbers will require at least one generation to reflect changes to productive capacity.

In the long term (thirty years after impoundment), changes in aquatic habitat are predicted to result in a 15% increase in the relative abundance of large-bodied species and a doubling of useable foraging habitat. Walleye and lake whitefish populations in the Keeyask reservoir are expected to benefit from impoundment over the long-term, with increases in density and total numbers. The modeled density of northern pike is expected to decrease but the number of northern pike is expected to increase due to the greater amount of useable habitat.

The habitat model is based on foraging habitat, which is likely the habitat that most influences the total amount of fish present in a system, if sufficient areas of other habitats (*e.g.*, spawning and overwintering) are available. While there will be an increase in the amount of foraging habitat available to walleye and lake whitefish populations, the homogenization of habitat conditions in the reservoir could result in a decrease in spawning habitat. To increase the amount of spawning habitat for these species, some areas in the reservoir will be modified prior to impoundment by constructing shoals of suitable materials (boulder/cobble/gravel substrate) in the vicinity of known spawning locations. Shoals will be constructed with a minimum surface area of 0.1 ha in areas that will be shallow (for walleye depths range from 0.3–0.8 m below the minimum reservoir level) or moderately deep (for lake whitefish water depths range from 2.0–2.5 m below the minimum reservoir level to avoid freezing during winter). The shoals will be exposed to sufficient water velocity or wave action to prevent the deposition of fine sediments. Up to eight potential locations have been identified near existing spawning locations. Design criteria are based on shoals that have been constructed in other areas (see AE SV Appendix 1A for additional information). The inundation of Birthday Rapids could also result in a loss of spawning habitat for these species; however, it is expected that fish will find alternative suitable habitat within Birthday Rapids or will move further upstream to access habitat available at Long Rapids. Once macrophyte beds re-establish in the reservoir, spawning habitat for northern pike will be available around flooded tributary mouths and in upstream unflooded reaches of these tributaries.

Overwintering habitat is expected to be abundant in the reservoir, as there will be ample off-current, deep-water habitat.

Map 6-57, Map 6-58 and Map 6-59 show the predicted locations of spawning, foraging, and over-wintering habitat in the post-Project environment, in comparison to the existing conditions, for walleye, northern pike and lake whitefish, respectively. Predicted habitat uses post-Project are based on the use of existing habitat, and predicted aquatic habitat post-Project.

Experience in Other Reservoirs

In addition to the habitat model described above, the assessment also considered changes in other similar reservoirs. Existing conditions in reservoirs that could be considered as proxies (*e.g.*, Stephens Lake and reservoirs in Québec) suggest that the abundance of the VEC species in the Keeyask reservoir will, over the long-term, remain similar to or become moderately higher than conditions that currently exist in Gull Lake. Compared to conditions in Gull Lake, walleye catch-per-unit-effort (CPUE) in Stephens Lake is about 20% higher, lake whitefish CPUE is similar, and northern pike CPUE is about 9% lower (AE SV Section 5.4). After about 15 years, the CPUE of fish populations in the Robert Bourassa and Opinaca reservoirs returned to levels observed before impoundment (Hayeur 2001; DesLandes *et al.* 1995). As has been observed in the reservoirs along the lower Nelson River (*e.g.*, Kettle, Long Spruce, and Limestone GSs), impoundment of the Keeyask reservoir is expected to result in a shift in the composition of the fish community (AE SV Section 5.3; Bretecher and MacDonell 2000; Johnson *et al.* 2004; NSC 2009). Over the long-term, the relative abundance of species typically associated with lake-like conditions, such as walleye, white sucker, northern pike, and burbot, are expected to increase, while species that prefer river-like conditions, such as longnose sucker, mooneye, and goldeye, may become less abundant.

Other Considerations

The GS will affect both downstream and upstream movements of fish between the reservoir and Gull Lake. The amount of drift of larval fish from Gull Lake downstream over Gull Rapids to Stephens Lake is not known; however, it is expected that downstream losses are negligible considering the area of upstream habitat. After the Project is built, it is expected that downstream transport would be reduced due to lower velocities in the reservoir upstream of the GS compared with the existing environment; however, this reduction is not expected to increase the size of the fish population in the reservoir. As discussed in Section 6.2.3.3.5, movement of adult walleye, northern pike, and lake whitefish upstream and downstream past Gull Rapids has been documented, but the incidence of these movements appears low and they are not associated with fulfilling a specific life history requirement (*e.g.*, spawning migration, movement to overwintering habitat). Therefore, populations of these species in Gull Lake are not reliant on habitat in Stephens Lake to maintain existing numbers. However, as discussed below with respect to effects downstream of the GS, a trap and transport program to maintain upstream movement of fish from Stephens Lake to the reservoir will be implemented. Downstream movement of fish from the reservoir to Stephens Lake will occur via the spillway (when it is in operation) and the turbines. Additional information is provided below.

At present, the fishing activity in Gull Lake is limited due to difficulty in access. The construction of the access road and reduction in velocity at Birthday Rapids will increase the potential for people to access these areas and could result in an increase in harvest. It is expected that harvesting will remain within sustainable levels, given regulation of recreational fisheries, the absence of commercial fisheries (the Stephens Lake fishery is expected to be discontinued by agreement), and the traditional sustainable approach employed by domestic fishers. In addition, the KCNs have indicated that they prefer harvesting off-system areas due to concerns with fish quality. It also is expected that the programs described in the AEAs will redistribute existing domestic fishing pressures to a broader land base (Section 6.7.3.1).

DOWNSTREAM OF THE KEEYASK GENERATING STATION

Changes in Habitat

As most of the changes to fish habitat downstream of the Keeyask GS will occur within a 3 km (1.9 miles) long reach between the powerhouse and Stephens Lake, it is anticipated that the major effect to the fish community and VEC species will be associated with the loss of fish habitat in Gull Rapids. Without mitigation, the loss of spawning habitat at Gull Rapids would likely result in a decrease in recruitment to the populations of some large-bodied species (*e.g.*, lake whitefish, walleye) in Stephens Lake. It is expected that these species would find alternative spawning habitat elsewhere in the reach or would use artificial spawning habitat created below the GS (see the discussion of lake sturgeon spawning habitat in Section 6.4.6.2.2 for more details). Since Gull Rapids is one of the few spawning locations known to be used by lake whitefish in Stephens Lake, a 0.1 ha spawning reef will be constructed in Stephens Lake to provide additional lake whitefish spawning habitat post-Project (AE SV Appendix 1A). The reef was designed using criteria that have been successfully applied in other areas. It will consist of a mixture of boulders, cobbles and gravels, placed to form a shoal 2.0–2.5 m below the minimum water elevation in Stephens Lake (to avoid freezing over winter), and exposure to sufficient water velocity or wave action to maintain the substrate free of fines (additional information is provided in AE SV Appendix 1-1A).The loss of spawning habitat at Gull Rapids has no potential to affect recruitment to northern pike populations in Stephens Lake as sufficient alternative spawning habitat is available in other areas.

Gull Rapids also provides foraging habitat for a variety of fish species. Data are limited due to difficulty in safe access, but the rapids and river channel immediately downstream provide habitat for a variety of forage species, as well as pisciviorous fish including walleye and pike. The abundance of VEC species in the river during summer is lower than in the north arm of Stephens Lake, suggesting that this is less important foraging habitat than other locations in Stephens Lake.

Effets to Fish Movements

The presence of the GS is expected to reduce the transport of larval and juvenile fish from Gull Lake into Stephens Lake. The proportion of larval and juvenile fish within Stephens Lake that originate upstream is not known, but given that Stephens Lake is much larger than Gull Lake and has abundant spawning habitat for walleye, northern pike and lake whitefish, the contribution from upstream is likely not required to maintain populations in Stephens Lake.

As discussed above, the movement of adult walleye, northern pike and lake whitefish between Stephens Lake and Gull Lake appears to be incidental and blocking access from Stephens to Gull Lake is not expected to reduce the size of the fish population in Stephens Lake. Movements do not appear to support a specific life history function, as there is no evidence of routine migrations back and forth over Gull Rapids (*e.g.*, fish resident in Stephens Lake migrating upstream to spawn and then returning downstream to use foraging and overwintering habitat in Stephens Lake).

The contribution of migrants from the upstream reservoir to Stephens Lake after the project is constructed is not expected to affect the size of the fish population in Stephens Lake, as only a small fraction of the adult fish in the reservoir are expected to move. Telemetry studies in the Limestone reservoir have shown that less than 15% of the walleye, northern pike, and lake whitefish marked with acoustic transmitters passed downstream through the generating station or spillway during three years of monitoring (Pisiak 2009).

Although creating a barrier to upstream fish movement is not expected to affect population size, Fisheries and Oceans Canada has identified the need to include upstream fish passage in the Project design to maintain existing connections among fish populations. This reflects a precautionary approach with respect to uncertainty regarding the importance of maintaining connections among populations. To address effects of the generating station on fish movements, the following measures will be implemented:

- Upstream fish passage will be provided by a trap and transport program that will target key fish species (walleye, northern pike, lake whitefish and lake sturgeon (see Section 6.4.6.2.2 for a discussion of lake sturgeon) during the initial period of station operation;

- Results of the trap and transport program, fish movements, and fish populations will be monitored to assist in optimizing fish passage in the long term; and
- Turbines and spillways will be designed in a manner that will allow fish moving downstream to do so without sufficient mortality to affect the fish populations.

A specific trap and transport program is under development (see Section 4.5.1.5 for a description of the phased approach) and will be implemented in close consultation with Fisheries and Oceans Canada and Manitoba Conservation and Water Stewardship. The conduct of the trap and transport program will be planned to avoid potential adverse effects, such as depletion of fish stocks in Stephens Lake and release of fish into unsuitable environments in the reservoir (*e.g.*, fish requiring fast-flowing water for spawning would not be transported to a deep section of the reservoir during the spawning season). Monitoring of the movements of fish that are transported in the program, as well as individuals that are immediately downstream of the station will be used to determine the success of the program. This would include both an assessment of the success in capturing fish for transport and determining whether transported fish are better able to fulfill their life history requirements than fish that remain below the generating station. Results of monitoring would be used to refine the trap and transport program or provide the rationale for selection of a different method of fish passage.

Fish moving downstream from the Keeyask reservoir would need to either move over the spillway (when it is in operation) or past the trash racks and turbines. Based on historic records, the spillway would be in operation approximately 12% of the time on an annual basis, though typically some years have frequent spills and others have none. Passage through the spillway, because it will follow the old river bed and not have any sudden drops, plunge pools, or barriers, is not expected to result in the injury or mortality of a large percentage of the fish. Members of FLCN predict that the Keeyask Project will negatively affect fish populations by causing spillway and turbine mortality (FLCN 2008 Draft; FLCN 2009 Draft). There is a potential for fish to become stranded in isolated pools after the spillway ceases operation; therefore, channels connecting these pools to Stephens Lake will be constructed to allow fish to escape.

Fish may also move past the trash racks and turbines. As described in Section 4.5.1.6, trash racks will be installed on the face of each intake to the powerhouse and be comprised of vertically oriented rectangular shaped steel bars with a clear bar spacing of 16.75 cm (6.6"). As discussed in the AE SV Appendix 1A, the largest individuals in the population (depending on species, greater than 1.4 m [4.6 feet] in fork length) will be physically excluded from passing downstream. Slightly smaller individuals would also not be expected to pass downstream as the opening would be only slightly larger than their body. Based on the estimated velocities at the intake (ranging from 1.0–1.2 metres/second [m/s] [3.3–3.9 feet/s]) and fish swimming capabilities, few fish are expected to become permanently impinged on the trash rack. Smaller fish that are moving downstream would move past the trash racks and the turbines.

The turbines of the Keeyask GS incorporate several design features to reduce injury and mortality to fish (Section 4.5.1.4). These features were selected based on experimental studies that have occurred at hydroelectric stations in Canada and the United States. Important features include methods to reduce the probability of fish being struck while passing through the turbines (by eliminating overhang by structures such as wicket gates and reducing rotational speed), reducing the size of gaps where fish may become trapped, and reducing the degree of injury (by providing blades with a thicker leading edge and reducing rotational speed), and incorporating measures to reduce turbulence. Based on the turbine specifications, the calculated survival rate for fish up to 500 mm (19.7 ") is greater than 90% (see AE SV Appendix 1A for more details).

The estimated survival rates for the Keeyask turbines are based primarily on extrapolations from studies involving fish such as salmonids (see AE SV Appendix 1A for more information). Experimental studies conducted at the Kelsey GS found that the survival rate of walleye and northern pike was greater than 75% (NSC and Normandeau Associates Inc. 2009). About 70% of walleye and small northern pike (150–450 mm [5.91–17.7 "] total length) passed through the turbines without injury. However, the rate of injury increased with northern pike length; about 60% of northern pike larger than 450 mm (17.7 ") were injured during turbine passage. Although survival rates are less than predicted for the Keeyask GS, the turbines at the Kelsey GS have a considerably higher rotational speed and sharp leading edges, which appeared to contribute to the injuries and mortalities. These issues have been addressed in the design of the Keeyask turbines.

As discussed for Gull Lake, construction of the access road and new boat launch facilities have the potential to increase fish harvest in Stephens Lake. However, it is expected that the current commercial harvest will cease operation (Section 6.7.4); therefore, a negligible decrease in the mortality due to harvest is expected.

RESIDUAL EFFECTS OF OPERATION

In summary, the following mitigation measures will be implemented to address operation effects on walleye, northern pike and lake whitefish:

- Escape channels will be constructed to connect present day Little Gull Lake to deeper sections of the reservoir;
- Coarse materials will be placed in suitable areas within the reservoir to create spawning habitat for lake whitefish and walleye;
- Access to small tributaries in the reservoir will be maintained by removing accumulations of debris;
- Large boulders interspersed with smaller boulders and cobble will be placed in an area along the north shore of the Nelson River, and downstream of the GS. Although

targeted at lake sturgeon, this area will also provide spawning habitat for walleye, and depending on conditions in the river, lake whitefish;

- Channels that connect spillway pools to Stephens Lake will be constructed to prevent fish stranding;
- A trap and transport program for upstream fish passage will be implemented. Downstream fish passage is being provided via the turbines and spillway, both of which incorporate design features to reduce the risk of injury and mortality to fish. The Project will be designed and constructed in a manner that would allow it to be retrofitted to accommodate other upstream and/or downstream fish passage options if required in the future; and
- A reef of coarse material will be constructed along the south shore of the Nelson River downstream of the GS to create spawning habitat for lake whitefish.

The mitigation measures described above have been discussed with Fisheries and Oceans Canada and Manitoba Conservation and Water Stewardship. Additional measures that would be implemented prior to or during Project operation may be identified as a result of ongoing discussions regarding Project effects and mitigation between the Partnership and regulatory agencies.

A detailed description of expected residual effects to VEC fish species is provided in AE SV Section 5.4. The following are the residual effects to walleye, northern pike and lake whitefish once the appropriate mitigation measures are applied:

- Some spawning sites for lake whitefish and walleye (*e.g.*, inlet of Gull Lake, constriction in Gull Lake upstream of Caribou Island) will not be available in the reservoir but these will be replaced by spawning habitat created at nearby locations;
- The existing littoral habitat in the lower portion of the reservoir will be lost. New littoral habitat that will develop will be of lower quality due to daily/weekly cycling within the reservoir;
- Fish habitat in the newly flooded areas of the reservoir will be of lower quality due to low DO conditions, shoreline instability, and the absence of aquatic plants for the first 10–15 years after impoundment. As conditions evolve, these areas will develop into suitable feeding habitat for many fish species and spawning habitat for species such as northern pike;
- Over the long-term, there will be an increase in the fish abundance in the reservoir. The composition of the fish community will shift towards species that prefer lacustrine (*e.g.*, walleye) rather than riverine conditions (*e.g.*, longnose sucker);
- Some areas of the reservoir will not be suitable for fish at certain times due to low DO levels; however, fish will be able to move to areas with adequate DO. In the area of

Little Gull Lake, where fish could be trapped following development of an ice cover, escape channels will be constructed to allow for the movement out of the area;

- Spawning habitat for lake whitefish and walleye will no longer be available in Gull Rapids; the loss of this habitat will be mitigated by constructed habitat in the tailrace and a reef in Stephens Lake;
- Effects of Project operation on fish habitat are generally expected to occur during the first 10 years, but gradual shifts in the abundance and composition of the fish community in response to environmental conditions will occur over decades; and
- The number of fish entering Stephens Lake from upstream may be reduced compared to existing conditions due to the creation of a reservoir environment in place of the existing river. Some of the fish that move downstream into Stephens Lake will be injured or killed by passage through the turbines or over the spillway but the majority are expected to survive.

Using the criteria established to determine the significance of Project effects for regulatory purposes (described in Section 5.5), the likely residual effects of Project operation on northern pike are expected to be negative, small, medium in geographic extent (reservoir) and short-term. Effects are reversible as they will disappear over time as littoral habitat becomes established. Effects of Project operation on walleye and lake whitefish are expected to be positive, small, medium in geographic extent (reservoir) and long-term. No residual effects to VEC species in Stephens Lake are expected.

6.4.6.1.3 Conclusion about Residual Effects on Walleye, Northern Pike and Lake Whitefish

Walleye and lake whitefish in Stephens Lake are predicted to experience negative effects during construction due to the loss of spawning habitat, but effects will be neutral in the long-term as replacement spawning habitat becomes available. In the Keeyask reservoir, both species are expected to experience a small, positive (population increase) effect. No construction-related effects are predicted for northern pike, but this species will experience some short-term negative effects until appropriate habitat becomes established in the reservoir. Predicted effects are continuous (for the duration of the effect). Adverse effects during construction and the initial years of operation are reversible, as VECs are expected to recover over time. The ecological context is moderate, reflecting the importance of the top level predators in the aquatic ecosystem (walleye and northern pike) and their sensitivity (lake whitefish), as well as the capability of the species to adapt to the altered environment.

The technical scale fish assessment is based on an analysis of existing habitats and their post-Project condition, observation of scale fish in a proxy reservoir (*i.e.*, Stephens Lake), and scientific literature that discusses their success in other reservoirs. These approaches provide moderate to high certainty regarding the prediction of adverse effects.

The adverse residual effects of the Project are not expected to overlap or interact spatially and temporally with effects from future projects (see Section 7.5.1).

Monitoring of scale fish has continued periodically since the conclusion of the EIS studies and will be repeated prior to construction to update the baseline. Fish, including VEC species, will be monitored every two years during construction and in the initial years of operation depending on results, and less frequently thereafter (Chapter 8). Monitoring will include measurement of the relative abundance and composition of the fish community, as well as indicators of fish health. The baseline for comparison to pre-Project results will include data presented as part of this EIS, as well as studies conducted periodically in the period from 2009 to 2014.

6.4.6.2 Lake Sturgeon

Lake sturgeon is an aquatic VEC. This species has been of particular concern for the development of the Project due to the current low population numbers and its vulnerability to the effects of hydroelectric development. The objectives of the extensive mitigation package developed for this Project are to provide habitat to support all life history stages upstream and downstream of the GS, and identify measures that can increase the regional population of lake sturgeon. A detailed description of the effects of construction and operation is provided in AE SV Section 6.4.

6.4.6.2.1 Construction Effects and Mitigation

Through the following pathways, the Project has the potential to affect lake sturgeon during construction:

- Relatively rapid changes in water levels and velocities in Gull Lake during Stage II construction;
- Disruption of spawning activity due to disturbance by construction activity and habitat loss/alteration;
- Alteration of aquatic habitat in Stephens Lake due to sediment deposition;
- Stranding of fish during cofferdam dewatering;
- Entrainment of fish in water intake pipes used for construction;
- Blasting effects;
- Water quality effects from instream construction activities, malfunctions, or accidental spills; and
- Potential harvest by aboriginal members of the workforce (lake sturgeon can only be used for subsistence harvest).

The effects of habitat alterations related to flooding and permanent loss of Gull Rapids that begin during construction, but are permanent changes in operation, are discussed in the operation section.

The construction effects described in the preceding section for scale fish apply to lake sturgeon; therefore, only points unique to lake sturgeon are described below.

As water levels in Gull Lake increase during construction, lake sturgeon may move upstream or potentially downstream in response to changes in water flows. This movement may result in a small increase in the number of lake sturgeon in Split Lake and/or Stephens Lake, and a decrease in adult and sub-adult lake sturgeon in the Keeyask reservoir. Over time, some lake sturgeon that move upstream may return downstream to the reservoir. Although fish that permanently leave Gull Lake will not be replaced with the same age classes, conservation stocking will be used to maintain the total number of lake sturgeon in the reservoir. A detailed description of the conservation stocking program is provided in AE SV Appendix 1A, and key points are summarized at the end of the operation assessment for lake sturgeon.

Construction of cofferdams will result in the loss of aquatic habitat in Gull Rapids. Spawning and foraging habitat in the north and central channels of the rapids will be lost during Stage I. Water velocities in the south channel will increase, and although conditions may be suitable for lake sturgeon spawning and foraging, it is not known whether lake sturgeon will use this habitat. Given this uncertainty, construction processes, such as blasting and the release of TSS, will be managed on the basis that lake sturgeon are continuing to spawn in the south channel during construction, to allow for appropriate protection of sensitive early life stages. Complete closure of the river through construction of cofferdams across the south channel (Stage II Diversion) will result in the loss of all remaining habitat in the rapids. A lake sturgeon spawning structure constructed downstream of the tailrace will be available after the station is in operation (see operation effects and mitigation); however, during the construction period, stocking will be used to mitigate the reduction in recruitment.

Instream construction activities are predicted to result in the deposition of a 0.1–0.6 cm (0.04–0.2 ") layer of sediment on the bottom of Stephens Lake; it is expected that this deposition will not result in a change in substrate composition (*e.g.*, sand will settle on existing areas of sand, silt will settle on existing areas of silt) (Section 6.4.3.2.1). Most of the deposition is predicted to occur near the entrance of Stephens Lake in an area approximately 4–6 km (2.5–3.7 miles) downstream of Gull Rapids that provides suitable habitat for YOY and sub-adult lake sturgeon. Although this deposition is unlikely to affect lake sturgeon use of this area, monitoring will determine if lake sturgeon continue to use this habitat.

During construction, there is no potential for an increase in fish mortality due to harvesting by Aboriginal members of the workforce. Due to restrictions within the construction site and the prohibition on bringing personal boats on site, workers will not be able to access areas where sturgeon would be vulnerable to harvest.

Residual Effects of Construction

In summary, the following mitigation measures will be implemented to address construction effects on lake sturgeon:

- Avoidance of instream construction during sensitive spawning periods, where possible;
- Fish salvage prior to dewatering;
- Application of guidelines for end-of-pipe screening and blasting;
- Measures to reduce effects on water quality;
- Measures that prevent harvest; and
- Stocking in both the reservoir and Stephens Lake.

A detailed description of expected residual effects to lake sturgeon is provided in AE SV Section 6.4. The following are the residual effects on lake sturgeon once the appropriate mitigation measures are applied:

- Potential loss of older sub-adults and adult lake sturgeon from Gull Lake due to emigration during construction. Overall population numbers will be maintained through stocking, but this strategy will not replace older year classes; and
- Loss of natural recruitment downstream of the GS due to loss of spawning habitat in Gull Rapids. Stocking of YOY and/or yearlings is expected to mitigate potential effects to the overall population.

Using the criteria established to determine the significance of Project effects for regulatory purposes (described in Section 5.5), the likely residual effects of Project construction on lake sturgeon are expected to be adverse, moderate, medium in extent, and medium-term.

6.4.6.2.2 Operation Effects and Mitigation

Through the following pathways, the Project has the potential to affect lake sturgeon during operation:

- Increase in lake sturgeon movements upstream to Split and Clark lakes due to velocity changes as a result of impoundment (*e.g.*, reduction in velocity at Birthday Rapids);
- Habitat changes in the reservoir due to changes in water levels and flow that will result in the loss or alteration of existing habitat (riverine channels in Gull Lake, Birthday Rapids) and creation of new habitat;
- Creation of a barrier to upstream fish movement at Gull Rapids due to the presence of the GS;

- Changes in downstream movement of larval, juvenile and adult fish due to the creation of the reservoir and presence of the GS structures (*i.e.*, dam, spillway, trash racks and turbines);
- Loss of Gull Rapids;
- Alteration of habitat in the river channel between Gull Rapids and Stephens Lake;
- Potential for fish to become stranded in the dewatered spillway channel after spillway operation; and
- Changes in domestic harvest levels.

WITHIN THE KEEYASK RESERVOIR

Key pathways are discussed below; all pathways are discussed in the AE SV Section 6.4.

In the long-term, upstream movement of lake sturgeon over Birthday Rapids may increase, but this could be accompanied by an increase in downstream movements from Split Lake into the reservoir; no measureable effect to numbers in either the Keeyask reservoir or Split Lake are expected.

Effects to water quality as a result of impoundment will be greatest in off-current flooded areas; as these are not preferred habitat for lake sturgeon no effect is expected.

Changes in Habitat

The reach of the Nelson River from the outlet of Clark Lake to the Keeyask GS, which will form the future Keeyask reservoir, will undergo substantial changes in habitat post-impoundment. Based on lake sturgeon use of the existing environment (Section 6.2.3.3) and habitat changes described in Section 6.4.3.2.2, the following are potential adverse changes with respect to the life history stages:

- Potential reduction/degradation of spawning habitat at Birthday Rapids due to increased depth, reduced velocity and loss of white water;
- Substantial alteration and loss of access to existing YOY rearing habitat in Gull Lake due to the deposition of silt over existing sand substrates and a reduction in velocity in the river channel connecting this habitat to the upstream spawning location; and
- Alteration of current preferred habitat for sub-adult lake sturgeon due to silt deposition throughout much of present-day Gull Lake.

It should be noted that impoundment will create substantially more deep water habitat, with low flow that is suitable for sub-adult and adult lake sturgeon. The amount of overwintering habitat will also increase, due to the increase in depth and decline in velocity in the faster-flowing river sections. Spawning habitat that currently exists at Long Rapids, upstream of

Birthday Rapids, will remain post-Project and may become more accessible due to the decline of water velocity at Birthday Rapids.

A habitat suitability index (HSI) model was developed to evaluate the importance of the habitat changes listed above, assess whether the reservoir will provide habitat to support all life history stages, provide a quantitative estimate of habitat changes from the existing condition, and assist in identifying key habitats that may require mitigation. Additional information on the model is provided in the AE SV Section 6.4.

The habitat assessment and mitigation program developed for lake sturgeon in the Keeyask reservoir focused on providing habitat for all life history stages. The largest changes to lake sturgeon habitat will be the potential loss of Birthday Rapids as a spawning site and the loss of riverine areas within Gull Lake associated with its conversion to a reservoir environment. The post-Project HSI model (Map 6-60) suggests that Birthday Rapids will no longer be suitable for spawning due to a loss of white water habitat. In some locations lake sturgeon have continued to spawn in areas where white water habitat has been lost but appropriate velocity and substrate conditions remain (AE SV Section 6.4). Should post-Project monitoring indicate poor or no spawning success in the vicinity of Birthday Rapids, contingency works to create suitable spawning habitat through shoreline modifications will be implemented. Spawning habitat will continue to be available at Long Rapids, post-Project, and more lake sturgeon may move upstream to this location when water velocity at Birthday Rapids is reduced.

Riverine areas that will be lost from Gull Lake appear to support greater aggregations of YOY and sub-adult lake sturgeon than other areas. It is unlikely that the combination of physical features that currently make these areas suitable to young lake sturgeon (particularly YOY) will be present in sufficient quantity to sustain the population in the post-Project environment. The HSI model indicates that the amount of high quality YOY habitat that will be available after impoundment will be substantially reduced, and the small amount that remains will be located several kilometres downstream from the areas where drifting YOY are expected to settle, which is at the upper end of former Gull Lake (Map 6-61).

Based on these predictions, it will likely be necessary to create YOY habitat through the placement of sand in the riverine section of the reservoir at the upper end of Gull Lake (AE SV Appendix 1A). However, monitoring will be conducted prior to habitat creation given that substrate conditions in the river reach where larval lake sturgeon are expected to settle may be suitable. If monitoring demonstrates that no juvenile lake sturgeon are being recruited, then coarse sand/fine gravel will be placed in a 20 ha area in the mid section of the Nelson River where velocity is sufficiently low to prevent the mobilization of sand but high enough to prevent silt deposition over the sand. A phased approach is proposed, and a second area of sandy habitat may be created depending on results from the first.

The HSI models predict net increases in foraging habitat for sub-adult and adult lake sturgeon between Clark Lake and the Keeyask GS (Map 6-62 and Map 6-63). However, given that in the existing environment lake sturgeon densities are highest in a few locations in Gull Lake despite the widespread presence of suitable habitat, not all the post-Project habitat will be highly preferred.

Experience in Other Reservoirs

In addition to the HSI model described above, the assessment considered changes that have occurred in other reservoirs. The three reservoirs on the lower Nelson River (*i.e.*, Stephens Lake, Long Spruce reservoir, and Limestone reservoir), all have smaller lake sturgeon populations than pre-impoundment. Both the Long Spruce and Limestone reservoirs are bounded by dams on both ends and are primarily channels with a U-shaped cross section with little habitat diversity. These reservoirs contain remnant lake sturgeon populations, but it is unclear whether the few young lake sturgeon captured in them are a product of spawning within the reservoirs or immigrants from upstream. Stephens Lake, which is immediately downstream of the Keeyask reservoir, is a better proxy for the Keeyask reservoir as conditions will be similar, in that the lower impounded portion of the reservoir is adjacent to a free-flowing river channel with large rapids. As predicted for the Keeyask reservoir, habitat for all life history stages is present in Stephens Lake. The reason(s) for the current low population numbers in Stephens Lake are not known, but are thought to be due to a combination of emigration of adults at impoundment, habitat changes (in particular a reduction in suitable YOY habitat) and harvest resulting in the population declining to below sustainable levels (see AE SV Section 6.4 for more details). As described in this section, the mitigation planned for the Keeyask Project will address all these potential causes of lake sturgeon decline post-impoundment.

There are numerous examples of reservoirs where sturgeon numbers have been maintained following impoundment or subsequent declines have been attributed to other factors (*e.g.*, harvest) (Table 6-17). Conditions in these reservoirs can assist in predicting the future condition of the Keeyask reservoir, as well as identifying appropriate mitigation measures. Reservoirs where sturgeon have persisted typically have the following characteristics:

- Conditions to meet all life history requirements;
- Substantial river sections or access to river environments; and
- No or minimal harvest.

It has been suggested that a minimum of 250–300 km (155–186 miles) of barrier-free river and lake habitat are necessary to support a self-sustaining lake sturgeon population (Auer 1996). However, self-sustaining lake sturgeon populations may exist in much smaller river reaches such as the Seven Sisters and Slave Falls reservoirs in the Winnipeg River (Table 6-17). There are also self-sustaining populations of other sturgeon species in relatively short reaches of impounded river (*e.g.*, white sturgeon, *Acipenser transmontanus*) in the Bonneville and Dalles reservoirs on the lower Columbia River (Table 6-17).

Table 6-17: Healthy Sturgeon Populations Residing in Impounded River Reaches

Species	Location	Downstream and Upstream Barriers	Length of River Reach	Estimated No. Fish (95% CI[1])	Harvest	References
Lake sturgeon	Winnipeg River, Manitoba	Seven Sisters GS and Slave Falls GS (1997)	41 km (25.5 miles)	2,998 (1,143–13,101)[2]	None	Block (2001)
		Slave Falls GS and Pointe du Bois GS (2006)	10 km (6.2 miles)	2,131 (1,443–3,167)[2]	None	Manitoba Hydro (2011)
White sturgeon	Lower Columbia River, Washington and Oregon	Bonneville GS and Dalles GS (2006)	74 km (46.0 miles)	113,300 (95% CI not provided)[3]	Sport and Commercial	Storch *et al.* (2008)
		Dalles GS and John Day GS (2005)	38 km (23.6 miles)	45,700 (37,000–56,300)[3]	Sport and Commercial	Storch *et al.* (2008)

Notes
1. Confidence interval.
2. Adult fish.
3. Includes sub-adult and adult fish.

Other Considerations

The lake sturgeon population in the Keeyask reservoir will also potentially be affected by the loss of access to habitat in Stephens Lake and the barrier to the upstream movement of fish from Stephens Lake (*e.g.*, potential loss of inputs to the population from immigration). The effect of the GS as a barrier to movements in the context of Stephens Lake is discussed below (see Downstream of the Keeyask Generating Station).

The construction of the access road and reduction in velocity at Birthday Rapids could increase the potential for domestic harvest. As discussed at the end of this section, a lake sturgeon conservation awareness initiative will be developed to inform resource users of the vulnerability of the lake sturgeon population in the reservoir.

In addition to the mitigation measures described above, a stocking plan has been developed to enhance the existing population in this reach and to compensate for potential population reductions. The stocking plan will be implemented at the start of construction and will include the introduction of fingerlings (three to four months old) and yearlings to the reservoir. Stocking of fingerlings and yearlings bypasses the more vulnerable life stages, which have the most specific habitat requirements (eggs, larvae, and early YOY). Maintaining a viable population will prevent the long-term decline that has occurred in some reservoirs, such as Stephens Lake.

DOWNSTREAM OF THE KEEYASK GENERATING STATION

Changes in Habitat

Habitat changes downstream of the Keeyask GS include: (i) the loss of spawning and foraging habitat in Gull Rapids; and (ii) the alteration of foraging habitat in the river channel between the GS and Stephens Lake. No change to habitat in Stephens Lake, including the sand and gravel area identified as habitat for YOY and sub-adult lake sturgeon, is predicted; this will be confirmed by monitoring (Section 6.4.3.2.2).

The loss of spawning habitat at Gull Rapids is expected to be the largest effect of the Project on lake sturgeon in Stephens Lake (Map 6-60). Members of CNP and FLCN are also concerned that lake sturgeon spawning habitat will be lost at Gull Rapids (FLCN 2010 Draft; CNP Keeyask Environmental Evaluation Report; FLCN Environment Evaluation Report (Draft)) and that those lake sturgeon that remain will be trapped between dams with less available habitat (CNP, YFFN and FLCN 2011).

To compensate for the loss of spawning habitat, several areas will be developed to provide suitable spawning habitat (see AE SV Appendix 1A for a detailed description). A spawning structure will be constructed along the north bank immediately downstream of the tailrace, based on a design that has proven effective at a hydroelectric station in Québec. The structure will consist of a 3 ha area with a base comprised of cobbles and boulders with a minimum diameter of 0.1 m (0.3 feet) to allow for ample interstitial spaces for egg incubation, and clusters of three large (greater than 0.9 m [2.9 feet]) boulders spread over the structure to create off-current resting areas and turbulent flow. A range of depths (1–10 m [3.3–33 feet]) and velocities (0.5–1.5 m/s [1.6–4.9 feet/s) will occur over the structure. During the lake sturgeon spawning and egg incubation period (late May to mid-July), operation of the GS will be constrained to include continuous operation of the two units immediately upstream of the structure to ensure adequate flows (Section 4.7.1). The structure will be monitored to determine whether successful spawning is occurring and, if not, it will be modified as required.

Lake sturgeon may, under some flow conditions, move upstream past the spawning structure and into the tailrace (in particular along the edges where velocity is lower). To provide appropriate habitat, the north bank of the tailrace will be modified to create a shelf with coarse substrates, and cuts in the wall of the tailrace will guide sturgeon moving at depth up towards the suitable substrate.

In addition, coarse materials from the remnants of the tailrace cofferdam will be spread to create conditions attractive to spawning fish in areas where interference with the outflow from the GS will not be a concern. The tailrace cofferdam extends from the transmission tower spur downstream and then to the north bank; locations where remnants will be left will be determined following further hydraulic modeling.

Lake sturgeon could also use habitat in the river below the spillway in years when the spillway is operating at sufficient discharges during the spawning and egg incubation period (estimated at 20–30% of the spring periods) (Map 6-60). During years when discharge from the spillway appears adequate to attract spawning sturgeon, the spillway channel and immediate downstream river environment will be monitored to determine whether lake sturgeon are spawning in this area and, if so, attempts will be made to identify locations and timing of egg deposition. If eggs are deposited, spillway discharge would be maintained at levels sufficient to permit egg hatch and survival of larval fish until they emerge and drift from the site.

Foraging habitat in the river reach below the GS will be altered by a redistribution of flows and deposition of fine sediments in some shoreline areas (Section 6.4.3.2.2). No marked effects to the suitability of this area for lake sturgeon is expected (Map 6-61, Map 6-62 and Map 6-63). Habitat suitable for YOY sturgeon is present in the western portion of Stephens Lake north of Cabin Island (Section 6.2.3.3.5); analysis of post-Project sedimentation indicates that this area will not be subject to silt deposition during construction or operation (Section 6.3.8.2). Based on predicted flow patterns downstream of the GS, larval sturgeon hatched on the spawning structure constructed along the north shore would drift to this area of suitable YOY habitat.

Effects to Fish Movements

Creation of the Keeyask reservoir will reduce or eliminate the transport of larval lake sturgeon from upstream of Gull Rapids into Stephens Lake. The number of larval lake sturgeon presently entering Stephens Lake and the importance of this influx to the population is not known. Given that spawning sturgeon have not been captured in Gull Rapids in recent years, and that the majority of flow from spawning locations at Long and Birthday rapids moves along the south channel of the Nelson River where there are few low velocity areas for larval sturgeon to settle, it is likely that a substantial number of larval sturgeon may drift over Gull Rapids and into Stephens Lake. Stocking of fingerlings and yearlings into Stephens Lake, which is planned to augment the small population (see below), will also compensate for any reductions in the input of drifting larval lake sturgeon.

The GS will block upstream movements of adult lake sturgeon from below the GS, and downstream movements from the reservoir, except for fish that pass over the spillway or past the turbines. Currently, adult lake sturgeon move upstream and/or downstream over Gull Rapids; however, these movements do not appear to be related to the fulfillment of a particular life history function (*e.g.*, spawning). Access to habitat in the Gull Lake area does not appear to be critical to the lake sturgeon population downstream of Gull Rapid, and likewise, sturgeon in Gull Lake do not appear to require habitat in Stephens Lake.

As discussed in the AE SV Section 6.4, provision of upstream and downstream passage at the GS does not provide a clear benefit to the lake sturgeon population. In addition, no fish passes that successfully move lake sturgeon upstream and downstream past a facility the size of the Keeyask GS exist. Therefore, the approach adopted by the Partnership has been to undertake mitigation measures to provide habitat for all life history stages both upstream and downstream of the GS, with the objective of creating/maintaining self-sustaining populations in both areas. This approach avoids reliance on untested fish passage methods. However, as discussed in Section 6.4.6.1.2, Fisheries and Oceans Canada has identified the need to include upstream fish passage in the Project design to maintain existing connections among fish populations. This reflects a precautionary approach with respect to uncertainty regarding the importance of maintaining connections among populations. Provision of fish passage would provide lake sturgeon with access to a greater habitat area, including riverine habitat upstream of Birthday Rapids, and avoid creating a partially isolated population in Stephens Lake.

The phased approach to fish passage described in Section 4.5.1.5 will permit trial implementation of fish passage for lake sturgeon with minimal risk to the Stephens Lake population. Analyses conducted to date indicate that a trap and transport program would be the most effective method to test the success of upstream passage and evaluate future options. Trap and transport will also allow selection of lake sturgeon for upstream passage (for example, to avoid depleting the remnant population, only sturgeon with tags that originated from upstream of Gull Rapids may be transported). Implementation of the fish passage program will be conducted in close consultation with Fisheries and Oceans Canada and Manitoba Conservation and Water Stewardship and rely on monitoring to determine the success of the program and potential modifications.

Sturgeon moving downstream from the Keeyask reservoir would need to pass either over the spillway (when it is in operation) or past the trash racks and turbines. Effects to lake sturgeon would likely be similar to those of other fish, as discussed in Section 6.4.6.1.2. Only the largest sturgeon (greater than 1.4 m [4.6 feet] in fork length) would be physically excluded by the trash racks, though slightly smaller fish would likely not pass due to the tight fit. Although experimental studies of turbine effects have not been conducted with lake sturgeon, studies of fish movements in the Limestone forebay have recorded downstream passage by lake sturgeon both over the spillway and past the turbines.

Other Considerations

Stephens Lake may be able to support more lake sturgeon than are currently present, and therefore, this area will be targeted in a conservation stocking program with the objective to re-establish a self-sustaining population. The key features of the stocking plan are described at the end of this section and details are provided in the AE SV Appendix 1A.

The construction of the access road will increase access by domestic harvesters and potentially increase lake sturgeon harvest. A lake sturgeon conservation awareness program for the Project will be developed in consultation with local domestic resource users and Manitoba Conservation and Water Stewardship to highlight the sensitivity of populations in the Keeyask reservoir and immediately downstream.

As discussed in Section 6.2.3.3.5, lake sturgeon were historically abundant in much of the lower Nelson River, but numbers have declined to the extent that they are currently assessed as endangered by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) and are being considered for listing under the Federal *Species At Risk Act* (SARA). Given that construction of the Project will alter existing lake sturgeon habitat, and the uncertainties with respect to their use of constructed or altered habitats, it is proposed that stocking be used to support and enhance lake sturgeon populations within the Clark Lake to Stephens Lake reach of the Nelson River. In addition, lake sturgeon will be stocked at off-site locations that currently provide habitat to support all life history functions where the current small populations are limiting the potential for recovery. To date, candidate sites have been identified in the upper Split Lake area, in the Nelson River below the Kelsey GS, the Grass River, and the Burntwood River below First Rapids (Map 6-18). A detailed description of the stocking program is provided in the AE SV Appendix 1A. Principle points are provided below:

- The stocking program will address effects of the Project, but be conducted in coordination with other regional recovery plans;
- The plan will be long-term, with a commitment by the Partnership to construct a hatchery and/or other facilities in northern Manitoba to provide the necessary infrastructure;
- Brood stock from the Nelson River will be selected based on genetic considerations, including numbers of individuals and genetic similarity to the target area;
- The program will be conducted in consideration of the need to maintain genetic diversity; and
- Target numbers and ages of fish stocked at each location will be determined based on the size and age structure of the existing population, the ability of the habitat to support additional fish, and recommended stocking rates and population targets developed elsewhere (*e.g.*, DFO 2010; Wisconsin stocking guidelines).

Stocking of lake sturgeon is one of the most effective means of recovering this species where adequate habitat is available (see AE SV Appendix 1A for details). Examples of successful conservation stocking programs include:

- The St. Louis River, a tributary of Lake Superior, where sturgeon were stocked from 1983 to 2000. Populations have increased in western Lake Superior and, recently, stocked sturgeon have been observed using historical spawning grounds on the St. Louis River;

- Red River of the North, a tributary of Lake Winnipeg, where a 20-year stocking plan has released fingerlings and fry across tributaries in Minnesota and lake sturgeon have been observed in the Red River to Lake Winnipeg; and
- Oneida Lake, New York, where lake sturgeon exhibited very high growth rates.

Lake sturgeon have also been stocked into the Saskatchewan, Assiniboine and upper Nelson rivers in Manitoba and initial observations indicate that stocked fish are surviving and growing.

The recovery of regional lake sturgeon populations will also be improved by other initiatives apart from the Project. For example, Manitoba Hydro, TCN, WLFN, YFFN, FLCN, Shamattawa First Nation and the Partnership have negotiated an agreement to establish a Lake Sturgeon Stewardship Committee. The goal is to conserve and enhance the present population of lake sturgeon in the lower Nelson River from Kelsey GS to Hudson Bay. Additional information is provided in Section 7.5.1.2.2.

RESIDUAL EFFECTS OF OPERATION

In summary, the following mitigation measures will be implemented to address operation effects on lake sturgeon:

- Monitoring to determine whether lake sturgeon continue to spawn at Birthday Rapids and, if not, placement of large structures along the shorelines to create turbulent flow to attract spawning fish;
- Monitoring of potential YOY habitat in the Keeyask reservoir and, if monitoring shows that recruitment is not successful, implementation of a program to create suitable habitat;
- Construction of spawning habitat downstream of the GS;
- Construction of channels to connect pools isolated after spillway operation to Stephens Lake to allow stranded fish to escape;
- A trap and transport program for upstream fish passage will be implemented. Downstream fish passage is being provided via the turbines and spillway, both of which incorporate design features to reduce the risk of injury and mortality to fish. The Project will be designed and constructed in a manner that would allow it to be retrofitted to accommodate other upstream and/or downstream fish passage options if required in the future;

- Development of a lake sturgeon conservation awareness initiative to inform domestic resource users of the vulnerability of the lake sturgeon populations in the Keeyask reservoir and Stephens Lake; and
- Implementation of a stocking program in the Kelsey to Kettle GS reach of the Nelson River.

These mitigation measures have been discussed with Fisheries and Oceans Canada and Manitoba Conservation and Water Stewardship. Additional measures that would be implemented prior to or during Project operation may be identified as a result of ongoing discussions regarding Project effects and mitigation between the Partnership and these regulatory agencies.

Details regarding expected residual effects to lake sturgeon are provided in AE SV Section 6.4. The following are the residual effects on lake sturgeon once the appropriate mitigation measures are applied:

- Potential shift in spawning location from existing areas at or downstream of Birthday Rapids to other nearby habitat (*e.g.*, Long Rapids) (modification of the shoreline at Birthday Rapids may be required to create suitable spawning cues);
- Shift in use of YOY habitat from the river channel in Gull Lake to the river channel in the reservoir at the upstream end of Gull Lake (placement of suitable substrate may be required);
- Alteration of current preferred habitat for sub-adult lake sturgeon due to silt deposition throughout much of present-day Gull Lake. This will be offset by a general increase in the amount of habitat in the Nelson River between Clark Lake and the GS;
- Shift in use of spawning habitat in Gull Rapids to constructed habitat in the tailrace;
- Replacement of larval lake sturgeon potentially entering Stephens Lake from spawning upstream of Gull Rapids with stocked fish; and
- In the long-term, an overall increase in the regional number of lake sturgeon due to augmentation of the currently depleted population by stocking.

Overall, no adverse residual effects on lake sturgeon populations due to Project operation are expected due to mitigation measures to provide habitat for all life history stages and the implementation of an extensive stocking program. In the long-term, an overall increase in the number of lake sturgeon in the Kelsey GS to Kettle GS reach of the Nelson River is expected as a result of lake sturgeon stocking and the management of the harvesting of these stocked fish.

6.4.6.2.3 Conclusion about Residual Effects on Lake Sturgeon

Lake sturgeon in the Nelson River are vulnerable to the effects of hydroelectric development due to the extremely low population numbers and requirements for specific habitats, such as large rapids, that are destroyed by the construction of generating stations. As such, this species has been of particular concern for the Keeyask Project and the focus of considerable study and mitigation planning. Development of mitigation has been guided by attributes of hydroelectric developments where healthy populations of lake sturgeon have been maintained, indicating that successful mitigation is possible.

The lake sturgeon response to the construction of the Project will result in moderate adverse effects over a medium spatial extent (lower reservoir and Stephens Lake) in the medium-term. In the long-term, no adverse effects to lake sturgeon numbers in the area directly affected by the Project are expected due to mitigation measures to provide habitat for all life history stages and the implementation of an extensive stocking program. An overall increase in the number of sturgeon in the Kelsey GS to Kettle GS reach of the Nelson River is expected in the long-term as a result of population augmentation due to stocking. There would be a commitment to extensive monitoring and adaptive management to modify and supplement stewardship as required to meet this goal. The adverse effects during construction are reversible (because the population will recover over time). The effects are continuous as they will last beyond the construction period. Finally, effects are of high ecological context due to the sensitivity of the species and the vulnerability of the population; however, there is also a high degree of cerntainty that stocking and spawning habitat creation will in the long-term offset any temporary adverse effects.

The technical lake sturgeon assessment is based on an analysis of their use of existing habitats and the habitat present post-Project, HSI models developed for the pre- and post-Project environment, and observations of lake sturgeon populations in a proxy reservoir (*i.e.*, Stephens Lake) and other reservoirs. These approaches provide moderate to high certainty regarding the prediction of adverse effects in the absence of mitigation. There is low to moderate certainty regarding the success of mitigation measures to create YOY habitat in the reservoir and moderate certainty regarding the success of mitigation measures to create spawning habitat in the reservoir and Stephens Lake. However, there is moderate to high certainty regarding effects to abundance following the implementation of a stocking program, resulting in an overall moderate to high certainty for the predicted increases in regional lake sturgeon numbers.

The adverse residual effects of the Project will not overlap or interact spatially and temporally with effects from future Projects (see Section 7.5.1).

Monitoring of the lake sturgeon population has continued periodically to 2012. An extensive monitoring program will be implemented for lake sturgeon, targeting both the effects of the Keeyask development and the success of various mitigation measures (Chapter 8). The program will begin prior to construction and some components (*e.g.*, monitoring of population changes in response to stocking) will continue for at least 30 years. The program will include monitoring movement of adult lake sturgeon using long-term telemetry tags, sampling for spawning and YOY lake sturgeon in predicted locations post-Project including constructed habitats, and continued year-class strength monitoring, in particular in relation to the stocking program.

6.4.7 MERCURY, PALATABILITY AND CYSTS IN FISH

Detailed descriptions of the effects of construction and operation on mercury, palatability and cysts in fish are provided in AE SV Sections 7.2, 7.5 and 7.4, respectively.

6.4.7.1 MERCURY

6.4.7.1.1 CONSTRUCTION EFFECTS AND MITIGATION

The Project has the potential to affect mercury during construction through the release of methylmercury and OC from disturbed soils and vegetation during construction activities. Flooding due to impoundment will begin during the construction phase but will continue in the operation phase; therefore this effect is considered under operation.

Clearing of trees from the reservoir and many other construction activities will be mainly carried out during the winter months, thus minimizing the disturbance of vegetation and soils and avoiding runoff. Stage I and early Stage II flooding is expected to be within the existing water level fluctuations of Gull Lake. Given the dilution capacity of the Nelson River as the receiving waterbody and the relatively large existing mercury methylation potential in the environment of the Project area, it is unlikely that the amounts of mercury/methylmercury entering on-system locations via runoff from construction sites will measurably affect the rates of mercury bioaccumulation in fishes when compared to the effects of flooding (*i.e.*, operation effects, see below).

RESIDUAL EFFECTS OF CONSTRUCTION

No residual effects on mercury concentrations in fish are expected.

6.4.7.1.2 OPERATION EFFECTS AND MITIGATION

The Project has the potential to affect mercury during operation in response to the flooding of wetlands and terrestrial soils associated with the creation of the reservoir starting during the construction phase.

It is expected that maximum mean concentrations will be reached within three to five years after the reservoir reaches full supply level in lake whitefish and four to seven years in northern pike and walleye of standard size (*e.g.*, 350 mm [13.8 "], 550 mm [21.7 "], and

400 mm [15.7 "] fork length for lake whitefish, northern pike, and walleye, respectively). Smaller, younger fish may experience a faster increase in mercury concentrations. Stephens Lake will not experience flooding due to the Project, but will receive Nelson River flow with potentially elevated methylmercury concentrations in water, fish food organisms, and fish that pass downstream via the GS or spillway. Maximum mercury concentrations and the persistence of elevated concentrations in fish from Stephens Lake may differ between species and individuals in relation to the proximity of their main feeding habitat to the area where the Nelson River flows through the lake.

Post-Project maximum mean mercury concentrations of lake whitefish, northern pike, and walleye from the Keeyask reservoir and Stephens Lake were estimated using models (Table 6-18), which are described in detail in AE SV Section 7.2.

Table 6-18: A Comparison of Current Mercury Concentrations in Fish to Model-Derived Estimates of Mean Maximum Mercury Concentrations in Parts per Million (ppm) during the Operation Period

Model	Species of Standard Length		
	Lake Whitefish	Northern Pike	Walleye
KEEYASK RESERVOIR			
Current (Gull Lake; 2002-2006)	0.07	0.22	0.23
PF model 1			
Day 1 area2	0.18	0.81	0.83
Year 5 area	0.18	0.83	0.85
Proxy model 3			
Day 1 area	0.19	1.30	1.42
Year 5 area	0.19	1.33	1.46
STEPHENS LAKE			
Current (2001-2005)	0.09	0.26	0.29
PF model 4			
Day 1 area	0.12	0.40	0.43
Year 5 area	0.12	0.41	0.43

Notes:

1. Percent flooded (PF) regression model modified after Johnston *et al.* (1991).
2. Day 1 area uses the reservoir area at the first time the initial fill level is in effect, Year 5 area uses the estimated reservoir area at Year 5 post-flooding (see Section 7.2 of AE SV).
3. Stephens Lake is used as a proxy for future conditions in the Keeyask reservoir.
4. Applies the proportion of flooded area to the combined area of Stephens Lake and the Keeyask reservoir.

Using scientific judgement and considering the limitations of the models and their relative strengths and weaknesses, mercury concentrations are expected to reach or slightly exceed 1.0 ppm in northern pike and walleye, and remain just below 0.2 ppm in lake whitefish from the Keeyask reservoir. Concentrations in northern pike and walleye from Stephens Lake may reach 0.5 ppm, and concentrations may also be slightly higher than the model estimate of 0.12 ppm in lake whitefish, at least in those areas of the lake along the Nelson River mainstem.

Predicted muscle concentrations for pike and walleye in the Keeyask reservoir have been shown to interfere with body biochemistry, disrupt reproduction, or alter the behaviour of fish mainly in laboratory experiments. To date, there is no clear evidence that such effects have resulted in, for example, reduced growth or population declines in wild fish, including northern pike and walleye with mean mercury levels exceeding 2.0 ppm.

Maximum mean mercury concentrations are not expected to persist for more than a few years but it will likely take in the order of 20–30 years before concentrations return to pre-Project levels or a new stable baseline level, at least in the Keeyask reservoir.

The predictive models developed for lake whitefish, northern pike and walleye were not applied to lake sturgeon as this species is expected to follow a different pattern of mercury accumulation due to its life history (long-lived, late age of first reproduction). There are no data on the effects of flooding on mercury concentrations in lake sturgeon, but maximum levels would likely be reached later post-impoundment and the recovery time could be longer than 30 years. Measures to mitigate the effects of increased fish mercury concentrations on the consumption habits of local resource users are described in Section 6.7.3.1.3.

RESIDUAL EFFECTS OF OPERATION

A detailed description of expected residual effects to mercury is provided in AE SV Section 7.2. The following are the predicted residual effects:

- Concentrations in lake whitefish, northern pike, and walleye from the Keeyask reservoir will see a large, medium-term increase to approximately three to five times the pre-impoundment levels recorded in 2002–2006; these maximum concentrations will decline in the long-term, but levels may remain higher than pre-Project concentrations for up to 30 years; and
- Concentrations in lake whitefish, northern pike, and walleye from Stephens Lake will increase moderately in the medium-term to approximately two times the pre-impoundment levels observed in 2001–2005; these maximum concentrations will decline over the long-term, but levels may remain higher than pre-Project concentrations for up to 25 years in areas close to the riverine corridor within Stephens Lake.

6.4.7.1.3 CONCLUSION ABOUT RESIDUAL EFFECTS ON MERCURY

Operation of the Project will cause large increases in mercury levels in predatory fish in the Keeyask reservoir and moderate increases in Stephens Lake. Although peak levels will decline after a few years, effects will persist for 25–30 years before levels return to stable conditions.

The technical assessment of fish mercury concentrations is based on models, scientific literature, and information collected from a proxy reservoir (*i.e.*, Stephens Lake) and the overall certainty associated with the predictions is moderate to high. There is high certainty regarding the nature and direction of effects and moderate to high certainty with regard to the magnitude and the duration of effects predicted for the Keeyask reservoir and areas of Stephens Lake near the river mainstem. There is low certainty as to how far effects will extend into the northern parts of Stephens Lake; therefore the assessment was based on the worst case of effects to all fish in Stephens Lake.

Monitoring of mercury levels in selected fish species and waterbodies has continued periodically since the conclusion of the EIS studies and will occur annually during the operation phase of the Project until maximum levels are reached and then every three years thereafter until concentrations return to long-term stable levels (Chapter 8).

6.4.7.2 PALATABILITY

6.4.7.2.1 CONSTRUCTION EFFECTS AND MITIGATION

The Project has the potential to affect palatability during construction through accidental spills or releases of hydrocarbons or other substances that are readily incorporated into fish musculature and may affect odour and/or flavour. However, the release of substantial amounts of such substances is unlikely because of the development and implementation of good management practices.

RESIDUAL EFFECTS OF CONSTRUCTION

No residual effects of Project construction on palatability are expected.

6.4.7.2.2 OPERATION EFFECTS AND MITIGATION

There are no pathways documented in technical studies that connect normal operation-related activities of a hydroelectric generating station to fish palatability, and no Project-related effects on fish taste are anticipated. Thus, the low acceptability score of fish from Gull Lake obtained in the 2002/2003 taste tests is not expected to change after the creation of the Keeyask reservoir. Based on KCNs' experience, changes in taste/texture can be expected, as reported for other reservoirs, and they expect that the consumptive quality of fish (palatability) will continue to decline (YFFN Evaluation Report [*Kipekiskwaywinan*]; FLCN Environment Evaluation Report (Draft)).

Accidental spills/releases of substances that have the potential to affect fish smell and flavour may occur during operation. However, the accidental release of such substances into the aquatic environment is unlikely because of the development and implementation of good management practices.

RESIDUAL EFFECTS OF OPERATION

No residual effects of Project operation on palatability are expected.

The decline in fish palatability reported by the KCNs is not expected to change as a result of Project operation.

6.4.7.2.3 CONCLUSION ABOUT RESIDUAL EFFECTS ON PALATABILITY

As discussed in the preceding section, there are no linkages identified in technical studies by which palatability is expected to be affected. The KCNs have stated that palatability is expected to continue to decline, based on experience from other reservoirs.

The technical assessment of fish palatability is based on information obtained from user (*i.e.*, KCNs Members) surveys. The overall certainty associated with the predictions is high.

6.4.7.3 *T. CRASSUS* CYSTS

6.4.7.3.1 CONSTRUCTION EFFECTS AND MITIGATION

No effects are expected during construction because the infection rates of *T. crassus* in lake whitefish are mainly related to the relative abundance of its intermediate and final host and changes to the zooplankton and fish communities are not expected during this period.

6.4.7.3.2 OPERATION EFFECTS AND MITIGATION

Based on conceptual models (that take into account Project effects on the zooplankton and fish communities), and empirical data from two lakes (Southern Indian Lake and Wuskwatim Lake) for which pre- and post-flooding data on *T. crassus* infection rates are available (AE SV Section 7.4), *T. crassus* cyst counts in lake whitefish from the Keeyask reservoir and Stephens Lake will not be measurably affected by the Project.

6.4.7.3.3 CONCLUSION ABOUT RESIDUAL EFFECTS ON CYSTS

No effects are expected.

The technical assessment of the prevalence of *T. crassus* cysts in lake whitefish is based on scientific literature and information from proxy reservoirs (*e.g.*, Southern Indian Lake). The overall certainty associated with the predictions is moderate to high.

6.4.8 SUMMARY OF RESIDUAL EFFECTS AND SIGNIFICANCE

Sources of potential effects to VECs, measures to mitigate these effects, and residual effects to VECs following mitigation are summarized in Table 6-19 through Table 6-23.

Note regarding the following residual effects tables:

1. Refer to Section 5.5 (Approach to Determination of Regulatory Significance) for full description of assessment characteristics. Under Step 1, all VECs were examined using the criteria of direction, magnitude, geographic extent and duration. As explained, where further analysis was warranted, a Step 2 analysis considered additional criteria of frequency, reversibility or ecological context.

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Table 6-19: Summary of Mitigation and Residual Effects on Valued Environmental Components for the Aquatic Environment: WATER QUALITY

VEC Effect and Mitigation by Phase	Residual Effects	Assessment Characteristics (1 see introductory text)
Construction Phase		
Potential effects due to: • Instream construction of cofferdams and other structures; and • Inputs from effluents, blasting, runoff and other sources. **Mitigation includes:** • Measures to control sediment releases; and • Management measures to maintain inputs at levels that are not harmful to aquatic life.	Increases in TSS concentration downstream of the construction site. Increases in the concentration of substances near source of inputs.	**Step 1:** Direction: Adverse Magnitude: Small to moderate Geographic Extent: Small to large Duration: Short-term **Step 2: Not Required**
Operation Phase		
Potential effects due to: • Changes in water levels and flows, flooding and erosion result in effects to water quality. **No mitigation required**	Changes to TSS, nutrients, DO, pH and metals in flooded areas for initial years of impoundment; long-term decrease of TSS in the mainstem of the reservoir and southwestern part of Stephens Lake.	**Step 1:** Direction: Adverse Magnitude: Moderate to large Geographic Extent: Small to medium Duration: Medium- to long-term **Step 2:** (TSS decrease only) Frequency: Continuous Reversibility: No Ecological Context: Moderate Note that the long-term decline of TSS is not expected to have a notable adverse effect on aquatic biota.

Table 6-20: Summary of Mitigation and Residual Effects on Valued Environmental Components for the Aquatic Environment: WALLEYE

VEC Effect and Mitigation by Phase	Residual Effects	Assessment Characteristics (1 see introductory text)
Construction Phase		
Potential effects due to: • Water quality changes; • Instream construction and dewatering; • Entrainment; • Blasting; and • Harvest. **Mitigation includes:** Measures to reduce effects to water quality; • Timing of instream construction; • Fish salvage; • Adherence to guidelines for blasting and end-of-pipe screening; and • Harvest controls for construction workers at site.	Possible reduced year-class strength during construction period due to the reduction in available spawning habitat in Stephens Lake.	**Step 1:** Direction: Adverse Magnitude: Moderate Geographic Extent: Medium Duration: Medium-term **Step 2: Not Required**
Operation Phase		
Potential effects due to: • Water quality changes; • Habitat changes within reservoir and at Gull Rapids; • Barrier to upstream fish movements and changes to numbers of fish moving downstream; and • Harvest. **Mitigation includes:** • Construction of winter escape channels at Little Gull Lake to avoid winterkill; • Spawning habitat enhancements in reservoir; • Spawning habitat creation below GS; • Provision of upstream fish passage by trap and transport; and • Measures to increase survival during downstream movement through the turbines or over the spillway.	Shift in use to new areas of habitat, including constructed spawning habitat. Long-term increase in fish abundance within the reservoir in response to habitat changes. Short-term avoidance of newly flooded areas of reservoir with reduced water quality. Reduced number of fish entering Stephens Lake from upstream. Reduced harvest in Stephens Lake (closure of commercial fishery).	**Step 1:** Direction: Positive Magnitude: Small Geographic Extent: Medium Duration: Long-term **Step 2: Not Required**

Table 6-21: Summary of Mitigation and Residual Effects on Valued Environmental Components for the Aquatic Environment: NORTHERN PIKE

VEC Effect and Mitigation by Phase	Residual Effects	Assessment Characteristics (1 see introductory text)
Construction Phase		
Potential effects due to: • Water quality changes; • Instream construction and dewatering; • Entrainment; • Blasting; and • Harvest. **Mitigation includes:** • Measures to reduce effects to water quality; • Timing of instream construction; • Fish salvage; • Adherence to guidelines for blasting and end-of-pipe screening; and • Harvest controls for construction workers at site.	Negligible	**Step 1: Not Required**
Operation Phase		
Potential effects due to: • Water quality changes; • Habitat changes within reservoir and at Gull Rapids; • Barrier to upstream fish movements and changes to numbers of fish moving downstream; and • Harvest. **Mitigation includes:** • Construction of winter escape channels at Little Gull Lake to avoid winterkill; • Removal of debris accumulations at the mouths of streams to allow fish to access tributary habitat; • Provision of upstream fish passage by trap and transport; and • Measures to increase survival during downstream movement through the turbines or over the spillway.	Loss of existing littoral habitat in the reservoir resulting in short-term adverse effects. Shift in area of habitat use as new littoral habitat develops. Short-term increase in spawning habitat at flooded tributary mouths. Short-term avoidance of newly flooded areas of reservoir with reduced water quality. Reduced number of fish entering Stephens Lake from upstream.	**Step 1:** Direction: Adverse Magnitude: Small Geographic Extent: Medium Duration: Short-term **Step 2: Not Required**

Table 6-22: Summary of Mitigation and Residual Effects on Valued Environmental Components for the Aquatic Environment: LAKE WHITEFISH

VEC Effect and Mitigation by Phase	Residual Effects	Assessment Characteristics (1 see introductory text)
Construction Phase		
Potential effects due to: • Water quality changes; • Instream construction and dewatering; • Entrainment; • Blasting; and • Harvest. **Mitigation includes:** • Measures to reduce effects to water quality; • Timing of instream construction; • Fish salvage; • Adherence to guidelines for blasting and end-of-pipe screening; and • Harvest controls for construction workers at site.	Reduced year-class strength during the construction period due to the reduction in available spawning habitat.	**Step 1:** Direction: Adverse Magnitude: Moderate Geographic Extent: Medium Duration: Medium-term **Step 2: Not Required**
Operation Phase		
Potential effects due to: • Water quality changes; • Habitat changes within reservoir and at Gull Rapids; • Barrier to upstream fish movements and changes in numbers of fish moving downstream; and • Harvest. **Mitigation includes:** • Construction of winter escape channels at Little Gull Lake to avoid winterkill; • Spawning habitat enhancements in reservoir; • Spawning habitat creation below GS; • Provision of upstream fish passage by trap and transport; and • Measures to increase survival during downstream movement through the turbines or over the spillway.	Shift to new areas of habitat use, including constructed spawning habitat. Short-term avoidance of newly flooded areas of reservoir with reduced water quality. Long-term increase in fish abundance within the reservoir in response to habitat changes. Reduced number of fish entering Stephens Lake from upstream.	**Step 1:** Direction: Positive Magnitude: Small Geographic Extent: Medium Duration: Long-term **Step 2: Not Required**

Table 6-23: Summary of Mitigation and Residual Effects on Valued Environmental Components for the Aquatic Environment: LAKE STURGEON

VEC Effect and Mitigation by Phase	Residual Effects	Assessment Characteristics (1 see introductory text)
Construction Phase		
Potential effects due to: • Water quality changes; • Instream construction and dewatering; • Entrainment; • Blasting; and • Harvest. **Mitigation includes:** • Measures to reduce effects to water quality; • Timing of instream construction; • Fish salvage; • Adherence to guidelines for blasting and end-of-pipe screening; • Harvest controls for construction workers at site; and • Stocking program.	Potential re-distribution of older sub-adults and adults due to emigration from reservoir to either upstream or downstream areas. Loss from reservoir is compensated in part by stocking of young fish. In Stephens Lake, replacement of natural recruitment with stocked fish, as lake sturgeon are not expected to spawn during construction (replacement spawning habitat will be available during operation).	**Step 1:** Direction: Adverse Magnitude: Moderate Geographic Extent: Medium Duration: Medium-term **Step 2:** Frequency: Continuous Reversibility: Yes Ecological Context: High due to the sensitivity of the species and the vulnerability of the population. However, there is a high degree of cerntainty that stocking and spawning habitat creation will in the medium-term offset any temporary adverse effects.

Table 6-23: Summary of Mitigation and Residual Effects on Valued Environmental Components for the Aquatic Environment: LAKE STURGEON

VEC Effect and Mitigation by Phase	Residual Effects	Assessment Characteristics (1 see introductory text)
Operation Phase		
Potential effects due to: • Water quality changes; • Habitat changes within reservoir and at Gull Rapids; • Barrier to upstream fish movements and changes to the numbers of fish moving downstream; and • Harvest. **Mitigation includes:** • Spawning habitat enhancements in reservoir, if monitoring shows that it is required; • Creation of YOY habitat in the reservoir, if monitoring shows that required; • Spawning habitat creation below GS; • Provision of upstream fish passage by trap and transport; • Measures to increase survival during downstream movement through the turbines or over the spillway. • Stocking program; and • Lake sturgeon conservation awareness initiative for the Keeyask Generation Project.	Shifts in areas of spawning, foraging, and YOY habitat use. Reduced number of fish entering Stephens Lake from upstream. No long-term decline in lake sturgeon abundance in the Keeyask reservoir or Stephens Lake. Overall increase in lake sturgeon abundance in the Kelsey GS to Kettle GS reach of the Nelson River.	**Step 1:** Direction: Positive Magnitude: Moderate Geographic Extent: Large Duration: Long-term **Step 2: Not required**

Based on the criteria to determine regulatory significance described in Chapter 5, Step 1 analysis was completed and no significant adverse effects were predicted for walleye, northern pike, lake whitefish and lake sturgeon. Step 2 analysis was screened out based on the magnitude, duration and spatial extent of adverse effects considered for Step 1 analysis. However, Step 2 analysis was applied to lake sturgeon during the construction period as Step 2 analysis was applied to all species listed or being considered for listing under SARA regardless of the results of Step 1 analysis (see Chapter 5 for more details).

Lake sturgeon will experience a temporary adverse effect during construction; as discussed in Section 6.4.6.2.3, mitigation measures will address these effects during the operation period. Adverse effects during construction are reversible (because recovery will occur) and continuous as they will last beyond the construction period. Finally, effects are of high ecological context due to the sensitivity of the species and the vulnerability of the population. However, proposed mitigation measures including stocking and creation of spawning habitat have a proven record of success in other areas and therefore there is a high certainty that these effects can be mitigated and no long-term adverse effects are expected. Therefore, this effect was considered not significant.

In regards to water quality, a long-term reduction in TSS levels could be considered adverse as it exceeds the water quality objectives. However, no notable adverse effects to aquatic biota are expected. In addition, Members of the KCNs have reported that current TSS levels are elevated due to existing hydroelectric developments and a moderate decrease in TSS due to the Project would represent a change towards pre-development conditions. Therefore, this effect was considered not significant.

Members of the KCNs have indicated that they expect effects of the Project to extend further upstream and downstream than described in the technical assessment based on their observations of previous hydroelectric developments and their understanding that all parts of the environment are interconnected. In addition, the KCNs are sceptical that proposed mitigation measures can avoid adverse effects to the extent predicted.

Therefore, monitoring programs will be undertaken and, if effects are observed outside of the spatial area predicted by the technical analysis, or if monitoring results indicate that mitigation measures are inadequate, adaptive management (as described in Chapter 8) will be used to identify the appropriate course of action.

6.4.9 SENSITIVITY OF RESIDUAL EFFECTS TO CLIMATE CHANGE

As discussed in Section 6.1.1.6, a review of the conclusions of the Project's residual effects on the physical environment indicates that the assessment is not sensitive to climate change. The robustness of the conclusions is largely due to two factors. First, the water regime within the open water hydraulic zone of influence and the reservoir operating range are not substantially changed when considering climate changes and resulting potential river flows. Second, the largest effects of the Project on the physical environment occur early in the operating period when climate changes are smaller.

As discussed in Section 6.3, direct alteration of aquatic habitat due to the presence of infrastructure and changes to the surface water regime and sediment deposition are the primary pathways by which water quality and aquatic habitat, and thus the remainder of the aquatic environment, are affected by the Project. Given that predicted changes to the physical environment are not expected to be altered by climate change, conclusions related to effects on the aquatic environment are expected to be similarly unaffected.

An additional consideration is that climate change will cause general changes in the aquatic environment but the nature of these changes cannot be definitively predicted. For example, water quality is closely related to conditions in upstream watersheds and varies at present depending on the relative contribution of the Burntwood/Churchill versus Nelson River systems (Section 6.2.3.3.2). Climate change may affect the water quality in the watersheds, in particular as areas become wetter or drier and may also alter the relative contribution of watersheds, but the net effect of these changes is not known. In general, a trend to warmer waters will result in an increase in general productivity and shifts in species composition, with concomitant alterations in the aquatic food web. In general, the production of lower trophic level organisms would increase. These changes could result in minor changes in effect predictions (*e.g.*, the duration of elevated levels of mercury may be somewhat longer than predicted and may stabilize at higher levels than occur at present), but are expected to be obscured by substantially larger changes in the aquatic environment. For example, warmer waters may result in the disappearance of cool water species such as lake whitefish and proliferation of warm water species such as carp. Higher productivity may also increase the capacity of the environment to support greater populations of species such as walleye and lake sturgeon, which are widespread in warmer waters.

6.5 EFFECTS AND MITIGATION TERRESTRIAL ENVIRONMENT

6.5.1 INTRODUCTION AND APPROACH

Section 6.5 focuses on effects of the Project on the terrestrial environment, mitigation measures to address those effects, residual effects that remain after mitigation, and the regulatory significance of the residual effects on VECs. This section will also assess the sensitivity of these effects to possible climate change scenarios.

The assessment of Project effects is based on the existing environment, as described in the preceding Section 6.2.3, including the predicted future environmental conditions and trends if the Project were not to proceed. This existing environment incorporates effects of past projects, most notably past and current projects identified for the cumulative effects assessment. This section also notes where there are overlaps or interactions between effects of the Project with potential future projects.

The technical analysis determined Project effects on the terrestrial environment by considering the linkages between the terrestrial environment and changes caused by the Project, both directly and indirectly. The TE SV details the potential pathways of Project effects and the expected changes to various terrestrial ecosystem components. Some of the main pathways by which Project construction and operation would affect terrestrial ecosystems are illustrated in Figure 6-16.

Several approaches were used in the technical assessment. Generally, potential effects were identified based on a combination of scientific knowledge of causal relationships (*e.g.*, how vegetation and soils are affected by elevated groundwater levels due to flooding) and the results from Project studies. The magnitude and the spatial and temporal extent of effects were determined through several methods, including:

- Collecting and using information from Stephens Lake (*i.e.*, the Kettle GS reservoir) provide examples of how Keeyask could affect ecosystem components and relationships between these components. Stephens Lake was particularly useful in this regard because its ecological context is very similar to the Keeyask;
- Comparison to empirical data from other northern reservoirs or waterbodies where water levels were regulated (*e.g.*, Wuskwatim Lake, the Eastmain reservoir in Québec); and
- Where applicable, developing quantitative models based on observed relationships in the study area and elsewhere.

Further details on the assessment methodology can be found in the TE SV Section 2.3 and other specific sections related to each of the terrestrial environment components in the TE SV.

Although the terrestrial assessment considered a wide range of terrestrial ecosystem components, the assessment was focussed on the VECs and supporting topics (see Chapter 5). The terrestrial VECs are as follows: ecosystem diversity, intactness, wetland function, priority plants, Canada goose, mallard, bald eagle, olive-sided flycatcher, common nighthawk, rusty blackbird, caribou, moose and beaver. The rationale for the VEC selection was provided in Section 6.2.3.4.

As discussed in Chapter 5, Section 5.2, this environmental assessment was the subject of two evaluations, the first of which was conducted by the KCNs in terms of their own worldview, values and expereince with past hydroelectric development, as well as their relationships with Askiy (Mother Earth); and a government regulatory assessment process.An evaluation based on the Cree worldview is provided in Chapter 2, and more detailed evaluations are provided in the CNP Keeyask Environmental Evaluation Report, YFFN Evaluation Report (*Kipekiskwaywinan*) and FLCN Environment Evaluation Report (Draft). The KCNs' ATK, including their lived experiences from past hydroelectric development, is summarized in Section 6.5.2 and woven into the effects assessment when available.

Detailed results for the technical component of the environmental assessment are provided in the TE SV. This section summarizes the results of the ATK and technical assessments, including a description of potential effects, mitigation measures designed to address these effects, and the residual effects expected after consideration of the mitigation measures. In terms of mitigation, a number of measures were considered throughout the assessment process (PD SV Section 7). Monitoring is outlined for situations where a prediction has substantial uncertainty or a difference between predicted and actual residual effects could substantially alter the effects assessment. Monitoring is briefly described with residual effects in each VEC section and fully described in Chapter 8.

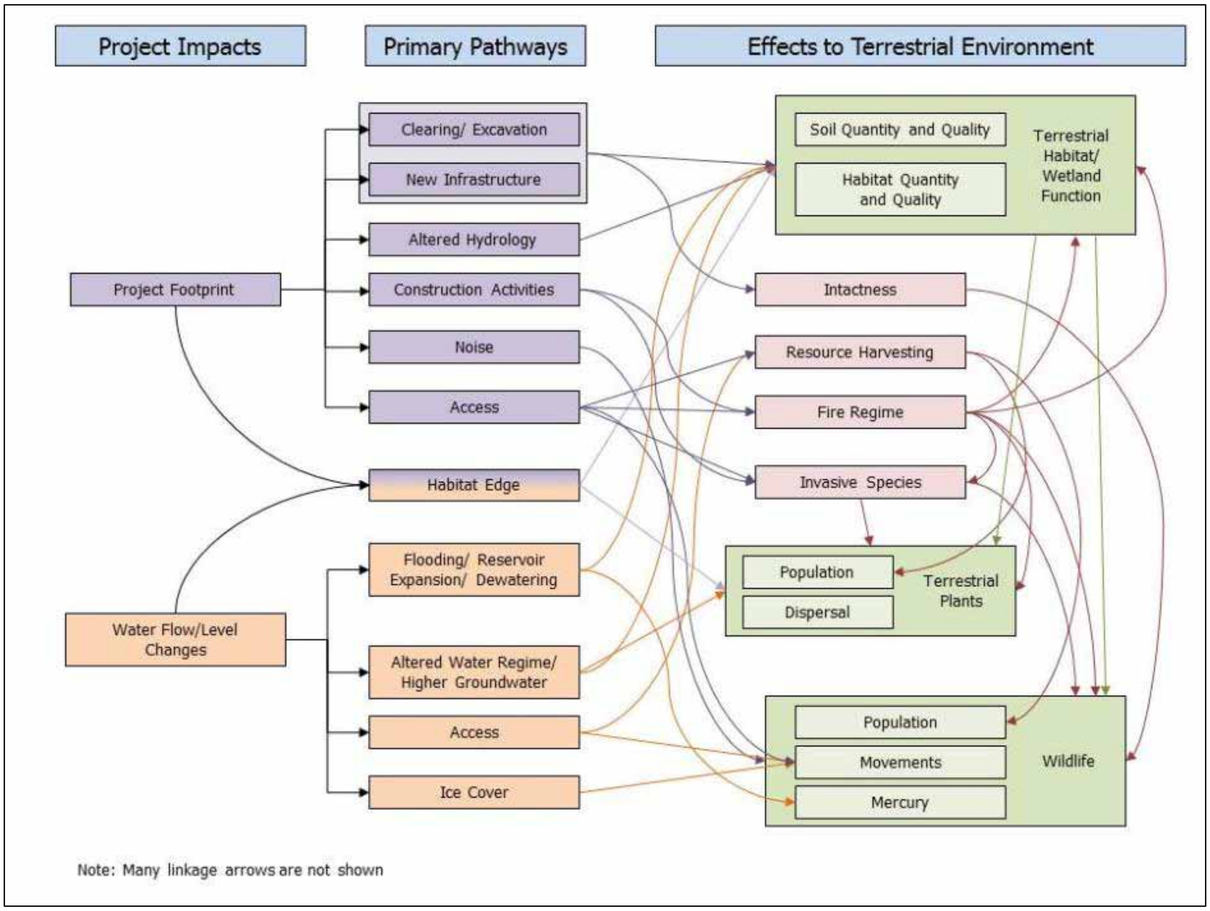

Figure 6-16: Terrestrial Ecosystem Pathways of Effects

6.5.2 Aboriginal Traditional Knowledge

This section includes a summary of Aboriginal traditional knowledge regarding the terrestrial environment that was provided by the KCNs, who live in the vicinity of the proposed Project. This ATK should be understood within the context of the worldview of the KCNs, which is set out in Chapter 2, *Partners' Worldviews and Evaluation Process*, and also in the KCNs' Environmental Evaluation Reports. The KCNs' worldview provides the broad understanding of the world and how it works, including the interrelationships among all things and that all things are alive and come from *Askiy* (Mother Earth)(land, water, animals, plants and people). The KCNs worldview also provides guidance regarding their stewardship of the environment, and how important respect and caring for *Askiy* (Mother Earth) is to the KCNs. This knowledge guided the KCNs in their participation in planning of the Project with Manitoba Hydro as well as providing guidance to environmental studies, including the Mammals Working Group (for more details see Chapter 5). In addition, each of the KCNs conducted their own community studies including those relevant to the terrestrial environment.

Many community Members express the belief that the effects of past projects were not fully understood or accurately predicted. This has led to a concern that Project effects may not be accurately predicted, which has resulted in an emphasis on mitigation, monitoring and adaptive management.

Some of the ATK with respect to Project effects on the terrestrial environment include the following (for further details, see the KCNs' Environmental Evaluation Reports and FLCN 2010 Draft).

A large land area will be affected by the Project. Within this area, many important habitats will be permanently affected, while the quality and size of many other habitats will be reduced (FLCN 2010 Draft, YFFN Evaluation Report (*Kipekiskwaywinan*), CNP Keeyask Environmental Evaluation Report). As a result of past hydroelectric projects, it was observed that considerable inland and shoreline wetland habitat was either lost to flooding or was rendered unusable to people and wildlife by water level and flow changes and ice scouring (Split Lake Cree – Manitoba Hydro Joint Study Group 1996a, 1996b, 1996c; FLCN 2010 Draft, YFFN Evaluation Report (*Kipekiskwaywinan*). There is concern that wetlands near the reservoir and smaller creeks will be affected (War Lake First Nation 2002).

The Project would flood plants that are used for food and medicine and are culturally important (FLCN 2010 Draft, CNP Keeyask Environmental Evaluation Report). There is concern that an important berry picking island east of Gull Rapids will disappear due to ice scouring (FLCN 2010 Draft, FLCN Environment Evaluation Report (Draft)). The combination of improved access to the area and greater numbers of resource harvesters will, at the very least, result in key plant and animal populations becoming stressed (CNP Keeyask Environmental Evaluation Report; FLCN Environment Evaluation Report (Draft)).

There is concern that waterfowl nests will be flooded (CNP Keeyask Environmental Evaluation Report). As well, the loss of shoreline habitat from flooding and erosion has been observed in the York Landing area. There are fewer gulls on Split Lake and the small islands where they nested are now under water (YFFN Evaluation Report (*Kipekiskwaywinan*)). There were concerns raised related to an increase in hunting pressure on geese, ducks, grouse and ptarmigan from construction workers coming to the Gillam area (FLCN Environment Evaluation Report (Draft)).

Effects on caribou and other mammals are expected as a result of the Project. There is concern that Keeyask reservoir levels will reduce caribou calving habitat due to the flooding of islands and there is uncertainty as to whether new reservoir islands will form as replacement calving habitat (FLCN Environment Evaluation Report (Draft)). Construction noise will scare animals away and result in fewer animals that could be harvested. Of the animals that remain, there will be increased competition for harvesting, more animal mortality, and a further depletion of these resources (CNP Keeyask Environmental

Evaluation Report; YFFN Evaluation Report (*Kipekiskwaywinan*), FLCN Environment Evaluation Report (Draft)). Flooding, changes in winter water levels and unpredictable ice conditions will cause the direct mortality of some species including muskrat, beaver and caribou (CNP Keeyask Environmental Evaluation Report). These occurrences happen more frequently with each new hydroelectric development. With each hydroelectric development, more incidences of caribou mortality are reported at water crossings (FLCN Environment Evaluation Report (Draft)). A number of wildlife species declined (*e.g.*, caribou, moose, beaver, muskrat, porcupine) in areas with hydroelectric development in the past. The tall shrub areas common along the Nelson River shoreline, which are good moose feeding areas, will be flooded (FLCN Environment Evaluation Report (Draft); FLCN 2010 Draft). There now are fewer animals to harvest where they used to be plentiful (FLCN Environment Evaluation Report (Draft); YFFN Evaluation Report (*Kipekiskwaywinan*)).

The interconnectedness of the ecosystem will change. Migratory pathways and local movement patterns will be altered for some animals, while some predators will hunt more effectively, causing a further decline in prey (FLCN Environment Evaluation Report (Draft)).

Each of the KCNs has negotiated an AEA with Manitoba Hydro that includes offset programs to provide replacement opportunities in alternate areas not affected by hydroelectric development for undertaking traditional harvesting and to enable the continuation of their relationship to *Askiy* (Mother Earth).

6.5.3 TERRESTRIAL ECOSYSTEMS AND HABITAT

Section 6.5.3 predicts and assesses potential Project effects on terrestrial habitat and the terrestrial ecosystems and habitat VECs. The VECs for this section are ecosystem diversity, intactness and wetland function. Terrestrial habitat, fire regime, and soil quantity and quality are discussed as supporting topics (see Section 6.2.3.4). Terrestrial habitat is addressed at some length in this section due to its high relevance for most components of the terrestrial assessment. In addition, total terrestrial habitat loss and alteration is sometimes used as a very general indicator for terrestrial ecosystem effects. Fire regime and soil quantity and quality, which the Project is not anticipated to substantially affect, are discussed in the TE SV (see Sections 2.5 and 2.9). Details regarding the ecosystems and habitat assessment are provided in the Terrestrial Environment Supporting Volume (TE SV) Section 2.

The sizes of the areas potentially affected by the Project that are reported in this section differ from those reported in the Project description section (Section 4.4.2) for two reasons. First, the areas in this section only include terrestrial areas whereas the Project description also includes the deeper portions of lakes and the Nelson River, which are classified as non-terrestrial areas. Second, the E-1 borrow area and access road was not included in the Project Footprint since it is quite unlikely that this borrow area will be used given its small size and distance from the Project Footprint (see Chapter 4, Borrow Sources and Quarries - Potential for the location of borrow area E-1). Additionally, as described below the area included in the Project Footprint is a substantial overestimate of the anticipated size of the actual Project Footprint even without including the E-1 areas.

6.5.3.1 TERRESTRIAL HABITAT

Potential Project effects on terrestrial habitat include habitat loss, alteration and disturbance in the Project Footprint and the surrounding area. Habitat loss is the conversion of terrestrial habitat into a human feature or an aquatic area. Examples of direct and indirect Project effects that create habitat loss are permanent infrastructure construction, flooding or reservoir expansion. Habitat alteration refers to changes in one or more habitat attributes that are large enough to convert a habitat patch to a different fine habitat type. Examples of direct and indirect Project effects that create habitat alteration are vegetation type changes resulting from Project-related reductions in depth to groundwater, a marsh develops in response to a modified water regime or soil permafrost melts due to vegetation clearing. Lesser changes in one or more habitat attributes are classified as habitat disturbance. Examples of Project-related habitat disturbance are a machine trail through a habitat patch or groundwater changes that reduce tree cover but not species composition.

Indicators used for the terrestrial habitat supporting topic were total terrestrial habitat area and the areas of the regionally common broad habitat types that will not eventually disappear due to natural permafrost melting (see Section 6.2.3.4.2). The ecosystem diversity and wetland function VECs address effects on the regionally uncommon and rare terrestrial habitat types (see Sections 6.5.3.2 and 6.5.3.4).

Predicted Project effects on terrestrial habitat were determined by measuring the habitat encompassed by the Project Footprint and areas of indirect habitat effects in the surrounding areas. Habitat relationships models were used to estimate the spatial extent and nature of indirect habitat effects.

The benchmark values used to evaluate the magnitude of residual effects on the terrestrial habitat indicators were based on the percentage of historical area affected as follows. Adverse residual effects of the Project in combination with past and existing projects are: small magnitude for area losses below 1% of historical habitat area in the Regional Study Area; moderate magnitude for area losses between 1% and 10% of historical regional habitat area; and, high magnitude for area losses greater than 10% of historical regional habitat area (Hegmann *et al.* 1999).

The TE SV Section 2.3.4 provides a detailed description of methods and how the Project is predicted to affect terrestrial habitat.

6.5.3.1.1 CONSTRUCTION EFFECTS AND MITIGATION

The Project Footprint, during construction, could remove or alter approximately 6,872 ha of terrestrial habitat (Table 6-20). Indirect habitat effects are generally expected to extend less than 50 m into the surrounding areas. Assuming that all of terrestrial habitat within 50 m of the Project Footprint is affected (*i.e.*, the habitat zone of influence during construction), the total amount of habitat directly and indirectly affected by the Project could increase to 8,927 ha (Table 6-20), or less than 1%, of the terrestrial habitat in the Regional Study Area.

This is anticipated to be an overestimate of habitat loss in the Project Footprint for several reasons. It is expected that substantial portions of the potential borrow and disturbance areas will not be used (Section 4.3.2.9). The environmental protection plans (EnvPPs; Section 8.3.2) include measures intended to minimize clearing and disturbance outside of the permanent Project components (*e.g.*, in the remaining potential disturbance areas), which should reduce the amount of habitat alteration and disturbance. A 50 m buffer of the Project Footprint is an overestimate of the spatial extent of physical disturbance and indirect habitat effects.

In the unlikely event that borrow area E-1 is used, the amount of directly affected terrestrial habitat could increase from 6,872 ha to nearly 6,952 ha and the amount of directly and indirectly affected habitat could increase from 8,927 ha to approximately 9,070 ha, which is still less than 1%, of total terrestrial habitat area in the Regional Study Area.

The coarse habitat composition of the different Project Footprint components is broadly similar (Table 6-21). Most components are dominated by black spruce treed on thin peatland, black spruce treed on shallow peatland, and black spruce treed on mineral ecosites. These coarse habitat types comprise 50% or more of all but three Project Footprint components. The remaining 5 ha of native habitat in the camp and work area footprint has a relatively high proportion of jack pine habitat. The infrastructure, borrow area and excavated material placement area footprints have the highest proportions of broadleaf treed habitat and broadleaf mixedwood habitat. The terrestrial portions of the construction flooding and altered water level footprints are dominated by tall shrub on riparian peatland and shrub and/or low vegetation on upper beach.

Black spruce dominant on thin peatland and black spruce dominant on shallow peatland are the regionally common broad habitat types that will not eventually disappear due to natural permafrost melting. Project construction is predicted to affect less than 1.0% of the area of each of these habitat types even in the unlikely event that borrow area E-1 is used.

Mitigation of Project effects on terrestrial habitat already achieved through avoidance during Project design includes selecting a low-head option that considerably reduced Project-related flooding and reducing the total sizes of the borrow area and EMPA footprints (Section 4.2.3). Additional mitigation during construction will include the following:

- The portion of borrow area N-6 identified as the N6 sensitive site in Map 6-65 will be avoided (see Section 6.5.3.2 for rationale);
- Clearing and disturbance within the Project Footprint will be minimized to the extent practicable;
- Disturbance of areas adjacent to the Project Footprint will be avoided to the extent practicable; and
- Except for existing resource-use trails (see Construction Access Management Plan), Project-related cutlines and trails will be blocked where they intersect the Project Footprint, and the portions of these features within 100 m of the Project Footprint will be revegetated to minimize the risk of habitat disturbance, invasive plant spreading, accidental fires and access-related effects.

Mitigation implemented for ecosystem diversity and wetland function (Sections 6.5.3.4 and 6.5.3.5) as well as the clearing and disturbance minimization measures in the EnvPPs are predicted to further reduce Project effects on terrestrial habitat. The EnvPPs will also include measures to minimize the risk that accidental fires and spills will affect terrestrial habitat.

6.5.3.1.2 RESIDUAL EFFECTS OF CONSTRUCTION

After considering mitigation, Project construction is expected to affect less than 1% of total terrestrial habitat area and the areas of the common habitat types. After considering these remaining Project effects in combination with the effects of other past and existing projects and activities, it is predicted that Project construction could increase the affected amounts of total terrestrial habitat and the common habitat types to almost 6% of historical area, which is a moderate magnitude residual effect.

Table 6-24: Estimated Maximum Area of Terrestrial Habitat Affected During Construction by Source

Location	Terrestrial Habitat Affected (ha)[1]
	Construction
Project Footprint	6,872
Direct and indirect effects in surrounding areas	2,055
Total for terrestrial areas before mitigation	**8,927**
Mitigation - Avoided site at borrow area N-6	-57
Total for terrestrial areas after mitigation	**8,870**

Notes: [1] The reported amounts of affected terrestrial habitat will be lower than the values reported in the Project Description (Section 4.4.2) because they only include terrestrial areas (*i.e.*, the deeper portions of lakes and the Nelson River within the Project Footprint are aquatic rather than terrestrial area). The reported amounts of affected terrestrial habitat do not include shallow water wetlands since bathymetry was not available to locate the boundary between shallow and deep water for all of the shoreline wetlands.

6.5.3.1.3 OPERATION EFFECTS AND MITIGATION

Flooding at the start of Project operation would be entirely contained within areas already affected during construction. Reservoir expansion, increased edge effects and increased groundwater-related habitat effects will be the primary additional adverse effects during operation. These effects will be somewhat offset by habitat rehabilitation and natural habitat regeneration in the disturbed and temporarily cleared areas and by accounting for potential construction areas that were not used. By Year 30 of operation, the nature of habitat effects will either be permanent loss, permanent alteration or temporary alteration. A description of these effects is provided below.

Before considering mitigation, Project operation is predicted to permanently remove approximately 5,339 ha of terrestrial habitat by Year 30 (Map 6-65). Permanent infrastructure and initial flooding comprise 4,667 ha of this total. Reservoir expansion due to peatland disintegration and mineral bank erosion (Section 6.4.2) is predicted to convert an additional 671 ha of inland habitat to aquatic areas by Year 30 of operation (Map 6-65), with most of this habitat change occurring during the first 15 years. Habitat loss is predicted to continue until some time between Year 50 and 100 but at declining and much lower rates.

Table 6-25: Predicted Coarse Habitat Composition of the Project Footprint Components

Land Cover Type	Coarse Habitat Type	Project Footprint: Infra-structure	Road and Road Corridor	Camp & Work Area	Borrow Areas	Reservoir	EMPA	River Management	Construction Flooding	Potential Disturbance Area	Mitigation Area	Altered Water Levels	Project Footprint Total	ZOI Construction	All
Broadleaf treed on all ecosites	Broadleaf treed on all ecosites	6.1	2.2	1.0	3.0	0.6	6.1	-	0.1	2.5	1.4	-	1.8	1.6	1.7
	Broadleaf mixedwood on all ecosites	-	0.1	-	2.8	0.6	0.0	-	0.2	0.5	1.5	-	1.0	1.6	1.1
Needleleaf treed on mineral or thin peatland	Black spruce mixedwood on mineral or thin peatland	0.1	0.8	-	0.1	0.1	0.1	-	0.1	0.3	0.8	-	0.2	0.5	0.3
	Jack pine mixedwood on mineral or thin peatland	1.3	0.0	35.7	1.2	0.0	-	-	-	0.7	-	-	0.4	0.9	0.5
	Jack pine treed on mineral or thin peatland	4.7	2.3	9.3	7.6	0.2	4.5	-	-	2.2	4.4	-	2.5	4.5	2.9
	Black spruce treed on mineral soil	15.6	8.6	-	20.6	6.8	7.7	18.2	2.9	11.8	30.3	16.7	11.0	16.6	12.3
	Black spruce treed on thin peatland	30.8	50.2	1.1	39.2	28.7	21.8	42.2	3.9	24.7	38.0	5.6	30.8	35.4	31.9
Tall shrub on mineral or thin peatland	Tall shrub on mineral or thin peatland	0.3	1.6	-	0.5	0.3	5.3	-	1.1	1.0	0.0	-	0.7	0.7	0.7
Low vegetation on mineral or thin peatland	Low vegetation on mineral or thin peatland	11.7	6.9	0.1	5.1	1.1	12.4	3.5	1.3	6.3	0.6	0.0	3.6	3.9	3.7
Needleleaf treed on other peatlands	Jack pine treed on shallow peatland	-	0.0	-	0.0	-	-	-	-	-	-	-	0.0	0.3	0.1
	Black spruce mixedwood on shallow peatland	-	0.0	-	-	0.0	0.1	-	-	0.1	-	-	0.0	0.1	0.0
	Black spruce treed on shallow peatland	13.4	15.3	27.1	14.2	38.7	20.2	24.1	9.3	23.3	18.1	-	27.4	21.7	26.1
	Black spruce treed on wet peatland	0.2	2.3	-	0.4	1.6	0.0	-	0.4	0.4	0.0	-	1.1	0.7	1.0
	Tamarack- black spruce mixture on wet peatland	0.0	0.3	-	-	0.6	-	-	-	0.2	-	-	0.3	0.2	0.3
	Tamarack treed on shallow peatland	0.2	2.2	-	0.2	1.1	0.0	-	0.1	0.2	0.1	-	0.8	0.7	0.7
	Tamarack treed on wet peatland	-	-	-	-	0.0	-	-	-	0.0	-	-	0.0	0.0	0.0
	Black spruce treed on riparian peatland	0.0	0.3	-	0.0	0.6	0.1	-	0.5	0.5	-	-	0.4	0.3	0.4
	Tamarack- black spruce mixture on riparian peatland		0.0	-	-	0.0	-	-	-	0.0	-	-	0.0	0.0	0.0
Tall shrub on other peatlands	Tall shrub on shallow peatland	0.3	0.1	-	-	0.3	0.0	-	0.8	0.4	0.0	-	0.2	0.4	0.3
	Tall shrub on wet peatland	-	-	-	-	0.7	-	-	0.4	0.2	-	-	0.4	0.2	0.3
Low vegetation on other peatlands	Low vegetation on shallow peatland	9.2	3.3	25.8	3.7	7.2	15.0	0.6	3.7	5.8	0.8	-	6.2	4.8	5.9
	Low vegetation on wet peatland	0.3	1.3	-	-	2.5	0.0	0.6	0.6	0.4	2.1	-	1.4	0.7	1.3
Shrub/ low vegetation on riparian peatland	Tall shrub on riparian peatland	0.0	0.3	-	0.0	2.7	0.3	0.0	29.7	5.1	0.9	23.1	3.1	0.3	2.5
	Low vegetation on riparian peatland	0.1	1.0	-	0.0	3.7	0.3	-	10.9	1.4	0.4	0.1	2.5	0.9	2.1
Nelson River shore zone	Nelson River shrub and/or low vegetation on ice scoured upland	5.7	0.3	-	0.6	1.1	3.5	9.4	3.9	3.4	-	34.8	1.6	0.6	1.4
	Nelson River shrub and/or low vegetation on upper beach	-	0.0	-	0.3	0.4		1.5	27.9	7.6	0.6	19.7	2.1	0.9	1.8
	Nelson River shrub and/or low vegetation on sunken peat	-	0.8	-	0.5	-	2.7	0.0	-	0.1	-	0.0	0.3	1.3	0.5
	Nelson River marsh	-	-	-	-	0.0	-	-	1.8	0.9	-	-	0.2	0.0	0.1
Off-system shore zone	Off-system marsh	0.0	-	-	-	0.2	0.0	-	0.4	0.1	0.0	-	0.1	0.0	0.1
Total habitat area (ha)		*246*	*405*	*5*	*1,466*	*3,414*	*262*	*14*	*277*	*631*	*138*	*14*	*6,872*	*2,055*	*8,927*

Note: Reported areas are land area only. Reported areas do not include shallow water wetlands since bathymetry was not available to locate the boundary between shallow and deep water for all of the waterbodies in Study Zone 4.

The amount of permanent habitat alteration is highly uncertain because the actual locations and sizes of the borrow areas, excavated material placement areas and potential disturbance areas will not be known until construction completion and because the degrees of habitat rehabilitation success and natural habitat recovery will not be known for many years into operation. To estimate long-term habitat alteration it was assumed that habitat alteration during operation would persist for longer than 30 years in the following locations (which are shown in Map 6-65):

- A 50 m buffer of the permanent infrastructure to account for edge effects;
- All of the PDAs and road corridors to account for permanent infrastructure edge effects and areas heavily disturbed during construction. Note that these areas overlap the 50 m permanent infrastructure buffer;
- A 50 m buffer of the reservoir at 30 year to account for reservoir-related edge effects. Shoreline erosion predictions indicate that by Year 30 most of the shoreline will either be relatively stable or will be receding at low rates that are similar to what would be there without the Project by (Section 6.4.2);
- Areas adjacent to the reservoir with surface elevations between 159 and 160 m ASL to account for reservoir-related groundwater effects. Note that these areas overlap the 50 m 30 year reservoir expansion area buffer; and
- Low-lying peatlands adjacent to the year 30 reservoir shoreline to capture reservoir-related hydrological effects in these peatlands and reservoir expansion beyond Year 30. Predictions are that the majority of reservoir expansion will have occurred by Year 30; Section 6.4.2). Note that these low lying peatlands overlap the areas delineated by the previous two bullets.

These assumptions were expected to overestimate the total amount of permanent habitat alteration because it is likely that all of the road corridors and a substantial proportion of the PDA area included by the second bullet will not be used.

Temporary habitat alteration was assumed to include all of the remaining areas affected during construction since most of these areas would be rehabilitated and/or undergo natural regeneration. It is anticipated that a substantial proportion of the borrow areas will not be used. While it is likely that portions of the used borrow areas would remain permanently altered, this area could be offset by the portions of the PDAs were not disturbed and where alteration is temporary.

Based on the above assumptions, it was estimated that the Project could permanently alter 2,580 ha of terrestrial habitat over the long-term. Approximately half of this total area arises from reservoir-related groundwater and edge effects (Map 6-65). The remaining 1,314 ha of permanent habitat alteration arises from clearing-related edge effects and heavily disturbed construction areas (*e.g.*, areas rutted by machinery).

It was estimated that approximately 1,497 ha of the terrestrial habitat affected during construction area would remain altered at Year 30 (Map 6-65). Most of this area could recover to native habitat by Year 100.

In summary, before considering mitigation and recovery of temporarily affected habitat, Project operation is predicted to affect approximately 9,416 ha of terrestrial habitat by Year 30 (Map 6-65), but this could increase to nearly 9,558 ha in the unlikely event that borrow area E-1 is used. Even in this unlikely scenario, less than 1% of the historical areas of total terrestrial habitat and each of the common broad habitat typeswould be affected by the Project. Habitat recovery and habitat rehabilitation in the areas that were disturbed or temporarily cleared during construction could potentially reduce to the total amount of affected terrestrial habitat to below 8,000 ha, which would also reduce effects on the two common broad habitat types used as indictors for overall terrestrial habitat effects.

Mitigation during operation, in addition to that already incorporated into the Project design, will include the following:

- Except for existing resource-use trails (see Construction Access Management Plan), Project-related cutlines and trails will be blocked where they intersect the Project Footprint, and the portions of these features within 100 m of the Project Footprint will be revegetated to minimize the risk of habitat disturbance, invasive plant spreading, accidental fires and access-related effects.

Mitigation implemented for ecosystem diversity and wetland function (Sections 6.5.3.4 and 6.5.3.5) is expected to further reduce Project effects on habitat. The EnvPPs will include measures to minimize the risk that accidental fires and spills will affect terrestrial habitat.

Table 6-26: Estimated Area of Terrestrial Habitat Affected at Year 30 of Operation by Location and Permanence

Location and Permanence	Habitat Affected (ha)
Permanent Terrestrial Habitat Loss	
Permanent infrastructure and initial flooding	4,667
Reservoir expansion to Year 30	671
Sub-total for permanent loss	**5,339**
Permanent Terrestrial Habitat Alteration	
Indirect reservoir effects over the long-term	1,266
Other long-term indirect effects	1,314
Sub-total for permanent alteration of terrestrial areas	**2,580**
Sub-total for permanent effects	**7,919**
Temporary Habitat Alteration at Year 30	1,497
Sub-total for permanent and temporary effects before mitigation	**9,416**
Mitigation - Off-system marsh development	-12
Total terrestrial habitat affected at Year 30	**9,404**

Notes: The reported amounts of affected habitat will be lower than the values reported in the Project Description (Section 4.4.2) because they include terrestrial areas only (*i.e.*, deeper portions of lakes that are aquatic rather than terrestrial area). For example, only 41.7 km^2 of the 44.6 km^2 of initial flooding is terrestrial.

6.5.3.1.4 Residual Effects of Operation

After considering mitigation, Project operation is expected to affect less than 1% of total terrestrial habitat area and the areas of the common broad habitat types. After considering these remaining Project effects in combination with the effects of other past and existing projects and activities, it is predicted that Project operation could increase the affected amounts of total terrestrial habitat and the common habitat types to almost 6% of historical area, which is a moderate magnitude residual effect.

6.5.3.1.5 Conclusion About Residual Effects on Terrestrial Habitat

Overall, the likely residual Project effects on terrestrial habitat are expected to be adverse but regionally acceptable because the Project-related increase in affected habitat is small enough to maintain the percentage of Regional Study Area habitat affected by human developments well below 10%. Cumulative area effects below 10% are considered to be regionally acceptable regardless of their duration because this degree of change is expected to fall within the range of natural variability and because there is no ongoing trend of substantial terrestrial habitat habitat loss and alteration. It is noteworthy that most of the affected area consists of habitat types that are regionally common.

As outlined in Chapter 5, the cumulative effects assessment step that deals with future projects and activities focuses on the VECs that are adversely affected by the Project and vulnerable to the effects of future projects and activities. As terrestrial habitat is not a VEC, it is not carried forward to the CEA with future projects in Chapter 7.

Terrestrial habitat monitoring provides an effective means to monitor a wide array of terrestrial ecosystem effects because it is readily monitored and it is the foundation for the terrestrial environment assessment. Terrestrial habitat monitoring will include documenting the actual direct and indirect effects on terrestrial habitat. Chapter 8 provides an overview of terrestrial habitat monitoring.

6.5.3.2 ECOSYSTEM DIVERSITY

The potential Project effects pathways described in the previous section also apply to ecosystem diversity because ecosystem diversity indicators were measured using the habitat mapping. Potential Project effects on ecosystem diversity include reducing the number of native ecosystem types, altering the distribution of area amongst the ecosystem types, reducing the total number of stands representing an ecosystem type and/or reducing the total area of a priority ecosystem type. The TE SV Section 2.4.3 provides a detailed evaluation of how the Project is predicted to affect ecosystem diversity.

Since ecosystem diversity was measured using the habitat mapping, terrestrial habitat effects predictions (Section 6.5.3.1) were used to predict Project effects on ecosystem diversity.

The acceptability of residual Project effects on ecosystem diversity was evaluated based on the number of stand level habitat types that would be completely removed, changes in stand level habitat composition and cumulative historical area losses for each of the priority habitat types. The complete removal of one or more stand level habitat types from the Regional Study Area is an unacceptable effect. For the habitat composition and priority habitat type indicators, effects that are small to moderate in magnitude are generally acceptable regardless of their duration or geographic extent because this degree of change is expected to fall within the range of natural variability. Exceptions could occur for a moderate magnitude residual effect if there was a substantial ongoing adverse trend in the amount of a habitat type being considered.

The magnitude of residual Project effects on habitat composition was measured as the percentage changes in the distribution of area amongst the native stand level habitat types within the Regional Study Area. For priority habitat types, magnitude was measured as the cumulative percentage of area affected by human development and activities in the Regional Study Area. Percentage change benchmarks for both indicators were as follows: percentage changes below 1% are small magnitude; percentage changes between 1% and 10% are moderate magnitude; and, percentage changes greater than 10% are high magnitude (Hegmann *et al*. 1999; Salmo *et al*. 2004 for the 10% value).

6.5.3.2.1 CONSTRUCTION EFFECTS AND MITIGATION

Project construction is not expected to change the total number of native stand level habitat types or to substantially change the proportions of any of the regionally common or uncommon native habitat types. The largest change in the percentage of area occupied by a native habitat type is 0.2% (black spruce mixture on mineral increases from 20.3% to 20.5%).

Project construction is predicted to reduce the total number of stands for six out of the eight habitat types with less than 20 stands, and two out of the four habitat types with less than 10 stands. The most affected habitat types are balsam poplar dominant on all ecosites (2 out of 4 stands) and tamarack dominant on mineral (5 out of 11 stands). In both cases, the removed stands are very small and represent less than 3% of the total area for the habitat type.

It is predicted that Project construction would not affect three of the 43 priority habitat types. Before considering potential mitigation measures and cumulative historical effects, Project construction could affect up to 3.8% of the area of 39 priority habitat types (see TE SV Table 2.7-5). For the only remaining priority habitat type, white birch mixedwood on all ecosites, Project construction could affect nearly 8% of its total area, including the largest known stand.

In descending order, priority habitat types with the highest effects before mitigation are white birch mixedwood on all ecosites, black spruce mixture on mineral, white birch dominant on all ecosites, tall shrub on mineral, tall shrub on riparian peatland, tamarack mixture on mineral, tall shrub on thin peatland, tamarack mixture on thin peatland, black spruce mixture on thin peatland and jack pine mixture on thin peatland. As explained in Section 6.5.3.1, this is likely an overestimate of the magnitude of direct and indirect effects on most of the priority habitat types.

Mitigation for ecosystem diversity effects already incorporated into the Project design includes avoiding some priority habitat patches by choosing a low-head option, refining the south access road routing, relocating some of the excavated material placement areas and refining the boundaries of the potential borrow areas and excavated material placement areas (see Section 4.2.3). Additional mitigation during construction will include the following:

- The portion of borrow area N-6 identified as the N6 sensitive site in Map 6-64 will be avoided to reduce effects on the white birch priority habitat types, and protection measures will be implemented to ensure that soil alteration or accidental disturbance within this site does not occur;

- Clearing and disturbance within the Project Footprint will be minimized to the extent practicable;
- Disturbance of areas adjacent to the Project Footprint will be avoided to the extent practicable;
- A rehabilitation plan will be developed that gives preference to rehabilitating the most affected priority habitat types using approaches that “go with nature” (Keeyask JKDA Schedule 7-1); and
- Except for existing resource-use trails (see Construction Access Management Plan), Project-related cutlines and trails will be blocked where they intersect the Project Footprint, and the portions of these features within 100 m of the Project Footprint will be revegetated to minimize the risk of habitat disturbance, invasive plant spreading, accidental fires and access-related effects.

Mitigation implemented for wetland function (Section 6.5.3.5) and the clearing and disturbance minimization measures in the EnvPPs could further reduce Project effects on ecosystem diversity. The EnvPPs will also include measures to minimize the risk that accidental events such as spreading invasive plants, fires and spills will affect ecosystem diversity.

6.5.3.2.2 Residual Effects of Construction

After considering mitigation, Project effects on ecosystem diversity during construction are expected to include affecting between 0.1% and 3.8% of estimated area for 40 of the 43 priority habitat types, depending on the type. After considering these remaining Project effects in combination with the effects of other past and existing projects and activities, it is predicted that the residual effects of Project construction on ecosystem diversity during construction would include affecting between 5.0% and 8.7% of estimated historical area for 40 priority habitat types, which are moderate magnitude effects.

Using the criteria established to determine the significance of Project effects for regulatory purposes (Section 5.5), the likely residual effects of Project construction on ecosystem diversity are expected to be adverse, medium in geographic extent, long term in duration and, depending on the ecosystem diversity indicator either nil, small or moderate in magnitude. For those ecosystem diversity indicators with a moderate magnitude residual effect, a Step 2 analysis indicates that the effects are expected to be irreversible, continuous in frequency, and low in ecological context.

6.5.3.2.3 Operation Effects and Mitigation

Reservoir expansion, additional edge effects and groundwater-related habitat effects will be the primary pathway for adverse Project effects on ecosystem diversity during operation.

These increases will be somewhat offset by elimination of temporary construction effects (see Section 6.5.3.1.3).

The predicted net increase in the total amount of affected terrestrial habitat is relatively small throughout operation, totalling approximately 6 ha at the start of operation and increasing 545 ha, or 0.04%, of Regional Study Area habitat by Year 30 (see Section 6.5.3.1.3). Most of the reservoir-related habitat loss occurs during the first 15 years.

Project operation is not expected to change the total number of native stand level habitat types or to substantially change the proportions of any of the regionally common or uncommon native habitat types because the increase in area affected is relatively small.

Project effects on most priority habitat types could increase slightly during operation. The amount of affected area could increase by more than 1% in absolute terms by Year 30 in four priority habitat types. In descending order of increased area effects, these priority habitat types include balsam poplar dominant on all ecosites (predicted to increase from 1.9% to 4.9% of area), white birch mixedwood on all ecosites (from 1.8% after construction mitigation to 3.8%), white birch dominant on all ecosites (from 1.1% after construction mitigation to 2.2%) and tamarack-black spruce mixture on riparian peatland (from 0.3% to 1.4%).

Mitigation during operation, in addition to that already incorporated into the Project design, will include the following:

- The portion of borrow area N-6 identified as the N6 sensitive site in Map 6-64 will be avoided to reduce effects on the white birch priority habitat types, and protection measures will be implemented to ensure that soil alteration or accidental disturbance within this site does not occur;
- The rehabilitation plan developed and initiated during construction will extend into the operation phase, and continue until all necessary rehabilitation is completed.
- Except for existing resource-use trails (see Construction Access Management Plan), Project-related cutlines and trails will be blocked where they intersect the Project Footprint, and the portions of these features within 100 m of the Project Footprint will be revegetated to minimize the risk of habitat disturbance, invasive plant spreading, accidental fires and access-related effects.

Mitigation implemented for wetland function could further reduce Project effects on ecosystem diversity by reducing the net area loss of habitat and priority habitat types.

6.5.3.2.4 Residual Effects of Operation

After considering mitigation, Project effects on ecosystem diversity during operation are expected to include affecting between 0.1% and 4.9% of estimated area for 40 of the 43 priority habitat types, depending on the type. After considering these remaining Project effects in combination with the effects of other past and existing projects and activities, it is predicted that the residual effects of Project operation on ecosystem diversity during construction would include affecting between 5.0% and 9.9% of estimated historical area for 40 priority habitat types, which are moderate magnitude effects.

Using the criteria established to determine the significance of Project effects for regulatory purposes (Section 5.5), the likely residual effects of Project operation on ecosystem diversity are expected to be adverse, medium in geographic extent, long term in duration and, depending on the ecosystem diversity indicator either nil, small or moderate in magnitude. For those ecosystem diversity indicators with a moderate magnitude residual effect, a Step 2 analysis indicates that the effects are expected to be irreversible, continuous in frequency, and low in ecological context.

6.5.3.2.5 Conclusion About Residual Effects on Ecosystem Diversity

Overall, the likely residual Project effects on ecosystem diversity are expected to be adverse but regionally acceptable because no stand level habitat types are lost, the distribution of area amongst the stand level habitat types is not expected to change substantially and the cumulative area losses for all of the priority habitat types is predicted to remain below 10%. As described in Section 6.2.3.4.2, the ecological context is that none of the habitat types considered in the ecosystem diversity assessment are experiencing substantial ongoing adverse changes in response to past human development and climate change.

The adverse residual effects of the Project on ecosystem diversity will overlap spatially and temporally with effects from the following future Projects: the Keeyask Transmission Project, Bipole III Transmission Project and Gillam Redevelopment. These cumulative effects are discussed in Chapter 7.

Ecosystem diversity monitoring will include confirming that the identified sensitive site was avoided, rehabilitation to native broad habitat types was successful at locations identified in the rehabilitation plan and documenting the actual direct and indirect effects on each of the priority habitat types. Chapter 8 provides an overview of ecosystem diversity monitoring.

6.5.3.3 Intactness

Potential Project effects on intactness include increased fragmentation from linear features, lower total core area and fewer large core areas. Newly constructed roads, transmission lines, trails and cutlines add to linear feature density. Core area is reduced by Project features that either remove existing core area or occur within 500 m of an existing core area. The TE SV Section 2.4.4 provides a detailed evaluation of how the Project is predicted to affect intactness.

Project effects on intactness were predicted by adding all Project features to the cumulative linear feature and cumulative human footprint maps (see Section 6.2.3.4.2).

The acceptability of residual Project effects on intactness was evaluated based on total linear feature density (especially outside of the Thompson portion of the Regional Study Area), core area percentage and the number of very large core areas. The complete removal of one or more very large core areas from the Regional Study Area is an unacceptable effect. For the linear feature density and core area percentage indicators, effects that are small to moderate in magnitude would generally be acceptable regardless of their duration or geographic extent because this degree of change is expected to fall within the range of natural variability. Exceptions could occur for a moderate magnitude residual effect if there was a substantial ongoing adverse trend in either of these indicators.

The benchmark values used to evaluate the magnitude of residual effects for the intactness indicators were as follows. For total linear feature density, adverse effects on intactness are: small magnitude for regional values below 0.40 km/km^2; moderate magnitude for regional values between 0.40 km/km^2 and 0.60 km/km^2; and, high magnitude for regional values greater than 0.60 km/km^2 (Salmo Consulting Inc. *et al.* 2003). For total core area as a percentage of land area, adverse effects on intactness are: small magnitude for regional values greater than 65%; moderate magnitude for regional values between 40% and 65%; and, high magnitude for regional values lower than 40% land area (Salmo Consulting Inc. *et al*. 2003; Athabasca Landscape Team 2009; and Dzus *et al.* 2010).

6.5.3.3.1 CONSTRUCTION EFFECTS AND MITIGATION

Total linear feature density declines during construction because existing cutlines would be replaced by Project features such as borrow areas and reservoir clearing. Most of the roads used by the Project during construction are either already existing or would be built on existing cutlines (TE SV Section 2.4.4.1).

The Project is predicted to reduce total linear feature density from 0.45 km/km^2 to 0.44 km/km^2 for the entire Regional Study Area and from 0.32 km/km^2 to 0.31 km/km^2 for the portion of the Regional Study Area outside of the Thompson area. Regional transportation density is predicted to remain at 0.07 km/km^2 due to the short length of new Project roads relative to the size of the Regional Study Area.

Project construction would have localized core area effects, primarily due to reservoir clearing, dyke construction and cofferdam diversion. One core area slightly larger than 1,000 ha and two core areas between 200 ha and 1,000 ha would be removed due to flooding. One of these latter core areas is on Caribou Island and is the largest core area on an island in the Keeyask segment of the Nelson River. Several larger core areas on the north and south sides of the Nelson River would become smaller.

Regional effects on core area are low during construction. The Project is predicted to reduce the percentage of the Regional Study Area in core areas larger than either 200 ha or 1,000 ha by a maximum of 1% to approximately 82%. This is anticipated to be an overestimate of the expected core area reduction since it is likely that that some portions of the Project Footprint will not be used (see Section 6.5.3.1).

The total number of core areas larger than 200 ha in the Regional Study Area is predicted to remain at 111 because, although a few core areas are completely removed, several other core areas are fragmented into smaller blocks. The total number of core areas larger than 1,000 ha would be reduced by one. None of the very large core areas would be lost.

Some of the potential Project effects on intactness were mitigated by minimizing the size of the Project Footprint during Project design (Section 4.2.3). Additional mitigation during construction will include the following:

- Clearing and disturbance within the Project Footprint will be minimized to the extent practicable;
- Disturbance of areas adjacent to the Project Footprint will be avoided to the extent practicable;
- A rehabilitation plan will be developed that gives preference to rehabilitating the most affected priority habitat types using approaches that "go with nature" (Keeyask JKDA Schedule 7-1); and
- Except for existing resource-use trails (see Construction Access Management Plan), Project-related cutlines and trails will be blocked where they intersect the Project Footprint, and the portions of these features within 100 m of the Project Footprint will be revegetated to minimize the risk of habitat disturbance, invasive plant spreading, accidental fires and access-related effects.

6.5.3.3.2 Residual Effects of Construction

After considering mitigation and the effects of other past and existing human features, total linear feature density is predicted to remain at the low end of the moderate magnitude effects range for the entire Regional Study Area (0.44 km/km^2) and well within the small magnitude range for the Regional Study Area outside of the Thompson area. The minimum core area percentage for the Regional Study Area during construction (82%) is well within the small magnitude range (*i.e.*, well above 65%).

Using the criteria established to determine the significance of Project effects for regulatory purposes (described Section 5.5), the likely residual effects of Project construction on intactness are expected to be adverse, medium in geographic extent, long-term in duration and small in magnitude. Step 2 analysis is screened out based on Step 1 analysis.

6.5.3.3.3 Operation Effects and Mitigation

Flooding and reservoir expansion during Project operation would remove portions of cutlines and temporary access roads. However, this change is so small during the first 30 years of operation that it is not expected to substantially reduce any of the linear feature density values. Over time, there would be some native habitat recovery in portions of existing and Project-related linear features (see Section 6.5.3.1), which could further reduce total linear feature density for the entire Regional Study Area into the small magnitude range (linear feature density in the portion of the Regional Study Area outside of the Thompson area remains well within the small magnitude range).

Although Project operation during the first 30 years is not expected to remove any of the individual 200 ha or 1,000 ha core areas, reservoir expansion (Section 6.3.7) is predicted to decrease total core area by approximately 180 ha. Habitat recovery in the temporarily cleared and rehabilitated areas would slightly increase core area, somewhat offsetting Project related habitat loss. Natural regeneration on portions of existing cutlines would further increase core area. In summary, the Regional Study Area core area percentage is expected to remain higher than 80%, which is well within the small magnitude range (*i.e.*, well above 65%).

Mitigation during operation, in addition to that already incorporated into the Project design, will include the following:

- The rehabilitation plan developed and initiated during construction will extend into the operation phase, and continue until all necessary rehabilitation is completed; and
- Except for existing resource-use trails (see Construction Access Management Plan), Project-related cutlines and trails will be blocked where they intersect the Project Footprint, and the portions of these features within 100 m of the Project Footprint will be revegetated to minimize the risk of habitat disturbance, invasive plant spreading, accidental fires and access-related effects.

The potential effects of improved public access on intactness will be somewhat offset if and when Manitoba Infrastructure and Transportation closes PR 280 between the junctions of the north access road and PR 290.

6.5.3.3.4 Residual Effects of Operation

After considering mitigation and the effects of other past and existing human features, residual Project effects on regional intactness during operation are expected to include positive changes to linear feature density and small adverse changes to core area percentage.

Using the criteria established to determine the significance of Project effects for regulatory purposes, the likely residual effects of Project operation on intactness are expected to be adverse, medium in geographic extent, long-term in duration and small in magnitude. Step 2 analysis is screened out based on Step 1 analysis.

6.5.3.3.5 Conclusion About Residual Effects on Intactness

Overall, the likely residual Project effects on regional intactness are expected to be adverse but regionally acceptable because no very large core areas are lost and core area percentage is expected to remain over 80%, which is well within the small magnitude range. This occurs because the Project is located in a portion of the Regional Study Area where intactness is already low due to past and current human development.

The small, adverse residual effects of the Project on intactness will overlap spatially and temporally with effects from the following future Projects: the Keeyask Transmission Project, Bipole III Transmission Project and Gillam Redevelopment. These cumulative effects are discussed in Chapter 7.

Intactness monitoring will include documenting actual Project effects on intactness and confirming the effectiveness of mitigation measures used to minimize access from the Project Footprint to existing linear features that were previously difficult to access . Chapter 8 provides an overview of intactness monitoring.

6.5.3.4 WETLAND FUNCTION

Potential Project effects on wetlands include wetland loss and alteration in the Project Footprint and surrounding areas primarily through pathways such as physical disturbance, edge effects, altered depth to groundwater, altered groundwater flows and/or changes to the nutrient status of surface and groundwater. Project-related wetland loss and alteration could affect wetland function, with the degree of these effects depending on wetland type and local conditions. The Project could also potentially affect the globally, nationally and/or provincially significant wetlands identified by Ramsar, the North American Waterfowl Management Plan, Ducks Unlimited and/or the Manitoba Heritage Marsh Program. The TE SV Section 2.8.4 provides a detailed evaluation of how the Project is predicted to affect wetland function.

As described in Section 6.2.3.4.2, particularly important wetlands were the focus of the assessment and mitigation because wetlands cover most of the Regional Study Area and most of these wetlands are relatively pristine. Particularly important wetlands were the off-system marsh types and the globally, nationally and/or provincially significant wetlands.

Since wetlands are a type of terrestrial habitat, the habitat effects predictions (Section 6.5.3.1) were the basis for predicting potential Project effects on wetland function.

The acceptability of residual Project effects on wetland function was evaluated based on how the particularly important wetlands would be affected and the cumulative historical area losses for each of the remaining native wetland types. Subtantial effects on any existing globally, nationally and/or provincially significant wetland would be an unacceptable effect. For the other particularly important wetland types, a net area loss would be an unacceptable effect. For the remaining native wetland types, effects that are small to moderate in magnitude would generally be acceptable regardless of their duration or geographic extent because this degree of change is expected to fall within the range of natural variability. Exceptions to this generalization could occur for a moderate magnitude residual effect if there was a substantial ongoing adverse trend in the amount of a wetland type being considered.

The magnitude of residual Project effects on those native wetland types not classified as being particularly important was measured as the cumulative percentage of area affected by human development and activities in the Regional Study Area. Percentage change benchmarks were as follows: percentage changes below 1% are small magnitude; percentage changes between 1% and 10% are moderate magnitude; and, percentage changes greater than 10% are high magnitude (Hegmann *et al*. 1999; Salmo *et al*. 2004 for the 10% value).

6.5.3.4.1 CONSTRUCTION EFFECTS AND MITIGATION

Project construction would directly remove and alter wetlands through activities such as clearing for Project infrastructure, excavating borrow areas, placing excavated material, reservoir clearing and flooding from cofferdam diversions. Edge effects and Project Footprint components that alter hydrology (*e.g.*, dykes redirecting drainage that is moving from inland areas towards the Nelson River) would be the primary indirect pathways for wetland effects during construction.

There are no globally, nationally or provincially significant wetlands in the Local Study Area.

Before considering mitigation, Project construction is predicted to affect up to 7,765 ha of wetlands, which includes 9 ha of off-system marsh, up to 1,851 ha of wetlands with wetland quality scores ranging from 20 to 56 and up to 5,904 ha of wetlands with quality scores of 19 or less. Included in these areas are 441 ha of Nelson River shoreline wetlands, all of which had wetland quality scores lower than 20. The total amount of affected off-system marsh does not include emergent vegetation patches that are too small to map, the inclusion of which could increase the amount of affected off-system marsh to approximately 12 ha.

Mitigation to replace Nelson River wetlands is not proposed. These wetlands are low quality, disrupted, non-native wetland types that will be replaced by wetlands that develop along the reservoir shoreline during the operation phase (see next section).

Some mitigation for the remaining wetland types was already incorporated into the Project design. Choosing a low-head option considerably reduced the amount of wetland loss. Examples of other design measures are avoiding some wetland patches with high and moderate wetland quality scores through south access road routing, relocating some of the excavated material placement areas and refining the boundaries of the potential borrow areas and excavated material placement areas (see Section 4.2.3).

Additional mitigation during construction will include the following:

- Measures to protect against erosion, siltation and hydrological alteration will be implemented in utilized construction areas that are within 50 m of any off-system marsh that is outside of the Project Footprint; and,

- 12 ha of the off-system marsh wetland type will be developed within or near the Local Study Area.

6.5.3.4.2 Residual Effects of Construction

After considering mitigation, Project construction is expected to result in the temporary loss of most of the Nelson River shoreline wetlands in the Local Study Area, create no net area loss for off-system marsh, have no effects on five wetland types and, depending on the wetland type, remove or alter between 0.2% and 2.4% of estimated historical area for the remaining wetland types. After considering these remaining Project effects in combination with other past and existing projects and activities, it is predicted that the Project would not increase historical effects on Nelson River wetlands, off-system marsh or several of the other native wetland types. The Project would increase historical effects on the remaining native wetland types to between 3.0% and 6.2% of estimated historical area, which is considered to be a moderate magnitude effect for each of these wetland types.

Using the criteria established to determine the significance of Project effects for regulatory purposes (Section 5.5), the likely residual effects of Project construction on wetland function are expected to be adverse, medium in geographic extent, long term in duration and, depending on the wetland type, nil to moderate in magnitude. For those wetland function indicators with a moderate magnitude residual effect, a Step 2 analysis indicates that the effects are expected to be irreversible, continuous in frequency and low in ecological context.

6.5.3.4.3 Operation Effects and Mitigation

Reservoir expansion, additional edge effects and groundwater-related habitat effects will be the primary pathways for Project effects on wetlands during operation. Virtually all of the flooding that initiates Project operation would occur within areas already that were already affected during construction. As described in Section 6.5.3.1.3, terrestrial habitat that recovers from temporary construction effects (*e.g.*, potential construction areas that were not actually disturbed, rehabilitation of temporarily cleared areas) will reduce the total amount of affected wetland area.

After considering habitat recovery but not mitigation, the first 30 years of Project operation are predicted to increase the amount of affected wetlands to 8,285 ha, which is comprised of the 9 ha of off-system marsh affected during construction, up to 2,086 ha wetlands with wetland quality scores ranging from 20 to 56 and up to 6,190 ha of wetlands with wetland quality scores lower than 20. This total amount of affected off-system marsh does not include emergent vegetation patches that are too small to map, the inclusion of which could increase the amount of affected off-system marsh to approximately 12 ha.

Additional reservoir expansion after Year 30 would likely be confined to the wetlands already affected by groundwater changes so that the amount of wetland area affected would not change. In other words, the effects assessment already assumed that all wetlands in the habitat zone of influence would be lost even though effects in some areas could be very low or nil.

Based on observations from Stephens Lake (the Kettle GS reservoir), it is expected that Nelson River shoreline wetlands that were removed or altered by the Project would be replaced by wetlands that develop along the reservoir shoreline during the operation phase. The Project would reduce the existing high monthly and annual variability in water elevations in the Keeyask segment of the Nelson River (PE SV Section 4.3.1.1), which would facilitate the development of marsh and riparian fen. A longer shoreline would further contribute to increasing the total area of Nelson River shoreline wetlands (the reservoir shoreline length is predicted to increase from about 198 km today to 264 km after initial impoundment and then decrease to about 244 km by 30 year of operation; Section 6.3.7.2).

Mitigation during operation, in addition to that already incorporated into the Project design, will include the following:

- Implement additional wetland development to the extent practicable if monitoring determines that further measures are needed to achieve successful development of 12 ha of the off-system marsh wetland type.

6.5.3.4.4 Residual Effects of Operation

After considering mitigation, Project operation is expected to increase the amount of Nelson River shoreline wetlands in the Local Study Area relative to what is typically there now, create no net area loss for off-system marsh, have no effects for five wetland types and, depending on the wetland type, remove or alter between 0.2% and 1.6% of historical wetland area for the remaining wetland types. After considering these remaining Project effects in combination with the effects of other past and existing projects and activities, it is predicted that the Project will not increase historical effects on Nelson River wetlands, off-system marsh or five native wetland types. The Project would increase historical effects on the remaining native wetland types to between 1.7% and 6.5% of estimated historical area, which is considered to be a moderate magnitude effect for each of these types.

Using the criteria established to determine the significance of Project effects for regulatory purposes (Section 5.5), the likely residual effects of Project operation on wetland function are expected to be adverse, medium in geographic extent, long term in duration and, depending on the wetland type, nil to moderate in magnitude. For those wetland function indicators with a moderate magnitude residual effect, a Step 2 analysis indicates that the effects are expected to be irreversible, continuous in frequency and low in ecological context.

6.5.3.4.5 Conclusion About Residual Effects on Wetland Function

Overall, the likely residual Project effects on wetland function are expected to be adverse but regionally acceptable because globally, nationally and/or provincially significant wetlands are not affected, there is no net area loss for off-system marsh and the cumulative area losses for all of the remaining native wetland types is below 10% of historical area. For those native wetland types with moderate magnitude effects, these effects are regionally acceptable because wetlands off the Nelson River are widespread, abundant and relatively pristine. As described in Section 6.2.3.4.2, the ecological context does not include substantial ongoing adverse trends that would alter the overall conclusion for any of the native wetland types with moderate magnitude effects.

Regarding the Nelson River shoreline wetlands that will be lost during construction, these wetlands are already highly disrupted by water regulation and will likely be replaced by reservoir wetlands during operation.

The adverse residual effects of the Project on wetland function will overlap spatially and temporally with effects from the following future Projects: the Keeyask Transmission Project, Bipole III Transmission Project and Gillam Redevelopment. These cumulative effects are discussed in Chapter 7.

Wetland monitoring will include documenting the actual direct and indirect effects on wetland habitat as well as monitoring the success of wetland mitigation. Chapter 8 provides an overview of wetland function monitoring.

6.5.4 TERRESTRIAL PLANTS

Effects on terrestrial plants were assessed by focusing on invasive plants as the supporting topic and priority plants as the VEC. The TE SV Section 3.2.4.2 provides a detailed evaluation of how the Project is predicted to affect terrestrial plants.

6.5.4.1 INVASIVE PLANTS

Potential Project effects on invasive plants include the introduction and/or further spreading of invasive species. Invasive plants could become a problem if the Project directly and/or indirectly: (i) introduces or spreads large numbers of seeds or other types of propagules; and/or (ii) creates areas with ideal conditions for the colonization of invasive species. Invasive plants could be introduced and/or further spread through various types of activities such as seeding cleared areas to control erosion, workers transporting seeds or other types of propagules on their vehicles or footwear and/or propagules being transported on construction equipment that was moved from other geographic areas. A severe accidental Project-related fire could create ideal conditions for some invasive plants by killing off a high proportion of the plant propagules and/or burning off the surface organic layer to expose the mineral soil. Invasive plant colonization centres could also be created in temporarily cleared areas.

Project effects on invasive plants were evaluated in terms of the risk of the Project increasing the rate at which invasive plants are introduced and/or spread.

Past and existing projects and activities, as well as natural dispersal processes, have introduced invasive plants into the Local Study Area. As described in Section 6.2.3.4.3, four of the invasive plants that are moderately to highly invasive in some parts of Canada are present in Manitoba. The risk that any of these species will be moderately to highly invasive in the Regional Study Area is probably low over the short to medium-term. Field studies conducted near existing developments in northern Manitoba, which included several generating stations, indicated that invasive plants are present but have not been spreading into adjacent native habitat.

Mitigation during construction and operation will include a number of measures specifically targeted towards minimizing the risk that the Project will introduce, spread or promote invasive plants (see TE SV Section 3.4.2). Mitigation will also include measures to minimize the risk that the Project will affect fire intensity and/or severity. It is anticipated that mitigation measures will minimize the risk that the Project would further spread invasive plants already in the Local Study Area and/or introduce new invasive plant species as well as provide a means to control the spread of invasive plants, should they become a problem.

With mitigation, the Project is not expected to substantially increase the rate at which invasive plants are introduced and/or spread in the Local Study Area.

6.5.4.2 Priority Plants

Direct Project effects on priority plants will include loss, alteration and disturbance of plants and their habitats in the Project Footprint (*e.g.*, clearing or flooding) as well any undefined Project activities that may ultimately occur outside of the Project Footprint (*e.g.*, machine trails), if any (see Chapter 4 for Project Footprint details). These direct effects will lead to indirect effects on terrestrial plants through pathways such as edge effects and altered groundwater levels. That is, Project impacts will have a zone of influence in adjacent areas below and surrounding the physical footprint. The spatial extent of the Project zone of influence on terrestrial plants (*i.e.*, the terrestrial plants zone of influence) was expected to be the same as the terrestrial habitat zone of influence.

The acceptability of residual Project effects on priority plants was evaluated based on the number of plant locations and/or the available priority plant habitat that could be affected by the Project. For both of these indicators, effects that are small to moderate in magnitude would generally be acceptable regardless of their duration or geographic extent because this degree of change is expected to fall within the range of natural variability. Exceptions could occur for a moderate magnitude residual effect on a species if there was a substantial ongoing adverse trend in either its population level or amount of available habitat.

The magnitude of residual Project effects on the number of plant locations was measured as the predicted percentage of known locations affected. Magnitude for available habitat was measured as the cumulative percentage of habitat affected within the Regional Study Area. For the endangered, threatened, globally rare, provincially very rare species and provincially rare species, the percentage benchmarks for both indicators were as follows: percentage changes below 1% are small magnitude; percentage changes between 1% and 5% are moderate magnitude; and, percentage changes greater than 5% are high magnitude (Hegmann *et al*. 1999; Wagner 1991). For the remaining priority plants, the percentage benchmarks for both indicators were as follows: percentage changes below 1% are small magnitude; percentage changes between 1% and 10% are moderate magnitude; and, percentage changes greater than 10% are high magnitude (Hegmann *et al*. 1999; Wagner 1991).

6.5.4.2.1 CONSTRUCTION EFFECTS AND MITIGATION

To predict potential Project effects, the priority plants effects assessment assumed that all of the plants and their habitat inside of the terrestrial plants zone of influence would be lost when construction starts. As described in Section 6.5.3.1, the Project could remove, alter or indirectly affect up to 8,870 ha of terrestrial habitat during construction, which would include some priority plant habitat. Improved access could increase the harvesting of some priority plant species and the alteration of their habitat. The potential for Project-related effects on priority plants due to invasive plants and fire regime changes should be negligible assuming that the EnvPP measures are effective (for details see TE SV Sections 3.4.2 and 2.5.4, respectively).

Project effects on endangered or threatened plant species during construction are not expected since none of these species are either known or expected to occur within the terrestrial plants zone of influence (Section 6.2.3.4.3).

Project effects on provincially very rare plant species are not expected since none were found during extensive field studies in the Regional Study Area and Project effects on their anticipated habitats are low (TE SV Section 3.4.3.1).

Elegant hawk's-beard was the only species found during field studies with an uncertain rank of provincially very rare or rare. It was not detected in the terrestrial plant local study area. The likelihood that it could occur there is considered to be low because it was not found during extensive field studies in the Local Study Area and its recorded local habitat is roadsides.

Seven of the 45 provincially rare to uncommon plant species that could potentially occur in the Regional Study Area were detected during field studies (Section 6.2.3.4.3). Of these species, small pondweed, oblong-leaved sundew, rock willow and shrubby willow were found in the Local Study Area. Project effects on these species are expected to be low since these species were more regionally common than suggested by their provincial conservation concern rank (see Section 6.2.3.4.3) and only a small percentage of the known locations for these species would be affected by the Project

It is unlikely that there would be substantial Project effects on the provincially very rare to rare species (S1 to S2 species) that were not found but are thought to occur in the Regional

Study Area. None of these species were found during fairly extensive field surveys, including searches in the habitat types that had the highest potential to harbour these species in the terrestrial plants zone of influence.

Because it is possible that existing locations of provincially very rare or provincially rare species were not found, mitigation for these species will include the following:

- Pre-construction rare plant surveys will be conducted in the Project Footprint and nearby areas that were not previously surveyed and have the highest potential for supporting provincially very rare to rare species; and,
- In the unlikely event that a provincially very rare to rare species is discovered in the terrestrial plants zone of influence and there are not at least 20 known healthy patches outside of the terrestrial plants zone of influence, then the discovered locations will be avoided where practicable. Where avoidance is not practicable, the plants will be transplanted outside of the terrestrial plants zone of influence.

Twenty-six regionally rare, range limit and/or species of particular interest to the KCNs were recorded in the terrestrial plants zone of influence. An additional 18 regionally rare species were not encountered but could potentially occur in the terrestrial plants zone of influence. Project effects on all of these species are anticipated to be low to moderate. Most of the KCNs species are either generally widespread or widespread in their preferred habitat. A small to moderate number of the known locations of each of the remaining species occurs within the terrestrial plants zone of influence. In addition, to the extent that the distributions of these species are related to terrestrial habitat type, Project-related habitat effects are expected to be small to moderate in magnitude. As described in Sections 6.5.3.1 and 6.5.3.2, Project construction is predicted to affect less than 10% of historical area for each of the native terrestrial habitat types.

Mitigation for priority plant effects already incorporated into the Project design includes avoiding some priority plant habitats by modifying the south access road route, refining the boundaries of the potential borrow areas and locating the excavated material placement areas away from areas of concern. Additional mitigation for priority plants during construction will include the following:

- Clearing and disturbance within the Project Footprint will be minimized to the extent practicable;
- Disturbance of areas adjacent to the Project Footprint will be avoided to the extent practicable; and
- Except for existing resource-use trails (see Construction Access Management Plan), Project-related cutlines and trails will be blocked where they intersect the Project Footprint, and the portions of these features within 100 m of the Project Footprint will be revegetated to minimize the risk of invasive plant, accidental fire and other access-related effects.

Priority habitat and wetland function mitigation (Sections 6.5.3.2 and 6.5.3.4) could also benefit priority plants to the extent that a priority plant species is associated with these habitat types.

6.5.4.2.2 Residual Effects of Construction

After considering mitigation and the effects of other past and existing human features, substantial residual Project effects on priority plants during construction are not expected. None of the species of highest conservation concern are either known or expected to occur in the Local Study Area. For the remaining species, the Project is predicted to affect low percentages of their known locations and/or available habitat.

Using the criteria established to determine the significance of Project effects for regulatory purposes (described Section 5.5), the likely residual effects of Project construction on priority plants are expected to be adverse, medium in geographic extent, long-term in duration and, depending on the species, nil to moderate in magnitude. For those priority plants with a moderate magnitude residual effect, a Step 2 analysis indicates that the effects are expected to be irreversible, continuous in frequency and low in ecological context.

6.5.4.2.3 Operation Effects and Mitigation

Potential Project effects on priority plants during operation include additional habitat loss, habitat alteration, population reductions, disturbance and access effects. Reservoir expansion, additional edge effects and groundwater-related habitat effects will be the primary pathways for Project effects on priority plants during operation. Habitat recovery in the temporarily cleared areas, disturbed areas and the habitat zone of influence could reduce Project effects on priority plants and their habitats. Better access may increase plant harvesting and/or disturbance.

Project operation is not expected to affect any provincially rare to uncommon plant species beyond those already affected during construction nor increase the number of known locations affected by the Project. Because it is possible that existing locations of provincially very rare or provincially rare species were not found, mitigation for these species will include:

- Pre-construction rare plant surveys will be conducted in the reservoir expansion areas that were not previously surveyed and have high potential for supporting provincially very rare to rare species; and
- In the unlikely event that a provincially very rare to rare species is discovered in the reservoir expansion area, the plants will be transplanted outside of the terrestrial plants zone of influence.

Project operation is expected to affect one additional location of a KCNs species (rock cranberry), but is not expected to increase the number of affected locations of regionally rare species. The predicted net effects on terrestrial habitat and the priority habitat types are the loss and alteration of less than 10% of the estimated historical area for each of the native habitat types. To the extent that these species are as common as their habitat, habitat effects are expected to be low and localized. The rehabilitation plan for temporarily cleared areas is expected to further reduce effects on some priority habitat types.

Improved access when the north and south access roads become part of PR 280 could increase harvesting and/or habitat alteration for some priority plant species. The effects of improved access on priority plants due to potential Project effects on invasive plants and the fire regime are expected to be small assuming that the EnvPP measures are effective (Sections 2.4.6 and 3.4.2 in the TE SV).

6.5.4.2.4 Residual Effects of Operation

After considering mitigation and the effects of other past and existing human features, substantial residual Project effects on priority plants during operation are not expected. None of the species of highest conservation concern are either known or expected to occur in the Local Study Area. For the remaining species, the Project is expected to affect low percentages of their known locations and/or available habitat.

Using the criteria established to determine the significance of Project effects for regulatory purposes (described Section 5.5), the likely residual effects of Project construction on priority plants are expected to be adverse, medium in geographic extent, long-term in duration and, depending on the species, nil to moderate in magnitude. For those priority plants with a moderate magnitude residual effect, a Step 2 analysis indicates that the effects are expected to be irreversible, continuous in frequency and low in ecological context.

6.5.4.2.5 Conclusion About Residual Effects on Priority Plants

Overall, the likely Project residual effects on priority plants are expected to be adverse but regionally acceptable. Project effects on endangered or threatened plant species are not expected since none of these species are either known to occur or are expected to occur in areas affected by the Project. Effects on the species of particular interest to the KCNs are expected to be low because most of these species are widespread in appropriate habitats and the percentages of known locations and available habitat affected by the Project are low. While the Project would affect the locations and/or habitat for some of the remaining priority plant species, the magnitude of these effects is anticipated to range from small to moderate, depending on the species, based on the percentage of known locations affected and/or the cumulative percentage area losses for the native habitat types. Regarding ecological context for species with moderate magnitude effects, although population trend information for these species in the Regional Study Area is not available, there are no substantial ongoing adverse trends in the amounts of native habitat types. Additional pre-construction mitigation has been included for the species of highest concern to address the unlikely event that patches of these species exist but have not been discovered to date due to the rarity of the species.

The adverse residual effects of the Project on priority plants will overlap spatially and temporally with effects from the following future Projects: the Keeyask Transmission Project, Bipole III Transmission Project and Gillam Redevelopment. These cumulative effects are discussed in Chapter 7.

Priority plant monitoring will include confirming that any priority plant patches marked for avoidance were not disturbed and documenting the actual direct and indirect effects on selected priority plant species. Chapter 8 provides an overview of priority plant monitoring.

6.5.5 TERRESTRIAL INVERTEBRATES

Terrestrial invertebrates are an important component of ecosystem health and function within the Terrestrial Invertebrate Regional Study Area (Study Zone 4 in Map 6-28). Key potential effects of the Project on terrestrial invertebrates include habitat loss and alteration through infrastructure and reservoir development and increased mortality due to increased traffic along access roads.

6.5.5.1 CONSTRUCTION EFFECTS AND MITIGATION

During construction, land clearing and site preparation associated with the development of the Project Footprint could result in the loss or alteration of 6,051 ha or 2.7% of terrestrial invertebrate habitats (*e.g.*, forest, woodland, and wetland) located within the Regional Study Area; this will lead to a decrease in the abundance of terrestrial invertebrates inhabiting the area.

Creation of the reservoir and subsequent flooding of wetlands and lakes will reduce the quality of 213 ha of breeding habitat for terrestrial invertebrate species that require aquatic environments for egg laying and development of young (*e.g.*, dragonflies). The quality of the reservoir area as breeding habitat for some terrestrial invertebrates will be marginal upon initial impoundment, increasing in quality with the establishment of aquatic plants. The re-establishment of emergent and submergent vegetation in the reservoir is anticipated to occur over the long-term.

Some marginal terrestrial invertebrate habitat may be created by the development of the south access road as pools of water may form in roadside ditches. Dust associated with the development of this road may have a small adverse effect on terrestrial invertebrates using these habitats as increased sedimentation may cause a local decrease in invertebrate abundance and diversity (Rosenberg and Wiens 1978; Rabeni *et al.* 2005; Sheridan and Noske 2007).

The use of the access roads during construction could also result in vehicle-related mortality of some terrestrial invertebrates. The effect of road traffic on terrestrial invertebrates will be limited to within the road footprint area.

Mitigation measures to minimize degradation/loss of terrestrial invertebrate habitat will include the following:

- Vegetation will be cleared in the winter, to the extent practicable, to avoid the bird breeding period (April 1 to July 31). This measure will benefit terrestrial invertebrates as snow provides a protective cover to soil and frozen soils may be more resistant to compaction by heavy equipment;
- Vegetated buffers adjacent to riparian areas will be retained, especially where wetlands, lakes and streams occur near roads;
- Roads will be watered appropriately to minimize road dust; and
- Mitigation for wetland function will be implemented through the development of wetlands in the Local Study Area (Section 6.5.3.4). This mitigation measure is expected to also benefit terrestrial invertebrates.

6.5.5.2 Residual Effects of Construction

The residual effect of construction on terrestrial invertebrates is primarily associated with the alteration of habitat through land clearing, site preparation and construction activities. The small, short-term residual effects of Project construction on terrestrial invertebrates are expected to be within the range of natural variability and limited to the Local Study Area. This is primarily related to the large invertebrate populations, their high reproductive capacities and the lack of any unique or critical habitat identified in the Regional Study Area.

6.5.5.3 Operation Effects and Mitigation

During operation, approximately 7 km^2 of additional terrestrial invertebrate habitat will be lost due to peatland disintegration and mineral erosion along reservoir shorelines. As the reservoir water levels stabilize, ponds may form in peatland areas that support higher water tables, leading to the establishment of some increasingly productive terrestrial invertebrate habitat.

Increased traffic on access roads during operation will result in the mortality of some terrestrial invertebrates. Road dust may have a small adverse effect on terrestrial invertebrates using aquatic roadside habitats (*e.g.*, ditches) as increased sedimentation may cause a local decrease in invertebrate abundance and diversity (Rosenberg and Wiens 1978; Rabeni *et al.* 2005; Sheridan and Noske 2007).

The following mitigation measure will be implemented to minimize degradation of terrestrial invertebrate habitat:

- Roads will be watered appropriately to minimize road dust.

The effects of traffic on terrestrial invertebrate communities during operation are expected to be within the range of natural variability and limited to the Local Study Area.

6.5.5.4 Residual Effects of Operation

There is a large population of terrestrial invertebrates and a lack of unique terrestrial invertebrate habitat within the Regional Study Area. The residual effects of Project operation on terrestrial invertebrates are expected to be within the range of natural variability and limited to the Local Study Area.

6.5.5.5 Conclusion about Residual Effects on Terrestrial Invertebrates

Terrestrial invertebrates will experience habitat loss through Project construction and operation; however, there are no unique invertebrate species or habitat present within the Regional Study Area expected to be affected by Project development. Residual effects to terrestrial invertebrate populations resulting from Project operation are expected to be within the range of natural variability for most species within the Regional Study Area and primarily associated with the long-term loss of habitat located within the reservoir footprint and adjacent shoreline sites.

As outlined in Chapter 5, the cumulative effects assessment step that deals with future projects and activities focuses on VECs that are adversely affected by the Project and vulnerable to the effects of future projects and activities. As terrestrial invertebrates are not a VEC, they are not covered in the cumulative effects assessment in Chapter 7.

Monitoring for changes in the terrestrial invertebrate community is not planned as Project effects are not anticipated to have measureable effects on terrestrial invertebrate populations, and no unique or rare terrestrial invertebrate species or species assemblages occur within the area.

6.5.6 Amphibians and Reptiles

This section only evaluates the potential effects that Project construction and operation will have on amphibians, since reptiles are neither expected to occur within the Amphibian Regional Study Area (Study Zone 4 in Map 6-28), nor to be affected by the Project (TE SV Section 5).

Key potential effects of the Project on amphibians include the following:

- Habitat loss, alteration and fragmentation of habitat; and
- Project-related disturbances such as noise, and frog mortality related to road traffic and winter clearing activities.

The primary pathways of Project effects on amphibians include the following:

- The loss or degradation of breeding, overwintering and foraging habitat resulting from reservoir creation and infrastructure development (*e.g.*, access roads and trails, camp areas, generating station, and dykes); and
- Direct mortality of some frogs.

6.5.6.1 CONSTRUCTION EFFECTS AND MITIGATION

Land clearing and grubbing activities associated with Project development will result in the loss and degradation of just over 2% (18 ha) of the total available amphibian breeding habitat in the Regional Study Area. Since land clearing activities will occur in frog overwintering habitat (*e.g.*, along margins of wetlands), a localized decrease in frog abundance is expected to occur within parts of the reservoir footprint area including infrastructure sites (*e.g.*, dykes) that currently support wetlands, ponds, or creeks.

Development of the south access road will result in the loss of some potential frog habitat; however, losses may be partially offset if marginal foraging and breeding habitat develops alongside the road, particularly in poorly drained roadside ditches. The south access road ROW may fragment some amphibian habitat and create a barrier that could partially constrain frog movements between habitats (Gibbs 1998; Yanes *et al.* 1995). The effect of fragmentation on the local amphibian population and the resulting alterations in amphibian movement patterns is anticipated to be small, partly due to there being alternate suitable frog habitat in nearby areas within which to disperse.

While the use of the north and south access roads by construction vehicles and heavy equipment may result in the mortality of some frogs, high frog mortality rates are not expected; this is due largely to the location of the infrastructure and the relatively low amphibian populations observed in the area. Detail on the effect of north access road construction on frogs is provided in the Keeyask Infrastructure Project EA Report (Keeyask Hydropower Limited Partnership 2009). Due to the low abundance and widespread distribution of amphibians within the Local Study Area (Study Zone 2 in Map 6-28), concentrated frog dispersal patterns near roads or other infrastructure sites are unlikely.

Measures to minimize Project effects on amphibians were considered during Project planning (*e.g.*, excavated material placement areas avoided amphibian breeding ponds; Chapter 4 and PD SV). Additional mitigation measures to minimize degradation/loss of amphibians and amphibian habitat will include the following:

- Hand clearing methods will be used within a minimum of 30 m around wetlands during the winter period. This will reduce amphibian mortality associated with compaction of ground cover; and
- Where construction activity may cause sediment flow into wetlands and slow-moving creeks, silt fences will be installed; and
- Retention of some slash piles and coarse woody debris (*i.e.*, snags and logs) on the forest floor to benefit boreal chorus frogs by providing cover.

6.5.6.2 RESIDUAL EFFECTS OF CONSTRUCTION

The residual effects of Project construction on amphibians include the loss and degradation (*e.g.*, fragmentation) of some amphibian habitat due to the construction of Project infrastructure (*e.g.*, south access road). Frog mortality is expected in some areas cleared for infrastructure and reservoir development, and along parts of the access roads where wetlands occur. Since amphibians are common and distributed throughout the Regional Study Area without there being any unique habitats or assemblages of amphibian populations, construction-related effects on amphibian populations within the Regional Study Area are expected to be within the range of natural variability.

6.5.6.3 OPERATION EFFECTS AND MITIGATION

Operation of the reservoir will result in the long-term loss of 27% (210 ha) of the total amount of amphibian habitat currently available within the Regional Study Area. Within the reservoir footprint, frog habitat currently associated with inland wetlands and ponds, including shallow, marshy areas of Gull Lake and the Nelson River will be flooded and rendered unsuitable for amphibians over the long-term.

Changes in drainage patterns resulting from infrastructure development may lead to the ponding of water in areas adjacent to the south access road and outside of dykes. These areas may develop into suitable breeding habitat for frogs, offsetting some of the habitat losses incurred during reservoir development.

Within the Local Study Area, shoreline erosion and peatland disintegration processes will lead to the long-term loss and/or degradation of some additional amphibian habitat. However, due to hydrological connections with the reservoir, new ponds may eventually form in areas adjacent to and further inland from the reservoir. Over time, these new ponds may provide suitable habitat for frogs.

Traffic along the north and south access roads may contribute to a small number of frog fatalities as frogs attempt to cross the access roads in areas where breeding habitat occurs. Due to the low abundance and widespread distribution of amphibians within the Local

Study Area, concentrated frog dispersal patterns near roads or other infrastructure sites are unlikely.

Mitigation measures used to minimize loss of amphibian habitat will include the following:

- Mitigation for wetland function will benefit amphibians through the development of wetlands in the Local Study Area (Section 6.5.3.4) and could off-set some of the losses in habitat for amphibians; and
- Some of the decommissioned borrow areas may be enhanced in a manner that creates suitable wetland habitat for amphibians.

6.5.6.4 RESIDUAL EFFECTS OF OPERATION

The residual effects associated with Project operation are not expected to be fully offset by the development of new amphibian habitat, such as ponding along access roads and dykes, or in newly formed or enhanced wetlands. However, the number of incidences of frog mortality associated with vehicle traffic are anticipated to be few and occur sporadically at different sites along the roads, particularly at a few sites where the road extends between a breeding pond and the summering habitat for wood frogs and boreal chorus frogs. As the mortality-related effects are expected to be infrequent and localized to a few sites within a Regional Study Area containing a large population of amphibians, the operational effects of the Project on regional frog populations are expected to be low and within the range of natural variability.

6.5.6.5 CONCLUSION ABOUT RESIDUAL EFFECTS ON AMPHIBIANS

Project construction and operation will have residual effects related to habitat fragmentation and loss as well as a low level of amphibian mortality within the Local Study Area. The residual effects of Project construction and operation on amphibians are expected to be low and within the range of natural variability. This is largely due to there being a large population of wood frogs and boreal chorus frogs throughout the Regional Study Area, in which the Project effects area represents a small portion of that overall area.

As outlined in Chapter 5, the cumulative effects assessment step that deals with future projects and activities focuses on VECs that are adversely affected by the Project and vulnerable to the effects of future projects and activities. As amphibians are not a VEC, they are not covered in the cumulative effects assessment in Chapter 7.

Amphibian monitoring is planned for the construction and operation phases of Project development (see Chapter 8).

6.5.7 BIRDS

Key potential effects of the Project on VECs and other priority birds include the following:

- Habitat loss, alteration and fragmentation of habitat; and
- Project-related disturbances such as noise, and bird mortality related to increased traffic and harvest.

The primary pathways of Project effects on birds include the loss or degradation of breeding, overwintering and staging habitat (for resting and foraging during migration) that results from reservoir creation and infrastructure development (*e.g.*, access roads and trails, borrow areas, camp areas, generating station and dykes).

Project disturbances related to construction noise and human activity may disrupt breeding and foraging activities, causing birds to avoid construction areas until the disturbance ends. Construction noise and activity may therefore reduce the amount of effective habitat available to birds in areas adjacent to construction sites. Traffic along access roads may lead to local increases in bird mortality, especially for species that use edge habitats. Increased human access along roads and trails may also lead to localized increases in the harvest of game birds including grouse, ptarmigan and waterfowl.

Accidental events that may occur during Project development, such as spills or fires, may affect the local bird populations and their habitats; however, the risk of these events occurring is small and will be adequately addressed through the implementation of measures to be outlined in the EnvPP.

Of the more than 172 bird species that could potentially be affected by the Project, about 150 are migratory species (*e.g.*, most songbirds, waterfowl, shorebirds, gulls and terns) and the remainder are resident or overwintering species (*e.g.*, grouse, ptarmigan, owls and woodpeckers). A review of the potential Project effects on all bird groups that occur within the Bird Regional Study Area is provided in Section 6.4 of the Terrestrial Environment Supporting Volume (TE SV). Construction and operation monitoring and follow-up regarding birds is provided in Chapter 8.

The following sections describe the assessment for the VECs (Canada goose, mallard, bald eagle, olive-sided flycatcher, rusty blackbird, and common nighthawk) and other priority birds (*i.e.*, other species at risk, rare birds, colonial waterbirds, and species at the edge of their range).

6.5.7.1 Canada Goose

6.5.7.1.1 Construction Effects and Mitigation

During the construction phase, sensory disturbances (*e.g.*, noise from construction equipment and blasting) that occur near lakes and/or along the Nelson River, will indirectly result in a temporarily reduction of some goose staging habitat. Construction noise is anticipated to be at or above thresholds known to elicit behavioural responses in waterfowl (*i.e.*, 80 to 85 dBA; Goudie and Jones 2004). Displaced birds will seek alternate habitats available throughout the Regional Study Area (Study Zone 5).

The following mitigation measures will be implemented to minimize or avoid potential effects of Project construction on mallards and Canada geese:

- 100m vegetated buffers will be retained wherever practicable around lakes located adjacent to infrastructure sites to minimize noise-related disturbances to geese; and
- Increases in local waterfowl harvest will be minimized through implementation of a Construction Access Management Plan.

6.5.7.1.2 Residual Effects of Construction

The residual effects of Project construction on Canada geese include noise disturbance causing avoidance of some staging habitat in areas adjacent to active construction sites. Residual construction-related effects are expected to be adverse, small in magnitude, small in geographic extent, and short-term. Step 2 analysis is screened out based on the Step 1 analysis.

6.5.7.1.3 Operation Effects and Mitigation

During the operation phase, flooding of shorelines and inundation of uplands will occur as the reservoir fills. Increased water levels in Gull Lake will have a long-term adverse effect on the quality of local migratory staging habitats for geese. Creation of the reservoir will inundate shallow areas (*e.g.*, back bays, inlets and creek mouths of Gull Lake) that in some years provide optimal staging habitat for migrating geese. While a negligible amount of marginal Canada goose breeding habitat will be lost (*e.g.*, islands in inland lakes) during reservoir filling, loss of suitable Canada goose breeding habitat is not expected, as their preferred breeding habitat (*e.g.*, ribbed fens) does not occur within the Local Study Area.

The loss of sedge-filled bays, inlets and creek mouths within the Gull Lake and Nelson River area (to Birthday Rapids) during reservoir creation could have an adverse, small to moderate, long-term effect on the regional goose populations that use Gull Lake and the Nelson River for staging during the spring and fall migration seasons. While alternate staging areas (*e.g.*, bays and inlets) occur within the Regional Study Area (*e.g.*, Stephens Lake), they are considered to be of low quality due to their limited provision of suitable food, cover and shelter required by geese. Like Stephens Lake, the Keeyask reservoir will likely have limited use by geese during the spring migration period due partly to the persistence of ice in May. Field studies indicate that reservoirs along the Nelson River tend to be some of the last waterbodies to thaw and become available to birds.

It is expected that until suitable shoreline wetland vegetation re-establishes in the reservoir, use of the reservoir by geese will be minimal during the fall migration period. Although some uncertainty exists, it is expected that geese will utilize other stop-over sites located in areas outside of the Local Study Area following reservoir impoundment.

During operation, there is a potential for increased harvest of Canada goose by local resource users due to increased access along new roads and trails. Increased access could potentially have an effect on the local populations of Canada geese using traditional waterfowl hunting areas that are important to the KCNs.

The following mitigation measures will be implemented to minimize potential effects of Project operation on Canada geese:

- Except for existing resource-use trails (See Construction Access Management Plan), Project-related cutlines and trails will be blocked where they intersect the Project Footprint, and the portions of these features within 100 m of the Project Footprint will be revegetated to limit the potential for increased local goose harvest resulting from increased hunter access.
- Mitigation for wetland function will benefit Canada geese through the development of wetlands in the Local Study Area (Section 6.5.3.4) and could off-set some of the losses in habitat for geese.

6.5.7.1.4 Residual Effects of Operation

The residual effects of Project operation on Canada geese are associated with decreased quality of staging habitats along the Nelson River resulting in the reduced use of the area by geese. Residual operation-related effects are expected to be adverse, small in magnitude, medium in geographic extent, and long-term. Step 2 analysis is screened out based on the Step 1 analysis.

6.5.7.1.5 Conclusion about Residual Effects on Canada Goose

The residual Project effects on Canada geese are associated with a decrease in the availability and quality of staging habitat within the Local Study Area. The overall potential Project-related residual effects on Canada geese are expected to be adverse but regionally acceptable, largely because there is a considerable amount of other available staging habitat in the region and no locally or regionally important Canada goose breeding habitat is being affected by the Project.

The residual operation effects on Canada goose will overlap temporally and spatially with the future Bipole III Transmission Project and Keeyask Transmission Project; it is also anticipated that there will be a very small potential for overlap with the Conawapa GS Project. The cumulative effects assessment is presented in Chapter 7.

Monitoring of local Canada goose populations staging within the Regional Study Area will occur during the migration seasons during Project operation (Chapter 8).

6.5.7.2 MALLARD

6.5.7.2.1 CONSTRUCTION EFFECTS AND MITIGATION

Land clearing and site preparation for the development of Project footprints will result in the direct loss of 3% (1,716 ha) of the total amount of available mallard upland nesting cover habitat within the Regional Study Area. Within the Regional Study Area, optimal mallard brood-rearing habitat occurs along sluggish, sedge-filled creeks and to a lesser degree along sedge-filled edges of inland lakes. In the boreal forest, mallards typically nest in upland areas located within 270 m of water (Ducks Unlimited 2010), which in the Regional Study Area includes areas adjacent to some of the inland lakes, wetlands and creeks.

During the construction phase, sensory disturbances (*e.g.*, noise from construction equipment and blasting) that occur near wetlands, creeks and lakes may temporarily reduce the amount of habitat available for mallard nesting and foraging. Construction noise is anticipated to be at or above thresholds known to elicit behavioural responses in waterfowl (*i.e.*, 80 to 85 dBA; Goudie and Jones 2004). Mallards disturbed by construction activity are expected to seek alternate habitats in unaffected areas.

The following mitigation measures will be implemented to minimize or avoid potential effects of Project construction on mallards:

- 100 m vegetated buffers will be retained wherever practicable around lakes, wetlands and creeks located adjacent to infrastructure sites to minimize the loss of mallard upland nesting habitat and limit noise-related disturbances to mallards;
- Clearing will be undertaken outside of the sensitive breeding period (April 1–July 31) to minimize disturbance to breeding birds (PD SV, Section 4.2.3.2);
- Increases in local waterfowl harvest will be minimized through implementation of a Construction Access Management Plan;
- Mitigation measures for wetland function will benefit mallard through the development of wetlands in the Local Study Area (Section 6.5.3.4) and is expected to off-set some of the losses in habitat for mallard; and
- Mallard nesting platforms will be installed in suitable wetlands in order to offset some of the losses in upland nesting cover.

6.5.7.2.2 Residual Effects of Construction

The residual effects of Project construction on mallard are associated with short-term avoidance of some breeding and staging habitats due to noise disturbance and loss and degradation of 1,716ha of upland nesting cover. Residual construction-related effects are expected to be adverse, small in magnitude, small in geographic extent, and long-term. Step 2 analysis is screened out based on the Step 1 analysis.

6.5.7.2.3 Operation Effects and Mitigation

As the reservoir fills, inundation of inland lake and wetland areas will result in the long-term loss of approximately 2.8% (1,896 ha) of the total available mallard brood-rearing habitat (*e.g.*, sluggish, sedge-filled creeks and wetlands) within the Regional Study Area. Along the Nelson River, flooding of bays, inlets, creek mouths and shorelines will have a long-term adverse effect on the quality of local migratory staging habitats for mallards. The quality of staging habitats will decrease due to the loss of emergent vegetation, which provides food, shelter and cover for mallards. The quality of staging habitats along parts of the Nelson River varies annually and seasonally with changes in water levels. In some years, emergent vegetation in shallow back bays, inlets and creek mouths supports numerous mallards and other migratory waterfowl.

Mallards displaced from inland breeding habitats (*e.g.*, creeks) will likely seek alternate suitable breeding and brood-rearing habitat available throughout the unaffected areas of the Regional Study Area (TE SV). The loss of sedge-filled bays, inlets and creek mouths within the Gull Lake and Nelson River area (to Birthday Rapids) resulting from reservoir creation could have an adverse, small, long-term effect on the local and regional mallard populations that use Gull Lake and the Nelson River for staging during migration. While alternate staging areas (*e.g.*, bays and inlets) occur within the Regional Study Area (*e.g.*, Stephens Lake), they are considered to be of low quality. Like Stephens Lake, the Keeyask reservoir is expected to have limited use by mallard during the spring migration period (*i.e.*, May) due to the persistence of ice. Field studies indicated that reservoirs along the Nelson River tend to be some of the last waterbodies to thaw and become available to migratory birds.

Peatland disintegration processes on Stephens Lake continue to marginalize this area as waterfowl habitat as does high water levels on Split Lake and Clark Lake. It is expected that until suitable wetland vegetation re-establishes in the reservoir, mallard use of the Keeyask reservoir during the migration periods will be minimal. Although some uncertainty exists, it is expected that mallards will utilize other stop-over sites located in off-system areas (*i.e.*, inland lakes) of the Regional Study Area.

During operation, there is a potential for increased harvest of mallards by local resource users due to increased access along new roads and trails. Increased access could potentially have an effect on the local populations of mallards using traditional waterfowl hunting areas that are important to the KCNs.

The following mitigation measures will be implemented to minimize potential effects of Project operation on mallards:

- Except for existing resource-use trails (see Construction Access Management Plan), Project-related cutlines and trails will be blocked where they intersect the Project Footprint, and the portions of these features within 100 m of the Project Footprint will be revegetated to limit the potential for increased local mallard harvest resulting from increased hunter access.
- Mitigation for wetland function will benefit mallard through the development of wetlands in the Local Study Area (Section 6.5.3.4) and could off-set some of the losses in breeding and staging habitat for mallards.

6.5.7.2.4 RESIDUAL EFFECTS OF OPERATION

The residual effects of Project operation on mallards are associated with habitat loss and degradation resulting from reservoir filling. Residual operation-related effects are expected to be adverse, small in magnitude, medium in geographic extent, and long-term. Step 2 analysis is screened out based on the Step 1 analysis.

6.5.7.2.5 CONCLUSION ABOUT RESIDUAL EFFECTS ON MALLARD

Overall, potential Project-related residual effects on mallard are expected to be adverse but regionally acceptable because there is currently limited breeding habitat within the Project effects area and staging habitat is not a limiting factor within the Local and Regional study areas. The residual effects of Project construction and operation on mallards are associated with the loss of 3% (1,908 ha) of mallard breeding habitat, decrease in the availability and quality of staging habitat and potential increase in local harvest associated with increased access. Since reservoir creation will flood many of the sites factored into the construction effects estimates for mallards (*i.e.*, the areas cleared prior to reservoir impoundment and later flooded), the estimate of 3% of mallard breeding habitat closely represents the operational footprint effects area. These effects are expected to be adverse, small in magnitude, medium in extent, and long-term.

Residual construction and operation effects on mallard will overlap temporally and spatially with the future Bipole III Transmission Project and Keeyask Transmission Project; it is also anticipated that there is a very small potential for overlap with the Conawapa GS Project. The cumulative effects assessment is presented in Chapter 7.

Monitoring of local mallard populations staging within the Regional Study Area will occur during Project operation (Chapter 8). The success of mallard nesting platforms and the need for adaptive management will also be monitored and assessed for a period following installation.

6.5.7.3 BALD EAGLE

6.5.7.3.1 CONSTRUCTION EFFECTS AND MITIGATION

Potential construction-related effects on bald eagle include habitat loss and alteration and Project-related disturbances (*e.g.*, noise). Within the Regional Study Area (Study Zone 5), bald eagles are most common and abundant along the shorelines of the Nelson River. Their strong association with the river is due to the abundance of their main food source (fish) and the availability of suitable tall trees for nesting and perching. Land clearing for the development of the reservoir, access roads, trails and GS will result in the loss of some potential bald eagle perching and/or nesting habitat. It is anticipated that reservoir clearing will require the removal of up to five nests located along the shores of the Nelson River (Map 6-35).

While noise disturbance during the construction phase (*e.g.*, operation of heavy equipment and blasting) may temporarily disrupt bald eagle foraging activities in the Gull Rapids area, displacement of eagles is not anticipated. Field investigations indicate that the Gull Rapids area does not have associated high concentrations of eagles; as such, only a small proportion of the local population would be affected by construction activity in this area. Blasting is not expected to alter the behaviour of nesting bald eagles, as the nearest bald eagle nest is more than 12 km from the proposed GS site. Furthermore, studies have shown that increased visibility of a perceived threat has more of an effect on eagles than noise level (Ellis *et al.* 1991).

The following mitigation measures will be implemented to avoid or minimize potential effects of Project construction on bald eagles:

- Clearing will be undertaken outside of the sensitive breeding period (April 1–July 31; PD SV Section 4.2.3.2) to the extent practicable to minimize disturbance to breeding birds; and
- Bald eagle nests (Map 6-35) removed as a result of reservoir clearing will be replaced by artificial nesting platforms located in suitable areas along the new reservoir shoreline.

6.5.7.3.2 RESIDUAL EFFECTS OF CONSTRUCTION

The potential residual construction-related effects on bald eagles are associated with temporary disturbance in foraging activities due to construction noise (*e.g.*, blasting). The residual effects of Project construction on bald eagles are expected to be adverse, small in magnitude, small in geographic extent, and short-term. Step 2 analysis is screened out based on the Step 1 analysis.

6.5.7.3.3 OPERATION EFFECTS AND MITIGATION

Development and operation of the reservoir will result in the loss of some fast-flowing riverine areas used by foraging bald eagles. The loss of these foraging areas will be partly offset by the creation of the tailrace, an area that typically attracts a large number of bald eagles at existing generating stations along the Nelson River (FLCN 2010 Draft). It is expected that the portion of the local bald eagle population that uses the Local Study Area will alter its distribution along the river in response to changes in the water regime. Eagles will concentrate in areas below the GS due to the increase in accessibility of fish. The turbulent waters downstream of a GS often make fish more accessible to foraging eagles. Local eagle populations are not expected to increase as a result of the proposed Project, as forage availability or accessibility is not a limiting factor for local bald eagle populations.

Flooding of soils during reservoir creation will result in an elevation of mercury levels in fish, and consequently bald eagles. The effects of mercury on bald eagles are discussed in Section 6.5.9.

Since peatland disintegration and mineral erosion along shorelines is anticipated to continue following reservoir creation, shoreline trees used for perching and potentially nesting by bald eagles will likely continue to be lost over time (*i.e.,* fall down and become woody debris at sites immediately adjacent to the waterway). Although adverse, the effect of tree loss for bald eagles using the Local Study Area is anticipated to be small as suitable perching and nesting trees will be available in areas along the new reservoir shorelines.

Most eagles observed in the Regional Study Area occur in association with rivers and lakes; however, some eagles may be drawn to road-kill remains that occur along roads. Although the risk is anticipated to be low, traffic along access roads has the potential to increase the collision risk for bald eagles scavenging on road-kill.

The following mitigation measures will be implemented to minimize or avoid potential effects of Project operation on bald eagles:

- Bald eagle nests located in trees at risk to eroding into the reservoir will be removed during the fall or winter and replaced by artificial nest platforms located in suitable adjacent sites not at risk to shoreline erosion; and
- The removal of road-killed mammals along access roads will mitigate the risk of vehicle-related bald eagle mortality.

6.5.7.3.4 RESIDUAL EFFECTS OF OPERATION

There are some adverse effects on bald eagles related to changes in the riverine and riparian habitat, as well as positive effects related to enhancement of foraging in the tailrace area. Project operation will have a neutral effect on bald eagles overall in the long-term. As such, no residual effects of Project operation on bald eagle are expected.

6.5.7.3.5 CONCLUSION ABOUT RESIDUAL EFFECTS ON BALD EAGLE

The overall potential Project-related residual effects on bald eagles are expected to be adverse but regionally acceptable due to the nature of the short-term and localized effects expected to occur during construction, the positive effects related to enhanced foraging opportunities during operation, and the observation that nesting habitat is not a limiting factor in the Regional Study Area.

Residual construction and operation effects on eagle are expected to be small, short-term and related to noise-related effects during construction. As a result, there is not expected to be any notable overlap with the future Keeyask Transmission and Conawapa Generation projects; as well, there is only a small potential for any overlap with the Bipole III Transmission Project. Since the operational effects of the Project on bald eagle are expected to be neutral, the development of the Conawapa Generation Project is anticipated to have a neutral effect on the regional bald eagle population, and the Keeyask Transmission Project is expected to have a very small residual effect, bald eagle is not considered in the cumulative effects assessment (Chapter 7).

Construction phase monitoring of natural and/or artificial eagle nest distribution within the Local Study Area will be conducted to assess the effectiveness of mitigation measures and determine need for adaptive management. To confirm EIS predictions, the distribution and abundance of bald eagles will be monitored during the Project operation (Chapter 8).

6.5.7.4 OLIVE-SIDED FLYCATCHER

6.5.7.4.1 CONSTRUCTION EFFECTS AND MITIGATION

As land is cleared in preparation for Project development (*e.g.*, reservoir, dykes, south access road and trails), approximately 3.6% (350 ha) of the regional olive-sided flycatcher breeding and foraging habitat will be lost or reduced in quality for the long-term (TE SV, Section 6). Suitable olive-sided flycatcher breeding habitat is widespread throughout the Regional Study Area (Study Zone 4) as forest edge adjacent to bogs, beaver floods and regenerating forest are common throughout the boreal forest (Map 6-36).

Construction-related noise from heavy equipment is short-term and temporary and not anticipated to have an effect on territorial use or reproductive success of olive-sided flycatcher (Lackey 2010). Blasting activities may temporarily disturb olive-sided flycatcher, but nest abandonment or reduction in reproductive success is unlikely (Ellis *et al*. 1991).

Increased human access during the construction phase is not anticipated to affect olive-sided flycatcher populations. While vehicle traffic may present a collision risk to olive-sided flycatchers foraging in open habitat, the risk is negligible as this species forages at heights well above vehicles (McCracken 2008).

The following mitigation measures will be implemented to minimize or avoid potential effects of Project construction on olive-sided flycatcher:

- Clearing will be undertaken outside of the sensitive breeding period (April 1–July 31; PD SV Section 4.2.3.2) to the extent practicable to minimize disturbance to breeding birds.

6.5.7.4.2 Residual Effects of Construction

The residual effects of Project construction on olive-sided flycatcher are associated with habitat loss and degradation. Residual construction-related effects are expected to be adverse, moderate in magnitude, small in geographic extent, and long-term. Althought not required based on the Step 1 analysis, Step 2 analysis is carried out because this VEC is a threatened species. Step 2 analysis indicates that the effects are infrequent, irreversible and have a high ecological context.

6.5.7.4.3 Operation Effects and Mitigation

Operation effects on olive-sided flycatcher are associated with the long-term loss of breeding habitat due to reservoir filling. Over time, peatland disintegration, shoreline erosion and changes to vegetation resulting from changes in groundwater will contribute to the loss of some additional olive-sided flycatcher habitat (potential loss of up to 120 ha or 1% of total available olive-sided flycatcher habitat within the Regional Study Area. Suitable olive-sided flycatcher breeding habitat is widespread throughout the Regional Study Area as forest edge adjacent to bogs, beaver floods, and regenerating forest is common throughout the boreal forest (Map 6-36).

Operation of the access roads is not anticipated to affect olive-sided flycatchers as this species forages at heights well above vehicles (McCraken 2008).

The following mitigation measures will be implemented to minimize potential effects of Project operation on olive-sided flycatchers:

- Some of the treed areas located within the future reservoir back bays may be retained to off-set some of the losses in olive-sided flycatcher habitat (Section 6.5.3.4); and
- Following Project construction, perching structures will be created in open, decommissioned borrow areas that retain water (sources of invertebrates for olive-sided flycatchers).

6.5.7.4.4 Residual Effects of Operation

The potential residual operation-related effects on olive-sided flycatchers are associated with habitat loss resulting from reservoir filling, shoreline erosion, and peatland disintegration processes. The residual effects of Project operation on olive-sided flycatchers are expected to be adverse, moderate in magnitude, small in geographic extent, and long-term. Although not required based on the Step 1 analysis, Step 2 analysis is carried out because this VEC is a threatened species (see below under 6.5.7.4.5).

6.5.7.4.5 Conclusion about Residual Effects on Olive-sided Flycatcher

The overall potential Project-related residual effects on olive-sided flycatcher are expected to be adverse but regionally acceptable, largely because suitable olive-sided flycatcher breeding habitat is widespread throughout the Regional Study Area. The residual effects of Project construction and operation on olive-sided flycatcher are associated with the loss of up to 470 ha of breeding habitat (5% of the available olive-sided flycatcher breeding habitat within the Regional Study Area). The 5% relative area estimated to be affected by the Project would be considerably smaller (less than 1%) if the Regional Study Area was the larger Study Zone 5 (Table 6-6), which would have been an acceptable regional zone for comparison purposes (*i.e.*, the smaller Study Zone 4 used in this evaluation has a higher degree of sensitivity to any potential Project-related changes to olive-sided flycatcher habitat).

The residual construction and operational effects on olive-sided flycatcher will overlap temporally and spatially with the future Bipole III Transmission Project and Keeyask Transmission Project. The cumulative effects assessment in presented in Chapter 7).

Ground-based monitoring of local olive-sided flycatcher populations will occur during the construction and operation phases of the Project (see Chapter 8).

6.5.7.5 Rusty Blackbird

6.5.7.5.1 Construction Effects and Mitigation

As land is cleared in preparation for Project development (*e.g.*, reservoir, dykes, south access road and trails), approximately 3.4% (547 ha) of the regional rusty blackbird breeding and foraging habitat will be lost or reduced in quality for the long-term (TE SV). Suitable, alternate rusty blackbird breeding habitat (*e.g.*, treed wet peatland and riparian habitats) is widespread throughout the Regional Study Area (Study Zone 4; Map 6-37).

Construction-related noise from heavy equipment is short-term and temporary and not anticipated to have an effect on territorial use or reproductive success of rusty blackbird (Lackey 2010). Blasting activities may temporarily disturb rusty blackbird, but nest abandonment or reduction in reproductive success is unlikely (Ellis *et al.* 1991).

Increased human access during the construction phase will increase the collision risk for rusty blackbirds along areas of the access roads where wetland habitat occurs. This collision risk is considered small and unlikely to have a measureable effect on local populations.

The following mitigation measures will be implemented to minimize or avoid potential effects of Project construction on rusty blackbird:

- Clearing will be undertaken outside of the sensitive breeding period (April 1–July 31; PD SV Section 4.2.3.2) to the extent practicable to minimize disturbance to breeding birds; and
- A minimum of 100m vegetated buffers will be retained wherever practicable around lakes, wetlands and creeks located adjacent to infrastructure sites to minimize the loss of rusty blackbird nesting habitat and limit noise-related disturbances to rusty blackbirds.

6.5.7.5.2 RESIDUAL EFFECTS OF CONSTRUCTION

The residual effects of Project construction on rusty blackbirds are expected to be adverse, moderate in magnitude, small in geographic extent, and long-term. Although not required based on the Step 1 analysis, Step 2 analysis is carried out because this VEC is a species of special concern. Step 2 analysis indicates that the effects are infrequent, reversible and of high ecological context.

6.5.7.5.3 OPERATION EFFECTS AND MITIGATION

Operation effects on rusty blackbird are associated with the long-term loss of some additional breeding habitat due to shoreline erosion and peatland disintegration processes. In areas adjacent to the reservoir, changes in groundwater may lead to the establishment of suitable rusty blackbird habitat over the long-term. Overall, upwards of an additional 374 ha or 3% of total available rusty blackbird habitat within the Regional Study Area may be affected during the operation phase. Suitable rusty blackbird breeding habitat (*e.g.*, conifer treed on wet peatland) is widespread throughout the Regional Study Area (Map 6-37).

Increased human access during the operation phase will increase the collision risk for rusty blackbirds along areas of the access roads where wetland habitat occurs. This collision risk is considered small and unlikely to have an effect on the local populations.

The following mitigation measures will be implemented to minimize potential effects of Project operation on rusty blackbirds:

- Mitigation for wetland function is being implemented through the development of wetlands in the Local Study Area (Section 6.5.3.4). Some of these wetland developments may provide habitat for rusty blackbirds.

6.5.7.5.4 RESIDUAL EFFECTS OF OPERATION

The potential residual operation-related effects on rusty blackbirds are associated with the loss of up to 374 ha of additional breeding habitat resulting from long-term shoreline erosion and peatland disintegration processes. The residual effects of Project operation on rusty blackbird are expected to be adverse, moderate in magnitude, small in geographic extent, and long-term. Although not required based on the Step 1 analysis, Step 2 analysis is carried out because this VEC is a species of special concern. Step 2 analysis indicates that the effects are continuous, irreversible and of high ecological context.

6.5.7.5.5 Conclusion about Residual Effects on Rusty Blackbird

The overall potential Project-related residual effects on rusty blackbird are expected to be adverse but regionally acceptable mainly because suitable rusty blackbird breeding habitat is widespread throughout the Regional Study Area. The residual effects of Project construction and operation on rusty blackbirds are associated with the loss of 921 ha of breeding habitat (6% of the available rusty blackbird habitat within the Regional Study Area). The 6% relative area of rusty blackbird habitat estimated to be affected by the Project would be considerably smaller (less than 2%) if the Regional Study Area was selected as the larger Study Zone 5 (Table 6-6), which is an acceptable alternative.

The residual construction and operation effects on rusty blackbird will overlap temporally and spatially with the future Bipole III Transmission Project and Keeyask Transmission Project. The cumulative effects assessment is presented in Chapter 7.

Ground-based monitoring of local rusty blackbird populations will occur during the construction and operation phases of Project development (see Chapter 8).

6.5.7.6 Common Nighthawk

6.5.7.6.1 Construction Effects and Mitigation

As land is cleared in preparation for Project infrastructure (*e.g.*, dykes, borrow areas, south access road and trails), 925 ha of the available common nighthawk breeding habitat will be lost or reduced in quality. Approximately 3689 ha will be temporarily created through reservoir clearing, resulting in a 14.8% increase (2764 ha) in common nighthawk breeding habitat within the Regional Study Area (Study Zone 4; Map 6-34).

Construction-related noise from heavy equipment, blasting and other human activities may cause common nighthawk to avoid using some of the areas within and/or adjacent to Project footprints. Sensory disturbances (*e.g.*, equipment noise and blasting) will likely cause some individuals to avoid all or parts of preferred habitats until disturbances have ceased. Birds displaced from breeding habitat will likely relocate to alternate available habitats not affected by construction disturbance. Since lights have the potential to attract flying insects (preferred forage food for nighthawks), floodlights used in camps, work areas, and for other infrastructure may enhance the quality of infrastructure sites as foraging habitats for common nighthawks.

Increased human access during the construction phase is not anticipated to have a notable effect on common nighthawk populations as this species forage at heights well above vehicles (McCracken 2008).

The following mitigation measure will be implemented to minimize or avoid potential effects of Project construction on common nighthawk:

- Clearing will be undertaken outside of the sensitive breeding period (April 1–July 31; PD SV Section 4.2.3.2) to the extent practicable to minimize disturbance to breeding birds; and
- With consideration of other planned rehabilitation measures (*e.g.*, revegetation efforts within temporary Project footprint components), some areas of open and flat habitat will be retained at locations deemed to be suitable nesting habitat for common nighthawks.

6.5.7.6.2 Residual Effects of Construction

The residual effects of Project construction on common nighthawk are associated with a net increase in 2,764 ha (15% of the available common nighthawk breeding habitat within the Regional Study Area) of common nighthawk breeding habitat (open, bare ground). Construction-related effects are expected to be positive, large in magnitude, small in geographic extent, and short-term. Step 2 analysis is screened out based on Step 1 analysis.

6.5.7.6.3 Operation Effects and Mitigation

Filling of the reservoir will result in the long-term loss of 4210 ha (522 ha of pre-Project habitat plus the 3688 ha created during reservoir clearing) of suitable common nighthawk breeding habitat. If only pre-Project habitat losses are considered, 522 ha of suitable common nighthawk habitat would be affected by reservoir filling. Ongoing shoreline erosion, peatland disintegration and changes to vegetation resulting from changes in groundwater are processes that could lead to an additional loss of up to 480 ha of common nighthawk habitat over the long-term. The development of borrow areas will likely result in small areas of open bare ground (including some remaining gravel areas at sites that undergo rehabilitation) that will provide suitable nesting habitat for common nighthawk.

A combined total of upwards of 1,002 ha (or 5% of the available common nighthawk habitat within the Regional Study Area) of additional habitat could be lost during Project operation. While this loss is considered high, the changing dynamics of the boreal forest will alter the availability of common nighthawk habitat on a constant basis. Wildfire and forest succession will continue to alter the landscape, removing and replacing suitable common nighthawk habitat over time. Common nighthawk habitat is widespread throughout the region and not considered to be limited within the Regional Study Area.

Increased human access during the operation phase is not anticipated to have a notable effect on common nighthawk populations as this species forage at heights well above vehicles (McCracken 2008).

6.5.7.6.4 Residual Effects of Operation

The residual effects of Project operation on common nighthawk are associated with loss of the short-term habitat created through reservoir clearing (construction phase) and the loss of up to 1,002 ha of pre-Project common nighthawk breeding habitat (a loss of 5% of the available common nighthawk breeding habitat within the Regional Study Area) due to reservoir filling. Due to the current uncertainty as to amount of beneficial habitat that will created by the Project and thereby offset some of the adverse effects, a conservative worst case scenario is being reflected in the estimation of up to 5% of the available common nighthawk habitat being affected by the Project during operation. Residual operation-related effects are expected to be adverse, high in magnitude, small in geographic extent and long-term. Although not required based on the Step 1 analysis, Step 2 analysis is carried out because this VEC is a species at risk. Step 2 analysis indicates that the effects are frequent, reversible in some areas and have a high ecological context.

6.5.7.6.5 Conclusion about Residual Effects on Common Nighthawk

The overall potential Project-related residual effects on common nighthawk are expected to be adverse but regionally acceptable, due to the widespread nature of the breeding habitat and the offsetting positive effects associated with the creation and enhancement of habitat. Positive residual effects are expected during the construction phase, as land clearing will increase the availability of nesting habitat (*i.e.*, open, bare ground) for common nighthawk. During operation, reservoir filling will result in the loss of habitat temporarily created during construction. Over time, shoreline erosion and peatland disintegration are processes that will lead to the additional loss of some common nighthawk habitat.

An overall total of 1,926 ha of pre-Project common nighthawk habitat (up to 10% of what is available within the Regional Study Area) will be lost due to Project development; this value does not include the increase in available habitat that would persist during the operational period in response to the clearing of borrow areas and other sites, and the site specific measures to further enhance nesting habitat for common nighthawk in the Local Study Area. Due to the current uncertainty regarding the amount of suitable nesting habitat that will created by the Project to offset some of the adverse effects, a conservative worst case scenario is being reflected in the estimation of up to 10% of the available common nighthawk habitat being affected by the Project. The relative area of common nighthawk habitat estimated to be affected by the Project would also be considerably smaller (less than 1%) if the Regional Study Area was selected as the larger Study Zone 5 (Table 6-6), which is an acceptable alternative. The residual effects of the Project on common nighthawk are expected to be adverse, moderate in magnitude, small in extent, and long-term.

The residual effects of construction and operation on common nighthawk will overlap temporally and spatially with the future Bipole III Transmission Project and Keeyask Transmission Project. The cumulative effects assessment is presented in Chapter 7.

Ground-based monitoring of local common nighthawk populations will occur during the construction and operation phases of Project development (see Chapter 8).

6.5.7.7 OTHER PRIORITY BIRDS

Other priority birds include native species that are rare and/or are highly sensitive to Project development features, and/or rely on rare environmental features (*e.g.*, rocky reefs). Birds are classified as rare if they have suffered population declines, are at the edge of their known breeding range or are expanding their breeding range (due to changes in environmental conditions). Rare birds include species at risk (species listed under the Manitoba *Endangered Species Act* [MESA] and/or Canada's *Species at Risk Act* [SARA] and/or COSEWIC).

6.5.7.7.1 SPECIES AT RISK

CONSTRUCTION EFFECTS AND MITIGATION

The effects of construction on species at risk are discussed under the bird VECs in Section 6.5.7.1. The only other species at risk that may be affected by Project construction include yellow rail, short-eared owl, red knot and peregrine falcon. Potential construction-related effects on red knot and peregrine falcon are anticipated to be minimal given their transitory nature. Construction effects on yellow rail include the short-term enhancement of some low quality breeding habitat through the removal of woody vegetation on open, wet peatlands. Reservoir clearing will also have short-term positive benefits on short-eared owl through the creation of an open, treeless landscape. Short-eared owls inhabiting the area are expected to be drawn to cleared areas in search of prey (*e.g.*, voles, and mice) exposed by land clearing.

Construction-related noise from heavy equipment, blasting and other human activities may cause bird species at risk (including those species migrating through) to avoid using areas within and/or adjacent to the Project Footprint for the short-term. Construction disturbances are expected to have negligible effects on short-eared owl as no suitable short-eared owl breeding habitat occurs within the Local Study Area.

The following mitigation measures will be implemented to minimize or avoid potential effects of Project construction on bird species at risk:

- Clearing will be undertaken outside of the sensitive breeding period (April 1–July 31; PD SV Section 4.2.3.2) to the extent practicable to minimize disturbance to breeding birds; and
- Manual hand-clearing techniques will be used within 30 m of wetland areas to minimize degradation of yellow rail breeding habitat by heavy equipment (PD SV, Reservoir Clearing Plan).

Residual Effects of Construction

The small residual effects of Project construction on yellow rail, peregrine falcon, and red knot are expected to be adverse and occur within the range of natural variability for rails if they occur in the Regional Study Area. The small residual effects of Project construction on short-eared owl are expected to be positive and occur within the range of natural variability for rails if they occur in the Regional Study Area.

Operation Effects and Mitigation

Operation effects on species at risk are associated with the long-term loss of breeding habitat for yellow rail and horned grebe, and foraging habitat for short-eared owl, peregrine falcon and red knot due to reservoir filling, shoreline erosion and ongoing peatland disintegration processes. These losses will have negligible effects on red knot and peregrine falcon as these species are transient and breed in areas further north of the Regional Study Area.

As the reservoir fills, short-eared owl habitat created by reservoir clearing (construction) will be lost for the long-term. Reservoir filling, shoreline erosion and ongoing peatland disintegration is not anticipated to affect any pre-Project short-eared owl breeding habitat (Section 6, TE SV). Filling of the reservoir will remove approximately 5% (230 ha) of the region's yellow rail habitat for the long-term. For horned grebe, loss of breeding habitat will be less than 3% of what is available within the region.

Increased human access during the construction phase is not anticipated to have a notable effect on bird species at risk populations. The risk of vehicle collisions involving yellow rails and short-eared owls is expected to be low as preferred habitat for these species is uncommon in areas planned for road development.

Residual Effects of Operation

There remains some small potential that Project operation and associated long-term loss of yellow rail breeding habitat within the reservoir footprint may have an adverse effect on local yellow rail populations if rails breed or migrate through areas potentially affected by the Project in the future.

Conclusion about Residual Effects on Species at Risk

The overall potential Project-related residual effects on bird species at risk are expected to be adverse but regionally acceptable, largely because some species are transient and typically do not utilize habitats in the Project area (*e.g.*, red knot and peregrine falcon). While a small amount of habitat for yellow rail and horned grebe will be flooded, there is no evidence of breeding by either species (or by short-eared owl) in the Local Study Area.

As outlined in Chapter 5, the cumulative effects assessment step that deals with future projects and activities focuses on VECs that are adversely affected by the Project and vulnerable to the effects of future projects and activities. As the species at risk bird group is not a VEC, it is not covered in the cumulative effects assessment in Chapter 7.

Ground-based monitoring of local species at risk populations will occur during the construction and operation phases of Project development (Chapter 8).

6.5.7.7.2 SPECIES AT THE EDGE OF THEIR RANGE

Approximately nine bird species that have been observed during environmental field studies are at the edge of their range with respect to the Regional Study Area. The assessment of Project effects on this group of birds focused on two representative species, American white pelican and ruffed grouse. Pelicans are currently expanding their range into parts of Northern Manitoba where their primary food source (*i.e.*, fish) is abundant. Ruffed grouse is a resident game bird that breeds in deciduous-dominated forests that have limited distribution within the Regional Study Area.

CONSTRUCTION EFFECTS AND MITIGATION

Construction-related effects on pelicans and ruffed grouse include the following:

- Loss and alteration of some foraging and/or breeding habitat; and
- Habitat avoidance due to noise disturbance from human activity and equipment.

There is currently no evidence of pelican nesting, or adequate breeding habitat, in the Local Study Area. The anticipated effects of construction on pelican foraging habitat are similar to those described for some fish-eating colonial waterbirds and eagles (Section 6.5.7.2). Within and upstream of the Gull Rapids area, changes in the water regime will cause a short-term decrease in the amount of suitable pelican foraging habitat. These changes, along with construction noise and human activity, are expected to temporarily deter pelicans from using the Gull Rapids area during construction.

Clearing and site preparation for the development of the Project Footprint (*e.g.*, reservoir, dykes, borrow areas, access roads and trails) will result in the loss of 10% (70 ha) of the ruffed grouse breeding habitat (*e.g.*, mixedwood forest with dense shrub understory) available within the Regional Study Area.

Clearing may contribute to local ruffed grouse mortality as these year-round residents have a strong tendency to remain within their home ranges and are slow to flush from potential danger (Schroeder 1985, Schieck and Hannon 1989, Marjakangas and Kiviniemi 2005).

In areas adjacent to construction sites, short-term habitat avoidance by ruffed grouse may occur as a result of noise disturbances from heavy equipment, blasting, and other human activities. The effect of construction noise on ruffed grouse is anticipated to be short-term and site-specific, affecting only grouse using habitats located immediately adjacent to construction activity. Grouse are expected to return to these areas once construction activity ends.

During construction, access road traffic could increase the risk of local ruffed grouse mortality, as grouse are often attracted to roadsides in search for grit (*i.e.*, a digestion aid; Alaska Fish and Game 2008). Increased human access resulting from the creation of new roads and trails may also contribute to localised increases in the harvest of ruffed grouse.

During Project planning, measures were taken to minimize the loss of white birch forest within the Project Footprint (*i.e.*, at borrow area N-6), a regionally rare forest type that provides important habitat for ruffed grouse. Additional mitigation measures to minimize or avoid potential effects of Project construction on birds at the edge of their range will include:

- Clearing will be undertaken outside of the sensitive breeding period (April 1–July 31; PD SV Section 4.2.3.2) to the extent practicable; and
- A Construction Access Management Plan (*e.g.*, prohibitions on personnel hunting and monitored gated entry along access roads) will be implemented to minimize the potential for increased harvest of local ruffed grouse populations.

RESIDUAL EFFECTS OF CONSTRUCTION

The overall residual effects of Project construction on birds at the edge of their range are associated with habitat loss and/or alteration and are expected to be adverse, small, and occur within the natural variability of those populations in the Regional Study Area.

OPERATION EFFECTS AND MITIGATION

The quality and quantity of pelican foraging habitat (*e.g.*, fast flowing turbulent water) upstream of Gull Rapids will decline as construction of the GS alters river flows and changes the riverine environment into a more lacustrine environment. The availability of fish to pelicans in the newly created reservoir is expected to drop as the water levels increase and the presence of faster moving, shallow water is reduced. Operation of the Project is anticipated to have a slight positive effect on pelicans in the tailrace area of the GS. Creation of the tailrace area may alter the distribution of pelicans in the Regional Study Area as pelicans likely seek to forage in the tailrace area downstream of the GS. Pelicans commonly forage in the tailrace areas of generating stations throughout Manitoba, foraging for available fish in the fast waters and stealing fish from other waterbirds, *e.g.*, double-crested cormorants and gulls. Enhancement of existing islands and the creation of an artificial island for other colonial waterbirds would also provide suitable nesting substrates for pelicans; while there is uncertainty as to whether pelican will begin to nest in the Local Study Area, the potential for nesting will increase as foraging and nesting opportunities are enhanced.

Potential operational effects on ruffed grouse include habitat loss associated with shoreline erosion, ongoing peatland disintegration process and changes in vegetation resulting from changes in groundwater. Up to 8% (65 ha) of the Regional Study Area's ruffed grouse breeding habitat could be affected. It is expected that over time, ruffed grouse habitat will form in some of the decommissioned borrow areas, camp areas and other infrastructure sites that are no longer required for the Project. These sites will likely eventually be colonized by plants (*e.g.*, shrubs), providing suitable forage habitat for ruffed grouse.

During operation, ruffed grouse may experience an increase in mortality risk due to increased hunter access and increased traffic levels along access roads. Increases in the harvest of ruffed grouse along roadsides are not anticipated to have a measureable effect on local populations.

Residual Effects of Operation

The residual effects of Project operation on American white pelicans are expected to be neutral. The residual effects of Project operation on ruffed grouse include a minimal increase in the risk of traffic collisions on access roads, which is not expected to be a notable effect within the regional population.

Conclusion about Residual Effects on Birds at the Edge of their Range

The overall potential Project-related residual effects on birds at the edge of their range are expected to be adverse but regionally acceptable, because some species such as American white pelican are not known to breed in the Local Study Area, are not limited by nesting or loafing structures, and may benefit from enhanced foraging opportunities. For ruffed grouse, the loss of up to 8% of their habitat is a worst-case estimate that doesn't include the long-term revegetation of some sites following disturbance. The relative area of common ruffed grouse estimated to be affected by the Project would also be considerably less (less than 2%) if the Regional Study Area was selected as the larger Study Zone 5 (Table 6-6), which is an acceptable alternative. While some of the available habitat for species at the edge of their range may be modified by the Project, loss of range-limited species from the Regional Study Area is not anticipated. For the American white pelican, residual Project effects are anticipated to be neutral. For ruffed grouse, the residual effects of the Project (*i.e.*, habitat loss and increased mortality risk) are expected to occur within the natural variability of the ruffed grouse population in the Regional Study Area.

As outlined in Chapter 5, the cumulative effects assessment step that deals with future projects and activities focuses on VECs that are adversely affected by the Project and vulnerable to the effects of future projects and activities. As the group of bird species at the edge of their range is not a VEC, it is not covered in the cumulative effects assessment in Chapter 7.

Monitoring the abundance and distribution of ruffed grouse populations within the Regional Study Area will occur during the construction and operation phases (Chapter 8).

6.5.7.7.3 Colonial Waterbirds

Colonial waterbirds are represented by ring-billed gull, herring gull and common tern, which are the three species that breed on rocky islands and reefs within the Regional Study Area.

Construction Effects and Mitigation

Construction-related effects on gulls and terns include the loss and alteration of foraging and breeding habitat, and habitat avoidance due to Project disturbances (noise). During the later stages of GS cofferdam construction, increased water levels in Gull Lake will result in the short-term loss of mineral shorelines. Exposed mineral shorelines are important in providing gulls with foraging and resting habitat. Stage I Cofferdam construction at Gull Rapids will cause a short-term loss in some of the gull and tern foraging habitat (*e.g.*, rapids along the north channel of the Nelson River) during the construction period.

Development of the GS will also result in the removal and/or degradation of approximately 2.7 ha of potential gull and tern breeding habitat (*i.e.*, reefs; PD SV Section 3.3.5). Less than 50% of this available habitat is typically used to support gull and tern colonies (TE SV Section 6). Changes to breeding and foraging habitat, along with construction disturbances (*e.g.*, equipment noise, worker presence and blasting) are factors that will likely deter some colonial waterbirds from using the Gull Rapids area during the construction phase. However since gulls have a strong tendency to return to traditional colonial nesting sites, there is potential that some may nest on reefs despite ongoing construction disturbances. If blasting occurs during the sensitive breeding period (April 1–July 31), gulls and terns nesting on these reefs may be disturbed by the blasts, which could lead to a reduction in reproductive success.

During construction, it is anticipated that the 800–1,500 pairs of gulls and 30–100 pairs of terns displaced from breeding in the Gull Rapids area will seek alternate, potentially sub-optimal sites for breeding in the Keeyask region; alternatively, some gulls and terns may move to other regions to breed (depending on timing of the disruption in the breeding cycle) or forego breeding until suitable breeding habitat becomes available. It is uncertain what proportion (if any) of the Gull Rapids gull and tern colony will relocate to existing islands located upstream of Gull Rapids. These islands vary in size with fluctuating river water levels and are typically densely occupied by other gulls and/or terns nesting colonies.

The following mitigation measures will be implemented to minimize or avoid potential effects of Project construction on colonial waterbirds:

- Deployment of artificial gull and tern (*e.g.*, reef raft) nesting platforms, breeding habitat enhancements to existing islands, and/or development of an artificial island will be implemented to off-set the loss of gull and tern nesting habitat at Gull Rapids and areas upstream; and
- Over the course of construction, if there is overlap of scheduled construction activities that could affect the breeding colonies at Gull Rapids with the bird breeding period

(April 1-July 31), measures will also be taken to avoid or minimize disturbance to active nesting colonies to the extent possible.

Residual Effects of Construction

Effects of Project construction on gulls and terns are expected to be short-term and result in a change in the distribution of the populations, similar to what may naturally occur in some years.

Operation Effects and Mitigation

Following construction, the quality and quantity of gull and tern foraging habitat at Gull Rapids will decline as the GS changes the riverine environment into a more lacustrine environment. While new shorelines will form along the reservoir, on-going mineral and peatland erosion processes will likely render some reaches of the new shoreline unsuitable for gulls over the long-term.

Creation of the reservoir and continued peatland disintegration and mineral erosion processes are expected to increase water turbidity, which may reduce tern and gull foraging efficiency over the short-term. The effect of increased turbidity in the reservoir and the loss of forage habitat may be offset by the foraging opportunity created in the tailrace, an area of fast flowing turbulent water located immediately downstream of the generating station. Over time, water turbidity is anticipated to decrease with the settling of sediments, improving gull and tern foraging efficiency throughout the reservoir area.

Development of the dam and alteration of the water regime is expected to result in the creation of peninsulas and exposure of rocky reefs in the tailrace and spillway areas. The variability in water levels in the spillway area will render most islands and reefs in this area unsuitable for colonial waterbird breeding. Due to lack of bathymetry data for the Gull Rapids area, it is also uncertain whether or not changes in the water regime will expose new reefs in downstream areas. Given the level of uncertainty associated with the availability of future alternate colonial waterbird breeding habitat, various mitigation measures to off-set habitat loss have been considered (see below).

During operation, increased traffic along the north and south access roads may result in vehicle-related mortality of some terns and gulls in areas where birds concentrate (*i.e.*, alongside or adjacent to the GS). Collision-risk is anticipated to be low as gulls and terns are agile flyers and respond quickly to human disturbance.

Mitigation measures that will be implemented to minimize potential effects of Project operation on colonial waterbirds include the following:

- Installing traffic signage to facilitate reduced vehicle speed over the GS and at other potentially sensitive waterbody crossing sites; and

- Deployment of artificial gull and tern nesting platforms (*e.g.*, reef rafts), breeding habitat enhancements to existing islands (*e.g.*, predator fencing or placement of suitable surface substrate), and/or development of an artificial island, or a combination of these measures, will be implemented to off-set the loss of gull and tern nesting habitat at Gull Rapids and areas upstream.

Residual Effects of Operation

Many of the potential effects of Project operation on gulls and terns will be mitigated. Long-term changes in the number and distribution of gulls and terns are expected to occur within the natural variability of gull and tern population in the Regional Study Area.

Conclusion about Residual effects on Colonial Waterbirds

The overall potential Project-related residual effects on colonial waterbirds are expected to be adverse but regionally acceptable, primarily because implementation of mitigation measures is expected to largely offset the long-term effects of the Project. Residual Project effects on colonial waterbirds are associated with short-term noise disturbances at Gull Rapids during the construction phase and the long-term loss of some foraging habitat along mineral shorelines during the operation phase.

As outlined in Chapter 5, the cumulative effects assessment step that deals with future projects and activities focuses on VECs that are adversely affected by the Project and vulnerable to the effects of future projects and activities. As the colonial waterbirds group is not a VEC, it is not covered in the cumulative effects assessment in Chapter 7.

The distribution of waterbirds will be monitored during Project construction and operation in order to assess the effectiveness of mitigation measures, determine the need for adaptive management and confirm the accuracy of EIS predictions (Chapter 8).

6.5.7.7.4 Willow Ptarmigan

As willow ptarmigan overwinter in the Regional Study Area and breed in areas further north (*e.g.*, tundra), the potential Project-related effects on ptarmigan will primarily be associated with effects on their winter habitat, which includes forest openings and forest and wetland edges where food (*e.g.*, willows) and shelter (*e.g.*, deep snow) is abundant.

Construction Effects and Mitigation

Construction-related effects on willow ptarmigan are associated with the loss and alteration of some foraging and overwintering habitat due to land clearing activities, and short-term habitat avoidance due to noise disturbance from human activity and equipment. Effects on breeding habitat are not expected, as suitable willow ptarmigan breeding habitat does not occur within the Local Study Area. Winter clearing within the reservoir footprint and infrastructure sites will result in the loss of some ptarmigan wintering habitat (*e.g.*, willows, forest edges). This loss is considered small as shrubby habitat adjacent to forest cover (primarily coniferous forest; NWT 2012) is abundant and widespread throughout the Regional Study Area (TE SV Section 2). It is anticipated that early successional species favoured as forage by willow ptarmigan (*e.g.*, willows) will proliferate along disturbed sites such as road rights-of way and borrow areas following initial land clearing. Ptarmigan frequent disturbed sites, being commonly observed around roads, gravel pits and bladed trails (Sempel and Barr 1982).

Mechanical clearing may result in the loss of some birds taking cover in the snow, especially in areas where deep snow and shrubs occur (*e.g.*, along forest edges). Mortality risk for willow ptarmigan may also increase in some localized areas due to improved hunter access along new trails and roads and collisions with construction vehicles.

Mitigation measures that will be implemented to minimize potential effects of Project construction on willow ptarmigan include the following:

- Ptarmigan mortality risk will be minimized through manual clearing in wetlands and within 30 m of wetland edges; and
- Implementation of a Construction Access Management Plan will minimize the potential for increased harvest of local willow ptarmigan populations.

Overall construction-related effects on the local ptarmigan population are anticipated to be small and not measurable at the population level.

RESIDUAL EFFECTS OF CONSTRUCTION

The residual effects of Project construction on willow ptarmigan are associated with habitat loss and/or alteration and increased mortality risk. Effects of Project-related construction on ptarmigan are expected to occur within the natural variability of the population in the Regional Study Area.

OPERATION EFFECTS AND MITIGATION

Potential operational effects on willow ptarmigan include some additional overwintering habitat loss associated with shoreline erosion, ongoing peatland disintegration processes and changes in vegetation resulting from changes in groundwater. This incremental loss of winter habitat is not anticipated to have a measureable effect on local ptarmigan populations as wintering habitat is abundant and widespread throughout the Regional Study Area.

During Project operation, willow ptarmigan may experience an increase in mortality risk due to increased hunter access and increased traffic levels along access roads. Increased access along the north and south access roads has the potential to increase winter hunting pressure on ptarmigan using these areas during the operation phase. Local increases in the harvest of willow ptarmigan along roadsides are anticipated to be sporadic and not measureable at the local population level.

Disturbances such as traffic noise and human activity along access roads and at permanent infrastructure sites are not anticipated to have any notable effects on ptarmigan populations utilizing adjacent habitats.

The following mitigation measure will be implemented to avoid or minimize potential effects of Project operation on willow ptarmigan:

- Except for existing resource-use trails (see Construction Access Management Plan), Project-related cutlines and trails will be blocked where they intersect the Project Footprint, and the portions of these features within 100 m of the Project Footprint will be revegetated to minimize the risk of access-related effects.

RESIDUAL EFFECTS OF OPERATION

Aside from the periodic loss of willow ptarmigan through resource harvest and vehicular collisions along access roads, the effect on populations of willow ptarmigan during the operational phase of the Project is expected to be minimal and local. Residual effects of Project operation on willow ptarmigan are expected to occur within the natural variability of the population in the Regional Study Area.

CONCLUSION ABOUT RESIDUAL EFFECTS ON WILLOW PTARMIGAN

The overall potential Project-related residual effects on willow ptarmigan (*i.e.*, habitat loss and increased mortality risk) are expected to be adverse but regionally acceptable because that Local Study Area is used for overwintering (*i.e.*, less sensitive than breeding habitat) and there are large and widely distributed populations of ptarmigan within and north of the Regional Study Area. The small effects on ptarmigan are expected to occur within the natural variability of the population in the Regional Study Area

As outlined in Chapter 5, the cumulative effects assessment step that deals with future projects and activities focuses on VECs that are adversely affected by the Project and vulnerable to the effects of future projects and activities. As willow ptarmigan is not a VEC, it is not covered in the cumulative effects assessment presented in Chapter 7.

Monitoring is not planned for willow ptarmigan (Chapter 8).

6.5.8 MAMMALS

This section describes Project effects and mitigation for mammal populations in the Keeyask region that were identified by the KCNs and technical science. Effects on mammals will affect resource users including the KCNs in various ways. Such effects are outlined in the Socio-Economic (Section 6.6.3.5) and Resource Use (Section 6.7) sections of this document. As discussed in Chapter 5, the environmental assessment was based on both ATK and technical scientific analysis. The Cree worldview regarding the importance of the interconnectedness of the environment is provided in Chapter 2; and each of the CNP, YFFN, and FLCN evaluation reports provide their respective perspectives on the effects of the Project, including effects on the terrestrial environment.

The technical analysis determined effects of the Project on mammals by considering the linkages among the physical, aquatic, and terrestrial environments and changes caused by the Project, both directly and indirectly. Changes to ecosystem function and existing disturbances were also considered. The technical assessment for mammals used several approaches to consider potential effects, including scientific knowledge of causal relationships, habitat models, and proxy comparisons to other hydroelectric projects. Further details on the assessment methodology can be found in the TE SV, and in specific sections related to each mammal species. Methods for determining regulatory significance are found in Chapter 5. Benchmarks established for mammals that determine the magnitude of effects for VECs are summarized in the TE SV Section 7.4.7. Effects were assessed in Local Study Areas and the magnitude of effects was determined at the regional level. Uncertainty between the predicted effects based on ATK and technical analysis is addressed though post-Project monitoring (Chapter 8).

Potential Project effects on mammals include the following:

- Habitat loss, alteration and fragmentation;
- Project-related disturbances; and
- Access effects such as increased predation and harvest.

Mammals are expected to experience a change in habitat structure, composition, and connectivity through reservoir clearing and the construction of dykes, access roads, the generating station (GS), work camps, borrow pits, and other associated infrastructure. Habitat will be lost in the reservoir footprint area, where increased water levels are expected to flood approximately 45 km^2 (17.4 square miles) of terrestrial area.

Project-related disturbances include sensory disturbance from construction activities, blasting, and traffic. Such disturbances could decrease the amount of effective habitat available for various species, as individuals disturbed by construction activities will likely avoid active construction zones. Sensory disturbance may also be due to traffic on the access roads during operation. Accidental events such as spills and human-caused fire could affect areas of varying sizes, thus different numbers of individuals of particular species. Such events would be most likely to occur during the construction phase. Measures to mitigate spills, human-caused fires, and other environmental issues are outlined in the preliminary Environmental Protection Plans. As a result of these measures, the probability of occurrence is low and the most likely potential effect on mammals in the Keeyask region will be negligible.

Mortality due to wildlife encounters with humans is a potential Project effect on species such as small mammals, black bear, gray wolf, and regionally rare species such as striped skunk, raccoon, and coyote. Best practices for camp and work area cleanliness, food storage procedures, and worker education will mitigate such effects.

Linear features including roads and cutlines act as movement corridors for predators such as red fox and gray wolf, and improve access to formerly remote areas by resource users. Increased mortality of prey species and harvested animals could result from increased access. Improved hunting efficiency could benefit some predator species. Roads and other linear features also contribute to habitat fragmentation, which reduces core area size for mammals requiring large, undisturbed blocks of habitat. Fragmentation also influences ecosystem processes and species, and promotes the dispersion of invasive species.

The following sections describe the assessment of potential Project effects on VECs (caribou, moose, and beaver); other priority mammals including small mammals, furbearers, large carnivores, rare or regionally rare species; and mercury in wildlife.

6.5.8.1 CARIBOU

6.5.8.1.1 CONSTRUCTION EFFECTS AND MITIGATION

Through the following pathways, the Project has the potential to affect caribou during construction:

- Habitat loss, alteration of food and cover, and fragmentation due to physical removal of vegetation from the principal structures, south access road, dykes, camps, borrow areas, clearing of the reservoir, other supporting infrastructure, and changes in vegetation in Zone 2;
- Project-related disturbances from sensory disturbances (blasting, machinery, and people) and potential wildlife-vehicle collisions due to increased traffic on the access roads; and
- Access effects from potential increases in predation and in harvest by the workforce.

Potential Project effects on caribou, including summer residents, during construction include habitat loss and alteration from land clearing in Zone 2 and changes in caribou distribution within the Caribou Local Study Area. Physical habitat losses will include the reduction of food and cover available to caribou in the Local Study Area. About 6% or 6,825 ha (26 square miles) of the physical caribou winter habitat in the Local Study Area is expected to be affected (Map 6-66). Approximately 1% of caribou winter habitat in Zone 5, the study zone in which intactness was assessed (see Section 6.2.3.4), will be affected. By extrapolation, less than 1% of the winter habitat in the Caribou Regional Study Area will likely be affected. As less than 1% of the vast winter range of the Qamanirjuaq, Cape Churchill, and Pen Islands herds will be affected, the effect of winter habitat loss on migratory caribou will be negligible to small. Although it is uncertain whether summer resident caribou use the Regional Study Area in winter, if they do, the effect of habitat loss is also expected to be negligible to small, especially if summer resident caribou travel with the migratory herds and range outside the Regional Study Area (Thompson and Abraham 1994; Manitoba Conservation, unpubl. data).

Summer resident caribou calving and rearing habitat will be lost in the Local Study Area. Evidence of calving was documented on approximately 10% of the islands in Gull and Stephens lakes and only 5% of the peatland complexes surveyed in 2010 and 2011, indicating that there is likely more habitat available than caribou are currently using. No suitable primary and secondary peatland complexes will be directly affected by the Project during construction. Two islands in Gull Lake will be lost at the GS site, only one of which was occupied by caribou with calves during field studies. As these islands comprise less than 1% of the primary calving and rearing habitat in the Regional Study Area, the initial loss of the islands at the GS site will likely be negligible.

Potential Project-related disturbances include sensory disturbances and mortality due to wildlife-vehicle collisions on the access roads. Sensory disturbances from blasting, machinery, and people will most likely cause caribou to avoid some winter habitat. Although a few caribou may habituate to small levels of noise disturbances and not all will be affected, blasting is unpredictable and could scare away most animals from the blasting zone of influence. Sensory disturbances in fall could affect rutting behaviour near the construction zone. It is unlikely that many caribou rut in Local Study Area, as the habitat is dominated by smaller peatland complexes that are generally unsuitable. Pre-rut behaviours observed on four large islands in Stephens Lake will not be affected. In the event that a few caribou rut near the construction zone, they are expected to find alternate areas in which to breed, and the effect of sensory disturbance on the rut are expected to be negligible to small.

In heavy construction areas, some summer resident caribou activity will likely decline within 2 km (1.2 miles) of the south access road and up to at least 4 km (2.5 miles) from the GS, which will most likely result in a loss of effective habitat (Manitoba Hydro 2011b). In addition to the loss of physical winter habitat, sensory disturbances will likely result in a 12% loss of effective habitat in the Local Study Area. Approximately 2% of winter habitat is expected to be affected in Zone 5, and by extrapolation, less than 1% of the winter habitat in the Regional Study Area will likely be affected. Caribou that move away from affected winter habitat will most likely find suitable habitat elsewhere in the Local and Regional Study Areas. As less than a 1% loss of effective winter habitat is anticipated in the Regional Study Area, the overall effect will likely be negligible to small (TE SV Section 7.4.7.2).

Sensory disturbances could result in a temporary loss of effective calving and rearing habitat and altered movements in Local Study Area. About 510 ha (2.0 square miles), or 5% of the primary calving and rearing habitat in the Local Study Area is expected to be affected by sensory disturbance, all on islands in Gull Lake. Additionally, 695 ha (2.7 square miles) or 24% of secondary calving and rearing habitat in the Local Study Area will likely be affected, including 23% of peatland complexes and less than 1% of islands in Gull Lake. In all, 1,205 ha (4.7 square miles) or 9% of primary and secondary calving and rearing habitat will be affected in the Local Study Area. Of this, 5% will be in peatland complexes and 4% will be on islands in lakes. Given the large amount of calving and rearing habitat, particularly peatland complexes, available on the landscape, less than 1% of effective primary and secondary calving and rearing habitat in the Regional Study Area is expected to be affected by sensory disturbance.

Caribou that encounter sensory disturbances prior to calving will likely move to unoccupied calving and rearing habitats elsewhere in the Local or Regional Study Areas. Sensory disturbances during the summer resident calving period could result in a very small number of cows and calves abandoning protective habitat in order to escape the disturbance. This could result in increased mortality through predation, as calves could leave protective habitat, resulting in increased predation risk. Caribou may avoid the Local Study Area due to construction noise, but the disturbance will be small in geographic extent and temporary, and no interruption of long-distance seasonal migration is anticipated. As sensory disturbance during construction will result in less than a 1% loss of calving and rearing habitat in the Regional Study Area and will not affect long-distance movements of migratory caribou, the overall effects will likely be negligible to small.

Collisions with vehicles are generally not listed as an important source of caribou mortality (Jalkotzy *et al*. 1997; Environment Canada 2011; Festa-Bianchet *et al*. 2011) and would likely be limited to caribou movement corridors and high-quality habitats between Thompson and the GS. Effects of mortality due to increased wildlife-vehicle collisions on caribou populations in the Regional Study Area will likely be small and should be negligible with mitigation.

Effects of improved access to the Local Study Area could include increased mortality due to predation. Predators, particularly gray wolves, often use linear features to travel and to hunt (James and Stuart-Smith 2000); wolves have been observed using transmission lines to move (Mammals Working Group 2010). Greater hunting efficiency and a potential influx of predators could increase caribou mortality, which is among the threats to some caribou populations (Environment Canada 2011; Festa-Bianchet *et al*. 2011). Habitat changes could result in the displacement of moose into areas occupied by caribou, increasing predation on caribou as predators follow (Kinley and Apps 2001). Both resident and transient gray wolves occur in the Regional Study Area. Most transient wolves are habitually wandering wolves that follow migratory caribou into the region. Resident wolves require moose as their primary prey base because there is not enough caribou and other alternate food biomass to sustain a wolf population with small or medium-sized territories in the Regional Study Area year-round (TE SV). When migratory caribou move into the territories of resident wolf packs for part of the year however, wolves usually hunt them while they are available. Limited prey switching can also occur if transient wolves opportunistically prey on moose. When the migratory prey leave, so do the transient wolves; the resident wolves remain and live off the regional population of moose.

Because the number and distribution of moose is not expected to change during construction (see moose section below), resident wolf density and distribution will not likely change. Mortality above the current rate for caribou as an alternative prey source is therefore highly unlikely during construction. Resident and transient gray wolf density in the Regional Study Area is low (estimated at less than 4/1,000 km²; TE SV) and is not expected to change with the Project; therefore, predation effects on summer resident caribou will likely be small. As no net increase in the density of linear features is predicted in the Local Study Area (see below) during construction, predation efficacy will not likely change, thus the overall effect of predation will likely be neutral.

Effects of improved access to the Local Study Area could also include increased mortality due to hunting. Opportunistic harvest of caribou by workers (Section 6.7.3.1) and other resource users could increase during construction due to improved access to the Local Study Area, also increasing caribou mortality. FLCN Members are particularly concerned that increased access will increase hunting pressure (FLCN Environment Evaluation Report (Draft)). However, Game Hunting Area (GHA) 3, the area where caribou hunting is permitted, overlaps only a small portion of the Local Study Area near Gillam, and the low number of resident licences available for caribou harvest is managed by the Province (Section 6.2.3.6; TE SV). The potential increase in caribou mortality due to workers hunting will be managed (see mitigation) and the overall effect will be neutral. In addition, as the north access road will be the main access route to the GS during construction (Chapter 4), effects are expected to be neutral on the south access road during construction.

Fragmentation, a landscape-level process in which human features progressively subdivide habitat blocks into smaller and more isolated fragments, is described in Section 6.2.3.4. The potential for the access roads to fragment habitat, compounded by increases in traffic (Laurian *et al.* 2008), could influence caribou by acting as a barrier to movement, contribute to mortality from predation and hunting access, and reduce core area size. Including the Thompson area, the current density of existing linear features in Zone 5 (0.45 km/km²; Section 6.5.3.3) is at the low end of the moderate magnitude range. The density of existing linear features in Zone 5 decreases when the area around Thompson is excluded (0.32 km/km²), and the magnitude of the effect of existing features on caribou is small. A small net decrease (less than 1%) in linear feature density is anticipated with the construction of the Project, as some existing linear features will be removed during clearing of borrow areas and camps, and some cutlines will be converted into the main access roads. For caribou, the overall effect of a reduction in linear feature density will be negligible to small and positive. The number of core areas larger than 200 ha (0.8 square miles) or 1,000 ha (3.9 square miles) that caribou most likely use is expected to decrease by only 1% in Zone 5. Eighty-two percent of the largest core areas will remain intact, and the overall effect of habitat fragmentation will likely be small.

The federal government outlines criteria to assess boreal woodland caribou ranges to measure the long-term viability of a caribou population. Habitat disturbance considers the effects of fire in addition to human features. A minimum of 65% of habitat should remain undisturbed in order to sustain a population (Environment Canada 2011). Currently, 48% of the estimated range for caribou in Zone 5 is undisturbed (Map 6-67). Fire has the largest effect on caribou habitat in the Keeyask region; 36% of Zone 5 is less than 40 years old. Based solely on this criterion, the Keeyask region is unsuitable for a sustainable boreal woodland caribou population, especially a small one that ranges from 20–50 animals. Because changes to intactness will be negligible, effects on caribou will likely be negligible. The Project will not contribute to measurable changes in caribou habitat intactness of the Regional Study Area.

While the level of natural and human-caused disturbance is an important factor in the assessment of the effects of habitat disturbance, others factors to consider include the types of caribou in the area, their ranges, and the availability of suitable calving habitat. In addition to the habitat requirements of those summer resident caribou represented in Zone 5, recent radio-collaring data have shown that at least one caribou spent a summer in the Keeyask region and migrated to the coast the following year (Manitoba Conservation, unpubl. data). Other caribou from the same study have shown large migratory movements nearing Shamattawa and large annual ranges, which are not consistent with the shorter migratory movements and small annual ranges of forest-dwelling woodland caribou populations found elsewhere in Manitoba (Manitoba Hydro 2011a). These movements indicate the actual range use of collared caribou extends beyond the Regional Study Area, and the undisturbed portion of their overall range is likely greater than in the Regional Study Area (Manitoba Hydro 2011a). The islands in Stephens Lake are frequently used for calving, and this area should be recognized as suitable habitat. Finally, recognized boreal woodland caribou populations in Manitoba have persisted on landscapes with less than the recommended 65% undisturbed habitat benchmark; however, the long-term viability of these populations is uncertain (Environment Canada 2011). Because some of the summer resident caribou are likely coastal caribou, caribou are not using all of the calving and rearing habitat currently available in the Regional Study Area, and the proportion of undisturbed habitat is greater beyond the Regional Study Area, the effect of habitat disturbance on summer resident caribou is predicted to be small.

Mitigation measures for caribou will include the following:

- The excavated material placement areas were sited to avoid caribou calving complexes and reduce habitat loss;
- The access roads were routed to avoid caribou calving complexes and reduce loss of effective habitat;
- Future calving islands greater than 0.5 ha in the reservoir area will be flagged and left undisturbed to protect the vegetation that will remain on these islands from clearing disturbances;
- Blasting will be minimized to the extent practicable from May 15 to June 30, to reduce the effects on calving females and their young;

- A Construction Access Management Plan will be implemented to reduce the effects of increased access to the Local Study Area;
- Gates will be added to the north and south dykes, to be kept closed and locked from May 15 to June 30 and during other sensitive periods as may be determined by monitoring (*e.g.*, the arrival of migratory caribou) to minimize disturbances by humans;
- Firearms will be prohibited in camps and at work sites to reduce mortality due to hunting during construction;
- Warning signs will be placed along the access roads near caribou travel corridors and high-quality habitats to reduce the potential of wildlife-vehicle collisions;
- Roadside ditches will be rehabilitated with native plants with low quality food value for caribou where practicable, to minimize attraction and the risk of collisions and harvest opportunities; and
- Fire prevention measures will be employed in remote working environments to minimize the risk of habitat loss for caribou.

6.5.8.1.2 Residual Effects of Construction

Residual effects on caribou that are expected and likely once the appropriate mitigation measures are applied will be localized altered movements and distributional changes due to sensory disturbance; and decreased abundance due to reduced habitat and increased mortality. Most Project effects will be negligible to small, particularly since habitat currently appears to be under-utilized, limited mainly to the Local Study Area, and affect two or more generations. Regional effects could include any indirect caribou mortality associated with the Project, but these are also expected to be negligible.

Using the criteria established to determine the significance of Project effects for regulatory purposes (described in Chapter 5), the likely residual effects of Project construction on caribou are expected to be adverse, small in geographic extent, long-term in duration, and small in magnitude. Step 2 analysis is screened out based on Step 1 analysis.

6.5.8.1.3 Operation Effects and Mitigation

Through the following pathways, the Project has the potential to affect caribou during operation:

- Habitat loss and alteration due to flooding, shoreline erosion, peatland disintegration, and reservoir-related groundwater and edge effects;
- Project-related disturbances due to sensory disturbances from traffic, potential changes in river crossings due to altered ice conditions, reduced movements along shorelines due to woody debris, and mortality from potential wildlife-vehicle collisions due to increased traffic on the access roads; and

- Access effects from potential increases in predation and in harvest by resource users.

During operation, effects on caribou, including summer resident caribou, will include additional habitat loss and alteration. Long-term effects are associated with flooding, shoreline erosion, peatland disintegration, and reservoir-related groundwater and edge effects; these are discussed in Section 6.5.3.1 and below. No additional loss of winter habitat is expected above construction losses, although with flooding, habitat loss will be permanent. As no additional loss of winter habitat is anticipated, effects are expected to be negligible to small.

Approximately 257 ha (1.2 square miles), or less than 2%, of primary calving and rearing habitat in the Local Study Area will be affected in the reservoir by year 30 of operation in the Local Study Area. A 65% increase in the area of islands in lakes between 0.5 and 10 ha is anticipated. Groundwater effects on vegetation could reduce the quality of potential caribou habitat on new islands formed in the reservoir and on existing islands such as Caribou Island. In a worst-case scenario, all islands in the reservoir could change from primary to secondary calving and rearing habitat, predicted with a moderate level of uncertainty. In total, less than 1% of all calving habitat in the Regional Study Area is predicted to be affected by the Project during operation. Thus, the effects of the loss or alteration of calving and rearing habitat will likely be small.

Project-related disturbances to caribou during operation could include sensory disturbances from traffic on the access roads and from noise and workers at the GS site, and mortality due to wildlife-vehicle collisions on the access roads and at river crossing sites. Sensory disturbance from traffic on the access roads could result in avoidance of the area by some caribou, particularly Pen Islands animals and summer residents on the south side of Stephens Lake in the Local Study Area. The degree of avoidance will likely depend on the volume of traffic on the access roads (Jalkotzy *et al*. 1997). It is predicted that primary calving and rearing habitat within 2 km (1.2 miles) of the GS will be less suitable for calving, and will be more likely to be used by adults without calves. Summer resident caribou with fidelity to existing calving sites will highly likely cross the highway to gain access to high quality calving habitat on Stephens Lake. Early in the operation phase, caribou will likely re-occupy most habitats that were avoided during construction, but some loss of effective habitat, up to 500 m from the road and less for cutlines, will continue over the long term. Less than 1% of the available calving and rearing habitat in the Regional Study Area is expected to be affected, thus effects will likely be negligible to small. Based on past experience by some of the KCNs, it will take decades before caribou return to the Project area (YFFN Evaluation Report (*Kipekiskwaywinan*)), or they may not return to the area (FLCN Environment Evaluation Report (Draft)). Monitoring will be required (see Chapter 8).

Collisions with vehicles are generally not listed as an important source of caribou mortality (Environment Canada 2011). As the risk of wildlife-vehicle collisions is unlikely to change during operation, the effects of mortality due to collisions with vehicles on caribou populations in the Regional Study Area are expected to remain negligible to small.

While few river crossing sites were found between Clark Lake and Gull Rapids, and very few caribou were recorded crossing the Nelson River during technical studies, resource users from the KCNs have observed caribou crossing the Nelson River just downstream of Gull Rapids (FLCN 2010 Draft). Based on experience with past hydroelectric projects, the KCNs raised concerns about caribou drowning as a potential Project effect due to an altered ice regime. Although no increase in caribou drowning as a direct result of the Project is anticipated, there is uncertainty associated with the conditions under which the risk of mortality can change. The earlier formation of thin ice across the reservoir, which coincides with the arrival of caribou in the Local Study Area, could increase the risk of drowning mortality. However, once the ice has formed, an increase in caribou drowning is unlikely on the reservoir because post-Project conditions include the formation of a stable ice cover on the reservoir (*i.e.*, smoother and more consistent than the existing environment), including maintaining a steady reservoir level during freeze-up and monitoring ice thickness (Project Description Supporting Volume), and less variation in water levels once the reservoir is established relative to current conditions (Mammals Working Group 2011). Monitoring will be required (see Chapter 8).

Other Project-related disturbances could include reduced local movements by caribou along shorelines due to debris. A negligible to small effect is anticipated because the Reservoir Clearing Plan (Chapter 4 Appendix 4A) and Waterways Management Program (Chapter 4 Appendix 4B) will mitigate these effects.

Effects of improved access to the Local Study Area could include increased mortality due to predation and hunting. During operation, the number and length of linear features in the Local Study Area is not expected to change (see Section 6.5.8.2), nor will the overall numbers of gray wolves or moose. As a result, the overall effect of predation on caribou is not expected to change and the effect will remain small during operation.

Effects of improved access also include increased caribou mortality due to hunting. With their low reproductive rate, caribou cannot sustain high losses due to hunting, which could increase as access to the Local Study Area by the public becomes available via the north and south access roads. Access to the area already includes waterbodies and watercourses, the existing Provincial Road 280, cutlines and trails, railways, and transmission lines, whose use as transportation routes to support the sustainable domestic harvest in the Regional Study Area varies seasonally. Once the Project is commissioned, PR 280 will be re-routed to include the north access road, the GS facility over the Nelson River and the south access road to Gillam (Chapter 4, Appendix 4B). This new section of PR 280 could increase local caribou hunting activity by domestic resource users. Increased access is also expected with the provision of boat launches above and below the GS (see Section 6.7.3.2.). The traditional harvest of caribou by the KCNs usually occurs in late fall and winter and focuses on migratory caribou populations. With the exception of two large harvests of migratory caribou in the last 10 years (TE SV; Manitoba Hydro 2011a), only a small number of caribou have been harvested from the Local Study Area (CNP Keeyask Environmental Evaluation

Report; YFFN Evaluation Report (*Kipekiskwaywinan*); FLCN 2010 Draft). However, many caribou are harvested from the Regional Study Area, from the surrounding GHAs, and into Ontario and Nunavut by all resource users. Including considerations for sustainable caribou management by the Province (mainly via regulation of licensed hunting in Manitoba), the effects of harvest on caribou populations in the Local Study Area are not expected to contribute to a large degree to the effects of the broader regional harvest, thus the effect is expected to be small during operation.

AEA offsetting programs will, among other purposes, provide alternative harvesting opportunities in the Split Lake Resource Management Area (SLRMA) to replace the loss of traditional resource use areas due to the Project. These programs are expected to disperse existing harvest pressures in the Local Study Area. For waterfowl and moose, traditional wildlife harvest land-use activities happen in the spring and fall respectively. The traditional harvest of caribou occurs in winter, and because there is no overlap with other hunting seasons, the harvest of caribou is not expected to increase in the SLRMA (Section 6.7.3.2) and effects of access programs on caribou will likely be neutral.

No additional change in the density of linear features is expected in Study Zone 5 during operation, therefore effects of habitat fragmentation on caribou during operation will be neutral.

Mitigation measures for caribou will include the following:

- Except for existing resource-use trails (see Construction Access Management Plan), Project-related cutlines and trails will be blocked where they intersect the Project Footprint, and the portions of these features within 100 m of the Project Footprint will be revegetated to minimize the risk of effects related to predation and human access;
- Temporarily cleared areas and excavated materials placement areas (Section 6.5.3.2) will be rehabilitated to native habitat types where feasible to improve caribou habitat;
- Warning signs should be maintained in areas along the access roads with caribou activity to caution motorists; and
- A plan is being developed to coordinate caribou mitigation and monitoring activities among Manitoba Hydro's northern developments, as well as with government authorities and existing caribou committees and management boards.

6.5.8.1.4 RESIDUAL EFFECTS OF OPERATION

Residual effects on caribou that are expected and likely once the appropriate mitigation measures are applied will be altered movements due to reduced intactness and sensory disturbance, and decreased populations due to reduced habitat and increased mortality. Effects will be small, extending towards the Regional Study Area due to the possible effects of harvest, and affect two or more generations.

Using the criteria established to determine the significance of Project effects for regulatory purposes (see Chapter 5), the most likely residual effects of Project operation on caribou are expected to be adverse, medium in geographic extent, long-term in duration, and small in magnitude. Step 2 analysis is screened out based on Step 1 analysis.

6.5.8.1.5 Conclusions About Residual Effects on Caribou

Overall, the likely Project residual effects on caribou are expected to be adverse but regionally acceptable because: less than 1% of region's under-utilized calving and rearing habitat and winter habitat will be lost; only a negligible change in intactness is expected in Zone 5; additive residual Project effects on caribou mortality will likely remain small and below established benchmarks; and, because altered movements and distributional shifts are most likely limited only to habitat near the Project infrastructure, these are unlikely to affect the landscape-level movements and distribution of caribou in the region. There is a moderate to high degree of certainty for caribou in the assessment because of some unpredictability regarding the long-term frequency and variability of habitat use and movements, but high confidence in habitat availability, and existing summer core areas and regional intactness estimates.

The adverse residual effects of the Project on caribou will overlap spatially and temporally with effects from the following future projects: Bipole III Transmission Project, Keeyask Transmission Project, Conawapa Generation Project, and Gillam Redevelopment. These projects will increase habitat loss, reduce intactness, increase fragmentation and increase mortality due to increased human presence and access effects. The cumulative effects are discussed in more detail in Chapter 7. The KCNs are concerned about cumulative effects with other future projects, and with the uncertainty associated with the presence of woodland caribou in the Regional Study Area. Monitoring plans are being developed to address uncertainties. These are discussed in Chapter 8.

6.5.8.2 Moose

6.5.8.2.1 Construction Effects and Mitigation

Through the following pathways, the Project has the potential to affect moose during construction:

- Habitat loss and alteration of food and cover due to physical removal of vegetation from the principal structures, south access road, dykes, camps, borrow areas, clearing of the reservoir, other supporting infrastructure, and changes in vegetation in Zone 2;
- Project-related disturbances from sensory disturbances (*i.e.*, blasting, machinery, and people) and mortality from potential wildlife-vehicle collisions due to increased traffic on the access roads; and

- Access effects from potential increases in predation and in harvest by resource users.

Project effects on the moose population during construction include habitat loss and alteration in Zone 2, habitat fragmentation, and changes in moose distribution within the Moose Local Study Area. Important moose calving and rearing habitat in the Local Study Area includes islands in lakes and peatland complexes that are similar to those used by summer resident caribou (see Map 6-66) and peninsulas and shorelines of lakes and rivers. Primary moose habitat covers about 10% of the Local Study Area (Map 6-66) and 69% is secondary moose habitat (TE SV Section 7.4.7.3). In comparison, 38% of the Moose Regional Study Area is primary moose habitat, and the remainder is considered secondary habitat. Approximately 1% of physical moose habitat will be lost in the Regional Study Area. A substantial portion of the primary habitat located near the Project Footprint is burned habitat, which is expected to become secondary habitat as it matures. The distribution, quantity, and quality of habitat are also expected to change in the long term, within a range of natural variation driven by the fire regime (see Section 6.2.3.4). As less than 1% of moose habitat in the Regional Study Area is expected to be lost during construction, and habitat alteration will likely be within the range of natural variation, the effect on moose will likely be negligible to small.

Fragmentation of habitat by the access roads could affect the moose population in the Local Study Area; however, moose are often found along highways and roads (Forman and Deblinger 2000; Laurian *et al.* 2008; Manitoba Hydro 2011b) where edge habitat is preferred. Because moose are adapted to survival in edge habitats, and intactness is unlikely to change (see Section 6.2.3.4), the effects of habitat fragmentation on moose are expected to be neutral.

Project-related disturbances could include sensory disturbances and mortality due to wildlife-vehicle collisions on the access roads. Sensory disturbances (*e.g.*, traffic, machinery, blasting), could result in a loss of effective habitat and the temporary abandonment of calving habitat. Moose exhibit a high level of calving site fidelity and will not easily abandon suitable areas due to disturbance (RRCS 1994), often returning once the disturbance ends (Colescott and Gillingham 1998). Moose cows and calves were often reported by workers during the construction of the Wuskwatim GS, and overall moose activity levels during construction remained high throughout the access road construction period (Manitoba Hydro 2011b). Sensory disturbances in fall could also affect rutting behaviour near the construction zone. Because moose do not easily abandon habitat due to sensory disturbance, and are likely to return when the disturbance ends, the effects of sensory disturbance on moose in the Local Study Area are expected to be negligible to small.

Collisions with vehicles on the access roads could result in increased moose mortality. Collisions with moose have been recorded in Manitoba (Manitoba Conservation, Wildlife and Ecosystem Protection Branch 2005b), and are most likely to occur during the periods of peak moose activity at dusk, night, and dawn, when roadside visibility is poor for vehicle operators (Joyce and Mahoney 2001). While vehicles may occasionally collide with moose on the access roads and PR 280 in the Local and Regional Study Areas, such events are uncommon and will likely have a negligible to small effect on the moose population in the Regional Study Area.

Potential effects of improved access to the Local Study Area include increased mortality due to predation and hunting. Predators, particularly gray wolves, often use linear features to travel and to hunt (James and Stuart-Smith 2000). Greater hunting efficiency and a potential influx of predators such as wolves could increase moose mortality (also see Caribou above). Resident and transient gray wolf density in the Regional Study Area is low (estimated at less than 4/1,000 km^2; TE SV) and is not expected to change as a result of the Project. As no net increase in the density of linear features is predicted in the Local Study Area during construction, predation efficacy will not likely change, and the effect of predation on moose will likely be small.

Harvest of moose by workers (see Section 6.7.3.1) and local resource users including the KCNs could increase during construction due to improved access to the Local Study Area, also increasing moose mortality, and the moose harvest will occur throughout the SLRMA as a result of the AEA offsetting programs. The current harvest in the SLRMA is estimated at less than 10% of the regional population (TE SV). With mitigation (prohibition of firearms in camp, see below) and continued regulation of licensed hunting by Manitoba Conservation, the moose harvest will not likely exceed sustainable limits and is expected to have a negligible effect on the regional moose population.

Mitigation measures for moose will include the following:

- A moose harvest sustainability plan will be implemented by the CNP so that the moose population will remain at a sustainable level in the SLRMA;
- Roadside ditches will be rehabilitated with native plants with low quality food values for moose where practicable, to minimize attraction of moose to the road and the risk of wildlife-vehicle collisions and harvest opportunities;
- Information about wildlife awareness will be provided for workers to reduce the risk of wildlife-vehicle collisions; and
- Firearms will be prohibited in camps and at work sites to reduce mortality due to hunting during construction.

6.5.8.2.2 RESIDUAL EFFECTS OF CONSTRUCTION

Residual effects on moose that are expected and likely once the appropriate mitigation measures are applied will be altered movements due to sensory disturbance, distributional changes, and a decreased population due to altered habitat and increased mortality. Effects will be negligible to small, extend to the Regional Study Area due to offset resource use programs, and affect one to two or more generations.

Using the criteria established to determine the significance of Project effects for regulatory purposes (see Chapter 5), the likely residual effects of Project construction on moose are expected to be adverse, medium in geographic extent, medium-term to long-term in duration, and small in magnitude. Step 2 analysis is screened out based on Step 1 analysis.

6.5.8.2.3 OPERATION EFFECTS AND MITIGATION

Through the following pathways, the Project has the potential to affect moose during operation:

- Habitat loss and alteration due to flooding, shoreline erosion, peatland disintegration, and reservoir-related groundwater and edge effects;
- Project-related disturbances due to sensory disturbances from traffic and mortality from potential wildlife-vehicle collisions due to increased traffic on the access roads; and
- Access effects from potential increases in predation and in harvest by resource users.

During operation, effects on moose will likely include the further alteration of habitat in the Local Study Area and the permanent loss of habitat in the reservoir. Long-term habitat loss or alteration is associated with flooding, shoreline erosion, peatland disintegration, and reservoir-related groundwater and edge effects (see discussion in Section 6.5.3.1). As primary and secondary moose habitat covers a large portion of the Regional Study Area (see Construction Effects and Mitigation section), the effects of additional habitat loss on moose will likely be negligible to small.

Project-related disturbances to moose could include sensory disturbance from traffic on the access roads, changes in habitat connectivity, and mortality due to wildlife-vehicle collisions. While moose may avoid roads, particularly where traffic is heavy, they are often found near roads (Laurian *et al*. 2008) and are known to cross them (Joyce and Mahoney 2001; Dussault *et al*. 2007). As such, effects of sensory disturbance and changes in habitat connectivity will likely be small.

Collisions with vehicles could increase moose mortality. Once the Project is commissioned, PR 280 will be re-routed to include the north access road, the GS facility over the Nelson River, and the south access road to Gillam. As such, traffic will likely increase on the access roads during operation, but a corresponding decrease in traffic could occur on the existing PR 280 route, and with no construction traffic contributing to the risk of wildlife-vehicle collisions, effects of collisions with vehicles on the moose population in the Regional Study Area are expected to be negligible.

Effects of improved access to the Local Study Area by resource users and predators could include increased moose mortality. Existing main access routes for moose harvest are similar to caribou harvest access routes (see Caribou above). As access to the Local Study Area via the access roads, which will become a section of PR 280, will not be restricted during operation, local moose hunting activity by domestic resource users could increase. Increases in access are also expected to occur due to the provision of boat launches above and below the GS (see Section 6.7.3.2). Moose mortality due to harvest in the SLRMA as a result of AEA offsetting programs will be an on-going effect. The current harvest in the SLRMA is estimated at less than 10% of the regional population (TE SV). With mitigation (see below) and continued regulation of licensed hunting by Manitoba Conservation, the moose harvest will not likely exceed sustainable limits and is expected to have a small effect on the regional moose population.

Mitigation measures for moose will include the following:

- Continue to communicate and coordinate with CNP Members to verify that recommendations in the moose harvest sustainability plan are being implemented;
- Except for existing resource-use trails (see Construction Access Management Plan), Project-related cutlines and trails will be blocked where they intersect the Project Footprint, and the portions of these features within 100 m of the Project Footprint will be revegetated to minimize the risk of habitat disturbance, invasive plant spreading, accidental fires and access-related effects; and
- Mitigation for wetland function will benefit moose through the development of wetlands in the Local Study Area (Section 6.5.3.4) and could off-set some of the losses in habitat for moose.

6.5.8.2.4 Residual Effects of Operation

The residual effects on moose that are expected and likely once the appropriate mitigation measures are applied will be a decreased population due to altered habitat and increased mortality. The effects are predicted to be negligible to small, extend to the Regional Study Area due to offset resource use programs, and affect two or more generations.

Using the criteria established to determine the significance of Project effects for regulatory purposes (see Chapter 5) the likely residual effects of Project operation on moose are expected to be adverse, medium in geographic extent, long-term in duration, and small in magnitude. Step 2 analysis is screened out based on Step 1 analysis.

6.5.8.2.5 Conclusions About Residual Effects on Moose

Overall, the likely Project residual effects on moose are expected to be adverse but regionally acceptable because: less than 1% of region's moose habitat will be lost; additive residual Project effects on moose mortality will likely remain small and below established benchmarks; and, because altered movements are most likely limited only to habitat near the Project infrastructure, these are unlikely to affect the landscape-level movements of moose in the region. To ensure that moose mortality does not change from the implementation of AEA offsetting programs, a moose harvest sustainability plan will be implemented by CNP.

There is a high degree of certainty for moose in the assessment because of high confidence in estimates of population abundance, distribution, and habitat availability estimates.

The adverse residual effects of the Project on moose will overlap spatially and temporally with effects from the following future projects: Bipole III Transmission Project, Keeyask Transmission Project, Conawapa Generation Project, and Gillam Redevelopment. These projects will increase habitat loss and mortality due to increased human presence and access effects. The cumulative effects are discussed in more detail in Chapter 7.

Monitoring plans are being developed to address uncertainties, including the effects of harvest. These are discussed in Chapter 8.

6.5.8.3 BEAVER

6.5.8.3.1 CONSTRUCTION EFFECTS AND MITIGATION

Through the following pathways, the Project has the potential to affect beaver during construction:

- Habitat loss and alteration of food and cover due to physical removal of vegetation from the principal structures, south access road, dykes, camps, borrow areas, clearing of the reservoir, other supporting infrastructure, and changes in vegetation in Zone 2;
- Project-related disturbances from sensory disturbances (*i.e.*, blasting, machinery, and people) and mortality from potential wildlife-vehicle collisions due to increased traffic on the access roads and wildlife control measures taken in work areas; and
- Access effects from potential increases in predation and in harvest by resource users.

Project effects on the beaver population during construction include habitat loss and mortality in Zone 1. Although vegetation clearing will begin during construction, habitat loss for beaver is considered in operation effects, where it will primarily occur during reservoir impoundment, and become permanent. Between 20 and 30 active beaver colonies will be removed during clearing in Zone 1, which is less than 10% of the estimated population in the Regional Study Area. Beavers reproduce relatively slowly but can easily compensate for local losses through rapid dispersal if corridors are maintained (Boyle and Owens 2007). As beaver can replace annual mortality of 30% and can compensate for greater losses with increased reproduction (Payne 1989), the effect of removing 20 to 30 beaver colonies is expected to be small.

Project-related disturbances during construction could include sensory disturbances and mortality due to wildlife-vehicle collisions and conflicts with humans. Sensory disturbance from traffic, machinery, and blasting could result in a loss of effective habitat, leading to habitat avoidance or temporary abandonment. Beaver are relatively tolerant of disturbance due to the protection afforded by their lodges, and with their ability to cache food, loss of effective habitat will most likely be negligible to small. Wildlife-vehicle collisions on the access roads could result in a marginal increase in beaver mortality, but such events are infrequent. Beaver often come into conflict with humans, particularly in construction areas where they plug culverts and create impoundments next to roads. Wildlife control measures such as removal or destruction of beaver could result in increased mortality but will likely affect a very small proportion of the population due to the reduced availability of suitable habitat in the Local Study Area. As beaver are tolerant of sensory disturbance, are strong dispersers and populations can replace annual mortality of 30%, the effect of Project-related disturbances will likely be negligible to small.

Potential effects of improved access to the Local Study Area include increased mortality due to predation and trapping. FLCN has identified increased beaver mortality as a result of easier trapping access as a Project effect (FLCN Environment Evaluation Report (Draft)). The creation of linear features could facilitate predator movement in the Local Study Area (Thurber *et al*. 1994; James and Stuart-Smith 2000), resulting in increased beaver predation, or a relative decrease if predation is focused on alternate prey. Access to the Local Study Area will be controlled with the Access Management Plan. Although trappers will be allowed to access their traplines using the main access roads, trapping effort is expected to be limited due to disturbances caused by construction activities. Potential increases in trapping activity are considered under operation.

Mitigation measures for beaver will include the following:

- A minimum of a 100 m buffer will be left at creeks, streams, ponds and lakes to the extent practicable to maintain existing beaver habitat;
- Individuals from affected areas will be trapped prior to and during reservoir clearing, and periodically until the reservoir reaches maximum capacity to manage inadvertent winter mortality that is highly likely to occur during operation; and
- Beaver baffles will be used where culverts and control structures are repeatedly blocked due to beaver dam construction to minimize mortality due to conflicts with humans.

6.5.8.3.2 Residual Effects of Construction

The residual effects on beaver that are expected and likely once the appropriate mitigation measures are applied will be increased mortality. The effects will be small, limited to the Local Study Area, and affect two or more generations.

Using the criteria established to determine the significance of Project effects for regulatory purposed (see Chapter 5), the likely residual effects of Project construction on beaver are expected to be adverse, small in geographic extent, long-term in duration, and small in magnitude. Step 2 analysis is screened out based on Step 1 analysis.

6.5.8.3.3 OPERATION EFFECTS AND MITIGATION

Through the following pathways, the Project has the potential to affect beaver during operation:

- Habitat loss and alteration due flooding, shoreline erosion, peatland disintegration, and reservoir-related groundwater and edge effects;
- Project-related disturbances due to sensory disturbances from traffic and mortality from potential wildlife-vehicle collisions due to increased traffic on the access roads; and
- Access effects from potential increases in predation and in harvest by resource users.

Beaver habitat has been affected by past hydroelectric projects on the Nelson River, especially shoreline wetland habitats (FLCN 2010 Draft). Beaver habitats are relatively uncommon in large river systems, most likely due to bank structure and high water velocities (Hill 1982). Although beaver habitat is limited mainly to creeks, streams, ponds, and lakes off the Nelson River, beaver are still abundant in the Regional Study Area, and throughout most of northern Manitoba.

Project effects on beaver during operation include population effects in a small geographic area and habitat loss in Study Zone Zone 2. Primary beaver habitat covers about 1% of the Local Study Area and 6% is secondary beaver habitat. Primary beaver habitat is found within 100 m of riparian areas, excluding the Nelson River, which is not considered beaver habitat due to wide water-level fluctuations beyond their tolerance (Map 6-69); see Section 7.4.6.1 of the TE SV for a detailed map of habitat loss). In comparison, 1% of the Regional Study Area is primary habitat and 8% is secondary habitat. Approximately 5% of physical beaver habitat will be affected in the Regional Study Area, thus the effects of habitat loss will likely be moderate.

Project effects on beaver during operation include habitat loss and alteration due in part to fluctuating water levels, and changes in beaver distribution in the Local Study Area. Fluctuating water levels will affect beaver during open water season (FLCN Environment Evaluation Report (Draft)). Reservoir impoundment will result in a loss of beaver habitat as creeks, tributaries, and small ponds and lakes will be flooded. During the first five years of operation, beaver are predicted to re-colonize the reservoir in bays with shoreline peatlands (Section 6.2.3.2). Once these peatlands break down (see Section 6.3.7), most beaver are predicted to abandon the reservoir. Long-term habitat losses are associated with reservoir impoundment, erosion, and peatland disintegration. Fluctuations in water levels in the reservoir will make any potential habitat unsuitable, as in Stephens Lake, where the density of beaver lodges is very low. Water level drawdowns exceeding 0.7 m in winter and annual water fluctuations exceeding 1.5 m yearly are not conducive to the survival of beaver (Smith and Petersen 1991). Fluctuating water levels in the sections of creeks and streams near the reservoir can expose lodge entrances in winter (Smith and Peterson 1991) and erode lodges, and changes in vegetation can result in poor quality habitat for beaver (Payne 1989; Boyle and Owens 2007). Overall, these effects are considered small.

Project-related disturbances to beaver include sensory disturbance and mortality due to wildlife-vehicle collisions. As beaver commonly build dams in roadside ditches and block culverts (Curtis and Jensen 2004), vehicular traffic will not likely reduce effective habitat for beaver. Mortality could increase due to collisions with vehicles, particularly near riparian areas and wetland habitats, although the risk of collisions is considered negligible and small in geographic extent. While traffic could increase on the new portion of PR 280 when it is re-rerouted to include the access roads during operation, a corresponding decrease in traffic could occur on the existing PR 280 route, offsetting potential regional effects to a small extent.

Effects of improved access to the Local Study Area by resource users and predators could include increased beaver mortality. Trappers are stewards of their traplines (Fur Institution of Canada 2003), and are responsible for sustaining beaver populations on their Registered Traplines. Additionally, the provincial government is reviewing a draft Furbearer Management Policy to maintain sustainable populations of furbearers (Manitoba Conservation. Wildlife and Ecosystem Protection Branch 2009), thus future harvest is not expected to exceed sustainable levels. No appreciable change in the beaver population is anticipated, and the effect of harvest on beaver in the Regional Study Area is expected to be small. An influx of predators such as gray wolf and increased hunting efficiency due to linear corridors could also result in increased beaver mortality. As predator density and intactness are not anticipated to change, the effect will likely be neutral.

Beaver have the ability to create and modify habitat, compensate for population reductions, and are expected to adjust to certain conditions in the reservoir. The overall effect of habitat loss and of the loss of about 20 to 30 colonies in the Regional Study Area will likely be small. Collectively, Project effects are highly unlikely to jeopardize the viability of the beaver population in the Regional Study Area.

The following mitigation measure will be included for beaver:

- Beaver baffles will be used where culverts and control structures are repeatedly blocked due to beaver dam construction to minimize mortality due to conflicts with humans.

6.5.8.3.4 Residual Effects of Operation

The residual effects on beaver that are expected and likely once the appropriate mitigation measures are applied will be a decreased population due to reduced habitat, distributional changes, and increased mortality. The effects are predicted to be small, limited to the Local Study Area, and affect two or more generations.

Using the criteria established to determine the significance of Project effects for regulatory purposes (see Chapter 5) the residual effects of Project operation on beaver are expected to be adverse, small in geographic extent, long-term in duration, and small in magnitude. Step 2 analysis is screened out based on Step 1 analysis.

6.5.8.3.5 Conclusion About Residual Effects on Beaver

Overall, the likely Project residual effects on beaver are expected to be adverse but regionally acceptable because beaver are resilient to Project-related effects. Beaver will continue to create their own habitat, compensate for population reductions, and will adjust to some changing conditions in the reservoir

There is a high degree of certainty for beaver in the assessment because of high confidence in estimates of population abundance, distribution, and habitat availability estimates. The adverse residual effects of the Project on beaver will overlap spatially and temporally with effects from the following future projects: Bipole III Transmission Project, Keeyask Transmission Project, and Gillam Redevelopment. These projects will mainly increase mortality due to increased human presence and access effects. The cumulative effects are discussed in more detail in Chapter 7.

Monitoring plans are being developed to address uncertainties. These are discussed in Chapter 8.

6.5.8.4 Small Mammals

6.5.8.4.1 Construction Effects and Mitigation

Through the following pathways, the Project has the potential to affect small mammals during construction:

- Habitat loss and alteration of food and cover due to physical removal of vegetation from the principal structures, south access road, dykes, camps, borrow areas, clearing of the reservoir, other supporting infrastructure, and changes in vegetation in Zone 2;
- Project-related disturbances from sensory disturbances (*i.e.*, blasting, machinery, and people) and mortality from potential wildlife-vehicle collisions due to increased traffic on the access roads and wildlife control measures taken in work areas; and
- Access effects from potential increases in predation.

Project effects on small mammal populations could include habitat loss, Project-related disturbances, and access effects. Clearing of the reservoir area will reduce the quality of small mammal habitat by removing trees. Small mammal species such as meadow vole that do not require trees as part of their microhabitat food and cover requirements are expected to increase in number and temporarily replace individuals affected by habitat loss (*e.g.*, red-backed vole). Effective habitat will likely be reduced due to construction-related sensory disturbance and due to traffic on the access roads. The access roads could create a barrier to small mammal movements (Kozel and Fleharty 1979); however, mortality due to road kills could increase, particularly as young disperse (Clevenger *et al.* 2001). A few small mammals could occupy the work camp. If they enter camp buildings, they will be controlled. No additional change in the density of linear features and intactness is expected (see Section 6.2.3.4) during construction, and fragmentation and predator effects on small mammal populations will likely be negligible. As small mammals reproduce rapidly (Banfield 1987) and readily disperse (Gaines and McClenaghan 1980), effects on populations in the Local Study Area will not likely be measurable.

Mitigation measures for small mammals will include the following:

- Roadside ditches will be rehabilitated with native plants with low quality food values for small mammals where practicable, to minimize the attraction of predators and incidental take.

6.5.8.4.2 Residual Effects of Construction

After considering mitigation, residual effects on small mammals that are expected and likely once the appropriate mitigation measures are applied will be altered movements and decreased small mammal populations due to reduced habitat and increased mortality. Effects will be unlikely to be detectable or measurable and are predicted to be limited to the Local Study Area and affect two or more generations.

6.5.8.4.3 Operation Effects and Mitigation

Through the following pathways, the Project has the potential to affect small mammals during operation:

- Habitat loss and alteration due to flooding, shoreline erosion, peatland disintegration, and reservoir-related groundwater and edge effects;
- Project-related disturbances due to sensory disturbances from traffic and mortality from potential wildlife-vehicle collisions due to increased traffic on the access roads; and
- Access effects from potential increases in predation and in harvest by resource users.

Project effects on small mammal populations could include habitat loss and alteration, Project-related disturbances, and access effects. Long-term habitat loss or alteration is associated with flooding, shoreline erosion, peatland disintegration (Section 6.3.7), and reservoir-related groundwater and edge effects (Section 6.5.3.1). Small mammals are expected to recolonize areas that were abandoned during construction. Only small changes in species composition and density are expected for habitats rehabilitated with native vegetation. The main access road could create a barrier to some small mammals' movements, but some accidental mortality can be expected due to road kills. Small mammal populations in the Local Study Area are abundant and resilient, and habitat availability for small mammals is not limiting. Further, as no additional change in the density of linear features and intactness is expected in Zone 5 during operation, no effects on small mammal populations are anticipated.

Mitigation measures for small mammals will include the following:

- Temporarily cleared areas and excavated materials placement areas (Section 6.5.3.2) will be rehabilitated to native habitat types where practicable to improve small mammal habitat.

6.5.8.4.4 Residual Effects of Operation

After considering mitigation, residual effects on small mammals that are expected and likely will be altered movements and decreased populations due to reduced habitat and increased mortality. Effects will be unlikely to be detectable or measurable and are predicted to be limited to the Local Study Area and affect two or more generations.

6.5.8.4.5 Conclusion About Residual Effects on Small Mammals

The extent of Project effects on small mammals are expected to be the same during construction and operation. No large effects are expected as habitat availability does not appear to be a limiting factor for these populations. The adverse residual effects of the Project on small mammals will not overlap with future projects.

As outlined in Chapter 5, the cumulative effects assessment step that deals with future projects and activities focuses on VECs that are adversely affected by the Project and vulnerable to the effects of future projects and activities. As small mammals are not a VEC, they are not covered in the second step of Cumulative Effects Assessment (CEA) in Chapter 7.

There is no monitoring planned for small mammals.

6.5.8.5 Furbearers

6.5.8.5.1 Construction Effects and Mitigation

Through the following pathways, the Project has the potential to affect furbearers during construction:

- Habitat loss and alteration of cover and food (*e.g.*, small mammals) due to physical removal of vegetation from the principal structures, south access road, dykes, camps, borrow areas, clearing of the reservoir, other supporting infrastructure, and changes in vegetation in Zone 2;
- Project-related disturbances from sensory disturbances (*i.e.*, blasting, machinery, and people) and mortality from potential wildlife-vehicle collisions due to increased traffic on the access roads and wildlife control measures taken in work areas; and

- Access effects from potential increases in predation and in harvest by resource users.

Changes in habitat composition due to clearing and construction could influence habitat use by terrestrial furbearers in Zone 1. As the majority of reservoir clearing will occur in winter (Chapter 4), potential resting and denning sites and vegetative shelter could be lost or disturbed. Habitat loss or alteration in riparian areas will affect aquatic furbearers.

Project-related disturbances such as sensory disturbance and increased mortality could affect furbearers. Sensory disturbance due to construction-related activity and on the access roads could result in a loss of effective habitat. Furbearers are expected to return to abandoned areas after construction is complete. Wildlife-vehicle collisions on the access roads (*e.g.*, Mech 1980; Clevenger *et al*. 2003) are a potential source of mortality, and a few species of furbearers, such as red fox, may have to be controlled to minimize the risk to humans living in camps. With the application of Environmental Protection Plan mitigation measures, including food disposal and waste management measures, human interactions are expected to be minimized.

Potential effects of improved access to the Furbearers Local Study Area include increased mortality due to predation and trapping. Predators could improve their hunting efficiency by travelling on roads and trails (Frey and Conover 2006), benefiting predators, but increasing predation pressure on furbearing prey species (Jalkotzy *et al*. 1997). Access to the Local Study Area will be controlled with the Access Management Plan. Although trappers will be allowed to access their traplines using the main access road, trapping effort is expected to be limited due to disturbances caused by construction activities. Potential increases in trapping activity are considered under operation.

Because intactness (see Section 6.2.3.4) will not change during construction, changes in the distribution and abundance of furbearers will likely be minimal, and the effects on small mammal populations as food sources will likely be neutral, effects on furbearers are unlikely to be measurable and the overall effect is considered neutral.

Mitigation measures for furbearers will include the following:

- A Construction Access Management Plan will be implemented to reduce the effects of increased access to the Local Study Area; and
- Muskrats from affected areas will be trapped prior to and during reservoir clearing, and periodically until the reservoir reaches maximum capacity.

6.5.8.5.2 RESIDUAL EFFECTS OF CONSTRUCTION

After considering mitigation, residual effects on furbearers that are expected and likely once the appropriate mitigation measures are applied will be altered movements and decreased furbearer populations due to reduced habitat and increased mortality. Effects are predicted to be within the range of natural variability, limited to the Local Study Area, and affect two or more generations.

6.5.8.5.3 OPERATION EFFECTS AND MITIGATION

Through the following pathways, the Project has the potential to affect furbearers during operation:

- Habitat loss and alteration due flooding, shoreline erosion, peatland disintegration, and reservoir-related groundwater and edge effects;
- Project-related disturbances due to sensory disturbances from traffic and mortality from potential wildlife-vehicle collisions due to increased traffic on the access roads; and
- Access effects from potential increases in predation and in harvest by resource users.

Project effects on furbearers during operation include habitat loss and alteration in the Local Study Area. Additional aquatic furbearer habitat will be lost during impoundment, most of which will have been cleared during construction. Lakes that provide suitable habitat for these species will be inundated. Long-term habitat loss or alteration is also associated with flooding, shoreline erosion, peatland disintegration (Section 6.3.7), and reservoir-related groundwater and edge effects (Section 6.5.3.1). Water level fluctuations could affect muskrat habitat, but since muskrats generally avoid large bodies of open water (Errington 1963), limited effects are anticipated.

Project-related disturbances during operation include barriers to movement, sensory disturbance, and mortality due to wildlife-vehicle collisions. The access roads could create a barrier to movements of species such as fisher (Witmer *et al.* 1998) and, to some extent, lynx (Koehler and Brittell 1990). Lynx, however, have also been reported to cross highways and travel road edges (Mowat *et al.* 1999). The access roads will cross five streams known to be inhabited by aquatic furbearers. Effects could be balanced by the potential reduction in traffic on the existing PR 280 route. Avoidance of the access roads will decrease the risk of wildlife-vehicle collisions.

The access roads will result in improved access to the Local Study Area by resource users and predators. Poaching of some furbearers is a possibility in remote areas opened up by roads (Koehler and Brittell 1990), which is a regulatory issue. Predators could benefit from increased hunting efficiency along linear corridors (Frey and Conover 2006), to the detriment of some prey species.

No additional change in the density of linear features and intactness is expected in the Zone 5 during operation, therefore no effects of habitat fragmentation on furbearers are anticipated.

Mitigation measures for furbearers will include the following:

- Except for existing resource-use trails (see Construction Access Management Plan), Project-related cutlines and trails will be blocked where they intersect the Project Footprint, and the portions of these features within 100 m of the Project Footprint will be revegetated to minimize the risk of effects related to access-related effects;

- A minimum of 100m vegetated buffers will be retained wherever practicable around lakes, wetlands and creeks to minimize the loss of furbearer; and
- Mitigation for wetland function will benefit muskrat through the development of wetlands in the Local Study Area (Section 6.5.3.4) and could off-set some of the losses in habitat for muskrat.

6.5.8.5.4 Residual Effects of Operation

After considering mitigation, residual effects on furbearers that are expected and likely once the appropriate mitigation measures are applied will be altered movements and decreased furbearer populations due to reduced habitat and increased mortality. Effects are predicted to be within the range of natural variability, most likely limited to the Local Study Area, and affect two or more generations.

6.5.8.5.5 Conclusion About Residual Effects on Furbearers

The extent of Project effects on furbearers are expected to be the same during construction and operation. No large effects are expected as habitat availability does not appear to be a limiting factor for these populations.

The adverse residual effects of the Project on furbearers will overlap spatially and temporally with effects from the following future projects: Bipole III Transmission Project and Keeyask Transmission Project. These projects will increase furbearer habitat loss, reduce intactness, and contribute to access effects. As outlined in Chapter 5, the cumulative effects assessment step that deals with future projects and activities focuses on VECs that are adversely affected by the Project and vulnerable to the effects of future projects and activities. As furbearers are not a VEC, they are not covered in the second step of Cumulative Effects Assessment (CEA) in Chapter 7.

Monitoring plans are being developed to address uncertainties. These are discussed in Chapter 8.

6.5.8.6 Large Carnivores

6.5.8.6.1 Construction Effects and Mitigation

Through the following pathways, the Project has the potential to affect large carnivores during construction:

- Habitat loss and alteration of cover and food (ungulates) due to physical removal of vegetation from the principal structures, south access road, dykes, camps, borrow areas, clearing of the reservoir, other supporting infrastructure, and changes in vegetation in Zone 2;

- Project-related disturbances from sensory disturbances (*i.e.*, blasting, machinery, and people) shifting both predators and prey into other areas and mortality from potential wildlife-vehicle collisions due to increased traffic on the access roads and wildlife control measures taken in work areas; and
- Access effects from harvest by resource users.

Project effects on black bear and gray wolf include habitat loss and alteration due to clearing in Zone 1. Large carnivores generally require large areas of contiguous habitat (Noss *et al.* 1996), rather than relying on specific habitat (Schoen 1990). Habitat loss and alteration affecting prey and other food sources are expected to have a small, indirect effect on large carnivores.

Project-related disturbances that could affect large carnivores include sensory disturbances and increased mortality. Individual reactions to sensory disturbance due to construction activity, such as blasting and heavy machinery near dens, range from tolerance to den abandonment (Linnell *et al*. 2000). Large carnivores may avoid roads (Thiel 1985; Mech *et al.* 1988), apparently to minimize contact with humans (Mech *et al*. 1988); however, gray wolves use roads to facilitate travel (Mladenof *et al*. 1999). Large carnivore populations could experience mortality through wildlife-vehicle collisions (Mech 1977; Brody and Pelton 1989; Forman and Alexander 1998) on the access roads. Human interactions with large carnivores, particularly near food sources, could increase. As these animals can pose a danger to workers in the area, they may have to be removed from areas with human activity, or destroyed. With the application of Environmental Protection Plan mitigation measures, including proper food disposal and waste management, human interactions are expected to be minimized.

Because intactness (see Section 6.2.3.4) is not expected to change during construction, changes in the distribution and abundance of large carnivores are expected to be small, and the effects on moose as a food source (see Section 6.5.8.2) will likely be small, the overall effect on large carnivores is predicted to be small.

Project effects also include those related to improved access to the Large Carnivores Local Study Area. Vulnerability to hunting could increase due to improved access of resource users to formerly remote areas. However, linear corridors could improve large carnivore hunting efficiency, potentially benefiting these species.

Mitigation measures for large carnivores are similar to those for furbearers, with the following additions:

- Where possible, 100 m buffers will be established around active gray wolf and black bear dens within Zone 1 to minimize the disturbance of animals during sensitive periods;
- Firearms will be prohibited in camps and at work sites, and a “no shooting” buffer zone of 300 m will be designated on either side of the access roads and around the Project work site to reduce mortality due to hunting during construction; and

- Roadside ditches will be rehabilitated with native plants with low quality food values for black bear where practicable, to minimize attraction, and the risk of wildlife-vehicle collisions and incidental take.

6.5.8.6.2 Residual Effects of Construction

After considering mitigation, the residual effects on large carnivores that are expected and likely once the appropriate mitigation measures are applied will be decreased populations due to reduced habitat and increased mortality. Effects are predicted to be within the range of natural variability, limited to the Local Study Area, and affect one or two generations.

6.5.8.6.3 Operation Effects and Mitigation

Through the following pathways, the Project has the potential to affect large carnivores during construction:

- Habitat loss and alteration of cover and food due to flooding, shoreline erosion, peatland disintegration, and reservoir-related groundwater and edge effects;
- Project-related disturbances due to sensory disturbances from traffic and mortality from potential wildlife-vehicle collisions due to increased traffic on the access roads; and
- Access effects from potential increases in harvest by resource users.

Project effects on large carnivores during operation include habitat loss and alteration associated with flooding, shoreline erosion, peatland disintegration (Section 6.3.7), and reservoir-related groundwater and edge effects (Section 6.5.3.1). It is likely that some wildlife will recolonize areas that were abandoned during construction. Recolonization of disturbed sites by prey species may benefit large carnivores.

Project-related disturbances include barriers to movement, sensory disturbance, and mortality due to wildlife-vehicle collisions. As the access roads will replace a portion of the existing PR 280 in the future, traffic will likely increase along the access roads, potentially creating a barrier to large carnivore movements. Sensory disturbance due to traffic could reduce effective habitat for large carnivores. Individuals that do not avoid the road would be susceptible to wildlife-vehicle collisions.

Effects of improved access to the Local Study Area could include increased mortality due to hunting and trapping. Black bear and gray wolf harvest is regulated as big game in Manitoba; however, the opportunity for harvesting large carnivores will increase with increased access to the area (Person and Russell 2008), whether legally or illegally. Trappers are stewards of their traplines (Fur Institution of Canada 2003), and are responsible for sustaining furbearer populations on their Registered Traplines. Additionally, the provincial government is reviewing a draft Furbearer Management Policy to maintain sustainable populations of furbearers (Manitoba Conservation, Wildlife and Ecosystem Protection Branch 2009), thus future harvest is not expected to exceed sustainable levels. No appreciable change in large carnivore populations is anticipated.

Access for large carnivores can improve hunting efficiency of prey (Jalkotzy *et al.* 1997). Large carnivores could continue to use linear corridors for ease of travel and more efficient hunting in the Local Study Area, particularly when human activity is low. Because access trails will be rehabilitated for the protection of caribou, and no additional change in the density of linear features and intactness is expected in Zone 5 during operation, effects on large carnivores will likely be neutral.

Mitigation measures for large carnivores will include the following:

- A Construction Access Management Plan will be implemented to reduce the effects of increased access to the Local Study Area.

6.5.8.6.4 RESIDUAL EFFECTS OF OPERATION

After considering mitigation, the residual effect on large carnivores that are expected and likely once the appropriate mitigation measures are applied will be decreased populations due to reduced habitat and increased mortality. Effects are predicted to be within the range of natural variability, extend to the Regional Study Area, and affect two or more generations.

6.5.8.6.5 CONCLUSION ABOUT RESIDUAL EFFECTS ON LARGE CARNIVORES

The extent of Project effects on large carnivores are expected to be the same during construction and operation. No large effects are expected as habitat availability does not appear to be a limiting factor for these populations.

The adverse residual effects of the Project on large carnivores will overlap spatially and temporally with effects from the following future projects: Bipole III Transmission Project, Keeyask Transmission Project, and Conawapa Generation Project. These projects will mainly increase mortality due to increased human presence and access effects. As outlined in Chapter 5, the cumulative effects assessment step that deals with future projects and activities focuses on VECs that are adversely affected by the Project and vulnerable to the effects of future projects and activities. As large carnivores are not a VEC, they are not covered in the second step of Cumulative Effects Assessment (CEA) in Chapter 7.

Monitoring plans are being developed to address uncertainties. These are discussed in Chapter 8.

6.5.8.7 UNGULATES

No ungulate species other than caribou and moose are found in the Keeyask region and effects were not assessed for other ungulates (see Sections 6.5.8.1 and 6.5.8.2).

6.5.8.8 Rare or Regionally Rare Species

Other than boreal woodland caribou, which may or may not occur in the Keeyask region and is discussed in Section 6.5.8.1, there are no threatened, endangered, or provincially rare mammal species in the Keeyask region. With the exception of wolverine, which is listed as a species of special concern by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), and little brown myotis, which is being considered for emergency status as an endangered species, the remaining species (American water shrew, porcupine, raccoon, striped skunk, and coyote), are regionally rare in the Keeyask region but are common elsewhere in Manitoba.

6.5.8.8.1 Construction Effects and Mitigation

Through the following pathways, the Project has the potential to affect rare or regionally rare species during construction:

- Habitat loss and alteration of cover and food due to physical removal of vegetation from the principal structures, south access road, dykes, camps, borrow areas, clearing of the reservoir, other supporting infrastructure, and changes in vegetation in Zone 2;
- Project-related disturbances from sensory disturbances (*i.e.*, blasting, machinery, and people) and mortality from potential wildlife-vehicle collisions due to increased traffic on the access roads; and
- Access effects from potential increases in predation and from wildlife control measures taken in work areas.

Potential Project effects on wolverine and regionally rare species include habitat loss, gain, or alteration during clearing in Zone 1. Changes in habitat composition and connectivity could influence habitat use and movements of wolverine, which are considered one of the most sensitive species of ecological integrity (COSEWIC 2003). Porcupine denning sites could be lost upon clearing of the reservoir, but maternity colonies for little brown bats, which are commonly found in mines, caves (Frick *et al.* 2010), and human structures (Barclay and Cash 1985), will not be affected because it is highly unlikely that there is maternity habitat in the Rare Mammals Local Study Area. Species such as striped skunk and raccoon may benefit from the habitat diversity created by fragmentation (Oehler and Litvaitis 1996; Larivière and Messier 2000).

Project-related disturbances to rare or regionally rare species during construction include sensory disturbance and increased mortality. Sensory disturbances due to construction activity and traffic on the access road could affect rare or regionally rare species during this phase. Effective habitat will likely be reduced in these areas, but individuals are expected to return to abandoned areas upon completion of construction. Mortality could increase due to collisions with vehicles on the access roads. As wolverine denning begins in February (Hash 1998), females and their young could be disturbed during clearing. Human interactions with striped skunk, raccoon, and coyote, particularly near food sources, could increase. As these animals can pose a danger to workers in the area, they may have to be removed from areas with human activity, or destroyed. With the application of Environmental Protection Plan mitigation measures, including proper food disposal and waste management, human interactions are expected to be minimized.

Effects of improved access to the Local Study Area could include increased mortality of some rare or regionally rare species due to trapping, and improved hunting efficiency of others. As areas are opened up to easier access, trapping activity could increase (Buskirk and Ruggiero 1994; COSEWIC 2003; Krebs *et al.* 2007). Access to the Local Study Area will be controlled with the Access Management Plan. Although trappers will be allowed to access their traplines using the main access road, trapping effort is expected to be limited due to disturbances caused by construction activities. Potential increases in trapping activity are considered under operation. Coyote could benefit from the creation of linear features, which could improve hunting efficiency and access to the Local Study Area.

Because intactness (see Section 6.2.3.4) will not change during construction, changes in the distribution and abundance of rare or regionally rare species will most likely be negligible to small. Effects on small mammal populations as food sources (see Section 6.5.8.4) will likely be neutral, and effects on rare or regionally rare species are unlikely to be measurable, thus the overall effect of habitat fragmentation will likely be neutral.

6.5.8.8.2 Residual Effects of Construction

The effects on rare or regionally rare species that are expected and likely once the appropriate mitigation measures are applied will be altered movements and decreased populations due to reduced habitat and increased mortality. Effects will be unlikely to be detectable or measurable, and are predicted to be limited to the Local Study Area and affect two or more generations.

6.5.8.8.3 Operation Effects and Mitigation

Through the following pathways, the Project has the potential to affect rare or regionally rare species during operation:

- Habitat loss and alteration due to flooding, shoreline erosion, peatland disintegration, and reservoir-related groundwater and edge effects;
- Project-related disturbances due to sensory disturbances from traffic and mortality from potential wildlife-vehicle collisions due to increased traffic on the access roads; and
- Access effects from potential increases in predation and in harvest by resource users.

Project effects on rare or regionally rare species during operation include habitat loss or alteration associated with flooding, shoreline erosion, peatland disintegration (Section 6.3.7), and reservoir-related groundwater and edge effects (Section 6.5.3.1). Little brown bats, which make extensive use of human-made structures for roosting (Barclay and Cash 1985), could benefit to a small degree from the structural components of the Project.

Potential Project-related disturbances to rare or regionally rare species include barriers to movement, sensory disturbance, and increased mortality. The access roads could create a barrier to wolverine movements, as wolverine tend to avoid roads (Bowman *et al*. 2010), but the effect will likely be negligible because the access roads will cross a very small portion of the large range that these animals occupy. Sensory disturbance due to traffic on the access roads could reduce effective habitat for rare or regionally rare species. Individuals of any species that do not avoid the road will be susceptible to wildlife-vehicle collisions, potentially increasing mortality. Human encounters with some species could result in increased mortality. Due to the rarity of these species in the Local Study Area, and the reduced human presence in during operation, these occurrences will be highly improbable, and the effect will likely be negligible.

Effects of improved access to the Local Study Area by resource users and predators could include increased mortality of some species, and improved hunting efficiency of others. As roads and other linear features will improve access to the area by resource users, trapping effort and harvest of species such as wolverine could increase (COSEWIC 2003). As trappers are stewards of their traplines, furbearer harvest will not likely exceed sustainable levels. Linear features such as cutlines and trails could increase the susceptibility of some regionally rare species to predation, while benefiting others such as coyote. Due to the rarity of these species in the Keeyask region, effects on rare or regionally rare species will likely be negligible.

No additional change in the density of linear features and intactness is expected in Zone 5 during operation, therefore effects of habitat fragmentation on rare or regionally rare species will likely be neutral.

Mitigation measures for rare or regionally rare species will include the following:

- Except for existing resource-use trails (see Cosntruction Access Management Plan), Project-related cutlines and trails will be blocked where they intersect the Project Footprint, and the portions of these features within 100 m of the Project Footprint will be revegetated to minimize the risk of effects related to habitat disturbance, accidental fires and access-related effects; and
- Temporarily cleared areas and excavated materials placement areas (Section 6.5.3.2) will be rehabilitated to native habitat types where feasible.

6.5.8.8.4 Residual Effects of Operation

The residual effects on rare or regionally rare species that are expected and likely once the appropriate mitigation measures are applied will be altered movements and decreased populations due to reduced habitat and increased mortality. Effects will be unlikely to be detectable or measurable, and are predicted to be limited to the Local Study Area and affect two or more generations.

6.5.8.8.5 Conclusion About Residual Effects on Rare or Regionally Rare Species

The extent of Project effects on rare or regionally rare species are expected to be the same during construction and operation. No large effects are expected as few individuals could be affected, and habitat availability does not appear to be a limiting factor for these populations outside the Regional Study Area.

The adverse residual effects of the Project on rare or regionally rare species will overlap spatially and temporally with effects from the following future projects: Bipole III Transmission Project, Keeyask Transmission Project, and Conawapa Generation Project. These projects will likely contribute to access effects. As outlined in Chapter 5, the cumulative effects assessment step that deals with future projects and activities focuses on VECs that are adversely affected by the Project and vulnerable to the effects of future projects and activities. As rare or regionally rare species are not a VEC, they are not covered in the second step of Cumulative Effects Assessment (CEA) in Chapter 7.

Monitoring plans are being developed for little brown myotis. These are discussed in Chapter 8.

6.5.9 Mercury in Wildlife

The following section outlines the predicted Project effects on mercury levels in birds and aquatic furbearers in the Keeyask region.

6.5.9.1 Mercury

6.5.9.1.1 Construction Effects and Mitigation

During construction, it is unlikely that the amounts of methylmercury entering on-system locations will measurably affect the rates of mercury bioaccumulation in fishes (Section 6.4.7.1). As a result, a measurable accumulation of methylmercury in wildlife is not anticipated during construction.

6.5.9.1.2 Residual Effects of Construction on Mercury in Wildlife

Using the criteria established to determine the significance of Project effects for regulatory purposes (see Chapter 5), there are no likely residual effects of Project construction on mercury in wildlife during construction.

6.5.9.1.3 Operation Effects and Mitigation

Flooding will increase mercury levels in the reservoir. Potential effects on wildlife are linked to increases in fish mercury concentrations (see Section 6.4.7.1) in the Keeyask reservoir and Stephens Lake.

Based on scientific literature, a surrogate model, and scientific judgement, predicted post-Project mercury levels in wildlife will increase over baseline conditions (Table 6-23) and peak about three to seven years after the reservoir is impounded (following the peak maximum mean concentrations in fish). Mercury levels are expected to decline after about seven years and reach pre-Project levels approximately 20 to 30 years post-Project, following the rate of mercury decline in fish (see Section 6.4.7.1).

Methylmercury concentrations in herbivores (*e.g.*, beaver, Canada goose) are not expected to change as a result of the Project due to the minute quantities of mercury taken up by plants. Small increases in total mercury concentrations will likely occur in some wildlife (*e.g.*, muskrat, mallard) that forage on lower trophic level foods (*e.g.*, aquatic invertebrates, molluscs) found within the reservoir and Stephens Lake. These increases are not expected to have any measureable effects on local populations. Larger increases in total mercury concentrations are expected for some fish-eating wildlife (*e.g.*, mink, river otter, bald eagle, and osprey) that forage within the Keeyask reservoir and/or Stephens Lake.

Table 6-27: Model Estimates of Mercury Concentrations (µg/g)[1] of Mammals and Birds Foraging in the Keeyask Reservoir and/or Stephens Lake

Species	Day 1[2]	Peak Year 3 to 7	Long-term Years 20-30
Beaver[3]	0.01[2] (<0.01–0.05)	0.01 (<0.01–0.05)	0.01 (<0.01–0.05)
Muskrat	0.02 (<0.01–0.06)	0.04 (<0.01–0.15)	0.02 (<0.01–0.06)
Mink	1.52 (0.56–3.16)	4.00 (0.56–30.60)	1.52 (0.56–3.16)
River otter	0.55 (0.28–3.97)	6.00 (0.28–17.63)[5]	0.55 (0.28–3.97)
Canada Goose[4]	0.03	0.03	0.03
Mallard	0.07–0.09	<0.19	0.07–0.09

1. µg/g = parts per million (ppm).
2. Represents the existing environment and uses the first time the initial fill level is in effect.
3. Median and most or most-likely range of total mercury concentrations in mammal liver tissue by wet weight.
4. Average total mercury concentrations in bird muscle tissue.
5. Maximum total mercury concentration based on a limited sample size.

Mercury levels in prey foods (*e.g.*, perch, sucker and other small-bodied fish) of most fish-eating birds are predicted to be at or below the threshold demonstrated to impair reproductive success (>0.35 µg/g; Barr 1986). While bald eagle and osprey may consume larger-bodied fish containing higher mercury levels (*i.e.*, up to 1.0 µg/g in northern pike and walleye), measureable effects on local bald eagle and osprey populations are not expected. Published studies examining the effects of mercury on bald eagle and osprey indicate that these species are fairly tolerant of high levels of methylmercury contamination (DesGranges *et al.* 1999; Bechard *et al.* 2009).

The potential impacts of the Project on mercury levels in wildlife were screened using a hazard quotients (HQ) risk characterization approach, which uses exposure and toxicity assessments to link methylmercury with potential adverse ecological effects on wildlife (Nalcor 2009). A hazard quotient is the ratio of "the average concentration of mercury being ingested" to a "known concentration where adverse effects may occur." A value less than one indicates that there is a low probability of adverse effects. Hazard quotients were calculated for river otter, mink, and osprey using modelled daily intake of fish from the Keeyask reservoir or Stephens Lake.

This risk characterization approach only assessed one pathway, the ingestion of fish, for methylmercury to accumulate in river otter. River otter are known to have a varied diet, of which fish is the primary food source, followed by shellfish, small mammals, and birds. It is therefore likely that multiple pathways for methylmercury accumulation exist for river otter. Consequently, it is possible that these other pathways could have a HQ greater than 0.10, making the overall HQ for methylmercury in river otter in the Keeyask region greater than one. Consequently, river otter would likely experience adverse effects from methylmercury on reproduction, growth, and/or survival. Even if additional pathways are considered, it is unlikely that river otter in the Stephens Lake area would have an HQ greater than 0.50, thus it is unlikely that river otter will experience adverse effects (Table 6-24).

Table 6-28: Hazard Quotient Scores for River Otter, Mink, and Bald Eagle on Fish in the Keeyask Reservoir and Stephens Lake

Species	Keeyask Reservoir	Stephens Lake
River otter	0.93	0.50
Mink	0.63	0.34
Bald eagle	0.23	0.12

River otter are common in the Furbearers Regional Study Area and throughout Manitoba. Otter populations are generally resilient (*i.e.*, with high reproductive capacity), and dispersal behaviours of individuals allow for re-occupation of vacant habitat. Reduced reproduction or survival in the Keeyask reservoir will likely result in a negligible to small decline in the number of otter found in the Furbearers Local Study Area. Adaptive management will be considered to mitigate potential effects of reduced abundance if a large, unexpected decline in the local otter population is detected.

Bald eagles are common and widespread along the Nelson River due to the abundance of suitable breeding and foraging habitat. Within the Local Study Area, bald eagle density generally increases in April and May with the arrival of breeders, and continues to increase throughout the summer with the arrival of non-breeders or unsuccessful breeders. The estimated HQ of 0.23 (based on ingestion of fish from the proposed Keeyask reservoir) assumes that the only methylmercury bioaccumulation in local bald eagle populations is from the Bird Regional Study Area. Results from an ecological risk characterization for bald eagles indicates that bald eagles are not expected to accumulate enough mercury though the ingestion of fish to experience any measurable adverse effects on local populations. That conclusion recognized that a higher HQ may result if eagles inhabiting the Local Study Area ingest mercury-laden fish on their wintering grounds. The prediction that bald eagle populations will not be adversely affected by increased mercury concentrations in the reservoir is supported by studies that find no population-level effects despite high methlymercury levels in eagle feathers (Bechard *et al.* 2009). The ability to remove mercury through feather loss and egg-laying are believed to buffer eagles and other birds from toxic effects of mercury (Braune 1987; Lewis and Furness 1991; DesGranges *et al.* 1998; TE SV Section 8).

Measures to mitigate the effects of increased wildlife mercury concentrations on the consumption habits of local resource users are described in Section 6.7.3.2.

6.5.9.1.4 Residual Effects of Operation

The residual effect of operation on mercury in wildlife that is expected and likely is a small to large, medium-term increase in mercury concentrations in wildlife that consume fish from the Keeyask reservoir. Maximum concentrations will decline in the long-term, but levels may remain higher than pre-Project concentrations for up to 30 years, affecting two or more wildlife generations. Reduced reproduction and survivorship in the Keeyask reservoir may result in a small decline in the abundance of river otter found in the Furbearers Local Study Area. Measureable changes in local bird populations, including those species that rely almost exclusively on fish, are not expected to occur as a result of the Project.

Using the criteria established to determine the significance of Project effects for regulatory purposes (see Chapter 5) likely residual effects of Project operation on mercury in wildlife are expected to be adverse, local, long-term, and small magnitude.

6.5.9.1.5 Conclusion About Residual Effects on Mercury in Wildlife

During operation, adverse ecological effects resulting from increased mercury in wildlife are anticipated for river otter in the Keeyask reservoir. A small decline in the abundance of river otter found in the Furbearers Local Study Area is expected. While some fish-eating birds foraging in the Keeyask reservoir and/or Stephens Lake may bioaccumulate high levels of methylmercury, measureable adverse effects on local bird populations are not expected. Although peak mercury levels will decline after a few years, effects will persist for 20 to 30 years.

The adverse residual effects of the Project will not overlap or interact spatially and temporally with effects from future Projects.

Monitoring plans are developed to address uncertainty regarding the small decline in abundance predicted for river otter. Mercury levels in country foods will also be monitored until mercury levels return to baseline conditions to address concerns related to the consumption habits of affected species by local resource users (see Section 6.2.3.5 Mercury and Human Health).

6.5.10 SUMMARY OF RESIDUAL EFFECTS AND SIGNIFICANCE

Sources of potential effects to VECs, measures to mitigate these effects, and residual effects to VECs following mitigation are summarized in Table 6-29 through Table 6-41.

While it is agreed that the Project will affect terrestrial ecosystems and habitat, plants, birds and mammals, past experience with hydroelectric development by KCN Members indicates that the effects will be of greater magnitude than predicted by technical science. KCNs Members are also sceptical that mitigation measures can lessen these effects to the extent proposed. As such, programs will be initiated to monitor Project effects on terrestrial habitat and follow-up action will be taken if required, as described in Chapter 8.

Notes regarding the following residual effects tables:

1. Additional mitigation not described in the tables includes standard environmental protection plan measures and avoidance incorporated through modifications to the Project design.
2. Refer to Section 5.1 for full description of assessment characteristics. Under Step 1, all VECs were examined using the criteria of direction, magnitude, geographic extent and duration. As explained, where further analysis was warranted, a Step 2 analysis considered additional criteria of frequency, reversibility or ecological context.

Table 6-29: Summary of Residual Effects Regarding Terrestrial Ecosystems and Habitat: ECOSYSTEM DIVERSITY

VEC Effect and Mitigation by Phase **(1 see introductory text)**	**Residual Effects**	**Assessment Characteristics** **(2 see introductory text)**
Construction Phase		
Potential effects primarily due to: • Clearing, cofferdam flooding, edge effects and access-related effects. **Mitigation includes:** • The portion of borrow area N-6 identified as the N6 sensitive site will be avoided, and protection measures will be implemented to ensure that soil alteration or accidental disturbance within this site does not occur; • Clearing and disturbance within the Project Footprint will be minimized to the extent practicable; • Disturbance of areas adjacent to the Project Footprint will be avoided to the extent practicable; • A rehabilitation plan will be developed that gives preference to rehabilitating the most affected priority habitat types using approaches that "go with nature" (Keeyask JKDA Schedule 7-1); and • Except for existing resource-use trails (see Construction Access Management Plan), Project-related cutlines and trails will be blocked where they intersect the Project Footprint, and the portions of these features within 100 m of the Project Footprint will be revegetated to minimize the risk of habitat disturbance, invasive plant spreading, accidental fires and access-related effects.	No effects on the total number of stand level ecosystem types. Proportions of the native habitat types will not change substantially. No effects on three priority habitat types. For the remaining priority habitat types, the Project is predicted to affect between 0.1% and 3.8% of area in the Terrestrial Habitat Regional Study Area, which would increase residual effects to between 5.0% and 8.7% of estimated historical area. The ecological context is that none of the priority habitat types with moderate magnitude effects are experiencing substantial ongoing adverse changes in the existing environment.	**Step 1:** Direction: Adverse Magnitude: Either nil, small or moderate, depending on the ecosystem diversity indicator. Geographic Extent: Medium Duration: Long term **Step 2:** Frequency: Continuous Reversibility: Irreversible Ecological Context: Low

Table 6-29: Summary of Residual Effects Regarding Terrestrial Ecosystems and Habitat: ECOSYSTEM DIVERSITY

VEC Effect and Mitigation by Phase (1 see introductory text)	Residual Effects	Assessment Characteristics (2 see introductory text)
Operation Phase		
Potential effects primarily due to: • Initial flooding, reservoir expansion, edge effects, groundwater changes and access-related effects. **Mitigation includes:** • The portion of borrow area N-6 identified as the N6 sensitive site in Priority Habitat Sites that will be Avoided During Construction and Operation will be avoided to reduce effects on the white birch priority habitat types, and protection measures will be implemented to ensure that soil alteration or accidental disturbance within this site does not occur; • The rehabilitation plan developed and initiated during construction will extend into the operation phase, and continue until all necessary rehabilitation is completed; and, • Except for existing resource-use trails (see Construction Access Management Plan), Project-related cutlines and trails will be blocked where they intersect the Project Footprint, and the portions of these features within 100 m of the Project Footprint will be revegetated to minimize the risk of habitat disturbance, invasive plant spreading, accidental fires and access-related effects.	No effects on the total number of stand level ecosystem types. Proportions of the native habitat types will not change substantially. No effects on three priority habitat types. For the remaining priority habitat types, the Project could affect between 0.1% and 4.9% of area in the Terrestrial Habitat Regional Study Area, which would increase predicted residual effects to between 5.0% and 9.9% of estimated historical area. The ecological context is that none of the priority habitat types with moderate magnitude effects are experiencing substantial ongoing adverse changes in the existing environment.	**Step 1:** Direction: Adverse Magnitude: Either nil, small or moderate, depending on the ecosystem diversity indicator. Geographic Extent: Medium Duration: Long term **Step 2:** Frequency: Continuous Reversibility: Irreversible Ecological Context: Low

Table 6-30: Summary of Residual Effects Regarding Terrestrial Ecosystems and Habitat: INTACTNESS

VEC Effect and Mitigation by Phase (1 see introductory text)	Residual Effects	Assessment Characteristics (2 see introductory text)
Construction Phase		
Potential effects primarily due to: • Roads, cutlines and dykes increasing the total length of linear features; • Clearing, cofferdam flooding and edge effects reducing the number and/or sizes of core areas (*i.e.*, large undisturbed areas); and • Access-related effects such as accidental fires and increased disturbance. **Mitigation includes:** • Clearing and disturbance within the Project Footprint will be minimized to the extent practicable; • Disturbance of areas adjacent to the Project Footprint will be avoided to the extent practicable; • A rehabilitation plan will be developed that gives preference to rehabilitating the most affected priority habitat types using approaches that “go with nature” (Keeyask JKDA Schedule 7-1); and • Except for existing resource-use trails (see Construction Access Management Plan), Project-related cutlines and trails will be blocked where they intersect the Project Footprint, and the portions of these features within 100 m of the Project Footprint will be revegetated to minimize the risk of habitat disturbance, invasive plant spreading, accidental fires and access-related effects.	Small reduction in linear feature density (a positive effect). Small reduction in the total amount of core area (an adverse effect), which reduces the percentage of land area that is in core areas larger than 1,000 ha in the Intactness Regional Study Area from 83% to 82%.	**Step 1:** Direction: Adverse Magnitude: Small Geographic Extent: Medium Duration: Long term **Step 2:** Not Required

Table 6-30: Summary of Residual Effects Regarding Terrestrial Ecosystems and Habitat: INTACTNESS

VEC Effect and Mitigation by Phase (1 see introductory text)	**Residual Effects**	**Assessment Characteristics** (2 see introductory text)
Operation Phase		
Potential effects primarily due to: • An increase in the total length of linear features; • Initial flooding, reservoir expansion and edge effects that reduce amount of core area (*i.e.*, large undisturbed areas); and • Access-related effects such as accidental fires and increased disturbance **Mitigation includes:** • The rehabilitation plan developed and initiated during construction will extend into the operation phase, and continue until all necessary rehabilitation is completed; and • Except for existing resource-use trails (see Construction Access Management Plan), Project-related cutlines and trails will be blocked where they intersect the Project Footprint, and the portions of these features within 100 m of the Project Footprint will be revegetated to minimize the risk of habitat disturbance, invasive plant spreading, accidental fires and access-related effects.	Negligible additional reduction in linear feature density (a positive effect). Negligible further reduction in the total amount of core area and core area percentage. Small reduction in regional intactness because changes to linear feature density and core area percentage are small, which occurs because the Project is located in an area where intactness is already low due to past and current human developments.	**Step 1:** Direction: Adverse Magnitude: Small Geographic Extent: Medium Duration: Long term **Step 2:** Not Required

Table 6-31: Summary of Residual Effects Regarding Terrestrial Ecosystems and Habitat: WETLAND FUNCTION

VEC Effect and Mitigation by Phase (1 see introductory text)	Residual Effects	Assessment Characteristics (2 see introductory text)
Construction Phase		
Potential effects primarily due to: • Clearing, cofferdam flooding and edge effects. **Mitigation includes:** • Measures to protect against erosion, siltation and hydrological alteration will be implemented in utilized construction areas that are within 50 m of any off-system marsh that is outside of the Project Footprint; and • 12 ha of the off-system marsh wetland type will be developed within or near the Local Study Area.	Temporary loss of most Nelson River shoreline wetlands in the Local Study Area. No net area loss for off-system marsh. No effects on five other native wetland types. For the remaining native off-system wetland types, the Project is predicted to affect between 0.2% and 2.4% of their area in the Wetland Function Regional Study Area, which would increase predicted residual effects to between 3.0% and 6.2% of estimated historical area. The ecological context is that none of the wetland types with moderate magnitude effects are experiencing substantial ongoing adverse changes in the existing environment.	**Step 1:** Direction: Adverse Magnitude: Either Nil or Moderate, depending on the wetland type Geographic Extent: Medium Duration: Long-term **Step 2:** Frequency: Continuous Reversibility: Irreversible Ecological Context: Low

Table 6-31: Summary of Residual Effects Regarding Terrestrial Ecosystems and Habitat: WETLAND FUNCTION

VEC Effect and Mitigation by Phase (1 see introductory text)	Residual Effects	Assessment Characteristics (2 see introductory text)
Operation Phase		
Potential effects primarily due to: • Initial flooding, reservoir expansion, edge effects and groundwater changes. **Mitigation includes:** • Implement additional wetland development to the extent practicable if monitoring determines that further measures are needed to achieve successful development of 12 ha of the off-system marsh wetland type.	Temporary loss of most Nelson River shoreline wetlands in the Local Study Area. No net area loss for off-system marsh. No effects on five other native wetland types. For the remaining native off-system wetland types, the Project is predicted to affect between 0.2% and 1.6% of their area in the Wetland Function Regional Study Area, which would increase predicted residual effects to between 1.7% and 6.5% of estimated historical area, which are moderate magnitude effects. The ecological context is that none of the wetland types with moderate magnitude effects are experiencing substantial ongoing adverse changes in the existing environment.	**Step 1:** Direction: Adverse Magnitude: Either Nil or Moderate, depending on the wetland type Geographic Extent: Medium Duration: Long-term **Step 2:** Frequency: Continuous Reversibility: Irreversible Ecological Context: Low

Table 6-32: Summary of Residual Effects Regarding Terrestrial Plant Valued Environmental Components: PRIORITY PLANTS

VEC Effect and Mitigation by Phase (1 see introductory text)	**Residual Effects**	**Assessment Characteristics** (2 see introductory text)
Construction Phase		
Potential effects primarily due to: • Loss, alteration and disturbance of plants and their habitats due to clearing, cofferdam flooding, edge effects and access-related effects. **Mitigation includes:** • Pre-construction rare plant surveys will be conducted in the Project Footprint and nearby areas that were not previously surveyed and have high potential for supporting provincially very rare to rare species; • If a provincially very rare to rare species is discovered in the terrestrial plants zone of influence and there are not at least 20 known healthy patches outside of the terrestrial plants zone of influence, then the discovered locations will be avoided where practicable. Where avoidance is not practicable, the plants will be transplanted outside of the terrestrial plants zone of influence; • Clearing and disturbance within the Project Footprint will be minimized to the extent practicable; • Disturbance of areas adjacent to the Project Footprint will be avoided to the extent practicable; and • Except for existing resource-use trails (see Construction Access Management Plan), Project-related cutlines and trails will be blocked where they intersect the Project Footprint, and the portions of these features within 100 m of the Project Footprint will be revegetated to minimize the risk of invasive plant, accidental fire and other access-related effects.	No predicted effects on endangered, threatened or provincially very rare plant species since none are either known or expected to occur in the Local Study Area. Effects on KCNs species are expected to be low because most of these species are widespread in appropriate habitats and the percentages of known locations and available habitat affected by the Project are low. For the remaining species, the Project is predicted to affect nil to moderate percentages of their known locations and/or available habitat. The ecological context is that none of the priority plants species with moderate magnitude effects are experiencing substantial ongoing adverse changes in the existing environment, to the extent this is known given their highly sparse distribution. Additional pre-construction mitigation has been included for the species of highest conservation concern to address the unlikely event that patches of these species exist but have not been discovered to date due to the rarity of the species.	**Step 1:** Direction: Adverse Magnitude: Nil to moderate, depending on the priority plant species. Geographic Extent: Medium Duration: Long term **Step 2:** Frequency: Continuous Reversibility: Irreversible Ecological Context: Low

Table 6-32: Summary of Residual Effects Regarding Terrestrial Plant Valued Environmental Components: PRIORITY PLANTS

VEC Effect and Mitigation by Phase (1 see introductory text)	**Residual Effects**	**Assessment Characteristics** (2 see introductory text)
Operation Phase		
Potential effects primarily due to: • Loss, alteration and disturbance of plants and their habitats due to initial flooding, reservoir expansion, edge effects, groundwater changes and and access-related effects. **No additional mitigation required**	No predicted effects on endangered, threatened or provincially very rare plant species. Effects KCNs species are expected to be low because most of these species are widespread in appropriate habitats and the percentages of known locations and available habitat affected by the Project are low. For the remaining species, additional Project effects during operation are predicted to be nil to very low. The ecological context is that none of the priority plants species with moderate magnitude effects are experiencing substantial ongoing adverse changes in the existing environment, to the extent this is known given their highly sparse distribution. Additional pre-construction mitigation has been included for the species of highest conservation concern to address the unlikely event that patches of these species exist but have not been discovered to date due to the rarity of the species.	**Step 1:** Direction: Adverse Magnitude: Either nil, small or moderate, depending on the priority plant species. Geographic Extent: Local Duration: Long term **Step 2:** Frequency: Continuous Reversibility: Irreversible Ecological Context: Low

Table 6-33: Summary of Residual Effects Regarding Bird Environmental Components: CANADA GOOSE

VEC Effect and Mitigation by Phase (1 see introductory text)	Residual Effects	Assessment Characteristics (2 see introductory text)
Construction Phase		
Effects include: • Construction noise and activity disturbance causing geese to avoid all or portions of aquatic habitats located adjacent to Project Footprints. • Increased access associated with road, trail and dyke development may result in localized increases in goose harvest. **Mitigation includes:** • Retention of 100m vegetated buffers around inland lakes located near construction sites in order to minimize noise disturbance. • Construction Access Management Plan to minimize increases in goose harvest resulting from increased access.	Noise from construction activity may cause some geese to temporarily avoid waterbodies located near construction sites.	**Step 1:** Direction – Adverse Magnitude – Small Geographic Extent – Small Duration – Short-term **Step 2:** **Not required**
Operation Phase		
Effects include: • Decrease in the quality of staging habitat resulting from reservoir filling and operation. • Increased access associated with road, trail and dyke use may result in localized increases in goose harvest. **Mitigation includes:** • Enhancement of shoreline wetlands within areas of the reservoir and off-system waterbodies in order to improve the quality of goose staging habitat within the Local Study Area. • Decommissioning of all trails created during Project construction but not required during operation in order to minimize increases in goose harvest resulting from increased access.	Decrease in the quality of staging habitat resulting in reduced use of the reservoir by geese. Potential for increased harvest due to increased hunter access (particularly during the migration periods).	**Step 1:** Direction – Adverse Magnitude –Small Geographic Extent – Medium Duration – Long-term **Step 2:** **Not required**

Table 6-34: Summary of Residual Effects Regarding Bird Environmental Components: MALLARD

VEC Effect and Mitigation by Phase (1 see introductory text)	Residual Effects	Assessment Characteristics (2 see introductory text)
Construction Phase		
Effects include: • Effects on mallards are associated with habitat loss and alteration as land is cleared in preparation for reservoir and infrastructure development, habitat avoidance due to construction noise and activity, and increased mortality risk resulting from increased hunter access. **Mitigation includes:** • Land clearing will avoid the sensitive breeding period (April 1- July 31). • Enhancement of inland wetland shorelines to off-set losses in wetland function will improve mallard breeding habitat. • Installation of mallard nesting platforms in suitable wetlands to offset some of the losses in upland nesting cover. • Retention of 100m vegetated buffers around inland lakes located adjacent to infrastructure sites to minimize construction noise disturbance. • Construction Access Management Plan to minimize increases in mallard harvest resulting from increased access.	Loss and alteration of 3% (1,716 ha) of available mallard nesting habitat within the Regional Study Area. Construction noise and blasting resulting in short-term avoidance of all or parts of some wetlands, inland lakes and creeks located near infrastructure sites.	**Step 1:** Direction – Adverse Magnitude – Small Geographic Extent – Small Duration – Long-term **Step 2:** **Not required**

Table 6-34: Summary of Residual Effects Regarding Bird Environmental Components: MALLARD

VEC Effect and Mitigation by Phase (1 see introductory text)	Residual Effects	Assessment Characteristics (2 see introductory text)
Operation Phase		
Effects include: • Decrease in the quality of staging habitat resulting from reservoir filling and operation. • Increased access associated with road, trail and dyke use may result in localized increases in mallard harvest. **Mitigation includes:** • Enhancement of shoreline wetlands within areas of the reservoir and off-system waterbodies in order to improve the quality of goose staging habitat within the Local Study Area. • Decommissioning of all trails created during Project construction but not required during operation in order to minimize increases in mallard harvest resulting from increased access.	In combination with construction phase effects, loss of 3% (1,908 ha) of the available mallard nesting and brood-rearing habitat within the Regional Study Area. A decrease in the quality of staging habitat at Gull Lake and parts of the Nelson River resulting from reservoir creation. Potential for increased mallard harvest due to increased access (particularly during the migration periods).	**Step 1:** Direction – Adverse Magnitude – Small Geographic Extent – Medium Duration – long-term **Step 2:** **Not required**

Table 6-35: Summary of Residual Effects Regarding Bird Environmental Components: BALD EAGLE

VEC Effect and Mitigation by Phase (1 see introductory text)	Residual Effects	Assessment Characteristics (2 see introductory text)
Construction Phase		
Effects include: • Land clearing associated with reservoir and infrastructure development will result in the loss of some trees used for perching and nesting by eagles. • Construction activity and noise disturbance may result in a reduction in bald eagle use of the Gull Rapids area during the open water season. **Mitigation includes:** • Land clearing will avoid the sensitive breeding period for birds (April 1- July 31). • 100m buffers will be retained around bald eagle nests that remain active beyond this date to minimize disturbance to nesting birds. • Bald eagle nests located within the zone of influence will be assessed to determine the need for removal and replacement by artificial nesting platforms.	Noise disturbance associated with construction activity and blasting may reduce bald eagle use of the Gull Rapids area.	**Step 1:** Direction – Adverse Magnitude – Small Geographic Extent – Small Duration – Short-term **Step 2:** **Not required**

Table 6-35: Summary of Residual Effects Regarding Bird Environmental Components: BALD EAGLE

VEC Effect and Mitigation by Phase (1 see introductory text)	**Residual Effects**	**Assessment Characteristics** (2 see introductory text)
Operation Phase		
Effects include: • Reservoir operations will reduce the quality of eagle foraging habitat in areas upstream of the GS. This loss will be offset with the creation of the tailrace area immediately downstream of the GS. • Shoreline erosion and peatland disintegration will result in the continued loss of shoreline trees over the long-term. **Mitigation includes:** • Removal of nest trees in danger of toppling into the reservoir will occur in the fall or winter. • Nests removed will be replaced with artificial nest platforms located in suitable areas.	There are some adverse effects related to changes in the riverine and riparian habitat as well as positive effects related to enhancement of foraging in the tailrace area. Project operations will have a neutral effect on bald eagles overall in the long-term.	**Step 1:** **Not required** **Step 2:** **Not required**

Table 6-36: Summary of Residual Effects Regarding Bird Environmental Components: OLIVE-SIDED FLYCATCHER

VEC Effect and Mitigation by Phase (1 see introductory text)	**Residual Effects**	**Assessment Characteristics** (2 see introductory text)
Construction Phase		
Effects include: • Land clearing associated with reservoir and infrastructure development will result in the loss of some olive-sided flycatcher breeding habitat. • Construction noise and activity (*e.g.*, blasting) may cause some individuals to avoid nesting in areas adjacent to active construction sites. **Mitigation includes:** • Land clearing will avoid the sensitive breeding period for birds (April 1- July 31).	Land clearing will result in the long-term loss of 3.6% (350 ha) of the available suitable olive-sided flycatcher habitat within the Regional Study Area.	**Step 1:** Direction – Adverse Magnitude – Moderate Geographic Extent – Small Duration – Long-term **Step 2:** Frequency – Infrequent Reversibility – Irreversible Ecological Context – High (listed species)
Operation Phase		
Effects include: • Over time, some olive-sided flycatcher habitat will continue to be lost due to shoreline erosion and peatland disintegration. **Mitigation includes:** • Retaining some areas of standing-dead trees within the reservoir back bays to off-set some of the losses in olive-sided flycatcher breeding habitat.	Peatland disintegration and shoreline erosion will result in the loss of up to 1% (120 ha) of the available suitable olive-sided flycatcher habitat within the Regional Study Area.	**Step 1:** Direction – Adverse Magnitude – Small Geographic Extent – Small Duration – Long-term **Step 2:** Frequency – Infrequent Reversibility – Irreversible Ecological Context – High (listed species)

Table 6-37: Summary of Residual Effects Regarding Bird Environmental Components: RUSTY BLACKBIRD

VEC Effect and Mitigation by Phase (1 see introductory text)	Residual Effects	Assessment Characteristics (2 see introductory text)
Construction Phase		
Effects include: • Land clearing associated with reservoir and infrastructure development will result in the loss of some rusty blackbird breeding habitat. • Construction noise and activity (*e.g.*, blasting) may cause some individuals to avoid nesting in areas adjacent to active construction sites. **Mitigation includes:** • Land clearing will avoid the sensitive breeding period for birds (April 1- July 31).	Land clearing will result in the loss of 3.4% (547 ha) of the available rusty blackbird breeding habitat within the Regional Study Area. Temporary habitat avoidance due to noise disturbance associated with construction activity and blasting.	**Step 1:** Direction – Adverse Magnitude – Moderate Geographic Extent – Small Duration – Long-term **Step 2:** Frequency: Infrequent Reversibility: Reversible Ecological Context: High (Listed Species)
Operation Phase		
Effects include: • Filling and operation of the reservoir will result in the loss of some additional rusty blackbird habitat over the long-term. **Mitigation includes:** • Development of wetlands within the Bird Local Study Area will benefit rusty blackbird through creation of some foraging habitat.	Peatland disintegration, shoreline erosion and changes in vegetation resulting from changes in groundwater could result in the additional loss of up to 3% (374 ha) of the available rusty blackbird habitat within the Regional Study Area.	**Step 1:** Direction – Adverse Magnitude – Moderate Geographic Extent – Small Duration – Long-term **Step 2:** Frequency: Continuous Reversibility: Irreversible Ecological Context: High (Listed Species)

Table 6-38: Summary of Residual Effects Regarding Bird Environmental Components: COMMON NIGHTHAWK

VEC Effect and Mitigation by Phase (1 see introductory text)	Residual Effects	Assessment Characteristics (2 see introductory text)
Construction Phase		
Effects include: • Land clearing associated with reservoir and infrastructure development will result in a net gain in common nighthawk breeding habitat. • Construction noise and activity (*e.g.*, blasting) may cause some individuals to avoid nesting in areas adjacent to active construction sites. **Mitigation includes:** • Land clearing will avoid the sensitive breeding period for birds (April 1- July 31).	Construction and clearing will remove 924 ha of existing common nighthawk habitat (about 5% in the Regional Study Area). However, there will be a net gain of up to 2764 ha of common nighthawk nesting habitat associated with reservoir clearing. This is a 15% gain in the total amount of nighthawk nesting habitat available within the Regional Study Area. Temporary habitat avoidance due to noise disturbance associated with construction activity and blasting.	**Step 1:** Direction – Positive Magnitude – Large Geographic Extent – Small Duration – Short-term **Step 2:** **Not required**
Operation Phase		
Effects include: • Filling and operation of the reservoir will result in the long-term loss of some common nighthawk habitat. **Mitigation includes:** • Portions of decommissioned borrow sites will not be remediated to promote vegetation growth as bare ground provides suitable nesting habitat for common nighthawk.	Reservoir filling will result in the loss of habitat created through land clearing (construction) and 522 ha of nighthawk habitat that existed in the reservoir area before construction. Peatland disintegration and shoreline erosion could remove up to 480ha of additional common nighthawk habitat. Upwards of 5% (1002 ha) of the available common nighthawk breeding habitat within the Regional Study Area could be lost due to Project operation.	**Step 1:** Direction – Adverse Magnitude – Moderate Geographic Extent – Small Duration – Long-term **Step 2:** Frequency – Frequent Reversibility – Reversible for some areas. Ecological Context – High (listed species)

Table 6-39: Summary of Residual Effects Regarding Mammal Valued Environmental Components: CARIBOU

VEC Effect and Mitigation by Phase (1 see introductory text)	Residual Effects	Assessment Characteristics (2 see introductory text)
Construction Phase		
Potential effects due to: • Habitat loss and alteration; • Sensory disturbance; and • Mortality due to wildlife-vehicle collisions, predation, and hunting. **Mitigation includes:** • Location of excavated material placement areas; • Routing of access roads; • Leaving calving islands greater than 0.5 ha in the reservoir area undisturbed; • Fire prevention measures; • Limiting blasting; • Construction Access Management Plan; • Gates at north and south dykes; • Prohibition of firearms in camps and at work sites; • Warning signs in areas along the access road with caribou activity; and • Rehabilitation of roadside ditches.	Decreased caribou population in the Caribou Regional Study Area for two or more generations due to reduced habitat and increasedmortality. Altered movements and distributional shifts due to sensory disturbance.	**Step 1:** Direction: Adverse Magnitude: Small Geographic Extent: Small Duration: Long-term **Step 2: Not Required**
Operation Phase		
Potential effects due to: • Habitat loss and alteration, including loss of calving islands; • Sensory disturbance; • Altered movements; and • Mortality due to predation, hunting, and wildlife-vehicle collisions. **Mitigation includes:** • Decommissioning of trails used during construction; • Rehabilitation of temporarily cleared areas and excavated materials placement areas; • Maintance of warning signs along the access roads; and • Development of a plan to ensure coordination of caribou mitigation and monitoring activities.	Decreased caribou population in the Regional Study Area due to reduced habitat and increased mortality. Altered movements and distributional shifts due to sensory disturbance.	**Step 1:** Direction: Adverse Magnitude: Small Geographic Extent: Medium Duration: Long-term **Step 2: Not Required**

Table 6-40: Summary of Residual Effects Regarding Mammal Valued Environmental Components: MOOSE

VEC Effect and Mitigation by Phase (1 see introductory text)	Residual Effects	Assessment Characteristics (2 see introductory text)
Construction Phase		
Potential effects due to: • Habitat loss and alteration including change in calving habitat; • Sensory disturbance; and • Mortality due to predation, hunting, and wildlife-vehicle collisions. **Mitigation includes:** • Rehabilitation of roadside ditches; • Prohibition of firearms in camps and at work sites; and • Implementation of the CNP moose harvest sustainability plan.	Decreased moose population in the Moose Regional Study Area for one to two or more generations due to reduced habitat and increased mortality. Effects of offset resource use programs will extend beyond the Regional Study Area. Altered movements due to sensory disturbance.	**Step 1:** Direction: Adverse Magnitude: Small Geographic Extent: Medium Duration: Medium- to long-term **Step 2:** **Not Required**
Operation Phase		
Potential effects due to: • Habitat loss and alteration; • Sensory disturbance; and • Mortality due to predation, hunting, and wildlife-vehicle collisions. **Mitigation includes:** • Decommissioning of trails used during construction; • Communication and coordination with CNP Members regarding the moose harvest sustainability plan; and • Mitigation for wetland function.	Decreased moose population in the Regional Study Area due to reduced habitat and increased mortality. Effects of offset resource use programs will extend beyond the Regional Study Area.	**Step 1:** Direction: Adverse Magnitude: Small Geographic Extent: Medium Duration: Long-term **Step 2:** **Not Required**

Table 6-41: Summary of Residual Effects Regarding Mammal Valued Environmental Components: BEAVER

VEC Effect and Mitigation by Phase (1 see introductory text)	Residual Effects	Assessment Characteristics (2 see introductory text)
Construction Phase		
Potential effects due to: • Habitat loss; • Sensory disturbance; and • Mortality due to conflicts with humans, flooding, trapping, and predation. **Mitigation includes:** • Trapping of beavers from affected areas; • Buffers at creeks, streams, ponds and lakes; and • Beaver baffles along culverts and control structures.	Decreased beaver population in the Beaver Local Study Area for two or more generations due to reduced habitat and increased mortality.	**Step 1:** Direction: Adverse Magnitude: Small Geographic Extent: Small Duration: Long-term **Step 2:** **Not Required**
Operation Phase		
Potential effects due to: • Habitat loss or alteration; • Sensory disturbance; and • Mortality due to trapping and conflicts with humans. **Mitigation includes:** • Beaver baffles along culverts and control structures.	Decreased beaver population in the Local Study Area due to reduced habitat and increased mortality.	**Step 1:** Direction: Adverse Magnitude: Small Geographic Extent: Small Duration: Long-term **Step 2:** **Not Required**

6.5.11 SENSITIVITY OF EFFECTS TO CLIMATE CHANGE

As described in Section 6.3.12.1, climate change scenarios, on average, project increasing temperatures and precipitation in the Project area. Winter is projected to experience the greatest change with annual temperature and precipitation changes increasing between the 2020s and the 2080s. A smaller subset of climate change scenarios also project increasing evapotranspiration for the same time periods, although climate modeling uncertainty is not well captured in the limited subset of scenarios.

Potential effects of future climate change on the physical environment that are relevant for the terrestrial habitat and ecosystems assessment are a possible increase in the total reservoir area and the rate at which the reservoir expands after the fifth year of operation (PE SV Section 11.4). These changes would create small increases the amounts of peatland loss. A longer reservoir shoreline could increase the amount of Nelson River shoreline wetland.

Regarding terrestrial habitat effects, almost 80% of the terrestrial habitat affected by the Project is within the Project Footprint (including the areas unlikely to be used) and this would not change with future climate change. The terrestrial habitat zone of influence could vary somewhat through climate change induced alterations to terrestrial ecosystem drivers. While the nature of these potential changes is uncertain, they would have to increase by approximately by three times before effects on total habitat area or the areas of the common broad habitat types would increase from moderate magnitude to high magnitude.

Since terrestrial habitat predictions are either the foundation or a key component for effects on all of the terrestrial habitat and ecosystems key topics, it is unlikely that residual effects predictions for these topics would change unless there is an alternative pathway for future climate change to substantially alter the Project effects predictions. As described in the TE SV Section 2.11, alterations along such pathways are not expected.

Potential effects of future climate change on the terrestrial plants residual effects predictions are as follows. For invasive plants, a warmer climate may: (i) increase the risk of Project-related introduction and/or spreading of highly invasive plants; (ii) that the invasive abilities of invasive plants could increase; and/or (iii) eradication or control may become more difficult for some species. A potential response if any of these situations develop is to implement more stringent application of EnvPP measures already in place to minimize the risk of Project-related invasive plant effects. For priority plants, since terrestrial habitat predictions are the key component for effects on all of the priority plants, it is unlikely that potential climate-induced increases to Project-related priority plant habitat effects would be sufficiently large to substantially alter the Project effects predictions.

Effects of climate change on birds in the Bird Regional Study Area could include habitat loss, habitat creation (through increased occurrence of wildfire), reduced food availability (*e.g.*, shifts in the seasonal timing of insect emergence, rotting of food caches due to warmer temperatures), increased predation, and shifts in ranges. Climate change may have a positive effect on some species of birds that use open habitats and/or forest edges, including olive-sided flycatcher (VEC) and common nighthawk (VEC). Increased frequency and severity of wildfire events that create forest openings and forest edge are expected with a warmer climate. For all other bird VECs (*i.e.*, rusty blackbird, bald eagle, mallard and Canada goose), residual project effects conclusions are not anticipated to change as a result of future climate change predictions.

The primary pathway for climate change to alter predicted Project effects on mammals is through increased terrestrial habitat loss due to greater reservoir expansion (Section 6.3.12). For mammals, a very large loss of habitat would be required for residual Project effects to increase from small to moderate magnitude. Additionally, climate change will never result in large magnitude Project-related effects on intactness, and similar conclusions would apply to mammal VECs that are most sensitive (*i.e.*, caribou) to habitat fragmentation. Overall, as the residual effects of the Project on the physical environment will not be affected by predicted changes in future climate conditions (Section 6.3.12), the Project is not expected to contribute to the effects of climate change on mammals in the Keeyask region.

6.6 EFFECTS AND MITIGATION SOCIO-ECONOMIC ENVIRONMENT

6.6.1 INTRODUCTION AND APPROACH

This section focuses on effects of the Project on the socio-economic environment components, mitigation measures (that are technically and economically feasible) to address those effects, residual effects that remain after mitigation, and the regulatory significance of the residual effects on VECs. This section also documents an assessment of the sensitivity of these effects to possible climate change scenarios.

In addition to working closely with the KCNs in understanding socio-economic issues and concerns about the Project, the public involvement program (PIP) provided additional perspectives from potentially affected and interested communities and groups, including Aboriginal communities and groups. Communities were positive about potential employment and training opportunities associated with the Project. At the same time, they were concerned about how to gain access to these opportunities (*e.g.*, timely information, appropriate training) and about hiring and worker retention issues that they felt occurred during construction of the Wuskwatim Generation Project. They also felt that there should be preference for local companies in construction contracts. They were concerned about potential crowding of schools and other infrastructure and services in neighbouring communities as a result of influx of workers during the construction phase. Concerns were noted about safety and deteriorating road conditions from construction traffic. Effects of elevated mercury levels in fish during the operation of the Project on human health, particularly for Aboriginal people who consume substantial amounts of fish from the area were raised. In addition, social concerns were raised regarding workers travelling to neighbouring communities during their time off from work (*e.g.*, to Split Lake, Gillam and Thompson). Cultural training for workers at the Project work camp about Aboriginal culture was considered important, as was the facilitation of appropriate religious and traditional ceremonies at key Project milestones. These perspectives informed the selection of VECs, and assessment of effects which follows. For more information regarding the perspectives of the KCNs regarding the Project, see Chapter 2 (Partners' Context, Worldviews and Evaluation Process), the KCNs' Environmental Evaluation Reports, Chapter 3 (Public Involvement) and the Public Involvement Supporting Volume.

The assessment of Project effects is based on the existing environment, as described in the preceding Section 6.2, including the predicted future environmental conditions and trends (where available) if the Project were not to proceed. This existing environment incorporates effects of past projects, most notably past and current projects identified for the cumulative effects assessment (see Chapter 7). This section also notes where there are overlaps or interactions between effects of the Project with potential future projects.

The technical analysis determined effects of the Project on the socio-economic environment by considering linkages between the socio-economic environment and changes caused by the Project, both through pathways from the physical and biophysical environment, and pathways through Project expenditures and revenues (see Figure 1-1 in the SE SV). The approaches used to assess socio-economic effects were tailored to specific SE SV VECs or groupings of related SE SV VECs and are described further in the VEC sections.

The extent to which the Project would have an effect on people depends largely on their proximity to and level of involvement in the Project. Two geographic regions were established to examine Project effects: the Socio-Economic Local Study Area (the four partner First Nation communities of TCN, WLFN, FLCN and YFFN, the Town of Gillam and the City of Thompson) (see Map 6-1); and the Socio-Economic Regional Study Area (defined by the boundary identified under Schedule D of the Burntwood Nelson Agreement and includes Statistics Canada census divisions 19, 21, 22 and 23 (see Map 6-41).

This Section documents an assessment of the major effects on the SE VECs resulting from construction and operation of the Project. Where there are overlaps or interactions between effects of the Project and past or potential future projects/activities, these are noted in the assessment (*e.g.*, worker interaction overlaps with other hydro projects in the vicinity of Gillam). Details on all SE VECs including pathways of effect are provided in the SE SV.

The assessment considered the components of the socio-economic environment described in Section 6.2.3.5, and reiterated in summary form below. However, as described in Chapter 5, the assessment of regulatory significance was focused on VECs.

- Economy VECs: Employment and training opportunities; business opportunities; income; cost of living; and resource economy;
- Population: Is a supporting topic as it is the driver of change related to infrastructure and services in the communities;
- Infrastructure and Services VECs: Housing; community infrastructure and services; land; and transportation infrastructure; and
- Personal, Family and Community Life VECs: Governance, goals and plans; community health; mercury and human health; public safety and worker interaction; travel, access and safety; culture and spirituality; and the way the landscape looks (or aesthetics).

The SE SV provides existing environment information related to the Regional Study Area population and transportation infrastructure. There are no material population changes predicted for the Regional Study Area, therefore this VEC is not discussed in this volume (see SE SV Section 4.4.1 for further details). Effects on the Regional Transportation Infrastructure, particularly highway PTH 6 during the construction phase, are discussed in the SE SV (see

Section 4.4.1) but are not included in this volume. Generally, the SE SV includes more detail on all pathways of effect; whereas this volume focuses on the key pathways.

As discussed in Chapter 5, the environmental assessment was based on both ATK and technical scientific analysis. Methods and general conclusions related to the ATK-based analysis are provided in Chapter 2, and detailed results are provided in the CNP Keeyask Environmental Evaluation Report, the YFFN Evaluation Report (*Kipekiskwaywinan*) and the FLCN Environment Evaluation Report (Draft). Detailed results for the technical component of the environmental assessment are provided in the SE SV. This section summarizes the results of the ATK and technical analysis. Given the difference in approach of the Cree worldview and technical science, the assessment of the nature of the residual effects differed for some components; these differences are also discussed (see Section 6.4.8).

6.6.2 ABORIGINAL TRADITIONAL KNOWLEDGE

As part of their historical connection to *Askiy* (Mother Earth), the KCNs have acquired ATK from life experiences and their relationship with the land, water and all living things. They have explained their holistic worldview in Chapter 2 and in more detail in the CNP Keeyask Environmental Evaluation Report, the YFFN Evaluation Report (*Kipekiskwaywinan*) and the FLCN Environment Evaluation Report (Draft). ATK in this section of the EIS should be understood as a component of the Cree worldview. This worldview and knowledge guided the KCNs in their participation in planning the Project with Manitoba Hydro and in providing guidance to the environmental assessment. As indicated in the Preface and Ch. 5, the Project is the subject of two evaluation processes. The Project was evaluated by each of the KCNs in terms of their own worldview, values and experience with past hydroelectric development, as well as their relationships with *Askiy* (Mother Earth); and the Project was evaluated through a government regulatory assessment (see Chapter 5).

Aboriginal people have lived, depended on and been part of the Socio-economic Local Study Area for millennia. Today, the KCNs have stressed the importance of their Cree worldview as being interconnected and or interrelated with all living things of the ecosystem, with emphasis on relationships, harmony and balance. The holistic Cree worldview does not consider individual parts or components as does a technical science approach; rather, it focuses on the relationships among all elements and functions in an ecosystem (see Chapter 2). The socio-economic effects section should be viewed in the context of the KCNs interrelationship of all living things and the relationship between people and their environment.

The past is essential toe the KCNs ATK and is important to understanding the socio-economic effects of the Project; in particular, personal, family and community life relationships, and resource access and use. This section includes KCNs perspectives about the anticipated effects of the Project on their people, their communities and their culture (for greater detail, refer to the SE SV).

The KCNs have also noted the importance of ATK in voicing concerns about the Project's effects on intangible culture and spirituality. For CNP, there will be disruption of their spiritual relationship with the land, the use of special cultural sites and their overall cultural identity (CNP Keeyask Environmental Evaluation Report). YFFN talks about "*Ochinewin*", which means there are consequences to inappropriate action. YFFN recognized that being a Project proponent will play an important role in how respectful relationships with the land are maintained. Similarly, FLCN uses "*Oochinehwin*" as "knowledge that there are consequences for inappropriate behaviour" (FLCN 2009 Draft). The Cree culture is rooted in the understanding that if they do not tend to the needs of the land through proper respect and honour, then the community will face adverse consequences including disease, bad fortune, disappearance of animals and social disorder (YFFN Evaluation Report (*Kipekiskwaywinan*); FLCN 2009 Draft).

The following effects of the Project are anticipated by each of CNP, YFFN and FLCN based on their ATK.

Adverse socio-economic effects identified by CNP during their negotiation of their AEA included:

- Loss of Gull Rapids, as well as sacred sites, unknown burial sites and archaeological artifacts due to flooding;
- Loss of historical and spiritual connection to the land through flooding;
- Harm to their emotional well-being as Project effects are seen as damaging and disrespectful to the land/failing to properly care for the land;
- Increased risk of drug and alcohol abuse, sexual abuse and family violence;
- Increase in mercury levels in certain fish in Gull Lake will pose a health hazard;
- Open water and winter travel may become more dangerous;
- Uneven distribution of the costs and benefits of the Project amongst CNP Members may cause increased stress and strain within the community; and
- Loss of trapping income.

CNP also notes the benefits of the Project, including job and business opportunities, revenue sharing for the overall benefit of the community and that the "Project provides an historic opportunity to renew harmony and balance by repairing our diminished relationships" (CNP Keeyask Environmental Evaluation Report).

Socio-economic effects identified by YFFN included:

- The effects of Keeyask will go beyond Manitoba Hydro's predicted open-water hydraulic zone of influence and will affect water quality at York Landing, the quality of fish and wildlife used for food; ice and open water travel will be more unsafe; and important community places will be lost. YFFN's concerns are based on the past 50 years of effects from hydro development.
- Keeyask will bring employment and business opportunities, capacity building and the prospect of revenue sharing for the community.
- YFFN expects Keeyask to add to the changes that they have already experienced in the land, water and wildlife (YFFN Evaluation Report (*Kipekiskwaywinan*)).

Socio-economic effects identified by FLCN included:

- Keeyask may "compound the social, environmental and cultural impacts of past projects; [or could be] a means to support healing initiatives, develop economically, and renew traditional values of self-determination." (FLCN 2009 Draft).
- Keeyask will have job and business opportunities for FLCN Members; however, there is concern over increased drug and alcohol abuse, increase in gang activity and family breakdown.

As discussed in Chapter 2, Elders and leadership of the KCNs came together to arrive at a consensus on a common understanding and statement of their Cree worldview and cultural values. This worldview has played a decisive role in shaping the environmental assessment and, most importantly, in post-Project monitoring. For example, YFFN notes that "... as a Partnership, we need to make a strong commitment to stewardship and to maintaining our relationships with the land" (YFFN Evaluation Report (*Kipekiskwaywinan*)).

For the socio-economic environment Cree values are likely to be key aspects of the cross-cultural awareness training for Project employees. In addition, the Cree worldview will influence the monitoring programs; and there will be specific opportunities for each of the KCNs to implement community-specific ATK monitoring (see Chapter 8).

The Partnership also shares the desire for a new path forward under the Project – to do things better than what was done in previous hydro developments. For CNP and YFFN in particular, they have voiced the desire for reconciliation, healing and the positive nature as stewards of *Askiy* (Mother Earth). In the socio-economic environment for example, the Project has the potential for increased employment and income for KCNs Members. This in turn has the potential for a positive effect on people's cost of living, social well-being and overall health. The KCNs have the opportunity, through the long-term infusion of equity income, to address community infrastructure needs, and to develop traditional cultural programs to maintain a long-term connection to the land. Monitoring programs that involve KCNs Members that use the land, as well as ATK monitoring undertaken by each of the KCNs, can facilitate a process of reconciliation and a positive path forward between the KCNs and Manitoba Hydro (see Chapter 8).

As noted earlier, the KCNs have voiced concern over uncertainty of effects and the importance of incorporating the Cree worldview into the Project's management and post-Project monitoring. The Cree worldview and oral teachings that speak of minimizing harm to the environment and paying respect and honour when *Askiy* (Mother Earth) shares resources with the people are relevant to post-Project monitoring (see for example YFFN Evaluation Report (*Kipekiskwaywinan*)).

Cumulative effects of past hydro projects have shaped the lives and values of the KCNs. Potential future projects can be expected to affect the way of life for future generations. The Partnership acknowledges there are sadness, anger and fear stemming from past development; however, these same experiences and ATK have provided valuable insight into shaping the mitigation and monitoring programs to address these concerns in the socio-economic environment. Examples include the following:

- Greater opportunities for successful Aboriginal employment through pre-Project training;
- Discussion and suggestions on ways of addressing challenges that may affect KCNs/Aboriginal employment levels;
- Development of the Waterways Management Program to address open water and winter travel safety (*e.g.*, safe landing sites, channel navigation supports);
- Mercury contamination mitigation through AEA offsetting programs and development of a communication strategy and communication products for use both prior to and after impoundment, as well as long-term monitoring; and
- Mitigation and monitoring strategies will be discussed and developed among Manitoba Hydro, FLCN, TCN and the Town of Gillam to address issues and concerns related to potential adverse worker interactions.

As a proactive approach, each of the KCNs negotiated an Adverse Effect Agreement (AEA) with Manitoba Hydro to address known and foreseeable adverse effects their traditional knowledge and past experience with hydro development was telling them could occur. For example, all the KCNs included AEA offsetting programs to strengthen their traditional relationships with the land and to provide long-term opportunities for pursuit of traditional activities and cultural programming.

Because ATK has perspectives that differ and doubt some of the results of technical science, an emphasis has been placed on mitigation and monitoring. These topics are covered in Chapter 8.

6.6.3 ECONOMY

As a result of enhancement measures favouring the KCNs, the most pronounced economic effects of the Project will be on Local Study Area communities. These effects will be generated through Project employment, business participation and the KCNs potential participation as equity partners. The Regional Study Area will also benefit mainly through Project employment. This is especially important for northern Manitoba Aboriginal people, whose unemployment levels are considerably higher than Manitoba as a whole. As well, the Project is of sufficient size that it can positively and noticeably affect the Manitoba and Canadian economies through the purchase of materials and equipment, labour supply, payments to the provincial and federal governments (*e.g.*, payroll tax, personal income tax, fuel tax and provincial sales tax) and re-spending of employment wages and other Project-related income.

This section examines in detail the economic effects on the KCNs, Gillam and Thompson communities in the Socio-Economic Local Study Area which will benefit most noticeably from the Project. Also examined are effects on the Aboriginal population of the Socio-Economic Regional Study Area and to a lesser extent effects on the provincial and national economies. The magnitude and nature of these effects will differ between the construction and operation phases. The Project is expected to create substantial employment, business activity and income within the Local and Regional Study Areas during the construction phase. Effects during the operation phase are expected to be limited to Gillam (employment) and the KCNs (potential employment throughout Manitoba Hydro's system and return on equity investment in the Project).

Socio-economic pathways of effect on the Economy VECs in the Local and Regional Study Areas include the following (see SE SV Sections 3.4.1 and 3.4.2 for details):

- Construction employment opportunities for qualified Aboriginal workers;
- Construction business opportunities through direct negotiated contracts (DNCs) for KCNs businesses;
- Operation phase employment opportunities associated with the Project;
- Operation employment opportunities throughout Manitoba Hydro's system associated with JKDA commitments and targets for KCNs Members;
- Equity income for KCNs from their investment as limited partners in the Project (operation phase); and
- Project-related changes to terrestrial and aquatic species used by people for domestic or commercial purposes (construction and operation).

6.6.3.1 EMPLOYMENT AND TRAINING OPPORTUNITIES

Construction of the Project will require a large, skilled workforce comprised of designated and non-designated trades, along with construction support occupations. The construction and employment analysis determined the extent to which Project employment opportunities will flow to the KCNs, Aboriginal residents of the Churchill-Burntwood-Nelson (CBN) communities (identified in the Burntwood Nelson Agreement (BNA)) and northern Aboriginal residents (as defined in the BNA). To understand the construction employment effects, a labour supply/demand matching model was developed to estimate the participation of these three target groups in Project construction employment opportunities. Employment challenges, identified through past experience and KCNs knowledge, were also included. For the operation phase, analysis of employment opportunities examined effects on the KCNs that flow from the JKDA targets and operation workforce requirements for the facility itself. These effects are derived from the number, type and location of the Project's operation and maintenance employment and Manitoba Hydro's experience with the uptake of these types of jobs (see SE SV Section 3.2.1 for details).

Sources of information included the following (see SE SV Section 1.2 for further details):

- Hydro Northern Training and Employment Initiative data;
- 2001 Statistics Canada Census Data; the most recent year for which complete labour force and employment data is available for the Local Study Area. 2006 Statistics Canada census data is incomplete and 2011 data was not available when the EIS was being prepared;
- Workforce requirements established by Manitoba Hydro;
- Key person interviews (Local Study Area) and the KCNs fieldwork research programs;
- Wuskwatim construction employment experience; and
- The JKDA and Burntwood Nelson Agreement.

6.6.3.1.1 Construction Effects and Mitigation

Construction employment opportunities are characterized by estimates of workforce requirements across the construction phase. Peak quarterly workforce requirements will be highest during the Project's middle years, 2016-2018, with the highest levels in Q3 of 2016 and Q2 of 2017(see Figure 4-1 in Chapter 4, Project Description). On average, there will be 630 workers on site during Project construction, with the largest numbers at about 1,600 workers. Employment will be seasonal, with a peak workforce occurring in the summer time period (Q2 and Q3).

Overall, the Project is expected to generate 4,218 person years (PY)[1] of construction employment (see Table 6-30) (see SE SV Section 3.4.1). Construction support, non-designated trades and designated trades are expected to account for 3,150 PYs or about 75% of the total; with another 1,068 or about 25% generated by Manitoba Hydro and key contractor personnel. Higher-skilled occupations (designated trades, contractor supervisory and Manitoba Hydro

[1] A person year is defined as a measure of the amount of work that could be available during a specific time period or for a specific type of work. One person-year approximates the amount of work that one worker could complete during twelve months of full-time employment. This would equate to between 2,090 to 2,295 hours per year (rounded, based on regular weekly hours of 40-44 hrs/week).

staff) account for 57% of total employment; with relatively lower skilled occupations accounting for 43%.

Direct negotiated contracts (DNCs) with the KCNs are estimated to account for 1,142 PYs (36%) of contract employment (not including Manitoba Hydro or contractor supervisory employment), with the majority of these DNCs starting at the beginning of Project construction.

Table 6-42: Construction Workforce Requirements by Occupational Category

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

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

Specific measures have been put in place to enhance economic opportunities for Aboriginal residents of the Regional Study Area, and the KCNs in particular, to gain economic benefits from the Project. These measures were intended to maximize involvement in training and employment and included the Hydro Northern Training and Employment Initiative (HNTEI), the Burntwood Nelson Agreement (BNA) (with hiring preferences), and the JKDA through provision of DNCs (see Section 6.2.3; as well as Section 3.3.1 of the SE SV for further details). Construction of the Project will be preceded by construction of the Keeyask Infrastructure Project (KIP) to which similar measures are being applied. The experience gained by KCNs Members and the Regional Study Area Aboriginal workforce from working on KIP can be expected to improve participation levels by these groups in the Keeyask Project's construction jobs.

As noted above, a labour supply/demand matching employment model was developed to estimate the extent to which KCNs Members and the Regional Study Area Aboriginal workforce would participate in construction employment opportunities. The model incorporates Project workforce requirements, labour supply projections built on 2001 Statistic Canada labour force and occupation category data and on pre-project training program data, and factors that can be challenges to participation in Project opportunities. Considerable uncertainty exists about the extent to which the challenges will manifest themselves with respect to construction of the Project. A range of estimates have been developed to illustrate the effects of varying assumptions about the extent of the challenges.

Results of the employment analysis, showing the estimated person years of employment for the KCNs and the Regional Study Area Aboriginal workforce by occupational category for both high and low employment estimates are presented in Table 6-31 below.

Table 6-43: Estimated Participation by Keeyask Cree Nations Members and the Regional Study Area Aboriginal Workforce in Project Employment Opportunities

Job Category	Person Years of Employment by KCNs Members		Person Years of Employment by Regional Study Area Aboriginal Workforce[1]	
	High Estimate (number)	**Low Estimate** (number)	**High Estimate** (number)	**Low Estimate** (number)
Construction Support	325	125	750	225
Non-Designated Trades	170	45	535	115
Designated Trades	95	55	310	105
Manitoba Hydro and Contractor Supervisory	10	10	105	105
TOTAL	*600*	*235*	*1,700*	*550*
Percent of Total Available Person Years	14%	6%	40%	13%

Source: InterGroup Consultants: Analysis prepared by InterGroup Consultants Ltd. Based on Keeyask Generation Project workforce demand supplied by Manitoba Hydro. Details are in the SE SV Section 3.4.1.

Notes:

1. Regional Study Area includes the KCNs and Churchill Burntwood Nelson area[1].

Numbers are subject to rounding.

The Project is projected to generate an estimated 235 to 600 person years of construction employment for KCNs Members, for between 6% and 14 % of the total construction workforce. These 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. If these were full-time positions, approximately 30 to 70 KCNs Members would be working throughout the eight and a half-year construction phase. However, much of the Project construction work would be seasonal and therefore, a person year of work would be spread over several individual jobs. For example, assuming two jobs per person year, the number of KCNs Members working during a given year could be between 60 and 140 persons, which would be substantial in these high

[1] CBN refers to areas (including communities) along the Churchill, Burntwood and Nelson (CBN) river systems that have been affected to some degree by past hydroelectric development. The boundaries of this area are defined in Section 12.1.1.3 of the BNA, which is the collective agreement governing the Project.

unemployment settings. This would vary among construction years, reflecting differences in numbers and skills mix of workers required throughout the construction phase.

During construction, Project related employment for KCNs Members will also be generated through Keeyask site representatives, participation in technical and ATK monitoring programs, and community based job referral and partner implementation staff. These jobs will contribute at least 35-40 additional person years of construction related employment for KCNs Members. Participation by KCNs workers is expected to remain fairly steady, largely due to the role of KCNs workers in DNCs, most of which extend over the entire construction phase. These contracts are expected to provide more stable employment than the tendered contracts and produce higher levels of KCNs employment than comparable tendered contracts would have. The JKDA includes an employment target of 630 person-years of construction employment for the KCNs. The target includes their participation in construction of the Project as well as their participation in KIP employment opportunities and all pre-construction employment following signing of the JKDA. The target is being measured and tracked by the Project Partners through a separate process and separate methodology.

The Project is expected to provide substantial construction employment for Aboriginal workers from the Regional Study Area as a whole (including KCNs and those living in the CBN area) ranging from an estimated 550 to 1,700 persons years. At these levels, between 13 % and 40 %, of total construction employment would be filled by Aboriginal workers from the Regional Study Area (see SE SV Section 3.4.1 for details). These percentages can be compared to the one for the Wuskwatim Generating Station, under construction since 2006 and currently nearing completion. Like Keeyask Generation, Wuskwatim construction had pre-project training and preferential hiring provisions for northern Aboriginal workers.

The construction phase has consisted of both infrastructure and major works. For a proper comparison of its employment results with the Keeyask Generation Project, only the major works construction can be considered. Construction of Wuskwatim major works resulted in 24% of its workforce being filled by Aboriginal workers from the Regional Study Area. This falls near the middle of the range of the Keeyask estimates.

Aboriginal workers from the Regional Study Area (including KCNs and the CBN area) are expected to secure a high percentage of employment in the construction support (26-88%) and non-designated trades (12-56%) categories since there are a large number of Aboriginal workers who are qualified for these positions. A smaller proportion of designated trades and Manitoba Hydro and contract supervisory positions are likely to be filled by Aboriginal workers from the northern Region.

As with all major construction projects, Project-related construction employment levels in local communities will increase and decline and will eventually cease, contributing to a minor boom and bust situation. During the bust, local economic activity will decline and unemployment levels will rise in the Local and Regional Study Area. However, this should be moderated in part by the experience gained during construction which will enhance the employability of KCNs community Members and northern Aboriginal residents who have worked on the Project.

ENHANCEMENT MEASURES

Key measures to enhance participation by KCNs Members and Aboriginal workers from the Regional Study Area in Project construction employment opportunities are already in place through the HNTEI, BNA and JKDA. These include:

- Pre-project training through the HNTEI undertaken between 2001 and 2010 to develop construction skills;
- The extensive use of DNCs and the opportunity for direct-hire provisions within these contracts, as well as preferential hiring provisions for TCs and associated Job Referral Service;
- The employee retention and services contract, expected to be implemented by YFFN and FLCN, which includes cultural training and on site counselling services;
- On-site employee liaison workers;
- Funding for the hiring of an Aboriginal union representative by the Allied Hydro Council;
- Establishment of the Advisory Group on Employment that can serve as forum for KCNs and others to identify and discuss construction employment issues; and
- Community based job referral officers.

While the planned measures are extensive and address key issues affecting KCNs participation in construction jobs, the analysis of factors affecting employment suggests that it would be beneficial to focus additional effort on challenges that can affect worker's availability for construction employment. These challenges include

- Maintaining a candidate's status in the job referral system;
- Reaching a selected candidate about a specific job opportunity;
- A candidate not accepting job offers; and
- The ability of the candidate to make arrangements to get to the job site.

Consideration should be given to implementing additional availability oriented measures to complement the measures that have already been implemented or are defined in existing agreements. A starting point for this would be reviewing the Wuskwatim experience with the respect to the challenges affecting availability and identifying opportunities for addressing some of the challenges. This would be a joint effort involving the KCNs, Manitoba Hydro Project staff, the Job Referral Service, key contractors and other relevant stakeholders.

As with Wuskwatim, a Socio-Economic Monitoring Program (SEMP) to monitor key data will be prepared and implemented (see Chapter 8).

Residual Effects of Construction

Using the criteria established to determine the significance of Project effects for regulatory purposes (described in Section 5.5), the residual effects of Project construction on construction employment are expected to be positive due to increased employment, medium to large in geographic extent, of short-term duration and of moderate magnitude. The full extent will depend on the uptake of the employment opportunities. Step 2 is screened out based on Step 1 analysis. There is a high degree of certainty in this assessment due to the extensive enhancement measures already in place through existing agreements and experience gained from construction of the Wuskwatim project.

6.6.3.1.2 Operation Effects and Mitigation

KCNs Members are expected to benefit from job opportunities that flow from the JKDA, which provides for target placement of Members in 182 operation positions across Manitoba Hydro's system. The JKDA established a 20-year period to achieve this target, divided amongst the KCNs as follows: 100 jobs for TCN Members, 10 for WLFN Members and 36 each for FLCN and YFFN Members. These are long-term, well-paying jobs that could generate substantial benefits for each of the KCNs in terms of full-time employment for their rapidly growing labour force, and therefore contribute to lowering their unemployment levels.

The Project is expected to require 46 full-time, well-paying operation positions based in Gillam: 37 Keeyask site staff and nine Gillam support staff. Estimated operation and maintenance requirements include nine electrical operating technicians and nine mechanical operating technicians; 13 technical and trades staff; six power supply worker trainees; and 11 administrative and support staff. These operation jobs will increase the current complement of Manitoba Hydro employees in Gillam (of 350) by about 13%, adding noticeably to the economic base of Gillam as well as to the overall population in Gillam (including families). The jobs may be filled by people from outside the Local Study Area as well as by local KCNs Members. These jobs would be filled through Manitoba Hydro's standard hiring procedures. Most of the workers to fill these operating positions are expected to come from outside of Gillam, since most of the qualified residents in Gillam are already employed by Manitoba Hydro. However, Qualified FLCN Members living in Gillam and Fox Lake (Bird) and TCN Members living in Split Lake are the most likely KCNs Members to fill Project operation jobs due to their close proximity to where the jobs would be based. No mitigation measures are required.

Residual Effects of Operation

Using the criteria established to determine the significance of Project effects for regulatory purposes (described in Section 5.5), the residual effects of Project operation on employment for the KCNs are expected to be positive, medium to large in geographic extent, long-term and moderate in magnitude. The residual effect for Gillam residents is expected to be positive, moderate in magnitude, and long-term. Step 2analysis is screened out based on the Step 1 analysis. There is a high degree of certainty in this assessment due to the measures already in place through the JKDA.

6.6.3.1.3 CONCLUSION ABOUT RESIDUAL EFFECTS ON EMPLOYMENT AND TRAINING OPPORTUNITIES

Overall, the expected and likely Project residual effects on employment and training opportunities are positive due to the HNTEI and measures already in place through the JKDA.

In terms of cumulative effects, the Project results in a positive effect for employment and training opportunities during both the construction and operation phases, therefore this VEC has been screened out for undertaking a cumulative effects assessment (see Section 5.5).

A detailed socio-economic monitoring plan (SEMP) will be developed that includes monitoring of relevant employment outcomes and to address uncertainties. To allow comparison across projects, the monitoring will be consistent with that used for the Wuskwatim project (see Chapter 8 for further details on monitoring).

6.6.3.2 BUSINESS OPPORTUNITIES

Analysis of business opportunities focused on the involvement of KCNs communities in Direct Negotiated Contracts (DNCs) for the Project. These contracts will provide KCNs businesses with substantial amounts of contract work during Project construction and will be their main source of business opportunities for the Project. Business effects on Gillam and Thompson were examined from the perspective of likely support and supply opportunities and population growth associated with the operation phase. Business effects in the Regional Study Area are expected to be minimal in comparison to communities in the Local Study Area; as such, limited analysis was undertaken.

Sources of information included the following (see SE SV for further details):

- The JKDA;
- Experience from the Wuskwatim Generation Project;
- Key person interviews in Local Study Area communities; and
- KCNs fieldwork research programs in the Local Study Area.

6.6.3.2.1 CONSTRUCTION EFFECTS AND MITIGATION

The majority of business opportunities in the Local Study Area are expected to flow to the KCNs through DNC's. Table 6-32 identifies the DNCs and which of the KCNs communities have been identified for their implementation. These contracts will follow a series of DNCs that had been awarded to the KCNs for KIP. The experience gained in implementing the KIP contracts is expected to strengthen the KCNs capacity to undertake DNCs for the Keeyask Generation Project.

Table 6-44: Direct Negotiated Contracts for Construction of 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 DNCs are expected to generate substantial benefits to KCNs and provide valuable overall business experience that can be used in further joint-venture contracts on other construction projects within or external to their home communities. The revenues associated with the DNCs can potentially be used to finance payments on buildings, equipment or other capital items for long-term use in the communities. Overall, it is anticipated that the DNCs will strengthen the local economy in the KCNs communities and provide construction jobs for Members.

Manitoba Hydro's most recent hydroelectric development project under construction (Wuskwatim) provides useful information on overall business benefits to the local First Nation; and is therefore a good predictor of anticipated Keeyask outcomes. Wuskwatim experience reported by NCN indicates they were able to establish a building supply company to serve the Wuskwatim Generation Project; the supply company subsequently expanded into Saskatchewan. In addition, NCN created joint ventures with road construction, catering and camp maintenance companies, gaining valuable experience negotiating business partnerships and creating jobs and revenue for NCN. NCN has also created its own environmental monitoring company Aski'Otutoskeo Ltd (AOL) to provide services as a contractor to Manitoba Hydro and other monitoring companies working on the project (NCN 2011).

Increased business opportunities generated by Manitoba Hydro and contractor purchases and the re-spending of worker wages will likely be concentrated in Thompson, and to a lesser extent Gillam; these opportunities are expected in the transportation, hospitality and retail sectors.

ENHANCEMENT MEASURES

The DNCs are the most important measures for enhancing KCNs participation in Project business opportunities. Other measures for enhancing local business participation during the construction phase include the following:

- Provide a mechanism to identify entrepreneurial opportunities associated with Project construction; and
- As occurred in the Wuskwatim Generation project, maintain communication with appropriate organizations on opportunities through Manitoba Hydro's Northern Purchasing Policy.

6.6.3.2.2 RESIDUAL EFFECTS OF CONSTRUCTION

Using the criteria established to determine the significance of Project effects for regulatory purposes (described in Section 5.5), the residual effects of Project construction on business opportunities are expected to be positive, medium in geographic extent, short-term in duration and moderate in magnitude. Residual effects include increased business opportunities as well as increased community capacity to develop and manage businesses that could extend beyond the construction phase. Step 2 analysis is screened out based on the Step 1 analysis. There is a high degree of certainty in the assessment of this VEC because the DNCs are already defined in the JKDA and the KCNs have already established key business partnerships to implement them.

6.6.3.2.3 OPERATION EFFECTS AND MITIGATION

The main direct effects on business opportunities associated with operating and maintaining the Project will be concentrated in Gillam and are likely to result from spending by operation workers (and their families) who have moved to the community. With the addition of 46 Project operation workers, some with families, as well as the workers filling indirect jobs, the population of Gillam may increase by 120 to 150 people as a result of the Project, resulting in a 10% increase in overall population. This increased population may enlarge the market for existing retail and consumer services in Gillam, enhancing their viability and purchasing power and possibly leading to a wider selection of products available to Gillam residents. The increased business activity in the operation phase may help to counter-balance the boom-bust nature of development projects by extending business activity beyond the construction phase.

During the operation phase, following the decline in activity due to completion of Project construction, Thompson is likely to experience some increased business activity as a result of increased spending by KCNs and Gillam-based operation staff. KCNs communities have described the importance of Thompson businesses and services to their Members. If the new Project-related population in Gillam and the KCNs communities follows existing trends, extra income could be spent in Thompson for entertainment, groceries, household goods and other items. While not quantifiable, the overall effect on Thompson businesses from this increased spending is expected to be small relative to the overall Thompson economy.

Ongoing purchases of goods and materials for Project operation and maintenance will likely result in opportunities for KCNs, Thompson and Gillam businesses, *e.g.*, snow clearing contracts.

Each of the KCNs will receive ongoing equity income relative to their equity investment in the Project and according to the terms of the JKDA. Some of this income could be used by each of the KCNs to facilitate development of new business capacity and opportunities for expansion of existing businesses. In addition, the employment and equity income flowing into the KCNs communities could result in increased spending on goods and services in both Thompson and Gillam (see Section 6.6.3.3.3). No mitigation or enhancement is required.

6.6.3.2.4 RESIDUAL EFFECTS OF OPERATION

Using the criteria established to determine the significance of Project effects for regulatory purposes (described in Section 5.5), the residual effects of Project operation on KCNs and Gillam business opportunities are expected to be positive, small in geographic extent for Gillam, and medium in geographic extent for the KCNs, of long-term duration and small to moderate in magnitude. Residual effects include increased business opportunities and community capacity to develop, manage and potentially expand businesses. There are very small residual effects related to Thompson businesses from re-spending of employment income. Step 2 analysis is screened out based on the Step 1 analysis. There is a moderate to high degree of certainty in the assessment of this VEC based on experience with other development projects that effect community growth.

6.6.3.2.5 Conclusion about Residual Effects on Business Opportunities

Overall, the expected and likely Project residual effects on business opportunities are positive due to the DNCs in place under the JKDA.

In terms of cumulative effects, the Project results in a positive effect for business opportunities during the construction and operation phases, therefore this VEC has been screened out for undertaking a cumulative effects assessment (see Section 5.4).

The SEMP will include monitoring of relevant business opportunities and participation indicators during the construction phase (see Chapter 8).

6.6.3.3 Income

Project construction will generate income from a number of sources including employment, business opportunities and payment of taxes. KCNs construction income will originate mainly from employment and to a lesser extent from business opportunities; while employment will be the main source of income for Aboriginal residents of the Regional Study Area.

- Construction employment income was determined using workforce estimates in conjunction with wage rates and other pertinent BNA information; and
- Business income was generated based on expected values of DNC construction packages, joint-venture participation rates and industry-standard profit margins from Industry Canada (see SE SV Section 3.2 for further details).

During the operation phase, the KCNs will receive additional equity income from being partners in the Project, depending on the level of their investment in the Project. The level of this income could not be estimated.

6.6.3.3.1 Construction Effects and Mitigation

Keeyask Cree Nations workers are expected to earn between $21 and $62 million working on construction of the Project. Most of this income (between $18 and $48 million) will be generated from DNCs (both employment and business income); and some will be generated through tendered contracts (TCs). Indirect income to communities includes workerspending in KCNs communities leading to local profit for the businesses.

Business income will come from the DNCs that will be active during the construction phase, and profits will only be evident after the contracts are complete. If costs are effectively managed, profits in excess of $15 million could be earned on the DNCs, of which more than half could accrue to KCNs businesses who must own at least half of the contracted enterprises. The level of profit is based on a target return of 10% of contract earnings.

Overall, employment income accruing to Aboriginal workers in the Regional Study Area (including CBN workers) is estimated to range between $49 and $180 million. Although both Gillam and Thompson are likely to experience some income benefits, these have not been quantified as most of the income generated in these communities occur as a result of re-spending and this is not readily estimated.

In Gillam, the income generated is likely to be in the transportation, hospitality, retail and construction sectors; in Thompson, indirect economic activity is likely in the construction, retail/wholesale goods, and the services and hospitality sectors. No mitigation or enhancement is required.

6.6.3.3.2 Residual Effects of Construction

Using the criteria established to determine the significance of Project effects for regulatory purposes (described in Section 5.5), the residual effects of Project construction on KCNs income are expected to be positive, medium in geographic extent, of short-term duration and moderate to large in magnitude. Residual effects related to Gillam and Thompson are expected to be positive, small to medium in geographic extent, short-term in duration and small to moderate in magnitude. Step 2 analysis is screened out based on the Step 1 analysis. There is a high degree of certainty in the assessment of this VEC based on the DNC opportunities to generate substantial direct employment income and indirect income through re-spending in Gillam and Thompson.

6.6.3.3.3 Operation Effects and Mitigation

Income effects will result from KCNs Members participating in Manitoba Hydro system-wide jobs and Keeyask operation jobs. The estimated[1] potential gross annual employment income for Members from each of the KCNs if the 20-year operation employment targets are achieved will be as follows:

- TCN: $11 million;
- WLFN: $1 million;
- FLCN: $4 million; and
- YFFN: $4 million.

In addition, KCNs communities will receive income based on their investment in the Project. Dividends will begin to accrue after the Project becomes operational and produces revenues. KCNs communities can choose to invest in the Project in one of two ways: 1) a common equity option, which requires a higher level of investment and generates a proportionate share of distributions from the Project based on Partnership financial performance; or 2) a preferred equity option. The latter option has a lower investment and a guaranteed return on investment.

[1] Estimates are based on the JKDA, Section 12.7.1 and numbers have been rounded; actual results may vary. Refer to the SE SV (Section 3.4.2) for further explanation and details.

In the long-term, annual dividends for the KCNs may approach tens of millions of dollars, providing substantial long-term, sustainable income for the communities.

Income from Keeyask operating jobs will be largely concentrated in Gillam and will amount to approximately $5 million (gross) annually. Some indirect income may be generated in Thompson as a result of the increased KCNs equity income and employment income expected in Gillam and resultant re-spending in Thompson; however, this has not been estimated.

No mitigation or enhancement is required.

6.6.3.3.4 Residual Effects of Operation

Using the criteria established to determine the significance of Project effects for regulatory purposes (described in Section 5.5), the residual effects of Project operation on KCNs income are expected to be positive, medium to large in geographic extent (large due to system-wide employment opportunities), of long-term duration and moderate to large in magnitude. Residual effects on Gillam and Thompson income are expected to be positive, small to medium in geographic extent, long-term and small to moderate in magnitude. Step 2 analysis is screened out based on the Step 1 analysis. Although exact income numbers cannot be predicted, there is reasonable confidence in the assessment that income opportunities for the KCNs are substantial.

6.6.3.3.5 Conclusion about Residual Effects on Income

Overall, the expected and likely Project residual effects on income are positive due to the employment and business opportunities available through the Project.

In terms of cumulative effects, the Project results in a positive effect related to income during the construction and operation phases, therefore this VEC has been screened out for undertaking a cumulative effects assessment (see Section 5.4).

Monitoring plans are being developed to address uncertainties. A SEMP will be developed after filing to determine the levels of employment income generated by Project construction, particularly for KCNs and CBN region employees (further details are described in Chapter 8).

6.6.3.4 Cost of Living

Cost of living analysis focused on using the Revised Northern Food Basket methodology and collecting specific cost of living prices in various locations in the Local Study Area and a comparative source in Winnipeg. This survey was augmented by information collected through key person interviews to further understand the cost of living in the Local Study Area communities.

Sources of information included the following:

- Data collection survey using the Revised Northern Food Basket methodology developed by Aboriginal Affairs and Northern Development Canada (formerly INAC) (RNFB 2008a: RNFB 2008b);
- Key person interviews in the Local Study Area and KCNs fieldwork research programs; and
- Literature review of federal government-based cost of living analysis (see SE SV Section 3.2 for further details).

6.6.3.4.1 CONSTRUCTION EFFECTS AND MITIGATION

Increased spending in the Local Study Area is estimated to have little effect on the differences in cost of living between these communities and communities in southern Manitoba. Some of the increased spending power in KCNs communities may prompt some retail and consumer service providers to widen their product or service range in order to capture a larger share of the growing market. YFFN has expressed concern that their Members will experience an increase in cost of living at York Landing (*e.g.*, food and transportation costs), reduced reliability and increased costs of access to Thompson and its services (including flights, hotel accommodation, fuel and select grocery items).

Thompson may be the exception depending upon the growth scenario experienced by the community without the Project (details on the population growth scenarios are included in Sections 6.2.3 of this Volume, and Section 4, Appendix 4C of the SE SV). If the Thompson economy grows at a substantial rate, the Project-related expenditures could worsen labour shortages and place upward pressure on local wages and related costs. However, the announcement by Vale (2010) of its intention to close its refinery and smelter by 2015, will likely result in a slowing down of the economy, leading to surplus capacity in the local labour market and in various business sectors. Under these circumstances, Project-related increases in expenditures in Thompson are unlikely to affect local prices or cost of living. The extent of effects related to Thompson cost of living cannot be quantified.

No mitigation is required.

6.6.3.4.2 RESIDUAL EFFECTS OF CONSTRUCTION

Using the criteria established to determine the significance of Project effects for regulatory purposes (described in Section 5.5), the residual effects of Project construction on cost of living are expected to be neutral. There is a moderate degree of certainty in the assessment of this VEC based on information collected; personal choice on spending may alter results for some communities and the situation in Thompson at the time of Project construction will have a considerable effect on the community's economy.

6.6.3.4.3 Operation Effects and Mitigation

There is expected to be little tangible effect on cost of living in KCNs communities, Gillam, Thompson and the rest of the Regional Study Area during the operation phase. For details, see the SE SV Section 3.4.

6.6.3.4.4 Conclusion about Residual Effects on Cost of Living

Overall, residual effects of the Project are expected to be neutral as increased spending in the Local Study Area is estimated to have little effect on cost of living.

In terms of cumulative effects, as the Project results in a neutral effect related to cost of living during the construction phase, this VEC has been screened out for undertaking a cumulative effects assessment (see Chapter 5).

No monitoring related to cost of living is planned.

6.6.3.5 Resource Economy

The resource economy section is dependent on the analysis undertaken in the Resource Use section of the SE SV. Based on this analysis, relevant findings related to various types of resource use have been extracted (*e.g.*, commercial trapping), and these findings are summarized in terms of their effects on income and livelihood in the resource sector of the local economy.

There is no evidence to date of effects on members of the Manitoba Metis Federation of Pimicikamak Cree Nation at the time this report was submitted. Manitoba Hydro has been working with the Manitoba Metis Federation and Pimicikamak Cree Nation to undertake studies identifying any effects of the Project related to rsource use of the area by their members; these studies will be funded by Manitoba Hydro (see PIP Section 3.4.1)

6.6.3.5.1 Construction Effects and Mitigation

Project effects during the construction phase on the resource economy will be a result of disturbances to wildlife resources and habitat loss due to noise and construction-related activity in the vicinity of the Project, shifting patterns of resource use through the KCNs offset programs, improved access from Project related roads, an influx of workers potentially creating additional resource harvest pressure, and changes in lifestyle of local resource harvesters who choose Project employment. The effects of these sources of change on resource use and resource users are described in the Resource Use Section 6.7.4. During construction, domestic resource use, commercial trapping, and commercial lodges and outfitters will be affected; however, the effects identified are expected to have limited consequences on cash and in-kind income of the affected resource users.

KCNs Resource Users

Losses of in-kind income from reduced domestic resource use in the vicinity of the Project are expected to be mitigated by the AEA offsetting programs that provide access to resource harvesting at alternative and unaffected locations as well as to healthy fish for consumption in communities.

Losses experienced by commercial trappers will be compensated through agreements negotiated or being negotiated by Manitoba Hydro on behalf of the Partnership. Provisions exist in the TCN AEA (Members Claims) and FLCN AEA (Citizens Claims) to provide for losses in net revenue and damages to property incurred by commercial trappers on a Registered Trapline. These provisions are expected to address any project related losses experienced on the potentially affected traplines (*i.e.*, Traplines 15, 9 and 7). A five year, extendable disturbance agreement has been reached with the holder of Trapline 09; an annual agreement with Trapline 15 is expected to be reviewed and renewed as needed on an annual basis; and compensation agreements aare expected to address the minor effects to Traplines 07 and 25 (a TCN community trapline).

Project related effects during construction and operation are expected to result in closure of the small (single-licence) Stephens Lake fishing business that operates under a special licence to sell fish locally in Gillam and Churchill. Discussions are underway with the affected fisherman to be compensated for losses and damages incurred.

Tourism, commercial forestry and mining

Concerns have been raised about potential risks to the property and operations of lodges and outfitters located on or near lakes being used as alternate harvesting areas under the AEA Access Programs. TCN has adopted guidelines and principles for its Members when they are participating in the AEA Access Programs. The guidelines and principles include respect for the land and environment including leaving areas clean, respect for others and their property, and conducting selective harvesting including applying traditional and cultural values on all harvesting activities. Implementation of these guidelines and principles should largely mitigate potential adverse effects on lodges and outfitters. A possible exception may be loss of customers who sense a loss of their “wilderness experience” from meeting participants of the AEA Access Program while they are using a lodge or outfitters services.

There are no anticipated Project effects on mining; and effects on forestry are expected to be negligible (see Resource Use Section 6.7.4).

No further mitigation is required.

6.6.3.5.2 Residual Effects of Construction

Using the criteria established to determine the significance of Project effects for regulatory purposes (described in Section 5.5), the residual effects of Project construction on the cash and in-kind income and livelihood of KCNs resource users are expected to be neutral (domestic and commercial resource use losses are to be compensated), effects on tourism and are expected to be neutral, and on commercial foresty are expected to be negligible. There are no residual effects on mining. There is a high to moderate degree of certainty in the assessment of this VEC as the key measures for mitigating effects including the Access Programs, TCN's guidelines and principles for Access Program participants and Manitoba Hydro's compensation programs are already in place.

6.6.3.5.3 OPERATION EFFECTS AND MITIGATION

Project effects on the resource economy during the operation phase are a result of loss of habitat and access due to raising of water levels and the creation of the reservoir, shifting patterns of resource use through the KCNs' AEA offsetting programs, increased mercury levels in fish, changes in access due to operation of the north and south access roads and income generated by KCNs investment in the Project. These effects are described in Section 6.9 Resource Use. Similar to the construction phase, the effects during the operation phase are expected to have limited consequences on cash and in-kind income and livelihood related to all resource use sectors. Similar mitigation and compensation programs will apply to the KCNs resource users and tourism operations as are noted under the construction phase. No further mitigation is required.

6.6.3.5.4 RESIDUAL EFFECTS OF OPERATION

Using the criteria established to determine the significance of Project effects for regulatory purposes (described in Section 5.5), the residual effects of Project operation on the cash and in-kind income and livelihood are expected to be neutral. The residual effects on tourism are expected to be adverse, small in magnitude, medium in geographic extent (limited to tourist operations) and long term. The residual effects on commercial forestry are expected to be negligible; and the effects on mining are expected to be positive due to increased access; small in magnitude, medium in geographic extent and long-term in duration. Step 2 analysis is screened out based on the Step 1 analysis. Similar to the construction phase, there is a high to moderate degree of certainty in the assessment of this VEC as the key measures for mitigating effects including the Access Programs, TCN's guidelines and principles for Access Program participants and Manitoba Hydro's compensation programs are already in place.

6.6.3.5.5 CONCLUSIONS ABOUT RESIDUAL EFFECTS ON RESOURCE ECONOMY

Overall effects of the Project on resource economy are expected to be neutral. Mitigation and compensation measures that already exist though the AEAs, standard Manitoba Hydro practices and TCN guidelines and principles will reduce, offset or compensate any losses incurred by resource users and the resource sectors as a result of Project related activities.

In terms of cumulative effects, as the Project results in a net neutral effect related to the resource economy, this VEC has been screened out for undertaking a cumulative effects assessment (see Chapter 8).

Further details on monitoring and follow-up regarding Economy VECs are described in Chapter 8.

6.6.4 POPULATION, INFRASTRUCTURE AND SERVICES

The construction and operation phases of the Project will each have different effects on population, infrastructure and services (including land). Most of these Project effects are linked to changes in population, either resulting from net in- or out-migration of people to communities in the Local Study Area. Details about the factors that encourage or deter migration are described in the SE SV (Section 4.4.1 and 4.4.2) for the construction and operation phases respectively. The socio-economic pathways of effect on Population, Infrastructure and Services include the following:

- Additional demand for infrastructure and services by new population (construction and operation);
- Expansion of the Town of Gillam in response to operation-phase employment and requirements for other future in-vicinity Manitoba Hydro projects;
- Construction of the south access road and operation of PR 280 along the north access road, across the generating station and long the south access road to Gillam (construction and operation); and
- Transportation of equipment, materials and workers to and from the construction site (construction).

As noted in the socio-economic Environmental Setting Section 6.2.3.5, the VECs used to focus this analysis include the following:

- Housing (Local Study Area);
- Infrastructure and Services (Local Study Area);
- Land (Local Study Area); and
- Transportation Infrastructure (Local Study Area and Regional Study Area).

6.6.4.1 POPULATION

Population is a supporting topic that leads to an understanding of changes to housing, infrastructure and services. The analysis focuses on the Local Study Area as there is no anticipation of a meaningful change in population in the Regional Study Area[1]. After

[1] A meaningful population increase is not expected in the Regional Study Area for many of the same reasons as for the Local Study Area, as well as due to the employment Job Referral Service which can be accessed throughout the province and online. This should limit the incentive for people to move closer to the site to access Project-related construction jobs.

establishing the current population in Local Study Area communities, population projections under the existing environment were calculated. For the KCNs communities, a cohort-component-based approach was undertaken; for Gillam, estimates were based on Manitoba Hydro's staffing forecasts; and for Thompson, two growth scenarios were developed based on low and suppressed economic growth in the community (see SE SV Section 4.2 for methodology). The Project is not expected to result in population changes in the Regional Study Area.

Information sources included the following:

- Statistical data from Statistics Canada, Aboriginal Affairs and Northern Development Canada (formerly INAC) , Health Canada and Manitoba Health;
- Key person interview program in Local Study Area communities; and
- KCNs fieldwork research program.

6.6.4.1.1 Construction Effects and Mitigation

There are two Project effects on population: 1) people potentially moving to communities as a result of the availability of employment in the construction workforce; and 2) the short-term influx of non-resident, camp-based workers visiting communities during their time off.

In-Migration

For the KCNs communities, net in-migration associated with Project construction is expected to be quite small (TCN at Split Lake: 0-15 people; WLFN at Ilford: 0-3 people; YFFN at York Landing: 0-3 people; and FLCN in Gillam and/or Bird[1] 0 -10 people) for the following reasons:

- Lengthy waiting lists for on-reserve housing in all of the KCNs communities due to existing housing shortages;
- Construction workers are provided with free accommodation and meals at the construction camp(s) while employed on the Project;
- The work rotation schedule (*e.g.*, 10 to12 hour days) and distance from the Project site to the KCNs communities would deter workers from daily commuting;
- The work rotation schedule is expected to provide sufficient time for workers to travel to more distant home locations during their time off, thus reducing the incentive to relocate closer to the Project;
- KCNs Members would not need to move to communities in the Local Study Area to access construction jobs since they would qualify for Project hiring preferences regardless of their home address within the province of Manitoba; and

[1] Housing constraints in Bird would impede net in-migration, while housing in Gillam may offer some opportunities for FLCN Members to return to the community, although housing in Gillam is also near capacity.

- Some out-migration may occur by community residents in the Local Study Area who secure construction employment and improve their financial status. Out-migration is likely to offset some of the in-migration; however, this cannot be quantified.

Wuskwatim experience supports the prediction of limited population growth as there has been a low level of in-migration to Nelson House due to the Wuskwatim Generation Project at the time of writing. Nevertheless, the KCNs have expressed concern that Project-related in-migration will stress housing and services that are already at capacity. To address this concern, tracking population changes in KCNs communities is an element of the SEMP to confirm the extent of Project-induced migration in KCNs communities and Gillam. If notable Project related in-migration is identified, the Partnership would undertake key person interviews to understand the influence of the Project on population (see Chapter 8). Gillam and Thompson are not expected to see any substantive net in-migration during construction because workers will be housed at the construction camp.

SHORT-TERM INFLUX OF CONSTRUCTION WORKERS

Gillam is expected to experience some short-term influx of workers including non-local senior Manitoba Hydro employees and contractors needing accommodation; however, the numbers cannot be accurately estimated. The short-term influx could also include construction workers in transit to/from the construction site and/or visiting the town during their leisure hours for services and amenities (*e.g.*, restaurant and bar services). The influx of workers is expected to peak during the summer seasons, and the years when the largest numbers of workers are at camp (*e.g.*, Years 3 and 4); however, the numbers cannot be accurately estimated. FLCN and TCN have expressed concern over short-term influx of workers seeking leisure activities in Gillam and Split Lake. These effects are discussed more fully in Section 6.6.5 (Personal Family and Community Life).

Workers may choose to spend some leisure time in Thompson; particularly for day-long visits since Thompson has more amenities than Gillam. Similar to Gillam, visits are expected to have seasonal peaks (Q2 and Q3) and yearly peaks (*e.g.*, Years 3 and 4). YFFN has expressed concern about effects associated with any influx of workers to Thompson as many YFFN Members live and access amenities and services in the city, resulting in potential harmful interactions.

The main camp on the north side of the Nelson River will have a suite of amenities for workers including a lounge and recreational opportunities available throughout the construction phase. These services will limit somewhat the need for travel to local communities; nevertheless, some interaction is expected. The south-side construction camp will be running for a shorter term and is expected to have no amenities. The location of the camp is yet to be determined (likely by the Project contractor), with possible locations near the Butnau Dam or somewhere in closer proximity to the Town. Mitigation is more fully addressed in Section 6.6.5 (Personal Family and Community Life section under Public Safety and Worker Interaction).

In terms of the Regional Study Area, construction of the Project is not expected to result in material effects on population levels in this area (see rationale under Net In-Migration); therefore, no mitigation is required (see SE SV Section 4.4.1 for details). As indicated previously, population is a supporting topic that leads to changes to housing and infrastructure and services. As a supporting topic, no further analysis (*e.g.*, residual and cumulative effects assessment) is provided (see methodology for residual and cumulative effects assessment as described in Chapter 5).

6.6.4.1.2 Operation Effects and Mitigation

Operation phase effects are expected to be driven by Project-related employment opportunities (direct and indirect) and associated population growth focused in Gillam. The Project is expected to create 46 operation jobs based in Gillam; of these, 37 will be required at the generating facility with workers commuting on a daily basis; and nine positions in technical, management and support services located in Gillam.

For the KCNs communities of Split Lake, York Landing and War Lake/Ilford, the operation phase of the Project is not expected to have an effect on population change for the same reasons noted in Section 6.6.4.1 above. The Gillam-based operation jobs also come with subsidized housing by Manitoba Hydro.

In contrast, the FLCN Members residing in Gillam and Fox Lake (Bird) are more likely to be affected by changes in population, to take advantage of Project operation jobs located in Gillam. Given that Gillam is the centre of Manitoba Hydro's northern operations and that FLCN has a reserve in Gillam, there is potential for FLCN Members currently living elsewhere to relocate to Gillam to access long-term operational jobs either associated with Keeyask or with other Gillam-based projects as part of the system-wide operation job targets noted previously. FLCN has noted they expect Members to return to their community for such a reason.

Project effects on population change in Gillam would depend on whether the Project operation staff are hired from within the community or relocate to the community from elsewhere. Growth in the Gillam population as a result of Project operation is estimated to increase between 120 and 150 people. This new population would be in addition to the projected population growth of 30-75 people over the next five to 10 years without the Project. As one component of a SEMP, population change in Gillam will be monitored to enable service providers and community-planning processes to plan and respond to anticipated change (see Chapter 8).

No change in the population of the City of Thompson is expected as a result of operation of the Project because operation jobs are located in Gillam. No mitigation is required.

As a supporting topic, no further analysis is provided (*e.g.*, residual and cumulative effects assessment) (methodology is described in Chapter 5).

6.6.4.2 Housing

During construction, the key drivers of change related to housing in the Local Study Area communities would be demand created by the population seeking or engaging in Project employment, including short-term accommodations in Gillam and Thompson during Project workers' time off. During the operation phase, housing demand would be driven primarily by increases in the population as a result of the Project's operation employment opportunities in Gillam.

The effects on housing and temporary accommodations were examined based on information obtained through key person interviews (KPIs) and predicted population growth. Particular attention was paid to collecting information about current conditions and available capacity of housing today and trends and plans for the future (without the Project) prior to undertaking the effects analysis.

6.6.4.2.1 Construction Effects and Mitigation

In the KCNs communities, the lack of available housing is a primary reason for a low estimate for returning community Members seeking to live in their home community as a result of Project construction. Further to this, the Job Referral System and provisions within the BNA provide preference status for hiring of KCNs Members irrespective of their place of residence within the Province, thus reducing the incentive to move to the Local Study Area to access employment. With limited new Project-related population, it is expected that there will be little new demand for housing in KCNs communities in the area as a result of the Project and existing housing capacity issues will remain largely unchanged. Some KCNs communities may experience some short-term crowding if KCNs Project workers choose to visit and stay with family/friends during their rotation time off.

Project effects on housing in Gillam and Thompson are focused on an increased demand for temporary accommodation. YFFN has expressed concern that their Members living in southern Manitoba may re-locate to Thompson to be closer to Keeyask employment while enabling access to educational, health and social services not available in York Landing (YFFN KPI Program 2009-2010). In addition, KCNs Members rely on short-term accommodation in Thompson when visiting for health appointments, grocery shopping, and other activities and therefore may be competing for short-term accommodation with construction workers.

No mitigation or enhancement is required. Monitoring will occur to determine if the above predictions are accurate in relation to KCNs communities and Gillam (see Chapter 8).

6.6.4.2.2 Residual Effects of Construction

Using the criteria established to determine the significance of Project effects for regulatory purposes (see Section 5.5), the residual effects of Project construction on housing in the KCNs communities, Gillam and Thompson are expected to be adverse, medium in geographic extent, of short-term duration and small in magnitude. Step 2 analysis is screened out based on the

Step 1 analysis. There is a high to moderate degree of certainty in the assessment of this VEC based on the current lack of housing in KCNs communities and because workers do not need to return to their home communities for Project work.

6.6.4.2.3 OPERATION EFFECTS AND MITIGATION

Effects of Project operation on housing stem from increases in population. The Project is predicted to have little effect on housing in Split Lake, York Landing and War Lake/Ilford since there are no substantial population changes anticipated in these communities. Some FLCN Members may return to Gillam or, to a lesser extent, to the community of Fox Lake (Bird); however, housing is very limited in Fox Lake (Bird) and this could discourage return migration.

Housing for operation workers and their families will be provided by Manitoba Hydro; upgrades to existing housing stock and planning of new development in order to meet the needs of current and future workforces are already underway as part of the Gillam Land Use Planning process to meet anticipated demand.

During the operation phase, the Project is not expected to generate new demand for housing in Thompson.

6.6.4.2.4 RESIDUAL EFFECTS OF OPERATION

Using the criteria established to determine the significance of Project effects for regulatory purposes (see Section 5.5), the residual effects of Project operation on housing in Gillam (including FLCN) are expected to be neutral (due to Manitoba Hydro's on-going planning for future demand and provision of housing for operation staff) There are no residual effects on housing for TCN, WLFN, YFFN communities or Thompson during the operation phase. here is a high degree of certainty in the assessment of this VEC due to the on-going planning and provision of operation staff housing.

6.6.4.2.5 CONCLUSION ABOUT RESIDUAL EFFECTS ON HOUSING

Overall, the expected residual Project-related effects on housing are adverse due to the potential for some minor short-term increases people visiting the KCNs communities and Gillam, as well as the cumulative effects on housing in the construction phase due to the potential for a small amount of net in-migration of people into the communities seeking employment opportunities on a wide variety of future projects and activities. The KCNs will communicate with their communities regarding the fact that Members do not need to move into the Local Study Area in order to access Keeyask employment opportunities, as per the Job Referral System and BNA. The adverse residual effects of the Project will overlap spatially and temporally with effects from the following future projects: the Keeyask Transmission Project, the Conawapa Generation Project, Bipole III and Gillam Redevelopment. Cumulative effects on housing as a result of the construction phase are discussed in more detail in Chapter 7.

Operation phase effects related to housing are expected to be neutral due to existing planning mechanisms in place (*e.g.*, the Gillam Land Use Planning Process); therefore, cumulative effects to housing aren't anticipated and the VEC has been screened out from a cumulative effects assessment (see Chapter 5).

As part of a SEMP, monitoring of population changes to gain an understanding of any increased demand for housing in KCNs communities (construction only) and Gillam (construction and operation) will be undertaken to confirm the predicted minimal demand for housing. In addition, KPIs with representatives of the KCNs housing authorities will be undertaken to confirm the predicted minimal demand for housing. Monitoring is described in Chapter 8.

6.6.4.3 INFRASTRUCTURE AND SERVICES

During the construction phase, Project effects on infrastructure and services stem from changes in population resulting from the Project, employment on the Project, proximity to the site and an increased need for social services resulting from non-local construction worker interaction and changes in lifestyle (described in greater detail in Section 6.6.5 Personal Family and Community Life).

During the operation phase, the effects of an increased population in Gillam on infrastructure and services were examined by:

- Estimating the potential Project-related population change in Gillam; and
- Examining the implications of providing infrastructure and services for an expanded population that may include an increased FLCN population residing in Gillam.

Operation effects in Thompson and the Regional Study Area are expected to be negligible due to no substantial population change.

The effects on infrastructure and services were examined based on information obtained through KPIs and predicted population growth. Particular attention was paid to collecting information about current conditions and available capacity of infrastructure and services today and trends and plans for the future (without the Project), as well as experience with past hydro development prior to undertaking the effects analysis.

6.6.4.3.1 CONSTRUCTION EFFECTS AND MITIGATION

The KCNs communities are likely to experience increased demands on infrastructure and services due to a variety of factors. Lifestyle changes and worker interaction may increase demand on community-run social services that are already at capacity in the KCNs communities, resulting in increased demands placed on addictions-related services (*e.g.*, National Native Alcohol and Drug Awareness Program [NNADAP]), other social services (*e.g.*, Awasis) and daycare options (see Sections 4.4.1 5.4.1 of the SE SV for causes behind this increased demand for additional services).

Parents who are involved in Project employment may need additional counselling and family support services both of which will be available at the Project site through the employee retention and support services contract.

Project employment is likely to place added demand on daycare facilities for those families with jobs in their communities and a partner working at the Project site. TCN, WLFN and YFFN's facilities are already operating at capacity. FLCN does not have a daycare facility in Fox Lake (Bird) but may access daycare services in Gillam (see below). Daycare options are particularly important to enable women to access Project jobs and can be an obstacle to a worker's ability or willingness to apply for and/or stay on the job. This is particularly relevant to single parents or families that wish to have two working parents and wanting to access Project-related employment. For the KCNs and in Gillam, provision of daycare services represents an entrepreneurial opportunity.

KCNs communities have also expressed concern that the Project may draw skilled individuals away from local jobs in the community (*e.g.*, social services, construction, local government) to work at the Project's construction camp, thereby reducing in-community capacity in these areas.

Each of the KCNs has negotiated its own AEA with Manitoba Hydro. These agreements have the potential to improve community infrastructure and services as indicated in Table 6-33.

Table 6-45: New Infrastructure and Services Described in Adverse Effects Agreements of the Keeyask Cree Nations

KCNs	Offset Program	New Infrastructure	New Services
TCN	Keeyask Centre	√	√
	Access, Land Stewardship, Healthy Food Fish and Traditional Foods Programs	√	√
	Traditional Lifestyle, Traditional Knowledge Learning, Cree Language and Museum and Oral Histories Programs		√
WLFN	Fish Distribution Centre	√	
	Improved Access and Community Fish Program	√	√
	Traditional Learning/Lifestyle, Cree Language and Museum and Oral Histories Program		√
FLCN	Gathering Centre	√	√
	Youth Wilderness Traditions, Cree Language, Gravesite Restoration and Alternative Resource Use Programs		√
	Crisis Centre and Wellness Counselling Programs; Alternative Justice Lateral Violence and "Where do we go from here" Program	√ (in Gathering Centre)	√
YFFN	Cultural Sustainability Program	√	√
	Resource Access and Use and Environmental Stewardship Programs		√

Split Lake is the closest community to construction activities at the Project site, while Gillam is the closest town with a range of amenities in proximity to construction activities. Both locations may experience effects on infrastructure and services associated with short-term influxes of workers, although the extent of this is anticipated to be greater in Gillam due to a broader ranges of amenities provided. This effect may result in the need for increased services to support residents due to increased pressure on emergency services and community facilities and services. The RCMP has recognized there may be the need to increase local capacity, particularly during peak construction years and overlap with other in-vicinity projects (see SE SV Section 4.4.1). Pressure on accommodation and hospitality services (*e.g.*, local hotels, restaurants and bars) are expected to be addressed by this sector. The Gillam child care facility has responded to increased demand and is building a new facility with expanded capacity (see Section 6.2.3).

Mitigation measures in the Local Study Area include the following:

- The Partnership will continue to keep the RCMP informed about the Project, including construction schedule and anticipated timing of the peak workforce (Gillam and Thompson);
- On-going communication between Manitoba Hydro and local service providers (*e.g.*, NNADAP[1]) to allow for effective and timely planning of service delivery (KCNs and Gillam);
- Through the FLCN AEA, increased youth recreation programming (*e.g.*, FLCN's Youth Wilderness Traditions Program);
- Available counseling services at the site for KCNs workers and their families (KCNs); and
- Increasing accessible and affordable daycare options (this is an entrepreneurial opportunity available to the KCNs communities) (KCNs).

In Thompson, a short-term influx of construction workers has the potential to affect emergency, accommodation and hospitality services. However, the effects on the hospitality sector are likely offset by the benefits from increased business to local hotels and restaurants. YFFN has expressed concern that the infusion of Project construction workers into Thompson will exacerbate existing demand, particularly on emergency, hotel, transportation and commercial services, thereby affecting YFFN's ability to access these services.

The Partnership will continue to keep the RCMP in Thompson informed about the Project, including construction schedule and anticipated timing of the peak workforce. Monitoring related to issues arising from worker-interaction is discussed more fully in Chapter 8 under the Personal, Family and Community Life section.

The Proponent is committed to keeping relevant government and community organizations informed about Project plans on a timely basis to enable these groups to undertake effective planning. In Gillam, the Gillam Land Use Planning process currently underway is a forum for addressing demands on infrastructure and services.

6.6.4.3.2 Residual Effects of Construction

Using the criteria established to determine the significance of Project effects for regulatory purposes (described in Section 5.5), the residual effects of Project construction on the KCNs infrastructure and services are expected to be adverse, medium in geographic extent, of short-term duration and small to moderate in magnitude. Residual effects on Gillam and Thompson infrastructure and services are expected to be adverse, small in geographic extent, of short-term

[1] It is assumed that government services will implement the mitigation measures noted above. Prior to construction, the Partnership will provide Project information to the relevant service providers in order that providers can plan a response to a potential change in needs.

duration and small in magnitude. Step 2 analysis is screened out based on the Step 1 analysis. There is a moderate degree of certainty in the assessment of this VEC based on the mitigation measures currently in place and those being planned.

6.6.4.3.3 Operation Effects and Mitigation

Project operation effects on infrastructure and services stem from the physical presence and operation of the Project and the expected population changes resulting from operation-phase employment.

In Gillam, infrastructure and services already experiencing capacity challenges may be placed under additional stress as a result of population growth associated with the operation phase. Effects on water and waste management, emergency services, social services and daycare facilities are of particular concern. While many of the facilities and services are funded on a per capita basis, Manitoba Hydro supports and subsidizes service delivery to Manitoba Hydro employees in the community and would continue to do so throughout the operation phase.

The Gillam Land Use Planning process is involved in planning for the Town of Gillam. This process has the ability to address joint planning and development issues within the community arising from the Project, and within the context of other future projects in the vicinity of Gillam.

6.6.4.3.4 Residual Effects of Operation

Using the criteria established to determine the significance of Project effects for regulatory purposes (described in Section 5.5), the residual effects of Project operation on infrastructure and services during the operation phase are restricted to Gillam (including FLCN Members) and are expected to be adverse, small in geographic extent, of long-term duration and small in magnitude. Step 2 analysis is screened out based on the Step 1 analysis. There is a high degree of certainty in the assessment of this VEC based on Manitoba Hydro has the major funder of services in Gillam and that a land use planning process is already underway.

6.6.4.3.5 Conclusions about Residual Effects on Infrastructure and Services

Overall, the expected Project-related effects on infrastructure and services (KCNs, Gillam and Thompson) are adverse due to the potential for small increases in pressure on community infrastructure and services.

The adverse residual effects of the Project will overlap or interact spatially and temporally with effects from the following future projects: the Keeyask Transmission Project, the Conawapa Generation Project, Bipole III and Gillam Redevelopment. Gillam is expected to be the most affected community due to the proximity to future projects and activities in the area. The cumulative effects are discussed in more detail in Chapter 7.

Monitoring plans are being developed to address any uncertainties. For the socio-economic environment, a SEMP will be developed after filing the EIS to track key data (see Chapter 8).

6.6.4.4 LAND

The analysis regarding land focused on land requirements identified in the Project Description supporting volume (*i.e.*, Crown land needed to build the Project) to see if these requirements overlapped with any KCNs reserve parcels, Treaty Land Entitlement parcels and land use within the Town of Gillam and City of Thompson boundaries.

Sources of information included the following (see SE SV Section 4.2 for further details):

- Project Description supporting volume;
- KCNs fieldwork research and resultant technical memos;
- Aboriginal Affairs and Northern Development Canada (formerly INAC)- First Nation community profiles;
- The Northern Flood Agreement and subsequent implementation agreements; and
- KPI program with representatives from YFFN, FLCN, Gillam and Thompson and published documents regarding land use planning in Gillam.

6.6.4.4.1 CONSTRUCTION EFFECTS AND MITIGATION

The Project site is located on provincial Crown land that will be purchased by the Partnership. Federally designated First Nation reserve lands will not be encroached upon by the Project's principal structures or infrastructure. There are no Treaty Land Entitlement selections extant or pending on these lands. The KCNs have noted that the Project will affect lands used and accessed by KCNs Members as the Project is located within their traditional territories.

Changes to land in Gillam relate primarily to the potential reconfiguration of transportation routes to improve efficiency and safety. In Thompson, effects on land use pertaining to the storage of materials at off-loading sites relate to the transportation of equipment and materials through the city. There is sufficient capacity at the rail yard for off-loading and short-term storage. No purchase of land is required.

No mitigation is required. Further discussion between the contractor, the Town of Gillam and Manitoba Hydro will occur once the location of the south access road and south side camp have been finalized (especially if the camp will be located within Gillam boundaries).

6.6.4.4.2 RESIDUAL EFFECTS OF CONSTRUCTION

Using the criteria established to determine the significance of Project effects for regulatory purposes (described in Section 5.5), there are no residual effects of Project construction on KCNs reserve or TLE land or land in the City of Thompson. Residual effects on land in Gillam are considered neutral (due to the land use planning process already in hand). There is a high degree of certainty in the assessment of this VEC based on the nature of the Project description (*e.g.*, lease of Crown land).

6.6.4.4.3 Operation Effects and Mitigation

The Partnership will purchase the Crown land required for the Project from the Province of Manitoba. Project operation is expected to have no effect on KCNs reserve or TLE land; however, operation will affect areas accessed by KCNs Members for traditional activities including harvesting. KCNs adverse effects agreements enable KCNs Members to continue traditional harvesting and cultural pursuits in areas away from the Nelson River system. No further mitigation is required.

Growth in the Town of Gillam may increase demand for land to support new housing and commercial developments. The ongoing Gillam Land Use Planning process will address increased demand for housing and commercial development. No further mitigation is required.

There are no anticipated changes to land in Thompson due to Project operation.

6.6.4.4.4 Residual Effects of Operation

Using the criteria established to determine the significance of Project effects for regulatory purposes (described in Section 5.5), there are no residual effects of Project operation on KCNs reserve or TLE land or land in the City of Thompson. Residual effects on land in Gillam are considered neutral (due to the land use planning process already in place). There is a high degree of certainty in the assessment of this VEC due to processes already in place for Gillam.

6.6.4.4.5 Conclusions about Residual Effects on Land

Overall, there is no variance between the analysis of criteria for construction and operation effects. The overall conclusion using the significance criteria noted in Section 5.5 is no residual effects on KCNs reserve or TLE land, or land in Thompson. There is a neutral effect on land in Gillam due to the land use planning process already in place.

In terms of cumulative effects on land, because the Project results either in no effect (KCNs, Thompson) or in a neutral effect (Gillam) related to land during both the construction and operation phases, this VEC has been screened out for undertaking a cumulative effects assessment (see Section 5.4).

No monitoring is required.

6.6.4.5 Transportation Infrastructure

Potential Project effects on transportation infrastructure in the Local Study Area were examined due to the pathway of effect from an increased use of rail, air and road networks related to the transport of people, equipment and materials to the Project site during construction. Effects on the Regional Study Area focused on the predicted increased use of PTH 6 for the transport of people, equipment and materials to the Project site during construction; and increased use of northern road networks by workers traveling to the site.

During the operation phase, analysis focused on the effects of the confirmed re-routing of PR 280 by Manitoba Infrastructure and Transportation (MIT) along the north access road, across the generating facility and along the south access road to Gillam.

Sources of information included the following (see SE SV Section 4.2 for further details):

- Information from MIT concerning road classification and design;
- Traffic projection model; and
- KPI fieldwork program and associated technical memos.

6.6.4.5.1 Construction Effects and Mitigation

Transportation infrastructure within KCNs communities is not anticipated to experience effects as a result of Project construction. No mitigation or monitoring is required.

In Gillam, Project effects on transportation infrastructure include the following:

- Increased vehicular traffic from construction workers and contractors visiting Gillam to access services;
- Increased truck travel and wear on the road networks related to construction of the south access road and dykes;
- Potential for increased air travel to Gillam by construction workers and contractors who fly to Gillam (rather than Thompson) en route to the Project site; and
- Increased use of the railway and siding for a small portion of equipment shipped to the site. An increase in rail traffic will also result in increased traffic between Gillam and the Project site at certain times.

Building the south access road and dykes is anticipated to require an upgrade to the Butnau Road. Upgrades will be undertaken by Manitoba Hydro.

In Thompson and area, Project effects on transportation infrastructure include the following:

- Increased use of rail and the provincial highway network for shipment of equipment and materials through Thompson (including PTH 6, PR 391 and PR 280);
- Increased use of the city road network within Thompson;
- Use of the Thompson rail siding as an off-loading facility for equipment and materials; and
- Increased use of air and bus travel services for construction workers traveling to Thompson en route to the Project site.

The rail, air and bus facilities and services in Thompson have sufficient capacity to accommodate the additional Project-related demand. Some maintenance of city roads may be required due to the potential increased traffic. It is anticipated that regular maintenance of PR 391 and the improvements to PR 280 by MIT, which have been based on projected traffic levels for both KIP and the Project, will be sufficient to handle the increased travel by road associated with the Project during the construction phase. KCNs Members have expressed concerns that the improvements will not adequately address the Project-related increases in damage to vehicles; as well as issues with dust and travel safety. MIT is the responsible authority for PR 280 (see Section 6.6.5.5 for mitigation related to travel safety).

There will be some increase in road, rail and air traffic related to movement of equipment, materials and personnel across the Regional Study Area; however, existing infrastructure is expected to handle the increase. No mitigation or monitoring is required.

6.6.4.5.2 Residual Effects of Construction

Using the criteria established to determine the significance of Project effects for regulatory purposes (described in Section 5.5), there are no residual effects of Project construction on transportation infrastructure internal to KCNs communities. Residual effects on transportation infrastructure are expected to be adverse, medium to large (large for the Regional Study Area) in geographic extent, short-term and small in magnitude. Step 2 analysis is screened out based on the Step 1 analysis. There is a moderate to high degree of certainty in the assessment of this VEC based on Project requirements and data collected through the KPI program.

6.6.4.5.3 Operation Effects and Mitigation

Once the Project is commissioned, MIT will re-route PR 280 to include the north access road, the generating station facility over the Nelson River and the south access road to Gillam. This will create a shorter route between the Project site and Gillam and between Thompson and Gillam (see Map 6-40). The road will be transferred from a private road to the provincial road system. At the same time, MIT plans to abandon the northeastern section of PR 280. FLCN has expressed concern that community Members living in Fox Lake (Bird) will face increased travel distances to reach Thompson if the northern portion of PR280 (around Stephens Lake) is decommissioned.

The operation of the Project is not expected to affect the water level on Clark Lake or Split Lake during open water conditions; and may affect peak winter water levels of Split Lake by 0.2 m (9 in) under low-flow conditions (see Physical Environment SV). However, YFFN have expressed scepticism with these calculations and are concerned that future water fluctuations on Split Lake may affect ferry service and landing sites, as well as the winter road on Split Lake.

6.6.4.5.4 Residual Effects of Operation

There are no anticipated residual effects on transportation infrastructure in either the Local or Regional Study Areas during the operation phase.

6.6.4.5.5 Conclusion about Residual Effects on Transportation Infrastructure

Overall, the expected Project residual effects on transportation infrastructure during the construction phase are adverse due to the ongoing use of road, rail and air networks. There are no residual effects on KCNs community-based transportation infrastructure; and no residual effects on transportation infrastructure during the operation phase.

The adverse residual effects of the Project during construction will overlap or interact spatially and temporally with effects from the following future projects: the Keeyask Transmission Project, the Conawapa Generation Project, Bipole III and Gillam Redevelopment. The cumulative effects are discussed in more detail in Chapter 7.

Monitoring plans are being developed to address uncertainties. In relation to YFFN scepticism noted above, monitoring of water levels on Split Lake is planned (see Chapter 8). In conjunction with MIT, TCN, WLFN and YFFN will continue to monitor the reliability and safety of ferry landing sites and the winter road across Split Lake.

6.6.5 PERSONAL, FAMILY AND COMMUNITY LIFE

This section examines the effects of the Project on personal, family and community life in the Local Study Area. The lives of individuals, families and communities are shaped by many factors; the relationship between direct and indirect effects and these factors can be complex and more difficult to characterize than other socio-economic effects. The contribution of Project-related effects relative to other factors in causing socio-economic change can only be examined in a qualitative way. In addition, a community's "history, culture, social structure, patterns of life, access to resources, community control and cohesion, and values and perspectives" (Harrison and Thomas 2003; Dale and Lane 1994; Ross 1990; as quoted in Lawrence 2004) all contribute to the interpretation of social effects.

Particular attention in the assessment of socio-economic effects was given to the KCNs communities' knowledge and prior experience with hydroelectric development as they relate to personal, family and community life.

As noted in Section 6.2.3.5, the VECs under the Personal, Family and Community Life section include governance, goals and plans; community health; mercury and health; public safety and worker interaction; travel, access and safety; culture and spirituality; and the way the landscape looks (or aesthetics).

Potential pathways of effect during the construction phase could arise from the following:

- Participation in construction employment and business opportunities by KCNs Members and residents of Gillam and Thompson;
- Potential worker-interaction issues in the Gillam and Split Lake areas in particular;
- Physical and biophysical changes to the landscape and resources used by people as a result of clearing and construction activities;
- New access to the Gull Lake and Gull Rapids area;
- Construction-related traffic; and

- The requirements for KCNs leadership to participate in the Partnership, make Project-related decisions and implement the JKDA and AEAs (construction and operation).

During the operation phase, effects on personal, family and community life may stem from:

- Continued implementation of the JKDA and programs and measures under each of the KCNs adverse effects agreement;
- Each of the KCNs receiving return on their respective investments to the benefit of their communities;
- Potential participation in operation phase employment;
- Physical and biophysical changes to the landscape (including the reservoir) and resources used by people as a result of operation of the generating station;
- Elevated methlymercury levels in Gull and Stephens lakes as a result of flooding;
- Changes to the community of Gillam to accommodate the operation workforce;
- Increased access to the Keeyask reservoir; and
- Re-routing of PR 280 allowing for a shorter travel time to Thompson from the Gillam area.

6.6.5.1 GOVERNANCE, GOALS AND PLANS

The Project was considered within the context of each of the Local Study Area communities' governance structures, goals and plans. Analysis of the effects to community governance, goals and plans considered the drivers of change associated with Project construction and operation (these are listed below).

Sources of information included the following (see SE SV Section 5.2 for further details):

- KPI program and fieldwork research program;
- KCNs, Gillam and Thompson planning documents (as available); and
- The KCNs' experience related to past hydroelectric development, and recent participation in the planning and environmental assessment of the Project.

6.6.5.1.1 CONSTRUCTION EFFECTS AND MITIGATION

The KCNs' Future Development and Negotiation teams and the Town of Gillam's leadership have been and continue to be involved in planning for the Project. For the KCNs, their teams will need to continue to coordinate with their communities' Chiefs and Councils as the Project transitions into construction. For Gillam the Town's leadership works closely with Manitoba Hydro currently and will continue as the Project moves into construction.

The KCNs negotiations of the JKDA and AEAs emphasized the importance of bringing their Cree values and worldview in reference to the development of the Project, including increased control of Project activities in their respective RMAs. The KCNs' Cree values are reflected in the ATK principles developed by the Partnership to guide the environmental assessment and preparation of the EIS (see Chapter 2, Appendix 2A).

During the construction phase, effects on community governance, goals and plans stem from the need for local First Nations and municipalities to deal with the implementation of the proposed development and its effects, including effects on their Members and residents. As described in Chapter 2, each of the four Cree Nations experienced uncertainty with respect to entering into the Partnership. Manitoba Hydro supported community-based research and involvement in the planning and assessment processes for the Project and continues to work together with the KCNs to develop the Project. As indicated in the Preface, each of the KCNs has evaluated the impact of the Project on their communities and Members in terms of their own worldview, values and experience with past hydroelectric development. Chapter 2 includes a statement on the KCNs Cree worldview and values, followed by details on the KCNs involvement in the early stages of Project planning (leading to the Agreement in Principle, the JKDA and the AEAs). In addition, each of the KCNs is participating along with Manitoba Hydro in the governance structure of the Partnership as the Project moves forward (see Chapter 2).

Construction effects on the KCNs would stem from the following:

- Decision-making regarding investment and equity participation in the Project;
- Implementation of the JKDA and AEAs; and
- Participation in various advisory activities delineated in the JKDA including the Advisory Group on Employment, Construction Advisory Committee and a Monitoring Advisory Committee.

Each of the KCNs held a community ratification process concerning their involvement in the Project—the voting was on the JKDA as well as a separate vote on each of their respective AEAs (see details in Chapter 2 under each of the KCNs); thus providing an indication that the Project they helped define was consistent with their future goals and plans. Key measures to address the KCNs goals and plans are already in place through provisions in the JKDA and AEAs. These include measures such as DNCs for business opportunities (and employment) related to the construction of the Project, and the implementation of AEA offsetting programs to address social, cultural and environmental adverse effects (see SE SV Section 5.4.1 for further information).

For example, for TCN, their Land Stewardship Program provides funding for TCN to monitor land use in the SLRMA and "to show respect for the land in a manner consistent with traditional TCN values and to assist TCN in caring for the land within the Split Lake Resource Management Area" (TCN and Manitoba Hydro 2009).

The JKDA governs how the Project will be developed. As noted above, there will be opportunities for Members of the KCNs to participate in advisory committees which will build community capacity and governance by exposing and involving greater numbers of community Members in Project governance. The partners will also work together to develop monitoring and follow-up programs that are consistent with the KCNs' goals related to stewardship of the land, including community-specific ATK monitoring (see Chapter 8).

Gillam will be the closest incorporated community to the construction site, which presents potential pressures on the Town's local government as a result of an influx of non-local construction workers into the area. These pressures are also likely to be experienced by FLCN, who represent a large part of the community's population. The Town's Mayor, Council and Chief Administrative Officer, along with Manitoba Hydro and leadership of FLCN will need to maintain strong communication on construction-related activities and mitigation measures. These groups are already involved in a community land use planning process as well as the Harmonized Gillam Development process.

Effects on community governance, goals and plans for Thompson are expected to be indirect and arise from the municipality's need to address other predicted effects on community services described above (including demand for services and use of Thompson as a storage and transportation hub).

No further mitigation or enhancements are required.

6.6.5.1.2 Residual Effects of Construction

Using the criteria established to determine the significance of Project effects for regulatory purposes (described in Section 5.5), the residual effects of Project construction on the KCNs governance, goals and plans are expected to be positive (due to experience gained during negotiations and planning of the Project and sense of increasing influence in stewardship of the Project), medium in geographic extent, long-term in duration and moderate in magnitude. Residual effects on Gillam and Thompson governance, goals and plans are expected to be neutral (due to planning already in place), small in geographic extent, short-term in duration and small in magnitude. Step 2 analysis is screened out based on the Step 1 analysis. There is a high degree of certainty with this assessment since the Partnership has noted the benefits already gained through the process; as well as the benefits embedded in each of the AEAs regarding stewardship and the monitoring and follow-up identified in Chapter 8.

6.6.5.1.3 Operation Effects and Mitigation

During the operation phase, there will be a continuing role for KCNs Members in oversight of the Project, including service on the board of directors and committees. Through these roles the KCNs will have the opportunity to continue to shape the Project; and will be involved in long-term monitoring, including ATK-focused monitoring.

The KCNs are eligible to own up to 25% of the Project (TCN and WLFN 15%, FLCN 5% and YFFN 5%), entitling them to receive annual returns on their investment (see Income Section 6.6.3; also refer to the JKDA for further details). These funds are expected to contribute to goals and plans of each of the KCNs. This increased income may initially increase pressure on community leadership as they determine the optimal ways to invest equity income to support community needs and interests. No further enhancement or mitigation is required.

Gillam will experience an increase in Project-related population. The Town of Gillam will need to respond to the needs of the growing population and associated changes. FLCN, with its urban reserve and substantial presence in Gillam, will also need to respond to community growth and change. Gillam is already undertaking a land use planning process that takes into account future needs related to the Project in coordination with Manitoba Hydro and FLCN. A community Development Plan has been prepared that includes a vision for the Town and various recommendations to address issues such as housing and infrastructure. Continued coordination among leadership of FLCN, the Town and Manitoba Hydro through the planning process will be required to manage change in a way that meets their common goals.

No further enhancements or mitigation are required.

6.6.5.1.4 Residual Effects of Operation

Using the criteria established to determine the significance of Project effects for regulatory purposes (described in Section 5.5), the residual effects of Project operation on the KCNs governance, goals and plans are expected to be positive, medium in geographic extent, long-term in duration and small to moderate in magnitude. Residual effects on Gillam governance, goals and plans are expected to be neutral due to planning already in place, small in geographic extent, long-term and small in magnitude. Step 2 analysis is screened out based on the Step 1 analysis. There is a high degree of certainty due to the long-term involvement in the Project of the KCNs and the planning process already in place related to Gillam.

6.6.5.1.5 Conclusions about Residual Effects on Governance, Goals and Plans

Overall the expected and likely Project residual effects on the KCNs governance, goals and plans are expected to be positive due to existing provisions of the JKDA and AEAs and ongoing involvement in Project committees and the Board. Residual effects on Gillam and Thompson governance, goals and plans are expected to be neutral (due to planning processes already in hand).

Residual effects related to governance, goals and plans are either positive (for the KCNs) or neutral (for Gillam); therefore, this VEC has been screened out for cumulative effects assessment (see Chapter 5 for rationale).

Monitoring related to governance, goals and plans is not necessary as each of the partners has a role in ongoing implementation of the Project through the Partnership Board.

6.6.5.2 Community Health

The approach to understanding community health in the Local Study Area considered factors such as the state of the environment, access to resources to meet basic needs, exposure to risks and capacity to cope with these, income and education level, and social networks and relationships with friends, families and neighbours that contribute to health and well-being (Quigley. *et al.* 2006). Given the complexity of the factors influencing health, the approach to community health began by gaining a broad understanding of the factors influencing health in the Local Study Area. In addition to this, a review of health indicators data from the First Nations and Inuit Health Branch, INAC and Manitoba Health was undertaken. Based on the analysis of health indicators (birth rates and infant health, hospitalization and physical visits, communicable diseases and mortality), key trends related to health were identified. Perspectives and insights from the KCNs and Gillam communities are used to support the health indicator data.

Sources of information included the following (see SE SV Section 5.2 for further details):

- KPIs and fieldwork research programs;
- Community workshops; and
- Data from the First Nations and Inuit Health Branch and Manitoba Health (provided with permission of the KCNs).

6.6.5.2.1 Construction Effects and Mitigation

Health goes beyond the absence of disease and, as noted in Section 6.2.3, it is shaped by a variety of factors or determinants of health, which include the social and economic environment, the physical environment, and a person's individual characteristics and behaviours (WHO 2009).

In addition to effects on mercury and human health, public safety and travel safety (which are treated as separate VECs in this assessment), direct Project effects focus on water quality (turbidity, sediments) during construction, and water quality and effluent treatment associated with the camp. The KCNs place very high value on fresh water – it sustains life (fish, animals and people) and provides access/transportation routes for the pursuit of traditional activities, for visiting friends and families and for staying connected with their broader communities. Each of the KCNs has commented on the fact they can no longer take a cup and dip it in the Nelson River for a drink (including Split, Gull and Stephens lakes).

The AE SV provides additional information on water quality in relation to the Project and measures water quality in relation to the Manitoba Water Quality Standards, Objectives, and Guidelines (MWQSOGs) for the protection of aquatic life. The guidelines for the protection of aquatic life are typically more stringent for things like metals (*e.g.*, mercury), while drinking water guidelines are more stringent for organic compounds (*e.g.*, benzene). The AE SV concludes that metals should generally remain within Manitoba Water Quality Standards, Objectives, and Guidelines for the protection of aquatic life in the reservoir and downstream. The key exceptions are iron and aluminum which are currently present at concentrations well above the MWQSOGs. The Human Health Risk Assessment conducted in relation to mercury and human health does not identify any risk to human health associated with surface water (refer to Appendix 5C of the SE SV for further detail). Direct drinking of surface water is not a recommended practice; Health Canada indicates that all untreated water should be boiled for one minute before consumption (Health Canada 2012). Since none of the communities use Gull Lake as their drinking water source, direct effects on health are not a pathway of effect from the Project. Drinking water at the camp will undergo appropriate water treatment as per regulations.

Indirect effects on the determinants of health may stem from a variety of factors associated with the presence of a major construction project in proximity to the KCNs communities. The KCNs' experiences with past hydroelectric development (as noted in Section 6.6.2) have noted the overall implications for community health associated with increased availability of disposable income (boom and/or bust effect and inappropriate use of new-found income), potential increase in alcohol and/or drug use and associated lifestyle, interactions with construction workers, change in access to country foods, and worry or scepticism about environmental changes, predictions of change and continued deterioration of environmental health. Although the extent and nature of specific effects on the health of individuals, families and communities cannot be quantified, potential changes could result from the following:

- Increased income – employment income could have positive effects on the level of living (*e.g.*, purchase of nutritious foods), or could have adverse effects if the income is used unwisely (*e.g.*, for purchase of alcohol and drugs). Increased income may not be distributed evenly within each KCNs community.
- Alcohol and drug use – increased availability of income may result in increased opportunity for alcohol and drug use, in addition to increasing the availability of drugs and associated gang presence in the area. This can lead to an increase in violence.
- Worker interaction – in addition to those effects described under Public Safety and Worker Interaction below, there is the potential for increases in sexually transmitted infections.
- The KCNs' AEAs provide the opportunity to increase access to country foods (*e.g.*, fish, moose and caribou). These programs may have a positive effect on overall community health as people choose more healthy country foods. For those people participating in the harvesting, the ability to spend more time on the land undertaking traditional pursuits also could have positive health benefits.
- KCNs Members have expressed worry about the impending changes expected in their environment, as well as scepticism and mistrust of the predicted changes (*e.g.*, see YFFN Evaluation Report (*Kipekiskwaywinan*) for concerns over the water regime). This could cause an increase in anxiety and have potential adverse indirect effects on health.

The KCNs communities' overall vulnerability needs consideration in devising mitigation for potential adverse effects on determinants of health. In addition to programs noted in each of the KCNs' AEAs, mitigation measures to enhance health services in both the KCNs communities and Gillam are noted below (further details are provided in Section 6.6.4.3 and Section 6.6.5.4):

- On-going communication between Manitoba Hydro and local service providers (*e.g.*, Awasis and NNADAP[1]) to allow for timely and effective planning of support services;
- Counselling and family support services available on site through the employee retention and support services contract;
- Increasing accessible daycare options (Gillam has addressed this concern with a larger facility set to open in 2012; for the KCNs communities, this is an entrepreneurial opportunity);
- The Partnership will keep the RCMP informed about the Project, including construction schedule and anticipated timing of the peak workforce (see Section 6.6.4.3);
- Through the FLCN AEA, increased youth recreation programming (*e.g.*, FLCN's Youth Wilderness Traditions Program); and
- Measures focused on construction workers on site (see Section 6.6.5.4).

It is also suggested that discussions with the BRHA take place prior to the onset of construction to help them prepare and plan for the construction period, including the potential need for public information campaigns to address such issues as sexually transmitted infections. No further mitigation or monitoring is required.

6.6.5.2.2 Residual Effects of Construction

Using the criteria established to determine the significance of Project effects for regulatory purposes (described in Section 5.5), the residual effects of Project construction on community health are expected to be adverse, medium in geographic extent, of medium-term duration and small in magnitude. Step 2 analysis is screened out based on the Step 1 analysis is not. There is a high degree of certainty in the assessment for this VEC due to existing AEA programs and the ongoing commitment of Manitoba Hydro to maintain communication with local service providers in Gillam.

6.6.5.2.3 Operation Effects and Mitigation

Community health has the potential to be directly affected during Project operation through the pathways of mercury and health (see Section 6.6.5.3 below), water quality changes in Gull Lake (see Physical and Aquatic Environment SVs), and travel safety related to road travel, trail and water-based travel (see Section 6.6.5.5 below). Each of those sections referenced above set out conclusions and mitigation measures to address potential adverse Project effects.

Indirect effects on the determinants of health during the operation phase stem from a variety of factors including increased income, population change affecting access to services, change in access to country foods and worry and scepticism about environmental changes and predictions of change. Although the extent and nature of specific effects on the health of individuals,

[1] It is assumed that government services will implement the mitigation measures noted above. Prior to construction, the Partnership will provide Project information to the relevant service providers in order that providers can plan to responds to a potential change in needs.

families and communities cannot be quantified, potential changes could result from the following:

- Increased income—equity income (KCNs) and operation employment income (Local Study Area) (see SE SV Section 3.4.2 for details) could have positive effects on the level of living at the individual and/or family level as well as the community level; or could have adverse effects if income is used to make poor choices (*e.g.*, spending on drugs or alcohol). The equity income can be used to provide infrastructure and services in the communities, having a positive overall effect on community health. There is more likelihood of seeing the positive health effects associated with increased income as both the 46 Project-related operation jobs and 182 system-wide job opportunities by 2029 identified in the JKDA will be long-term in nature.
- Access to services—Gillam is the location of operation employment associated with the Project and is expected to see population growth, placing increased pressure and demand for health and social services.
- Increased access to country foods—the KCNs AEAs provide a long-term opportunity to increase access to country foods, thus having a positive effect on community health.
- Scepticism of predicted environmental change—KCNs Members have expressed worry about long-term environmental changes associated with the Project (*e.g.*, YFFN Members feel there could be changes to water quality at York Landing despite Manitoba Hydro's predicted open-water hydraulic zone of influence).
- Some KCNs Members continue to have mistrust of Manitoba Hydro based on their past experiences with hydroelectric development in the Local Study Area, potentially resulting in increased anxiety.
- KCNs also believe in "what goes around comes around" and that acting as Partners in the Project could have implications for well-being. This could cause an increase in anxiety and have potential adverse indirect effects on health.

In addition to programs noted in each of the KCNs' AEAs, the Partnership will continue the existing dialogue with health and social services providers in Gillam and the KCNs communities regarding Project activities, so as to allow these agencies to react to potential demands on their capacity. The target agencies for Project-related communication include:

- Health and social services providers (*e.g.*, NNADAP, Awasis);
- Emergency services (*e.g.*, the Burntwood Regional Health Authority and Gillam Hospital); and
- The RCMP (Gillam and Thompson).

Manitoba Hydro, the Town of Gillam, and FLCN are already involved in long-term planning initiatives for Gillam, which can assist in identifying potential future trends related to infrastructure in the community. Further to this, the KCNs will be involved in ATK monitoring and follow-up programs to address community-specific concerns.

6.6.5.2.4 Residual Effects of Operation

Using the criteria established to determine the significance of Project effects for regulatory purposes (described in Section 5.5), the residual effects of Project operation on community health for the KCNs and Gillam residents are expected to be positive due to employment and equity income providing the opportunity for a higher standard of living, of medium geographic extent, of long-term duration and small in magnitude. Step 2 analysis is screened out based on the Step 1 analysis. There is high degree of certainty in the assessment for this VEC due to existing AEA programs and the ongoing commitment to communication with service providers and planning in the Town of Gillam.

6.6.5.2.5 Conclusions about Residual Effects on Community Health

Overall, residual Project effects on community health are expected to be adverse for the construction phase due to the potential for increased alcohol and drug use, adverse worker interactions and worry about impending changes to the environment; and positive for the operation phase due to the implementation of AEA programs and the commitment to ongoing communication and planning.

For the construction phase, the adverse residual effects of the Project on community health will overlap or interact spatially and temporally with effects from the following future projects: the Keeyask Transmission Project, the Bipole III Transmission Project, the Conawapa Generation Project and Gillam Redevelopment (for FLCN and Gillam residents). The cumulative effects are discussed in more detail in Chapter 7.

The KCNs involvement in monitoring and communication programs identified elsewhere in this chapter will assist in reducing uncertainty and identifying any needed follow-up. No additional monitoring related to community health is suggested; however, communication of the monitoring results and follow-up related to other programs (*e.g.*, Physical Environment Monitoring Program) to the KCNs Members is important to alleviate the concerns identified in this section.

6.6.5.3 Mercury and Human Health

Since the Project will result in flooding and the subsequent release of methylmercury into the Nelson River biologicial system (*i.e.*, food chain), and in response to concerns expressed by the KCNs and Manitoba Hydro, the approach to understanding mercury and human health was threefold. Initially, TCN recognized the need to address elevated methylmercury levels in fish post-Project during their negotiations of their AEA. This resulted in TCN's Healthy Food Fish Program becoming an integral element of their AEA. Similar programs were also incorporated into the War Lake and YFFN AEAs. A Mercury and Human Health Technical Working Group (hereafter the "Technical Working Group") was then established comprised of KCNs representatives, Manitoba Hydro and its consultants, and experts in the area of mercury and human health identified and retained by the group. Finally, a human health risk assessment was undertaken by an external toxicologist selected by the Technical Working Group. The human health risk assessment was prepared based on information provided by various members of the environmental assessment study team as well as members of the Technical Working Group (see SE SV Section 5.3.3 for details on the Technical Working Group and Appendix 5C to the SE SV for the HHRA).

In order to characterize the effects of impoundment on methylmercury levels and subsequently human health, exposure to methylmercury considered both the current and post-impoundment conditions. Concentrations of methylmercury were measured or predicted for country foods identified by the KCNs, including fish, wild game, and waterfowl in addition to surface water.

The human health risk assessment evaluated the potential exposure to methylmercury for the KCNs, as these are the communities at greatest risk due to their use of country foods. Although the human health risk assessment focused on the KCNs, the baseline conditions and results of the risk assessment are also generally applicable to non-First Nation individuals who use Stephens Lake and/or Gull Lake for resource harvesting in a similar capacity (*i.e.*, residents from Gillam; with similar frequency and size of meals).

The assessment of effects of methylmercury on human health is limited to the operation phase as there are no anticipated effects of construction of the Project in relation to methylmercury and human health. Methylmercury will not be released into the environment prior to impoundment.

Sources of information included the following (see SE SV Section 5.3.3 for further details):

- Mercury concentrations in samples of fish and wild game collected by members of the aquatic and terrestrial study teams;
- Literature on the topic; and
- KCNs Members identification of key country foods selected for the human health risk assessment.

6.6.5.3.1 Construction Effects and Mitigation

The effect of methylmercury on human health is an issue of concern to each of the KCNs and to Manitoba Hydro. Past hydroelectric developments of the 1970s in northern Manitoba led unexpectedly to raised levels of methylmercury in fish from affected waterways. For example, methylmercury levels in northern pike and walleye rose in differing amounts within 3 to 7 years after flooding. These elevated levels then declined over time so that, 20 to 30 or more years after flooding, they had returned to near original concentrations or levels that are similar to those found in fish from lakes in the area that were not affected by flooding (see SE SV and associated appendices related to mercury and human health).

Country food is an important part of the diet in KCNs communities. In the period after past flooding, many communities in the Local Study Area became aware they should not eat fish from affected waterways because of methylmercury contamination. This caused alarm in the communities and led many people to reduce the amount of local fish in their diet. When the Keeyask Generation Project was proposed, flooding of Gull Lake again raised the concern about effects of methylmercury on human health through the pathway of consumption of country food, particularly fish.

There are no anticipated effects of the Project during the construction phase in relation to methylmercury and human health because the pathway of effect is through reservoir flooding, where effects appear in fish a few years after impoundment (*i.e.*, during the operation phase).

6.6.5.3.2 Residual Effects of Construction

There are no residual effects from methylmercury on human health during the construction phase.

6.6.5.3.3 Operation Effects and Mitigation

As noted above, a Mercury and Human Health Technical Working Group was established by the KCNs and Manitoba Hydro (with support from technical specialists) to address Project effects of methylmercury on human health. Their focus was to both understand the potential risks to human health as a result of the Project and devise communication strategies to inform the public about these risks currently and after impoundment (see SE SV Section 5.3.3 for details on the Technical Working Group and their work during the planning and assessment stage).

A human health risk assessment (HHRA) was undertaken by an external toxicologist, Mr. Ross Wilson; and the HHRA was peer reviewed by Dr. Laurie Chan, an international expert on mercury and human health. The methods used to estimate human health risks were primarily based on risk assessment procedures cited by Health Canada, the World Health Organization, and the U.S. Environmental Protection Agency (see the SE SV Appendix 5C for the details on the HHRA). The HHRA was informed by the KCNs who shared knowledge regarding types, locations, and estimates for consumption of selected country foods. Post-impoundment methylmercury concentrations in water and country food sources were predicted in other sections and volumes of the EIS (see AE and TE SVs for concentrations in fish, waterfowl and mammals; and the SE SV for conclusions related to people).

As noted in the Aquatic Section 6.4.7 fish methylmercury concentrations are predicted to increase in the Keeyask reservoir and Stephens Lake and will reach peak levels within three to five years in lake whitefish and four to seven years in northern pike and walleye of standard size (350 mm (14 inches), 550 mm (22 inches), and 400 mm (16 inches) fork length for whitefish, jackfish (northern pike), and pickerel (walleye), respectively). Peak levels of methylmercury concentrations are not expected to persist for more than a few years; however, it will likely take about 20–30 years before concentrations will return to pre-Project levels in the Keeyask reservoir (Section 6.4.7.)

The greatest post-impoundment risks are estimated from consumption of jackfish and pickerel from Gull Lake due to tissue concentrations of methylmercury predicted to reach or slightly exceed 1.0 ppm. Methlymercury concentrations in these fish in Stephens Lake are predicted to be between 0.2 and 0.5 ppm[1]. Lake whitefish that are a standard size or smaller (*e.g.*, 350 mm or 14 inches) from either lake are expected to be safe to eat because methlymercury concentrations in these fish are predicted to remain at less than 0.2 ppm. Table 6-34 provides the overall recommendations for consumption of lake whitefish, jackfish and pickerel after impoundment and when methylmercury is estimated to be at its peak. To maintain a desirable margin of safety, the HHRA recommends that women of childbearing age and young children, considered to be vulnerable populations, avoid eating jackfish and pickerel of standard length or larger, and select safe country foods in their place (*e.g.*, lake whitefish, or fish from off-system areas). Overall, eating country foods safely is an important part of a healthy diet; community residents are encouraged to follow the consumption recommendations that afford substantive health benefits from eating country food.

Table 6-46: Overall Recommendations for Domestic Consumption of Fish from Gull and Stephens Lakes based on Fish Size Class: Post-Impoundment Conditions

Receptor Group of Concern	Lake Whitefish of Standard Length (*e.g.*, 350 mm)	Jackfish of Standard Length (*e.g.*, 550 mm)	Pickerel of Standard Length (*e.g.*, 400 mm)
GULL LAKE			
Women of childbearing age and toddlers	Unrestricted eating	Avoid eating	Avoid eating
Women past childbearing age and all adult men	Unrestricted eating	Avoid eating	Avoid eating
STEPHENS LAKE			
Women of childbearing age and toddlers	Unrestricted eating	Avoid eating	Avoid eating
Women past childbearing age and all adult men	Unrestricted eating	Eat up to 1 meal per week	Eat up to 1 meal per week

Source: Wilson Scientific, 2012 (see SE SV Appendix 5C).

In the case of moose, beaver and snowshoe hare, the concentrations of total mercury in the tissue of these animals are not expected to change post-impoundment. As a result, there is no change in risk from consumption and these animals are considered safe to eat. In the case of

[1] 0.2 ppm of methylmercury is the guideline for domestic consumption of fish used in the HHRA and 0.5 ppm is the guideline for commercial sale of fish.

muskrat, the estimated concentrations may increase from 0.02 ppm to 0.04 ppm; the risks from consumption were estimated to be acceptable (SE SV Appendix 5C).

Other mammals such as caribou, bear or lynx were not considered in the HHRA; however, these animals are not expected to have higher concentrations of mercury than the wild game considered in the HHRA since these species have less contact with the aquatic ecosystem and are not consumed as frequently. Some aquatic mammals such as otter and mink may experience higher mercury concentrations than the mammals considered in the HHRA: however, these animals are not consumed by the KCNs communities. (For more details on the HHRA, refer to Appendix 5C of the SE SV). Overall, based on the HHRA results, consumption of duck is not expected to pose unacceptable health risks under post-impoundment conditions.

Project-related increases in mercury in surface water in Gull and Stephens lakes are not expected to be detectable or to cause or contribute to exceeding the drinking water quality guideline in or downstream of the Keeyask reservoir (*e.g.*, <0.05 µg/L) (see SE SV Section 5.4.2 and Appendix 5C of the SE SV). Therefore, no unacceptable health risks related to methylmercury are expected as a result of exposures from ingestion, swimming or bathing in surface water post-impoundment.

Reduced use of country foods may have its own health effects. To address this concern, fish replacement programs have been included in each of the KCNs AEAs as a key measure to encourage continued use of country food from areas unaffected by the Project (*e.g.*, TCN's Healthy Food Fish Program). In addition to these AEA programs, the following mitigation measures will be in place to address effects:

- Monitoring of methylmercury concentrations in fish under the Aquatic Environment Monitoring Plan (see Chapter 8).
- Voluntary collection of samples of wild game, waterfowl and plants for mercury testing to confirm mercury concentrations remain acceptable for domestic consumption as a part of the Terrestrial Environment Monitoring Program (see Chapter 8).
- Preparation of a risk communication strategy for the KCNs (see SE SV Section 5.4.2), Gillam and other users of the affected lakes prior to impoundment. The strategy will include communication products and development of a monitoring program. The strategy will also include a balanced message to encourage residents to eat country foods (including fish from unaffected areas provided via AEA offsetting programs for the KCNs communities), and to avoid high methylmercury fish from affected areas. Prior to impoundment, prepare and distribute communication products (*e.g.*, poster, placemat, fish yardstick, maps and video) (see Section 5.3.3 of the SE SV) to inform KCNs communities and Gillam about increases in mercury concentrations post-impoundment, and implementation of monitoring.
- Employment of a risk communication protocol similar to that developed for the KCNs for residents of Gillam, with particular focus on Stephens Lake. In addition to this, signage will be placed at Gull Lake to identify the recommendations for fish consumption.

- Communication of monitoring results as they become available.
- The HHRA will be updated every five years after peak mercury levels have been reached to determine if adjustments can be made to the consumption recommendations; updates will continue until mercury levels return to pre-Project conditions.
- Liaison (through the Partnership MAC) with provincial and federal health authorities and Manitoba Conservation and Water Stewardship regarding preparation of restrictions at Gull and Stephens lakes.

No further mitigation is required.

6.6.5.3.4 Residual Effects of Operation

Using the criteria established to determine the significance of Project effects for regulatory purposes (described in Section 5.5), the residual effects of Project operation on mercury and human health are expected to be adverse, medium in geographic extent, of medium-term duration (as mercury levels decline over time) and moderate in magnitude. The key pathway of concern is the protein content that community members (KCNs and Gillam residents) will lose given the recommendations to avoid eating certain species of fish or reducing consumption levels. The AEA offsetting programs that the KCNs communities negotiated along with the mitigation measures identified above are fundamental to addressing residual effects of methylmercury on human health. Although the effects will last longer than a decade (to enable methylmercury levels to decline), the effects are ultimately not permanent (*i.e.*, they are reversible). The concept of addressing vulnerable groups is also inherent in the consumption recommendations related to fish with elevated methylmercury levels. Step 2 analysis is screened out based on the Step 1 analysis and additional social context noted above. There is a high degree of certainty in the assessment of this VEC based on the preparation of the HHRA and information provided directly by those eating the country foods.

There are no residual effects related to residents of Thompson.

6.6.5.3.5 Conclusions about Residual Effects on Mercury and Human Health

Overall, residual Project effects on mercury and human health are expected to be adverse during the operaton phase only due to the elevated levels of methylmercury in country foods. . Methylercury and human health effects are expected to be adverse; however, there is no spatial overlap with future projects and activities that could also affect methylmercury levels. It should be noted that resource users who travel throughout broad areas may be exposed to other lakes (on and off system) that have increased methylmercury levels (both naturally occurring and from anthropogenic sources).

Monitoring plans are being developed to address uncertainties (see Chapter 8). Most of the monitoring plans related to methylmercury are identified in the AE and TE SVs. Communication of these results will be an important element related to human health, as will involvement of the KCNs in implementing communication strategies post-impoundment.

6.6.5.4 Public Safety and Worker Interaction

Analysis of the effects to public safety considered the drivers of change associated with Project construction, and to a lesser extent, Project operation. Drivers of change during the construction phase considered several factors, all of which were identified by the KCNs as areas of potential concern (see SE SV Section 5.2.4 for details).

Based on the KCNs' experience with past projects, the assessment of effects focused on issues associated with the influx of non-local construction workers into communities and new income associated with employment on the Project. An assessment of worker interaction risks was carried out taking into account the size of the incoming workforce, availability of leisure time amenities at the construction camp and in Split Lake, Gillam and Thompson, travel distances and local resident knowledge of what happened on past projects and what might be done to avoid similar occurrences during Project construction. A worker interaction workshop was held with FLCN Members in January 2010 to better understand past experience and identify potential mitigation measures.

Sources of information included the following (see SE SV Section 5.2.4 for further details):

- KPI program and fieldwork research program memos;
- Documented experience with past hydroelectric projects in Manitoba;
- Literature concerning effects of major development projects on local communities; and
- Annual crime statistics from the two RCMP units which police the Local Study Area.

6.6.5.4.1 Construction Effects and Mitigation

Construction phase effects focus on two main factors: 1) the influx of non-local construction workers into a community, and 2) the availability of new disposable income for residents employed during construction that result in the potential adverse interaction of construction workers and local community Members. Public safety effects are particularly relevant to those communities in closest proximity to the Project, namely Gillam, including FLCN, and Fox Lake (Bird), and Split Lake. The KCNs have also noted that their Members residing in Gillam and Thompson have the potential to come into contact with non-local construction workers.

The KCNs' past experience with hydroelectric projects such as Kettle, Long Spruce and Limestone generating stations indicate that an influx of non-local workers can result in a broad array of effects on those residing in proximity to developments (see SE SV Section 2 for more detail on past developments). Members of FLCN anticipate effects similar to what was experienced in the past, as reflected by statements such as "The quiet town [FLCN] once knew was transformed almost overnight into a place where street parties, brawls and violence were commonplace" and "I can't say how many thousands of men there were – but there were a lot of men and all the women around here were ours. Ours, unfortunately" (FLCN 2009 Draft).

Contributing to issues associated with worker interaction are increased disposable income, the potential for inappropriate spending on alcohol and drugs, the temporary/transient nature of a non-local construction workforce, and increased traffic on the roads, including the increased potential for impaired driving (Section 6.6.5.5 addresses this issue) (SE SV Section 5.4.5). These issues are relevant to all Local Study Area communities.

Increased disposable income and the potential for increased spending and availability of alcohol and drugs is a key concern (FLCN KPI Program 2009-2010; CNP 2010b). Lack of alternative expenditure opportunities in Gillam and the KCNs communities may contribute to these spending choices. The potential for violence, aggression or other behaviour that threatens an individual or group's safety is often correlated with alcohol consumption (Bushman 1993; Chermacks *et al*., 1997; Parker Nash and Auerhahn 1998) and has been identified as an important concern by all of the KCNs. The concern over increased gang activity has also been expressed by FLCN Members, particularly related to their youth (FLCN KPI Program 2009-2010).

The Project construction workforce likely will be on a 10 to 12 hour day, 6 days per week work rotation. Leisure amenities at the main camp on the north side of the Nelson River will include recreation facilities and a lounge; however, Gillam and Thompson have a variety of amenities to draw workers from the camp at the end of their rotation and/or weekly shifts (*e.g.*, bars, liquor stores, restaurants, hotels and shopping). Split Lake offers ameneties including a gas station, store and fast food outlet. Most of the construction workers will be stationed at the main camp on the north side of the Nelson River fluctuating between 100 to 1,600 total workers. The peak workforce will occur during the summer construction season (Q2 and Q3) each year; and the peak years are generally at the mid-construction period (2016/2017/2018).

Construction of the south access road is anticipated between 2014 and 2015, resulting in a smaller camp (approximately 100 people) located on the south side of the Nelson River, in close proximity to Gillam boundaries (location of south camp has yet to be determined). The south access road camp will not include amenities such as a lounge and recreation facilities; therefore camp workers are more likely at the south camp than at the north camp to drive to Gillam on a regular basis.

Travel distance to Thompson from the main construction camp (north side) is about 208 km, Gillam is about 140 km away, and Split Lake (although offering the fewest amenities) is the closest at approximately 72 km. Generally, it is expected that workers at the main camp would be more likely to travel to Thompson than to Gillam during their off-hours (due to a greater variety in amenities as compared to Gillam), but it is also anticipated that Gillam would be visited. Although the community of Split Lake is en route to Thompson, visits to Split Lake are expected to be limited to workers with family and friends living in the community, and a small number of non-local workers. The rational is that Split Lake lacks the broad range of amenities that non-local construction workers would be seeking (*e.g.,* banking, restaurants, lounges and shopping). The south access road camp is more likely than the north camp to result in regular visits to Gillam (possibly daily visits) for the reasons noted above as well as the requirement to drive through Gillam for travel to Thompson.

The total number of visits to each community is difficult to predict and the number and type of interactions during visits are not possible to forecast with any accuracy; however, given that past experiences with hydroelectric development often have been adverse, even a single incident could have a damaging effect on KCNs Members. Members of the KCNs have expressed strong concern over potential adverse effects related to worker interaction, particularly in Gillam and Thompson. Although Split Lake has a larger population than Gillam, the community may be more sensitive to visits from non-local workers as this is not as common an occurrence as it is in Gillam and Thompson. YFFN has noted that many of their youth attend high school in Thompson and there is the potential for adverse interactions with construction workers.

Mitigation measures include preventative measures at the camp, as well as overall coordination and discussion across all projects involving Manitoba Hydro in the vicinity of Gillam to address worker interaction issues. Mitigation is geared not only towards KCNs Members, but also to construction workers on site, and the broader community in Gillam. Additional measures are noted under Population, Infrastructure and Services – Section 6.6.4

Measures focused on construction workers at the Project site include the following:

- Cultural training for all construction workers as part of the YFFN and FLCN DNC on Employee and Retention Support re: behaviour expectations;
- A lounge and recreational facilities at the main camp to encourage workers to stay on site during their leisure hours;
- Restriction of unauthorized public visits to the construction camp and associated facilities (included in the Keeyask Generation Project Construction Access Management Plan);
- Restriction of the use of company vehicles for personal use;
- Operation of a shuttle to transfer incoming and outgoing workers between Gillam and Thompson airports and the site, thereby discouraging non-northern workers from bringing their personal vehicles to site; and
- Establishment of a camp committee to oversee implementation of consequences of inappropriate behaviour by workers in camp (part of Camp Rules).

Measures addressing prevention and coping are focused primarily on Gillam, FLCN (Gillam and Fox Lake (Bird) and Split Lake. Considerable uncertainty exists concerning the expected number of visits by non-local construction workers in Local Study Area communities (especially Gillam) and the expected number and types of adverse occurrences. Ongoing dialogue between Manitoba Hydro and Gillam and Thompson RCMP, who are responsible for policing in the KCNs communities, during the construction phase will assist in identifying whether worker interaction is an issue in Gillam, in other KCNs communities (*e.g.*, Split Lake) or in Thompson. Discussions will also begin prior to the start of construction among Manitoba Hydro, the Town of Gillam, FLCN and TCN to determine the best mechanism for tracking and addressing worker interaction issues and concerns across all of Manitoba Hydro's proposed projects in the vicinity of Gillam. It is anticipated that local justice and social agencies will be involved in these discussions, where appropriate, to gather data and to participate in the development of suitable mitigation measures.

6.6.5.4.2 RESIDUAL EFFECTS OF CONSTRUCTION

Using the criteria established to determine the significance of Project effects for regulatory purposes (described in Section 5.5) the residual effects of Project construction on public safety and worker interaction in KCNs communities and Gillam are expected to be adverse, medium in geographic extent, of short to medium-term duration and moderate in magnitude. As there is some uncertainty that Project effects can be completely mitigated, it will be important to have a SEMP in place and for the Partnership, Manitoba Hydro and other parties identified above to be prepared to evaluate situations and develop appropriate strategies in response (see Chapter 8). The analysis undertaken respecting public safety and worker interaction has inherently included the nature of the population with a heightened sensitivity to possible worker interaction issues, including history with past hydroelectric projects and their associated effects. Step 2 analysis is screened out based on the Step 1 analysis and inclusion of social context within Step 1 analysis.

Residual effects in Thompson are expected to be adverse, small in geographic extent, short to medium-term in duration and moderate in magnitude.

There is a moderate degree of certainty in the assessment of the VEC since considerable effort was undertaken to understand the nature of past effects of hydroelectric development on the KCNs communities, and information provided by the KCNs on the severity of past effects has been incorporated into the analysis. In addition, steps are being taken to address the issue of worker interaction with relevant stakeholders across all of Manitoba Hydro's proposed projects and activities in the vicinity of Gillam, rather than on a project by project basis. This coordinated approach provides greater certainty that the issue will be addressed in an effective and timely manner.

6.6.5.4.3 OPERATION EFFECTS AND MITIGATION

Project effects on public safety and worker interaction during the operation phase are expected to be minimal since the number of workers involved in the operational workforce is small, workers may be a combination of KCNs Members as well as non-local people, and workers will be living in Gillam long-term resulting in having a stake in the community. These factors will assist in minimizing the potential for adverse worker interactions. As noted, a coordinated approach to addressing issues related to worker interaction across all Manitoba Hydro projects in the vicinity of Gillam is planned. Any related processes and measures implemented during the construction phase could be extended into operation if required.

6.6.5.4.4 RESIDUAL EFFECTS OF OPERATION

Given the above, and using the criteria established to determine the significance of Project effects for regulatory purposes (described in Section 5.5), residual effects in Gillam are expected to be adverse, medium in geographic extent, long-term in duration and small in magnitude. Similarly to the construction phase, there is a moderate degree of certainty in this assessment. Step 2 analysis is screened out based on the Step 1 analysis.

6.6.5.4.5 CONCLUSIONS ABOUT RESIDUAL EFFECTS ON PUBLIC SAFETY AND WORKER INTERACTION

Overall, residual Project effects on public safety and worker interaction are primarily associated with the construction phase and are expected to be adverse due to the potential for adverse worker interactions occurring. The adverse residual effects of the Project will overlap or interact spatially and temporally with effects from the following future projects: the Keeyask Transmission Project, the Conawapa Generation Project, Bipole III and Gillam Redevelopment. The cumulative effects are discussed in more detail in Chapter 7.

Monitoring plans are being developed to address uncertainties. The SEMP will address monitoring of potential adverse interactions between non-local construction workers and residents in Gillam (including FLCN Members) as discussed in Chapter 8.

6.6.5.5 TRAVEL, ACCESS AND SAFETY

Travel, access and safety consider two general forms of transportation and associated issues with access and safety: 1) water- and ice-based travel; and 2) road-based travel. The assessment of water-based travel effects take into account the extensive waterways management programs that have been established through the JKDA. In the case of road travel, the analysis takes into account the extensive improvements to PR 280 that are currently being carried out to meet the added traffic loads of the KIP as well as the proposed Project. A traffic analysis was undertaken to provide forecasted type and size of traffic estimated for the Project (KGS Acres 2010). A revised traffic analysis based on updated workforce estimates and construction timing will be provided in a supplementary filing.

Sources of information included the following (see SE SV Section 5.2.5 and 5.3.5 for further details):

- Traffic volume and collision data from Manitoba Infrastructure and Transportation and the RCMP;
- Traffic forecast analysis;
- KPIs and fieldwork research programs;
- The JKDA provisions; and

- Information from the other supporting volumes (particularly PD, PE and the KCNs' Environmenal Evaluation Reports).

6.6.5.5.1 CONSTRUCTION EFFECTS AND MITIGATION

Travel, access and safety include consideration of effects on the navigability of the affected water bodies in addition to road travel and safety (*i.e.*, Project-related traffic).

WATER AND ICE-BASED TRAVEL

Project effects on travel, access and safety on the waterways will be experienced by those who use the Nelson River for transportation and for traditional activities such as hunting, fishing and trapping. The Project activities that will impede travel along the river, affect shoreline access and affect navigation safety on the Nelson River include the construction of cofferdams, dykes, installation of the ice boom, the north, central and south dams and the generating facility, the south access road (re: access) as well as the creation and impoundment of the reservoir during the latter years of the construction phase (see Map 4-15 in Project Description Section).

KCNs with experience with past hydroelectric developments have highlighted the following effects: access restrictions along the shoreline and landing sites in vicinity of the Project site, interference with the flow of the waterway and restricted access in vicinity of the Project site for safety reasons (including no access over Gull Rapids, although existing travel over the rapids is highly dangerous, and the historic portage is poorly maintained and currently not used).

For safety reasons, boat and snowmobile access and travel is expected to be restricted in areas in closest proximity to the Project site where construction activity will occur. Resource users and others accustomed to travelling on open water, ice and land-based trails in these areas will have to modify their travel patterns while construction is taking place. Further to this, access programs under the AEAs were implemented to provide for alternative resource use locations.

Currently, there are existing waterways management programs in place under the Comprehensive Implementation Agreements with TCN and YFFN to address travel safety in the Split Lake and York Landing areas because the Nelson River is a regulated system. In addition to these existing programs and restrictions noted above, Project mitigation measures are contained in the Reservoir Clearing Plan and the Waterways Management Program – Phase I (Schedules 11-1 and 11-2 respectively of the JKDA; see Chapter 4, Appendix 4A and 4B). These mitigation measures were developed with the KCNs based on their ATK and past experience with hydroelectric projects, and include pre-flooding clearing along shorelines and areas of access; construction and maintainance of one or more safe haven cabins; installation and monitoring the condition of safe ice trails and the nature and extent of use; and a multi-purpose boat patrol to monitor waterways activities and to liaise with users of the Nelson River

(Schedule 11-2, Section 7.2). Additional measures to mitigate or avoid risks to the public include the following:

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

A Keeyask Generation Project Construction Access Management Plan, as part of the Environmental Protection Program, includes provisions to restrict travel along the north and south access roads during construction. In addition, measures are included to permit access to the Project site for authorized users of the road (including registered KCNs Members).

YFFN has expressed concern over travel safety related to ice and open water travel across Split Lake, as their Members will be using the ferry and winter road to access PR 280 to travel to the site for Project employment. As indicated in Chapter 8, monitoring of open water and ice conditions on Split Lake is part of existing waterways management programs implemented through the TCN and YFFN Comprehensive Implementation Agreements.

ROAD TRAVEL

During construction, the Project will generate road traffic, including delivery of materials, equipment and personnel to the Project site (including construction workers and contractors providing services).

Section 5.4.1.5 of the SE SV provides detailed traffic projections (KGS-Acres 2010)[1]. Background or existing traffic levels are generally low, and Project-related traffic will increase these levels across all construction years an average of 20%, with peak levels between 39-41% in summer and 24-29% in winter during the peak construction years (KGS-Acres 2010). The following focuses on the peak construction period between the junction of PR 391 and PR 280 and the Project Site (see SE SV section 5.4.1.5):

- Between PR 391/280 junction and the Split Lake junction, traffic is expected to increase 29% across all sources of traffic (freight, personnel and incidental source), within a range of 20 – 29% (the summer months produce the largest volumes). Freight transport is expected to produce the greatest wear and tear on the road and road safety, with an increase between 22 and 41%.
- Between the Split Lake junction and the Keeyask access road junction, traffic is expected to increase 29-41% (depending on the construction year and season). Freight traffic is expected to increase between 10 and 29%, with increases in traffic greater than 20% in both summer and winter for several peak years.

[1] As noted previously, an updated traffic analysis will be provided in a supplementary filing.

In anticipation of increased traffic levels associated with the Project, improvements were initiated by MIT in 2011 at several locations on PR 280 prior to the Project, including widening, curve shaping and grade improvements. Road improvements will continue to be made in 2012 to complete the MIT activity prior to Project construction. KCNs Members have expressed concern about the safety and conditions of PR 280 prior to the improvements, citing numerous examples of damaged windows and vehicles, traffic accidents as well as concerns over dust from trucks creating visibility hazards (see Section 6.6.4 for information related to road infrastructure). At the time of writing, it was not known whether road improvements had dealt with the concerns identified by the KCNs as road improvements were not yet complete.

A Keeyask Generation Project Construction Access Management Plan will be developed for the operation of the north access road and for construction and operation of the south access road. Restrictions on who is authorized to travel on the north access road is included in the KIP AMP and will be included in this Project's AMP, as well as restrictions on bringing firearms, boats, ATVs and snowmobiles to site. The north and south access roads will be private access roads during the construction phase, with traffic restricted by a security gate on both access roads to restrict use of the access roads by those with authorization to access the Project site.

MIT may need to consider implementing increased signage during peak construction seasons (May through October) to advise motorists to expect increases in traffic. The Partnership would track statistics collected by MIT on traffic-related incidents and complaints on PR280. If traffic incidents and/or complaints have increased considerably, the Partnership would dialogue with MIT to determine if additional mitigation measures are appropriate (see Chapter 8).

6.6.5.5.2 Residual Effects of Construction

Using the criteria established to determine the significance of Project effects for regulatory purposes (described in Section 5.5) the residual effects of Project construction on water and ice-based travel are expected to be adverse due to changes needed in travel patterns and restricted access, medium in geographic extent, of long-term duration and small in magnitude.

Residual effects related to road travel are expected to be: adverse due to the potential for increased vehicle damage and accidents, medium in geographic extent, of short-term duration and moderate in magnitude. Step 2 analysis is screened out based on the Step 1 analysis.

There is a high degree of certainty in the assessment of this VEC due to the programs already in place in the JKDA for water and ice-based travel; and since operation and maintenance of PR 280 is under the authority of the Provincial Government (through MIT).

6.6.5.5.3 OPERATION EFFECTS AND MITIGATION

WATER AND ICE-BASED TRAVEL

The operation of the Project is expected to alter various characteristics of the existing water and ice regimes within the Project's predicted hydraulic zone of influence which extends approximately 40 km upstream from the Project site (to the outlet of Clark Lake) (see Map 6-2). The primary changes to navigation are expected to be limited to areas upstream in the hydraulic zone of influence and immediately downstream of the generating station.

Effects on the Keeyask Reservoir

The creation of a reservoir and operation of the station will result in changes to the water levels, velocities and water surface profiles (see PE SV Section 4.4.2). The upstream reservoir section will be changed from a riverine to a rreservoir environment, resulting in safer open water travel conditions since waters may be moderated or smoothed and velocities reduced. In particular, Birthday Rapids will become an easier area to navigate by boat.

During winter conditions, ice cover is expected to occur earlier in the winter, developing a thermal ice cover extending approximately 25 km upstream of the station that will resemble that of Stephens Lake. The ice cover in the reservoir would create safer ice travel conditions than the existing environment. In the reach between Two Goose Creek and the outlet of Clark Lake, higher water levels will result in earlier formation of the ice cover (see PE SV Section 4.2.2).

Some hanging of the ice in the Project reservoir along the shoreline is expected as a result of fluctuations in reservoir water levels. There may be areas along the shoreline where cracks that form fill with water and subsequently create slush ice conditions that could create hazardous travel conditions. This is most likely in the early winter when the ice cover is relatively thin (see PE SV Section 4.4.2).

The JKDA Waterways Management Program was developed to address the issues of submersion of portions of land-based trails, relocation of access points, new boat launches and safe landing sites. The Plan also includes provision to address navigation hazards (including debris) during open water conditions and provision of safe ice trails during winter conditions.

The presence of the generating station and associated dams will be a barrier to downstream movement. Access to Stephens Lake will be via a new portage around the generating station. The presence of a series of dykes along the north and south sides of the Nelson River and inundation of the surrounding lands will destroy portions of land-based trails used to access the Nelson River.

TCN and YFFN have both indicated they are sceptical about the predicted open water hydraulic zone of influence and have raised concerns that the Project will affect open water and ice conditions on Split Lake. A fundamental feature stated in the JKDA is that the operation of the Project will not affect open water levels on Split Lake.

As indicated in Chapter 8, water levels on Split Lake will continue to be monitored during Project operation, and monitoring of open water and ice conditions on Split Lake is part of existing waterways management programs implemented through the TCN and YFFN Comprehensive Implementation Agreements. In addition, monitoring is also included in the JKDA Waterways Management Program.

Effects Downstream of the Keeyask Generating Station

There should be no material effect on travel on Stephens Lake during either open water or winter ice conditions.

During open water conditions, boaters will continue to be required to portage, in this case around the generating facility rather than the rapids (as existed under historic conditions).

During winter conditions, the existing hanging ice dam that occurs immediately downstream of Gull Rapids is not expected to occur in the future; instead, a thermal ice cover will form. In addition, immediately downstream of the powerhouse an area of about 800 m long is expected to remain ice free all winter; and a portion of the south channel of Gull Rapids near the spillway is expected to be dry when the spillway is not operational (about 88% of the time based on historical records) (see PE SV Section 4.4.2). Travel during the winter will require a modification of snowmobile routes to go around the facility, to avoid open water conditions downstream of the powerhouse, and to be aware of slush ice formation near the reservoir's edges.

As with the construction phase, the effects of Project operation on water travel and access are addressed through a comprehensive program of mitigation measures contained in the Waterways Management Program (Phase II) that was developed with the KCNs (Schedule 11.2 of the JKDA; Chapter 4, Appendix 4B). This includes provisions for collecting floating debris, preparing reservoir depth charts and identifying safe travel routes; navigation and hazard markers; safe landing sites; and an ice monitoring and safe trails program (including maintenance of trails and the portage) (see Appendix 4B). The Project also includes an array of safety measures such as safety railings on the spillway deck, powerhouse forebay deck, the main dam and tailrace deck; fencing off potentially hazardous areas around the infrastructure; and a siren system to provide advance warnings of the movement of the spillway gates (see Project Description SV Section 4.7). Monitoring is an ongoing element of these programs (see Chapter 8). No further mitigation is required.

ROAD TRAVEL

Once the Project is complete, Manitoba Infrastructure and Transportation (MIT) will re-route PR 280 along the north access road, across the Keeyask Generating Station and along the south access road to Gillam. This will reduce the overall travel time between Thompson and Gillam by about an hour. The presence of this route is expected to change travel patterns in the Gillam area, resulting in an ongoing benefit to Gillam area residents, including FLCN Members who reside in Gillam.

Operation of the Project is expected to have a very minor effect on the number of vehicles travelling on roads in the Local Study Area although the re-routing of PR 280 may alter the route taken to locations such as Gillam and Fox Lake (Bird). FLCN Members living in the community of Fox Lake (Bird) have expressed concerns about the “abandonment” by MIT of the parts of PR 280 between the Keeyask junction and Fox Lake (Bird) since their trip to Thompson would be shorter on the existing route than via the south access road. Concerns have been expressed by the KCNs Members regarding travel, access and safety on Split Lake, including with respect to the winter road between Split Lake and York Landing. Water levels on Split Lake will continue to be monitored during Project operation, and monitoring of open water and ice conditions on Split Lake is part of existing waterways management programs implemented through the TCN and YFFN Comprehensive Implementation Agreements. Monitoring of the winter road between Split Lake and York Landing is undertaken on an annual basis by MIT in consultation with the communities (see Chapter 8).

6.6.5.5.4 Residual Effects of Operation

Using the criteria established to determine the significance of Project effects for regulatory purposes (described in Section 5.5) the residual effects of Project operation on water and ice-based travel are expected to be positive due to anticipated changes from a riverine to a reservoir environment, and with the implementation of the Waterways Management Program and safety measures associated with the generating station, medium in geographic extent, long-term in duration and small in magnitude. Residual effects on road travel are expected to be positive due to the shorter distance between Thompson and Gillam, medium in geographic extent, of long-term duration and small in magnitude.

Step 2 analysis is screened out based on the Step 1 analysis. There is a high degree of certainty in this assessment due to the existence of the Waterways Management Program and safety measures planned for the generating station.

6.6.5.5.5 Conclusions about Residual Effects on Travel, Access and Safety

Overall, residual Project effects on travel, access and safety are expected to be adverse due to the changes in travel patterns required during construction; and positive during operation due to the Waterways Management Program, improvements to PR 280 by MIT and facility safety measures planned to be in place.

The adverse residual effects of the Project regarding road travel will overlap or interact spatially and temporally with effects from the following future projects: the Keeyask Transmission Project, the Conawapa Generation Project, Bipole III Transmission and Gillam Redevelopment. The adverse residual effects of the Project regarding water and ice-based travel are not expected to overlap spatially with any future projects. The cumulative effects are discussed in more detail in Chapter 7.

Monitoring plans are being developed to address uncertainties. Monitoring related to travel, access and safety for open water and ice-based travel is included in the Waterways Management Program. Additional tracking of MIT data and monitoring on Split Lake are noted in Chapter 8.

6.6.5.6 CULTURE AND SPIRITUALITY

KEEYASK CREE NATIONS

As noted in Section 5.3.1, culture and spirituality represent a composite of world views, values, beliefs, perceptions, principles and traditions that are based on individual and collective history, experience and interpretation. These cognitive values act as a unified force to direct the flow of cultural change. In the context of this assessment, cultural indicators are used to capture cultural issues and perspectives of importance to the KCNs (see Section 6.2.3 for a description of the cultural system model used in this assessment). The nine cultural indicators used in the effects assessment are: worldview, language, traditional knowledge, cultural practices, health and wellness, kinship, leisure, law and order, and cultural products. The assessment of effects examines how the existing and projected characteristics of each indicator could be altered by Project-induced changes in the physical, aquatic and terrestrial environment, by participation in Project opportunities and by the KCNs participation in the Project partnership.

Sources of information include the following:

- Programs noted in the AEAs;
- KPIs and fieldwork research programs;
- KCNs workshops and oral histories; and
- The KCNs' Environmenal Evaluation Reports.

As described in Chapter 2 of the Core EIS, the Cree worldview indicates that everything is alive, is interconnected and needs to be respected. The Cree view themselves as important stewards of *Askiy* (Mother Earth) (land, water and living things). As part of everything, it is important to give thanks and respect for the gifts given through rituals, ceremonies, vigil and offering of prayer. Through KCNs efforts and their desire to uphold this worldview, processes and measures have been put in place to address, in a meaningful and enduring manner, the potential effects of Project construction and operation on Cree culture and spirituality. These measures and processes, tailored to the specific circumstances and needs of the KCNs, strive to moderate and offset potential effects on culture and spirituality that are expected to be experienced as a result of the Project. The following are especially important in this regard:

- Being partners in the Project;
- The AEAs negotiated and signed by each of the KCNs; and
- The Employee Retention and Support Services direct negotiated contract.

Each of these factors is described in further detail below.

PARTNERSHIP

Being partners in the Project provides the KCNs with meaningful involvement in Project decision-making and legitimate influence over how the Project has been planned, and will be constructed and operated. Through this mechanism, the KCNs are able to bring to bear the Cree worldview and implications for Cree culture and spirituality in Project decision making. Being partners provides the opportunity for the *Ininewak* to care for *Askiy* (Mother Earth) for the Cree today and for future generations by being involved in the planning, the assessment and implementation of the Project (see Chapter 2 for more details on the KCNs worldview). The *Ininewak* can provide oversight of the Project to watch that the Project is done right (see also Section 6.6.5.1 Governance, Goals and Plans).

ADVERSE EFFECTS AGREEMENTS

The AEAs between Manitoba Hydro and the individual KCNs were designed to address and resolve known present and anticipated Project adverse effects. Within each agreement, a set of cultural and AEA offsetting programs were developed which deal directly with the potential adverse effects of the Project on culture and spirituality. Programs agreed upon in the AEAs deal with traditional lifestyles, Cree language, land and/or environmental stewardship, access programs that provide replacement opportunities to access resources, wellness counselling and a cultural sustainability program that can assist in maintaining cultural success and tempering Project effects. The AEAs provide an opportunity to reconcile differing world views by addressing and acknowledging the need for continued stewardship of the land, culture and spirituality that binds the KCNs to their environment.

Each of the AEAs differs among the communities; however, most of these programs will be in place by the start of construction. During the construction phase, the AEA programs will be ongoing to minimize the loss of use of the Project site. In addition, the AEAs will actively engage the mechanisms of cultural transmission, stewardship and spirituality within the communities. AEA programs will also proactively engage the health and wellness of the communities to promote employment and business opportunities, and increased country food usage; and offer the return to cultural sharing practices. During the operation phase, AEA programs will continue to address physical changes to the landscape, inter and intra cultural and community interactions and long-term employment and business goals.

EMPLOYEE RETENTION AND SUPPORT SERVICES CONTRACT

The Employee Retention and Support Services contract implemented by the KCNs, which will extend over the entire construction phase, will include cross-cultural training of construction workers, counselling for construction workers and the opportunity for conducting ceremonies at key Project milestones, all of which will provide opportunities for cultural engagement at the construction work area. The ceremonies part of the contract can be used to give thanks and show respect for *Askiy* (Mother Earth) when a noteworthy feature of *Askiy* (Mother Earth), such as the rapids, is being disturbed or lost for the benefit of future generations.

6.6.5.6.1 CONSTRUCTION EFFECTS AND MITIGATION

Anticipated construction effects on the cultural landscape and intangible culture and spirituality within the Local and Regional study areas are summarized below, according to each of the nine cultural indicators.

Worldview: Being a partner in the Project has facilitated a greater than normal ability to express and gain acceptance of Cree culture and worldview, including having a Project oversight role. A Project feature aligned with the Cree worldview is the AEA offsetting programs of each Cree Nation; as well as actively participating in the development and implementation of monitoring and follow-up programs. KCNs involvement in Project planning, assessment and monitoring, along with ceremonies and rituals at Project milestones will address the KCNs noted incremental loss or decrease in the understanding of the spiritual connection to the land (which could affect community organization). However, while working at the construction site, there is potential for other world views (*e.g.*, non-Aboriginal) to be in conflict with the Cree worldview. Anticipated grief associated with the loss of part of the cultural landscape, in particular the rapids, may express itself in anxiety that could lead to social distress.

Language: KCNs Members working at the construction site are expected to have reduced opportunities to use Cree language as the language of Project construction will be English. However, ceremonies and rituals at Project milestones are opportunities for conducting traditional activities in Cree. The development of cultural centres and conducting cultural transmission programs as provided under the AEAs will provide the opportunity for maintaining and/or strengthening the use of the Cree language. Each of the KCNs also has Cree language programs identified in their AEAs.

Traditional Knowledge: There is concern by some KCNs Members that traditional knowledge within the construction area will undergo rapid change and be lost. Accelerated change and loss of Aboriginal traditional knowledge are linked to parts of the physical landscape disturbed by Project construction and changes in water regime. Traditional knowledge provides the opportunity for interaction between generations – it provides a "how-to" manual that guides the next generation through cultural ways of doing that is based on years of experience and observation. Traditional knowledge is dynamic and interactive. While this interaction is notably in decline because of other factors, the process of loss may be accelerated. On the other hand, traditional land use and related studies undertaken with funding from the Project have contributed to the retention and transmission of aspects of ATK. Further, ATK monitoring programs implemented as part of the Project will provide opportunities for Elders, resource users and youth to undertake site visits and participate in monitoring based on traditional knowledge, and traditional activity programs in each of the AEAs will provide the opportunity to foster ongoing traditional knowledge related to the offset areas.

Cultural Practices: Changes to cultural practices and traditional activities within the construction site could occur due to physical changes to the environment requiring adaptation, abandonment or relocation to other areas. This will include the inability to access certain construction-related areas for gathering of medicinal and edible plants, and harvesting of animals and fish. The offsetting programs in the KCNs AEAs that provide replacement opportunities to access resources at alternative sites present substantial opportunity to continue undertaking traditional activities in areas away from the disturbed environment.

Health and Wellness: Loss of traditional medicines and knowledge of resource habitat in the Local Study Area may result in adverse effects on health and wellness, particularly if resource harvesting levels decline resulting in changes in country food diet. This can be offset by increased opportunity to pursue traditional activities through the access programs in other "offset" areas. See also Section 6.6.5.2 Community Health for a review of effects on western framework of health and wellness.

Kinship: Kinship relationships are built on old and established practices that are characteristic of northern Cree bands. Traditionally, multiple bonds were created between limited numbers of relatives and others such as clan members where certain rules and obligations were followed (Smith 1974). Kinship terminology has been modified to reflect a western tradition; however, subtle, inherent rules still apply. However, the new cultural and traditional lifestyle programs available through the AEAs should help to maintain kinship ties.

Leisure: Leisure activities (*e.g.*, playing sports, skating, bingo) may be decreased due to being away from their home community while employed on the Project. However, other forms of leisure will be available to construction workers on-site at the recreation centre (*e.g.*, gym, weight room, computer lab), recreational fishing and other activities are accessible to workers.

Law and Order: At the construction site, KCNs workers will be exposed to a set of rules as different from their traditional customary law. However, being partners in the Project and having an oversight role as stewards of *Askiy* (Mother Earth) provides a balance that includes traditional customary law as it is interpreted by the KCNs. Cross-cultural awareness training provides a linkage between activity on site and traditional customary law (see also Section 6.6.5.1 on governance).

Cultural Products: The preparation of cultural products may be affected by changes to the environment and/or availability of time to commit to making cultural products due to Project employment. This is counterbalanced by the offset programs and their opportunity for pursuing traditional activities leading to provision of furs and other items for creation of cultural products.

MITIGATION

Mitigation to address the potential for loss and grieving associated with for example, the loss of the rapids, includes:

- Rituals and ceremonies at key Project milestones (*e.g.*, stream crossings, road cleaning); and
- Counselling services provided as part of the Employee and Retention Support DNC that are available to assist Cree Members in coping with changes to the landscape through construction activities and the loss of the rapids.

See also effects of construction activities on heritage resources (Section 6.8.3.1 which is more focused on the tangible resource) for proposed mitigation measures that have overlapping concern related to culture and spirituality.

KCNs Members are anticipated to experience culturally related disturbances and losses during project construction, particularly in conjunction with losses in their cultural landscape and from working at the construction site. These effects would be offset by the combination of processes and measures established during the planning stage of the Project, including the AEA programs, and moderated by the proposed mitigation measures. No further mitigation is required.

6.6.5.6.2 Residual Effects of Construction

Using the criteria established to determine the significance of Project effects for regulatory purposes (described in Section 5.5) the residual effects of Project construction on culture and spirituality are expected to be adverse, small in geographic extent, long-term in duration and small in magnitude (due to the key role of the AEA programs and other mitigation measures noted above in addressing effects). Step 2 is not required.

There is a high degree of certainty in the assessment of this VEC based on the existence of the AEAs agreed to by the KCNs. The associated programs were developed based on each of the KCNs' individual experiences with past hydro development that affected their community. There is also latitude within the programs for adjustment or reallocation of funding to areas deemed of greatest importance.

6.6.5.6.3 Operation Effects and Mitigation

The effects of operation on culture and spirituality within the Local and Regional Study Areas are summarized below, according to the nine cultural indicators.

Worldview: Long-term, some KCNs Members may question their decision to be partners in the Project because of its disturbance to *Askiy* (Mother Earth). The Partnership however, provides the opportunity for the Cree to offer respect for the giving of the land and the rapids for future generations through ritual and ceremony; as well as the opportunity for participation in the long-term monitoring of effects, thus partially fulfilling their stewardship role to care for *Askiy* (Mother Earth) (see Chapter 2 for more details on the KCNs worldview statement).

Language: Cree place names and other mnemonic devices act as catalysts for language and the oral narrative. Loss of Cree language associated with loss of place names and landmarks affected by the Project could cause grief and unhappiness because the Cree words that describe an area may be rendered meaningless once those areas are disturbed or lost. This is balanced by offset language programs to strengthen long-term use of Cree in the communities; as well as the overall AEAs agreed to by the KCNs.

Traditional Knowledge: There will be rapid change and loss of Aboriginal traditional knowledge associated with physical and biophysical changes in the environment affected by the Project. This will be offset by the retention and transmission of ATK that continues to flow from the land use and related studies already undertaken with funding from the Project; the development and implementation of ATK monitoring programs, and through a video of the area between Birthday and Gull rapids.

Cultural Practices: Cultural practices and pursuit of traditional activities within the Local Study Area will diminish and may not be transferable to other areas. The reservoir area will be restrictive to current traditional activities. Winter access will be altered due to changing water levels and ongoing shoreline erosion, and summer access could be dangerous in the vicinity of the generating station. KCNs Members who regularly camp will likely have to find new areas for their traditional campsites. This will be balanced by the ongoing Waterways Management Program (new camp sites and trail access). In addition, opportunities are available for conducting traditional activities and cultural practices in areas visited as part of the AEA offset programs where such activity was more difficult due to access or ability to reach these locations. This will also result in an overall benefit to health and well-being.

Health and Wellness: Overall health and wellness may increase due to access to healthy country foods (fish and wild game) through the access programs, as well as opportunities for wilderness camps and actively undertaking traditional activities. See also Section 6.6.5.2 Community Health for a review of effects on western modes of health and wellness.

Kinship: Kinship and family ties have the potential to be strengthened during the operation phase through the AEA offsetting programs.

Leisure: There is not expected to be any Project operation effect on leisure (*e.g.*, playing sports, bingo, skating).

Law and Order: Customary law and order is not expected to be affected by the operation of the Project.

Cultural Products: The emotional and historic connection to particular areas for harvesting of traditional plants and resources for making cultural products will be altered due to physical changes to the environment during operation. However, the ability to collect materials and create cultural products from the offset areas identified in the AEAs will provide opportunities for completing traditional tasks and continuing the flow of ATK.

The same AEA programs noted above during the construction phase also apply during the operation phase. Degree of confidence for all indicators is high.

MITIGATION

Mitigation to address the effects from Project operation, beyond those found in the AEAs, include

- Prior to construction, preparation of a video of Gull Rapids and the river between the outlet of Clark Lake and Stephens Lake (including the sound of the rapids). In a visitor space at the generating facility, include the video and interpretative boards that enable KCNs and other community Members to visit, remember the area prior to construction of the Project and pay ongoing respect for *Askiy* (Mother Earth).
- Cross-cultural training to be provided to Keeyask operation staff.

KCNs Members will continue to experience culturally-related disturbances and losses in conjunction with losses in their cultural landscape. These effects would be offset by the combination of processes and measures established during the planning stage of the Project, including the AEAs, and moderated by the proposed mitigation measures. No further mitigation is required.

6.6.5.6.4 RESIDUAL EFFECTS OF OPERATION

Using the criteria established to determine the significance of Project effects for regulatory purposes (described in Section 5.5) the residual effects of Project operation on culture and spirituality are expected to be adverse, small in geographic extent long-term in duration and small in magnitude (due to the key role of the AEA programs and other mitigation measures noted above in addressing effects). Step 2 is not required.

Similarly under residual effects of construction, there is a high degree of certainty in the assessment of this VEC based on the existence of the AEAs agreed to by the KCNs.

6.6.5.6.5 CONCLUSION ABOUT RESIDUAL EFFECTS ON CULTURE AND SPIRITUALITY

Overall, the residual Project effects on culture and spirituality are expected to be adverse, small in geographic extent, long-term in duration and small in magnitude for both construction and operation phases.

The adverse residual effects of the Project will overlap or interact spatially and temporally with effects from the following future projects: the Keeyask Transmission Project, the Conawapa Generation Project, Bipole III Transmission and Gillam Redevelopment (particularly for FLCN). The cumulative effects are discussed in more detail in Chapter 7.

Monitoring plans are being developed to address uncertainties. As stewards of *Askiy* (Mother Earth), the Cree have voiced concern over effects to Cree culture related to both Project construction and operation. Adverse Effects Agreements have been negotiated with each of the KCNs based on each community's assessment of the Project's potential effects, including any interference with its traditional customs, practices and traditions. Monitoring by the KCNs on an annual basis would evaluate whether the AEAs continue to address the adverse effects of the Project (see Chapter 8).

6.6.5.7 Aesthetics – The Way the Landscape Looks

The approach to the analysis of aesthetics considered the physical changes to the Local Study Area that would result from the construction and operation of the Project. Visual impacts are the focus of this assessment; however, consideration is also given to the auditory effects resulting from the Project. The KCNs in particular, characterize aesthetics as "the way the landscape looks."

The characterization of effects from Project construction and operation on the aesthetic environment included the following:

- Project description: All site alterations arising from Project activities, including the development of access roads and trails, use of granular and impervious borrow areas, the actual development of the dam infrastructure, and flooding of the area between Gull Rapids and the outlet of Clark Lake.
- Project visibility within landscape context: The characteristics that make a location distinctive in contrast with the presence of the Project with consideration of the number and types of viewers.
- Viewer value and sensitivity levels: Consideration of the viewer's expectations and cultural values (*e.g.*, the KCNs worldview would result in a different appreciation of the area's aesthetics than an average resident from Gillam or southern Manitoba).

The assessment of aesthetic effects also considers the reversibility of an effect; *i.e.*, whether a change to the landscape is likely to be temporary (*e.g.*, borrow areas which will later be rehabilitated) or permanent (*e.g.*, flooding of the rapids and creation of a reservoir).

Sources of information included the following (see SE SV Section 5.2.7):

- KPIs and fieldwork research program;
- KCNs prepared documents including their evaluation reports;
- The KCNs' AEAs; and
- KCNs perspectives on past hydro development.

6.6.5.7.1 Construction Effects and Mitigation

The characterization of Project effects on the way the landscape looks considers all site alterations arising from Project activities, the project visibility within the landscape context (*i.e.*, characteristics that make the location distinctive in contrast with the presence of the Project), and value to the viewer and associated sensitivity levels. The KCNs worldview is likely to result in an adverse reaction to the aesthetic changes associated with Project construction, since they place an inherent value on the earth, the trees, the water, the rocks, the rapids and other living things that inhabit the area (see Chapter 2). Construction activities will result in physical alteration of the landscape, noise, dust, and increased human presence. Changes to the landscape that affect aesthetics include the excavation and development of identified borrow areas as well as development of the construction site (*e.g.*, dyke construction *etc.*). The construction of cofferdams will change the overall flow of the Nelson River, diverting water into other channels of the river. There may be temporary visible changes to water quality during certain phases of construction.

The JKDA includes a Reservoir Clearing Plan in order to minimize the overall amount of debris resulting from flooding (see Schedule 11-1). The clearing of the reservoir will occur prior to impoundment; and will ultimately transform the area from a vegetated to a clear-cut environment that will be submerged when the reservoir is filled.

Construction effects to the way the landscape looks will be limited in duration, and in many instances, decommissioning activities will rehabilitate disturbed areas to the native habitat types (see Section 6.5.3.3). The changes to the landscape and loss of the rapids also has a linkage to culture (see Section 6.6.5.6 above). As noted under Seciton 6.6.5.6, ceremonies and rituals at key milestones of construction (*e.g.*, stream crossings, closing of the river) may also assist in dealing with the feeling of loss as the landscape is disturbed. The AEAs agreed to by the KCNs address known and foreseeable adverse effects of the Project, including the changes to the way the landscape looks and the loss of the rapids. Specifically, the access programs in the AEAs will provide for replacement opportunities to access resources off-system to the Nelson River in areas not disturbed by hydro development. Mitigation in the form of nature trails within the north side camp will provide opportunities to KCNs construction workers in particular, to find beauty (*e.g.*, access to water, views of sunsets and sunrises and quiet) and will address the Project effect on the Cree core values and the VEC of the way the landscape looks.

No further mitigation is required.

6.6.5.7.2 Residual Effects of Construction

Using the criteria established to determine the significance of Project effects for regulatory purposes (described in Section 5.5) the residual effects of Project construction on the way the landscape looks (aesthetics) are expected to be adverse, medium in geographic extent, long-term and small in magnitude (the key measures here are the AEAs agreed to by the KCNs). Step 2 analysis is screened out based on the Step 1 analysis. Given the AEA programs and mitigation measures above, there is a high degree of certainty in the assessment of this VEC.

6.6.5.7.3 Operation Effects and Mitigation

Upon completion of construction and final commissioning of the generating station, several outcomes of the Project will affect the way the landscape looks including the following:

- The flooding of 45 km^2 upstream of the generating station ;
- Changes from a riverine to a reservoir environment;
- Ongoing shoreline erosion;
- Loss of the rapids, including the loss of the sound of the rapids;
- Replacement of the rapids with a physical barrier (the dam and generating station) resulting in a transition from a natural to a built environment; and
- Re-routing of PR 280 via the north access road, over the dam, and via the south access road into Gillam.

Operation phase effects to the way the landscape looks (*i.e.*, aesthetics) will be permanent in nature. The reservoir will resemble the environment present at Stephens Lake, although the extent of debris is likely to be less given the Reservoir Clearing Plan.

The KCNs are likely to experience an adverse reaction to the changes to the landscape – land and river environments – associated with the Project's operation phase. Ceremonies and rituals will be undertaken to assist the KCNs in coping with the inevitable loss of the rapids through flooding, a value which is inherently important to the communities. The AEAs agreed to by the KCNs address the known and foreseeable changes to the landscape.

A park and/or rest area associated with boat launches both upstream and downstream of the generating station on the north side of the Nelson River is planned. As well, a commemorative plaque or memorial is planned to recognize people who have used and continue to use the Gull Lake area. Reclamation of site construction areas such as borrow areas are to follow the principles set out in Schedule 7-1 of the JKDA, including using native plant types in disturbed areas.

Additional mitigation includes a video taken of the stretch of the Nelson River between Birthday Rapids and Gull Rapids prior to construction and available for viewing in a visitor space at the generating station once the station is in operation. Additional interpretative plaques are also included (see culture and spirituality Section 6.6.5.6 above).

No further mitigation is required.

6.6.5.7.4 Residual Effects of Operation

Using the criteria established to determine the significance of Project effects for regulatory purposes (described in Section 5.5) the residual effects of Project operation on the way the landscape looks (aesthetics) are expected to be adverse, medium in geographic extent, of long-term duration and small in magnitude. Step 2 analysis is screened out based on the Step 1 analysis. There is a moderate degree of certainty in the assessment of Project effects of this VEC. The AEAs and above-noted mitigation will help to address the considerable changes to the way the landscape looks. Because each individual will view these changes in a personal manner, it is not possible to predict with complete certainty that all effects are completely mitigated.

6.6.5.7.5 Conclusion about Residual Effects on the Way the Landscape Looks

Overall, the residual Project effects on the way the landscape looks are expected to be adverse due to the lasting changes to the physical landscape. Although these effects are not reversible (*i.e.*, are permanent) in terms of the new infrastructure and the loss of the rapids, the substantial programs related to each of the AEAs, and the process of planning and addressing known adverse effects prior to voting to become partners on the Project indicates the willingness for the KCNs to move forward with the Project despite these changes to the landscape.

The adverse residual effects of the Project will overlap or interact spatially and temporally with effects from the following future project: the Keeyask Transmission Project. The cumulative effects are discussed in more detail in Chapter 7.

Monitoring plans are being developed to address uncertainties. These are discussed in Chapter 8. No monitoring related to the way the landscape looks is needed.

6.6.6 Summary of Residual Effects and Significance

This section summarizes residual effects of the Project (*i.e.*, after mitigation) on socio-economic VECs, summarized under Economy (Table 6-47), Population, Infrastructure and Services (Table 6-52), and Personal, Family and Community Life (Table 6-56). A summary statement on the significance ratings for each of these VECs, noting where conclusions from ATK may differ from those of technical science, follows each summary table.

6.6.6.1 Summary of Residual Effects on Economy

Table 6-47 through Table 6-51 provide a summary of mitigation and residual effects pertaining to the economy of the Local Study Area and the Regional Study Area.

Note regarding the following residual effects tables:

1. Refer to Section 5.1 (Approach to Determination of Regulatory Significance) for full description of assessment characteristics. Under Step 1, all VECs were examined using the criteria of direction, magnitude, geographic extent and duration. As explained, where further analysis was warranted, a Step 2 analysis considered additional criteria of frequency, reversibility or ecological context.

Table 6-47: Summary of Mitigation and Residual Effects on Economy Valued Environmental Components: EMPLOYMENT OPPORTUNITIES

VEC Effect and Mitigation by Phase	Residual Effects	Assessment Characteristics (1 see introductory text)
KEEYASK CREE NATIONS, ABORIGINAL RESIDENTS OF NORTHERN MANITOBA		
Construction Phase		
Potential effects due to: • Project includes substantial increased employment throughout construction phase, particularly through DNCs for the KCNs **Enhancement includes:** • Strategies to enhance participation of northern Aboriginal workers to work on construction jobs, particularly availability-oriented measures	Increased employment	**Step 1:** Direction: Positive Magnitude: Moderate Geographic Extent: Medium to Large Duration: Short-term **Step 2: Not Required**
Operation Phase		
Potential effects due to: • Increased employment (Keeyask operation jobs (all) and system-wide opportunities (KCNs) **Enhancement includes:** • None required beyond JKDA targets for system-wide employment for KCNs Members Socio-economic Monitoring plan (see Chapter 8)	Increased employment	**Step 1:** Direction: Positive Magnitude: Moderate Geographic Extent: Medium to Large Duration: Long-term **Step 2: Not Required**
GILLAM/THOMPSON		
Construction Phase		
Potential effects due to: • Increased employment opportunities **No mitigation/enhancement required**	Increased employment	**Step 1:** Direction: Positive Magnitude: Moderate Geographic Extent: Medium Duration: Short-term **Step 2: Not Required**
Operation Phase		
Potential effects due to: • Increased employment opportunities **No mitigation/enhancement required** Socio-economic monitoring program (see Chapter 8)	Increased employment	**Step 1:** Direction: Positive Magnitude: Moderate Geographic Extent: Medium Duration: Long-term **Step 2: Not Required**

Table 6-48: Summary of Mitigation and Residual Effects on Economy Valued Environmental Components: BUSINESS OPPORTUNITIES

VEC Effect and Mitigation by Phase	Residual Effects	Assessment Characteristics (1 see introductory text)
KEEYASK CREE NATIONS		
Construction Phase		
Potential effects due to: • Increased business opportunities through DNCs in place **Enhancement includes:** • Identification of entrepreneurial opportunities	Increased business opportunities and community capacity	**Step 1:** Direction: Positive Magnitude: Moderate Geographic Extent: Medium Duration: Short-term **Step 2: Not Required**
Operation Phase		
No mitigation/enhancement required	Increased business opportunities and community capacity	**Step 1:** Direction: Positive Magnitude: Small to Moderate Geographic Extent: Medium Duration: Long-term **Step 2: Not Required**
GILLAM/THOMPSON		
Construction Phase		
Potential effects due to: • Increased business opportunities **Enhancement includes:** • Maintain communication with organizations on opportunities through Manitoba Hydro's Northern Purchasing Policy	Increased business opportunities	**Step 1:** Direction: Positive Magnitude: Small to Moderate Geographic Extent: Medium Duration: Short-term **Step 2: Not Required**
Operation Phase (Gillam)		
Potential effects due to: • Increased business opportunities **No mitigation/enhancement required**	Increased business opportunities, with wider selection of goods and services, increase in variety of businesses	**Step 1:** Direction: Positive Magnitude: Small to Moderate Geographic Extent: Small Duration: Long-term **Step 2: Not Required**

Table 6-49: Summary of Mitigation and Residual Effects on Economy Valued Environmental Components: INCOME

VEC Effect and Mitigation by Phase	Residual Effects	Assessment Characteristics (1 see introductory text)
KEEYASK CREE NATIONS		
Construction Phase		
Potential effects due to: • Increased income through employment opportunities **No mitigation/enhancement required**	Increased income	**Step 1:** Direction: Positive Magnitude: Moderate to Large Geographic Extent: Medium Duration: Short-term **Step 2: Not Required**
Operation Phase		
Potential effects due to: • Increased income through long-term employment opportunities **No mitigation/enhancement required**	Increased income	**Step 1:** Direction: Positive Magnitude: Moderate to Large Geographic Extent: Medium to Large Duration: Long-term **Step 2: Not Required**
GILLAM/THOMPSON		
Construction Phase		
Potential effects due to: • Increased income **No mitigation/enhancement required**	Increased income	**Step 1:** Direction: Positive Magnitude: Small to Moderate Geographic Extent: Small to Medium Duration: Short-term **Step 2: Not Required**
Operation Phase		
Potential effects due to: • Increased income **No mitigation/enhancement required**	Increased income	**Step 1:** Direction: Positive Magnitude: Small to Moderate Geographic Extent: Small to Medium Duration: Long-term **Step 2: Not Required**

Table 6-50: Summary of Mitigation and Residual Effects on Economy Valued Environmental Components: COST OF LIVING

VEC Effect and Mitigation by Phase	Residual Effects	Assessment Characteristics (1 see introductory text)
KEEYASK CREE NATIONS		
Construction Phase		
Potential effects due to: • Little tangible effect **No mitigation/enhancement required**	Little tangible effect	**Step 1:** Direction: Neutral
Operation Phase		
• No effect **No mitigation/enhancement required**	No effect	No effect
GILLAM/THOMPSON		
Construction Phase		
• Little tangible effect **No mitigation/enhancement required**	Little tangible effect	**Step 1:** Direction: Neutral
Operation Phase		
• No effect **No mitigation/enhancement required**	No effect	No effect

Table 6-51: Summary of Mitigation and Residual Effects on Economy Valued Environmental Components: RESOURCE ECONOMY

VEC Effect and Mitigation by Phase	Residual Effects	Assessment Characteristics (1 see introductory text)
KEEYASK CREE NATIONS		
Construction Phase		
Potential effects due to: • Domestic/commercial resource use losses **Mitigation includes:** • Settlements with affected resource users	No residual effect	**Step 1:** Direction: Neutral
Operation Phase		
Potential effects due to: • Domestic/commercial resource use losses **Mitigation includes:** • Settlements with affected resource users	No residual effect	**Step 1:** Direction: Neutral
TOURISM, COMMERCIAL FORESTRY AND MINING		
Construction Phase		
Potential effects due to: • Potential disturbance of certain lodges and outfitters • Loss of forestland for Project infrastructure **Mitigation includes:** • Implementation of TCN's guidelines and principles for Access Program participants • Compensation for loss of standing timber No effects on commercial mining.	Disturbance of certain lodges and outfitters Negligible loss in forestland	**Step 1:** Direction: Neutral/Neglible
Operation Phase		
Potential effects due to: • Potential disturbance of existing lodges and outfitters • Permanent loss of forestland (negligible) **Mitigation includes:** • Implementation of TCN's guidelines and principles for Access Program participants • As per construction, compensation for loss of standing timber No effects on commercial mining.	Disturbance of certain lodges and outfitters	**Step 1:** Direction: Adverse (tourism); Positive (mining); Negligible (forestry) Magnitude: Small Geographic Extent: Medium Duration: Long-term **Step 2: Not Required**

In summary, residual effects of the Project after mitigation on employment opportunities, business opportunities and income are expected to be positive for the KCNs during both the construction and operation phases. YFFN has expressed concern over access to and from York Landing during freeze up and break up seasons in order to participate in Project employment; their ability to access construction jobs may temper the overall positive effect for their community.

Residual effects on Gillam and Thompson business opportunities during both the construction and operation phases are expected to be positive.

There are little or no tangible residual effects related to cost of living in any of the communities in either the construction or operation phase. Residual effects on resource economy of the Local Study Area are expected to be neutral or neglibile (with a minor positive effect on mining for the long-term due to increased access).

6.6.6.2 SUMMARY OF RESIDUAL EFFECTS ON INFRASTRUCTURE AND SERVICES

Table 6-52 through Table 6-55 provide a summary of mitigation measures and residual effects on infrastructure and services in communities in the Local Study Area and on relevant aspects of the Regional Study Area.

Note regarding the following residual effects tables:

1. Refer to Section 5.1 (Approach to Determination of Regulatory Significance) for full description of assessment characteristics. Under Step 1, all VECs were examined using the criteria of direction, magnitude, geographic extent and duration. As explained, where further analysis was warranted, a Step 2 analysis considered additional criteria of frequency, reversibility or ecological context.

Table 6-52: Summary of Mitigation and Residual Effects on Infrastructure and Services Valued Environmental Components: HOUSING

VEC Effect and Mitigation by Phase	Residual Effects	Assessment Characteristics (1 see introductory text)
KEEYASK CREE NATIONS		
Construction Phase		
Potential effects due to: • Net in-migration and new demand for housing **No mitigation/enhancement required**	Very limited new demand for housing	**Step 1:** Direction: Adverse Magnitude: Small Geographic Extent: Medium Duration: Short-term **Step 2: Not Required**
Operation Phase		
• No effect **No mitigation/enhancement required**	No effect	No effect
GILLAM/THOMPSON		
Construction Phase		
Potential effects due to: • Demand for temporary accommodation **No mitigation/enhancement required**	Ongoing demand for temporary accommodation	**Step 1:** Direction: Adverse Magnitude: Small Geographic Extent: Medium Duration: Short-term **Step 2: Not Required**
Operation Phase – Gillam/FLCN		
Potential effects due to: • Increased demand for housing by operation workers and their families **Mitigation includes:** • Plans for new housing currently underway	Continued planning of new housing through Gillam Land Use Planning process	**Step 1:** Direction: Neutral

Table 6-53: Summary of Mitigation and Residual Effects on Infrastructure and Services Valued Environmental Components: INFRASTRUCTURE AND SERVICES

VEC Effect and Mitigation by Phase	Residual Effects	Assessment Characteristics (1 see introductory text)
KEEYASK CREE NATIONS		
Construction Phase		
Potential effects due to: • Increased demand for infrastructure and services **Mitigation includes:** • Ongoing communication with local service providers • Improved daycare options (entrepreneurial opportunity)	Limited increased demand	**Step 1:** Direction: Adverse Magnitude: Small to Moderate Geographic Extent: Medium Duration: Short-term **Step 2: Not Required**
Operation Phase (note: FLCN under Gillam)		
• No effect **No mitigation/enhancement required**	No effect	No effect
GILLAM (including FLCN)		
Construction Phase		
Potential effects due to: • Increased demand for infrastructure and services **Mitigation includes:** • Gillam Land Use Planning process underway • Keep RCMP informed • Ongoing communication with local service providers • Through FLCN AEA, increased youth programming	Limited demand for increased infrastructure and services	**Step 1:** Direction: Adverse Magnitude: Small Geographic Extent: Small Duration: Short-term **Step 2: Not Required**
Operation Phase		
Potential effects due to: • Increased demand for infrastructure and services **Mitigation includes:** • Gillam Land Use Planning process underway	Very limited demand	**Step 1:** Direction: Adverse Magnitude: Small Geographic Extent: Small Duration: Long-term **Step 2 Not Required**

Table 6-53: Summary of Mitigation and Residual Effects on Infrastructure and Services Valued Environmental Components: INFRASTRUCTURE AND SERVICES

VEC Effect and Mitigation by Phase	Residual Effects	Assessment Characteristics (1 see introductory text)
THOMPSON		
Construction Phase		
Potential effects due to: • Limited demand for infrastructure and services **Mitigation includes:** • Keep RCMP informed	None anticipated	**Step 1:** Direction: Adverse Magnitude: Small Geographic Extent: Small Duration: Short-term **Step 2 Not Required**
Operation Phase		
• No effect	No effect	No effect
No mitigation/enhancement required		

Table 6-54: Summary of Mitigation and Residual Effects on Infrastructure and Services Valued Environmental Components: LAND

VEC Effect and Mitigation by Phase	Residual Effects	Assessment Characteristics (1 see introductory text)
KEEYASK CREE NATIONS		
Construction and Operation Phase		
• No effect	No effect	No effect
No mitigation / enhancement required		
GILLAM		
Construction Phase		
Potential effects due to: • Limited demand for land within Gillam	Very limited demand	**Step 1:** Direction: Neutral
No mitigation / enhancement required		
Operation Phase		
Potential effects due to: • Increased demand for land within Gillam associated with operation workers and their families	None anticipated	**Step 1:** Direction: Neutral
Mitigation includes: • Gillam Land Use Planning process underway		

Table 6-55: Summary of Mitigation and Residual Effects on Infrastructure and Services Valued Environmental Components: TRANSPORTATION INFRASTRUCTURE

VEC Effect and Mitigation by Phase	Residual Effects	Assessment Characteristics (1 see introductory text)
LOCAL STUDY AREA		
Construction Phase		
Potential effects due to: • Increased use and wear and tear on road, rail and air networks **Mitigation includes:** • Upgrades to PR 280 underway	Increased use of road, rail and air networks	**Step 1:** Direction: Adverse Magnitude: Small Geographic Extent: Medium Duration: Short-term **Step 2 Not Required**
Operation Phase		
• No effect **No mitigation/enhancement required**	No effect	No effect
REGIONAL STUDY AREA		
Construction Phase		
Potential effects due to: • Increased use and wear/tear on road, rail and air networks **No mitigation/enhancement required**	Increased use of road, rail and air networks	**Step 1:** Direction: Adverse Magnitude: Small Geographic Extent: Large Duration: Short-term **Step 2 Not Required**
Operation Phase		
• No effect	No effect	No effect

In summary, residual effects of the Project after mitigation, on KCNs housing during the construction phase are expected to be adverse (due to very limited net in-migration potentially causing new demand for housing) and of small magnitude. During the operation phase, there will be little effect on housing in Split Lake, York Landing and War Lake / Ilford.

Residual effects on housing in Gillam and Thompson during construction are focused on temporary accommodations related to visiting construction workers outside of work. Effects on housing are expected to be adverse, of small magnitude and short-term. During the operation phase, there are no expected residual effects on housing in Thompson; whereas housing in Gillam is expected to increase due to net in-migration of workers and their families moving into Gillam for operation jobs. Residual Project effects on housing in Gillam are expected to be neutral (since Manitoba Hydro is currently planning for future growth), of moderate magnitude and of long-term duration.

Effects, after mitigation, on KCNs / Gillam / Thompson infrastructure and services are expected to be adverse, small in magnitude and short-term. During the operation phase, effects on infrastructure and services are limited to Gillam (including FLCN) to meet the growing population demand. The residual effects are expected to be adverse, small in magnitude and long-term.

There are no effects on KCNs reserve or TLE land due to the Project; although the Project is located within the traditional territories of the KCNs, mainly TCN, who use these areas for traditional pursuits. There will be some minor effects on land in the Gillam and Thompson areas for transportation-related needs during the construction phase. Residual effects on land in Gillam during the operation phase are expected to be neutral since Gillam is involved in a Land Use Planning process to prepare for future changes, of small magnitude and long-term.

Transportation infrastructure within the Local and Regional Study Areas will have some short-term, adverse residual effects, of small magnitude, due to the increase in movement of equipment, materials and personnel. It is anticipated that existing infrastructure will be able to handle the increased demand since MIT is improving PR 280 in anticipation of future projects, including the Keeyask Generation Project. The KCNs have expressed concern over the condition of PR 280, and the expectation that these conditions will worsen with the Project. During the operation phase, there are no expected effects on transportation infrastructure in the Local or Regional Study Areas. However, YFFN has expressed scepticism over long-term effects on open water and ice conditions at Split Lake which has the potential to adversely affect ferry service in the summer and the ice road in the winter. Monitoring is identified (see Chapter 8).

6.6.6.3 Summary of Residual Effects on Personal, Family and Community Life

Table 6-56 through Table 6-63 provide a summary of residual effects on Personal, Family and Community Life VECs for the communities in the Local Study Area.

Note regarding the following residual effects tables:

1. Refer to Section 5.1 (Approach to Determination of Regulatory Significance) for full description of assessment characteristics. Under Step 1, all VECs were examined using the criteria of direction, magnitude, geographic extent and duration. As explained, where further analysis was warranted, a Step 2 analysis considered additional criteria of frequency, reversibility or ecological context.

Table 6-56: Summary of Mitigation and Residual Effects on Personal, Family and Community Life Valued Environmental Components: GOVERNANCE, GOALS AND PLANS

VEC Effect and Mitigation by Phase	Residual Effects	Assessment Characteristics (1 see introductory text)
KEEYASK CREE NATIONS		
Construction Phase		
Potential effects due to: • Increased demand on KCNs Members to participate in the Partnership **Mitigation includes:** • Measures already in place through JKDA and AEAs	Increased demand on KCNs to address construction issues and participate in Partnership committees and the Partnership board. Increased capacity of KCNs representatives from intensive involvement in project planning and development	**Step 1:** Direction: Positive Magnitude: Moderate Geographic Extent: Medium Duration: Long-term **Step 2 Not Required**
Operation Phase		
Potential effects due to: • Ongoing role for KCNs in oversight of the Project, including on the Partnership board and committees • Demand on KCNs leadership re: use of equity income **Mitigation includes:** • Measures already in place through JKDA and AEAs	Ongoing demands related to planning and decision-making re: use of equity income	**Step 1:** Direction: Positive Magnitude: Small to Moderate Geographic Extent: Medium Duration: Long-term **Step 2 Not Required**

Table 6-56: Summary of Mitigation and Residual Effects on Personal, Family and Community Life Valued Environmental Components: GOVERNANCE, GOALS AND PLANS

VEC Effect and Mitigation by Phase	Residual Effects	Assessment Characteristics (1 see introductory text)
GILLAM / THOMPSON		
Construction Phase		
Potential effects due to: • Increased demand on community leadership **Mitigation includes:** • Involvement in Gillam Land Use Planning process underway	Ongoing demand to deal with influx of workers	**Step 1:** Direction: Neutral
Operation Phase (Gillam)		
Potential effects due to: • Ongoing demand for leadership in community planning **Mitigation includes:** • Involvement in Gillam Land Use Planning process underway	Ongoing demand for community planning	**Step 1:** Direction: Neutral

Table 6-57: Summary of Mitigation and Residual Effects on Personal, Family and Community Life Valued Environmental Components: COMMUNITY HEALTH

VEC Effect and Mitigation by Phase	Residual Effects	Assessment Characteristics (1 see introductory text)
KEEYASK CREE NATIONS		
Construction Phase		
Potential effects due to: • Increased demand for social services **Mitigation includes:** • Measures already identified in other sections, as well as the KCNs AEAs	Ongoing demand for social services	**Step 1:** Direction: Adverse Magnitude: Small Geographic Extent: Medium Duration: Medium-term **Step 2 Not Required**
Operation Phase		
Potential effects due to: • Increased demand for health and social services **Mitigation includes:** • Programs noted in each of the KCNs AEAs • Continue existing dialogue with health and social services providers in Gillam (*e.g.,* NNADAP, Awasis, RCMP, BRHA) • Continued involvement in the Gillam Land Use Planning Process	Increased demand	**Step 1:** Direction: Positive Magnitude: Small Geographic Extent: Medium Duration: Long-term **Step 2 Not Required**

Table 6-58: Summary of Mitigation and Residual Effects on Personal, Family and Community Life Valued Environmental Components: MERCURY AND HUMAN HEALTH

VEC Effect and Mitigation by Phase	Residual Effects	Assessment Characteristics (1 see introductory text)
KEEYASK CREE NATIONS		
Construction Phase		
• No effect **No mitigation/enhancement required**	No effect	No effect
KEEYASK CREE NATIONS AND GILLAM		
Operation Phase		
Potential effects due to: • Elevated levels of methylmercury that will result in consumption restrictions on Gull and Stephens lakes **Mitigation includes:** • Monitor mercury concentrations in fish (see Section 6.4 AE SV) • Voluntary sampling of wild game, waterfowl, plants and gull eggs for mercury analysis • Encourage use of fish from unaffected lakes (via AEA programs) • Employment of a risk communication strategy and communication products for post-impoundment conditions; encourage use of country foods generally, and use of fish with low mercury concentrations • Prior to impoundment, prepare and distribute communication products (*e.g.*, poster, placemat, fish yardstick, maps and video) to inform KCNs communities and Gillam about increases in mercury concentrations post-impoundment, and implementation of monitoring; • Employment of a risk communication protocol for residents of Gillam (including signage) • Based on results of Aquatic and Terrestrial monitoring, additional HHRA until levels return to pre-Project conditions • Communicate monitoring results • Liaison (through MAC) with federal and provincial health authorities/Water Stewardship re: consumption restrictions	Restricted consumption of pickerel and jackfish (all groups) and lake sturgeon (for toddlers and women of child-bearing age only) in Gull and Stephens lakes	**Step 1:** Direction: Adverse Magnitude: Moderate Geographic Extent: Medium Duration: Medium-term **Step 2 Not Required**

Table 6-59: Summary of Mitigation and Residual Effects on Personal, Family and Community Life Valued Environmental Components: PUBLIC SAFETY AND WORKER INTERACTION

VEC Effect and Mitigation by Phase	Residual Effects	Assessment Characteristics (1 see introductory text)
KEEYASK CREE NATIONS AND GILLAM		
Construction Phase		
Potential effects due to: • Risk to public safety related to influx of non-local construction workers **Mitigation includes:** • Preventative measures focused on construction workers at Project • Coordinated discussion among Manitoba Hydro, the Town of Gillam, FLCN and TCN (where appropriate) to determine the best mechanism for tracking and addressing worker interaction issues	Risk to public safety	**Step 1:** Direction: Adverse Magnitude: Moderate Geographic Extent: Medium Duration: Short to Medium-term **Step 2 Not Required**
THOMPSON		
Construction Phase		
Potential effects due to: • Risk to public safety related to influx of non-local construction workers **Mitigation includes:** • Ongoing dialogue with the RCMP	Risk to public safety	**Step 1:** Direction: Adverse Magnitude: Moderate Geographic Extent: Small Duration: Short to Medium-term **Step 2 Not Required**
Operation Phase		
Potential effects due to: • Some risk to public safety related to community growth from operation workers in Gillam **Mitigation includes:** • Coordinated approach to addressing worker interaction issues identified under the construction phase	Risk to public safety	**Step 1:** Direction: Adverse Magnitude: Small Geographic Extent: Medium Duration: Long-term **Step 2 Not Required**

Table 6-60: Summary of Mitigation and Residual Effects on Personal, Family and Community Life Valued Environmental Components: TRAVEL, ACCESS AND SAFETY – WATER AND ICE BASED TRAVEL

VEC Effect and Mitigation by Phase	Residual Effects	Assessment Characteristics (1 see introductory text)
Construction Phase		
Potential effects due to: • Changes to travel on and access to Nelson River; restricted access near construction site **Mitigation includes:** • Implementation of the Reservoir Clearing Plan, the Waterways Management Program (WMP) Phase I and the Project's Construction Access Management Plan • Existing waterways management programs under the Comprehensive Implementation Agreements with TCN and YFFN	Changes to travel and access	**Step 1:** Direction: Adverse Magnitude: Small Geographic Extent: Medium Duration: Long-term **Step 2 Not Required**
Operation Phase		
Potential effects due to: • Changes to travel on and access to Nelson River; use of new trails, boat launches and a portage to navigate around facilities **Mitigation includes:** • Implementation of the Waterways Management Program (WMP) Phase II (includes a monitoring component) • Safety features associated with generating facility (*e.g.*, siren and fencing) • Existing waterways management programs under the Comprehensive Implementation Agreements with TCN and YFFN	Changes to travel and access	**Step 1:** Direction: Positive Magnitude: Small Geographic Extent: Medium Duration: Long-term **Step 2 Not Required**

Table 6-61: Summary of Mitigation and Residual Effects on Personal, Family and Community Life Valued Environmental Components: TRAVEL, ACCESS AND SAFETY – ROAD TRAVEL

VEC Effect and Mitigation by Phase	Residual Effects	Assessment Characteristics (1 see introductory text)
Construction Phase		
Potential effects due to: • Increased traffic on PR 391 and 280, with possible increase in accidents **Mitigation includes:** • Improvements to PR 280 undertaken by MIT prior to Project • The Project's Construction Access Management Plan	Increased traffic	**Step 1:** Direction: Adverse Magnitude: Moderate Geographic Extent: Medium Duration: Short-term **Step 2 Not Required**
Operation Phase		
Potential effects due to: • Shorter travel distance between Thompson and Gillam • TCN/YFFN concern about winter road travel on Split Lake **Mitigation includes:** • TCN and YFFN Comprehensive Implementation Agreement provisions regarding monitoring of ice conditions on Split Lake	Shorter travel distance	**Step 1:** Direction: Positive Magnitude: Small Geographic Extent: Medium Duration: Long-term **Step 2 Not Required**

Table 6-62: Summary of Mitigation and Residual Effects on Personal, Family and Community Life Valued Environmental Components: CULTURE AND SPIRITUALITY

VEC Effect and Mitigation by Phase	Residual Effects	Assessment Characteristics (1 see introductory text)
KEEYASK CREE NATIONS		
Construction Phase		
Potential effects due to: • Loss of cultural landscape and the rapids **Mitigation includes:** • Offsetting programs in AEAs are key to addressing effects on culture and spirituality • Ceremonies and rituals at key Project milestones • Counselling services as part of Employee and Retention Support DNC	Loss of cultural landscape and rapids	**Step 1:** Direction: Adverse Magnitude: Small Geographic Extent: Medium Duration: Long-term **Step 2 Not Required**
Operation Phase		
Potential effects due to: • Loss of cultural landscape and the rapids **Mitigation includes:** • Offsetting programs in AEAs are key to addressing effects on culture and spirituality • Video of Gull Rapids and Nelson River between outlet of Birthday Rapids and Stephens Lake prior to impoundment • Interpretative display in visitor space of generating station • Cultural training for operation staff	Loss of cultural landscape and rapids	**Step 1:** Direction: Adverse Magnitude: Small Geographic Extent: Medium Duration: Long-term **Step 2 Not Required**

Table 6-63: Summary of Mitigation and Residual Effects on Personal, Family and Community Life Valued Environmental Components: THE WAY THE LANDSCAPE LOOKS (AESTHETICS)

VEC Effect and Mitigation by Phase	Residual Effects	Assessment Characteristics (1 see introductory text)
Construction Phase		
Potential effects due to: • Changes in physical landscape and scenic views **Mitigation includes:** • KCNs' AEAs • Implementation of Reservoir Clearing Plan • Ceremonies and rituals at key Project milestones • Nature trails within north camp area • Reclamation of construction site as per Sch. 7-1 of JKDA	Ongoing changes to physical landscape and views	**Step 1:** Direction: Adverse Magnitude: Small Geographic Extent: Medium Duration: Long-term **Step 2 Not Required**
Operation Phase		
Potential effects due to: • Gull Lake changed from riverine to reservoir environment; loss of rapids **Mitigation includes:** • KCNs' AEAs • Park/rest area with boat launch • Commemorative plaque or memorial • Video of Gull Rapids and stretch of the Nelson River between Birthday Rapids and Stephens Lake prior to construction • Interpretative display in visitor space of generating station	Ongoing changes to Gull Lake and loss of rapids	**Step 1:** Direction: Adverse Magnitude: Small Geographic Extent: Medium Duration: Long-term **Step 2 Not Required**

In summary, residual effects on KCNs governance, goals and plans during construction are expected to be positive (due to experience gained in negotiations and planning of the Project) of moderate magnitude and long-term. During the operation phase, residual effects are expected to be positive (due to opportunity to use equity income for community goals and plans), of small to moderate magnitude, and long-term.

Residual effects on governance related to Gillam are expected to be neutral due to ongoing planning in place now and into the future to prepare for future Project changes. Residual effects on governance related to Thompson are limited to the construction phase, are neutral and small in magnitude.

Residual effects related to community health in the construction phase (KCNs, Gillam and Thompson) are adverse (due to increased demand for health and social services), medium-term and small in magnitude; and in the operation phase (KCNs, Gillam and Thompson) are positive (due to employment and equity income providing the opportunity for a higher standard of living), of long-term duration and small in magnitude.

There are no residual effects related to methylmercury and human health in the construction phase. During the operation phase, there will be elevated levels of methylmercury, particularly in pickerel and jackfish from Gull Lake (and to a lesser extent Stephens Lake). Residual effects after mitigation are expected to be adverse, of moderate magnitude, and medium-term and continuous for several decades, with declining trends over time. Undertaking further human health risk assessments will provide the necessary information to reduce the consumption restrictions as the methylmercury levels decline.

Residual effects, after mitigation, related to public safety and worker interaction for the KCNs and residents of Gillam and Thompson during the construction phase are expected to be adverse, moderate in magnitude and medium term in duration. A key mitigation measure is the coordinated approach across all Manitoba Hydro projects in vicinity of Gillam, working with the Town, FLCN and TCN (where appropriate). Residual effects during the operation phase are expected to be adverse, small in magnitude and long-term in duration.

Residual effects, after mitigation, related to water and ice-based travel access and safety during the construction phase are expected to be adverse due to change in travel patterns and restricted access, small in magnitude, and of long-term duration. During the operation phase, residual effects are expected to be positive (due to provisions in the Waterways Management Program, including new trails, boat launches and a portage and safe landing sites), of small magnitude, and long-term in duration.

Residual effects, after mitigation, related to road-based travel access and safety during construction are expected to be adverse (due to increased traffic), moderate in magnitude and short-term. Residual effects during the operation phase are expected to be positive (due to shorter travel distance between Thompson and Gillam), small in magnitude and long-term.

Effects on culture and spirituality are moderated by the KCNs' involvement in shaping the Project, the AEA offsetting programs that are focused on culture and provision for ceremonies at key milestones. Residual effects, after mitigation, on culture and spirituality are adverse, small in magnitude and long-term.

Residual effects after mitigation related to the way the landscape looks during the construction phase are expected to be adverse (due to the physical alteration of the landscape), small in magnitude, and long-term. During the operation phase, residual effects are expected to be adverse (due to a change from riverine to a reservoir environment and the loss of the rapids), moderate in magnitude, long-term and irreversible.

6.6.7 SENSITIVITY OF EFFECTS TO CLIMATE CHANGE

As described in Sections 6.3.32 and 6.3.12 the probable scenario of climate change for the 2020s, 2050s and 2080s for the area in the vicinity of Gillam predicts increasing temperatures, particularly in December through February; with temperatures gradually increasing between the 2020s and the 2080s. Similarly, climate change scenarios are also predicting increasing precipitation in the same time period. Sensitivity to climate change is focused on the operation phase as climate change is a longer-term issue.

The socio-economic environment assessments and the conclusions on residual effects were reviewed to determine if these conclusions would change as a result of climate change effects. Valued environmental components that could be susceptible to climate change include:

- Methylmercury and human health;
- Water-based travel; and
- The way the landscape looks (or aesthetics).

In terms of methylmercury and human health, measurable changes on today's fish methylmercury levels would likely occur several years after the Keeyask Project has gone into service (*i.e.*, the earliest being approximately 2021 or three years after reservoir impoundment), and after the largest effects of the Project on the physical environment have occurred. Lake whitefish, pickerel and jackfish are predicted to reach maximum mean methylmercury concentrations within three to seven years post-construction and would likely not be measurably affected by climate change. Given the above, climate change is not expected to have an effect on consumption recommendations for eating fish, waterfowl or mammals (as predictions in waterfowl are based on the fish).

Effects on travel, access and safety that stem specifically from climate change relate primarily to later ice formation and earlier ice break-up due to increasing temperatures predicted by the climate change models. These changes will have an effect on travel that depends on ice conditions (*e.g.*, winter roads) (see Physical Environment Section 6.3.12). For YFFN

Members at York Landing who depend on winter road across Split Lake, later ice formation and earlier spring break-up can result in a shorter winter road season. Conversely, a shorter winter road season may result in a longer open water season, enabling the ferry to operate longer (depending on overall weather conditions). There is also the possibility of thinner ice conditions and changes in the location of pressure ridges which could pose hazards to winter travel. Increased snowfall in the November to January period may also result in slush ice on top of the ice cover (see Section 6.3.12), causing a further hazard to winter road travel. These effects are related to changes in climate; they are not attributable to the Project. Overall, the residual effects assessment for travel, access and safety (with mitigation in place) do not materially change as a result of climate change.

During the operation phase, the landscape will change from a riverine to a reservoir environment. Over time, there is likely to be increased shoreline erosion and expansion of the flooded area. However, the majority of shoreline erosion and reservoir expansion is expected to occur when climate conditions are still similar to existing conditions (see Section 6.3.12). In summary, the way the landscape looks does not appear to be materially sensitive to climate change.

6.7 EFFECTS AND MITIGATION RESOURCE USE

6.7.1 INTRODUCTION AND APPROACH

This section focuses on effects of the Project on the resource use environment components, mitigation measures (that are technically and economically feasible) to address those effects, residual effects that remain after mitigation, and the regulatory significance of the residual effects on VECs. This section also assesses the sensitivity of these effects to possible climate change scenarios.

The assessment of Project effects is based on the existing environment, as described in the preceding Section 6.2, including the predicted future environmental conditions and trends if the Project were not to proceed. This existing environment incorporates effects of past projects, most notably past and current projects identified for the cumulative effects assessment. This section also notes where there are overlaps or interactions between effects of the Project with potential future projects.

Two geographic regions were examined: the Local Study Area (including Split Lake Resource Management Area (SLRMA) Traplines 09, 15 and 25 and the portion of Trapline 07 which will be affected by flooding); and the Regional Study Area (the Split, Fox and York Factory Resource Management Areas). Both study areas are shown on Map 6-42.

As discussed in Chapter 5, the environmental assessment was based on both ATK and technical scientific analysis. Methods and general conclusions related to the ATK-based analysis are provided in Chapter 2, and detailed results are provided in the CNP Keeyask Environmental Evaluation Report, YFFN Evaluation Report (*Kipekiskwaywinan*) and FLCN Environment Evaluation Report (Draft). Detailed results for the technical component of the environmental assessment are provided in the Resource Use Section of the SE SV. This section summarizes the results of the ATK and technical analysis. Given the difference in approach of the Cree worldview and technical science, the assessment of the nature of the residual effects differed for some components; these differences are also discussed (Section 6.7.6).

The technical analysis determined effects of the Project on the resource use environment by considering the linkages between the resource use environment and changes caused by the Project, both directly (*e.g.*, changes in access) and indirectly through changes to the physical environment (*e.g.*, changes to fish or wildlife resources that, in turn, change fishing or hunting activity).

As described in Chapter 5, the assessment of regulatory significance was focused on the VECs. The resource use VECs are: domestic fishing, domestic hunting and gathering and commercial trapping. Rationale for the VEC selection was previously discussed in Section 6.2.3.6.

6.7.2 ABORIGINAL TRADITIONAL KNOWLEDGE

As part of their historical connection to *Askiy* (Mother Earth), the KCNs have acquired ATK from life experiences and their relationship with the land, water and all living things. They have explained their holistic worldview in Chapter 2 and in more detail in the CNP Keeyask Environmental Evaluation Report, YFFN Evaluation Report (*Kipekiskwaywinan*) and FLCN Environment Evaluation Report (Draft). ATK in this section of the EIS should be understood from the perspective of the Cree worldview. This worldview and knowledge guided the KCNs in their participation in planning the Project with Manitoba Hydro and in providing guidance to the environmental assessment. Many community Members expressed doubt that the effects of past projects were fully understood or accurately predicted and hold similar reservations regarding the current Project. Descriptions of the offsetting programs available to each KCNs community as part of their Adverse Effects Agreements (AEAs) are also included below.

CNP ATK observations with respect to resource use environment were provided in their evaluation report (2012). These were made before technical studies were completed and before mitigation was applied and include the following:

- Construction noise and workforce harvesting are expected to reduce hunting and trapping success;
- Increases in debris and sediment are expected to reduce safety for domestic fishers and in turn reduce fish available to CNP Members (construction and operation);
- Traditional hunting, fishing and trapping grounds will be altered or destroyed (construction and operation);
- There will be fewer animals such as moose, waterfowl, muskrat and beavers to harvest (construction and operation);
- The increase in mercury level in some fish species, especially jackfish (also known as northern pike) and pickerel (also known as walleye) will pose a health hazard (operation);
- Travel over ice may be more dangerous due to increases in slush ice (operation);
- Medicinal plants, firewood and building materials are expected to be lost to flooding (operation);
- Traditional camp sites and trappers' cabins will be flooded (operation); and

- CNP Members who trap in the Keeyask area will suffer lost revenue because there will be fewer furbearing animals to trap due to flooding caused by the Project.

Offsetting programs which have been incorporated into the AEA are regarded as an excellent opportunity to strengthen cultural and social well-being and increase opportunity to hunt, fish and gather (CNP Keeyask Environmental Evaluation Report). These programs are expected to provide CNP Members with appropriate replacements, substitutions or opportunities to offset unavoidable Keeyask adverse effects on practices, customs and traditions integral to their distinctive cultural identity.

Given the Cree responsibility for showing respect for every part of creation and being keepers of the land, the AEA offsetting programs have been central to establishing the Keeyask Partnership. For example, the TCN anticipate that participation in AEA offsetting programs such as the Access Program will allow for expanded opportunities to show respect in other parts of their homeland ecosystem and the programs will restore traditional ecological knowledge to a condition better than presently exists (CNP Keeyask Environmental Evaluation Report). The TCN Land Stewardship program also will provide opportunities for TCN to show respect for the land within the SLRMA (TCN and Manitoba Hydro 2009).

In addition to the WLFN Community Fish Program and the Improved Access Program, the WLFN Traditional Learning/Lifestyle Program (WLFN and Manitoba Hydro 2009) is designed to provide young adults the opportunity to experience a traditional lifestyle program.

FLCN have provided the following perspectives from their evaluation report (2012):

- All FLCN Members are considered resource users as all Members benefit from resource use and country foods produced;
- Increased access and populations in and near the FLCN Resource Management Area will increase harvesting and will decrease the abundance of traditional foods available to FLCN Members (construction and operation);
- FLCN Members expect that present unsafe ice conditions (caused by water fluctuations on Stephens Lake) will be exacerbated by the Project (construction and operation);
- The creation of the reservoir will increase existing FLCN Member concerns about declining quality of fish (mercury and the changes in taste and texture) (operation); and
- Traditional use areas for harvesting plants and berries will be lost (operation).

The FLCN Alternative Resource Use and the FLCN Youth Wilderness Traditions Programs (FLCN and Manitoba Hydro 2009) are available to provide alternate resource use locations and provide young Members the opportunity to experience a traditional lifestyle.

YFFN have provided the following perspectives from their evaluation report:

- The numbers and quality of fish and wildlife will be reduced by the Project and these effects will be apparent in areas beyond the predicted extents of Project effects in areas such as Split Lake and the Aiken River;
- Ice and open water travel conditions will become more treacherous on Split Lake and the Aiken River; and
- Meaningful involvement of the YFFN community Elders, resource users and youth in monitoring is a priority to the community.

The YFFN Resource Access and Use and the Cultural Sustainability programs provide for resource use in alternate locations and for cultural programs and seasonal gatherings and celebrations (YFFN and Manitoba Hydro 2009). The Environmental Stewardship Program provides YFFN with the capacity to monitor and assess potential environmental changes resulting from the Project.

Most AEA offsetting programs begin in the pre-construction period and continue through the operation period. Provisions within the Adverse Effects Agreements are available to shift funding among and between programs if priorities change or if desired.

Because, in some instances, ATK has perspectives that differ and doubt some of the results of technical science, an emphasis has been placed on monitoring and adaptive management. These topics are covered in Chapter 8.

6.7.3 DOMESTIC RESOURCE USE

This section considers domestic resource use and focuses on domestic fishing and domestic hunting and gathering VECs.

6.7.3.1 DOMESTIC FISHING

6.7.3.1.1 CONSTRUCTION EFFECTS AND MITIGATION

Through the following pathways, the Project has the potential to affect domestic fishing during construction:

- Disturbances causing changes in navigation and access;
- Disturbances causing potential changes to fish resources;
- The presence of a large workforce potentially increasing competition for fish;
- Increases in the wage economy potentially reducing domestic fishing activity; and

- Shifting patterns of resource use due of offsetting programs.

The effects described below are predicted for KCNs communities. Use of the Local Study Area by other Aboriginal groups has not been identified through the Public Involvement Program or through direct consultations, which are ongoing with Aboriginal groups and communities (see Chapter 3). To date, no effects to other Aboriginal groups have been identified.

Flow velocities and open-water levels will be altered between 3 km downstream of the outlet of Clark Lake and the inlet of Stephens Lake (Section 6.3.6.2). Depending on location and the stage of construction, changes will range from being so small that they are difficult to detect (*i.e.*, upstream of Birthday Rapids and at the inlet of Stephens Lake) to being noticeable at areas close to the construction site (*i.e.*, close to cofferdam construction areas where flows will be redirected during Stage I and II Diversions). Areas close to the Project site have existing high flow velocities that presently limit navigation and therefore changes in these local areas are not expected to cause an important decline in domestic fishing activity. Boat travel in these local areas will be restricted for safety reasons.

Increasing open-water levels and decreasing flow velocities on Gull Lake are predicted over the construction phases. Construction of spillway rollways in Stage II of construction will allow for reservoir impoundment approximately one year prior to the end of construction (Section 6.3.10). These locations will undergo substantial change as portions of the Nelson River and Gull Lake are converted from a river environment into a reservoir environment during the final stage of construction. The nature of any domestic fishing on these waterbodies also will change requiring a period of adjustment to new navigation and access conditions for domestic fishers.

To mitigate changes in the open-water environment to domestic fishers, AEA offsetting programs (see AEAs: TCN and Manitoba Hydro 2009; WLFN and Manitoba Hydro2009; YFFN and Manitoba Hydro 2009; and FLCN and Manitoba Hydro 2009) are in place to conduct domestic fishing activity in alternate and unaffected locations. As part of Schedule 11-1 of the JKDA, the Reservoir Clearing Plan is expected to minimize the impacts of standing trees and shrubs on fishing in selected areas within the reservoir. This plan also is expected to minimize hazards to boating safety and fishing resulting from large floating debris by reducing debris sources. Annually prior to reservoir impoundment, the Waterways Management Program (JKDA, Schedule 11-2) will involve operation of a multi-purpose boat patrol which will monitor waterway activities between Split and Stephens lakes, liaise with individuals and groups using the Nelson River and construct and maintain one or more safety cabins.

In winter and under low to moderate flows, the ice boom (Section 6.3.6.1) is expected to facilitate stable ice cover upstream of Gull Rapids three to four weeks sooner than under existing conditions, thereby expanding the upstream extents of ice coverage (due to an extended period for ice formation) (Section 6.3.6.2). Under high flow conditions formation of ice cover may occur six to eight weeks earlier (PE SV Section 4.4.1.3). Similar to existing environment conditions, the ice cover will continue to form by a shoving and mechanical thickening process and will remain difficult to travel on (PE SV Section 4.4.1.3). These conditions are similar to the existing environment, which already limits opportunities to access domestic fishing areas in winter.

The ice boom is predicted to reduce frazil ice formation that causes a hanging ice dam downstream of Gull Rapids (Section 6.3.6.2). The reduction of hanging ice downstream (and associated ice accumulation) is anticipated to enable domestic fishers to access the Nelson River upstream of the inlet of Stephens Lake earlier in the spring and possibly improve snowmobile access in winter (due to more stable ice). Improved spring access will be offset in part by the requirement for restricting boat traffic in areas close to construction activities, particularly during the Stage II Diversion when high flow velocities are expected to extend approximately 800 m downstream. This area and the south channel downstream of the ice boom will be designated as Dangerous Waterway Zones within which use of the waterway will be strongly dissuaded or prevented (PD SV). Buoys will be installed at the upstream and downstream boundary of the Dangerous Waterway Zones (PD SV).

During winter and to facilitate safe travel, the Waterways Management Program will install and regularly monitor the condition of safe ice trails and the nature and extent of their use. As mentioned above, one or more safety cabins also will be constructed.

The construction of cofferdams and alteration of Nelson River flows will result in a loss of aquatic habitat in Gull Rapids, which is used as spawning habitat for fish in Stephens Lake (Section 6.4.6). The loss of habitat and alteration of downstream flows are predicted to result in a reduction in the year class strength of fish species in Stephens Lake that rely on spawning habitat in Gull Rapids (*e.g.*, lake whitefish, lake sturgeon, and, to a lesser extent, pickerel) for the years the cofferdams are in place (Section 6.4.6). However, local reductions in fish availability will not be noticeable to resource users during the construction period because of the time required for fish to become recruited into the fishery. This effect is discussed under operation effects.

The presence of a large workforce residing in camp may cause increased competition for resources at local and/or road accessible fishing areas. At Wuskwatim, catch and release fishing has been conducted by a very small proportion of the construction workforce (*i.e.*, approximately 1%) (Resource Use Section 1.2 of the SE SV). This level of fishing, if it remains similar or even increases moderately at Keeyask, is not expected to reduce domestic fishing resources. Due to KCNs concerns expressed with respect to construction workforce harvest (see CNP Keeyask Environmental Evaluation Report; FLCN Environment Evaluation Report (Draft); FLCN 2009 Draft), monitoring of construction workforce fish harvest within the construction site (which will be permitted in areas away from construction activity that are safe to access) will be conducted (see Chapter 8). On-site fishing will be limited to angling from shore (*i.e.*, net fishing by boat will not be conducted by Aboriginal workforce members) due to restrictions in the AMP with respect to bringing boats on site.

Net in-migration to Gillam during construction is expected to be low (Section 6.6.4.1), therefore, harvest undertaken by any construction workforce residing in Gillam is expected to be nominal or very low. No effects are expected.

Increases in the wage economy, though typically regarded as a positive effect for northern communities with limited employment options, may reduce the quantity of domestic fishing activity as resource harvesters may choose to engage in construction employment. Alternatively, wage employment may increase the capacity of resource users to purchase equipment such as boats or fishing gear. Pursuing Project employment is an individual choice and may affect individuals and groups both positively and negatively. Effects cannot be readily assessed.

AEA offsetting programs are expected to reduce fishing (and hunting and gathering) pressures in existing areas of resource use concentration and redistribute it over larger land bases such as community RMAs. These offsetting programs will provide the option to increase KCNs country food supply and more KCNs Members will be able to participate in cultural practices and traditions on the land. AEA offsetting programs will also improve inter-generational transmission of knowledge (CNP Keeyask Environmental Evaluation Report). A residual effect may occur in areas where existing resource users will experience increased use of areas they typically use, though this is offset to some degree by the capability of existing users to participate in AEA offsetting programs themselves.

The Cree stewardship role which incorporates self-regulation of fish (and wildlife) harvest when resources are scarce (Section 6.2.3.6) is expected to safeguard resources needed to conduct the TCN Access Program, the WLFN Improved Access Program, the YFFN Resource Access and Use Program and the FLCN Alternative Resource Use program (which is shorter-term due to selection of other offsetting priorities).

Additional measures to support the long-term sustainability of fishing programs such as the TCN Healthy Foods Fish Program and the WLFN Community Fish Program will be addressed through a fish harvest sustainability plan developed by CNP and WLFN (CNP Keeyask Environmental Evaluation Report). As part of their AEAs, the TCN and WLFN will take the sole responsibility for the management, implementation and operation of AEA offsetting programs (TCN and Manitoba Hydro 2009; WLFN and Manitoba Hydro 2009). The AEAs provide for coordination with and annual reports to be submitted to the Resource Management Boards with respect to the management and administration of the AEA offsetting programs (TCN and Manitoba Hydro 2009; WLFN and Manitoba Hydro 2009; YFFN and Manitoba Hydro 2009; FLCN and Manitoba Hydro 2009).

Apart from the programs implemented for the Project there also are additional initiatives that would affect the abundance of sturgeon in the Local and Regional Study Areas. Manitoba Hydro, TCN, WLFN, YFFN, FLCN and Shamattawa First Nation, and potentially other parties including the Partnership, are developing a Lower Nelson River Sturgeon Stewardship Agreement, which has the goal to conserve and enhance the present population of lake sturgeon in the lower Nelson River (see Section 7.4.1.2 for more details). A similar agreement also is being developed for the Churchill River.

6.7.3.1.2 Residual Effects of Construction

In summary, the following mitigation measures will be implemented to address construction effects on domestic fishing:

- Offsetting fishing programs;
- Reservoir Clearing Plan;
- Waterways Management Program; and
- Fish harvest sustainability plan.

The following are the residual effects on domestic fishing that are expected once the appropriate mitigation measures are applied:

- Domestic fishing pressures will be re-distributed to a larger (regional) land base which will increase KCNs opportunity to acquire country food and increase the KCNs cultural practices and traditions associated with domestic fishing. The fish harvest sustainability plan will serve to secure these benefits by sustainably managing fish resources.
- Redistribution of domestic fishing to a broader area through AEA offsetting programs may overlap existing areas used by domestic fishers that may increase competition and contact among resource users. This effect will be offset to some degree because existing domestic fishers also will be able to participate in AEA offsetting programs.
- Resource users who choose to continue to use the Local Study Area are expected to experience changes to water flow patterns and ice conditions on local waterbodies. For example, flows will be concentrated and redirected by cofferdams. These effects will be mitigated to some degree by provisions in the Reservoir Clearing Plan (*i.e.*, removal of potential debris) and Waterways Management Program (*i.e.*, boat patrols). Current use of these areas is considered low due to difficult access (see Resource Use Section 1.2 of the SE SV).

For communities as a whole, the AEA offsetting programs are expected to positively benefit domestic fishing by providing KCNs with fish for food and by increasing opportunities to practice cultural traditions. However, it is recognized that some resource users may be negatively affected by a change in the spiritual and cultural nature of their domestic fishing activities neutralizing the positive effects of the AEA offsetting programs (*e.g.*, local knowledge would need to be relearned at new fishing locations; fishing may not be as spontaneous for some Members as it would become, in part, a planned activity through AEA offsetting programs).

Using the criteria established to determine the significance of Project effects for regulatory purposes (described in Section 5.5), the residual effects of Project construction on domestic fishing are expected to be neutral.

6.7.3.1.3 OPERATION EFFECTS AND MITIGATION

Through the following pathways, the Project has the potential to affect domestic fishing during operation:

- Changes to the fish resources from local waterbodies due to increased mercury and changes in habitat;
- Changes in navigation and access;
- Increasing populations in Gillam; and
- Shifting patterns of resource use due of AEA offsetting programs.

Change to the fish resource (*e.g.*, increased mercury in fish) is predicted for the reservoir and downstream of the GS to Stephens Lake (Section 6.4.7). Though many KCNs Members report that they do not consume fish from the Nelson River, the presence of increased mercury in fish may further reduce local fish consumption. No effects are predicted for Split Lake or the Aiken River.

Mitigation measures include monitoring of mercury levels in fish and education and communication strategies to advise KCNs Members (and also Gillam residents) on local consumption recommendations with respect to mercury (see Section 6.6.5 and Chapter 8).

As discussed above and in Section 6.7.3.1.1, year class strength may be reduced during construction for pickerel, lake whitefish and lake sturgeon (sturgeon populations will be replaced through stocking) in Stephens Lake. Because of the eight year delay for these fish to reach sufficient size to be recruited into the fishery, the reduction in lake whitefish and pickerel spawn during the construction period has the potential to be observed for the first eight to nine years of operation. However, this effect is expected to be undetectable to domestic fishers due to:

- Harvest reduction of pickerel (and likely whitefish by-catch) associated with discontinuing the (single license) Stephens Lake commercial fishery (see Section 6.7.4.2);
- The ongoing availability of alternate pickerel and whitefish spawning locations in Stephens Lake; and
- Low to negligible levels of existing domestic fish harvest below Gull Rapids.

Domestic fishers who choose to use local waterbodies will undergo a period of adjustment resulting from changes in navigation and access. During the operation phase, the Waterways Management Program (JKDA Schedule 11-2) will continue to contribute to the safe use and enjoyment of the waterways between Split Lake and Stephens Lake. Two boat crews and one ice trail crew will operate for various durations upstream of the GS conducting the following selected activities as applicable:

- Collection of floating debris that are a risk to navigation;
- Monitoring waterway activity 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;
- Constructing and maintaining safe landing sites and required docks and shelters;
- Installing and regularly monitoring the condition of safe ice trails and the nature and extent of their use; and
- Maintaining trails and portages.

One additional boat patrol crew will also operate downstream of the GS, primarily to implement safety measures, deliver information to downstream resource users and help people become accustomed to the powerhouse's operating mode. This activity is planned for a three-year duration and will be re-evaluated thereafter. Areas in close proximity to the GS will be designated as Dangerous Waterway Zones and marked with buoys (PD SV).

Increasing populations in Gillam (ranging from 120 to150 people in total from 46 Keeyask operation jobs) (Section 6.6.3.2), may increase recreational (non-Aboriginal) harvesting which may compete for domestic fish resources.

Increases in both recreational and domestic fishing have the potential to occur in the Project reservoir (where a new boat launch and access roads will make the area accessible) and downstream of the GS though any increase in fish harvest is expected to remain within sustainable levels due to the following:

- Predicted population increases in Gillam are conservative (high) and only a small proportion of the new population in Gillam would be expected to fish recreationally;
- Provincial harvest regulations such as recreational fishing licences limit fish harvest (and prohibit recreational lake sturgeon harvest);
- Low levels of use are expected due to distance from Gillam (greater than 30 km) and from Split Lake (greater than 80 km);
- The availability of similar fishing areas (*i.e.*, type of species available for fishing and a reservoir fishing environment) are located closer to Gillam (*e.g.*, Stephens Lake) and closer for TCN members on Split Lake; and
- Domestic fishing pressures will be distributed over regional land bases through AEA offsetting programs.

Resource users may notice, however, increases in the numbers of people fishing at popular locations such as Stephens Lake, the North and South Moswakot rivers, the Limestone River and other areas. This may reduce aesthetics for some domestic fishers due to feeling "crowded" at various fishing sites.

As discussed in the construction phase effects, shifting patterns of resource use will also occur during the operation phase. Access and fishing programs will provide TCN, WLFN and YFFN with healthy food fish from off-system lakes. Also discussed above, measures to facilitate the long-term sustainability of the fish resource will continue through the operation phase.

6.7.3.1.4 Residual Effects of Operation

In summary, the following mitigation measures will be implemented to address operation effects on domestic fishing:

- AEA offsetting fishing programs;
- Communication of local consumption recommendations with respect to mercury in fish;
- Waterways Management Program; and
- Fish harvest sustainability plan.

The following are the residual effects on domestic fishing that are expected once the appropriate mitigation measures are applied:

- Domestic fishing pressures will be re-distributed to a larger (regional) land base which will increase KCNs opportunity to acquire country food and increase cultural practices and traditions associated with domestic fishing. The fish harvest sustainability plan will serve to secure these benefits by sustainably managing fish resources;
- Individual preferences (quantity or species) for domestic fish consumption are expected to change (CNP Keeyask Environmental Evaluation Report; YFFN Evaluation Report (*Kipekiskwaywinan*); FLCN 2008 Draft; FLCN 2010 Draft; FLCN Environment Evaluation Report (Draft)) which will be offset by communication strategies with respect to mercury in fish (see Section 6.6.5);
- A short to medium-term period of adjustment to new conditions and reduced predictability of the environment for resource users choosing to use the reservoir area and directly downstream of the GS. This effect will be mitigated in part by the Waterways Management Program; and
- Increased contact among resource users (*e.g.*, potential for crowding) at fishing sites due to population increases in Gillam. This effect is expected to affect aesthetics but not domestic fishing success.

For communities as a whole, the AEA offsetting programs are expected to positively benefit domestic fishing by providing KCNs with fish for food and by increasing opportunities to practice cultural traditions. However, it is recognized that some resource users may be negatively affected by a change in the spiritual and cultural nature of their domestic fishing activities neutralizing the positive effects of the AEA offsetting programs (*e.g.*, local knowledge would need to be relearned at new fishing locations and fish consumption would require more caution with respect to mercury levels in fish).

Using the criteria established to determine the significance of Project effects for regulatory purposes (described in Section 5.5), the residual effects of Project operation on domestic fishing are expected to be neutral.

6.7.3.1.5 Conclusions about Residual Effects on Domestic Fishing

The overall conclusion about residual effects on domestic fishing in both the construction and operation phases is neutral. Certainty is high that the long-term positive benefits of AEA offsetting programs in combination with measures within the Waterways Management Program and measures to ensure long-term sustainability of the fish resources will offset negative effects or provide additional benefits to most individuals. The AEA offsetting programs have been negotiated by the KCN communities to meet the specific needs of their Members and each community-specific AEA has been ratified by their respective community. ATK monitoring programs are being developed by each of the KCNs (see Chapter 8).

6.7.3.2 Domestic Hunting and Gathering

6.7.3.2.1 Construction Effects and Mitigation

Through the following pathways, the Project has the potential to affect domestic hunting and gathering during construction:

- Disturbances causing increases in noise and dust affecting resource users;
- Disturbances affecting resource user safety;
- Changes in access and navigation in areas proximal to Project construction;
- Disturbances causing potential reductions to wildlife resources that resource users target;
- The presence of a large workforce potentially increasing competition for resources;
- Increases in the wage economy potentially reducing domestic hunting and gathering activity; and
- Shifting patterns of resource use due of AEA offsetting programs.

The effects described below are predicted for KCNs communities. Use of the Local Study Area by other Aboriginal groups has not been identified through the Public Involvement Program or through direct consultations with Aboriginal groups and communities (see Chapter 3). Therefore, no effects to other Aboriginal groups have been identified.

Disturbances from Project construction may include reduced aesthetics to resource users due to construction noise (and potentially dust) close to the construction site, on the north access road and near the south access road during construction. Owners of cabins located adjacent to Provincial Road 280 (PR 280) may be affected by increases in dust and traffic-associated noise (CNP Keeyask Environmental Evaluation Report). With respect to noise, resource users that are in close proximity to the construction site or access roads will notice increases in construction and traffic-associated noise. This may affect resource users differently depending on their perceptions and their proximity to the construction activity.

Mitigation (and regular maintenance) planned to address traffic-related dust on PR 280 affecting cabin owners includes upgrading of the highway by Manitoba Infrastructure and Transportation (MIT) which is ongoing (Section 6.2.3.5) and dust control under MITs Maintenance and Preservation Program which is a regular maintenance program (Manitoba Infrastructure and Transportation 2011). For resource users using areas adjacent to the north access road and later in the construction period, the south access road, mitigation measures include use of dust control and speed reductions where required (Section 6.3.4.1). Though there are no specific measures that can be implemented to reduce the effects of noise on resource users, noise effects are predicted to be localized (Section 6.3.4). For those resource users who are affected by noise, AEA offsetting programs can provide alternate locations to conduct domestic hunting and gathering.

Domestic hunter safety also may be affected by crossing the north access road. The use of rifles in proximity to the access roads has the potential to increase risk to those using the roads (both resource users and construction workers travelling on roads).

Measures identified in the Keeyask Generation Project Construction Access Management Plan are in place to address resource user safety related to Project construction disturbances. Measures include providing signage at road crossings and limiting hunting in the vicinity of the construction site and access road right-of-ways. Alternate resource use areas are provided by the AEA offsetting programs. For safety reasons and to prevent hunting by the workforce, the construction workforce will not be permitted guns or recreational vehicles on site.KCNs Members who have been regular resource users (*e.g.*, cabin owners), will still be able to conduct resource use in the Local Study Area in areas safe to do so (see AMP for details).

As discussed in Section 6.2.3.6.2, much domestic hunting, particularly moose hunting, is conducted along shorelines by boat, which is predicted to be affected by changes in access and navigation in areas proximal to Project construction activity. Mitigation for boat-based travel in areas close to Project construction activity is discussed above under domestic fishing.

Disturbances from Project construction have the potential to reduce wildlife populations that resource users target due to habitat loss, sensory disturbances and traffic-related mortality. These potential effects have been identified as important concerns among KCNs Members (CNP Keeyask Environmental Evaluation Report; YFFN Evaluation Report (*Kipekiskwaywinan*); FLCN Environment Evaluation Report (Draft)).

The Project assessment indicates that no noticeable (*i.e.*, small magnitude) reduction in wildlife abundance will occur during construction and operation of the Project (Section 6.5.8.1 for caribou, Section 6.5.8.2 for moose and Section 6.5.7.2 for Canada goose and mallard). In addition to mitigation measures described in Section 6.5 and to address KCNs concerns, the terrestrial monitoring program will monitor caribou, moose, waterfowl (*i.e.*, Canada goose and mallard) in the Keeyask region (see Chapter 8 for monitoring).

The presence of a large workforce residing in the construction camp has the potential to increase competition for resources in the Project vicinity. This has been identified as a concern by KCNs Members who expect that increasing competition for resources by the workforce has the potential to reduce domestic hunting success.

To mitigate workforce effects on resource use due to potential increases in competition, AMP provisions, such as gated access at PR 280 and on the south access road, will limit access to the construction site by the public. Harvest of wildlife by the workforce residing at the construction camp will be prohibited by Camp Rules (see AMP). Firearm and recreational vehicle restrictions in the AMP also will limit hunting opportunities. Established KCNs resource users will still be able to conduct resource use in areas within the gated area considered safe to access (see AMP). Net in-migration to Gillam during construction is expected to be low (Section 6.6.4.1), therefore, harvest undertaken by any construction workforce residing in Gillam is expected to be nominal or very low. No mitigation is required.

Increases in the wage economy, though typically regarded as a positive effect for northern communities with limited employment options, may reduce the quantity of resource use activity as resource users may choose to engage in construction employment. Alternatively, wage employment may increase the capacity of resource users to purchase equipment such as snowmobiles, guns and all-terrain vehicles. Pursuing Project employment is an individual choice and may affect individuals and groups both positively and negatively. Effects cannot be readily assessed.

AEA offsetting programs are expected to reduce hunting and gathering pressures in existing resource use areas and redistribute KCNs' domestic hunting and gathering activity over larger (regional) land bases. KCNs Members will have the opportunity to increase country food supplies, more KCNs Members will be able to participate in cultural practices and traditions on the land and improved inter-generational transmission of knowledge is anticipated. This effect is expected to begin in the construction phase and continue through the operation phase.

The following two measures are anticipated to safeguard wildlife resources on a long-term basis which, in turn, support AEA offsetting programs:

- The traditional Cree stewardship role which protects wildlife populations; and
- The moose harvest sustainability plan.

As part of the TCN AEA Access Program, the CNP expect that their inherent stewardship role will be fulfilled in part by having a greater relationship with wildlife in other parts of the SLRMA (CNP Keeyask Environmental Evaluation Report). Shared by all KCNs, this Cree stewardship role incorporates self-regulation of wildlife harvest when resources are scarce (see Section 6.2.3.6) which is expected to safeguard resources for the long-term success of the TCN Access Program, the WLFN Improved Access Program, the YFFN Resource Access and Use Program and the FLCN Alternative Resource Use program (which is shorter-term due to selection of other AEA offsetting priorities).

The moose harvest sustainability plan is anticipated to sustainably manage changes in SLRMA moose populations incorporating factors external to CNP community control such as moose predation, changes in habitat and harvest pressures by other resource user groups.

Increases in caribou hunting are not expected in relation to the AEA offsetting programs due to their timing (spring and fall) which does not coincide with the late fall to winter timing of the traditional caribou hunt.

6.7.3.2.2 Residual Effects of Construction

In summary, the following mitigation measures will be implemented to address construction effects on domestic hunting and gathering:

- Speed reductions and dust control on north and south access roads;
- AEA offsetting (Access) programs;
- Construction AMP;
- Waterways Management Program; and
- Moose harvest sustainability plan.

The following are the residual effects on domestic hunting and gathering that are expected once the appropriate mitigation measures are applied:

- Hunting and gathering pressures will be re-distributed to a larger (regional) land base which will increase KCNs opportunity to harvest country food and increase cultural practices and traditions associated with domestic hunting and gathering. The moose harvest sustainability plan will serve to secure these benefits by sustainably managing moose resources. The nature of caribou hunting is not expected to change due to AEA offsetting programs (due to timing of the programs in spring and fall as opposed to winter months when caribou are traditionally hunted).

- Redistribution of resource use to a broader area through AEA offsetting programs may overlap existing areas of domestic hunting and gathering, which may increase competition and contact among resource users. To a certain extent, this effect will be offset because existing domestic hunters and gatherers also will be able to participate in AEA offsetting programs.
- Opportunities to gather plants and other items in the reservoir area and at construction sites will be lost due to reservoir clearing activities. This will be mitigated to a certain extent by AEA offsetting programs.
- Resource users who choose to continue to use areas proximal to construction are expected to experience residual effects related to construction noise. The magnitude of this residual effect will depend on the perceptions of individual resource users and their proximity to construction activities.
- ATK indicates that hunting success in areas local to construction activity will be reduced resulting in a residual effect. Wildlife populations in areas local to construction activity will be monitored (see Chapter 8).

For communities as a whole, the AEA offsetting programs are expected to provide positive benefits by providing KCNs with increased opportunities to practice cultural traditions associated with hunting and gathering. However, it is recognized that some resource users may be negatively affected by a change in the spiritual and cultural nature of their domestic hunting and gathering activities neutralizing the positive effects of the AEA offsetting programs (*e.g.*, local knowledge would need to be relearned at new locations; hunting or gathering may not be as spontaneous for some Members as it would become, in part, a planned activity through AEA offsetting programs).

Using the criteria established to determine the significance of Project effects for regulatory purposes (described in Section 5.5), the residual effects of Project construction on domestic hunting and gathering are expected to be neutral.

6.7.3.2.3 OPERATION EFFECTS AND MITIGATION

Through the following pathways, the Project has the potential to affect domestic hunting and gathering during operation:

- Shifting patterns of resource use due of AEA offsetting programs;
- Increasing populations in Gillam;
- Increases and decreases in access;

- Loss of plant harvesting opportunities; and
- Changes to navigation in the reservoir area and reduced access downstream of the GS.

As discussed above in construction phase effects and mitigation section, shifting patterns of resource use caused by the AEA offsetting programs will begin in the construction phase and continue through operation. Effects and mitigation are the same for both the construction and operation phases.

Increasing populations in Gillam (ranging from 120 to 150 people associated with 46 Keeyask operation jobs) (Section 6.6.4.1) may increase recreational (non-Aboriginal) harvesting which may in turn, compete for domestic hunting resources.

This effect will be mitigated by the AEA offsetting programs that will redistribute domestic harvests to other locations. Harvest by recreational harvesters also is expected to be constrained by existing Provincial harvest regulations. The addition of a nominal number of hunters is not expected to affect domestic harvest success. A residual effect may occur as increasing competition (*e.g.*, potential for crowding) in the fall-winter when both domestic and recreational groups are conducting moose and caribou hunting. Areas of increasing and overlapping use may occur on waterbodies commonly used for moose hunting by both recreational and Aboriginal hunters such as Stephens Lake.

Once the Project is commissioned, PR 280 will be re-routed to include the north access road, the GS over the Nelson River and the south access road to Gillam. Increased access to the Local Study Area has the potential to increase local hunting activity by both recreational (non-Aboriginal) and domestic resource users.

Increases in access are also expected to occur due to the provision of boat launches above and below the GS. Any increased access will benefit domestic hunters who may choose to hunt by boat along reservoir shorelines and downstream of the GS. Increased access provided by the boat launches may also benefit recreational hunters which in turn has the potential to reduce domestic resources available.

Increases in recreational harvester access by access roads and by the boat launches is not expected to affect the domestic resources available to KCNs community Members for two reasons:

- Recreational harvest is expected to be constrained by existing provincial harvest restrictions; and
- AEA offsetting programs are available to provide alternate domestic hunting locations which are expected to disperse existing harvest pressures in the Local Study Area.

Wildlife resources are managed by the Provincial Government through harvest restrictions and licensing. If necessary, Resource Management Boards can be used as a forum to develop appropriate responses to any increases in recreational harvest (see Chapter 8).

The reservoir and footprints of the GS and dykes are expected to reduce plant harvesting opportunities. Plant harvest and other gathering activity will no longer be possible along a large portion of the shorelines of the reservoir and where permanent infrastructure will be built. Lillian Island was identified as a gathering site that will no longer be available in the operation phase (CNP Keeyask Environmental Evaluation Report). This effect will be mitigated by AEA offsetting programs that will enable plant harvest in alternate locations.

Changed access is expected in the reservoir area. The existing shorelines along Gull Lake and at several locations on the Nelson River downstream of Clark Lake will shift to the new reservoir shorelines and increased water levels at Birthday Rapids (Section 6.3.6.2.1) will make the rapids more navigable. Hunting along these modified shorelines could still occur, but in a modified state. Resource users will require a period of adjustment to navigate in the changed environment because of differences in terms of navigation routes, water depth and velocities. Shoreline access will also be affected. Changes to the winter ice regime will improve access in some locations (*i.e.*, more stable ice cover on the reservoir), while access will remain the same in others (Section 6.3.6.2.2).

For cabins in the Local Study Area which may be subject to damage due to flooding, Article 10 of the TCN AEA provides measures to recover personal losses to property.

Conditions for winter access are expected to change within approximately 800 m downstream of the GS in winter due to a lack of ice cover (Section 6.3.6.2.2). However, it should be noted that winter access to this area is generally not possible in most years currently due to the presence of a large ice dam. Downstream of this reach to Stephens Lake is expected to have a thermal (navigable) ice cover similar to Stephens Lake which will improve access (*i.e.*, by snowmobile). Resource harvesters using the Nelson River downstream of the GS will require time to become accustomed to the new conditions (in winter and summer) in this area.

To mitigate changes to navigation or reductions in access, AEA offsetting programs are available to provide substitute opportunities for domestic hunting and gathering in other locations. As discussed in the domestic fishing effects and mitigation section, mitigation described in the Waterways Management Program also will address changes in navigation and access between Split Lake and Stephens Lake.

6.7.3.2.4 Residual Effects of Operation

In summary, the following mitigation measures will be implemented to address operation effects on domestic hunting and gathering:

- AEA offsetting (Access) programs;
- Waterways Management Program; and
- Moose harvest sustainability plan.

The following are the residual effects on domestic hunting and gathering that are expected once the appropriate mitigation measures are applied:

- Hunting and gathering pressures will be re-distributed to a larger (regional) land base which will increase country food availability for KCNs and increase the KCNs cultural practices and traditions associated with domestic hunting and gathering;
- Potential increases for crowding at popular hunting sites due to increases in populations in Gillam; and
- A short to medium-term period of adjustment to new conditions and reduced predictability of the environment for resource users using the reservoir and areas directly downstream of the GS.

For communities as a whole, the AEA offsetting programs are expected to provide positive benefits by providing KCNs with increased opportunities to practice cultural traditions associated with hunting and gathering. However, it is recognized that some resource users may be negatively affected by a change in the spiritual and cultural nature of their domestic hunting and gathering activities neutralizing the positive effects of the AEA offsetting programs (*e.g.*, local knowledge would need to be relearned at new locations; hunting or gathering may not be as spontaneous for some Members as it would become, in part, a planned activity through AEA offsetting programs).

Using the criteria established to determine the significance of Project effects for regulatory purposes (described in Section 5.5), the residual effects of Project operation on domestic hunting and gathering are expected to be neutral.

6.7.3.2.5 Conclusions about Residual Effects on Domestic Hunting and Gathering

The overall conclusion about residual effects on domestic hunting and gathering in both the construction and operation phases is neutral. Certainty is high that the long-term positive benefits of AEA offsetting programs in combination with measures within the Waterways Management Program and measures to ensure long-term sustainability of the moose resource will offset negative effects or provide additional benefits to most individuals. The AEA offsetting programs have been negotiated by the KCN communities to meet the specific needs of their Members and each community-specific AEA has been ratified by their respective community. ATK monitoring programs are being developed by each of the KCNs (see Chapter 8).

6.7.4 Commercial Resource Use

This section summarizes effects, mitigation and monitoring for commercial trapping, commercial fishing, forestry, mining and tourism (lodges and outfitters). Commercial trapping is a VEC. Eco-tourism activity in the region is minimal and no effects have been identified.

6.7.4.1 COMMERCIAL TRAPPING

6.7.4.1.1 CONSTRUCTION EFFECTS AND MITIGATION

Through the following pathways, the Project has the potential to affect commercial trapping during construction in the following ways:

- Disturbances causing increases in noise and dust affecting resource users;
- Disturbances affecting resource user safety;
- Disturbances causing potential reductions to furbearer resources that resource users target;
- The presence of a large workforce potentially increasing competition for resources;
- Increases in the wage economy potentially reducing commercial trapping activity; and
- Shifting patterns of resource use due of AEA offsetting programs.

Project construction disturbances (noise, dust and changes to safety) may affect commercial trappers in the same way as domestic hunters. Mitigation measures also are the same though there are some additional provisions in trapline agreements discussed at the end of this section. Project construction disturbances to the furbearer resources can be caused by increases in sensory disturbances (*i.e.*, noise), reservoir clearing, increases in predation, and wildlife-vehicle disturbances (Section 6.5.8). The KCNs expect these disturbances to affect trapping success. Project construction disturbances expected on Traplines 09 and 15 and are expected to be addressed through trapline agreements (an agreement is currently in place with the Trapline 09 holder). An agreement with the Trapline 07 holder is expected to address the area of Trapline 07 that will be cleared as part of the Reservoir Clearing Plan.

The presence of a large workforce potentially increasing competition for fur resources is not expected due to furbearer harvest being prohibited by anyone other than a licensed trapper under *The Wildlife Act* (Manitoba).

Increases in the wage economy may cause short-term decreases in the number of individuals interested in commercial trapping. The extent to which a decrease occurs is dependent on personal preferences of individual trappers and the availability of winter employment which will compete with winter trapping activities.

Traplines may be visited by people other than the licensee or helpers more frequently due to the AEA offsetting programs. This is not expected to cause a substantive effect on trapping due to the timing of AEA offsetting programs (spring and fall) which does not coincide with peak trapping activity (winter months). Within communities, licensed trappers are recognized and respected as the stewards of the furbearer resources. Harvest of furbearers is not expected to occur as part of the AEA offsetting programs without permission of the trapline holder (TCN OWL Staff 2009).

To mitigate effects on commercial trapping, commitments under "Members Claims" in the TCN AEA and "Citizens' Claims" in the FLCN AEA provide for loss of net revenue from commercial trapping and for any direct loss or damage to any buildings, structures or other infrastructure located on a Registered Trapline.

The Trapline 15 agreement provisions are expected to extend until December 2012. The compensation agreement will be reviewed and renewed as needed on an annual basis after December 2012.

To address disturbances on Trapline 09, a five-year compensation agreement has been reached ending in 2015. Upon conclusion of this agreement, further discussions with the holder of Trapline 09 will be pursued.

Compensation agreements are expected to address minor effects to Trapline 07 and 25 (a TCN community line).

6.7.4.1.2 Residual Effects of Construction

Compensation agreements are expected to address disturbance activities associated with the Project resulting in no residual effects.

Using the criteria established to determine the significance of Project effects for regulatory purposes (described in Section 5.5), there are no residual effects of Project construction on commercial trapping expected. Certainty is high that compensation agreements will address adverse effects to traplines and trappers.

6.7.4.1.3 Operation Effects and Mitigation

Through the following pathways, the Project has the potential to affect commercial trapping during operation:

- Changes to furbearer populations; and
- Improved access on Traplines 15 and 09.

Changes to furbearer populations are expected to be caused by flooding in the reservoir area and by operation of access roads. Flooding will occur on small proportions of Traplines 07, 15, and 25 (a TCN community line), and increase marginally due to reservoir expansion over 30 years. New roads, which will form a new segment of PR 280, will pass through Traplines 09 and 15, potentially affecting furbearer populations while at the same time improving access.

To mitigate potential adverse effects, Manitoba Hydro expects to have trapline agreements in place for all affected Traplines including 07, 09, 15 and 25.

6.7.4.1.4 Residual Effects of Operation

The following are the residual effects on commercial trapping that are expected once the appropriate mitigation measures are applied:

- Improved access via access roads to additional trapping areas in Traplines 15 and 09 is expected to make trapping more economical.

Using the criteria established to determine the significance of Project effects for regulatory purposes (described in Section 5.5), there are no residual effects of Project operation on commercial trapping expected. Certainty is high that compensation agreements will address adverse effects to traplines and trappers.

6.7.4.1.5 Conclusions About Residual Effects On Commercial Trapping

The overall conclusion about residual effects on commercial trapping is neutral. Given that effects are neutral, there is no concern with overlap with future projects and no cumulative effects assessment was conducted. No monitoring activities are planned.

6.7.4.2 Commercial Fishing

6.7.4.2.1 Construction Effects and Mitigation

Through the following pathways, the Project has the potential to affect commercial fishing during construction:

- Disturbances from Project construction limiting access; and
- Disturbances from Project construction causing potential reductions to fish resources.

All effects pertain to the small (single license) Stephens Lake fishery. No effects are predicted for the Split and Assean lake fisheries.

Changes in flows downstream of the Project on the Nelson River and upstream of Stephens Lake have the potential to affect the Stephens Lake commercial fishery by both changing fish congregations and affecting navigation. It is expected that this fishery, due to both construction and operation effects (discussed below), will be discontinued through a compensation agreement. Discussions are underway to conclude an agreement.

6.7.4.2.2 Residual Effects of Construction

The following are the residual effects on commercial fishing that are expected once the appropriate mitigation measures are applied:

- Assuming the fishing is discontinued by agreement, no residual effects will occur in relation to this commercial fishery.

There are no residual effects of Project construction on commercial fishing expected.

6.7.4.2.3 Operation Effects and Mitigation

Through the following pathway, the Project has the potential to affect commercial fishing during operation:

- Changes to the fish resource due to mercury in fish.

In Stephens Lake, the mean standardized mercury level in pickerel (which is targeted by this fishery) is predicted to increase from 0.33 ppm to 0.5 ppm (Section 6.4.7.1.2). The latter value is the threshold at which the Canadian Food Inspection Agency refuses fish for national sale. Based on these predictions, the fishery is expected to be discontinued by agreement. Discussions are underway to conclude an agreement.

6.7.4.2.4 Residual Effects of Operation

The following are the residual effects on commercial fishing that are expected once the appropriate mitigation measures are applied:

- Assuming this small fishery is discontinued by agreement, no residual effects will occur in relation to this commercial fishery.

There are no residual effects of Project operation on commercial fishing.

6.7.4.2.5 Conclusions about Residual effects on Commercial Fishing

A compensation agreement is expected to offset adverse residual effects on commercial fishing resulting in a neutral effect. No monitoring activities are planned.

6.7.4.3 Tourism, Commercial Forestry and Mining

6.7.4.3.1 Construction Effects and Mitigation

Through the following pathways, the Project has the potential to affect tourism (lodge and outfitting operations) and commercial forestry during construction:

- Increases in the wage economy affecting tourism;
- Shifting patterns of resource use due of AEA offsetting program affecting tourism;
- Increased competition for fish resources affecting tourism; and
- Reductions to the commercial wood supply.

Eco-tourism is not expected to be affected and will not be discussed further. No effects to mining are expected in the construction phase.

Due to increases in the wage economy, tourism operators (lodge owners and outfitters) may have decreased ability to attract guides and other staff from KCNs communities. The extent to which a decrease in qualified staff will occur depends on personal preferences and choices of selected individuals. No mitigation is feasible.

Some lodge operators and outfitters that supply a variety of equipment and facilities at remote locations expect that the TCN Access program activities may pose some risk to their equipment/facilities due to increases in the number of people using the same areas. There is also an expectation that resource user conflicts (*e.g.*, hunting for the same resource at the same time and place) may occur under shifting patterns of resource use. This may affect moose resources in localized areas common to lodge and outfitting operations depending on the level of hunting conducted by Access Program participants. Moose resources are prioritized for Aboriginal use over all other users of this resource.

TCN, which is solely responsible for the management, implementation and operation of the TCN AEA offsetting programs, established guidelines and principles for participants as part of the TCN Access Program (which began in 2009 after five years of a pilot Access Program) (TCN OWL Staff 2009).These include the following:

- Respect for the land and environment (*i.e.*, leaving areas clean);
- Firearm safety measures to reduce risks to TCN Members and others;
- Conducting selective harvest;
- Respect for others (including refraining from acts of aggression and disrespect to property); and
- Participants are to provide notification to Trapline holders.

The TCN Access Program is implemented consistent with all applicable laws and standards in force in the Province of Manitoba and also in compliance with applicable federal legislation. Assuming ongoing compliance with the guidelines and principles (OWL Staff 2009) in future years of the Access Program, effects are expected to be minimal.

A residual effect may occur if lodge and outfitting clientele, who may expect a private “wilderness” experience, come into contact with resource users and become disappointed with the services offered by lodge and outfitters. Such conditions can potentially affect the ability of lodge owners and outfitters to retain clientele and reduce their resilience to withstand other business challenges. If effects occur, effects are expected to begin in the construction period and continue through the operation period. Effects may not be continuous or even noticeable to some operators.

Increased competition for fish resources may occur in relation to the TCN Healthy Food Fish Program planned for lakes such as Waskaiowaka and Pelletier (among others) where a lodge business and its outcamp are in operation. These lakes, in addition to three others, may be subject to a combined harvest of up to 62,000 kg of fish (round weight) annually beginning March 31, 2013. The fish harvest sustainability plan is expected to manage this fishery sustainably to support the ongoing operation of the TCN Program. However, net fisheries and commercial sports fisheries are typically incompatible. Reductions in the abundance of large trophy fish would likely be noticeable to the Waskaiowaka and Pelletier lodge clientele if the designated harvest level is achieved from these lakes.

While forested areas will be cleared as part of the Reservoir Clearing Plan and for infrastructure requirements, this will have no immediate effect on the forest industry in Manitoba and will result in a very small reduction (738 ha/0.7%) of the productive forestland under forest management by the Province within FMU 86. Loss in standing timber will be compensated for as per Manitoba Conservation's *Forest Damage Appraisal and Valuation* policy (2002).

Potentially salvageable timber within the Keeyask GS footprint, within the Commercial and Non-commercial Forest Zones is identified (Resource Use Section 1.5 of the SE SV) by approximate volume and location. The economics and practicality of timber salvage on a commercial scale will have to be examined at the time of clearing to determine its viability. Some may be made available as fuel wood to local communities where demand exists and where practical (see Reservoir Clearing Plan, JKDA Schedule 11-1).

6.7.4.3.2 Residual Effects of Construction

In summary, the following mitigation measures will be implemented to address construction effects on tourism and commercial forestry:

- Measures implemented by TCN as part of the Access Program such as respect for the environment, safety measures, selective harvest and respect for others will minimize effects to lodges and outfitters with respect to ongoing Access Programs;
- Fish harvest sustainability plan;
- Loss in standing timber will be compensated as per Manitoba Conservation's *Forest Damage Appraisal and Valuation* policy (2002);
- Timber salvage will be undertaken to the extent practical; and
- Reservoir clearing practices will be conducted in a manner consistent with the Reservoir Clearing Plan.

The following are the residual effects on tourism that are expected once the appropriate mitigation measures are applied:

- Potential for increased contact among lodge and outfitting clientele and TCN Access Program participants may affect lodge and outfitting activities. The frequency and duration of any residual effects is largely dependent on the destinations, timing and number of people selecting areas that overlap with lodge and outfitting allocation areas.
- Reductions in the abundance of large trophy fish in Waskaiowaka and/or Pelletier lakes would be noticeable to lodge clientele if the designated harvest level (62,000 kg) of the

Healthy Foods Fish Program is achieved. Hunting pressures for moose may increase in lodge and outfitting allocation areas.

Residual effects of Project construction on commercial mining is expected to be neutral. The residual effects of Project construction on tourism are expected to be adverse, small, of small geographic extent (to tourist operations), and short-term. The residual effect on commercial forestry is expected to be negligible due a very marginal reduction of productive forestlands in Forest Management Unit 86 (due to clearing of areas within the Project Footprint areas) and no current or foreseeable demand for commercial forest resources in the region.

6.7.4.3.3 OPERATION EFFECTS AND MITIGATION

Through the following pathways, the Project has the potential to affect tourism, commercial forestry and mining during operation:

- Reservoir expansion;
- Shifting patterns of resource use due of AEA offsetting program affecting tourism; and
- Improvements in access affecting tourism and mining.

Effects on commercial forestry are expected to be negligible due to reservoir expansion during operation.

Operation phase effects and mitigation on lodge and outfitters are the same as for the construction phase with the exception of improved access resulting from a re-route of PR 280 to include the north access road, the GS over the Nelson River and the south access road to Gillam. Improvements in ground transportation for lodges and outfitters based out of Gillam or those that use Gillam as a transportation hub will occur. Clientele will have improved access to these operations due to a shorter direct road link from Thompson to Gillam.

Improved local access may marginally increase other competing resource use interests such as mining exploration, tourism and recreational activities though any increases related to access are expected to be nominal. Commercial forestry interests are not expected to increase due to the existing low productivity of local forest resources. Mitigation is not required. No residual effects are expected for commercial forestry and mining. Residual effects to tourism are discussed in the construction phase.

6.7.4.3.4 RESIDUAL EFFECTS OF OPERATION

In summary, the following mitigation measures will be implemented to address operation effects on tourism:

- Ongoingmeasures implemented by TCN as part of the AEA Access Program such as respect for the environment, safety measures, selective harvest and respect for others

(OWL Staff 2009)2 will address lodge and outfitter concerns with respect to the ongoing Access Programs.

The following are the residual effects on tourism that are expected once the appropriate mitigation measures are applied:

- Potential for increased contact among lodge and outfitting clientele and TCN Access Program participants may affect lodge and outfitting businesses. The frequency and duration of any residual effects is largely dependent on the destinations, timing and number of people selecting areas that overlap with lodge and outfitting allocation areas; and
- Reductions in the abundance of large trophy fish in Waskaiowaka and/or Pelletier lakes would likely be noticeable to lodge clientele if the designated harvest level (62,000 kg) of the Healthy Foods Fish Program is achieved. Hunting pressures for moose may increase in lodge and outfitting allocation areas.

Residual effects of Project operation on commercial mining are expected to be neutral. The residual effects of Project operation on tourism are expected to be adverse, small, of small geographic extents (limited to tourist operations), and long-term. Residual effects on commercial forestry are expected to be negligible due to a marginal reduction of productive forestlands in Forest Management Unit 86 (Resource Use Section 1.5 of the SE SV).

6.7.4.3.5 Conclusions about Residual effects on Tourism, Commercial Forestry and Mining

The overall conclusion about residual effects on mining is neutral. The overall conclusion about residual effects on tourism is adverse, small magnitude and of small geographic extents (limited to tourist operations) and long-term. Effects on commercial forestry are expected to be negligible.

6.7.5 Other Resource Use

Other resource use includes:

- Recreational fishing and hunting;
- Protected areas; and
- Scientific sites.

No effects are predicted for protected areas and they are not discussed further.

6.7.5.1 Recreational Fishing and Hunting and Scientific Sites

6.7.5.1.1 Construction Effects and Mitigation

Through the following pathways, the Project has the potential to affect recreational (non-Aboriginal) fishing and hunting and scientific sites during construction:

- Changes in access;
- The presence of a large workforce; and
- Reservoir clearing.

Existing levels of recreational fishing and hunting in areas affected by Project construction are nominal. No effect due to reduced access (see AMP) to the Project site is expected due to nominal existing use of this area.

Recreational hunting is not expected to be conducted by the Project workforce residing in the construction camp and levels of recreational fishing are expected to be negligible. To address KCNs concerns, Project workforce fish harvest will be monitored and hunting will be prohibited as per Camp Rules within the Project site (see Chapter 8). Due to nominal net in-migration of Keeyask GS workforce populations to Gillam during construction (see Section 6.6.4.1), minimal increases in recreational fishing and hunting are expected.

The Canadian Forest Service National Forest Inventory Program photo plot #1101466 is expected to be cleared in the construction period. The effect will prevent monitoring forest growth at this site but it will be unimportant to the program (Gillis *pers. comm.* 2010) and requires no mitigation (see Resource Use Section 1.9 of the SE SV for further information).

6.7.5.1.2 Residual Effects of Construction

In summary, there are no residual effects predicted for recreational fishing and hunting and scientific sites.

6.7.5.1.3 Operation Effects and Mitigation

Through the following pathways, the Project has the potential to affect recreational fishing and hunting and scientific sites during operation:

- Improved access;
- Increasing populations in Gillam; and
- Flooding of scientific site #1101466.

The Project reservoir area and the Nelson River downstream of the GS will be made more accessible by boat launches up and downstream from the GS. In combination with new access along the north and south access roads, improved access may attract recreational fishers and hunters to these areas.

Potential effects of increases in recreational fishing and hunting on the availability of resources are managed by the Provincial government through harvest restrictions and licensing.

Increasing populations in Gillam (ranging from 120 to 150 people associated with 46 Keeyask operation jobs) (Section 6.6.4.1) may increase recreational harvesting. A residual effect may occur as increasing use occurs (*e.g.*, potential for crowding), which will be most noticeable at spring fishing locations and in the fall-winter periods when both (KCNs and recreational) groups are conducting moose and caribou hunting. Again, potential increases in recreational fishing and hunting and the associated effects on resources will be managed by the Provincial government.

Flooding will occur on the National Forestry Inventory photo site # 1101466. No mitigation is required.

6.7.5.1.4 Residual Effects of Operation

The following are the residual effects on recreational fishing and hunting that are expected once the appropriate mitigation measures are applied:

- Better accessibility (*i.e.*, boat launches up and downstream of the GS); and
- Increasing contact among resource users (*e.g.*, potential for crowding) at fishing and hunting sites.

The residual effect on recreational hunting and fishing during operation is neutral because potential increases in crowding at popular sites are not expected to affect the ability to conduct recreational fishing or hunting. Benefits associated with increased access (*i.e.*, boat launches) are expected to provide only nominal benefit due to low existing use of areas located closer to population centers (*i.e.*, Gillam). As noted, harvests, even if they are increased, are expected to be within sustainable limits due to existing harvest restrictions. No mitigation is planned.

6.7.5.1.5 Conclusions about Residual effects on Recreational Fishing and Hunting and Scientific Sites

During construction, little recreational fishing and no hunting is expected to be conducted by the construction workforce. A low level of net in-migration to Gillam during construction is expected to have a minimal effect on existing levels of recreational harvest. Resource use is expected to increase at popular recreational sites during operation, but use is not expected to have a noticeable effect on resource abundance (Resource Use Section 1.7 of the SE SV). Changes to aesthetics (*i.e.*, crowding) are not expected to have an important effect on recreational fishers and hunters.

The overall conclusion about residual effects on recreational fishing and hunting and scientific sites is neutral. To address any uncertainty with respect to workforce harvest during construction affecting the availability of resources for domestic use, monitoring of construction workforce fish harvest is planned and hunting will be prohibited (see Chapter 8). The Provincial government is responsible for the licensing of recreational harvest undertaken by non-Aboriginal Gillam (and other) residents. Resource Management Boards are expected to provide a forum for ongoing communication in addition to ATK monitoring so that KCNs concerns can be raised and addressed if required (see Chapter 8 for a more detailed discussion).

6.7.6 SUMMARY OF RESIDUAL EFFECTS AND SIGNIFICANCE

This section summarizes residual effects of the Project (*i.e.*, after mitigation) by phase on the three resource use VECs: domestic fishing, domestic hunting and gathering and commercial trapping (Table 6-64, Table 6-65, Table 6-66).

Note regarding the following residual effects tables:

1. Refer to Section 5.5 (Approach to Determination of Regulatory Significance) for full description of assessment characteristics. Under Step 1, all VECs were examined using the criteria of direction, magnitude, geographic extent and duration. As explained, where further analysis was warranted, a Step 2 analysis considered additional criteria of frequency, reversibility or ecological context.

Table 6-64: Summary of Mitigation and Residual Effects on Valued Environmental Components for the Resource Use Environment: DOMESTIC FISHING

VEC Effect and Mitigation by Phase	Residual Effects	Assessment Characteristics (1 see introductory text)
Construction Phase		
Effects related to: • Changes in access and navigation on local waterbodies; • Redistribution of fish harvest pressures to larger land-base, increases in country food availability, increases in cultural practices and traditions; and • Changes in harvesting patterns (distribution and intensity) potentially affecting resource users in existing areas. **Mitigation includes:** • Waterways Management Program; • Reservoir Clearing Plan; and • AEA offsetting programs available for KCNs resource users.	Domestic fishing pressures will be distributed to a larger geographic region. Increased community-wide opportunity to acquire country food and conduct cultural practices and traditions associated with domestic fishing. AEA offsetting programs may overlap existing areas used by individual domestic fishers causing increased competition. New conditions on local waterbodies will require adjustment period for individuals. Overall, neutral effect.	**Step 1:** Direction: Neutral **Step 2:** **Not Required**

Table 6-64: Summary of Mitigation and Residual Effects on Valued Environmental Components for the Resource Use Environment: DOMESTIC FISHING

VEC Effect and Mitigation by Phase	Residual Effects	Assessment Characteristics (1 see introductory text)
Operation Phase		
Effects related to: • Changes to the fish resource (increases in mercury) and changes to preferences for fish consumption; • Changes in access and navigation on local waterbodies; • Increases in populations in Gillam some of whom may conduct recreational resource use; • Long-term positive redistribution of fish harvest pressures to larger land-base, increased opportunity to harvest country food, increases in cultural practices and traditions; and • Changes in harvesting patterns (distribution and intensity) potentially affecting resource users in existing areas. **Mitigation includes:** • Communication of local fish consumption recommendations; • Reservoir Clearing Plan; • Waterways Management Program; • AEA offsetting programs; and • Fish harvest sustainability plan to manage fish resources.	Domestic fishing pressures will be distributed to a larger geographic region. Increased community-wide opportunity to acquire country food and conduct cultural practices and traditions associated with domestic fishing. AEA offsetting programs may overlap existing areas used by individual domestic fishers causing increased competition. Fish preferences may change. New conditions on local waterbodies will require adjustment period for individuals. Overall, neutral effect.	**Step 1:** Direction: Neutral **Step 2:** **Not Required**

Table 6-65: Summary of Mitigation and Residual Effects on Valued Environmental Components for the Resource Use Environment: DOMESTIC HUNTING AND GATHERING

VEC Effect and Mitigation by Phase	Residual Effects	Assessment Characteristics (1 see introductory text)
Construction Phase		
Effects related to: • Local disturbances from Project construction (noise, dust, and safety issues); • Potential reduction of local wildlife affecting hunting; • Loss of plant harvest area in reservoir and construction sites from clearing and construction; • Long-term positive redistribution of wildlife and plant harvest pressures to larger land-base, increased opportunity to harvest country food, increases in cultural practices and traditions; and • Changes in harvesting patterns (distribution and intensity) potentially affecting resource users in existing areas. **Mitigation includes:** • AMP; • Compensation agreement for local area resource users; • AEA offsetting programs; and • Moose harvest sustainability plan to manage moose resources.	Domestic hunting and gathering pressures will be distributed to a larger geographic region. Increased community-wide opportunity to acquire country food and conduct cultural practices and traditions associated with domestic hunting and gathering. AEA offsetting programs may overlap existing areas used by individual domestic hunters and gatherers causing increased competition. New conditions on local waterbodies and near the construction site will require adjustment period for individuals. Overall, neutral effect.	**Step 1:** Direction: Neutral **Step 2:** **Not Required**

Table 6-65: Summary of Mitigation and Residual Effects on Valued Environmental Components for the Resource Use Environment: DOMESTIC HUNTING AND GATHERING

VEC Effect and Mitigation by Phase	Residual Effects	Assessment Characteristics (1 see introductory text)
Operation Phase		
Effects related to: • Changes in access and navigation on local waterbodies; • Increases in populations in Gillam; • Long-term positive redistribution of wildlife and plant harvest pressures to larger land-base, increased opportunity to harvest country food, increases in cultural practices and traditions; and • Changes in harvesting patterns (distribution and intensity) potentially affecting resource users in existing areas. **Mitigation includes:** • Waterways Management Program; • AEA offsetting programs; and • Moose harvest sustainability plan to manage moose resources.	Domestic hunting and gathering pressures will be distributed to a larger geographic region. Increased community-wide opportunity to acquire country food and conduct cultural practices and traditions associated with domestic hunting and gathering. AEA offsetting programs may overlap existing areas used by individual domestic hunters and gatherers causing increased competition. New conditions on local waterbodies and near the construction site will require adjustment period for individuals. Overall, neutral effect.	**Step 1:** Direction: Neutral **Step 2:** **Not Required**

Table 6-66: Summary of Mitigation and Residual Effects on Valued Environmental Components for the Resource Use Environment: COMMERCIAL TRAPPING

VEC Effect and Mitigation by Phase	Residual Effects	Assessment Characteristics (1 see introductory text)
Construction Phase		
Effects related to: • Local noise and dust disturbances; • Disturbances having the potential to affect safety; • Potential reductions to furbearer resources; • Workforce increasing competition for resources; and • Shifting patterns of resource use from AEA offsetting programs may affect trappers. **Mitigation includes:** • Compensation Agreements; • AMP; and • TCN Access Program Guidelines and Principles.	No residual effects	**Step 1:** Direction: Neutral **Step 2:** **Not Required**
Operation Phase		
Effects related to: • Potential reductions to furbearer resources; • Potential increases in competition; and • Improved access. **Mitigation includes:** • Compensation Agreements; and • TCN Access Program Guidelines and Principles.	Improved access on Traplines 09 and 15.	**Step 1:** Direction: Neutral **Step 2:** **Not Required**

The following VECs, that require Step 1 analysis only, are expected to have no significant adverse effects:

- Domestic fishing;
- Domestic hunting and gathering; and
- Commercial trapping.

6.7.7 SENSITIVITY OF EFFECTS TO CLIMATE CHANGE

As described in Section 6.3.12, the probable scenario of climate change for the 2020s, 2050s and 2080s involves increasing temperatures and precipitation in the Resource Use Local Study Area.

As a residual effect of the Project, resource users are predicted to undergo a period of adjustment to new environmental conditions in the Local Study Area such as changes to water levels and flows and changing winter ice conditions. This period of adjustment is expected to last a few years into the operation phase as resource users become familiar with new conditions on the reservoir and the GS operation mode downstream of the Project. This period of adjustment will be facilitated and expedited by the Waterways Management Program in both winter and summer by the development of ice trails and navigation routes as well as communication with resource users.

Climate change is considered a longer-term phenomenon and therefore residual Project effects to resource use are not expected to interact with climate change variables.

6.7.8 CUMULATIVE EFFECTS ASSESSMENT

Resource use VECs include domestic fishing, domestic hunting and gathering and commercial trapping. Given a neutral assessment on the resource use VECs, there are no concerns with overlap with future projects and no cumulative effects assessment was conducted.

6.8 EFFECTS AND MITIGATION HERITAGE RESOURCES

6.8.1 INTRODUCTION AND APPROACH

This section focuses on effects of the Project on the Heritage Resources environment components, mitigation measures (that are technically and economically feasible) to address those effects, residual effects that remain after mitigation, and the regulatory significance of the residual effects on VECs. Mitigation is required by law as mandated by *The Heritage Resources Act* (1986) This section will also assess the sensitivity of these effects to possible climate change scenarios.

The assessment of Project effects is based on the existing environment, as described in the preceding Section 6.2, including the predicted future environmental conditions and trends if the Project were not to proceed. This existing environment incorporates effects of past projects, most notably past and current projects identified for the cumulative effects assessment. This section will also note where there are overlaps or interactions between effects of the Project with potential future projects.

The technical analysis determined effects of the Project on the heritage resources environment by considering the linkages between the heritage resources environment and changes caused by the Project, both directly and indirectly through changes to the physical environment. The approach used to assess heritage resource effects considers a single VEC, as all heritage resources are protected equally under Provincial legislation, the *Heritage Resources Act* (1986).

Three geographic regions were examined for the assessment of Project effects; the Heritage Resources Regional, the Local; and the Core Study areas (see Map 6-46) (for detailed descriptions of these geographic regions refer to Section 6.2.3.7 and Heritage Resources Section 1.3 in the SE SV).

Community Members, Elders and youth from the KCNs were actively involved in the archaeological field studies within the Core and Local Study areas, including school programs for TCN and WLFN. Students participated in archaeological programs that offered high school credits. KCNs youth and Band Members also participated in excavation programs at Fox/Atkinson and Clark lakes.

The approach taken to interpreting the effects and extending the appropriate mitigation to heritage resources known and unknown was based on the results of archaeological field investigations, ATK and the use of proxy sites to determine the effects of changes to water regimes on archaeological sites (*e.g.*, what can be expected to occur if the integrity of an archaeological site is compromised by changes to the physical environment). Proxy sites located outside the Core Study Area were used for comparative evidence of site behaviour, with or without controlled changes to the physical environment. While other factors such as effects of past hydroelectric projects exist, these sites provide valuable baseline for the existing environment. The methodology of assessing effects to heritage resources is discussed in the SE SV but not in this volume.

It is understood that heritage resources that occur within the Core Area will be permanently lost by construction and operation. The only positive effect in terms of heritage resources is likely the advancement of knowledge about the Local Study Area's ancient and historic past; this was assisted by KCNs community Members who identified, during formal and informal discussion, potential locations for heritage resources to be located and the mitigation of effects of the Project. Heritage resources studies for the Project provided evidence of an archaeological record that extends to *ca*. 4800 BP (1 Sigma A calibrated (Cal BC 2920 to 2890 (Cal BP 4870 to 4840 -284758 2010 Beta Analytic Inc. 2010). Prior to the Project-related field studies little was known of the archaeological record for the reach of the Nelson River between the outlet of Clark Lake to the inlet of Stephens Lake.

Regardless of the increased knowledge of heritage resources, the condition of sites within the Project Core Study Area will be affected by physical changes to the environment caused by the Project.

As discussed in Chapter 5, the environmental assessment was based on both ATK and technical scientific analysis. Methods and general conclusions related to the ATK-based analysis are provided in Chapter 2, and detailed results are provided in the CNP Keeyask Environmental Evaluation Report, YFFN Evaluation Report (*Kipekiskwaywinan*)and FLCN Environment Evaluation Report (Draft). Detailed results for the technical component of the environmental assessment are provided in the SE SV. The following section summarizes the results of the ATK and technical analysis. Given the difference in approach of the Cree world view and technical science, the assessment of the nature of the residual effects differed for some components; these differences are also discussed (Section 6.4.8).

6.8.2 Aboriginal Traditional Knowledge

Aboriginal traditional knowledge is an essential component of First Nation culture. ATK describes values that are inherently tied to lands and waters, particularly those that are within landscapes identified as traditional lands. The Keeyask Cree Nations worldview considers all components of the environment, both natural and socio-cultural as having the capacity to affect all levels of an ecosystem, temporally and spatially.

For the assessment of heritage resources, the traditional knowledge of the KCNs played a role in identifying the potential location of heritage resources and in assessing the effects of the Project on heritage resources sites. During the course of community interactions and participatory action research (see the Heritage Resources section of the SE SV for further details) the connection to certain cultural landscapes became very evident; particularly at Gull Lake, where Elders had indicated historic winter settlements and burials.

As part of their historical connection to *Askiy* (Mother Earth), the KCNs have acquired ATK from life experiences and their relationship with the land, water and all living things. They have explained their holistic worldview in Chapter 2 and in more detail in the CNP Keeyask Environmental Evaluation Report, YFFN Evaluation Report (*Kipekiskwaywinan*) and FLCN Environment Evaluation Report (Draft). ATK in this section of the EIS should be understood from the perspective of the Cree worldview. This worldview and knowledge guided the KCNs in their participation in planning the Project with Manitoba Hydro and in providing guidance to the environmental assessment. Many community Members expressed doubt that the effects of past projects were fully understood or accurately predicted and hold similar reservations regarding the current Project.

KCNs community ATK observations with respect to heritage resources provide further knowledge of the relationships and understandings of the people to the land. The KCNs have noted the importance of certain key areas that may experience Project's effects on heritage resources.

- Four key areas have been identified by TCN ATK (see Map 6-70) as historically-known burial locations; Bechonea, Effie Bay, Old Boat, and Caribou Island, all within the Core Study Area.
- Gull Rapids has been noted by the KCNs as an important location for recalling memory, resource activity, ceremonial and spiritual purposes, and as a place for reaffirming social cohesion.

Despite discussions with KCN Elders and intensive archaeological investigations, no definitive evidence of burials was found at these four sites. However, human remains were found in 2010 on the south shore of Gull Lake. Radiocarbon analysis dated these remains to (*ca.* 4800 BP (1 Sigma A caliabrated (Cal BC 2920 to 2890 (Cal BP 4870 to 4840 -284758 2010 Beta Analytic Inc. 2010)). TCN considers these remains as ancestral to Cree people. KCNs have expressed ongoing concern for the potential effects that the Project may have on undiscovered burials in the Local and Project Core Study Areas. ATK is also a valuable resource for interpreting site use and in providing context to the archaeological evidence.

ATK was especially influential in the ongoing investigations of the heritage resources where traditional activities were cited. Of heritage note was the documentation of a winter pole tepee at Bechonea, constructed in the 1960s by an Elder of the Kitchikeesick family as a teaching tool for the younger generation. This pole tepee was covered with mud and moss for insulation; to date this is the only known documented example of this form of Aboriginal architecture. This site will be lost by the creation of the Keeyask reservoir.

Because ATK has perspectives that differs from and doubts some of the results of technical science, an emphasis has been placed on monitoring and adaptive management. These topics are covered in Chapter 8.

6.8.3 HERITAGE RESOURCES

Heritage Resources are a singular VEC and rationale for the VEC selection has been previously discussed in Section 6.2.3.7. The characterization of heritage resources is through the cultural chronology of human occupation within the context of northern Manitoba and the Regional Study Area and through the inclusion of ATK into the research design (see the Heritage Resources section of the SE SV for further details). Occupation by people within the Regional Study Area is divided into two general temporal periods: Pre-European contact (7,500 – 350 years ago) and Historic (350 – 50 years ago).

The Project will adversely affect heritage resources in the Project Core Study Area. The magnitude and nature of these effects will differ between the construction and operation phases. When avoidance is not possible, tangible evidence of past human occupation will be removed to the extent possible; the continual involvement of the Environment Officer and implementation of Waterways Management Program serve to monitor, plan and implement protection and preservation measures of high priority sites from Gull Rapids to Split Lake.Any new discoveries associated with the Project are managed through the Heritage Resources Protection Plan.

6.8.3.1 CONSTRUCTION EFFECTS AND MITIGATION

Through the following pathways, the Project has the potential to affect heritage resources within the Project Core Study Area and result in the loss of heritage resources, as well as potentially adversely affecting unknown heritage resources during construction:

- Clearing of trees with dislodgement of heritage resources within tree roots;
- Grading for access roads across land features may cut through undiscovered heritage resources sites;
- Drilling for foundations and potable water sources which may dislodge or change the provenience of heritage resources;
- Excavation of soils that may contain heritage resources and/or burials;
- Borrow/quarry excavation of gravel pits and destruction of rock features that may contain heritage resources and which may be culturally sensitive;
- Disposal of unclassified excavated materials which may damage unknown or known heritage resources below water surface;

- Construction of supporting infrastructure and principal structures;
- Installation of the ice boom up river from the generating station may accelerate loss of heritage resources;
- Dewatering of areas within cofferdams; and
- Clearing of the vegetation in the area that is to become the reservoir has the potential to affect known and unknown heritage resources.

Map 6-46 identifies the location of archaeological sites that likely will be affected by planned construction activities. These changes will be most notable in the Project Core Study Area specifically where Project structures, dikes, access roads and other facilities will be constructed. The heritage resources upriver of the development will experience less noticeable changes. In addition to the potential loss of registered archaeological sites, KCNs Elders have noted that there are burial sites within the Project Core Study Area that may be affected by initial clearing, grading, drilling, excavation and placement of excavated materials in various locations.

As a result of the Project further evidence of ancient people, *Keteyatisak*, has been revealed and many thousands of artifacts have been found and preserved that would have otherwise not have been found. Within the Project Core Study Area, seven known archaeological sites located between the outlet of the Nelson River at Clark Lake to Gull Rapids may be affected by the construction phase because they cannot be preserved through avoidance.

Construction activities can cause the following effects to heritage resources:

- Permanent disturbance/destruction of heritage resources and burial sites -- during the course of construction, including the dewatering of areas inside the cofferdams, many of the heritage resources that are currently recorded will be irreparably disturbed or destroyed;
- Permanent loss of future heritage resources data - the loss of heritage resources and burial sites may occur instantly with little time to record pertinent data;
- Permanent loss of heritage objects or sites - heritage objects and sites are non-renewable resources and loss of same will result in an incomplete historical record;
- Permanent changes in the interpretive capacity of the region reduces the ability to provide a complete record of both Manitoba and Cree history; and
- Permanent loss of cultural landscapes and the ability of the KCNs to orally recount history may have an effect on the culture and spirituality of KCNs Members.

All sites are located within 100 metres of the present shoreline. Six of the seven archaeological sites that may be affected occur in conjunction to the proposed planned-to-use borrow areas. Two of the sites fall within borrow area boundaries, four occur within a 100m of the borrow areas; one additional site is located in the Core Study Area and may be affected. Known sites that may be affected due to construction activity are listed and described in Table 6-45.

Table 6-67: Archaeological Sites Which May be Affected by the Construction Phase

Borden #	Temporal Period	Site Type	Source of Impact
HcKt-02	Pre-European contact - Undated	Workshop	Keeyask Generation Construction
HcKt-04	Pre-European contact – Undated, Historic Middle, Late	Campsite	Borrow Area N-6
HcKt-05	Pre-European contact – Archaic	Workshop	Borrow Area N-6
HcKt-06	Pre-European contact - Undated	Isolated Find	Borrow Area N-6
HbKu-24	Pre-European contact - Archaic	Burial	Borrow Area S-5
HbKu-12	Pre-European contact - Woodland	Campsite	Borrow Area S-5
HcKt-08	Historic – Late	Campsite	Borrow Area S-18

Human remains were found at low water on the south shoreline of Gull Lake near the edge of S-5 borrow area; these were removed in accordance with the *Heritage Resources Act*. These have now been temporarily reinterred in the backshore approximately 90 metres inland from the water's edge. The site was assigned as HbKu-24. Additional human remains could be situated in this high priority area and therefore the area will require ongoing monitoring during construction.

No heritage resources were identified during investigations in the areas of the South Access Road and the north and south dykes.

Heritage resource sites within the Local Study Area at the inlet of the Nelson River into Clark, Stephens, Moosenose, Kettle, Fox/Atkinson and Carscadden lakes and Aiken/Landing River will not be affected by the construction phase of the Project.

The best form of mitigation is avoidance; however, this will not be possible in some areas. Activities during the construction phase of the Project that cause disturbance to the ground surface have the greatest potential to impact undiscovered *in situ* heritage resources within the Project Core Study Area. In summary, the following mitigation measures will be implemented to address construction effects on heritage resources:

- Prior to construction activities, the seven archaeological sites that may be affected by construction activities will undergo archaeological salvage in the form of controlled artifact collection, shovel testing and, salvage excavation. The sites will be completely removed, with proper documentation. The salvage archaeology conducted at each site will recover artifacts and record valuable cultural information. However, the cultural value of a site in its original context will be irrevocably lost. In addition, a Reburial

Ground will be identified by the KCNs in an area along the North Access Road. Any human remains that are found within the Core Study Area during the construction phase will be reinterred in this area.

- Phase 1 of the Waterways Management Program (Schedule 11-2 in the JKDA) consists of measures to work with KCNs to identify and contribute to impact management measures at high priority heritage sites that will be flooded.
- The dewatering process inside the cofferdam work areas will require an archaeological salvage of the exposed riverbed to recover any heritage resources that may be present.
- The seven known heritage sites that will be affected by construction will require yearly monitoring during the construction phase to ensure all components of each site have been fully recovered (see Chapter 8 for further details on monitoring).
- A Heritage Resources Protection Plan (HRPP) will be drafted to support the protection and future management of archaeological sites within the Project Core Study Area. The HRPP will be an instructional guideline designed to address heritage resource issues that arise during the construction phase. Provincial heritage legislation, Manitoba's *Heritage Resources Act (*1986) and The Policy Respecting the Reporting, Exhumation, and Reburial of Found Human Remains (1987), and any requirements established by the KCNs will guide the management of affected or undiscovered heritage resources impact during the Project. The Project Archaeologist will advise and provide field support should any heritage concerns be raised.
- Environmental Officers as described in the HRPP will receive basic instruction regarding artifact identification. Their presence on-site will facilitate the immediate reporting of discovered heritage resources to the Project Manager and Project Archaeologist. At that time, a plan, based on legislation the HRPP and the KCNs requirements, will be implemented based on the nature of the heritage resource site as to mitigation in the form of salvage archaeology or avoidance of the site.
- The HRPP and existing legislation will apply in the event of discovered human remains.

6.8.3.1.1 Residual Effects of Construction

Extensive ATK studies have been undertaken by the KCNs as part of the Keeyask Project. These studies have collected and preserve important knowledge of the cultural environment for future generations, especially as it relates to the study area. These studies should help to reduce some of the ATK losses that may have otherwise been experienced. Based on the mitigation measures for the existing archaeological sites, there will be no residual effects on heritage resources once mitigation of archaeological sites is completed. For unknown or deeply buried components the following are the residual effects on heritage resources that are expected and likely once the appropriate mitigation measures are applied:

- The cultural landscape will be altered resulting in the loss of a cultural link to a tangible heritage resource in the Gull Lake area.
- As well, the oral tradition and Cree historic record will be compromised as heritage resource sites can act as mnemonic triggers to the collective experience, identity, kinship, and history of KCNs.

Effects on heritage resources would overlap in space and time with effects of the future Keeyask Transmission Project (see Chapter 7).

Using the criteria established to determine the significance of Project effects for regulatory purposes (described in Section 5.5), the likely residual effects of Project construction on heritage resources are expected to be: adverse, within the Project Core Study Area, short-term in duration and moderate in magnitude.

6.8.3.2 Operation Effects and Mitigation

Through the following pathways, the Project will affect heritage resources during operation:

- The reservoir impoundment and operation phase of the Project will commence with the start of reservoir impoundment and the production of first power by the Keeyask Generation Station. This phase will adversely affect 43 known heritage resources, including heritage objects and sites within the Project Core Study Areas; those site locations within the reservoir area will be immediately lost or irreparably disturbed during the initial flooding of the reservoir area. Heritage objects and sites are non-renewable resources and permanent loss of these site locations removes a tangible component of Cree history. During archaeological investigations related to the HRIA process many artifacts were removed by controlled methods. Mitigation in the form of salvage will occur prior to inundation to the extent practicable of the reservoir to recover artifacts and record valuable cultural information. However the cultural value of a site in its original context will be irrevocably lost.
- There will also be continued loss of unknown heritage resources within this area caused by ongoing shoreline erosion caused by flooding or fluctuating water levels over a prolonged period. The loss of heritage resources and burial sites may occur instantly due to rapid peat disintegration with little time to record pertinent data. Elsewhere loss of land will occur more slowly depending on the rate of shoreline erosion. In addition to the loss of archaeological sites, KCNs Elders have noted that there are burial sites within the Project Core Study Area at Caribou Island, Effie Bay and Bechonia that will be included in the reservoir. There is concern that other unknown burials within the Project Core Study Area will be lost.

Other Project effects to known and undiscovered heritage resources include the following:

- Permanent changes in the interpretive capacity of the region. This reduces the ability to provide a complete record of both Manitoba and Cree history related to this area;
- Permanent loss of historically-known cultural landscapes and the ability of the KCNs to orally recount history which may have an effect on the culture and spirituality of KCNs Members;
- Increased vehicular and pedestrian traffic over areas of unknown and known heritage resources;
- Any additional disturbances to the physical that may happen (if needed) in the future; and
- In addition, the heritage resources within the upriver reach between Birthday Rapids and the outflow of the river from Clark Lake may experience less noticeable changes. Table 6-41 identifies the 43 archaeological sites that will be affected by physical change during the operation phase by temporal period, site type and location; and Map 6-46 identifies the location of those archaeological sites that will be affected during the operation phase.

While Clark Lake is outside the Project Core Study Area and the predicted hydraulic zone of influence, there is concern amongst the KCNs that even the slightest changes in water level will negatively impact the heritage resources at lake shore. The sites within Clark Lake are fragile because of their location at the shoreline. KCNs Members believe these sites will be affected should there be back flow into Clark Lake above the predicted zone of hydraulic influence. There are obligations, processes and protocols in place at Manitoba Hydro to monitor and protect archaeological sites and heritage resources affected by hydro development projects.

The concerns noted above can be addressed by monitoring of sites outside the hydraulic zone of influence through existing initiatives, including, for example, the Waterways Management Program and the “System-Wide Archaeological Project”[1].”

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[1]System-Wide Archaeological Project: Manitoba Hydro and the Historical Resources Branch of Manitoba Culture, Heritage and Tourism entered into an agreement to assess the impacts of past Hydro development projects on the archaeological heritage resources in Manitoba (excluding those areas monitored through the Churchill River Diversion Archaeological Project (CRDAP) or the Sipiwesk Lake Archaeological Project). The System-Wide Archaeological Project is modeled on the highly successful CRDAP. It began in fiscal year 2006-2007, and focuses on inventory and assessment of heritage resources within lands adjacent to hydro impacted waterways.

Table 6-68: Archaeological Sites Affected by the Operation Phase

Borden #	Temporal Period	Site Type	Location
HcKt-01	Pre-European contact – Archaic to Late Woodland; Historic – Early, Middle, Late	Campsite	Gull Lake
HcKt-03	Pre-European contact - Undated	Isolated Find	Gull Lake
HcKt-04	Pre-European contact – Undated, Historic Middle, Late	Campsite	Gull Lake
HcKt-05	Pre-European contact – Archaic	Workshop	Gull Lake
HcKt-06	Pre-European contact - Undated	Isolated Find	Gull Lake
HbKt-01	Pre-European contact - Undated	Workshop	Gull Lake
HbKu-01	Historic - Late	Campsite	Nelson River
HbKu-02	Pre-European contact – Undated, Historic - Late	Campsite	Gull Lake
HbKu-03	Pre-European contact – Late Woodland	Campsite	Gull Lake
HbKu-04	Historic – Middle, Late	Isolated Find	Gull Lake
HbKu-05	Pre-European contact – Late Woodland, Historic - Middle	Campsite	Gull Lake
HbKu-06	Pre-European contact – Middle Woodland	Workshop	Gull Lake
HbKu-07	Pre-European contact – Woodland, Historic – Early, Middle	Workshop	Gull Lake
HbKu-08	Pre-European contact - Undated	Workshop	Gull Lake
HbKu-09	Pre-European contact – Undated; Historic – Middle, Late	Campsite	Gull Lake
HbKu-10	Pre-European contact - Undated	Workshop	Gull Lake

Table 6-68: Archaeological Sites Affected by the Operation Phase

Borden #	Temporal Period	Site Type	Location
HbKu-11	Pre-European contact - Undated	Workshop	Nelson River
HbKu-12	Pre-European contact – Late Woodland	Campsite	Gull Lake
HbKu-13	Pre-European contact – Woodland; Historic – Early to Late	Campsite	Nelson River at Rabbit Creek
HbKu-14	Pre-European contact - Undated	Campsite	Nelson River at Rabbit Creek
HbKu-15	Historic - Late	Portage	Nelson River
HbKu-16	Pre-European contact - Undated	Isolated Find	Nelson River
HbKu-17	Pre-European contact – Late Woodland	Campsite	Gull Lake
HbKu-18	Pre-European contact – Late Woodland	Campsite	Gull Lake
HbKu-19	Pre-European contact - Undated	Isolated Find	Gull Lake
HbKu-20	Pre-European contact – Undated, Historic - Late	Workshop	Gull Lake
HbKu-21	Pre-European contact – Undated; Historic - Late	Workshop	Gull Lake
HbKu-22	Pre-European contact - Undated	Workshop	Gull Lake
HbKu-23	Pre-European contact - Undated	Workshop	Gull Lake
HbKu-24	Pre-European contact - Archaic	Burial	Gull Lake
HbKv-01	Pre-European contact - Undated	Workshop	Nelson River
HbKv-02	Pre-European contact - Undated	Workshop	Gull Lake
HbKv-03	Pre-European contact - Undated	Workshop	Gull Lake
HbKv-04	Pre-European contact – Undated, Historic - Cree	Workshop	Gull Lake
HcKt-07	Historic - Cree	Campsite	Gull Lake

Table 6-68: Archaeological Sites Affected by the Operation Phase

Borden #	Temporal Period	Site Type	Location
HcKt-08	Pre-European contact – Undated; Historic – Cree	Campsite	Gull Lake
HcKt-09	Pre-European contact - Undated	Workshop	Gull Lake
HcKu-01	Pre-European contact – Undated; Historic - Cree	Burial/Campsite	Gull Lake, Effie Bay
HcKu-02	Historic - Cree	Campsite	Gull Lake
HcKu-03	Historic - Late	Burial	Gull Lake
HcKu-04	Pre-European contact - Undated	Workshop	Gull Lake
HcKu-05	Historic – Late, Cree	Portage	Gull Lake
HbKv-05	Pre-European contact - Undated	Isolated Find	Portage Creek, Nelson River

In summary, the following mitigation measures will be implemented to address operation effects on heritage resources:

- 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.
- Key mitigation within the Project Core Study Area will be on-going seasonal monitoring during the course of construction and during the operation phase until the maximum predicted reservoir shoreline is reached. This will be conducted by the Project Archaeologist and/or by the Environmental Officer and Members of the KCNs who are assigned to the task of shoreline monitoring. This is considered to be of great importance given the on-going discovery and/or exposure of heritage resources in other areas; for example, Wuskwatim Lake and South Indian Lake (as a result of CRD) and Cedar Lake (as a result of the Grand Rapids reservoir).
- The HRPP will provide objectives for the protection of any known and any future discoveries of heritage resources during the operation phase (to the extent feasible). This will allow that provincial legislation *The Act* and Policy Respecting the Reporting, Exhumation, and Reburial of Found Human Remains and any requirements established by the KCNs are observed. The Project Archaeologist will advise and provide field support should any heritage concerns be raised.
- Increased human traffic due to the Project is expected to have an adverse effect on known and unknown heritage resources. Key mitigation measures will involve education and awareness of Project workers as to the nature of heritage resources and management of any heritage resources that may be encountered.
- In the event that previously unknown heritage resources are unearthed or exposed during operation, the same procedure will be used to manage the discovered heritage resources as described above for discovery of unknown resources during the construction phase.
- As part of TCN's AEA program repatriation, display and interpretation of heritage resources found within this area will be part of the Keeyask Cultural Centre's Museum and Oral Histories Program.

6.8.3.2.1 Residual Effects of Operation

Similar to the Construction Phase, for existing archaeological sites there will be no residual effects on heritage resources once mitigation of archaeological sites is implemented. For unknown or deeply buried components, the following are the residual effects on heritage resources that are expected and likely once the appropriate mitigation measures are applied:

- The cultural landscape will be altered resulting in the loss of a cultural link to a tangible heritage resource in the Gull Lake area.

- As well, the oral tradition and Cree historic record will be compromised as heritage resource sites can act as mnemonic[1] triggers to the collective experience, identity, kinship, and history of KCNs.

Effects on heritage resources would overlap in space and time with effects of the future Keeyask Transmission Project (see Chapter 7).

Using the criteria established to determine the significance of Project effects for regulatory purposes (described in Section 5.5), the likely residual effects of Project operation on heritage resources are expected to be: adverse, within the Project Core Study Area long-term in duration and moderate in magnitude.

6.8.3.3 CONCLUSION ABOUT RESIDUAL EFFECTS ON HERITAGE RESOURCES

Overall, the residual Project effects on Heritage Resources are expected to be adverse, local, long-term in duration, small in geographic extent and moderate in magnitude for both construction and operation phases. There is a potential for unknown heritage resources to experience residual effects if not addressed through the HRPP; however the terms of the HRPP will be designed to mitigate any residual effects to known and discovered heritage resources that may occur as a result of the construction or operation phase of the Project. Existing archaeological sites that may be affected during the construction and operation phase will require constant appraisal and monitoring during all activities within 100 metre buffer of these sites.

Increased shoreline erosion and peatland disintegration is expected to continue to expose existing heritage resources sites and those potential heritage resources sites which have not yet been discovered. The 43 known heritage sites within the Project Core Study Area would be lost or disturbed if not salvaged through the operation phase, therefore archaeological salvage discussed in Section 6.6.2.2 and the monitoring discussed in Chapter 8 should be implemented to mitigate the effects on these sites. All found, tangible evidence of human occupation will be recovered and processed using standard archaeological methods.

Given mitigation measures described above, and the development of an HRPP and monitoring plans (the latter described in Chapter 8), there are no overall significant adverse effects on the existing VEC heritage resources.

The adverse residual effects of the Project will overlap or interact spatially and temporally with effects from the following future Projects: Keeyask Transmission Project, and Bipole III. The cumulative effects are discussed in more detail in Chapter 7.

Monitoring plans are being developed to address uncertainties. These are discussed in Chapter 8.

[1] Mnemonics are learning techniques that aid memory.

6.8.4 SUMMARY OF RESIDUAL EFFECTS AND SIGNIFICANCE

6.8.4.1 CONSTRUCTION PHASE

The terms of the HRPP will be designed to mitigate any residual effects to known and discovered heritage resources that may occur as a result of the construction phase of the Project. The seven known heritage sites that may be affected during the construction phase will require regular appraisal and monitoring during all construction activities within 100 metres of the sites. All found, tangible evidence of human occupation will be recovered and processed using standard archaeological methods.

Table 6-69 summarizes residual effects during the construction phase. Given mitigation measures described above, and the development of an HRPP and monitoring (the latter described in Chapter 8), there are no significant adverse effects on the existing VEC heritage resources during the construction phase. Unknown heritage resources if unknowingly affected by construction activities will be lost and thus experience residual.

The Heritage Resource VEC requires a Step 1 analysis onlyand is expected to have no significant adverse effects. Although heritage resource site loss is permanent the KCNs AEAs address the loss of heritage sites. Tangible heritage resources that are collected during the construction phase will be sent to the Keeyask Cultural Centre for interpretation. Uncertainties that exist from ATK regarding burial locations will be addressed through monitoring (see Chapter 8) and will take follow-up action, if required.

Note regarding the following residual effects table:

1. Refer to Section 5.1 (Approach to Determination of Regulatory Significance) for full description of assessment characteristics. Under Step 1, all VECs were examined using the criteria of direction, magnitude, geographic extent and duration. As explained, where further analysis was warranted, a Step 2 analysis considered additional criteria of frequency, reversibility or ecological context.

Table 6-69: Summary of Mitigation and Residual Effects on HERITAGE RESOURCES

VEC Effect and Mitigation by Phase	Residual Effects	Assessment Characteristics (1 see introductory text)
Construction Phase		
Effect on seven existing archaeological sites within the Project Core Study Area Effect on undiscovered archaeological sites within the Project Core Study Area **Mitigation includes:** • Archaeological salvage in the form of controlled artifact collection, shovel testing and, excavation at each of the seven existing archaeological sites • Assessment of the dewatered cofferdam and spillway channel constructed within the cofferdam. • Compliance with the terms of the HRPP	No residual effect on existing archaeological sites after mitigation Loss of artifacts and features associated with undiscovered archaeological sites Loss of linkage with cultural landscape	**Step 1:** Direction: Adverse Magnitude: Moderate Geographic Extent: Small Duration: Short-term **Step 2: Not Required**
Operation Phase		
Effect on forty-three existing archaeological sites within the Project Core Study Area Effect on undiscovered archaeological sites within the Project Core Study Area **Mitigation includes:** • Compliance with the terms of the HRPP • Archaeological salvage in the form of controlled artifact collection and excavation existing archaeological sites • Regular monitoring of shoreline during the operation phase until the maximum predicted reservoir shoreline is reached	No residual effect on existing archaeological sites Loss of artifacts and features associated with undiscovered archaeological sites Loss of linkage with cultural landscape	**Step 1:** Direction: Adverse Magnitude: Moderate Geographic Extent: Small Duration: Long-term **Step 2: Not Required**

6.8.4.2 OPERATION PHASE

The terms of the HRPP will be designed to mitigate any residual effects to known heritage resources that may occur as a result of the operation phase of the Project. Ongoing shoreline erosion and peatland disintegration is expected to continue to expose existing heritage resources sites and those potential heritage resources sites which have not yet been discovered. The 43 known heritage sites within the Project Core Study Area would be lost or disturbed if not salvaged through the operation phase, therefore archaeological salvage discussed in Section 6.6.2.2 and the monitoring discussed in Chapter 8 should be implemented to mitigate the effects on these sites. All found, tangible evidence of human occupation will be recovered and processed using standard archaeological methods.

Table 6-47 summarizes the residual effects during the operation phase. Given mitigation measures described above, and the development of an HRPP and monitoring (the latter described in Chapter 8); there are no significant adverse effects to the existing VEC heritage resources during the operation phase. There is a potential for unknown heritage resources to experience residual effects if not addressed through the HRPP.

The Heritage Resource VEC requires a Step 1 analysis only and is expected to have no significant adverse effects. Although heritage resource site loss is permanent the AEA's which have been signed with the KCNs address the loss of heritage sites. The Waterways Management Program and the "System-Wide Archaeological Project" will address any further heritage resource sites that are discovered during the operation phase. Uncertainties that exist from ATK regarding burial locations will be addressed through monitoring (see Chapter 8) and will take follow-up action, if required.

6.8.5 SENSITIVITY OF EFFECTS TO CLIMATE CHANGE

As described in Section 6.3.1.2, the effects of climate change for the 2020s, 2050s and 2080s projects increasing temperatures and precipitation for the local region around Gillam. Climate change will not have any affects during the construction phase; therefore all discussion for sensitivity of effects on heritage resources focus on the operation phase.

Heritage resources could be susceptible to effects from climate change through the pathways of changes in river flows and soil conditions caused by changes in weather patterns. Abnormally dry seasons may cause forest fires and destroy sites through heat and subsequent soil erosion.

Predictions noted in Section 6.3.1.2 suggest no change in the reservoir operating range; and a slightly larger reservoir if high flow events increased by 10% and a slightly smaller reservoir if low flow events were to decrease by 10%. Ice formation is expected to occur later in the year with earlier ice break-up. Shoreline erosion is not expected to be substantially affected by climate change as most erosion will likely occur during the first few years of operation.

Given the above predictions, it is not expected that climate change will have substantive effects on heritage resources during the operation phase as the largest effects may occur early in the operation phase when climate change effects are smallest.

6.9 EFFECTS OF THE ENVIRONMENT ON THE PROJECT

6.9.1 INTRODUCTION

The guidelines require information on how weather conditions and other natural hazards could affect the Project and potentially result in impacts to the environment. The guidelines also provide information on the Project's sensitivity to the longer-term effects of climate change. The guidelines ask for information on the planning, design and construction strategies to minimize potential adverse effects of the environment on the Project.

This section will discuss climate conditions considered during the planning of the Project, and the sensitivity to environmental factors, including climate change considerations.

6.9.2 PLANNING AND DESIGN

Manitoba Hydro has considerable experience in the design and operation of hydroelectric generation projects in northern Manitoba. This background has provided technical expertise within Manitoba Hydro in dealing with severe climatic conditions in the region. Appropriate engineering design parameters for the Project have been developed according to current and anticipated environmental conditions. Design loads and other design requirements have been established through the application of a set of design criteria compiled for the Project. The design criteria were developed from the most current standards and guidelines relevant to the construction of a hydroelectric generating station in Manitoba. They include the requirements of the current Canadian Dam Association (CDA) Dam Safety Guidelines, the National Building Code of Canada (NBCC) with Manitoba Amendments, the Canadian Standards Association (CSA), American National Standards Institute (ANSI) and other codes and standards that must either be met by law, or which otherwise define the basis on which the generating station will be designed and constructed. The environmental factors considered in the Project design process included severe precipitation events (hydrology), severe ice conditions, earthquakes and high winds.

6.9.3 KEY CLIMATE FACTORS / HAZARDS

Several important factors related to climate conditions that could affect the Project are discussed below.

6.9.3.1 HYDROLOGY

Manitoba Hydro operates and maintains a network of hydrometric stations throughout the Nelson River and Churchill River Watersheds. It also utilizes data from hydrometric stations operated by Environment Canada. As a result, Manitoba Hydro has developed a sound understanding of the historical hydrology of the watershed and this understanding has been incorporated into the Project design, for both construction and operation phases.

The flow of the lower Nelson River is regulated by the Lake Winnipeg Regulation Project and the Churchill River Diversion, as discussed in Chapter 4. The operation of these two major projects is well understood by Manitoba Hydro and has been factored into the design of the Project.

6.9.3.2 CONSTRUCTION PHASE

During the construction phase, the Project structures will be designed to withstand flows and levels associated with a flood having an annual frequency of occurrence of 1:20 years. Both summer and winter conditions are considered when determining the flows and levels associated with the construction design flood. During construction of the Project (with the ice boom in place), the most adverse water levels 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 Stage I powerhouse cofferdam during a construction design flood would be about 144 m (472 ft.). This level exceeds the open water construction design flood level and therefore it was used as the governing level for the construction of the powerhouse cofferdam.

For the upstream cofferdams (rock groin, north channel cofferdam and island cofferdam), the water levels at the upstream end of Gull Rapids during the open water (summer) construction design flood would be higher than during winter conditions. Therefore, the design elevation is based on open water conditions. The structures will have an additional 1.0 m [3.3 ft.] of freeboard for open water conditions and 1.5 m [4.9 ft.] for cofferdams under which winter conditions govern, allowing the passage of a larger flood without overtopping of the cofferdams. As discussed in Chapter 4, Project Description, emergency response plans will be developed for the possibility of exceeding the design event for the cofferdams so that worker safety is maintained.

6.9.3.3 OPERATION PHASE

The Project has been designed to safely pass the probable maximum flood (PMF). The PMF is defined by the Canadian Dam Association 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). Statistically, this flood represents an extremely remote event, less than a 1:10,000-year event , which is the largest potential flood that is thought could reasonably occur in the river basin.

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. The estimated PMF for the Project is more than double the flow experienced during the summer of 2005, which is the highest recorded daily average flow since 1908, the year measurements began. The PMF is estimated at 12,700 m^3 (448,480 ft^3/s). The PMF for the Project is considered to be greater in magnitude than the 1:10,000-year event.

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 be operated at the speed-no-load discharge 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-flow load discharge for six of seven units, assuming one unit is shut down for maintenance, is 1,400 m^3/s (49,439 ft^3/s). During the probable maximum flood event, 1,400 m^3/s (49,439 ft^3/s) would pass through the powerhouse and 11,300 m^3/s (399,041 ft^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 (521.6 ft.) to an elevation of 160.3 m (525.9 ft.).

The spillway can pass an estimated 9,960 m^3/s (351,721 ft^3/s) without the use of the powerhouse at the FSL of 159 m (521.6 ft.). It is therefore capable of passing a 1:1,000-year event flow of 8,705 m^3/s (307,403 ft^3/s).

The dykes and dams have been designed to provide a freeboard of 1.7 to 2.3 m [5.6 to 7.5 ft.] above the maximum expected water level during the passage of a PMF.

The elevation of the north, central and south dams' crests will range between 162.0 m (531.5 ft.) and 162.6 m (533.5 ft.). The crest elevations of the dams have been set to accommodate the highest reservoir water levels arising during the passage of the PMF. The required crest elevations take into account the appropriate combined effects of the wind-generated waves and post-construction embankment settlements. Two design conditions were considered:

- With the reservoir at its normal maximum level (FSL 159.0 m [521.6 ft.]) a wave run-up and reservoir setup due to a wind having a return period of 1:1000 years; and

- With the reservoir at its extreme maximum level during the passage of the PMF (el 160.3 m [525.9 ft.]) plus an allowance for reservoir tilt, a wave run-up and reservoir set-up due to a wind having a return period of 1:2 years.

The north and south dykes contain the water in the reservoir and limit the extent of flooding in areas of relatively low-lying topography. A series of discontinuous earth fill dykes will be located along both sides of the river, extending 11.6 km (7.21 mi.) on the north and 11.2 km (7.0 mi.) on the south side of the river dyke. The crest of the dykes will vary between elevations 161.8 m (530.8 ft.) and 163.0 m (534.8 ft.) but may be somewhat higher in areas where the foundations are expected to settle over a period of time. The north dyke and south dyke will have maximum heights of about 20 m (65.6 ft.) and 13 m (42.6 ft.) respectively.

Since these dykes will be located within a discontinuous permafrost region, their design will account for the thawing of permafrost affected soils and the resultant potential for differential settlements. In order to minimize the settlements and the problems associated with thaw consolidation, in most areas the top layers of peat and clay will be removed and the dykes will be founded on glacial till. 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 small in geographic extent and will be removed prior to placement of the fill.

The main dykes will be located on ground that is below the full supply level of the reservoir. Some of these dykes will be composed of an impervious core, granular filters, transition zones, and outer rockfill shells. This type of dyke will be located on glacial tills. Other dykes will consist of semi-pervious zones, a downstream toe drain, and slope-protection zones. These dykes will be used in areas of limited length where overburden affected by permafrost is relatively thick and excavation is impractical. These dykes are designed to limit seepage to a controllable volume and accommodate differential foundation settlements that will occur due to thaw consolidation of the permafrost-affected post-glacial clays.

A roadway will be constructed on top of the dykes and between the sections of dykes to facilitate inspection and maintenance.

6.9.3.4 SEVERE WIND EVENTS

The crests of the dykes and dams have been designed to accommodate the safe passage of the design floods, combined with high winds and wind directions that would result in large waves and wave uprush. The dykes and dams are protected from erosion due to these windy conditions by rock riprap. A freeboard is provided, as discussed earlier. As stated in Section 6.3.13.3, the design conditions also allow for the Project to safely pass floods up the PMF under circumstances where winds may cause outage of the transmission line from the Project.

6.9.3.5 Seismic Activity

Manitoba in general is an area of very low seismicity. In particular, the Precambrian Shield, within which the Project is located, is also of very low seismicity. It is evident from the historical records since the 1600s and relatively recent seismic monitoring, which presents the distribution of magnitude 3 and greater earthquakes in Canada since 1627 (Natural Resources Canada 2008), that no major earthquakes, and hence no important earthquake-generating fault movements, have occurred in Manitoba (Map 6-6).

A review of available data to assess the risk of active faulting and the risk associated with potential fault movement concluded that the existing faults at Keeyask are seismically inactive, and that the probability of reactivation of existing faults is infinitesimally small. The review also concluded that the depth of the Keeyask reservoir would be too shallow to induce a significant reservoir triggered seismic event.

Considerations to account for earthquake loads will be incorporated into the final design of the earthworks and concrete structures. The design criteria will incorporate design earthquake forces. The earth fill and concrete structures will be analyzed under both horizontal and vertical ground accelerations and hydrodynamic forces due to a seismic event. In addition, a seismic sensitivity analysis will be performed on the permanent structures.

6.9.3.6 Lightning

Lightning can potentially cause disruption of transmission. Provisions are in place for Manitoba Hydro to take the Project offline in the event that transmission is lost. The Project would then revert to an emergency mode of operation and this would not affect the integrity of the powerhouse.

Lighting can also cause forest fires. The Province has substantial experience in dealing with forest fires in the general area, as forest fires are fairly common in the region. There is low threat to the Project from forest fire.

6.9.4 Climate Change

It is recognized that the global climate is changing, as is regional climate, and these changes must be considered in the design of the Project, which is expected to last for many decades. A changing climate has the potential to alter the dynamics and characteristics of the watershed and thus the flow of the water can change and affect the generation of electricity over the life of the Project. Potential climate change scenarios for the region have been described in Section 6.12 and also in the Climate section of the PE SV. These scenarios are linked to the Project region and do not necessarily correspond with changes that might occur in the overall larger lower Nelson River Watershed.

Long-term climate scenarios for the region have been identified (see Section 6.3.12). The scenarios a generally warmer and wetter climate in the Project region. As discussed in Section 6.3.12, the Nelson River and Churchill River watershed is very large and local runoff constitutes only about 3% of the Nelson River flows. The design approach to address potential changes in Nelson River flows has been to design for the PMF, as discussed in Section 6.3.13 (Hydrology), which represents the largest flood flow that is considered to potentially occur in the overall river basin. The potential warming trends in climate and their implications for design of the Project have been addressed, as discussed below.

The vulnerability of the Project to potential climate change was considered. Some observations as to potential climate change variables are discussed below.

6.9.4.1 CHANGE IN NELSON RIVER FLOW

As discussed in Section 6.12, the sensitivity of the Project to a ±10% change in flows across all flow percentiles was reviewed because there are no estimates of how climate change may affect flows in the lower Nelson River. It was observed that the operating range of the reservoir of 158.0 m to 159.0 m (518.4 ft to 521.6 ft.) would remain unchanged regardless of the changes in the Nelson River flows resulting from such potential climate change, *i.e.*, ±10% change in river flows. As described in previous sections, the Project will be able to safely manage the flows in the future if river flows are substantially higher or lower. The water regime in the open water hydraulic zone of influence of the Project is not expected to change materially in response to increases or decreases in Nelson River flows.

The Project has been designed to safely pass the PMF, as discussed in Section 6.3.13.3.3.

6.9.4.2 WARMER TEMPERATURES

The formation of ice cover on the reservoir could be delayed for a few weeks in the future and ice breakup could occur a few weeks earlier but these would not affect the functionality of the reservoir. The ice cover would likely be thinner and perhaps exert less force on structures than under the design conditions.

The design of the principal structures has considered the potential of permafrost melting.

6.9.4.3 WIND AND EXTREME EVENTS

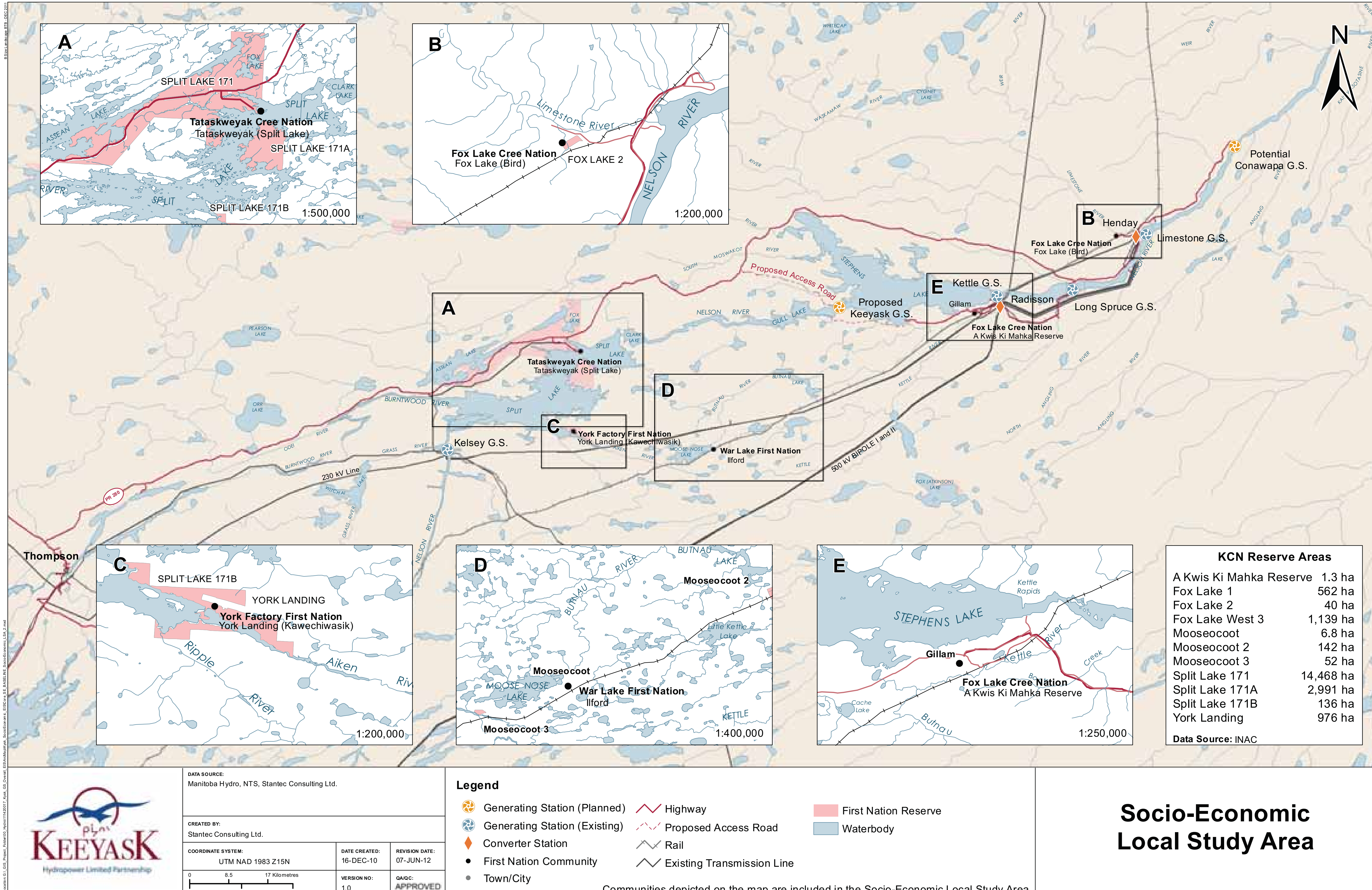
Climate change studies have suggested that wind and storm events could become more severe or extreme in the future. These conditions could result in transmission line outages. The Project will be capable of taking generating units off-load and, as discussed in Section 6.3.13.3.3, still safely pass floods up to the PMF.

6.9.5 CONCLUSIONS

The planning and design by Manitoba Hydro explicitly addresses potential effects that the environment may have on the Project resulting in a low risk to the Project itself from these key climate factors, as well as a low risk to the environment and the public.

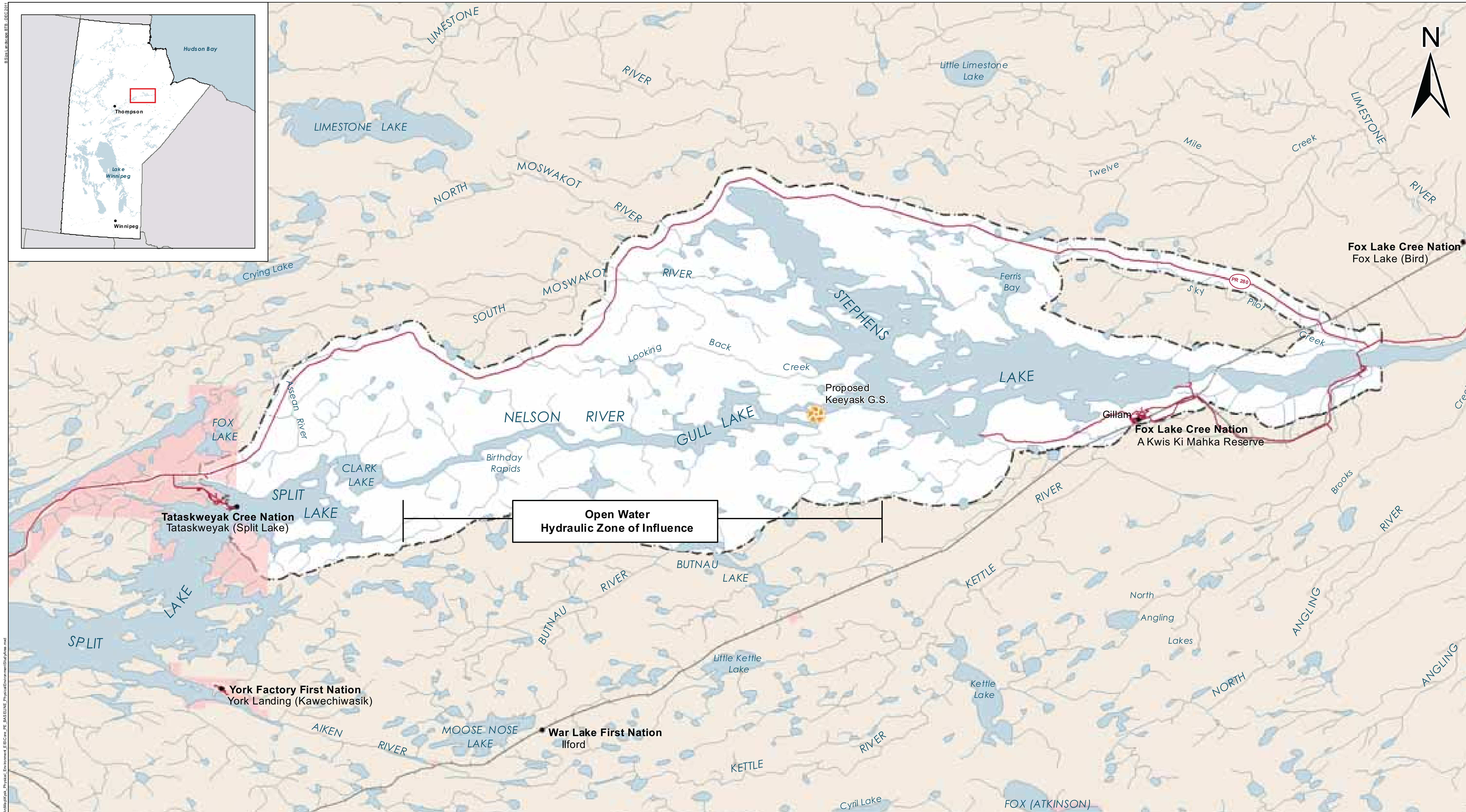
6.10 CAPACITY OF RENEWABLE RESOURCES

The EIS Guidelines (Section 6.1) require that the EIS consider the capacity of renewable resources that are likely to be significantly affected by the Project to meet the needs of the present and those of the future. The Guidelines also provide criteria by which significance is to be determined for regulatory purposes. The effects assessment has reviewed the impact of the Project on renewable resources and has not identified any renewable resources that are likely to be significantly affected by the Project according to the regulatory criteria. Accordingly, no further consideration is required of the capacity of renewable resources.



A
SPLIT LAKE 171
Tataskweyak Cree Nation
Tataskweyak (Split Lake)
SPLIT LAKE 171A
SPLIT LAKE 171B
1:500,000
B
Limestone River
Fox Lake Cree Nation
Fox Lake (Bird)
FOX LAKE 2
NELSON RIVER
1:200,000
N
Potential
Conawapa G.S.
Henday
Limestone G.S.
Fox Lake Cree Nation
Fox Lake (Bird)
Kettle G.S.
Gillam
Radisson
Long Spruce G.S.
Fox Lake Cree Nation
A Kwis Ki Mahka Reserve
Proposed Access Road
Proposed
Keeyask G.S.
Tataskweyak Cree Nation
Tataskweyak (Split Lake)
York Factory First Nation
York Landing (Kawechiwasik)
War Lake First Nation
Ilford
Kelsey G.S.
230 KV Line
500 KV BIPOLE I and II
PR 280
Thompson
C
SPLIT LAKE 171B
YORK LANDING
York Factory First Nation
York Landing (Kawechiwasik)
Ripple River
Aiken River
1:200,000
D
Mooseocoot 2
Mooseocoot
MOOSE NOSE LAKE
War Lake First Nation
Ilford
Mooseocoot 3
KETTLE
1:400,000
E
STEPHENS LAKE
Kettle Rapids
Gillam
Kettle River
Fox Lake Cree Nation
A Kwis Ki Mahka Reserve
Butnau
Cache Lake
1:250,000
KCN Reserve Areas
A Kwis Ki Mahka Reserve 1.3 ha
Fox Lake 1 562 ha
Fox Lake 2 40 ha
Fox Lake West 3 1,139 ha
Mooseocoot 6.8 ha
Mooseocoot 2 142 ha
Mooseocoot 3 52 ha
Split Lake 171 14,468 ha
Split Lake 171A 2,991 ha
Split Lake 171B 136 ha
York Landing 976 ha
Data Source: INAC
KEEYASK
Hydropower Limited Partnership
DATA SOURCE:
Manitoba Hydro, NTS, Stantec Consulting Ltd.
CREATED BY:
Stantec Consulting Ltd.
COORDINATE SYSTEM:
UTM NAD 1983 Z15N
DATE CREATED:
16-DEC-10
REVISION DATE:
07-JUN-12
VERSION NO:
1.0
QA/QC:
APPROVED
0 8.5 17 Kilometres
0 7 14 Miles
Legend
Generating Station (Planned)
Generating Station (Existing)
Converter Station
First Nation Community
Town/City
Highway
Proposed Access Road
Rail
Existing Transmission Line
First Nation Reserve
Waterbody
Communities depicted on the map are included in the Socio-Economic Local Study Area
Socio-Economic
Local Study Area

Map 6-1



KEEYASK Hydropower Limited Partnership

DATA SOURCE:
Province of Manitoba, Manitoba Hydro, Stantec Consulting Ltd., NTS, NR CAN

CREATED BY:
Stantec Consulting Ltd.

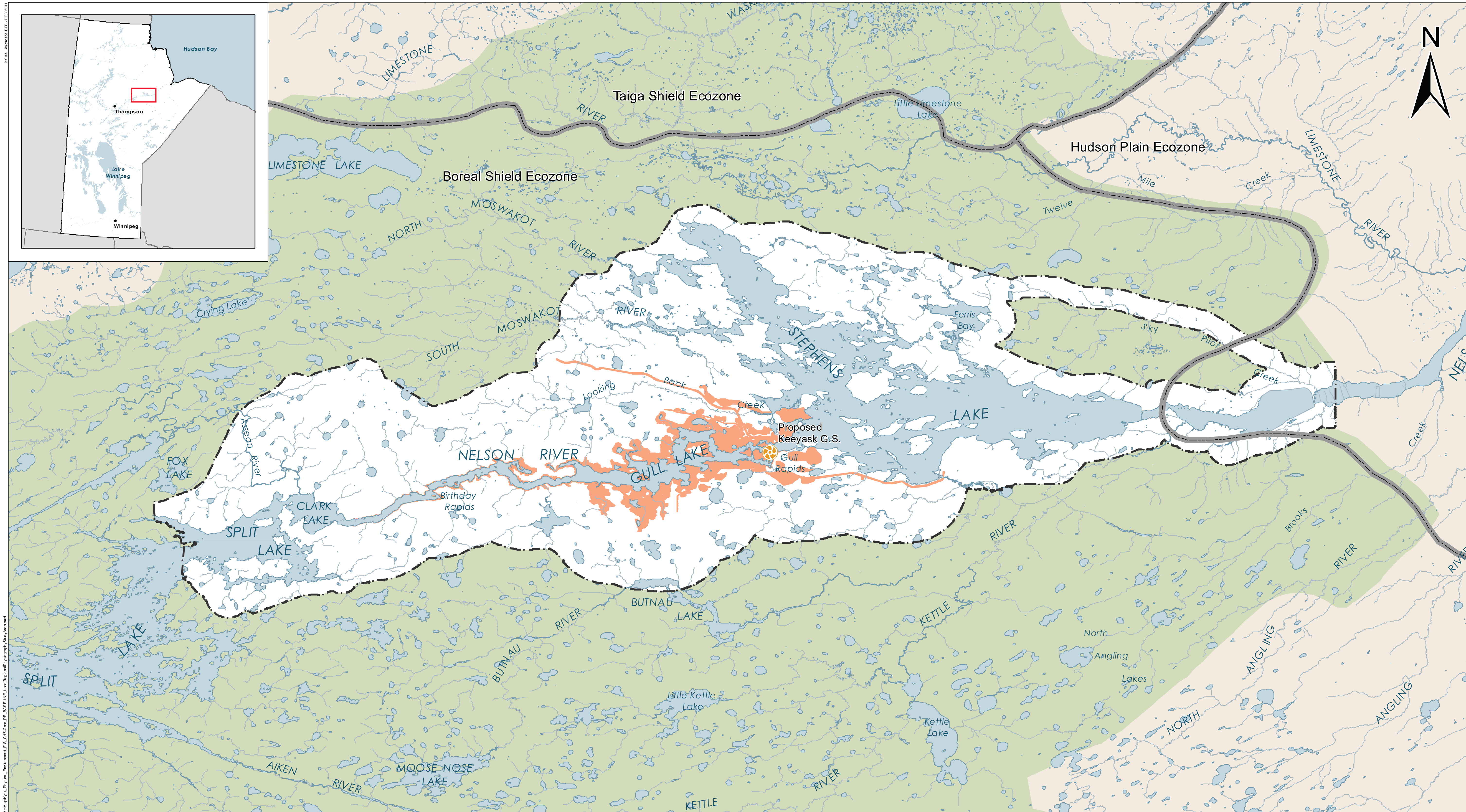
COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	18-FEB-11	18-MAY-12
0 4 8 Kilometres / 0 3.5 7 Miles	VERSION NO: 1.0	QA/QC: APPROVED

Legend

- Generating Station (Planned)
- Physical Environment Local Study Area
- Highway
- Rail
- First Nation Reserve
- Waterbody

Physical Environment Local Study Area

Map 6-2



KEEYASK
Hydropower Limited Partnership

DATA SOURCE:
Province of Manitoba, Manitoba Hydro, Stantec Consulting Ltd., NTS, Natural Resources Canada.

CREATED BY:
Stantec Consulting Ltd.

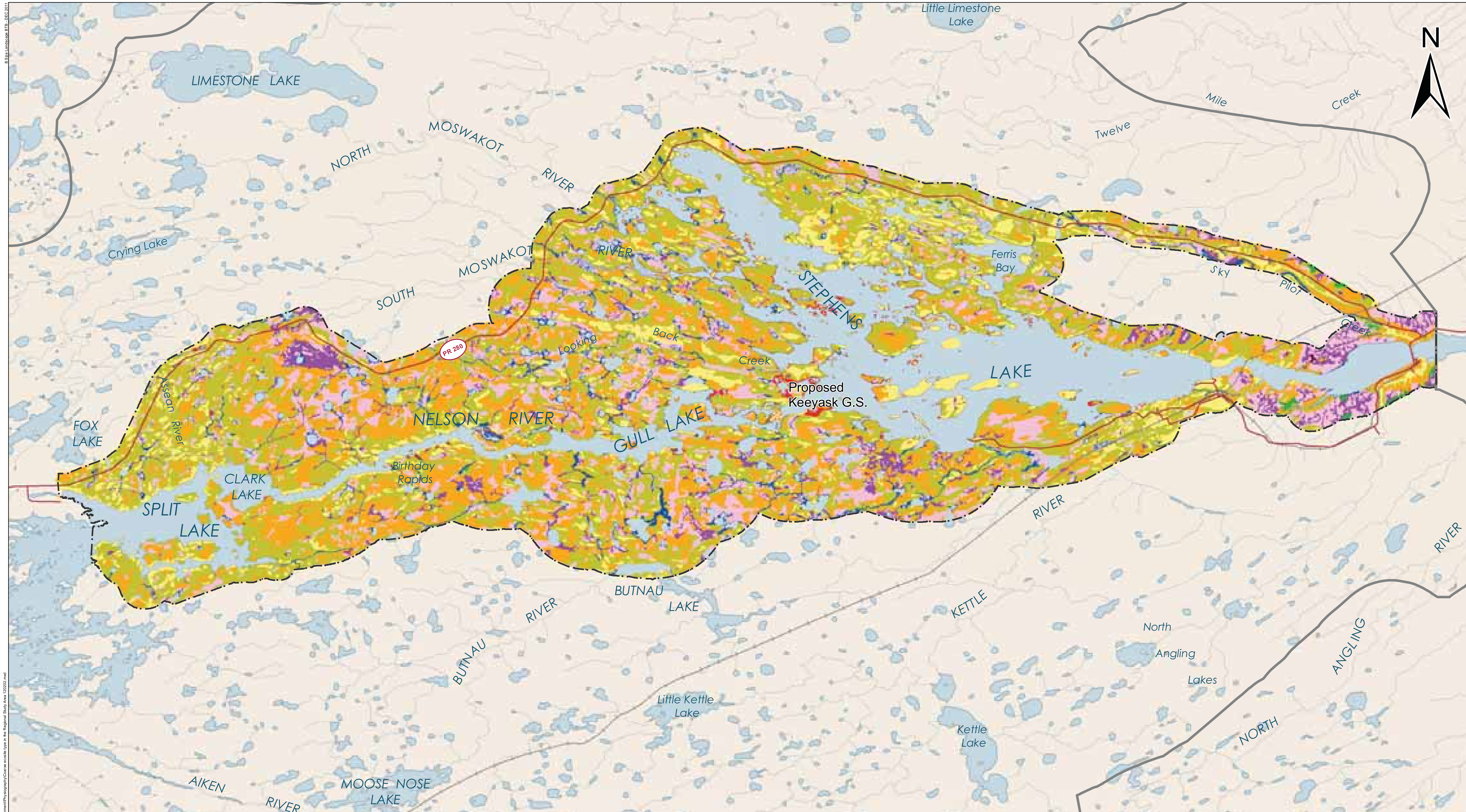
COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	13-JAN-11	10-FEB-12
	VERSION NO:	QA/QC:
0 4 8 Kilometres / 0 3 6 Miles	1.0	APPROVED

Legend

- Generating Station (Planned)
- Project Footprint and Surrounding Areas (intensely studied)
- Local Study Area
- Regional Study Area
- Ecozone
- Waterbody

Local and Regional Physiography Study Areas

Map 6-3



KEEYASK Hydropower Limited Partnership

DATA SOURCE:
Study areas, ecosite data and Nelson River shoreline - ECOSTEM Ltd.; Water - NTS; Infrastructure - Manitoba Hydro; Roads and rail - Manitoba Conservation.

CREATED BY:
ECOSTEM Ltd.

COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	03-FEB-12	27-APR-12
0 2 4 Kilometres / 0 2.5 5 Miles	VERSION NO: 1.0	QA/QC: APPROVED

Legend

Coarse Ecosite
- Mineral
- Thin Peatland
- Shallow Peatland
- Ground Ice Peatland
- Permafrost Peatland - Other
- Deep Peatland
- Wet Deep Peatland
- Riparian Peatland
- Ice Scour - Mineral
- Shoreline Wetland
- Waterbody

- Physiography Local Study Area
- Physiography Regional Study Area

Coarse Ecosite
in the Physiography Local Study Area

Map 6-4

Keeyask Hydropower Limited Partnership

DATA SOURCE:
Study areas, permafrost data and Nelson River shoreline - ECOSTEM Ltd.; Water - NTS; Infrastructure - Manitoba Hydro; Roads and rail - Manitoba Conservation.

CREATED BY:
ECOSTEM Ltd.

COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	06-FEB-12	27-APR-12
0 2 4 Kilometres / 0 3 6 Miles	VERSION NO: 1.0	QA/QC: APPROVED

Legend

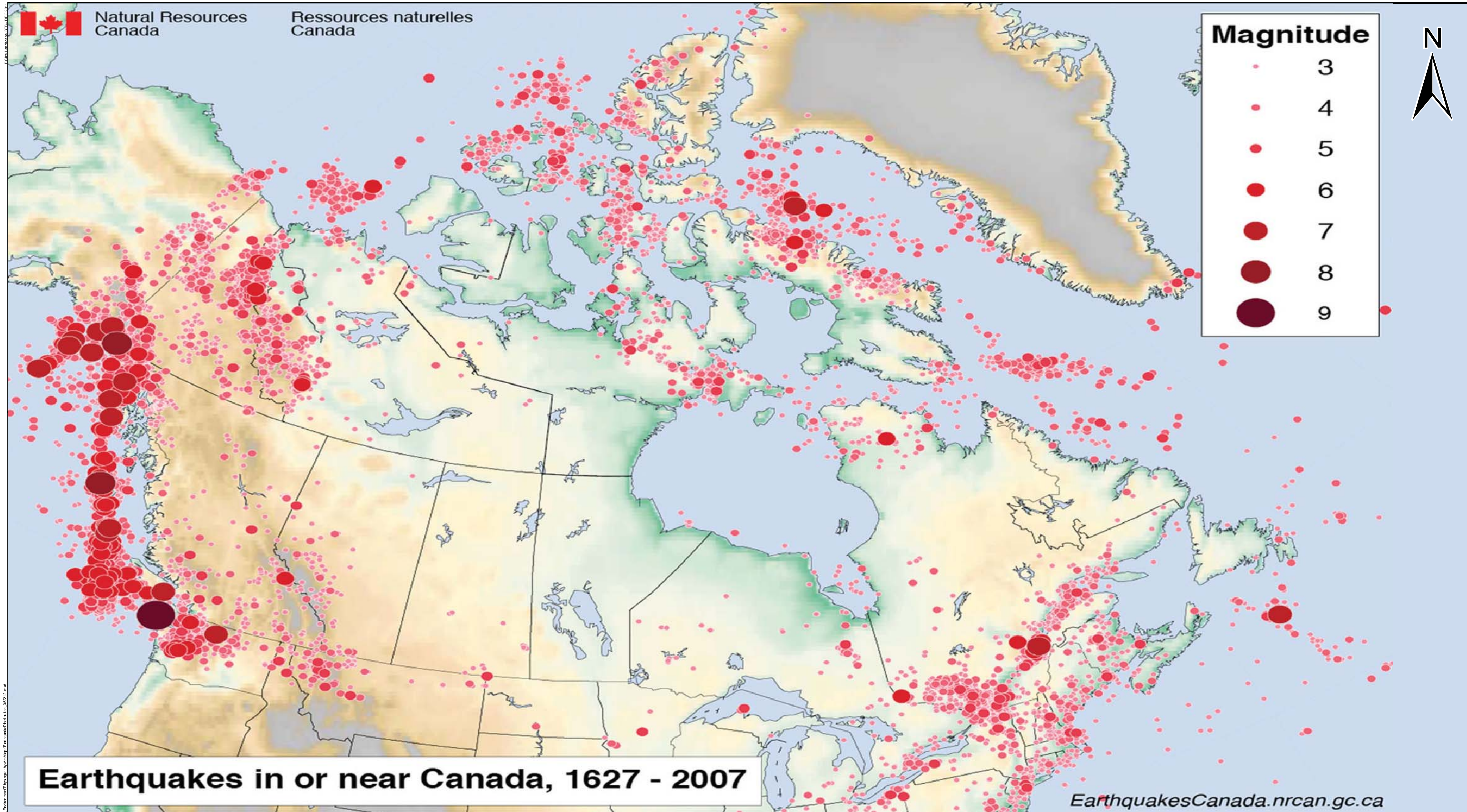
Permafrost Continuity

- Continuous
- Extensive Discontinuous
- Sporadic Discontinuous
- Isolated Patches
- None

- Physiography Local Study Area
- Physiography Regional Study Area

Surface Permafrost
in the Physiography Local Study Area

Map 6-5

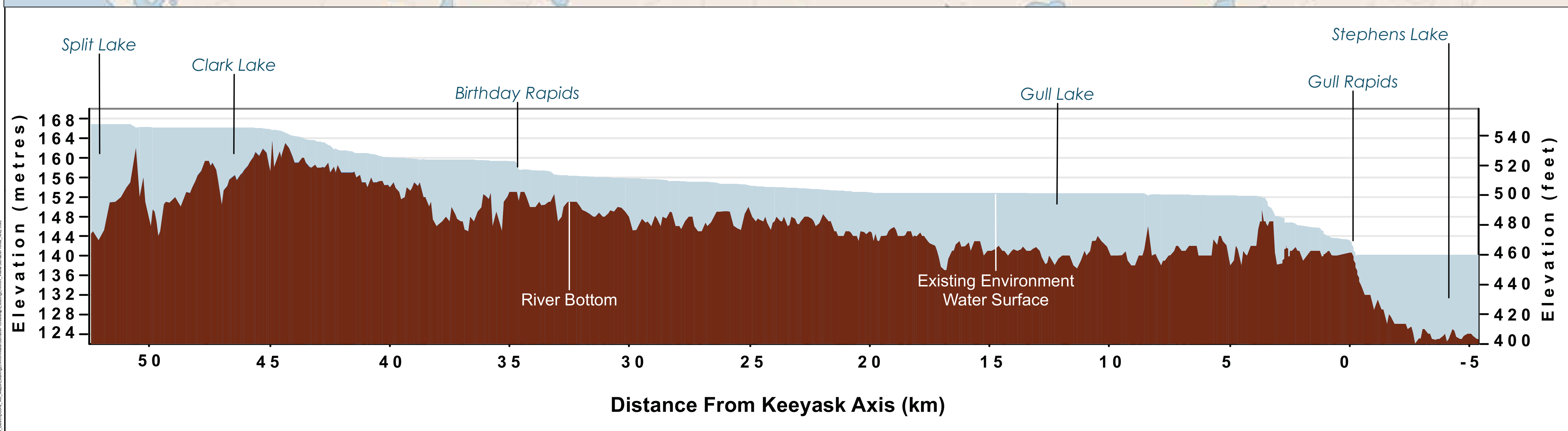


KEEYASK Hydropower Limited Partnership

DATA SOURCE:		
Natural Resources Canada EarthquakesCanada.nrcan.gc.ca		
CREATED BY: Stantec		
COORDINATE SYSTEM: UTM NAD 1983 Z15N	DATE CREATED: 10-FEB-10	REVISION DATE: 23-MAY-12
	VERSION NO: 1.0	QA/QC: APPROVED

Earthquakes in or Near Canada, 1627-2007

Map 6-6



DATA SOURCE:	Government of Canada; Government of Manitoba; Manitoba Hydro: gull-ee-50perc-3032cms-rev3
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COORDINATE SYSTEM:	UTM NAD 1983 Z15N
DATE CREATED:	26-Jan-10
REVISION DATE:	18-MAY-12
VERSION NO:	1.0
QA/QC:	APPROVED

0 1.5 3 Kilometres
0 1.5 3 Miles

Legend

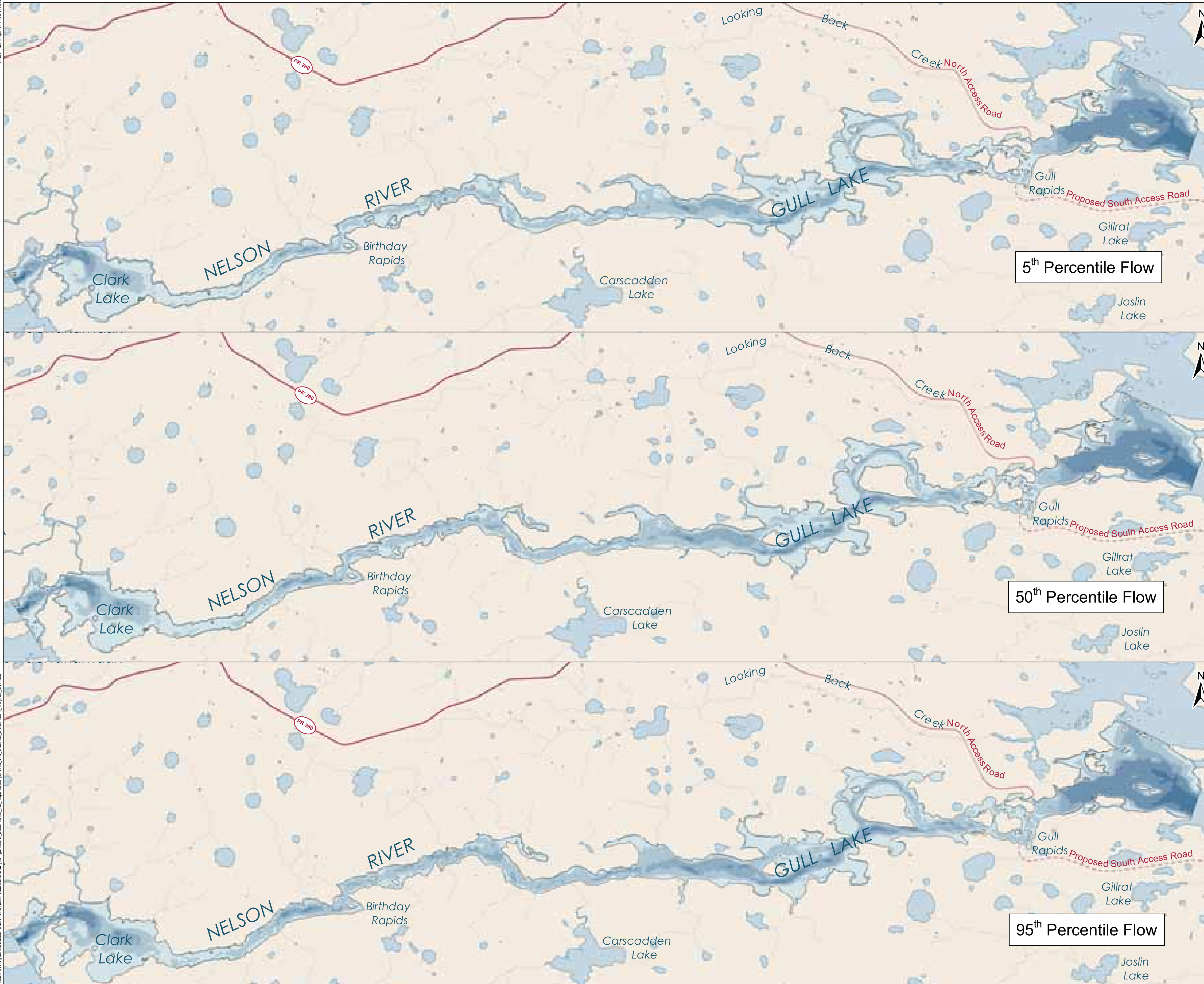
Existing Environment

Keeyask Hydropower Limited Partnership

Open Water Surface Profile

Typical Existing Environment

Map 6-7



KEEYASK
Hydropower Limited Partnership

Legend

Depth (m)

- 0 - 4
- 4 - 8
- 8 - 12
- 12 - 18
- 18 - 23
- 23 - 31

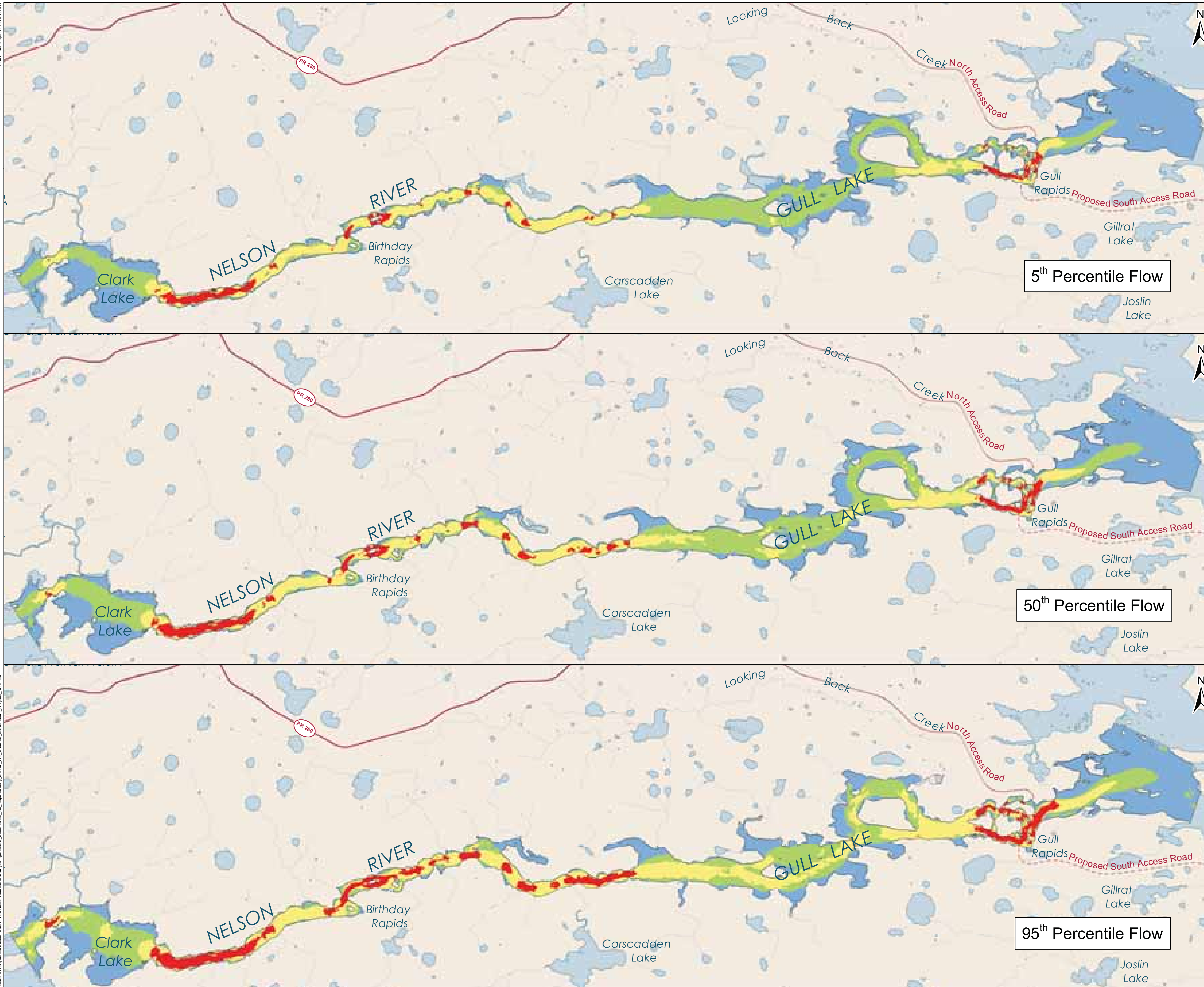
DATA SOURCE:
Manitoba Hydro; Government of Manitoba; Government of Canada

CREATED BY:
Manitoba Hydro - Water Resources Engineering Department

COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	08-JAN-10	17-MAY-12
0 2 4 Kilometres / 0 1.5 3 Miles	VERSION NO: 1.0	QA/QC: APPROVED

Water Depth Grids
Existing Environment

Map 6-8



KEEYASK
Hydropower Limited Partnership

Legend

Velocity (m/s)

- Standing (0 - 0.2)
- Low (0.2 - 0.5)
- Moderate (0.5 - 1.5)
- High (>1.5)

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

CREATED BY:
Manitoba Hydro - Water Resources Engineering Department

COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	08-JAN-10	23-MAY-12
0 2 4 Kilometres / 0 1 2 Miles	VERSION NO: 1.0	QA/QC: APPROVED

Water Velocity Grids
Existing Environment

Map 6-9

KEEYASK
Hydropower Limited Partnership

DATA SOURCE:
Photos from Manitoba Hydro
Ice condition data from KGS Acres Ltd., 2010

CREATED BY:
KGS Acres Ltd.

COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	16-MAY-12	16-MAY-12
0 1.5 3 Kilometres / 0 1 2 Miles	VERSION NO: 1.0	QA/QC: APPROVED

Legend

- Hanging Ice Dams
- Border Ice
- Waterbody
- Bridging Locations
- Anchor Ice Location
- Keeyask Principal Structures
- Highway
- Access Road
- Proposed Access Road
- Rail
- Rivers

Overview of Existing Environment Ice Processes

Between Split Lake and Stephens Lake

Map 6-10

KEEYASK
Hydropower Limited Partnership

DATA SOURCE:
Shore material and Nelson River shoreline - ECOSTEM Ltd.; Water - NTS; First Nation Reserves - Natural Resources Canada; Roads and rail - Manitoba Conservation; Photos - J D Mollard and Associates Limited. and ECOSTEM Ltd.

CREATED BY:
ECOSTEM Ltd.

COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	18-JAN-12	09-FEB-12
0 0.9 1.8 Kilometres / 0 0.4 0.8 Miles	VERSION NO: 1.0	QA/QC: APPROVED

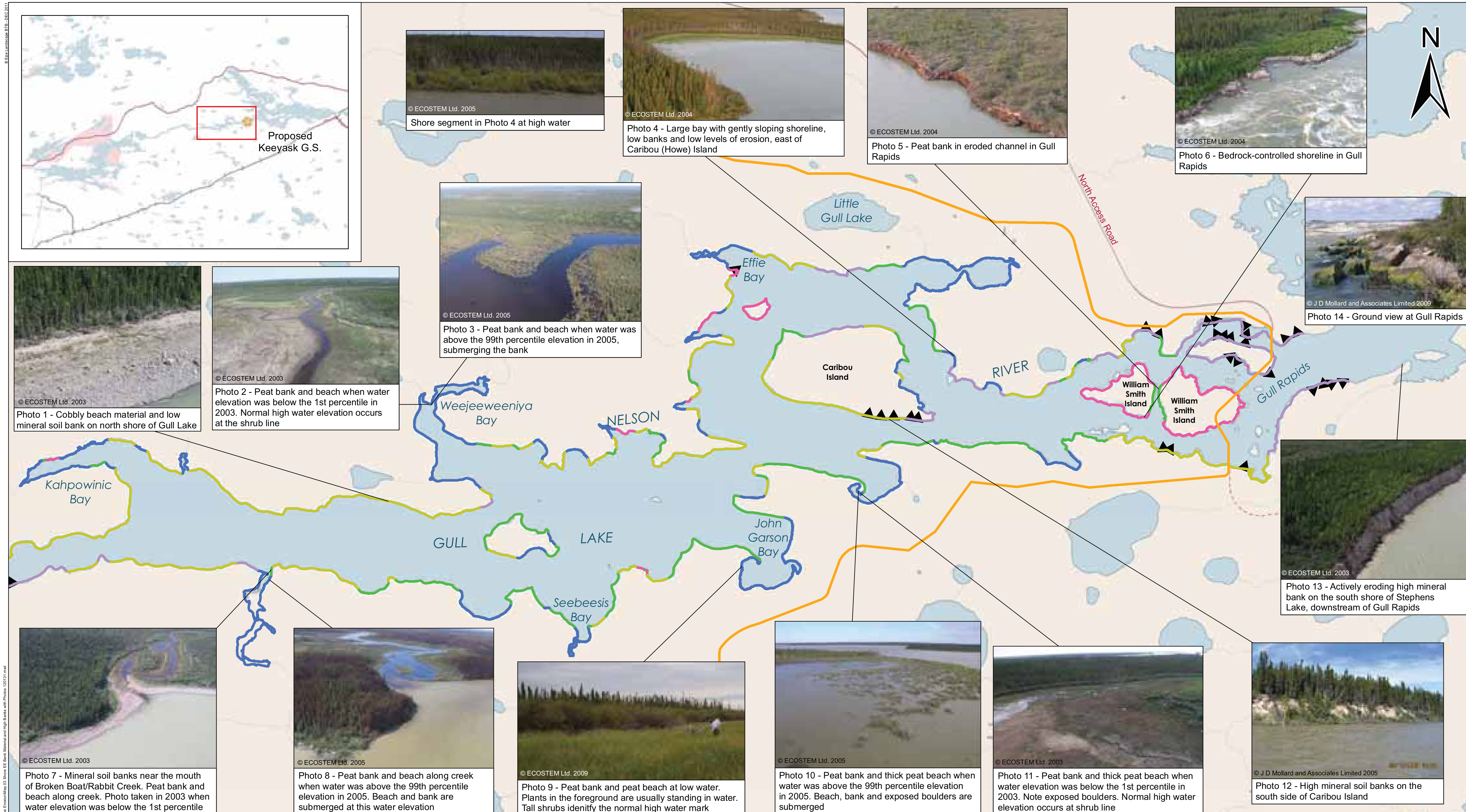
Legend

Shore Material

- Bedrock
- Coarse Mineral
- Fine Mineral
- Mineral Overlain By Peat
- Peat
- Shore At Least 3m High

Nelson River Bank Material Type and Segments With High Banks

in Western Upstream Reaches



KEEYASK
Hydropower Limited Partnership

DATA SOURCE:
Shore material and Nelson River shoreline - ECOSTEM Ltd.; Infrastructure and access roads - Manitoba Hydro; Water - NTS; First Nation Reserves - Natural Resources Canada; Roads and rail - Manitoba Conservation; Photos - J D Mollard and Associates Ltd. and ECOSTEM Ltd.

CREATED BY:
ECOSTEM Ltd.

COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	18-JAN-12	09-FEB-12
0 0.9 1.8 Kilometres / 0 0.4 0.8 Miles	VERSION NO: 1.0	QA/QC: APPROVED

Legend

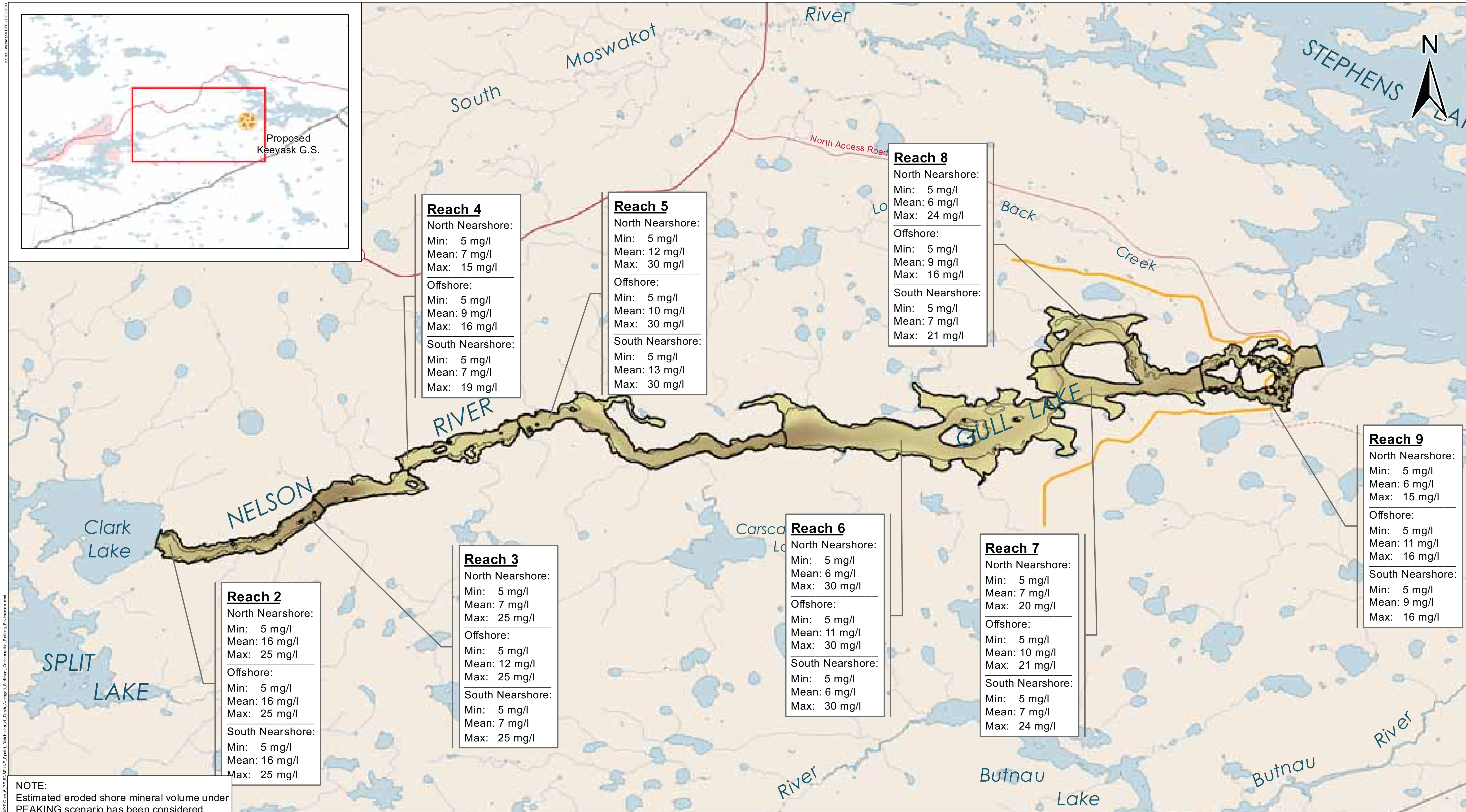
Shore Material

- Bedrock
- Coarse Mineral
- Fine Mineral
- Mineral Overlain By Peat
- Peat
- Bank At Least 3m High
- Keeyask Principal Structures

Nelson River Bank Material Type and Segments With High Banks

in Eastern Upstream Reaches

Map 6-12



NOTE:
Estimated eroded shore mineral volume under PEAKING scenario has been considered

KEEYASK
Hydropower Limited Partnership

DATA SOURCE:
TSS data from KGS Acres LTD., 2010
Modelling reach boundary data from North/South Consultants
Manitoba Hydro
Backround data provided by Geogratis

CREATED BY:
KGS Acres Ltd.

COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	02-MAY-12	03-MAY-12
0 1.5 3 Kilometres / 0 1 2 Miles	VERSION NO: 1.0	QA/QC: APPROVED

Legend

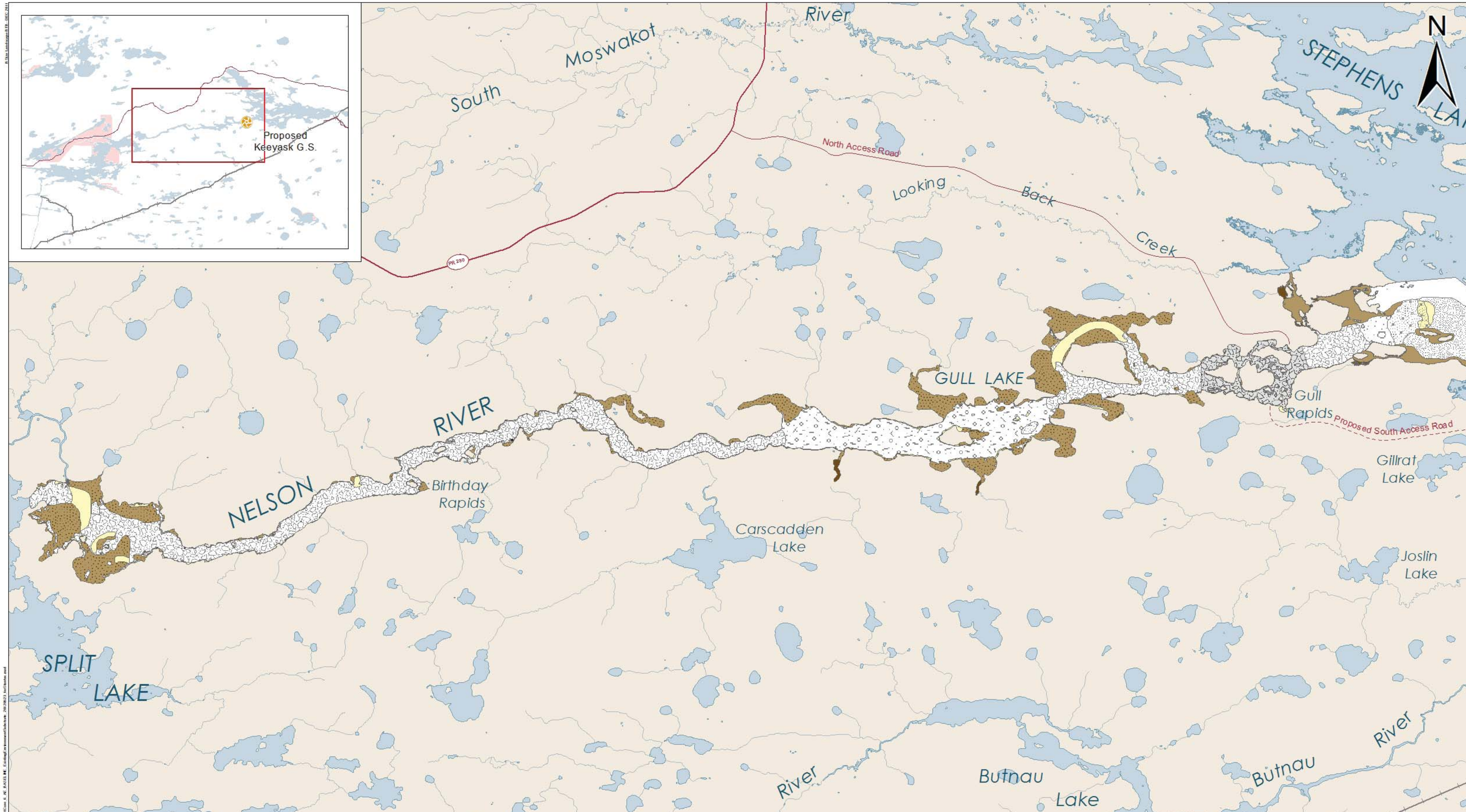
Total Suspended Solids (TSS mg/L)
High : 50
Low : 0

Reach Boundaries
Nearshore Boundaries
Keeyask Principal Structures
Access Road
Proposed Access Road
Highway
Rail
Rivers
Waterbody

Spatial Distribution of Depth Averaged Sediment Concentration

Existing Environment

Map 6-13



DATA SOURCE:
Manitoba Hydro, North/South Consultants, Government of Canada
gull-ee-95perc-4327cms-rev3

CREATED BY:
North/South Consultants

COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	26-MAR-10	03-JUL-12

0 1.5 3 Kilometres
0 1 2 Miles

VERSION NO:	QA/QC:
3.0	APPROVED

KEEYASK
Hydropower Limited Partnership

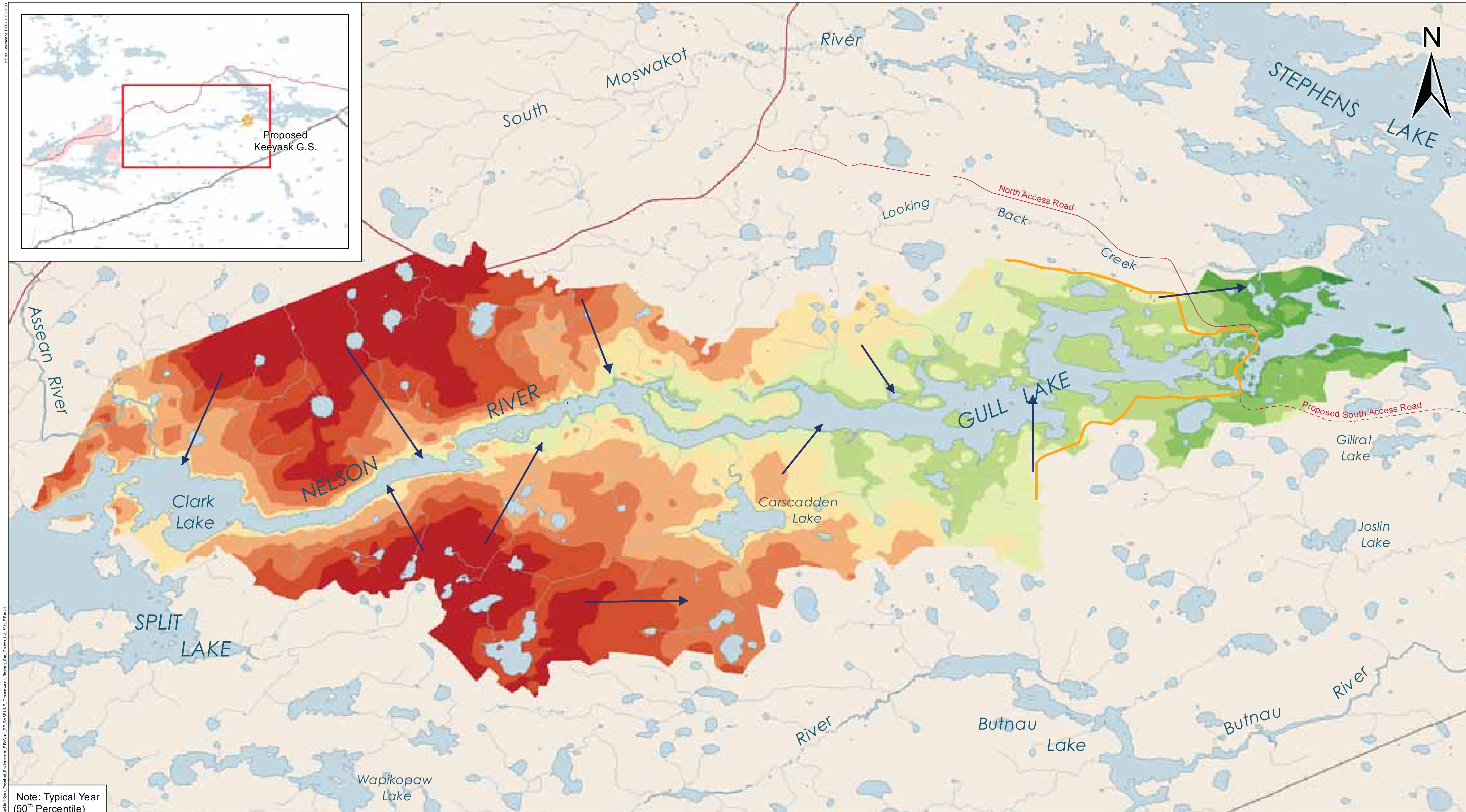
Legend

Substrate

- Bedrock
- Boulder
- Cobble/Boulder/Bedrock
- Cobble/Boulder
- Cobble
- Cobble/Gravel
- Gravel/Cobble/Boulder
- Gravel
- Gravel/Sand
- Sand
- Silt
- Silt/Clay
- Clay
- Organic
- No Data

Substrate
Existing Environment
95th Percentile Inflow Keeyask Area

Map 6-14



KEEYASK
Hydropower Limited Partnership

DATA SOURCE:
Manitoba Hydro, NTS, Stantec Consulting Ltd.

CREATED BY:
Stantec Consulting Ltd.

COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	18-JUL-11	15-MAY-12
0 1.5 3 Kilometres / 0 1 2 Miles	VERSION NO: 1.0	QA/QC: APPROVED

Legend

Groundwater Elevation (m)

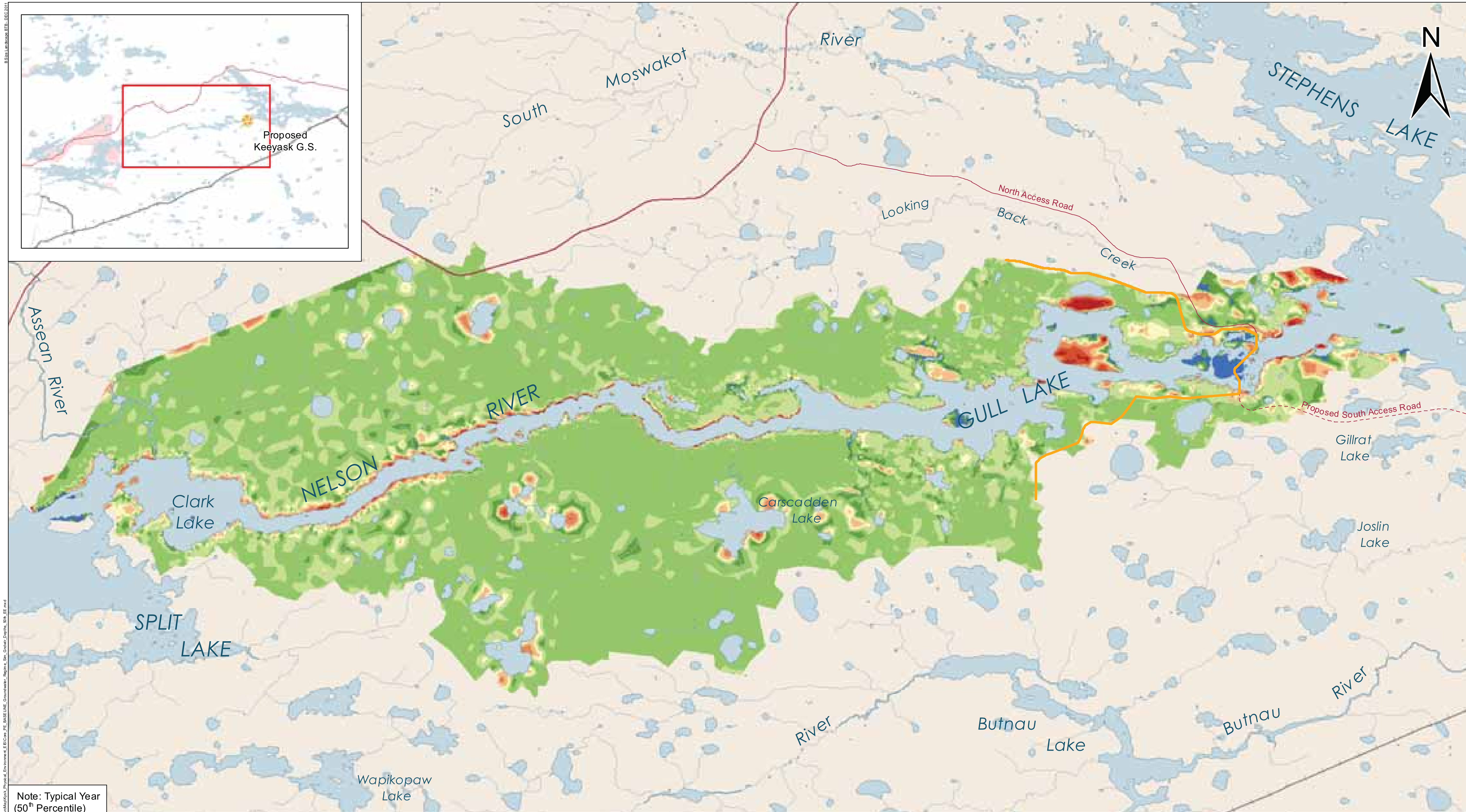
< 140	158 - 164	182 - 188
140 - 146	164 - 170	> 188
146 - 152	170 - 176	
152 - 158	176 - 182	

- Groundwater Flow Direction
- Keeyask Principal Structures
- Proposed Access Road
- Access Road
- Waterbody

Keeyask Groundwater Regime

Simulated Groundwater Level
(Existing Environment)

Map 6-15



KEEYASK
Hydropower Limited Partnership

DATA SOURCE:
Manitoba Hydro, NTS, Stantec Consulting Ltd.

CREATED BY:
Stantec Consulting Ltd.

COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	18-JUL-11	15-MAY-12
0 1.5 3 Kilometres / 0 1 2 Miles	VERSION NO: 1.0	QA/QC: APPROVED

Legend

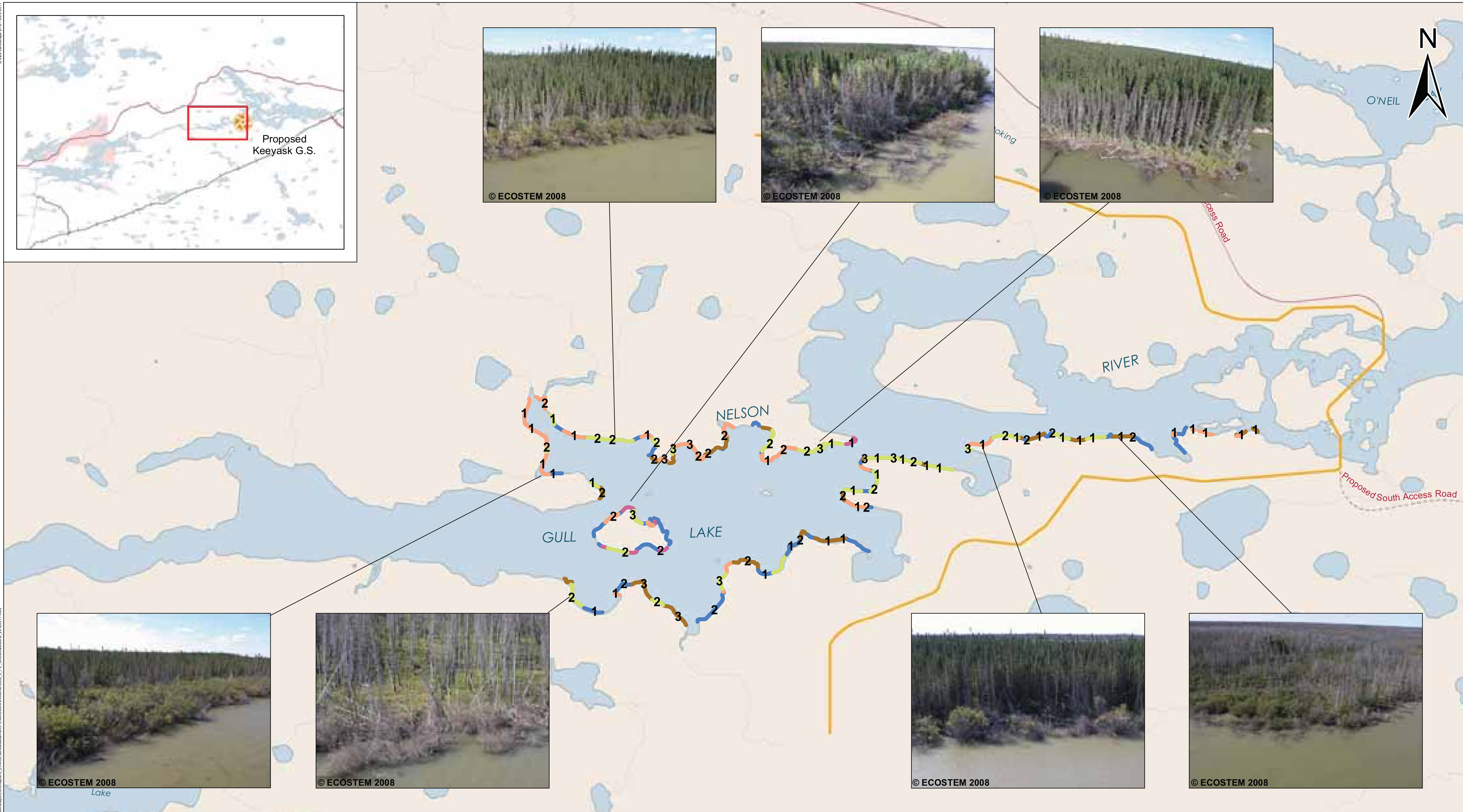
Depth to Groundwater (m)

- Groundwater at Surface
- 0 - 0.5
- 0.5 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- 2.0 - 3.0
- 3.0 - 5.0
- 5.0 - 7.5
- > 7.5
- Keeyask Principal Structures
- Proposed Access Road
- Access Road
- Waterbody

Groundwater Regime

Simulated Groundwater Depths
(Existing Environment)

Map 6-16



DATA SOURCE:
Manitoba Hydro; Government of Manitoba; Government of Canada;
ECOSTEM 2008-09-01 Shoreline Photos

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

COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	11-AUG-09	11-MAY-12

0 0.7 1.4 Kilometres
0 0.6 1.2 Miles

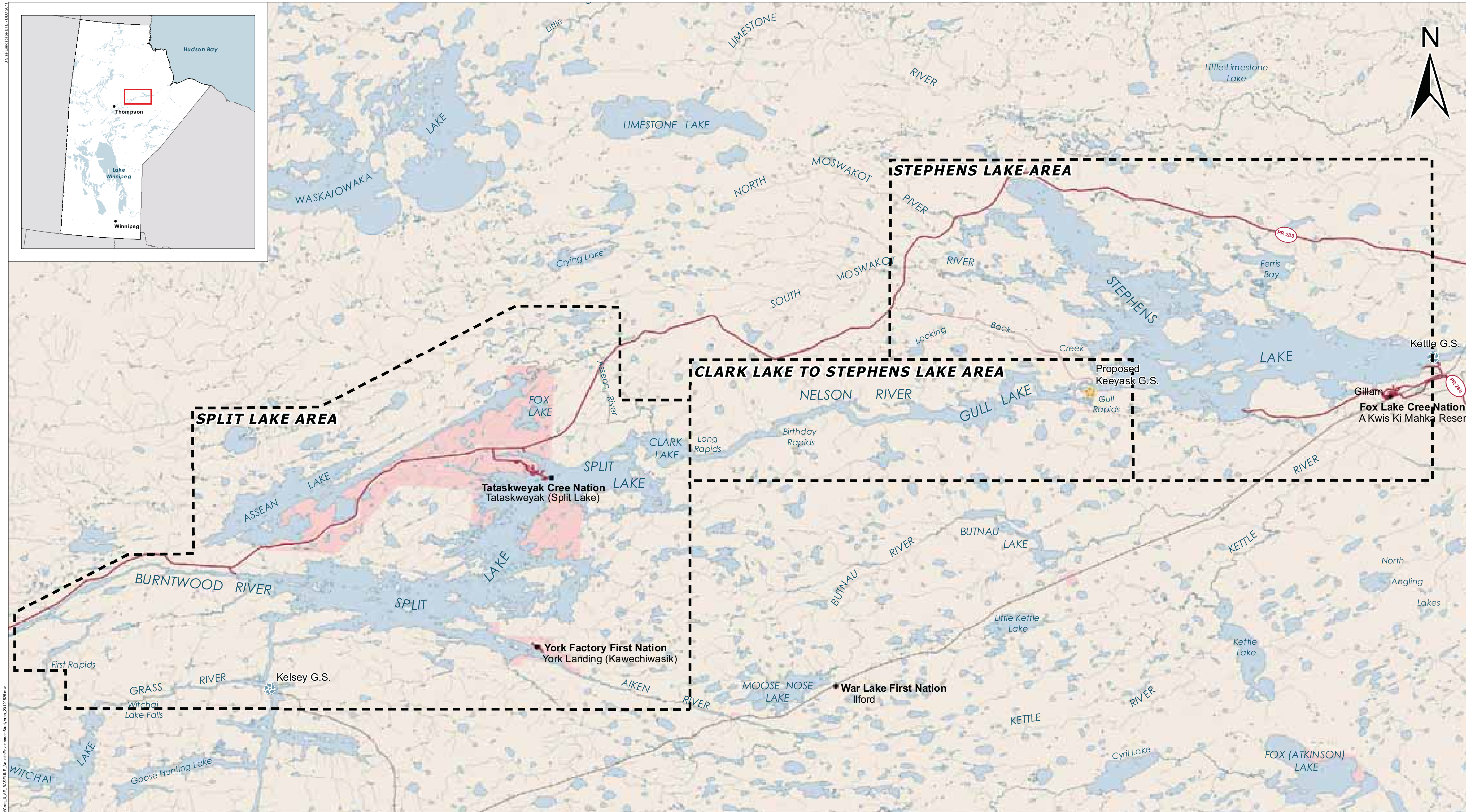
VERSION NO:	QA/QC:
1.0	APPROVED

Legend

Debris Density
1 Low
2 Medium
3 Dense

Debris Type
Beached Debris
Floating Debris
Leaning Trees
Standing Dead Trees
Submerged Debris
None
Access Road
Proposed Access Road
Keeyask Principal Structures

Shoreline Debris



DATA SOURCE:
Government of Canada, North/South Consultants

CREATED BY:
North/South Consultants

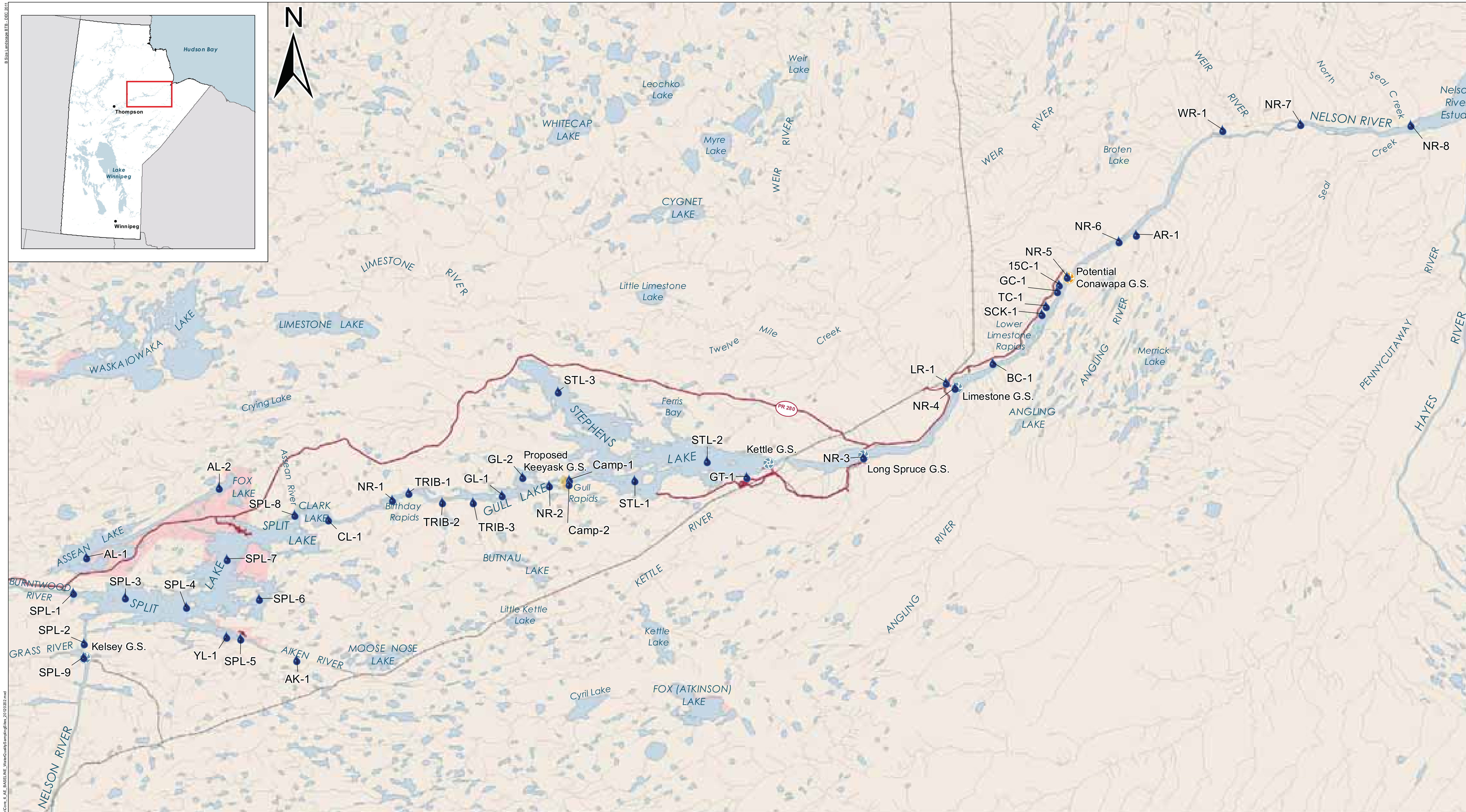
COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	26-FEB-10	25-MAY-12
0 4 8 Kilometres / 0 3.5 7 Miles	VERSION NO: 2.0	QA/QC: APPROVED

Legend

- Area Boundary
- Generating Station (Planned)
- Generating Station (Existing)
- First Nation Community
- Highway
- Access Road
- Proposed Access Road
- Rail
- First Nation Reserve
- Waterbody

KEEYASK
Hydropower Limited Partnership

Aquatic Environment Study Area



DATA SOURCE:
Government of Canada, Province of Manitoba, North/South Consultants

CREATED BY:
North/South Consultants

COORDINATE SYSTEM: UTM NAD 1983 Z15N

DATE CREATED: 05-MAY-10

REVISION DATE: 18-MAY-12

VERSION NO: 2.0

QA/QC: APPROVED

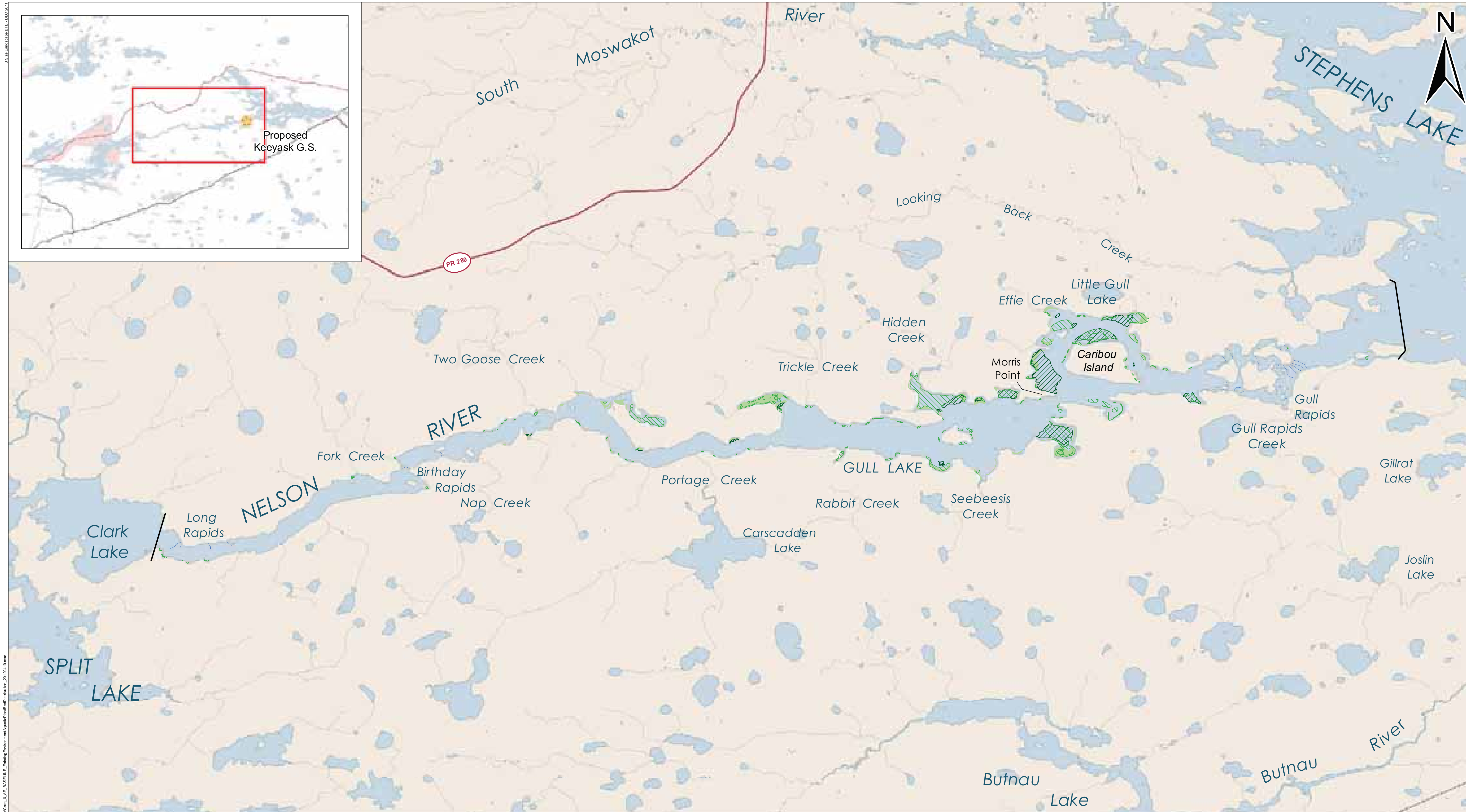
0 7 14 Kilometres
0 6 12 Miles

Legend
- Water Quality Sampling Sites
- Generating Station (Planned)
- Generating Station (Existing)
- Highway
- Rail
- First Nation Reserve
- Waterbody

KEEYASK Hydropower Limited Partnership

Water Quality Sampling Sites

Map 6-19



KEEYASK
Hydropower Limited Partnership

DATA SOURCE:
North/South Consultants, Government of Canada
Topo_50k_CanVec_Hydrography_Permanent_Seamless

CREATED BY:
North/South Consultants

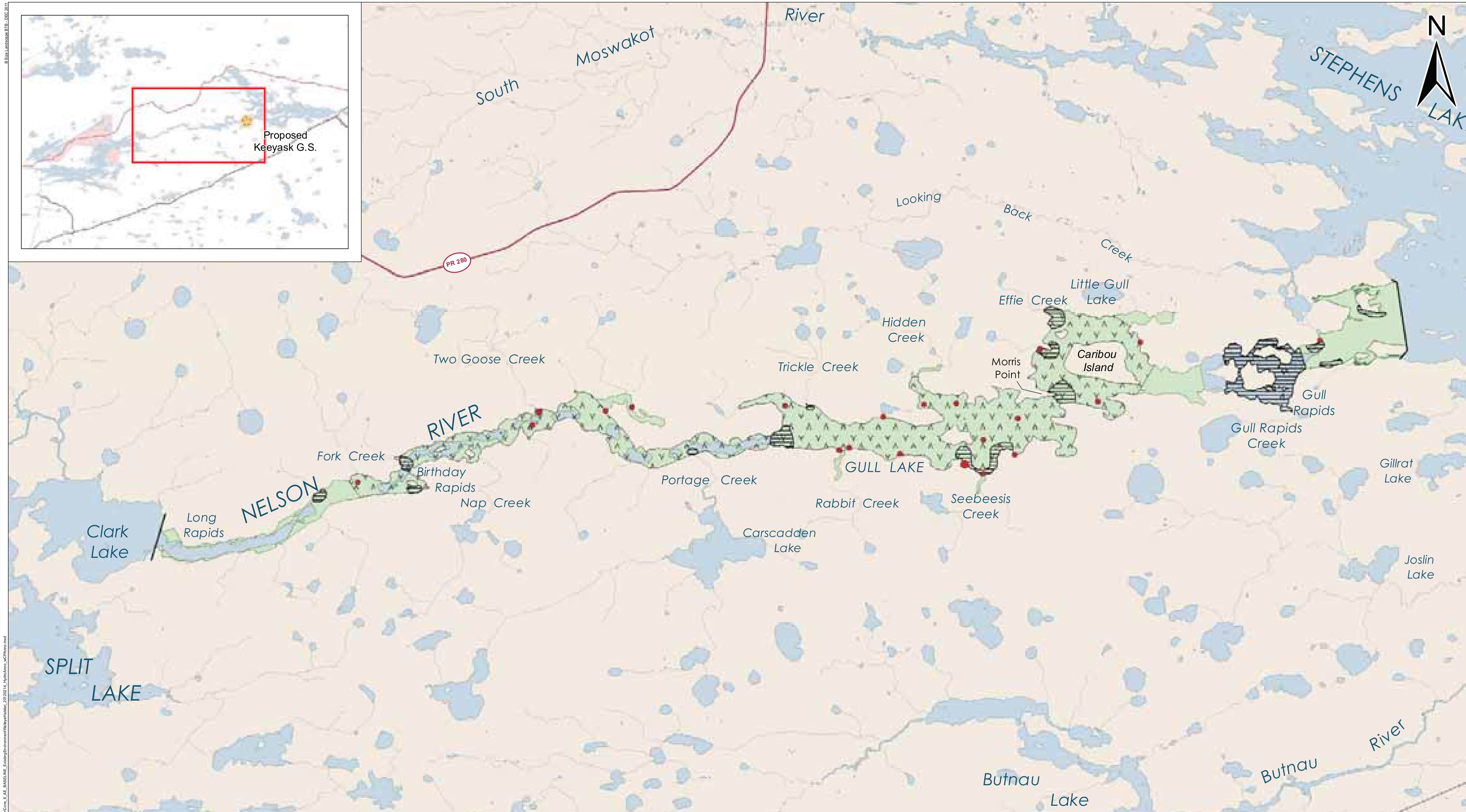
COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	26-MAR-10	28-MAY-12
0 1.5 3 Kilometres / 0 1 2 Miles	VERSION NO: 4.0	QA/QC: APPROVED

Legend

- 2001 Aquatic Plant Bed
- 2003 Aquatic Plant Bed
- 2006 Aquatic Plant Bed
- Clark Lake to Stephens Lake Area Boundary

Aquatic Plant Bed Distribution
Existing Environment

Map 6-20



KEEYASK
Hydropower Limited Partnership

DATA SOURCE:
Manitoba Hydro, North/South Consultants, Government of Canada
gull-ee-95perc-4327cms-rev3

CREATED BY:
North/South Consultants

COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	26-MAR-10	28-MAY-12
0 1.5 3 Kilometres / 0 1 2 Miles	VERSION NO: 3.0	QA/QC: APPROVED

Legend

Spawning
Overwintering
Foraging

Young-of-the-Year Captures

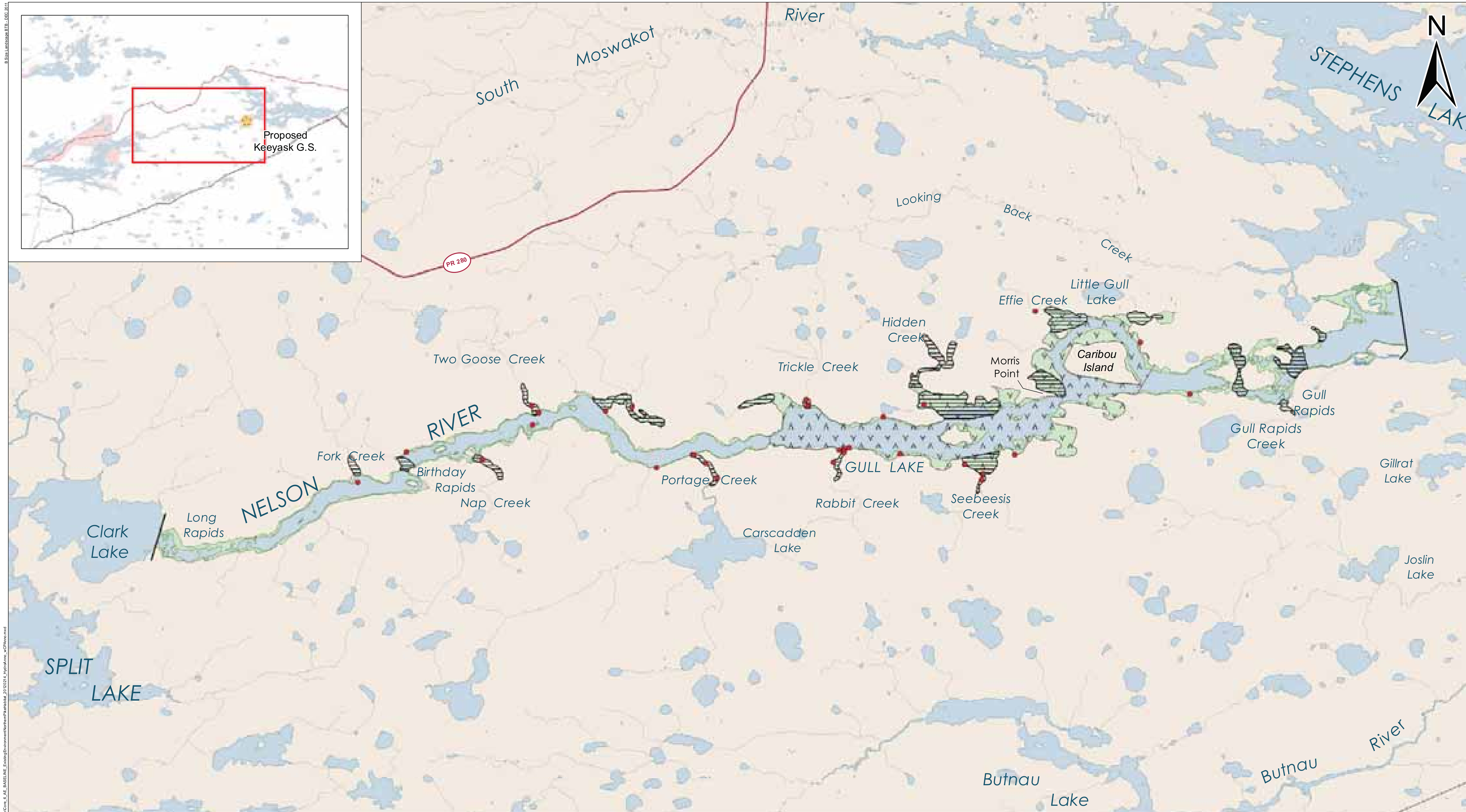
< 25
26 - 99
> 100

Clark Lake to Stephens Lake Area Boundary

Note: Shows 95th percentile inflow.

Walleye Habitat
Existing Environment

Map 6-21



KEEYASK
Hydropower Limited Partnership

DATA SOURCE:
Manitoba Hydro, North/South Consultants, Government of Canada
gull-ee-95perc-4327cms-rev3

CREATED BY:
North/South Consultants

COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	26-MAR-10	28-MAY-12
0 1.5 3 Kilometres / 0 1 2 Miles	VERSION NO: 3.0	QA/QC: APPROVED

Legend

Spawning
Overwintering
Foraging

Young-of-the-Year Captures

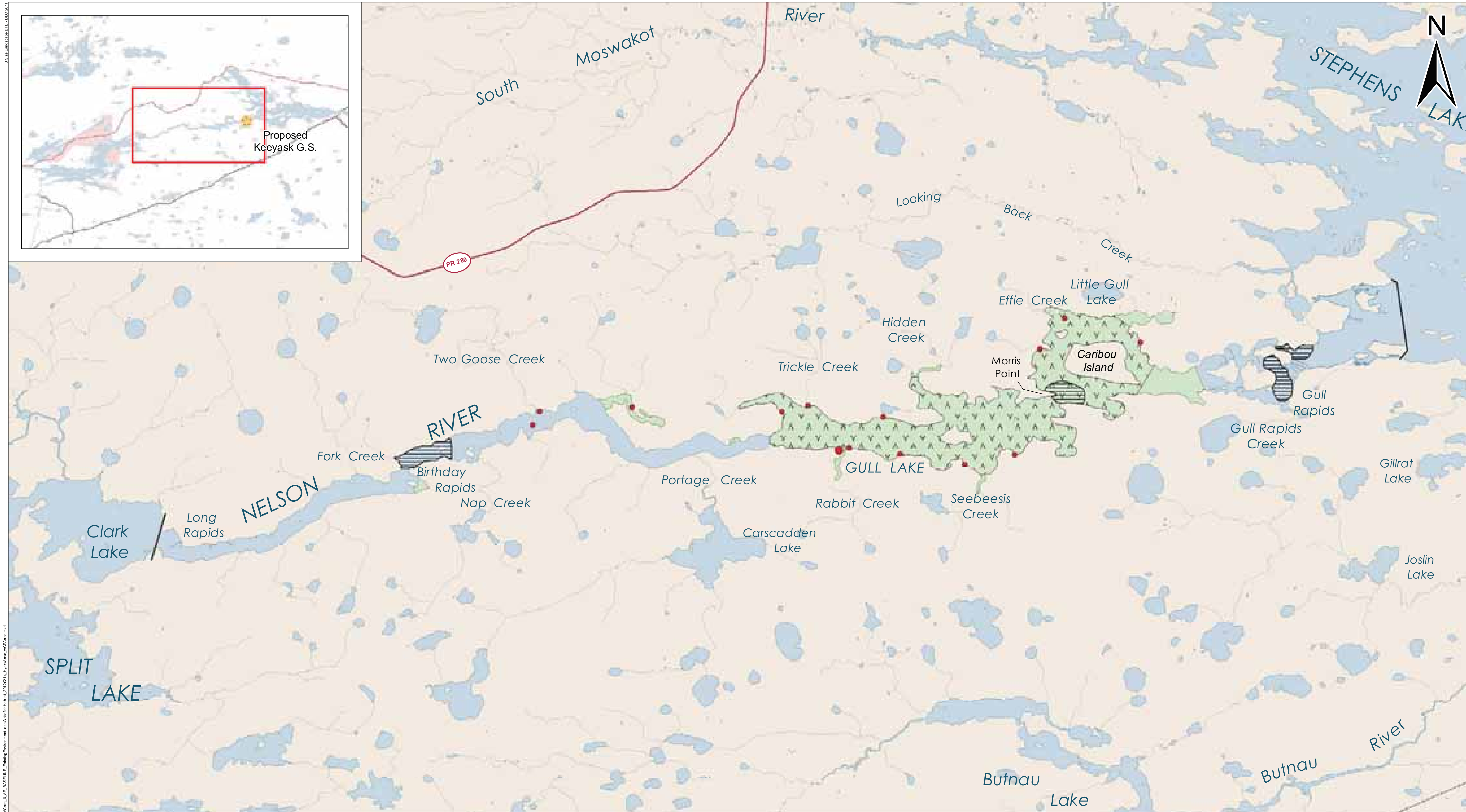
< 25
26 - 99
> 100

Clark Lake to Stephens Lake Area Boundary

Note: Shows 95th percentile inflow.

Northern Pike Habitat
Existing Environment

Map 6-22



DATA SOURCE:
Manitoba Hydro, North/South Consultants, Government of Canada
gull-ee-95perc-4327cms-rev3

CREATED BY:
North/South Consultants

COORDINATE SYSTEM:
UTM NAD 1983 Z15N

DATE CREATED:
26-MAR-10

REVISION DATE:
28-MAY-12

VERSION NO:
3.0

QA/QC:
APPROVED

0 1.5 3 Kilometres
0 1 2 Miles

KEEYASK
Hydropower Limited Partnership

Legend

Spawning
Overwintering
Foraging

Young-of-the-Year Captures

- < 25
- 26 - 99
- > 100

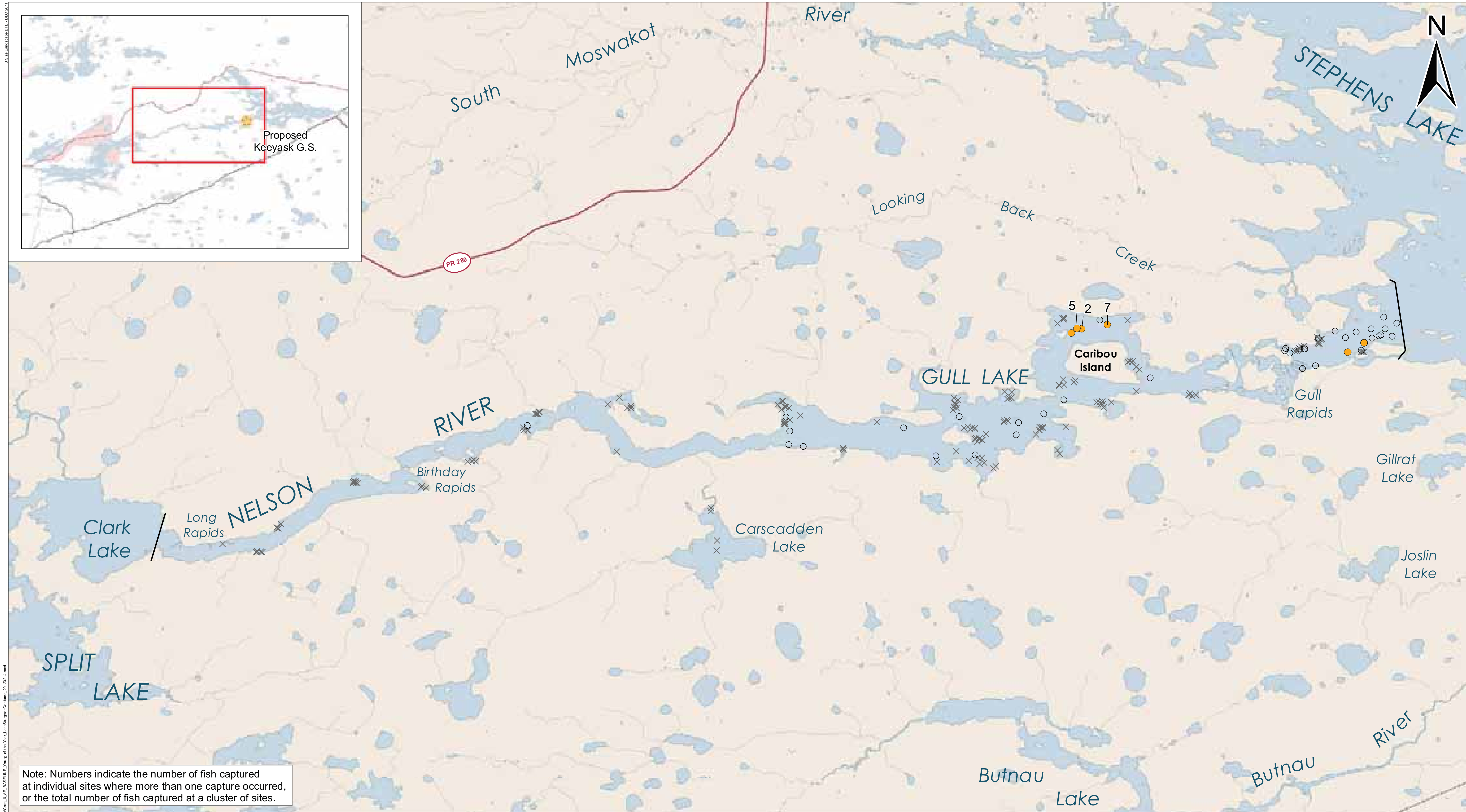
Clark Lake to Stephens Lake Area Boundary

Note: Shows 95th percentile inflow.

Lake Whitefish Habitat

Existing Environment

Map 6-23



KEEYASK
Hydropower Limited Partnership

DATA SOURCE:
North/South Consultants, Government of Canada
Topo_50k_CanVec_Hydrography_Permanent_Seamless

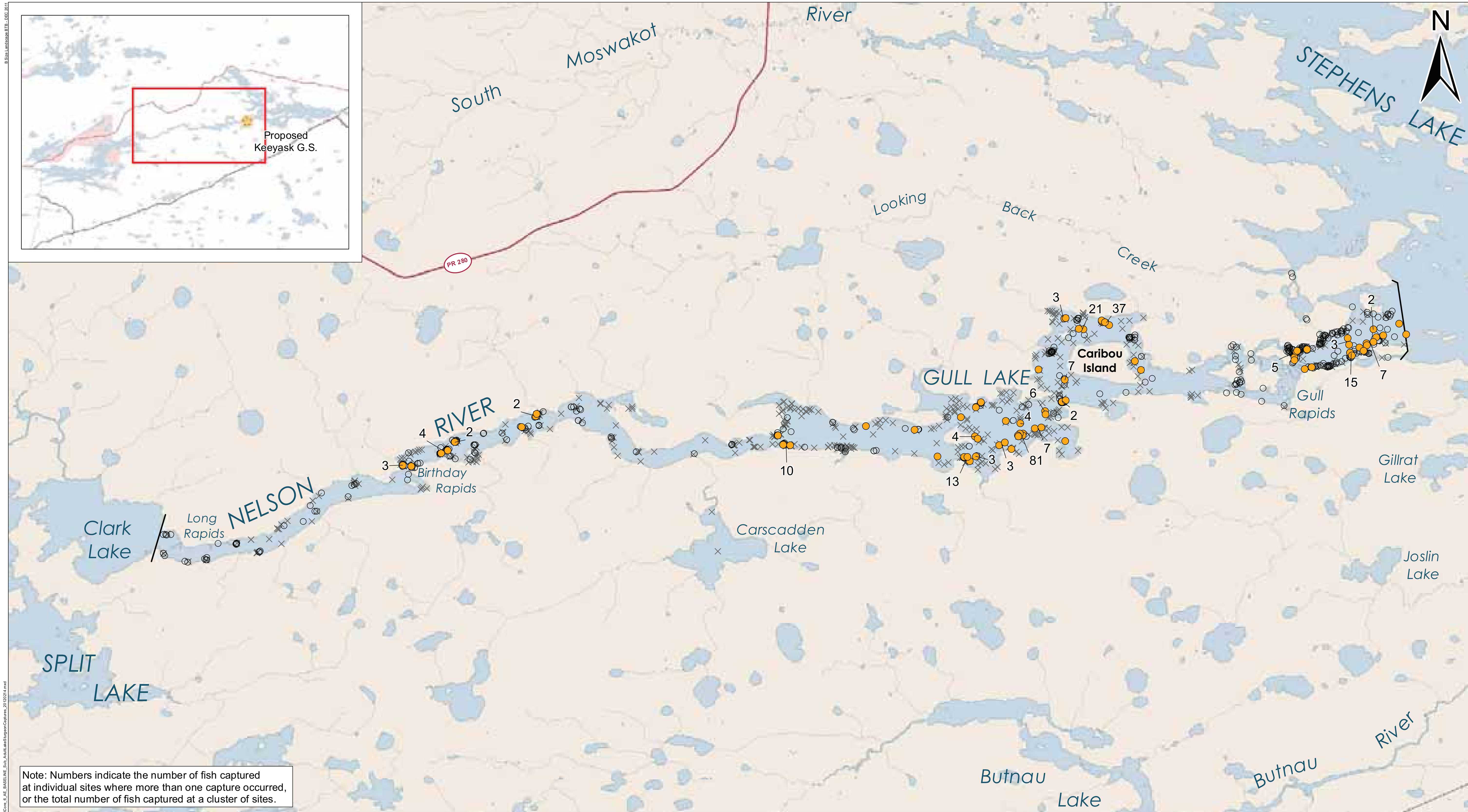
CREATED BY:
North/South Consultants

COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	26-MAR-10	28-MAY-12
0 1.5 3 Kilometres / 0 1 2 Miles	VERSION NO: 3.0	QA/QC: APPROVED

Legend
- Young-of-the-Year Lake Sturgeon Gillnet Captures
- Lake Sturgeon Gillnet Sites
- Index Gillnet Sites
- Clark Lake to Stephens Lake Area Boundary

Young-of-the-Year Lake Sturgeon Captures

Map 6-24



Note: Numbers indicate the number of fish captured at individual sites where more than one capture occurred, or the total number of fish captured at a cluster of sites.

KEEYASK Hydropower Limited Partnership

DATA SOURCE:
North/South Consultants, Government of Canada
Topo_50k_CanVec_Hydrography_Permanent_Seamless

CREATED BY:
North/South Consultants

COORDINATE SYSTEM: UTM NAD 1983 Z15N

DATE CREATED: 26-MAR-10

REVISION DATE: 28-MAY-12

0 1.5 3 Kilometres
0 1 2 Miles

VERSION NO: 3.0

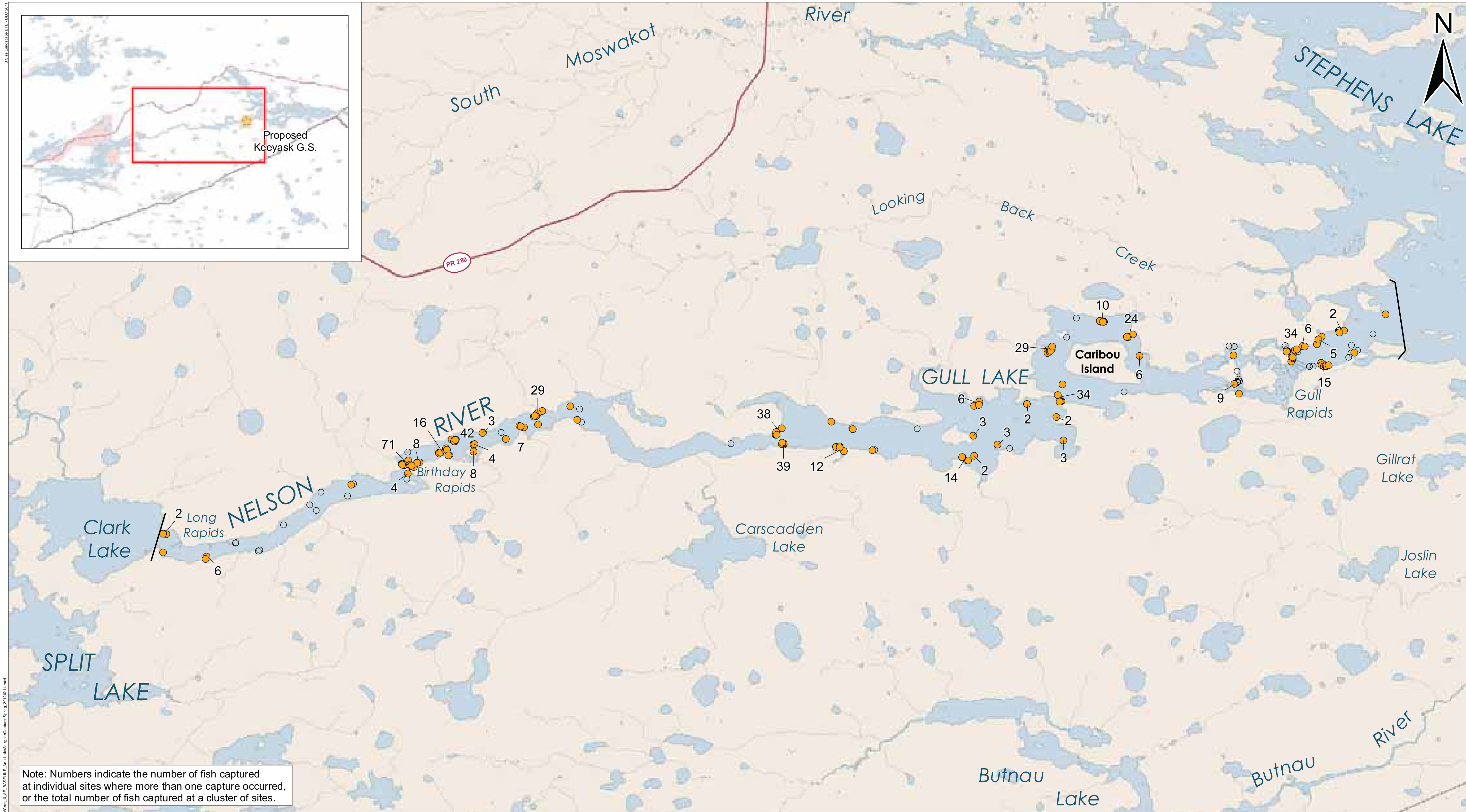
QA/QC: APPROVED

Legend

- Sub-Adult Lake Sturgeon Gillnet Captures
- Lake Sturgeon Gillnet Sites
- Index or Tagging Gillnet Sites
- Clark Lake to Stephens Lake Area Boundary

Sub-Adult Lake Sturgeon Captures

Map 6-25



Note: Numbers indicate the number of fish captured
at individual sites where more than one capture occurred,
or the total number of fish captured at a cluster of sites.

KEEYASK
Hydropower Limited Partnership

DATA SOURCE:
North/South Consultants, Government of Canada
Topo_50k_CanVec_Hydrography_Permanent_Seamless

CREATED BY:
North/South Consultants

COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	26-MAR-10	28-MAY-12

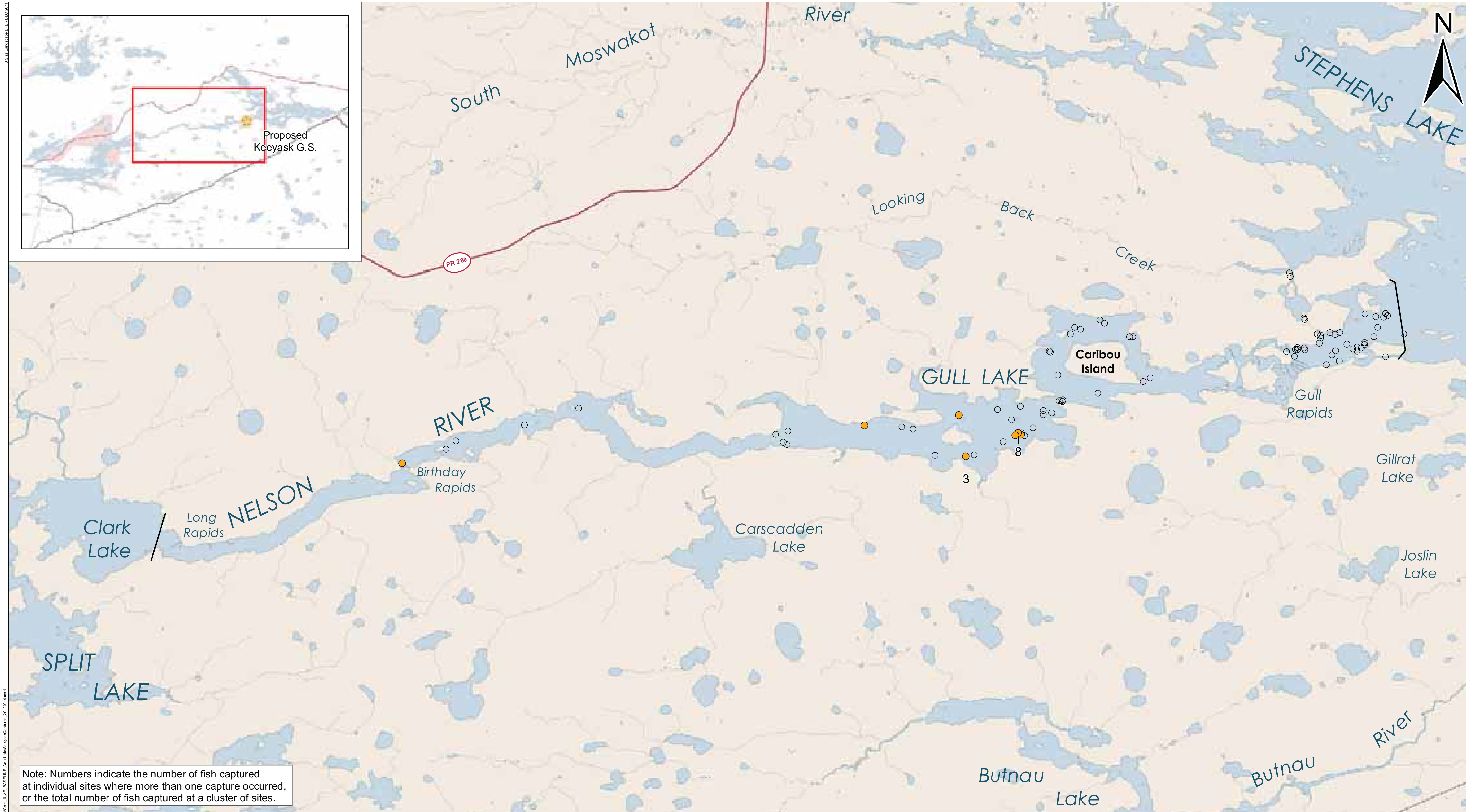
0 1.5 3 Kilometres
0 1 2 Miles

VERSION NO:	QA/QC:
3.0	APPROVED

Legend

- Adult Lake Sturgeon Gillnet Captures
- Lake Sturgeon Gillnet Sites
- Clark Lake to Stephens Lake Area Boundary

Adult
Lake Sturgeon Captures
Spring



Note: Numbers indicate the number of fish captured at individual sites where more than one capture occurred, or the total number of fish captured at a cluster of sites.

KEEYASK
Hydropower Limited Partnership

DATA SOURCE:
North/South Consultants, Government of Canada
Topo_50k_CanVec_Hydrography_Permanent_Seamless

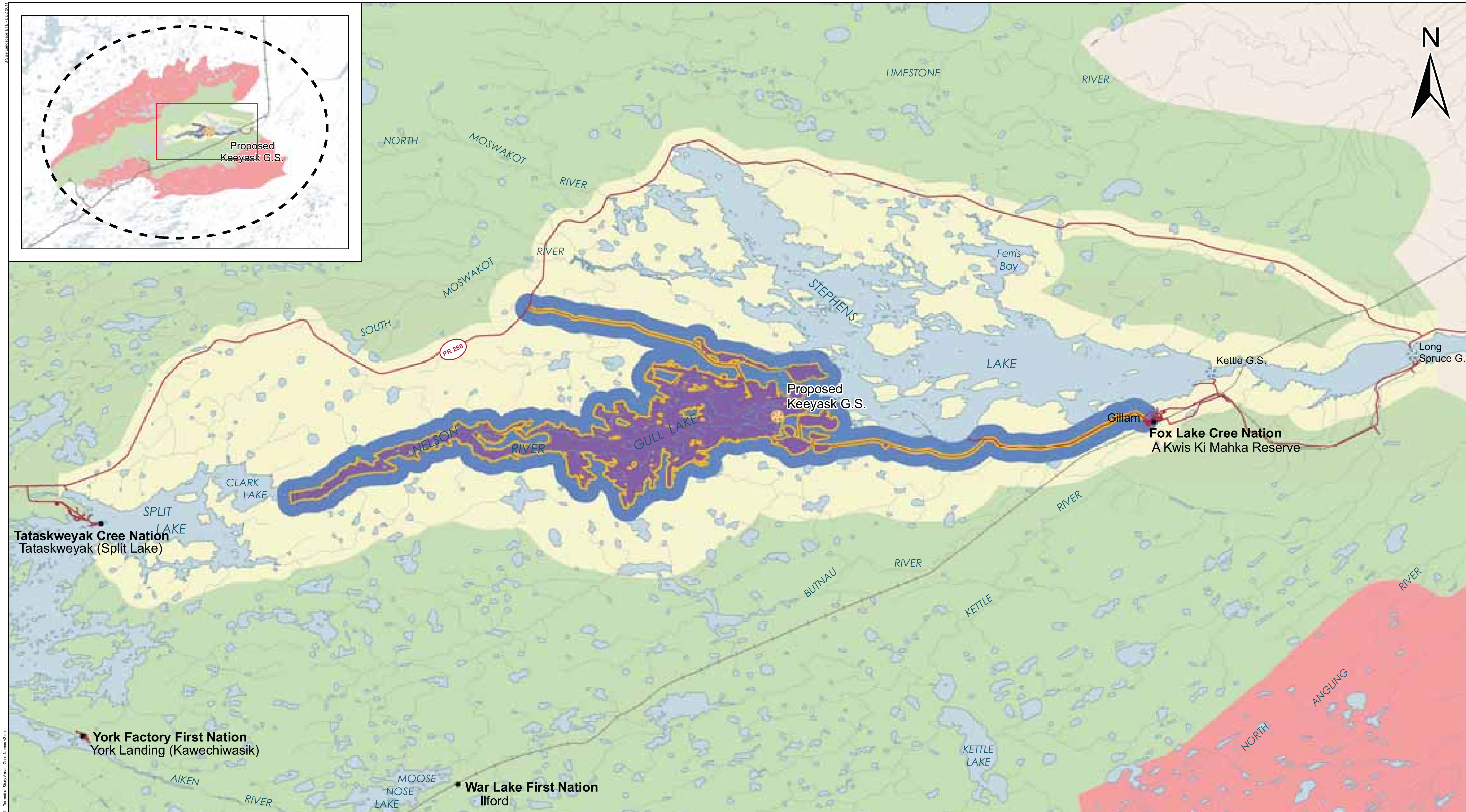
CREATED BY:
North/South Consultants

COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	26-MAR-10	28-MAY-12
0 1.5 3 Kilometres / 0 1 2 Miles	VERSION NO: 3.0	QA/QC: APPROVED

Legend

- Adult Lake Sturgeon Gillnet Captures
- Lake Sturgeon Gillnet Sites
- Clark Lake to Stephens Lake Area Boundary

Adult Lake Sturgeon Captures
Summer/Fall



KEEYASK
Hydropower Limited Partnership

DATA SOURCE:
Study areas - ECOSTEM Ltd.; Water - NTS; Roads and rail - Manitoba Conservation.

CREATED BY:
ECOSTEM Ltd.

COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	13-MAR-12	18-MAY-12

	VERSION NO:	QA/QC:
0 2.5 5 Kilometres; 0 3 6 Miles	1.0	APPROVED

Legend

Geographic Zones

- Study Zone 1 (Project Footprint for Both Phases)
- Study Zone 2
- Study Zone 3
- Study Zone 4
- Study Zone 5
- Study Zone 6

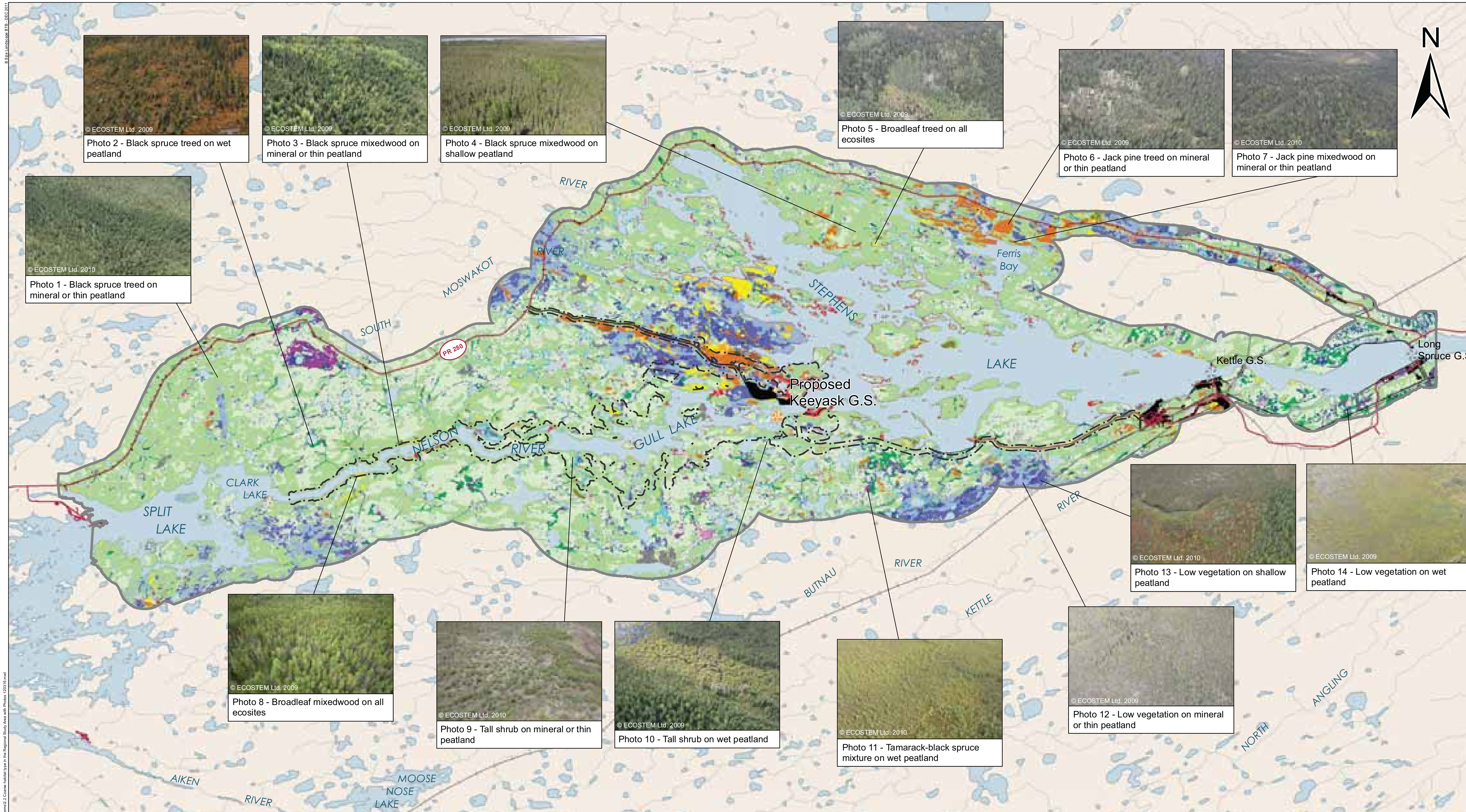
Project Areas

- Keeyask Generation Project Area

Note: Each zone includes all of the smaller zones within its perimeter

Geographic Zones Used for Terrestrial Study Areas

Map 6-28



KEEYASK
Hydropower Limited Partnership

DATA SOURCE:
Study areas, habitat data and Nelson River shoreline - ECOSTEM Ltd.; Water - NTS; Roads and rail - Manitoba Conservation.

CREATED BY:
ECOSTEM Ltd.

COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	20-MAR-12	18-MAY-12

0 2.5 5 Kilometres
0 3 6 Miles

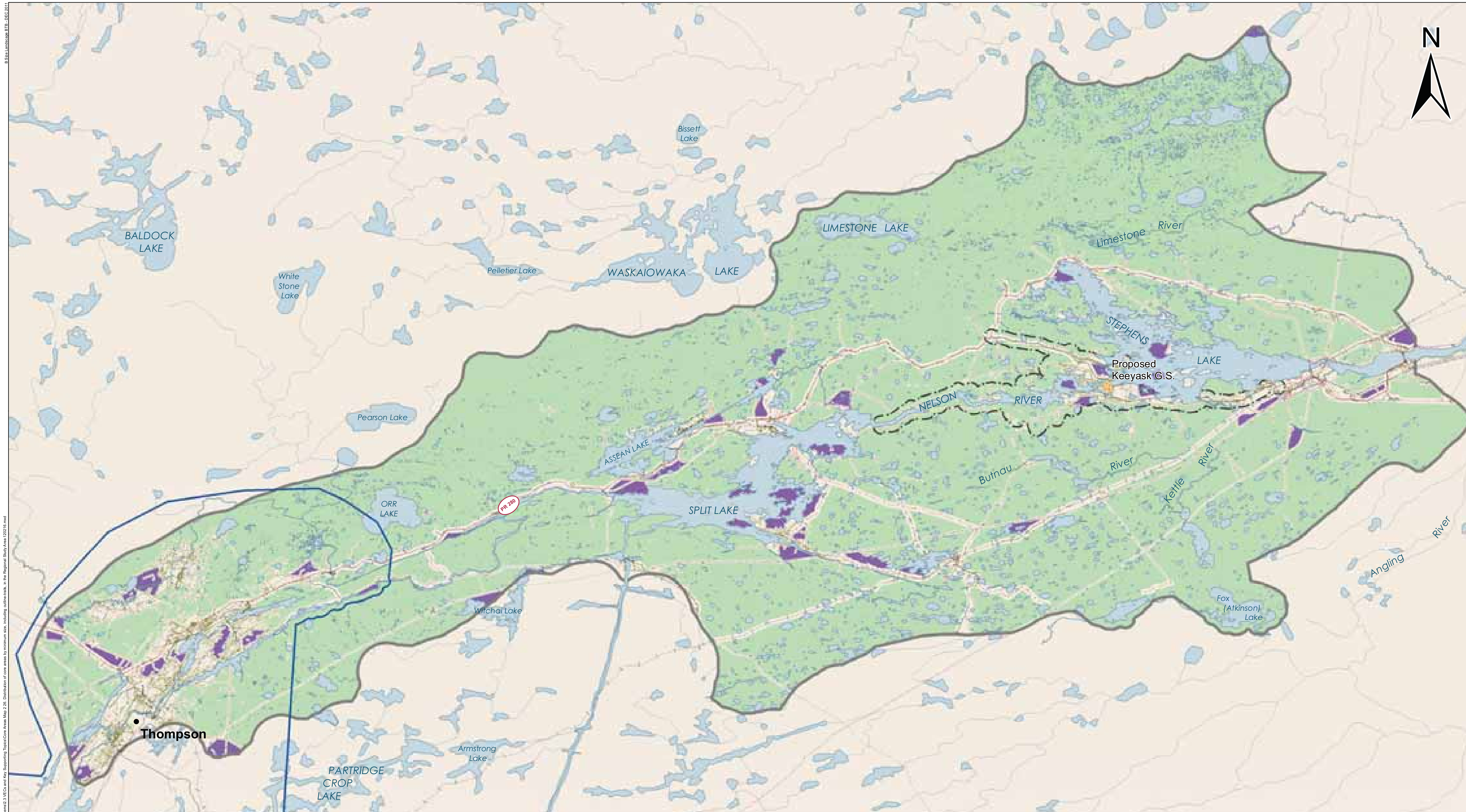
VERSION NO:	QA/QC:
1.0	APPROVED

Legend

- Broadleaf Treed on All Ecosites
- Broadleaf Mixedwood on All Ecosites
- Black Spruce Treed on Mineral or Thin Peatland
- Black Spruce Treed on Shallow Peatland
- Black Spruce Treed on Wet Peatland
- Black Spruce Treed on Riparian Peatland
- Black Spruce Mixedwood on Mineral or Thin Peatland
- Black Spruce Mixedwood on Shallow Peatland
- Jack Pine Treed on Mineral or Thin Peatland
- Jack Pine Treed on Shallow Peatland
- Jack Pine Mixedwood on Mineral or Thin Peatland
- Low Vegetation on Mineral or Thin Peatland
- Low Vegetation on Shallow Peatland
- Low Vegetation on Wet Peatland
- Marsh
- Shrub /Low Vegetation on Ice Scour -Mineral
- Shrub /Low Vegetation on Riparian Peatland
- Tall Shrub on Mineral or Thin Peatland
- Tall Shrub on Shallow Peatland
- Tall Shrub on Wet Peatland
- Tamarack Treed on Shallow Peatland
- Tamarack Treed on Wet Peatland
- Tamarack Treed on Riparian Peatland
- Tamarack-Black Spruce Mixture on Wet Peatland
- Tamarack-Black Spruce Mixture on Riparian Peatland
- Unclassified Burn
- Water
- Permanent Human Footprint
- Habitat Local Study Area
- Study Zone 4

Coarse Habitat
In Study Zone 4

Map 6-29



KEEYASK Hydropower Limited Partnership

DATA SOURCE:
Core areas, linear features and Nelson River shoreline - ECOSTEM Ltd.; Roads - Manitoba Conservation; Transmission lines - Manitoba Hydro; Water and rail - NTS.

CREATED BY:
ECOSTEM Ltd.

COORDINATE SYSTEM:
UTM NAD 1983 Z15N

DATE CREATED:
13-MAR-12

REVISION DATE:
04-APR-12

0 5 10 Kilometres
0 4 8 Miles

VERSION NO:
1.0

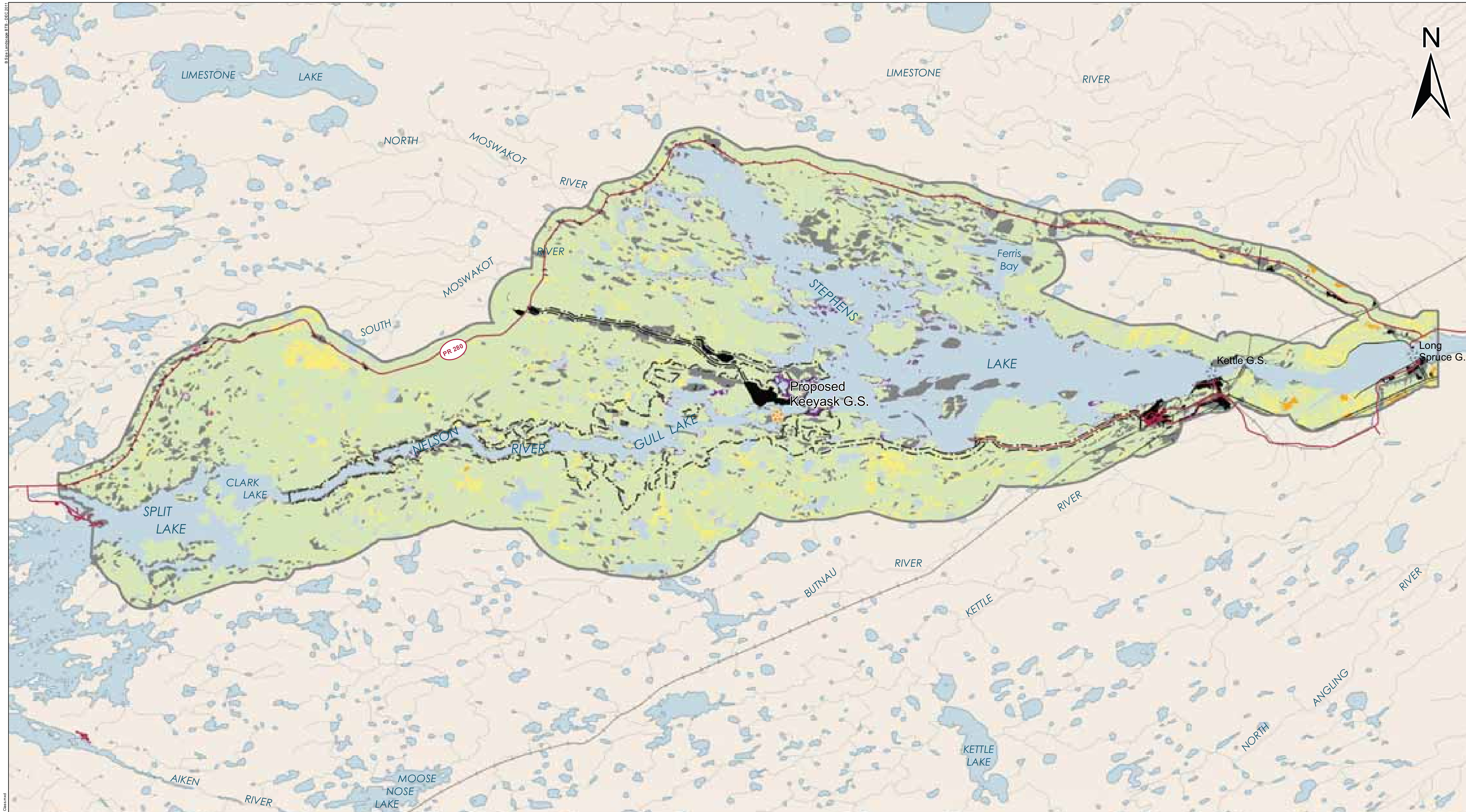
QA/QC:
APPROVED

Legend

Core Areas and Linear Features

- 1,000 ha minimum size
- Additional core area when minimum size reduced to 200 ha
- Highway
- Road
- Winter Road
- Rail Line
- Transmission Line
- Dyke
- Cutline
- Ditch
- Path
- Intactness Local Study Area
- Intactness Regional Study Area
- Thompson Area

Linear Features and Core Areas



KEEYASK
Hydropower Limited Partnership

DATA SOURCE:
Study areas, wetland class data and Nelson River shoreline - ECOSTEM Ltd.; Water - NTS; Roads and rail - Manitoba Conservation.

CREATED BY:
ECOSTEM Ltd.

COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	08-MAY-12	18-MAY-12

	VERSION NO:	QA/QC:
0 2 4 Kilometres / 0 3 6 Miles	1.0	APPROVED

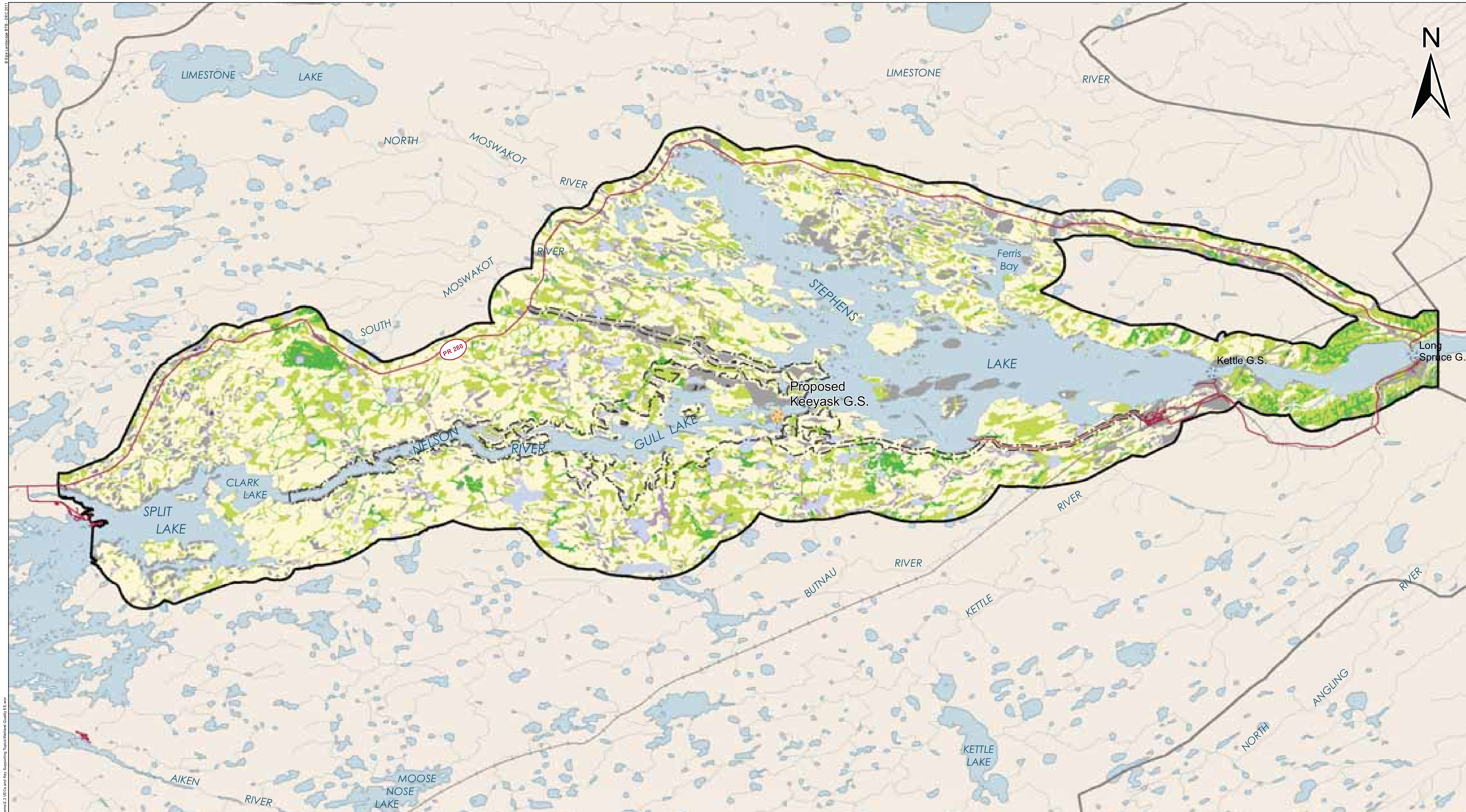
Legend

Wetland Class
- Fen
- Swamp
- Bog
- Fen / Bog Mixture
- Marsh - Nelson River
- Marsh - Off System
- Shallow Water

Other Terrestrial Areas
- Uplands
- Human

Study Areas
- Wetland Function Local Study Area
- Study Zone 4

Wetland Class



KEEYASK
Hydropower Limited Partnership

DATA SOURCE:
Study areas, wetland quality data and Nelson River shoreline - ECOSTEM Ltd.; Water - NTS; Roads and rail - Manitoba Conservation.

CREATED BY:
ECOSTEM Ltd.

COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	25-MAY-12	25-MAY-12

0 2.5 5 Kilometres
0 3 6 Miles

VERSION NO:	QA/QC:
1.0	APPROVED

Legend

Wetland Quality Score

- 60 - 69
- 50 - 59
- 40 - 49
- 30 - 39
- 20 - 29
- 10 - 19
- Uplands / Human Infrastructure

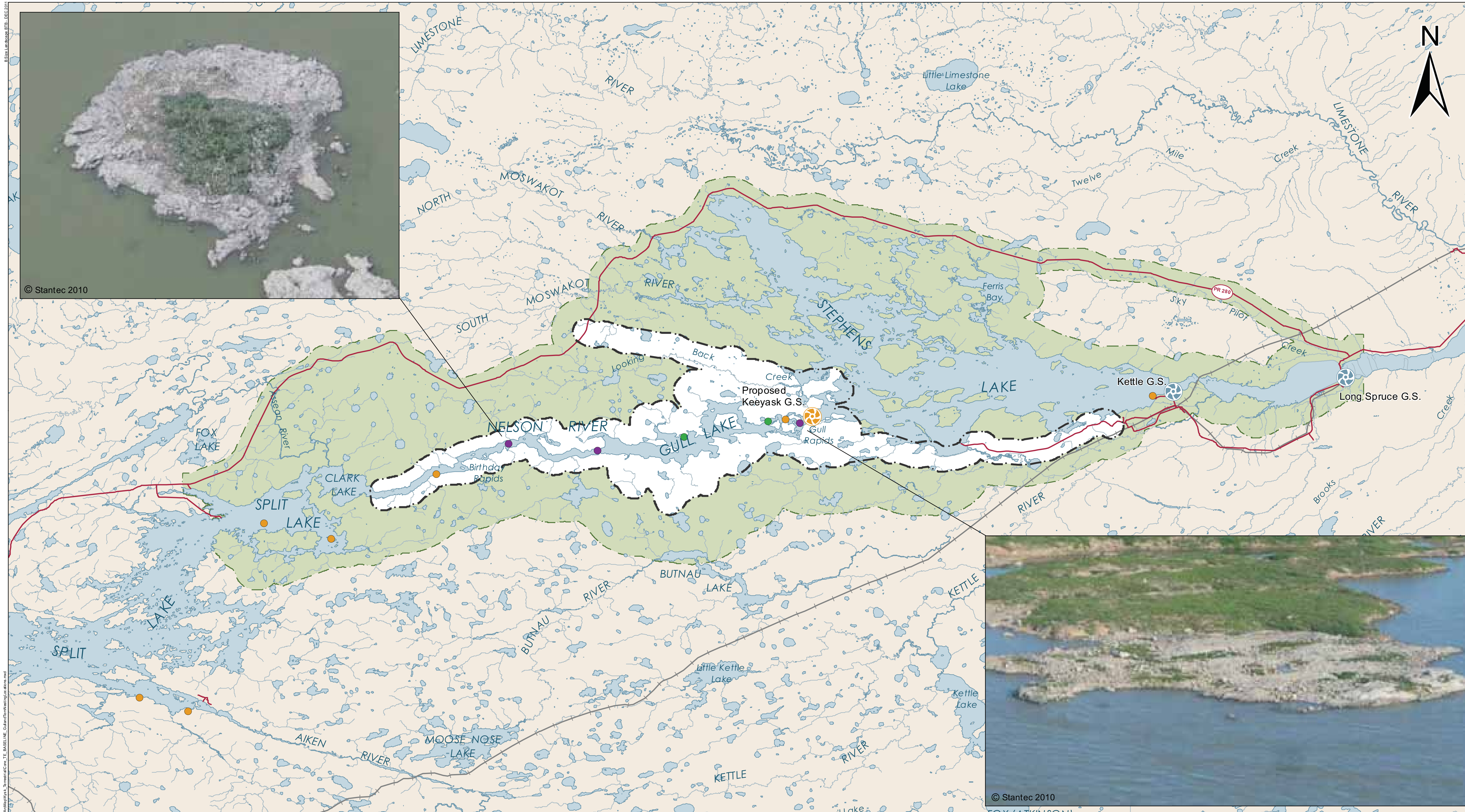
Study Areas

- Wetland Function Local Study Area
- Study Zone 4
- Wetland Function Regional Study Area

Note: Shallow water wetland class not assigned a wetland quality score for this map

Wetland Quality
in Study Zone 4

Map 6-32



KEEYASK
Hydropower Limited Partnership

DATA SOURCE:
Government of Manitoba, Manitoba Hydro, Stantec Consultants, NTS, Natural Resources Canada, Ecostem Ltd.

CREATED BY:
Stantec Consulting Ltd.

COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	11-OCT-11	18-MAY-12
0 4 8 Kilometres / 0 3.5 7 Miles	VERSION NO: 1.0	QA/QC: APPROVED

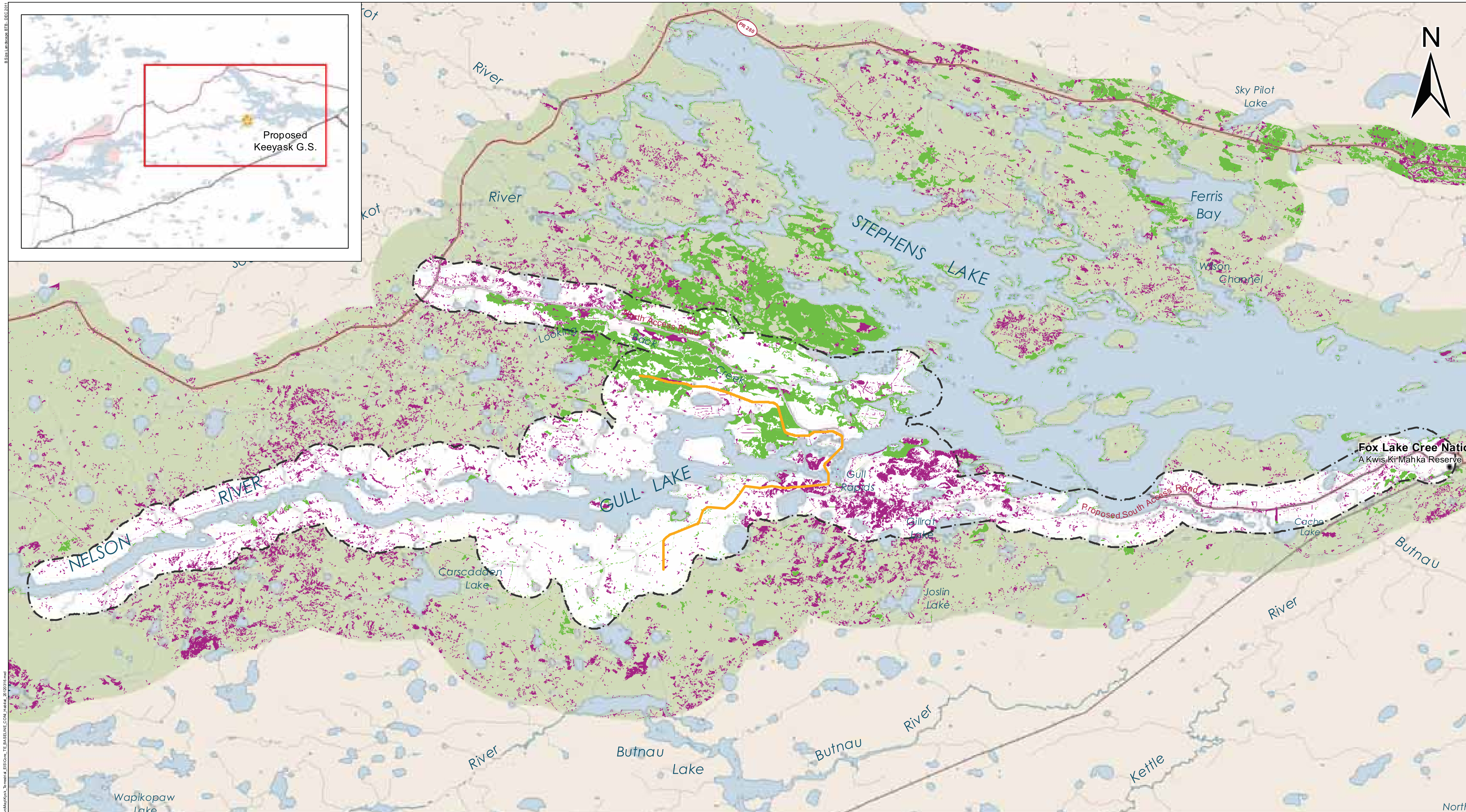
Legend

Gull and/or Tern Nesting Locations
- Gulls
- Gulls and / or Terns
- Terns

- Bird Local Study Area
- Bird Regional Study Area
- Generating Station (Planned)
- Generating Station (Existing)

Gull and Tern Nesting Locations

Map 6-33



DATA SOURCE:
Government of Manitoba, Manitoba Hydro, Stantec Consultants, NTS, Natural Resources Canada, Ecostem Ltd.

CREATED BY:
Stantec Consulting Ltd.

COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	16-MAR-12	05-APR-12

0 2 4 Kilometres
0 1.5 3 Miles

VERSION NO:	QA/QC:
1.0	APPROVED

KEEYASK
Hydropower Limited Partnership

Legend

Common Nighthawk Habitat

- Primary Habitat
- Secondary Habitat
- Bird Local Study Area
- Bird Regional Study Area
- Proposed Access Road
- Access Road
- Keeyask Principal Structures

Common Nighthawk Breeding Habitat

KEEYASK
Hydropower Limited Partnership

DATA SOURCE:
Government of Manitoba, Manitoba Hydro, Stantec Consultants, NTS, Natural Resources Canada, Ecostem Ltd.

CREATED BY:
Stantec Consulting Ltd.

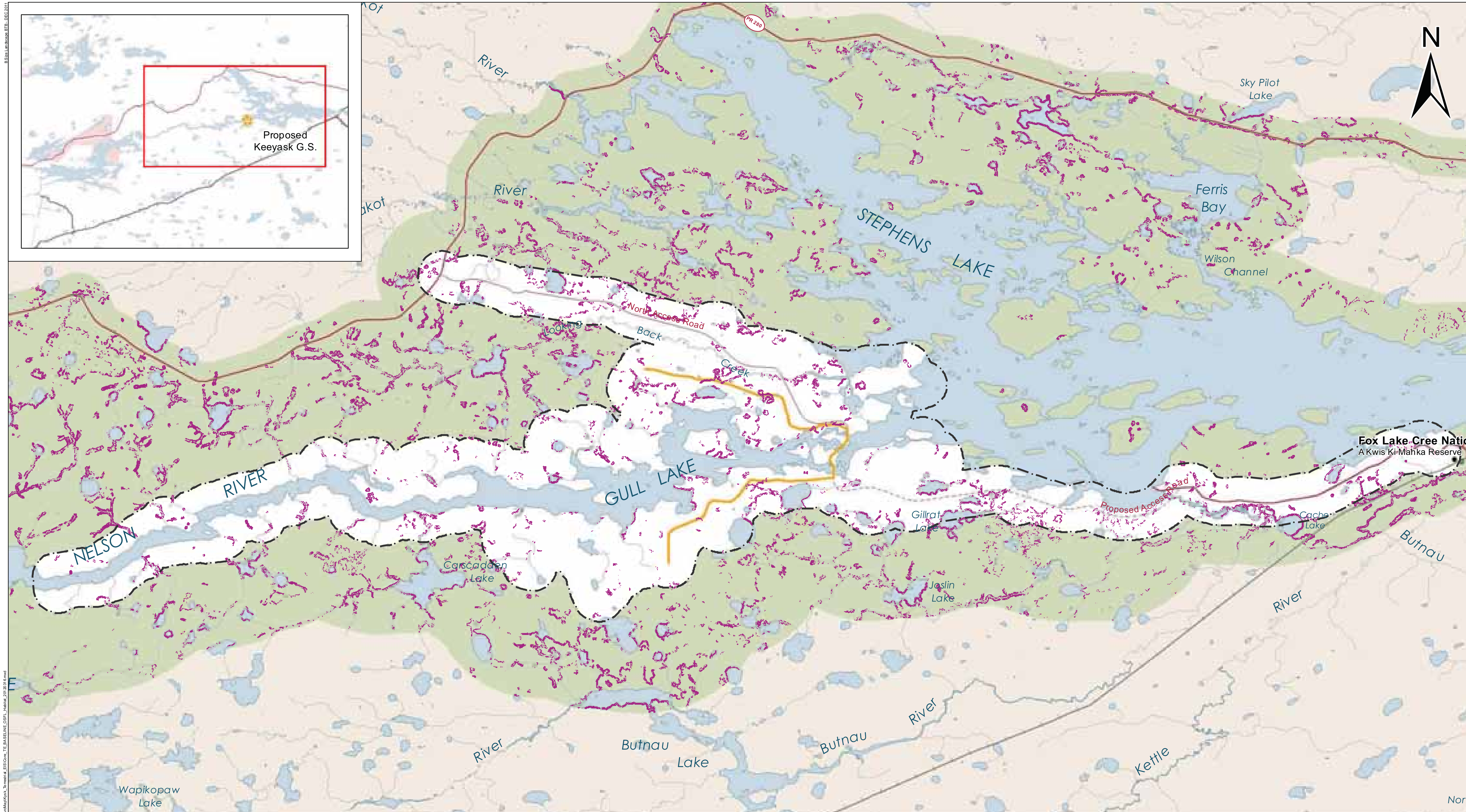
COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	11-OCT-11	18-MAY-12
0 5 10 Kilometres / 0 3.5 7 Miles	VERSION NO: 1.0	QA/QC: APPROVED

Legend

- Bald Eagle Nest Location
- Bird Local Study Area
- Bald Eagle Regional Study Area
- Generating Station (Planned)
- Generating Station (Existing)

Bald Eagle Nest Locations

Map 6-35



KEEYASK
Hydropower Limited Partnership

DATA SOURCE:
Government of Manitoba, Manitoba Hydro, Stantec Consultants, NTS, Natural Resources Canada, Ecostem Ltd.

CREATED BY:
Stantec Consulting Ltd.

COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	16-MAR-12	24-MAY-12
0 2 4 Kilometres / 0 1.5 3 Miles	VERSION NO: 1.0	QA/QC: APPROVED

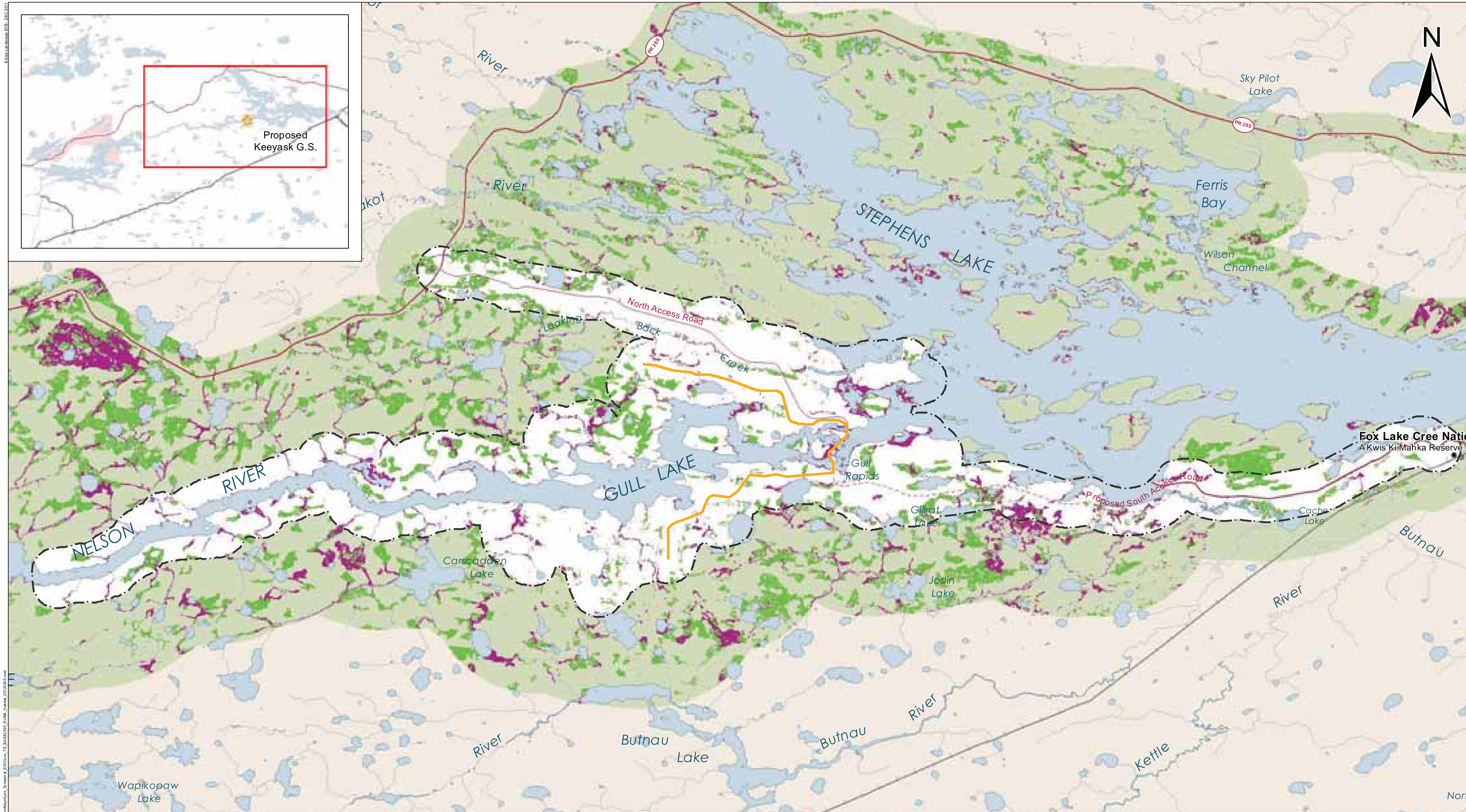
Legend

Olive-sided Flycatcher Habitat

- Primary Habitat
- Secondary Habitat (DN: in development)
- Bird Local Study Area
- Bird Regional Study Area
- Proposed Access Road
- Access Road
- Keeyask Principal Structures

Olive-sided Flycatcher Breeding Habitat

Map 6-36



DATA SOURCE:
Government of Manitoba, Manitoba Hydro, Stantec Consultants, NTS, Natural Resources Canada, Ecostem Ltd.

CREATED BY:
Stantec Consulting Ltd.

COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	16-MAR-12	05-APR-12
0 2 4 Kilometres / 0 1.5 3 Miles	VERSION NO: 1.0	QA/QC: APPROVED

Legend

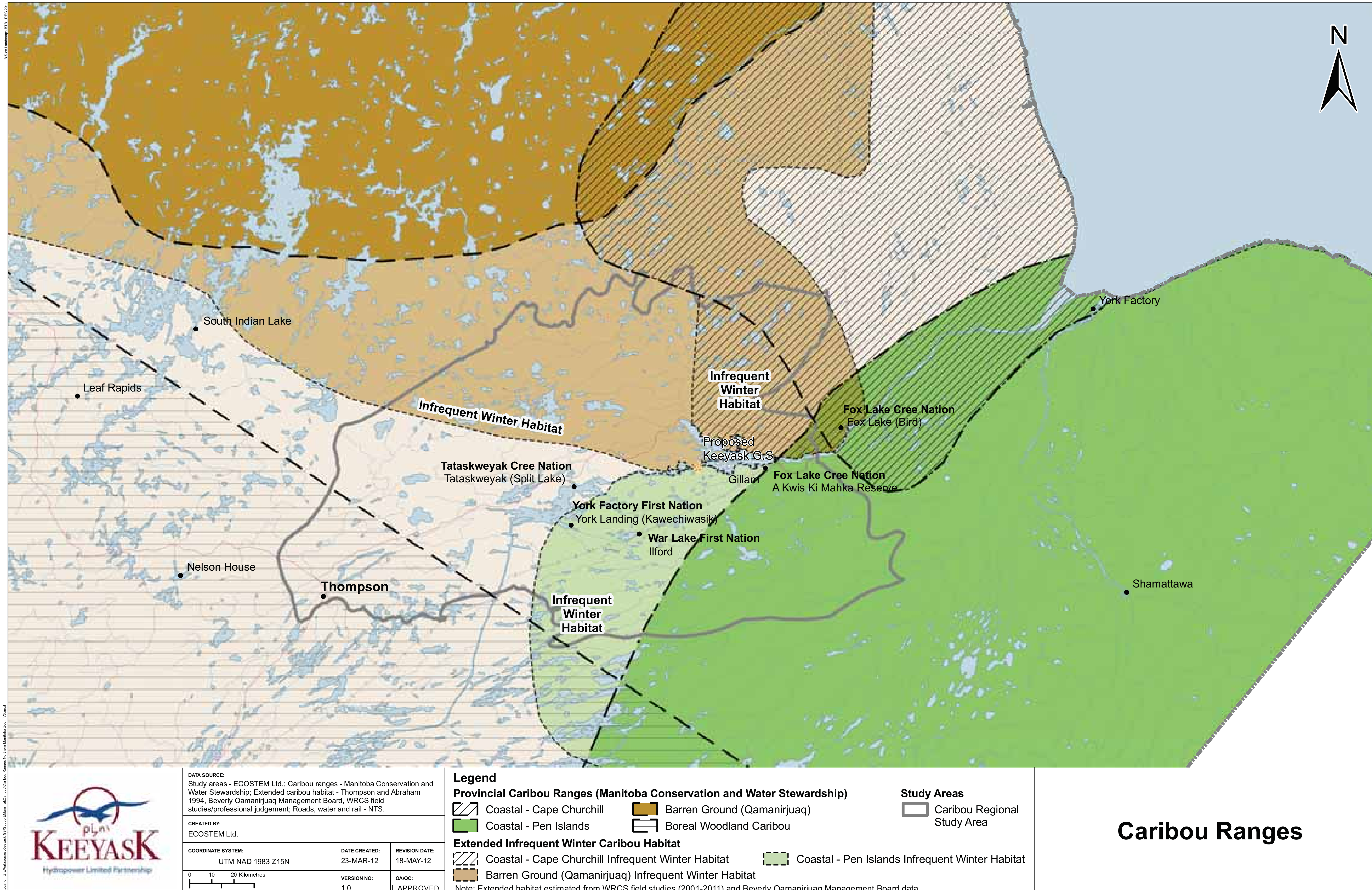
Rusty Blackbird Habitat

- Primary Habitat
- Secondary Habitat
- Bird Local Study Area
- Bird Regional Study Area
- Proposed Access Road
- Access Road
- Keeyask Principal Structures

KEEYASK
Hydropower Limited Partnership

Rusty Blackbird Breeding Habitat

Map 6-37



KEEYASK
Hydropower Limited Partnership

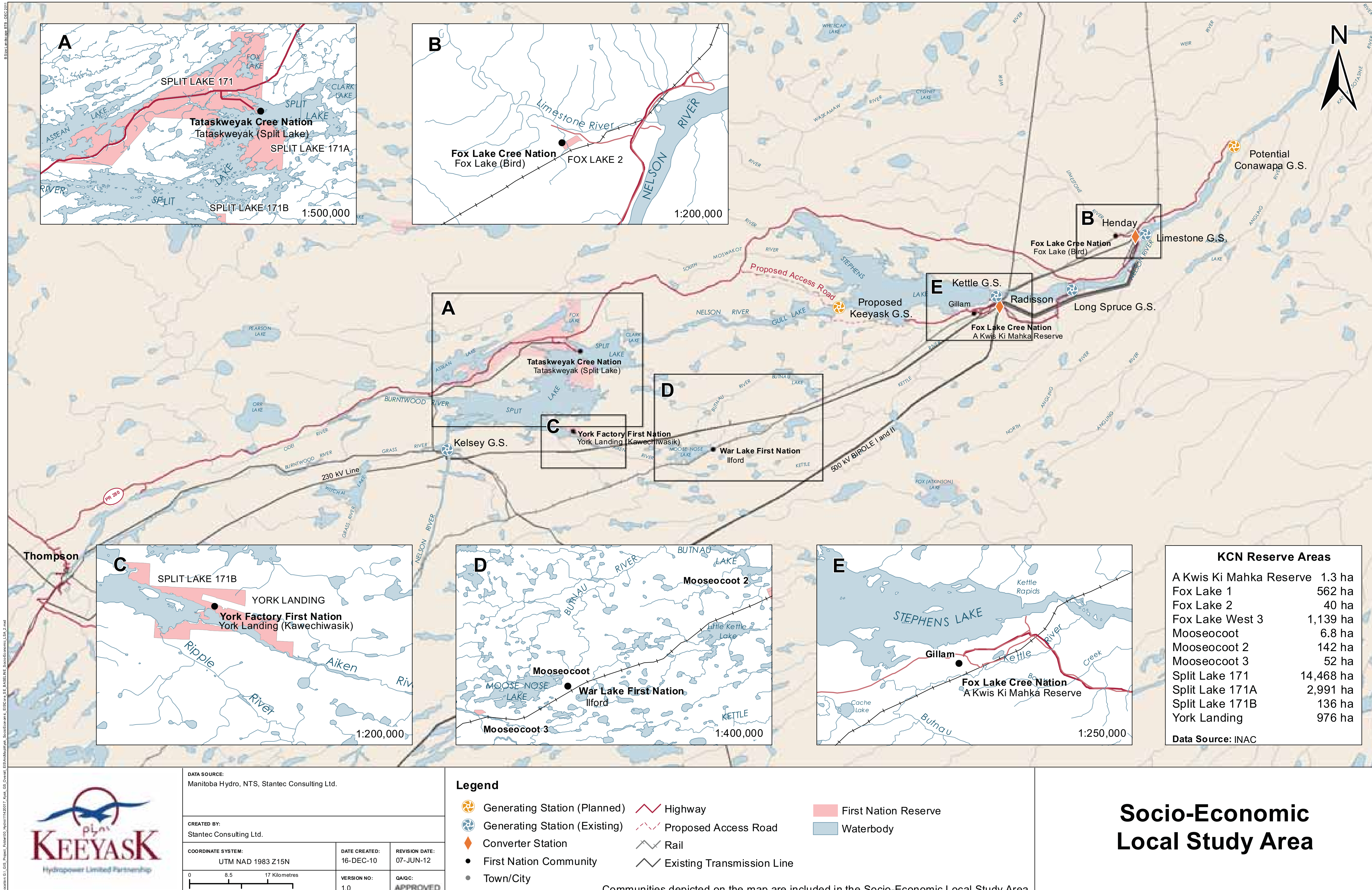
DATA SOURCE:
Study areas - ECOSTEM Ltd.; Caribou ranges - Manitoba Conservation and Water Stewardship; Extended caribou habitat - Thompson and Abraham 1994, Beverly Qamanirjuaq Management Board, WRCS field studies/professional judgement; Roads, water and rail - NTS.

CREATED BY:
ECOSTEM Ltd.

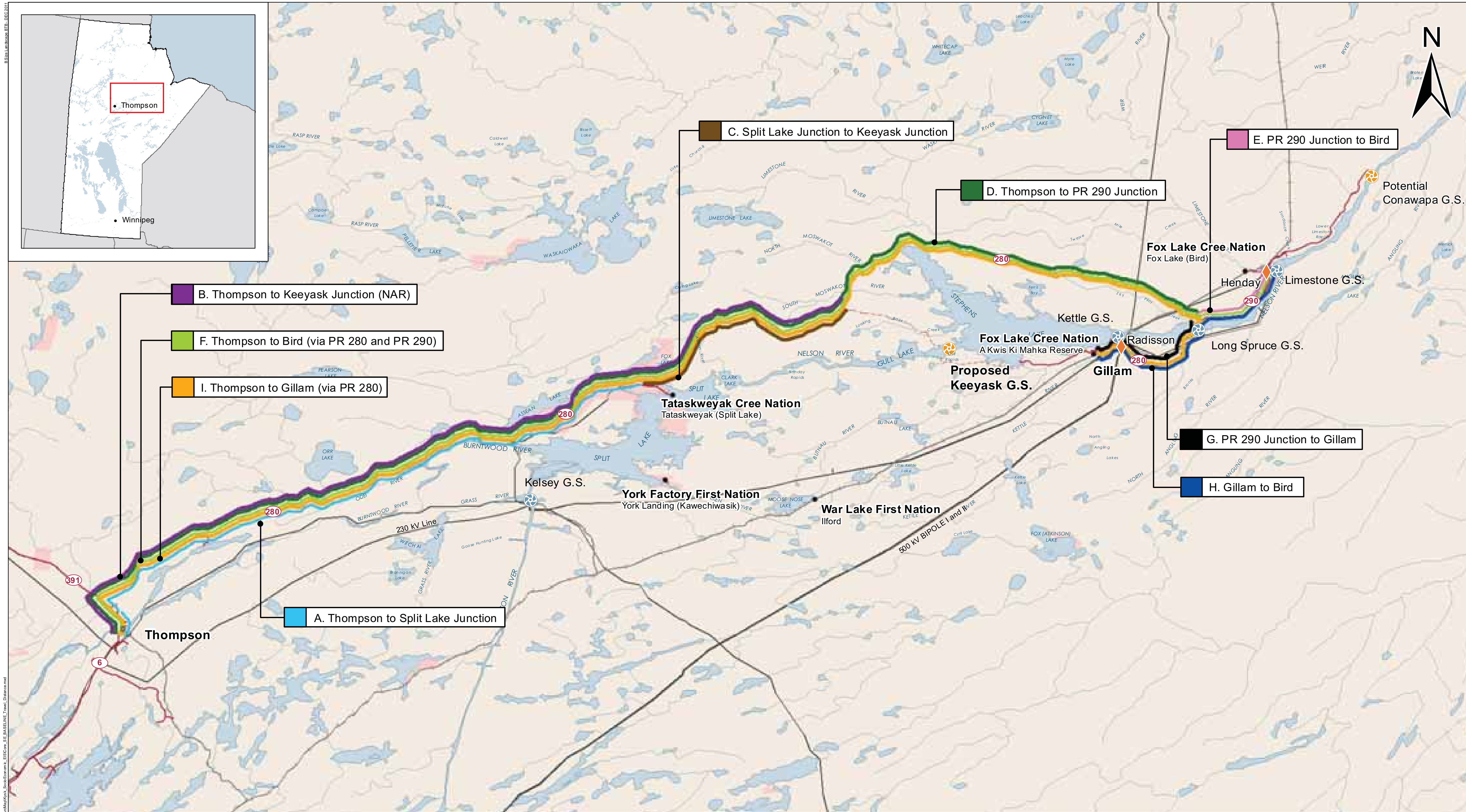
COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	23-MAR-12	18-MAY-12
	VERSION NO: 1.0	**QA/QC:** APPROVED

Caribou Ranges

Map 6-38


A
SPLIT LAKE 171
Tataskweyak Cree Nation
Tataskweyak (Split Lake)
SPLIT LAKE 171A
SPLIT LAKE 171B
1:500,000
B
Limestone River
Fox Lake Cree Nation
Fox Lake (Bird)
FOX LAKE 2
NELSON RIVER
1:200,000
N
Potential Conawapa G.S.
Henday
Limestone G.S.
Fox Lake Cree Nation
Fox Lake (Bird)
Kettle G.S.
Gillam
Radisson
Long Spruce G.S.
Fox Lake Cree Nation
A Kwis Ki Mahka Reserve
Proposed Access Road
Proposed Keeyask G.S.
Tataskweyak Cree Nation
Tataskweyak (Split Lake)
York Factory First Nation
York Landing (Kawechiwasik)
War Lake First Nation
Ilford
Kelsey G.S.
230 KV Line
500 KV BIPOLE I and II
Thompson
C
SPLIT LAKE 171B
YORK LANDING
York Factory First Nation
York Landing (Kawechiwasik)
Ripple River
Aiken River
1:200,000
D
Mooseocoot 2
Mooseocoot
War Lake First Nation
Ilford
Mooseocoot 3
1:400,000
E
STEPHENS LAKE
Gillam
Fox Lake Cree Nation
A Kwis Ki Mahka Reserve
1:250,000
KCN Reserve Areas
A Kwis Ki Mahka Reserve 1.3 ha
Fox Lake 1 562 ha
Fox Lake 2 40 ha
Fox Lake West 3 1,139 ha
Mooseocoot 6.8 ha
Mooseocoot 2 142 ha
Mooseocoot 3 52 ha
Split Lake 171 14,468 ha
Split Lake 171A 2,991 ha
Split Lake 171B 136 ha
York Landing 976 ha
Data Source: INAC
KEEYASK Hydropower Limited Partnership
DATA SOURCE: Manitoba Hydro, NTS, Stantec Consulting Ltd.
CREATED BY: Stantec Consulting Ltd.
COORDINATE SYSTEM: UTM NAD 1983 Z15N
DATE CREATED: 16-DEC-10
REVISION DATE: 07-JUN-12
VERSION NO: 1.0
QA/QC: APPROVED
0 8.5 17 Kilometres
0 7 14 Miles
Legend
Generating Station (Planned)
Generating Station (Existing)
Converter Station
First Nation Community
Town/City
Highway
Proposed Access Road
Rail
Existing Transmission Line
First Nation Reserve
Waterbody
Communities depicted on the map are included in the Socio-Economic Local Study Area
Socio-Economic Local Study Area

Map 6-39



DATA SOURCE:
Manitoba Hydro, NTS, Stantec Consulting Ltd.

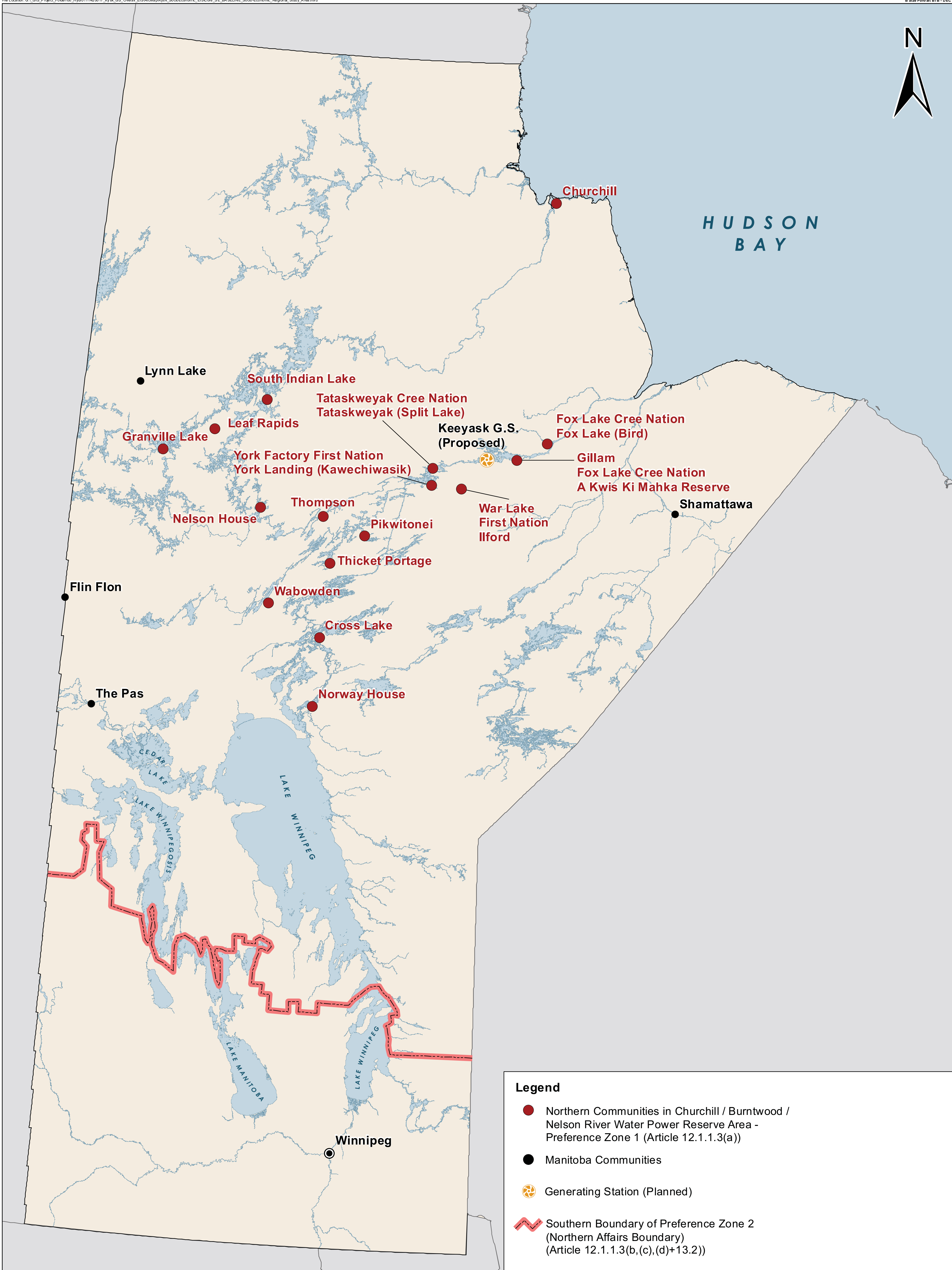
CREATED BY:
Stantec Consulting Ltd.

COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	16-DEC-10	18-MAY-12
0 8.5 17 Kilometres / 0 7 14 Miles	VERSION NO: 1.0	QA/QC: GS/YYY/MWZ

Legend

Road Segment	Distance (km)
A Thompson to Split Lake Junction	135.4
B Thompson to Keeyask Junction (NAR)	182.7
C Split Lake Junction to Keeyask Junction	47.3
D Thompson to PR 290 Junction	269.5
E PR 290 Junction to Bird	23.2
F Thompson to Bird (via PR 280 and PR 290)	292.7
G PR 290 Junction to Gillam	29.8
H Gillam to Bird	53.0
I Thompson to Gillam (via PR 280)	299.3

Travel Distances in Local Study Area



KEEYASK
Hydropower Limited Partnership

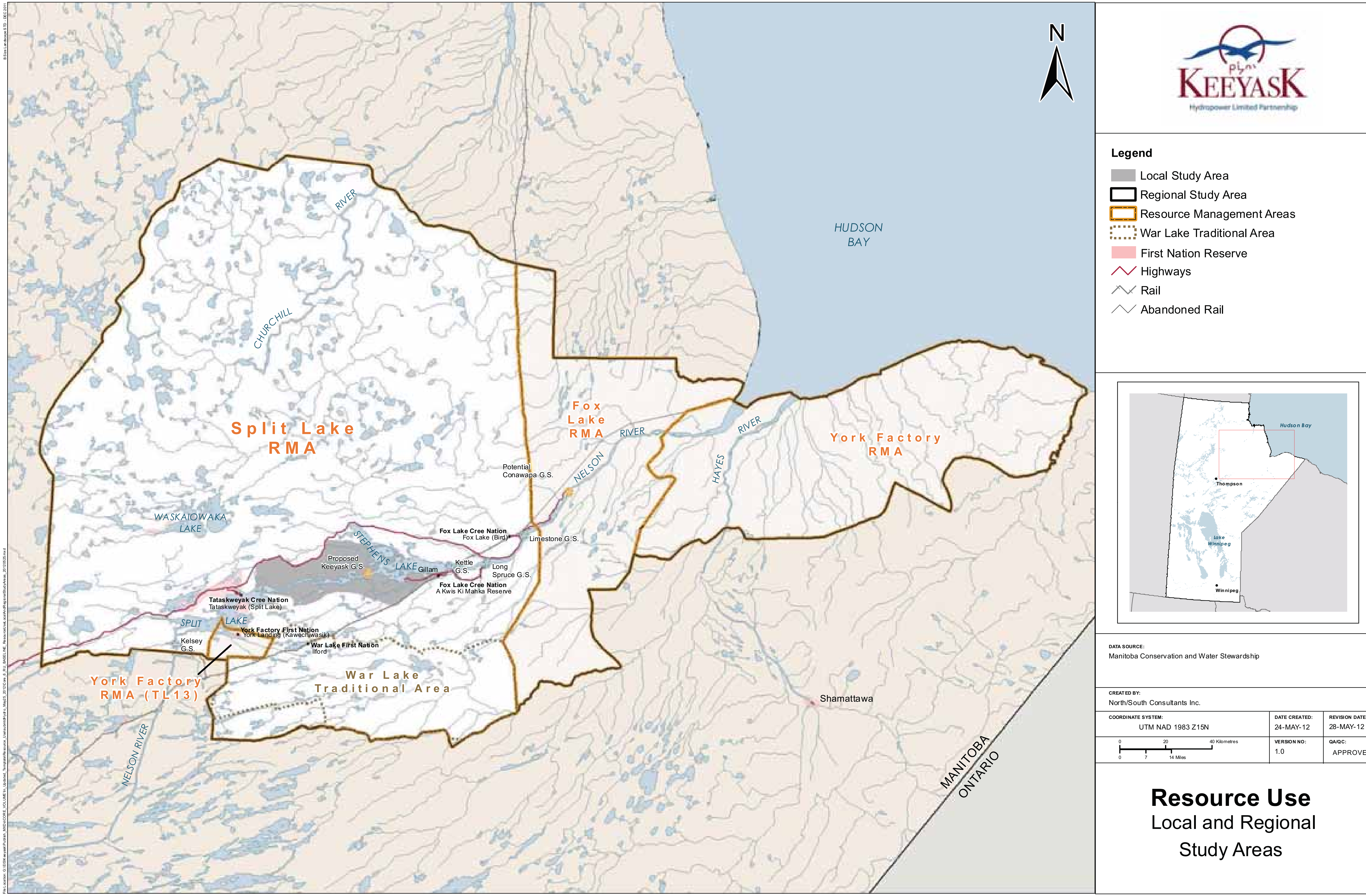
DATA SOURCE:
Manitoba Hydro, NTS, Stantec Consulting Ltd., Government of Canada

CREATED BY:
Stantec Consulting Ltd.

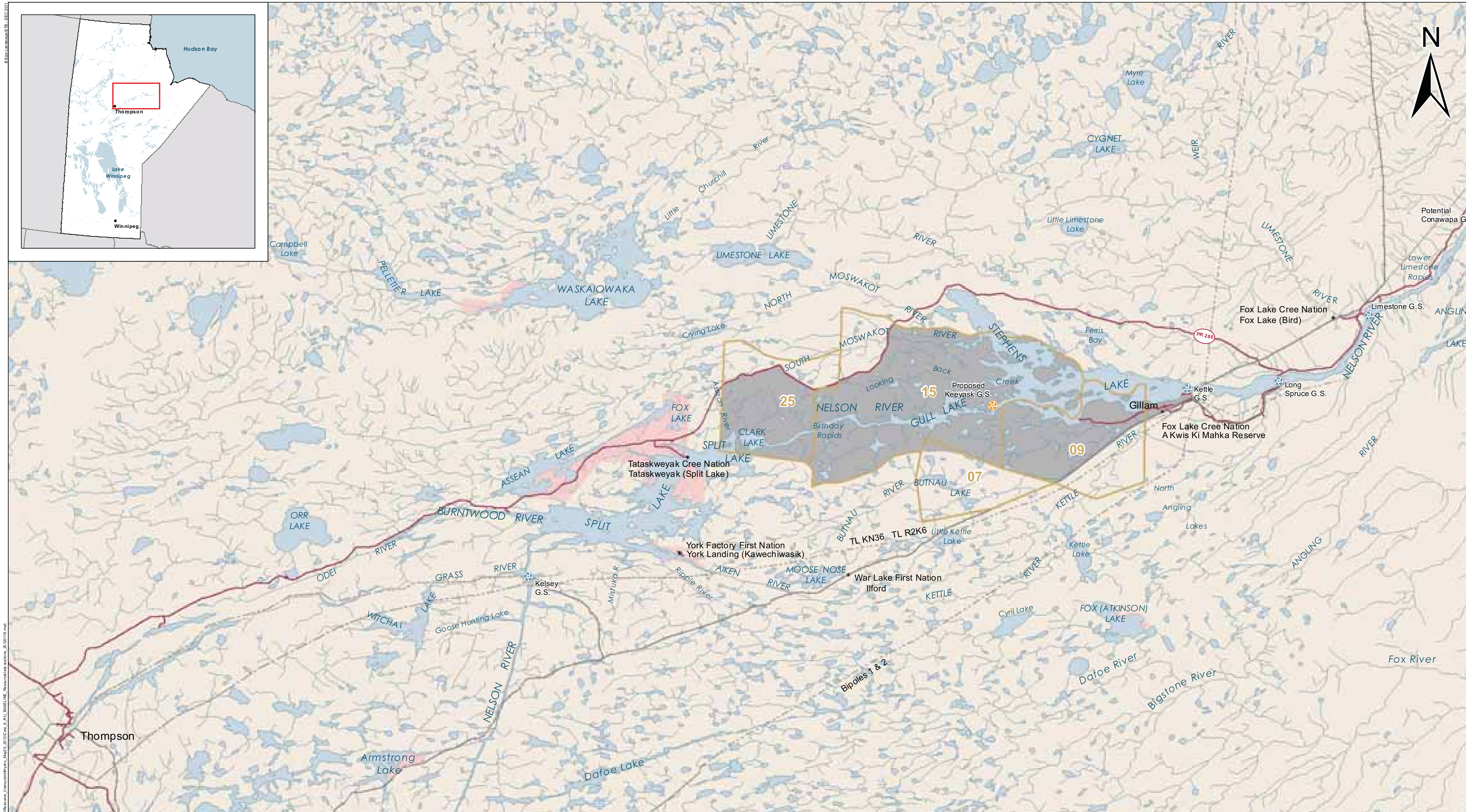
COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	18-JAN-12	18-MAY-12
0 40 80 Kilometers / 0 30 60 Miles	VERSION NO: 1.0	QA/QC: GS/YYY/MWZ

Socio-Economic Regional Study Area

Map 6-41


N
KEEYASK
Hydropower Limited Partnership
Legend
Local Study Area
Regional Study Area
Resource Management Areas
War Lake Traditional Area
First Nation Reserve
Highways
Rail
Abandoned Rail
Hudson Bay
Thompson
Lake Winnipeg
Winnipeg
DATA SOURCE:
Manitoba Conservation and Water Stewardship
CREATED BY:
North/South Consultants Inc.
COORDINATE SYSTEM:
UTM NAD 1983 Z15N
DATE CREATED:
24-MAY-12
REVISION DATE:
28-MAY-12
0 20 40 Kilometres
0 7 14 Miles
VERSION NO:
1.0
QA/QC:
APPROVED
Resource Use
Local and Regional Study Areas
HUDSON BAY
CHURCHILL RIVER
Split Lake RMA
Fox Lake RMA
NELSON RIVER
HAYES RIVER
York Factory RMA
Potential Conawapa G.S.
WASKAIOWAKA LAKE
STEPHENS LAKE
Fox Lake Cree Nation
Fox Lake (Bird)
Limestone G.S.
Proposed Keeyask G.S.
Gillam
Kettle G.S.
Long Spruce G.S.
Fox Lake Cree Nation
A Kwis Ki Mahka Reserve
Tataskweyak Cree Nation
Tataskweyak (Split Lake)
SPLIT LAKE
York Factory First Nation
York Landing (Kawechiwasik)
Kelsey G.S.
War Lake First Nation
Ilford
War Lake Traditional Area
York Factory RMA (TL13)
NELSON RIVER
Shamattawa
MANITOBA
ONTARIO

Map 6-42



KEEYASK
Hydropower Limited Partnership

DATA SOURCE:
Government of Canada

CREATED BY:
North/South Consultants Inc.

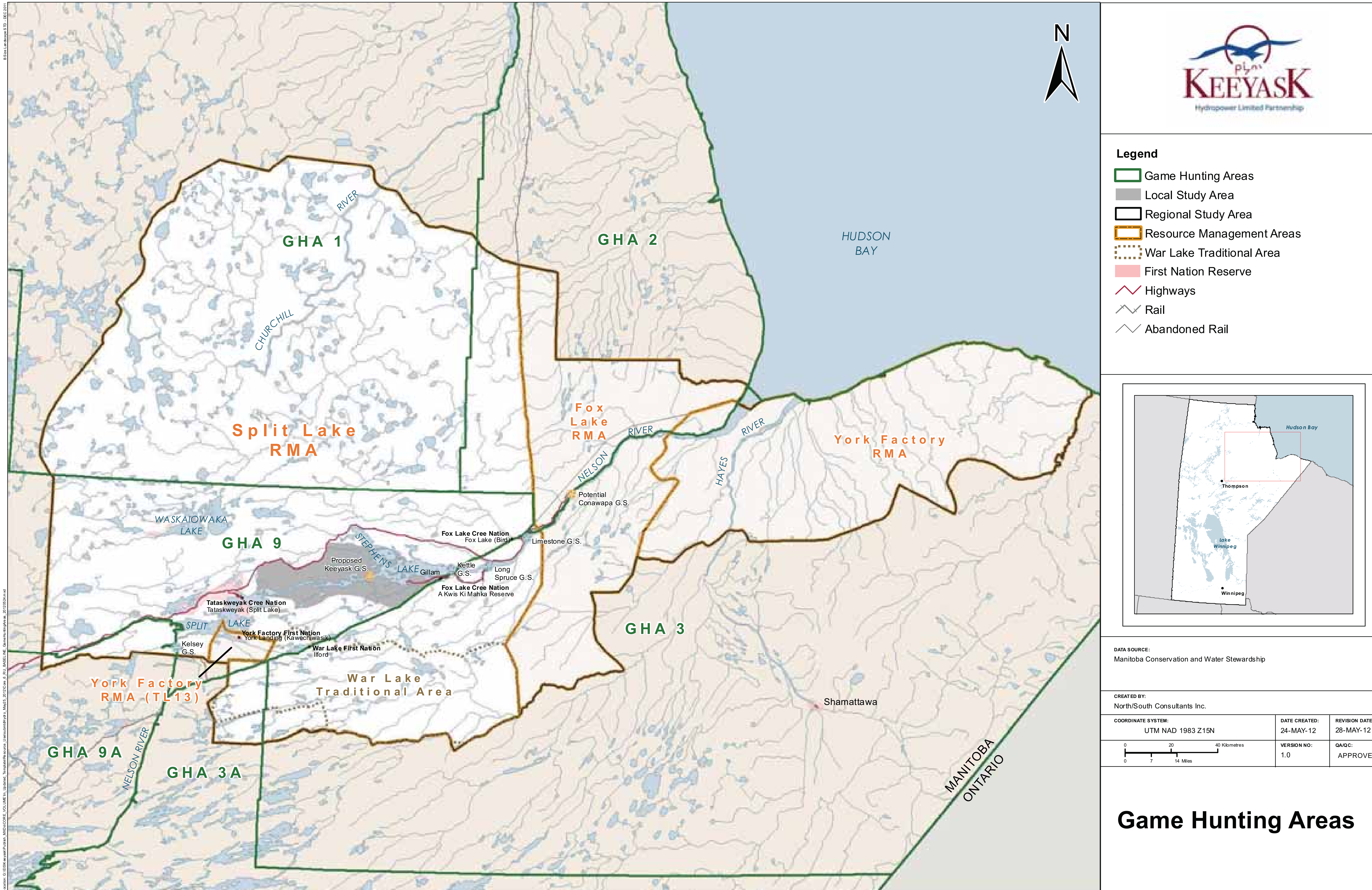
COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	25-MAY-12	28-MAY-12
0 8 16 Kilometres / 0 6 12 Miles	VERSION NO: 1.0	QA/QC: APPROVED

Legend

- Local Study Area
- Trapline Boundary
- First Nation Reserve
- Highway
- Rail
- Transmission Line
- Abandoned Rail

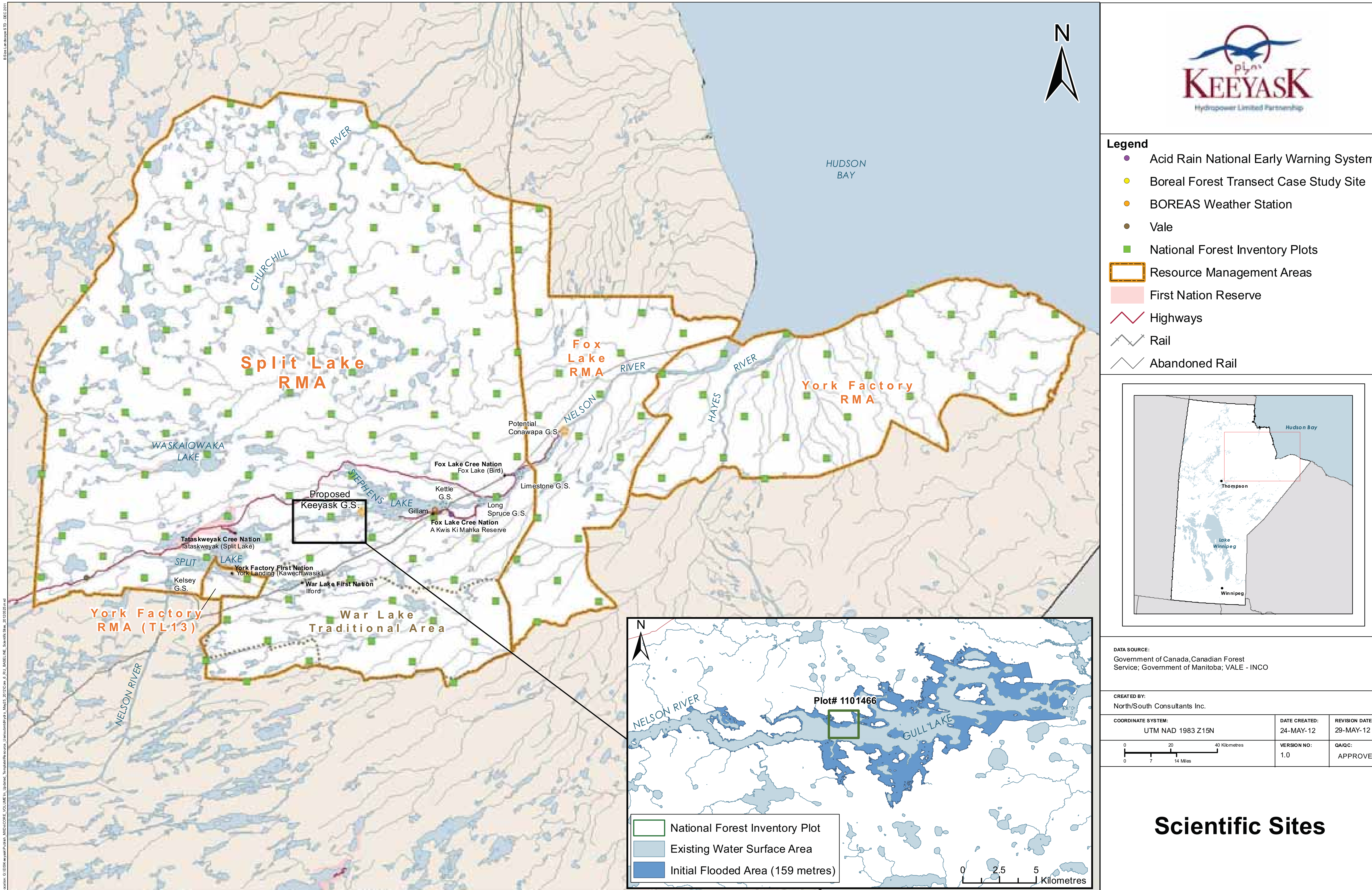
NOTE: Lillian Island is reported to be located less than 1.6 km upstream from Gull Rapids (CNP SV)

Resource Use
Locations and Local Study Area Traplines



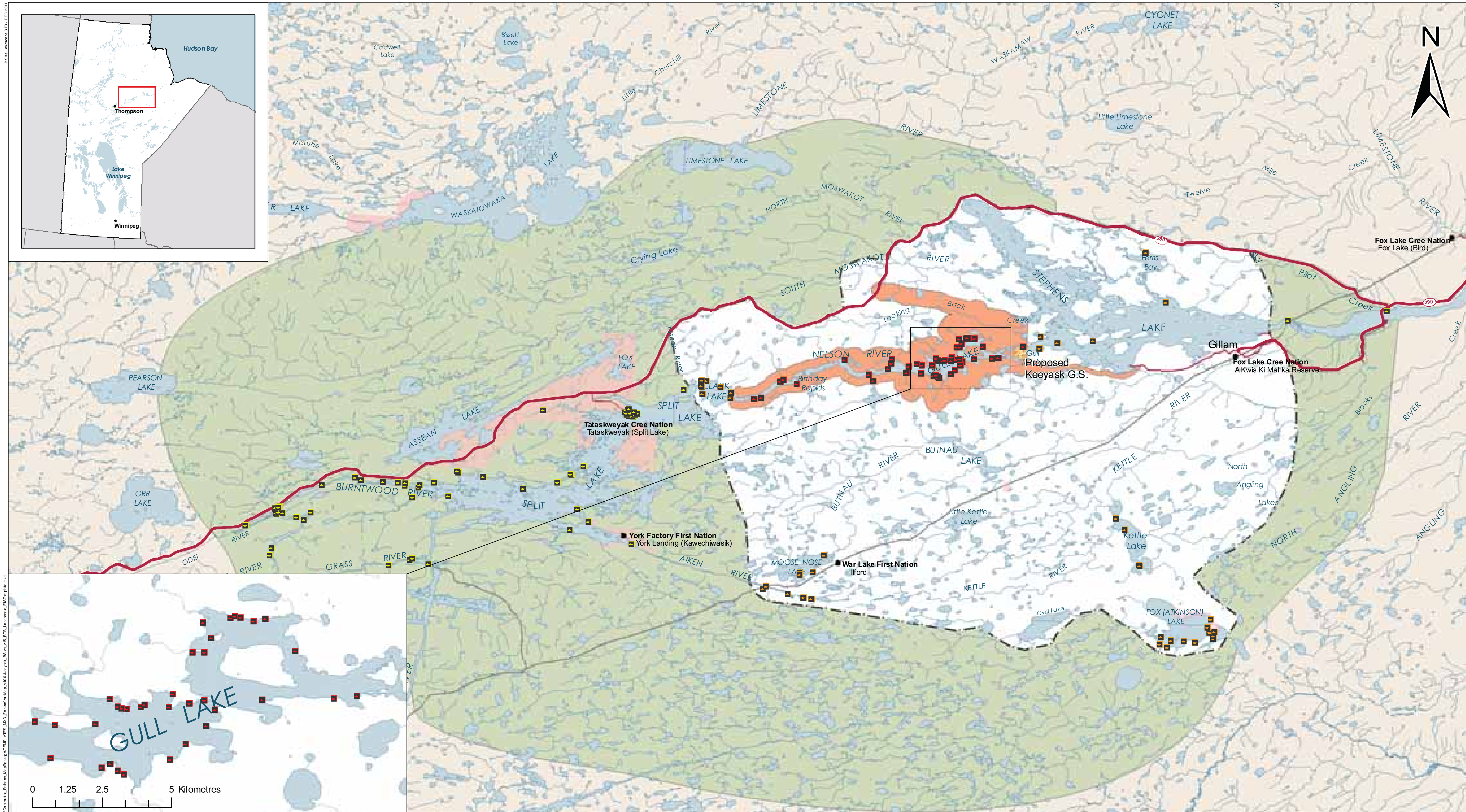
Game Hunting Areas

Map 6-44



Scientific Sites

Map 6-45



DATA SOURCE:
Manitoba Hydro
Historic Resources Branch, Culture, Heritage and Tourism

CREATED BY:
Northern Lights Heritage Services Inc.

COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	24-MAY-12	24-MAY-12
0 5 10 Kilometres / 0 4 8 Miles	VERSION NO: 1.0	QA/QC: APPROVED

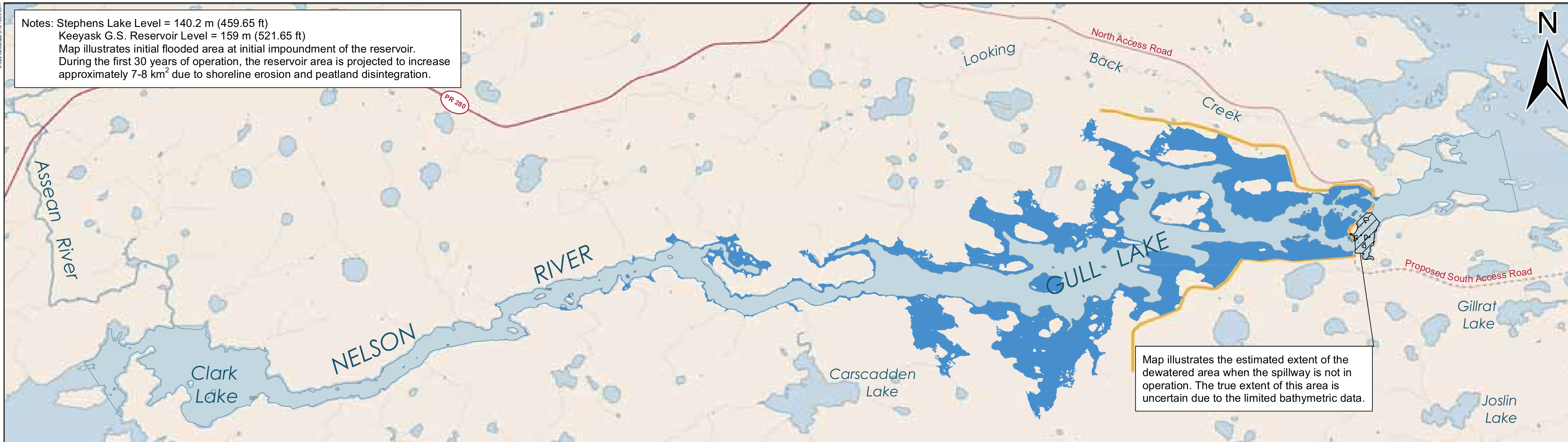
Legend

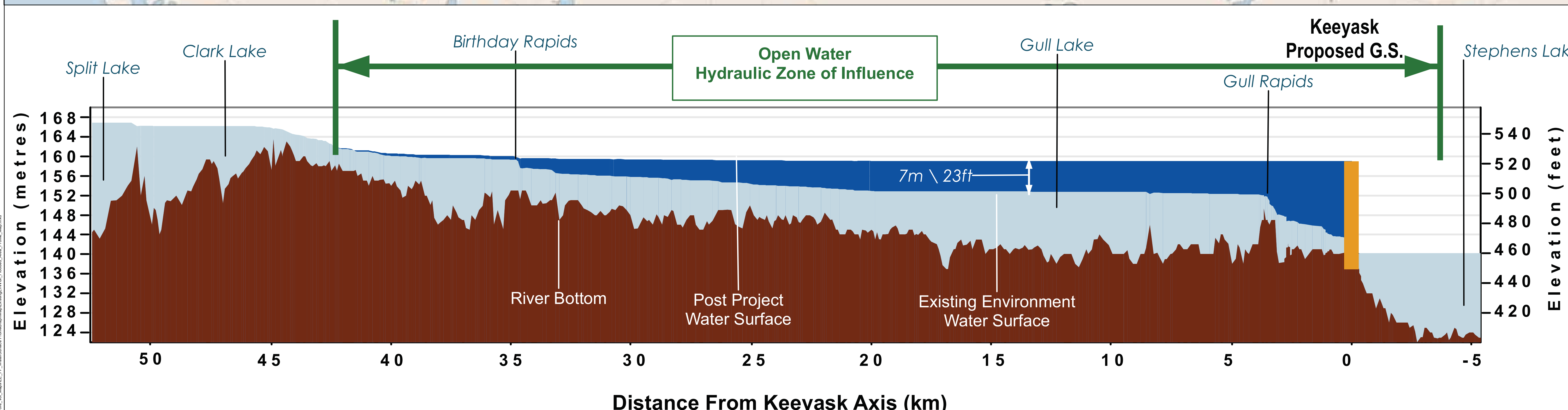
- Archaeological Site (Core), 50
- Archaeological Site (Local), 100
- Archaeological Site (Regional), 162
- Generating Station (Planned)
- First Nation Community
- Town
- Highway
- Rail
- Core Study Area
- Local Study Area
- Regional Study Area
- First Nation Reserve

Note: the number of archaeological sites in each Study Area is cumulative and incorporates sub-regions.

Heritage Resources Study Areas
with Registered Archaeological Sites

Map 6-46





KEEYASK
Hydropower Limited Partnership

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

CREATED BY:
Manitoba Hydro - Water Resources Engineering Department

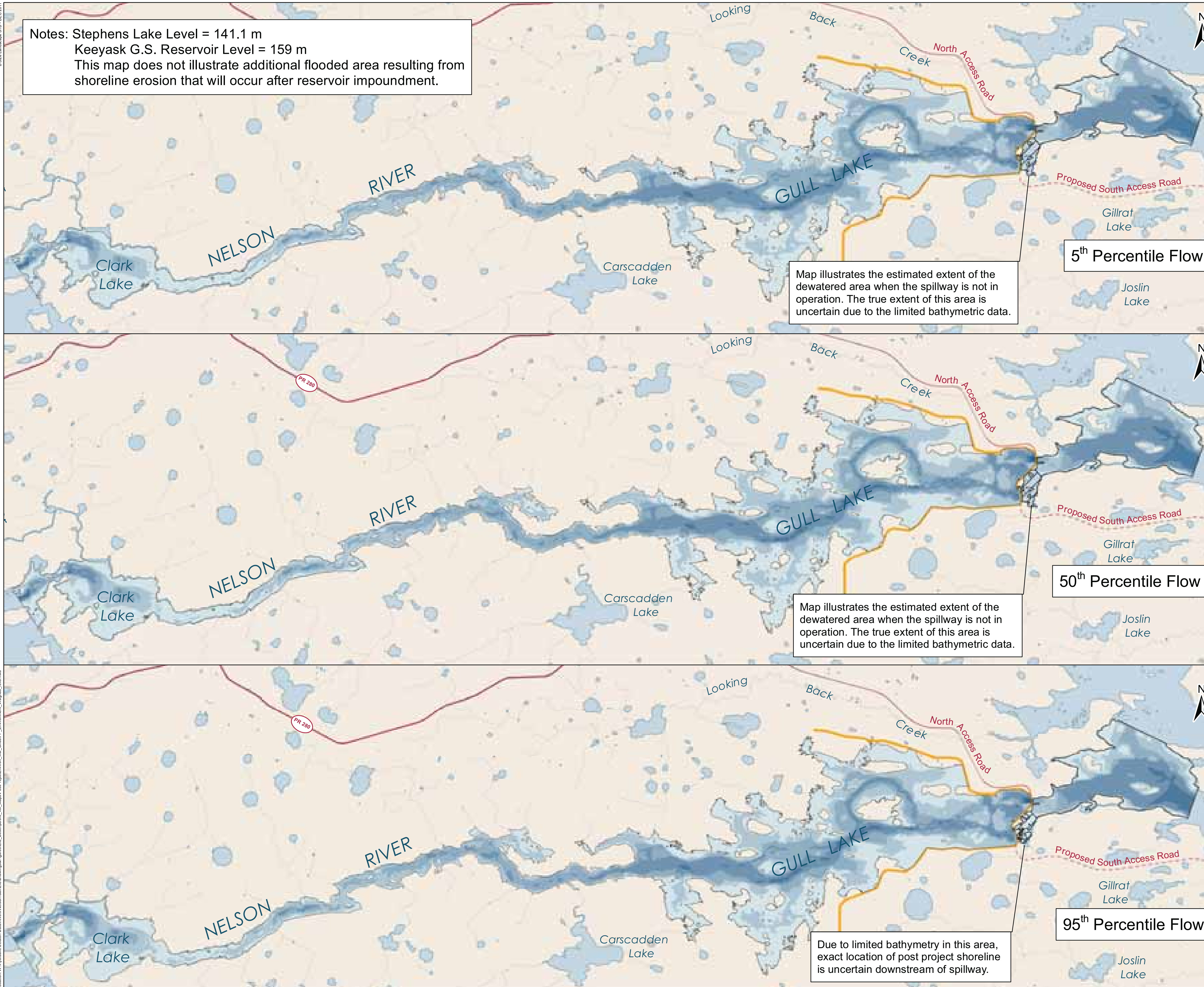
COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	26-Jan-10	23-MAY-12
0 1.5 3 Kilometres / 0 1.5 3 Miles	VERSION NO: 1.0	QA/QC: APPROVED

Legend
- Existing Environment
- Post Project
- Keeyask Principal Structures

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

Water Surface Profiles and Flooded Area

Map 6-47



Legend

Depth (m)

- 0 - 4
- 4 - 8
- 8 - 12
- 12 - 18
- 18 - 23
- 23 - 31
- Keeyask Principal Structures

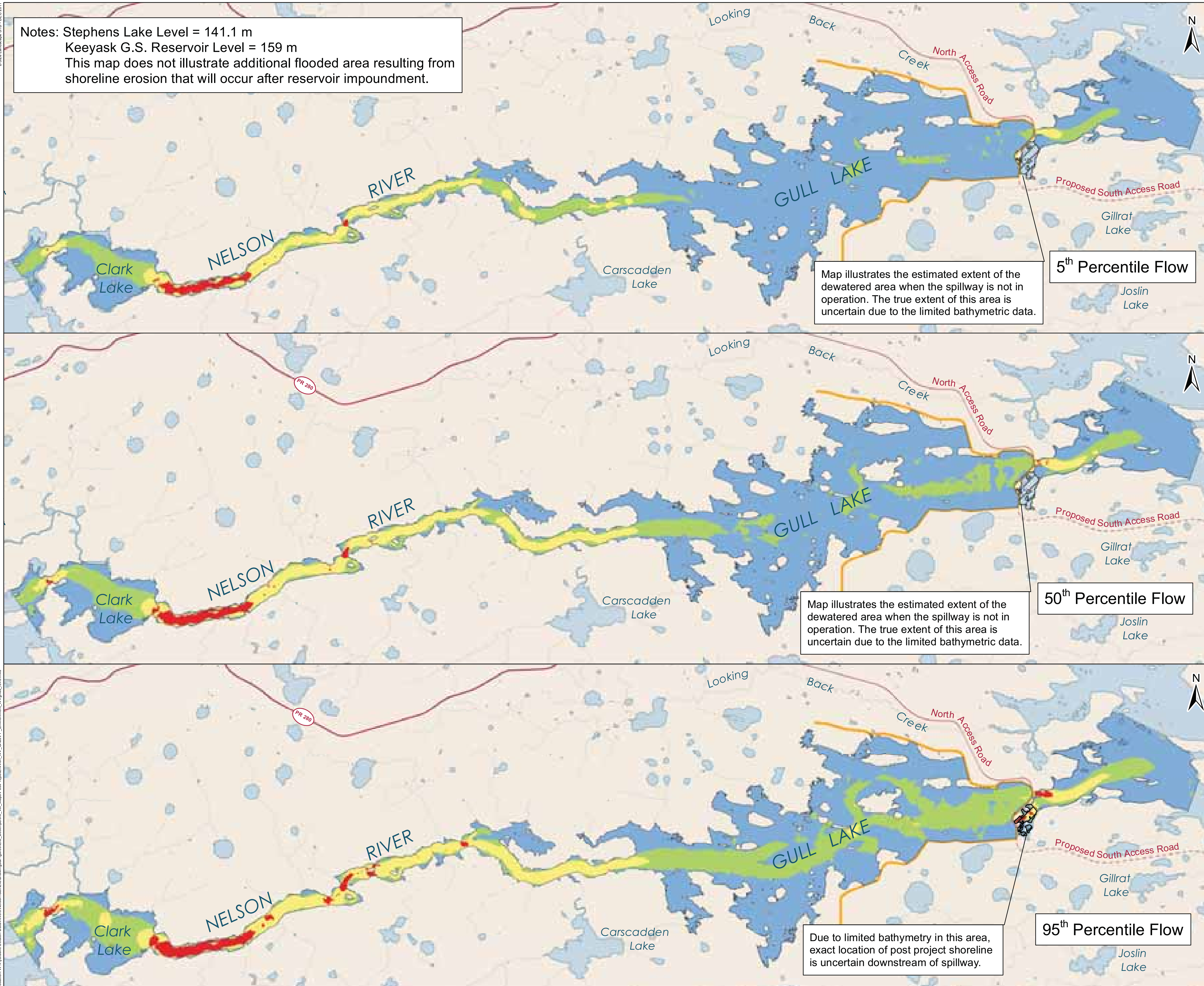
DATA SOURCE:
Manitoba Hydro; Government of Manitoba; Government of Canada

CREATED BY:
Manitoba Hydro - Water Resources Department

COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	08-JAN-10	23-MAY-12
0 2 4 Kilometres / 0 1 2 Miles	VERSION NO: 1.0	QA/QC: APPROVED

Water Depth Grid
Post Project Environment

Map 6-48



KEEYASK
Hydropower Limited Partnership

Legend

Velocity (m/s)

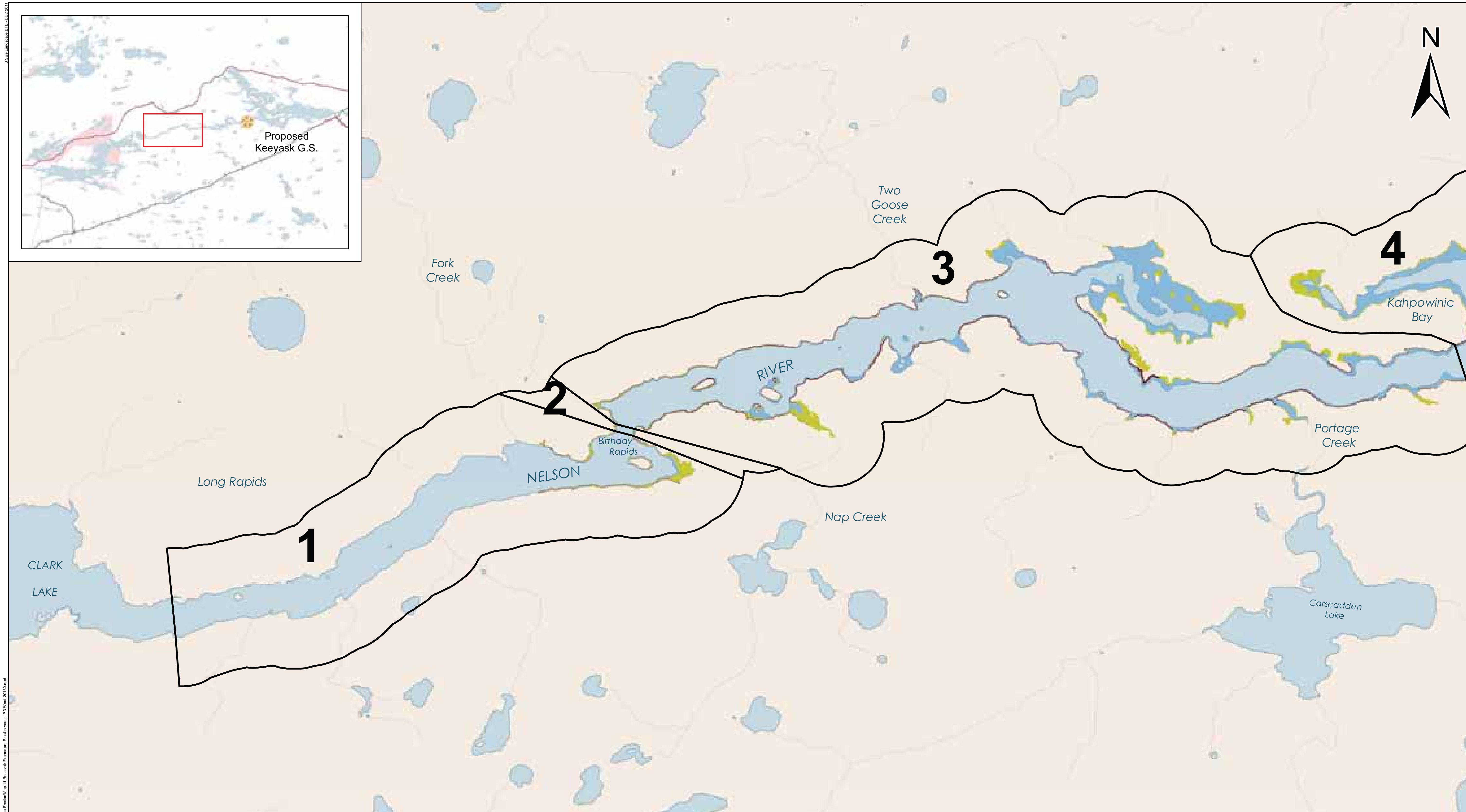
- Standing (0 - 0.2)
- Low (0.2 - 0.5)
- Moderate (0.5 - 1.5)
- High (>1.5)
- Keeyask Principal Structures

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

CREATED BY:
Manitoba Hydro - Water Resources Engineering Department

COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	08-JAN-10	23-MAY-12
0 2 4 Kilometres / 0 1 2 Miles	VERSION NO: 1.0	QA/QC: APPROVED

Water Velocity Grids
Post Project Environment



KEEYASK
Hydropower Limited Partnership

DATA SOURCE:
Reaches - North/South Consultants Inc.; Peatland disintegration - ECOSTEM Ltd.; Mineral bank erosion - J D Mollard and Associates Ltd.; Existing water (gull-ee-95perc-4327cms-rev3), flooded area (pp-95perc-4327-159-shore-rev5), Infrastructure - Manitoba Hydro; Water - NTS; Roads and rail - Manitoba Conservation; First Nation Reserves - Natural Resources Canada.

CREATED BY: ECOSTEM Ltd.

COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	19-JAN-12	14-FEB-12
0 1 2 Kilometres / 0 0.4 0.8 Miles	VERSION NO: 1.0	QA/QC: APPROVED

Legend

- Existing Water Surface Area
- Initial Flooded Area (159 m)
- Peatland Disintegration
- Mineral Bank Erosion

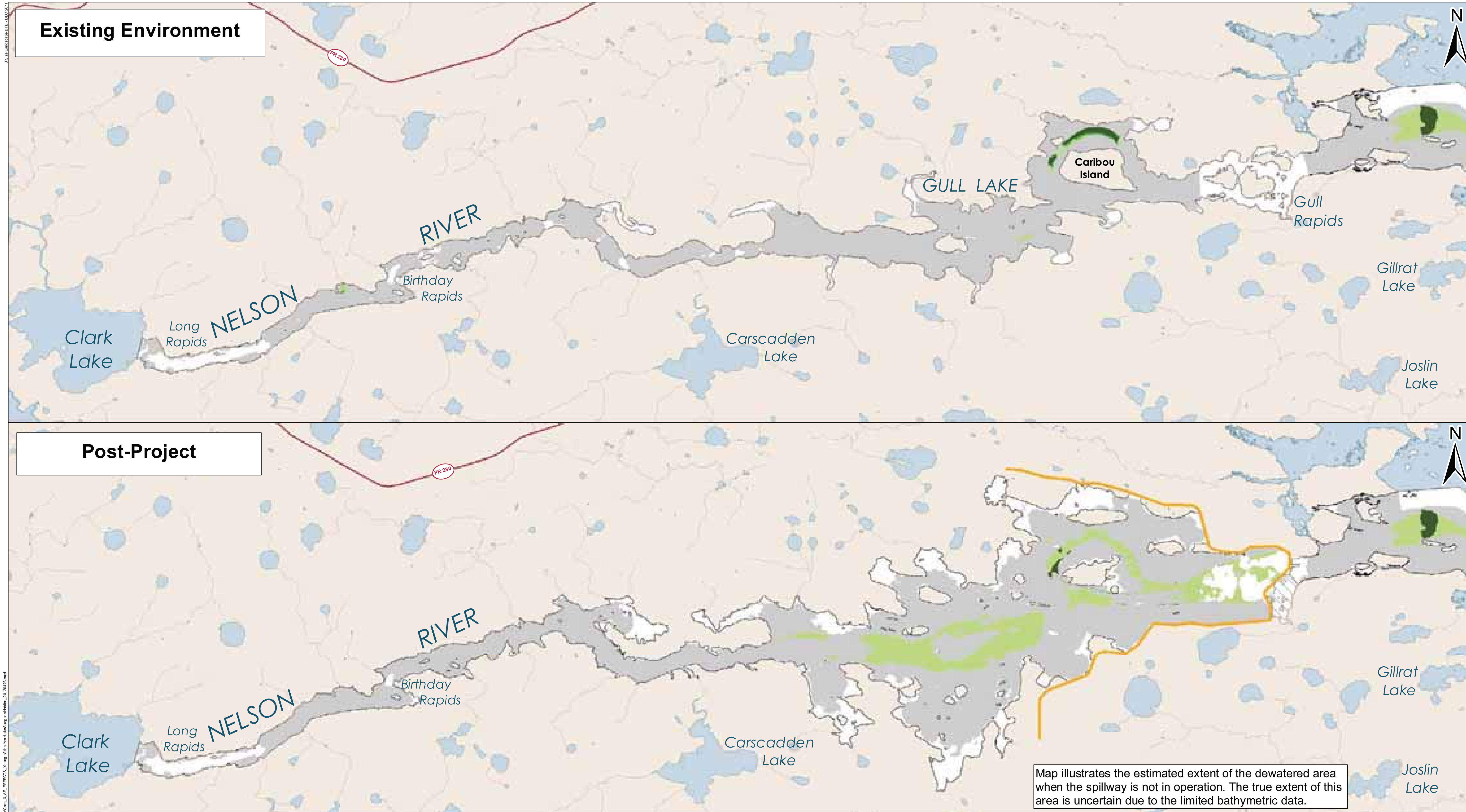
Post Project Reach

- 1 = Riverine Shore Zones Upstream of Birthday Rapids
- 2 = Riverine Shore Zones at Birthday Rapids
- 3 = Riverine Shore Zones Downstream of Birthday Rapids to the Inlet of Gull Lake
- 4 = Lake Shore Zones in Gull Lake

Peatland Disintegration and Erosion in the Western Upstream Reaches

During First 30 Years of Operation

Map 6-50



KEEYASK Hydropower Limited Partnership

DATA SOURCE:
Manitoba Hydro, North/South Consultants, Government of Canada
gull-ee-95perc-4327cms-rev3, pp-95perc-4327-159-shore-rev5

CREATED BY:
North/South Consultants

COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	26-MAR-10	24-MAY-12
0 2 4 Kilometres / 0 1 2 Miles	VERSION NO: 4.0	QA/QC: APPROVED

Legend

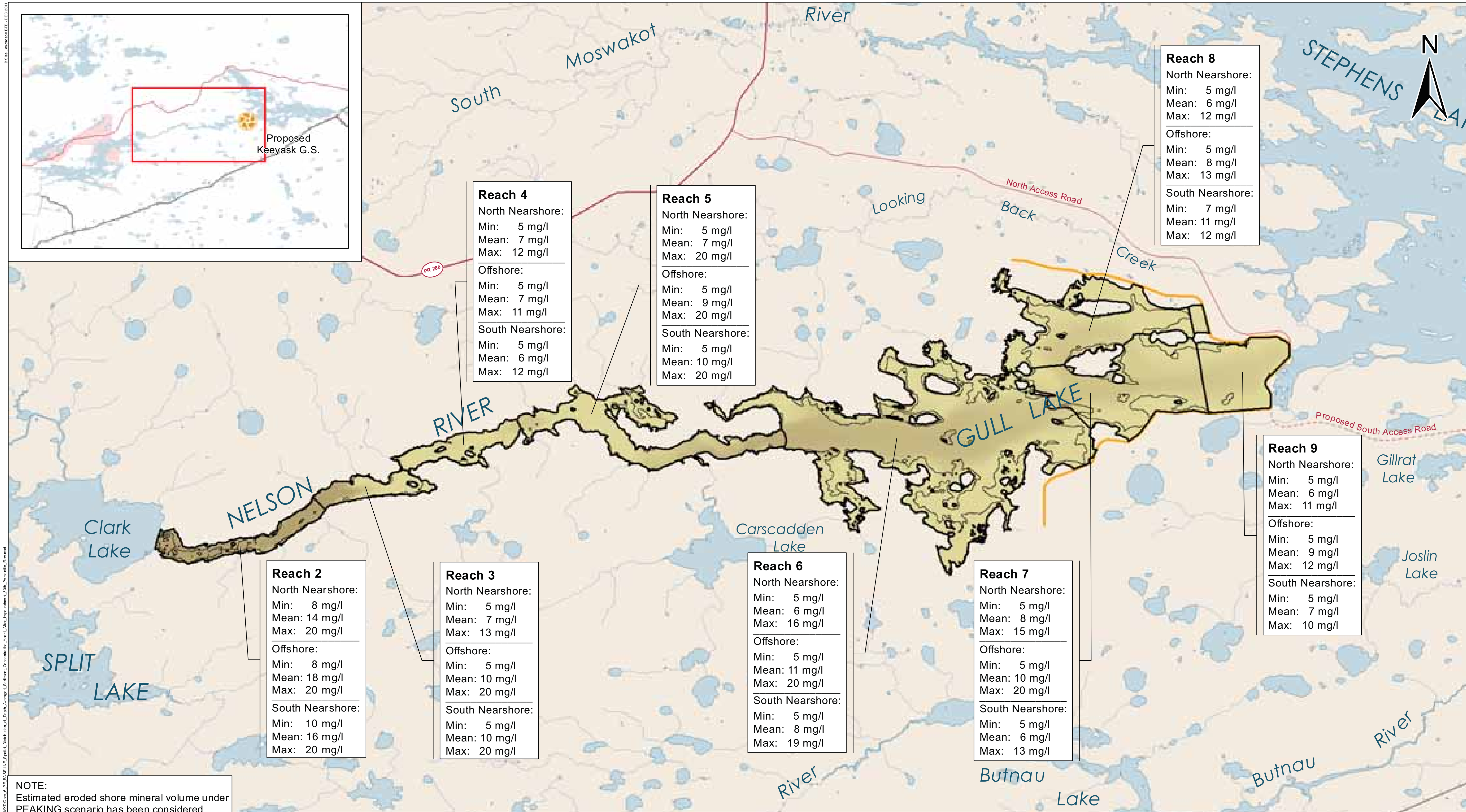
Habitat Suitability Index
- 0.00
- 0.01 - 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00

- Potential Dewatered Area
- Keeyask Principal Structures

Note: Existing Environment frame shows 95th percentile inflow and Stephens Lake level of 141.1m. Post-Project frame shows Year 30 shoreline, reservoir at 159 metres and 95th percentile inflow with 7 unit full gate plant operation with spill and Stephens Lake level of 141.1m. Mitigation measures are not shown. Extents of dewatered area are estimated based on the existing environment 95th percentile flow.

Young-of-the-Year Lake Sturgeon Habitat

Habitat Suitability Index Model Output



KEEYASK
Hydropower Limited Partnership

DATA SOURCE:
TSS data from KGS Acres LTD., 2010
Modelling reach boundary data from North/South Consultants
Manitoba Hydro
Backround data provided by Geogratis

CREATED BY:
KGS Acres Ltd.

COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	02-MAY-12	03-MAY-12
0 1.5 3 Kilometres / 0 1 2 Miles	VERSION NO: 1.0	QA/QC: APPROVED

Legend

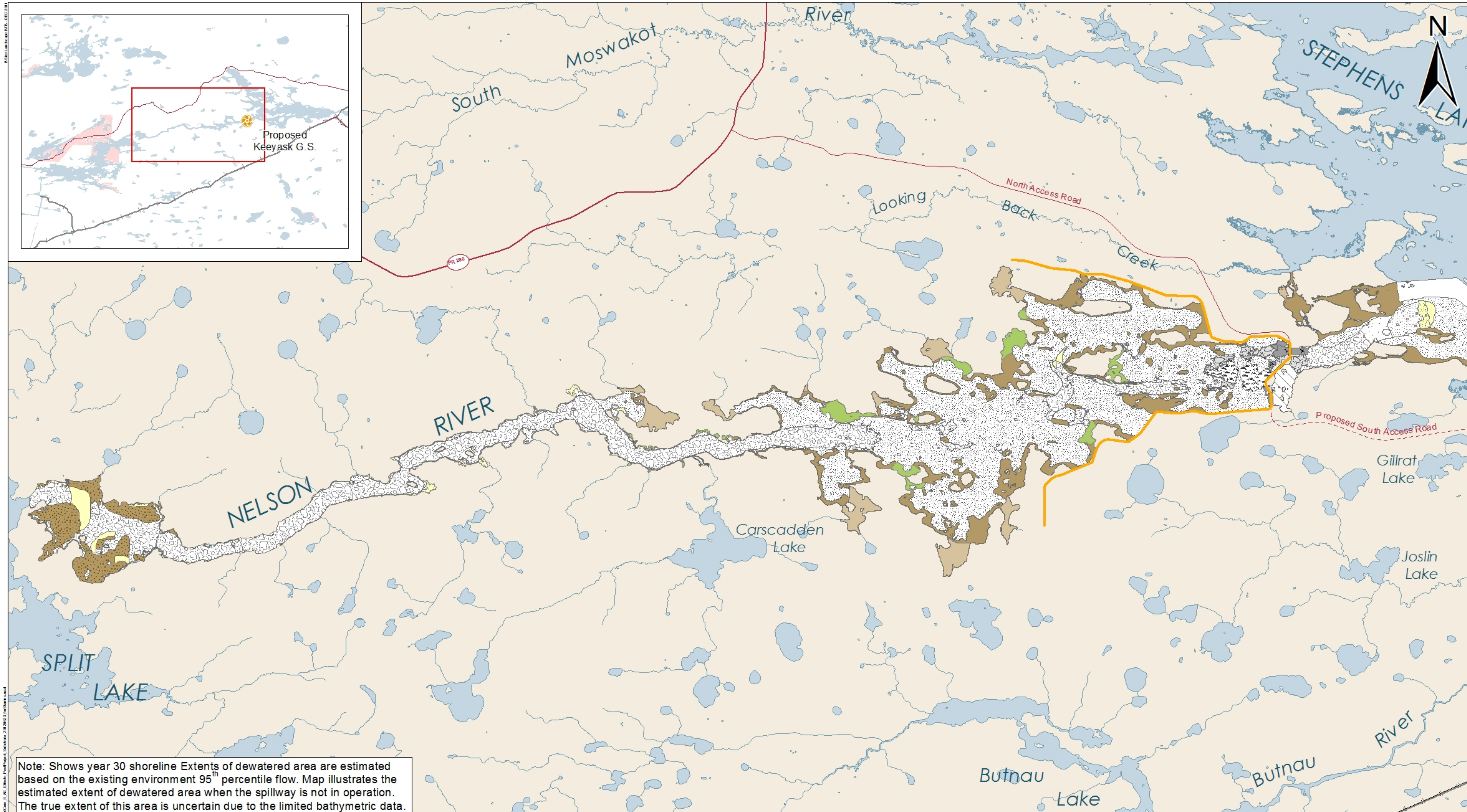
Total Suspended Solids (TSS mg/L)
High : 50
Low : 0

Reach Boundaries
Nearshore Boundaries
Keeyask Principal Structures
Access Road
Proposed Access Road
Highway
Rail

Spatial Distribution of Depth Averaged Sediment Concentration

Year 1 After Impoundment - 50th Percentile Flow

Map 6-52



KEEYASK Hydropower Limited Partnership

DATA SOURCE:
Manitoba Hydro, North/South Consultants, Government of Canada
gull-ee-95perc-4327cms-rev3

CREATED BY:
North/South Consultants

COORDINATE SYSTEM: UTM NAD 1983 Z15N

DATE CREATED: 26-MAR-10

REVISION DATE: 23-MAY-12

VERSION NO: 3.0

QA/QC: PMC/FSV/MWZ

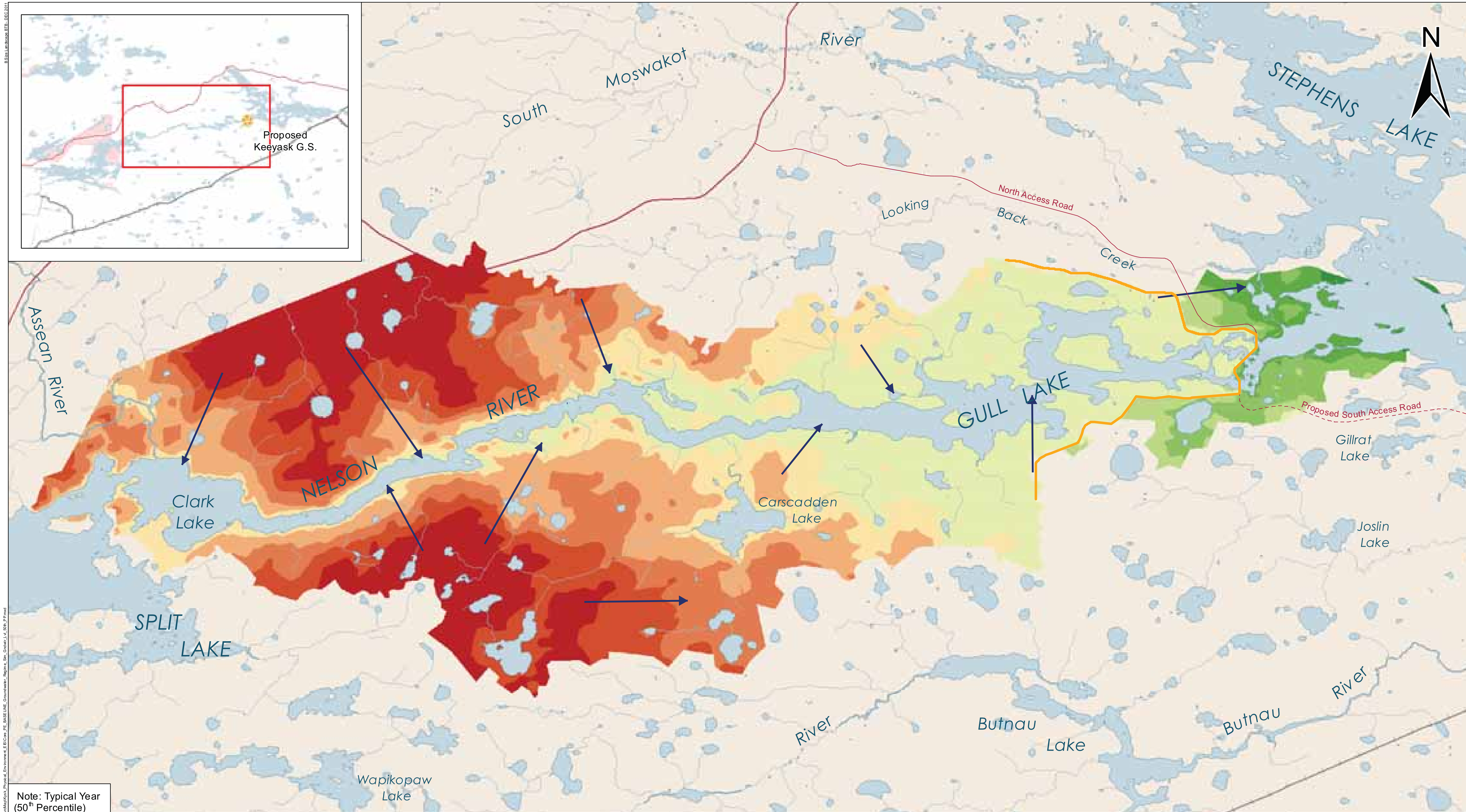
0 1.5 3 Kilometres
0 1 2 Miles

Legend

Substrate

- Bedrock
- Boulder
- Cobble/Boulder/Bedrock
- Cobble/Boulder
- Cobble
- Cobble/Gravel
- Clay
- Gravel
- Gravel/Sand
- Sand
- Sandy Clay
- Silt
- Silt/Clay
- Organic
- Flooded Terrestrial Soils
- Peat
- No Data
- Potential Dewatered Area
- Keeyask Principal Structures

Substrate Post-Project
Year 30 Keeyask Area



DATA SOURCE:
Manitoba Hydro, NTS, Stantec Consulting Ltd.

CREATED BY:
Stantec Consulting Ltd.

COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	18-JUL-11	15-MAY-12
0 1.5 3 Kilometres / 0 1 2 Miles	VERSION NO: 1.0	QA/QC: APPROVED

Legend

Groundwater Elevation (m)

- < 140
- 140 - 146
- 146 - 152
- 152 - 158
- 158 - 164
- 164 - 170
- 170 - 176
- 176 - 182
- 182 - 188
- > 188

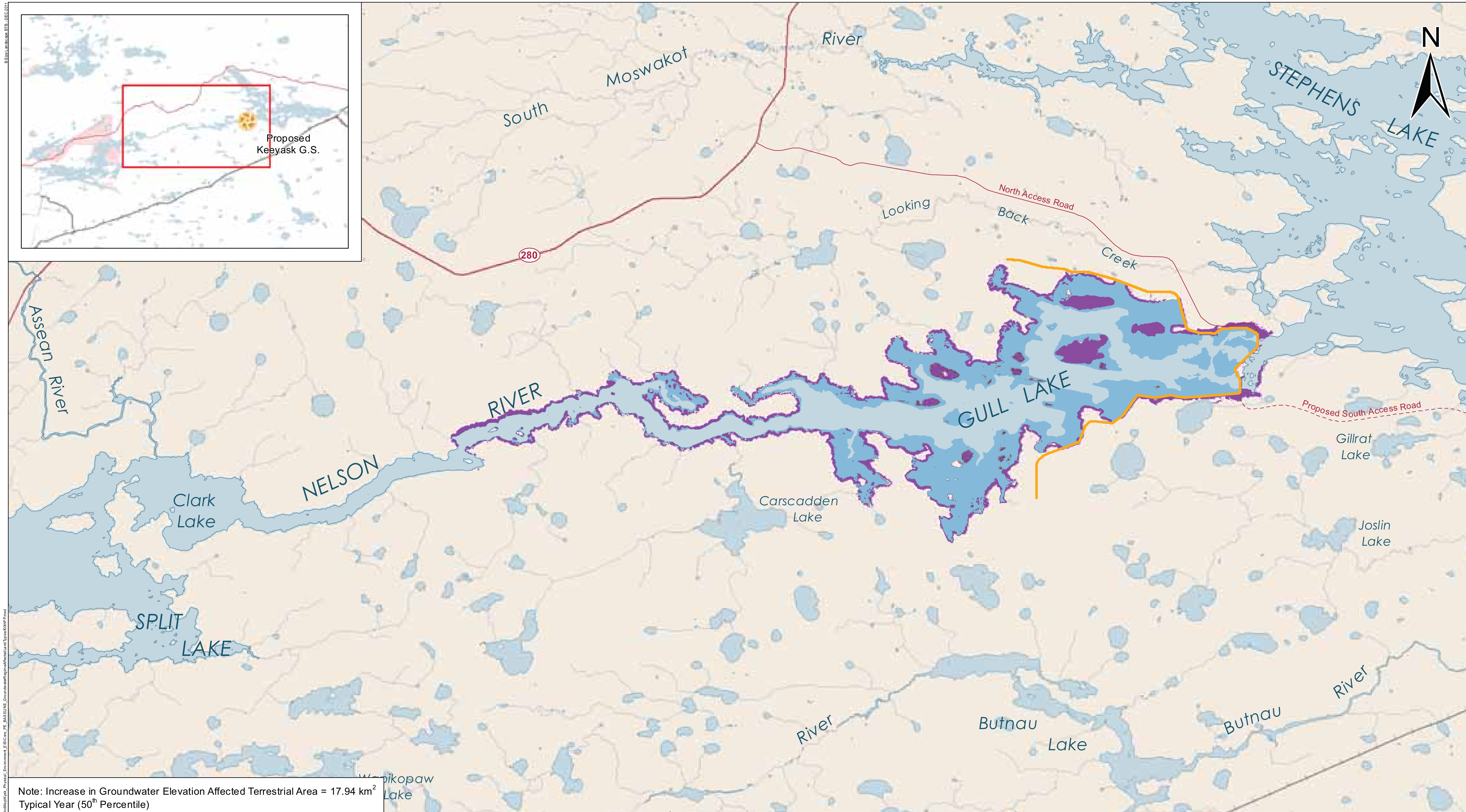
- Groundwater Flow Direction
- Keeyask Principal Structures
- Proposed Access Road
- Access Road
- Waterbody

KEEYASK
Hydropower Limited Partnership

Groundwater Regime

Simulated Groundwater Level
(Post Project)

Map 6-54



KEEYASK
Hydropower Limited Partnership

DATA SOURCE:
Manitoba Hydro, NTS, Stantec Consulting Ltd.

CREATED BY:
Stantec Consulting Ltd.

COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	16-SEP-11	15-MAY-12
0 1.5 3 Kilometres / 0 1.5 3 Miles	VERSION NO: 1.0	QA/QC: APPROVED

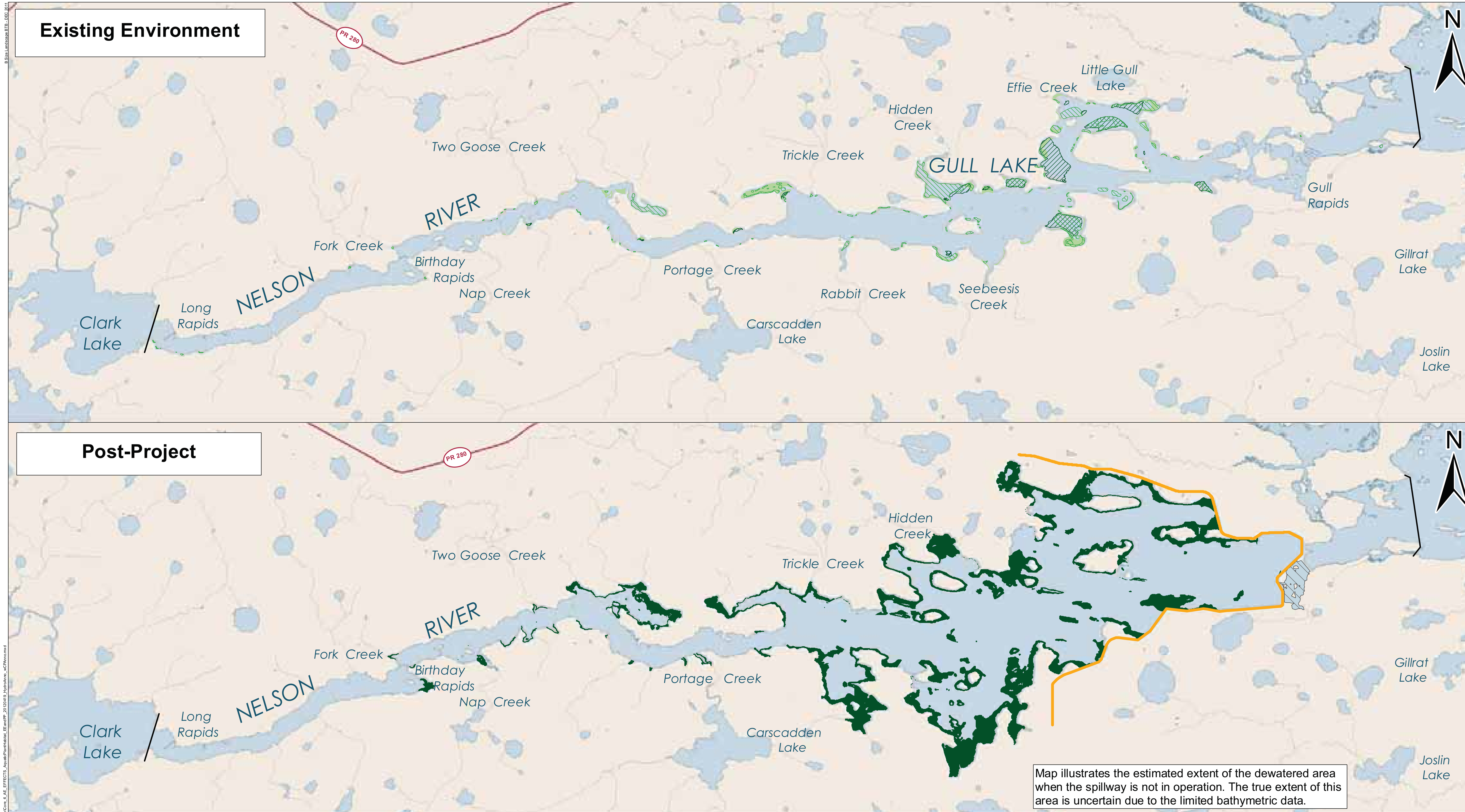
Legend

- Existing Waterbody
- Projected Extent of Initial Flooding Area
- Terrestrial Area Where Groundwater Levels Are Predicted To Be Affected
- Keeyask Principal Structures
- Proposed Access Road
- Access Road

Groundwater Regime

Predicted Future Change in Groundwater Regime

Map 6-55



DATA SOURCE:	Manitoba Hydro, North/South Consultants, Government of Canada gull-ee-95perc-4327cms-rev3, pp-95perc-4327-159-shore-rev5
CREATED BY:	North/South Consultants
COORDINATE SYSTEM:	UTM NAD 1983 Z15N
DATE CREATED:	26-MAR-10
REVISION DATE:	30-MAY-12
VERSION NO:	2.0
QA/QC:	APPROVED

0 2 4 Kilometres
0 1 2 Miles

Legend

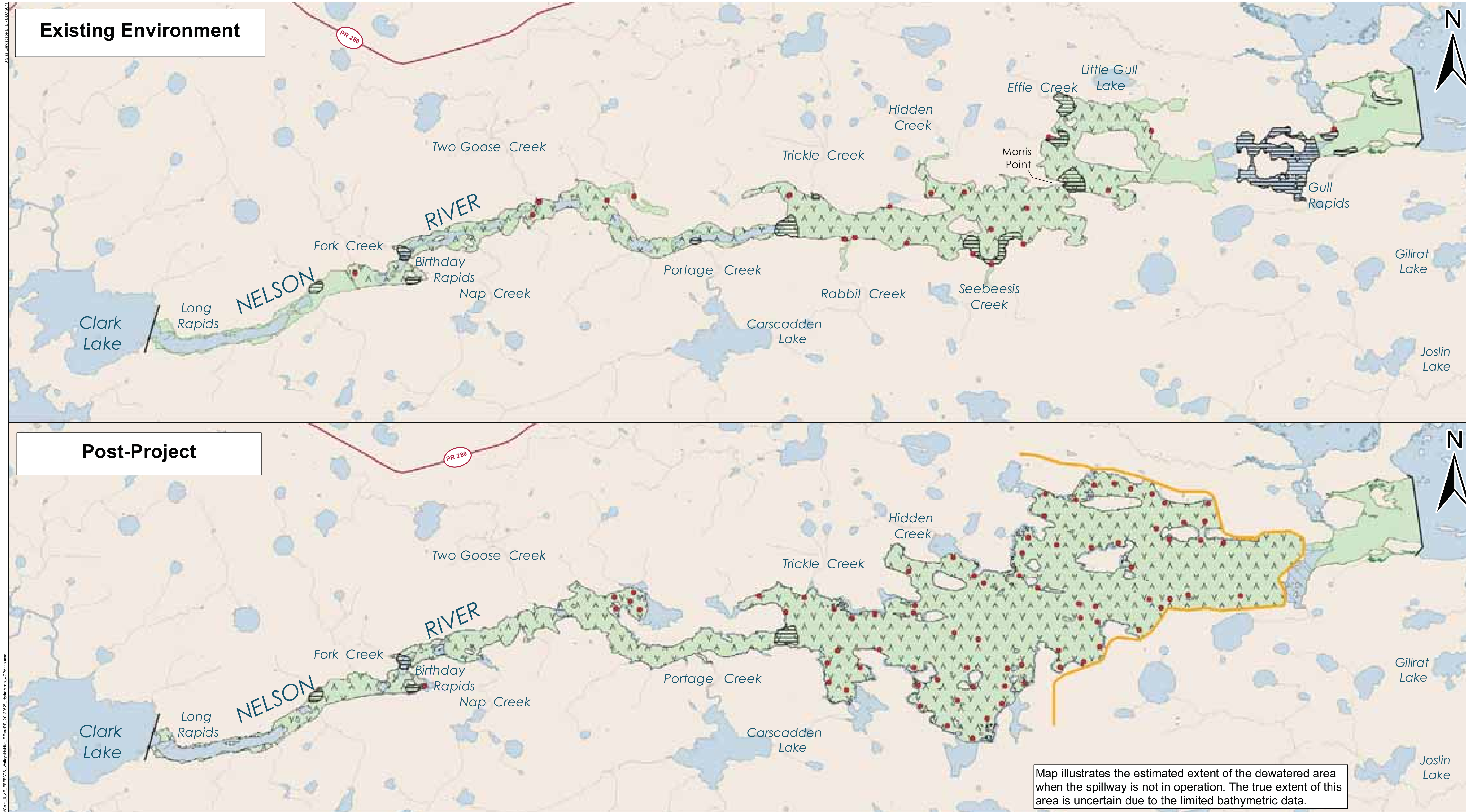
- 2001 Aquatic Plant Bed
- 2003 Aquatic Plant Bed
- 2006 Aquatic Plant Bed
- Post-Project Aquatic Plant Habitat
- Potential Dewatered Area
- Keeyask Principal Structures
- Clark Lake to Stephens Lake Area Boundary

Note: Post-Project frame shows Year 30 habitat - aquatic plant beds not expected to cover entire area. Extents of dewatered area are estimated based on the existing environment 95th percentile flow.

KEEYASK Hydropower Limited Partnership

Aquatic Plant Habitat

Map 6-56



KEEYASK Hydropower Limited Partnership

DATA SOURCE:
Manitoba Hydro, North/South Consultants, Government of Canada
gull-ee-95perc-4327cms-rev3, pp-95perc-4327-159-shore-rev5

CREATED BY:
North/South Consultants

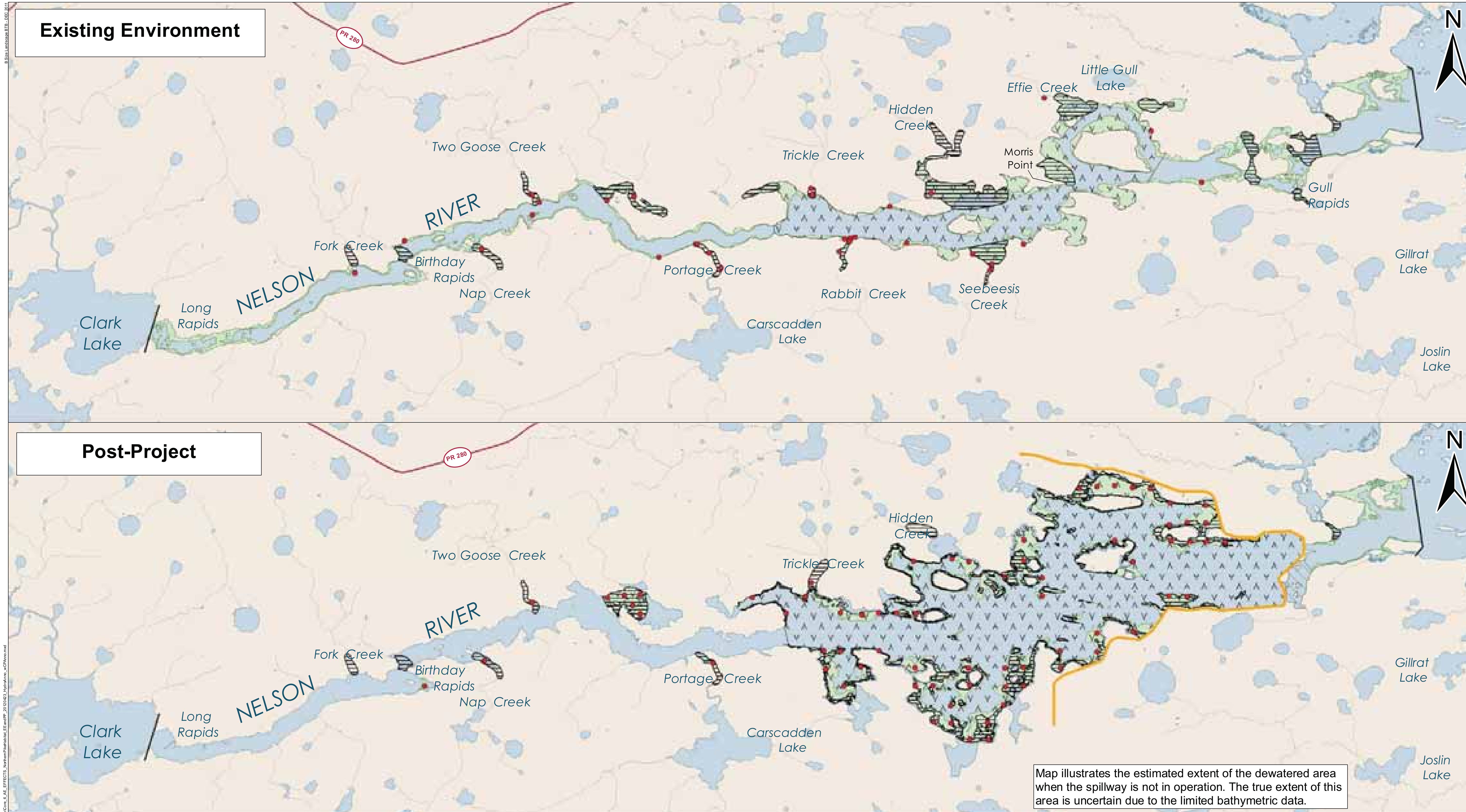
COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	26-MAR-10	24-MAY-12
0 2 4 Kilometres / 0 1 2 Miles	VERSION NO: 3.0	QA/QC: APPROVED

Legend

- Rearing
- Spawning
- Foraging
- Overwintering
- Potential Dewatered Area
- Keeyask Principal Structures
- Clark Lake to Stephens Lake Area Boundary

Note: Existing Environment and Post-Project frames show 95th percentile inflow. Extents of dewatered area are estimated based on the existing environment 95th percentile flow. Mitigation measures are not shown

Walleye Habitat



DATA SOURCE:
Manitoba Hydro, North/South Consultants, Government of Canada
gull-ee-95perc-4327cms-rev3, pp-95perc-4327-159-shore-rev5

CREATED BY:
North/South Consultants

COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	26-MAR-10	24-MAY-12
0 2 4 Kilometres / 0 1 2 Miles	VERSION NO: 3.0	QA/QC: APPROVED

Legend

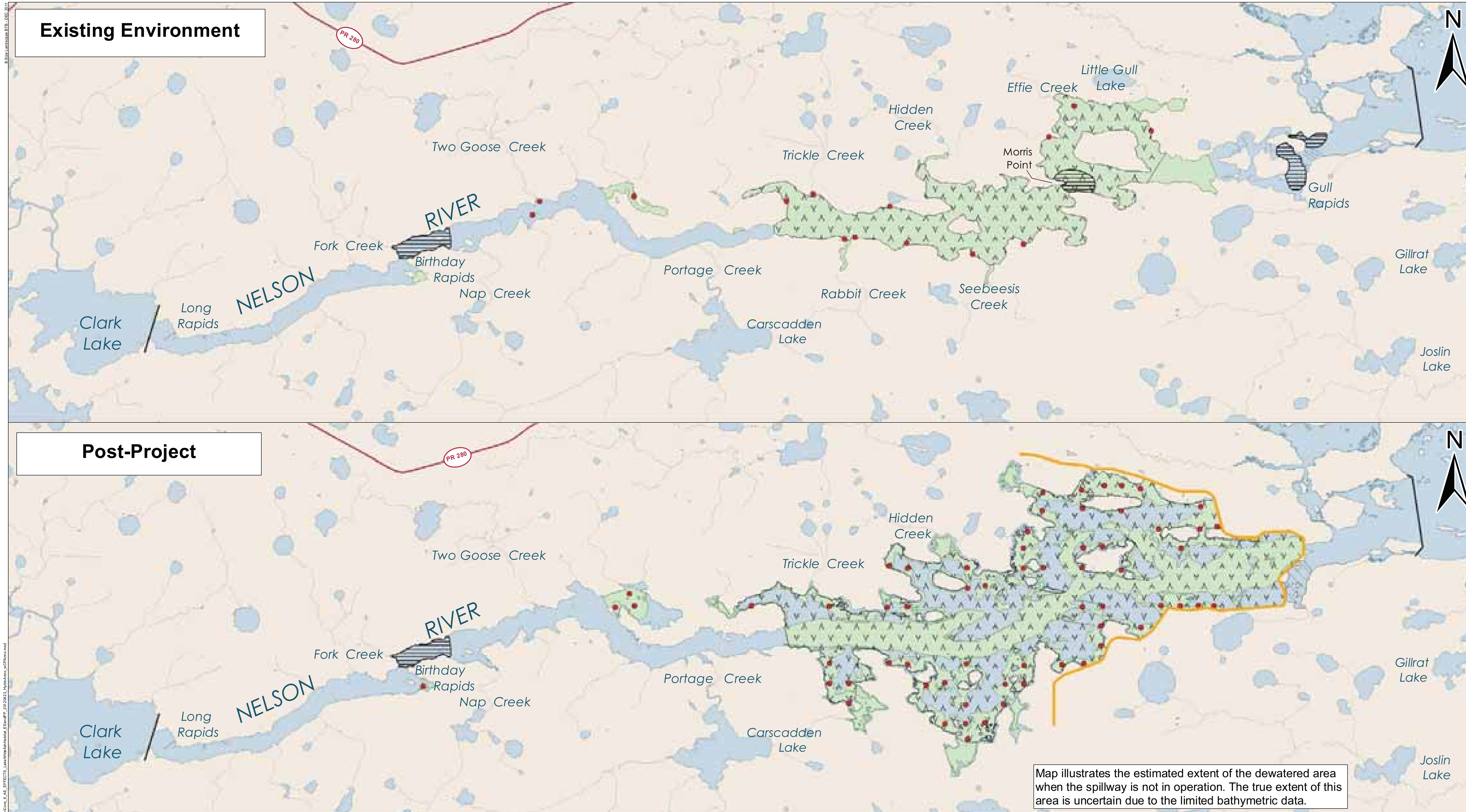
- Rearing
- Spawning
- Foraging
- Overwintering
- Potential Dewatered Area
- Keeyask Principal Structures
- Clark Lake to Stephens Lake Area Boundary

Note: Existing Environment and Post-Project frames show 95th percentile inflow. Extents of dewatered area are estimated based on the existing environment 95th percentile flow. Mitigation measures are not shown

Northern Pike Habitat

KEEYASK Hydropower Limited Partnership

Map 6-58



Keeyask Hydropower Limited Partnership

DATA SOURCE:
Manitoba Hydro, North/South Consultants, Government of Canada
gull-ee-95perc-4327cms-rev3, pp-95perc-4327-159-shore-rev5

CREATED BY:
North/South Consultants

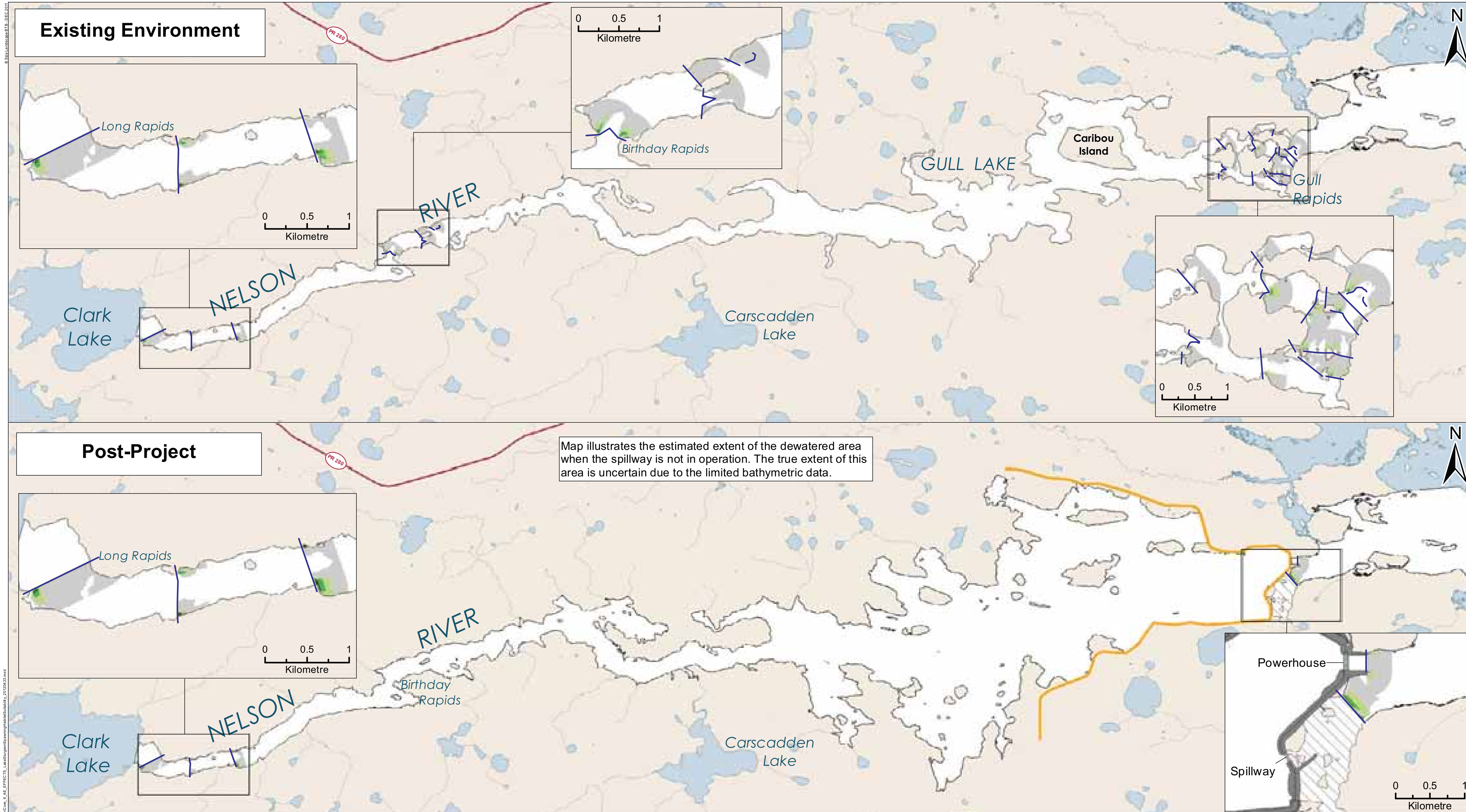
COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	26-MAR-10	24-MAY-12
0 2 4 Kilometres / 0 1 2 Miles	VERSION NO: 3.0	QA/QC: APPROVED

Legend

- Rearing
- Spawning
- Foraging
- Overwintering
- Potential Dewatered Area
- Keeyask Principal Structures
- Clark Lake to Stephens Lake Area Boundary

Note: Existing Environment and Post-Project frames show 95th percentile inflow. Extents of dewatered area are estimated based on the existing environment 95th percentile flow. Mitigation measures are not shown

Lake Whitefish Habitat



DATA SOURCE:
Manitoba Hydro, North/South Consultants, Government of Canada
gull-ee-95perc-4327cms-rev3, pp-95perc-4327-159-shore-rev5

CREATED BY:
North/South Consultants

COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	26-MAR-10	22-JUN-12
0 2 4 Kilometres / 0 1 2 Miles	VERSION NO: 4.0	QA/QC: APPROVED

Legend

Habitat Suitability Index
- 0.00
- 0.01 - 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00

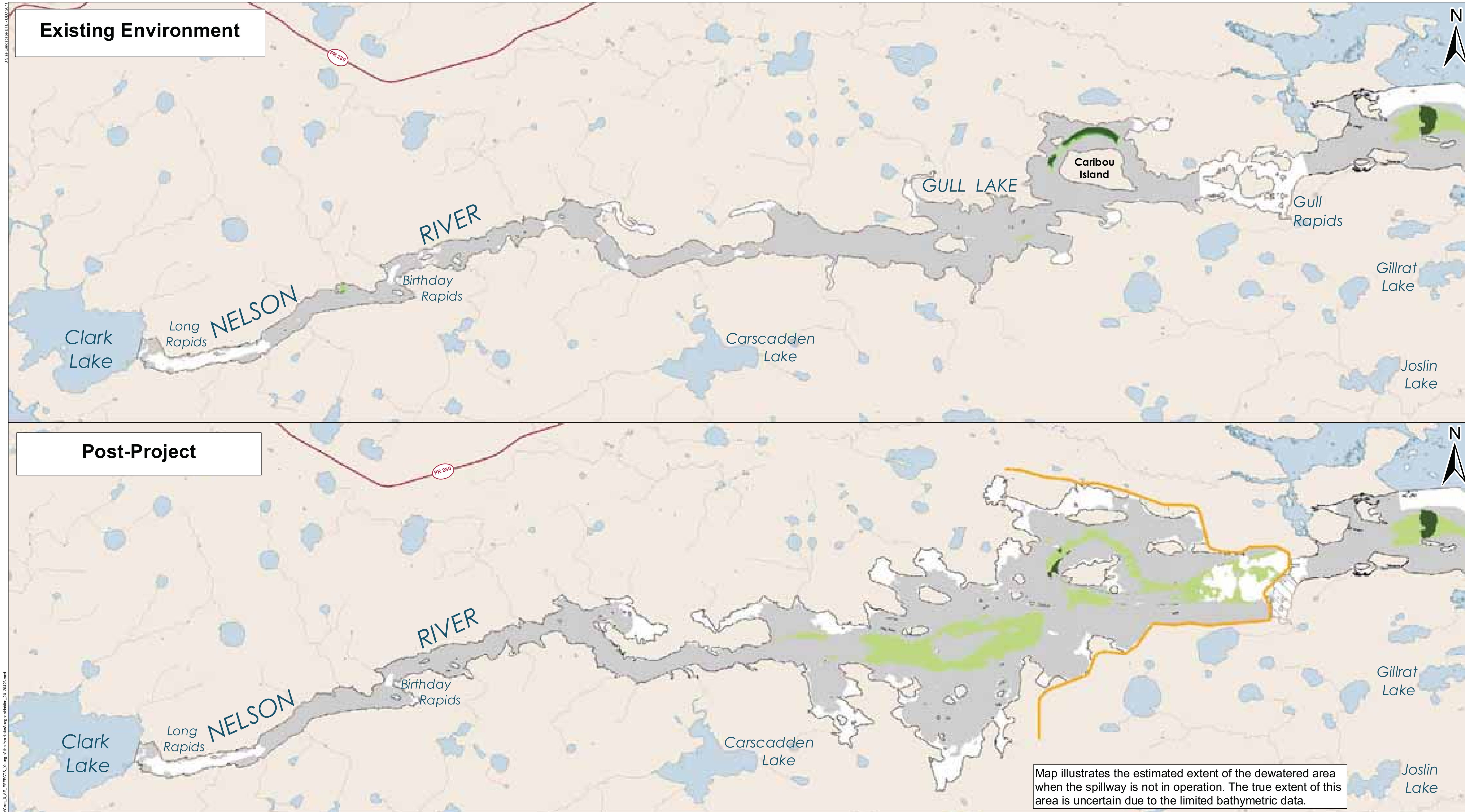
- Potential Dewatered Area
- Keeyask Principal Structures
- Hydraulic Feature

Note: Existing Environment frame shows 95th percentile inflow and Stephens Lake level of 141.1m. Post-Project frame shows Year 30 shoreline, reservoir at 159 metres and 95th percentile inflow with 7 unit full gate plant operation with spill and Stephens Lake level of 141.1m. Mitigation measures are not shown. Extents of dewatered area are estimated based on the existing environment 95th percentile flow.

Lake Sturgeon Spawning Habitat

Five Variable Habitat Suitability Index Model Output

Map 6-60



KEEYASK
Hydropower Limited Partnership

DATA SOURCE:
Manitoba Hydro, North/South Consultants, Government of Canada
gull-ee-95perc-4327cms-rev3, pp-95perc-4327-159-shore-rev5

CREATED BY:
North/South Consultants

COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	26-MAR-10	24-MAY-12
0 2 4 Kilometres / 0 1 2 Miles	VERSION NO: 4.0	QA/QC: APPROVED

Legend

Habitat Suitability Index
- 0.00
- 0.01 - 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00

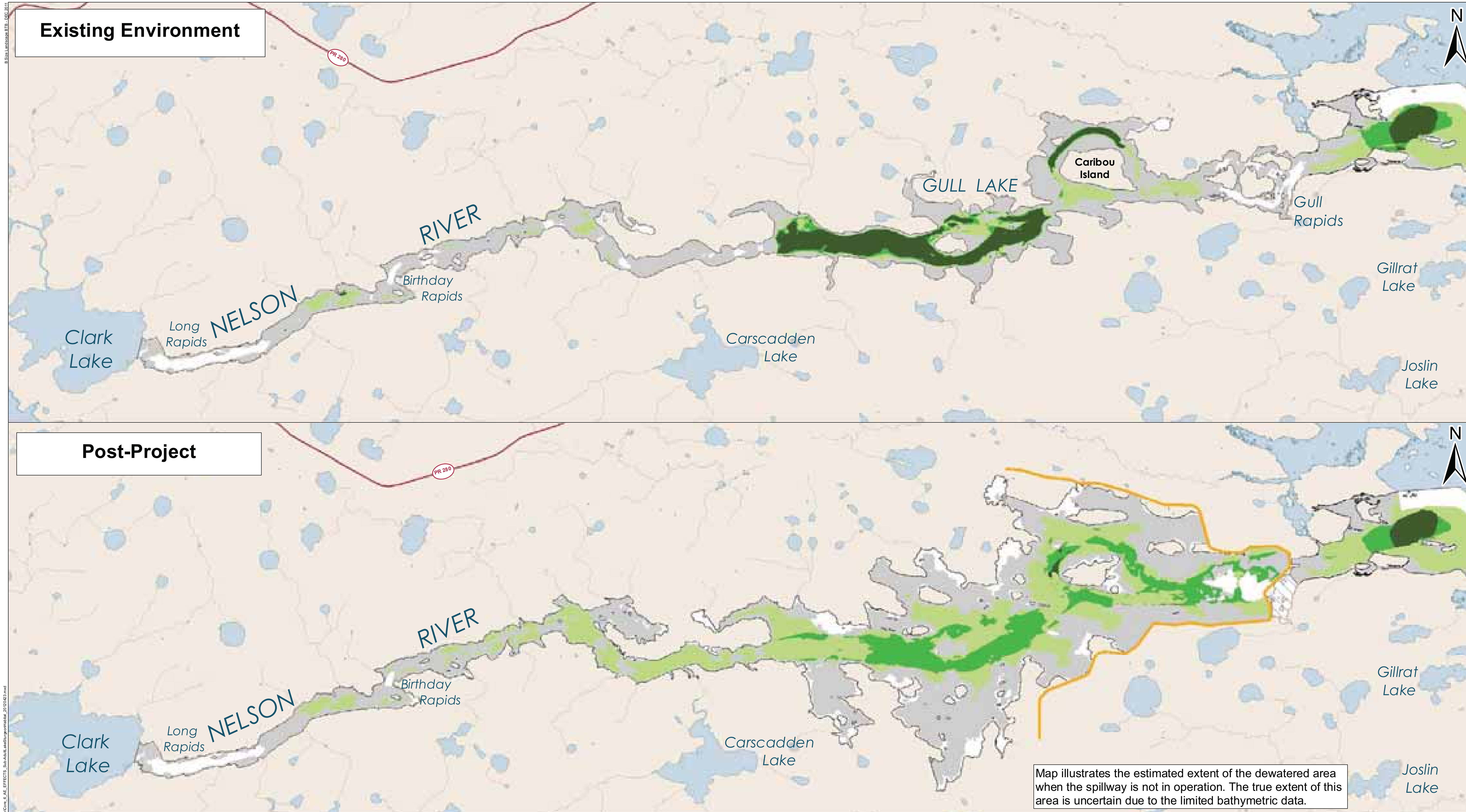
- Potential Dewatered Area
- Keeyask Principal Structures

Note: Existing Environment frame shows 95th percentile inflow and Stephens Lake level of 141.1m. Post-Project frame shows Year 30 shoreline, reservoir at 159 metres and 95th percentile inflow with 7 unit full gate plant operation with spill and Stephens Lake level of 141.1m. Mitigation measures are not shown. Extents of dewatered area are estimated based on the existing environment 95th percentile flow.

Young-of-the-Year Lake Sturgeon Habitat

Habitat Suitability Index Model Output

Map 6-61



KEEYASK
Hydropower Limited Partnership

DATA SOURCE:
Manitoba Hydro, North/South Consultants, Government of Canada
gull-ee-95perc-4327cms-rev3, pp-95perc-4327-159-shore-rev5

CREATED BY:
North/South Consultants

COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	26-MAR-10	24-MAY-12
0 2 4 Kilometres / 0 1 2 Miles	VERSION NO: 3.0	QA/QC: APPROVED

Legend

Habitat Suitability Index

- 0.00
- 0.01 - 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00

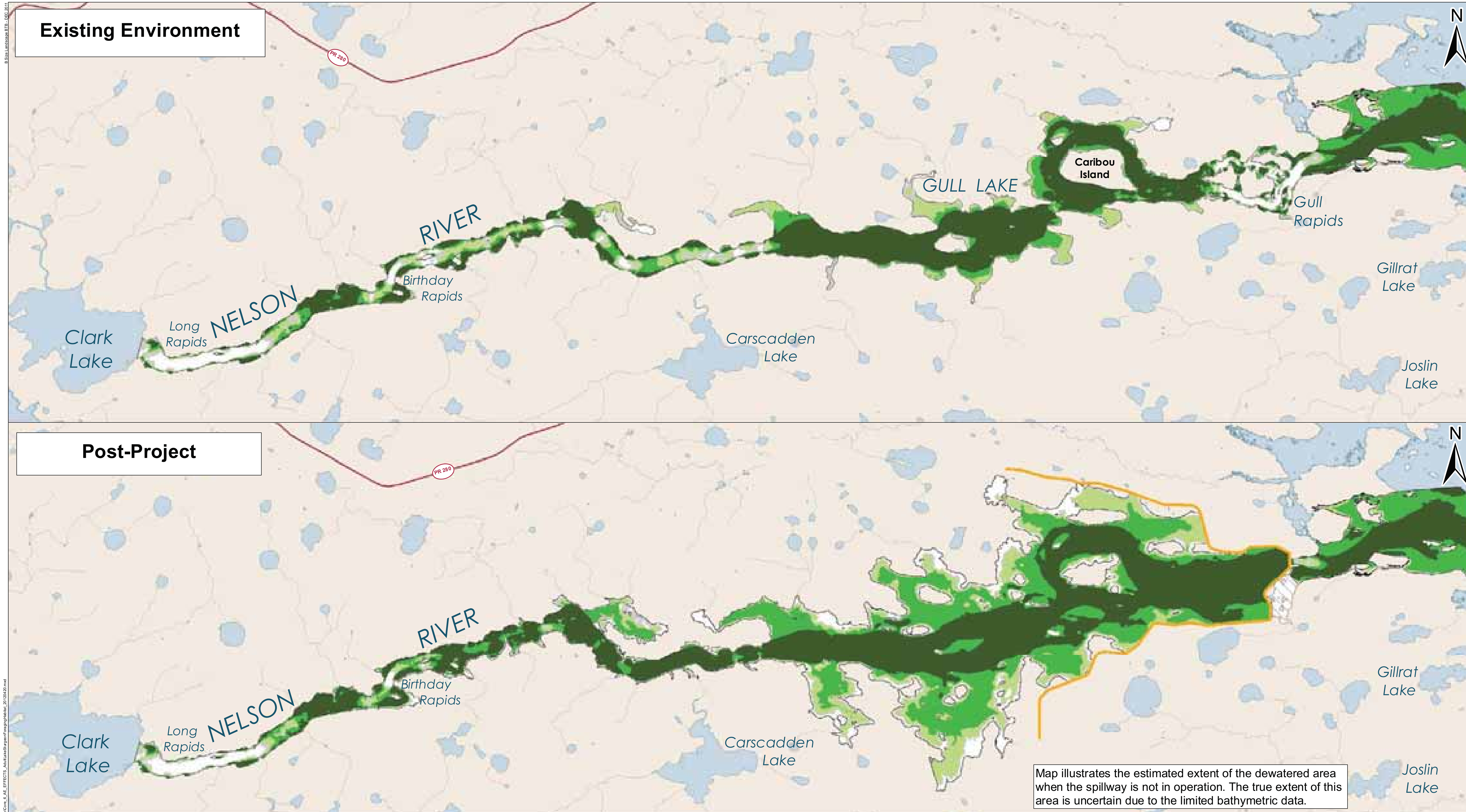
- Potential Dewatered Area
- Keeyask Principal Structures

Note: Existing Environment frame shows 95th percentile inflow and Stephens Lake level of 141.1m. Post-Project frame shows Year 30 shoreline, reservoir at 159 metres and 95th percentile inflow with 7 unit full gate plant operation with spill and Stephens Lake level of 141.1m. Mitigation measures are not shown. Extents of dewatered area are estimated based on the existing environment 95th percentile flow.

Sub-Adult Lake Sturgeon Habitat

Habitat Suitability Index Model Output

Map 6-62



KEEYASK Hydropower Limited Partnership

DATA SOURCE:
Manitoba Hydro, North/South Consultants, Government of Canada
gull-ee-95perc-4327cms-rev3, pp-95perc-4327-159-shore-rev5

CREATED BY:
North/South Consultants

COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	26-MAR-10	24-MAY-12

	VERSION NO:	QA/QC:
0 2 4 Kilometres / 0 1 2 Miles	3.0	APPROVED

Legend

Habitat Suitability Index
- 0.00
- 0.01 - 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00

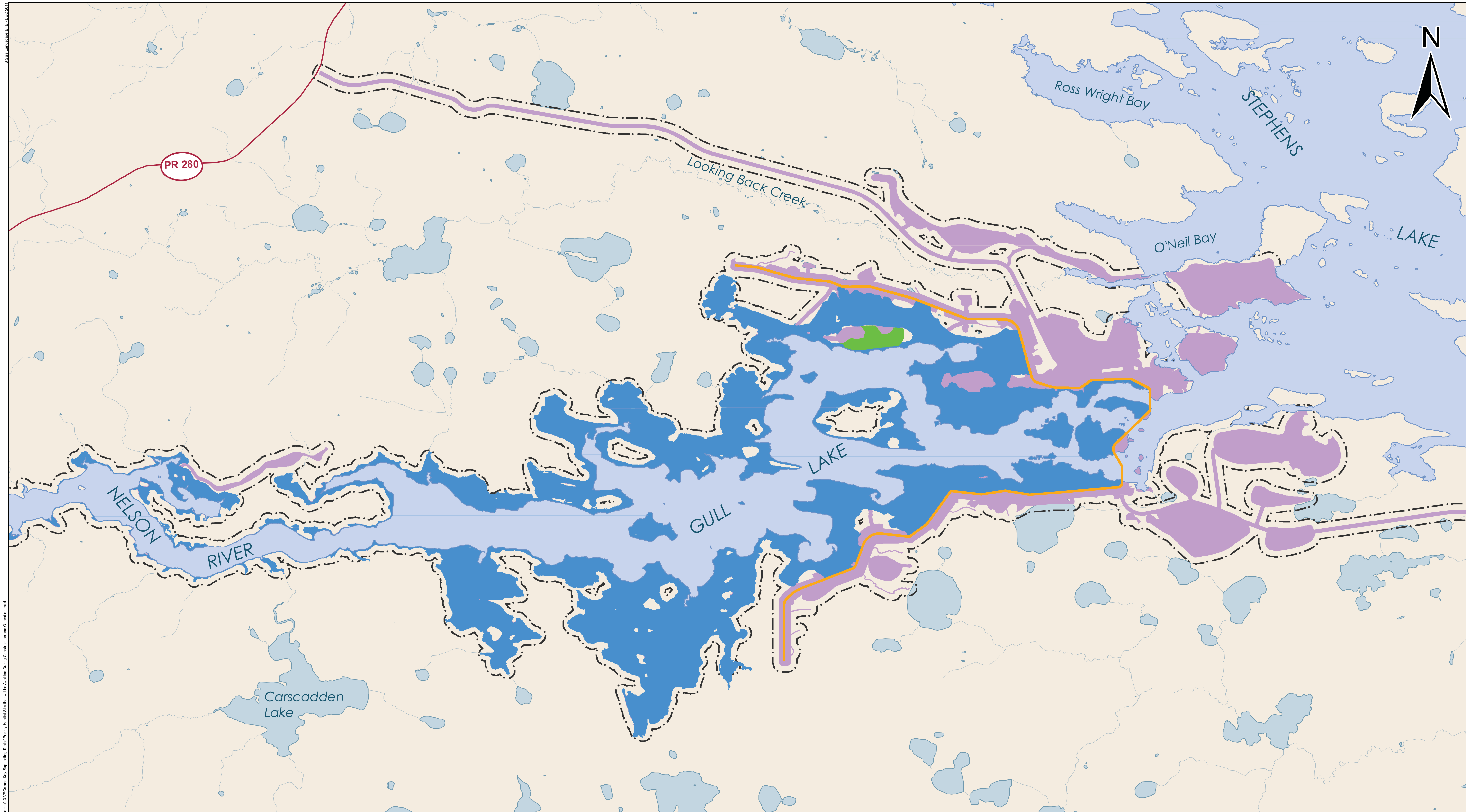
- Potential Dewatered Area
- Keeyask Principal Structures

Note: Existing Environment frame shows 95th percentile inflow and Stephens Lake level of 141.1m. Post-Project frame shows Year 30 shoreline, reservoir at 159 metres and 95th percentile inflow with 7 unit full gate plant operation with spill and Stephens Lake level of 141.1m. Mitigation measures are not shown. Extents of dewatered area are estimated based on the existing environment 95th percentile flow.

Adult Lake Sturgeon Foraging Habitat

Habitat Suitability Index Model Output

Map 6-63



DATA SOURCE:
Study areas, habitat site and Nelson River shoreline - ECOSTEM Ltd.; Year 30 reservoir - ECOSTEM Ltd. and J D Mollard and Associates; Water - NTS; Roads and rail - Manitoba Conservation.

CREATED BY:
ECOSTEM Ltd.

COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	30-MAY-12	30-MAY-12

0 0.9 1.8 Kilometres
0 0.8 1.6 Miles

VERSION NO:	QA/QC:
1.0	JWE/YYY/ZZZ

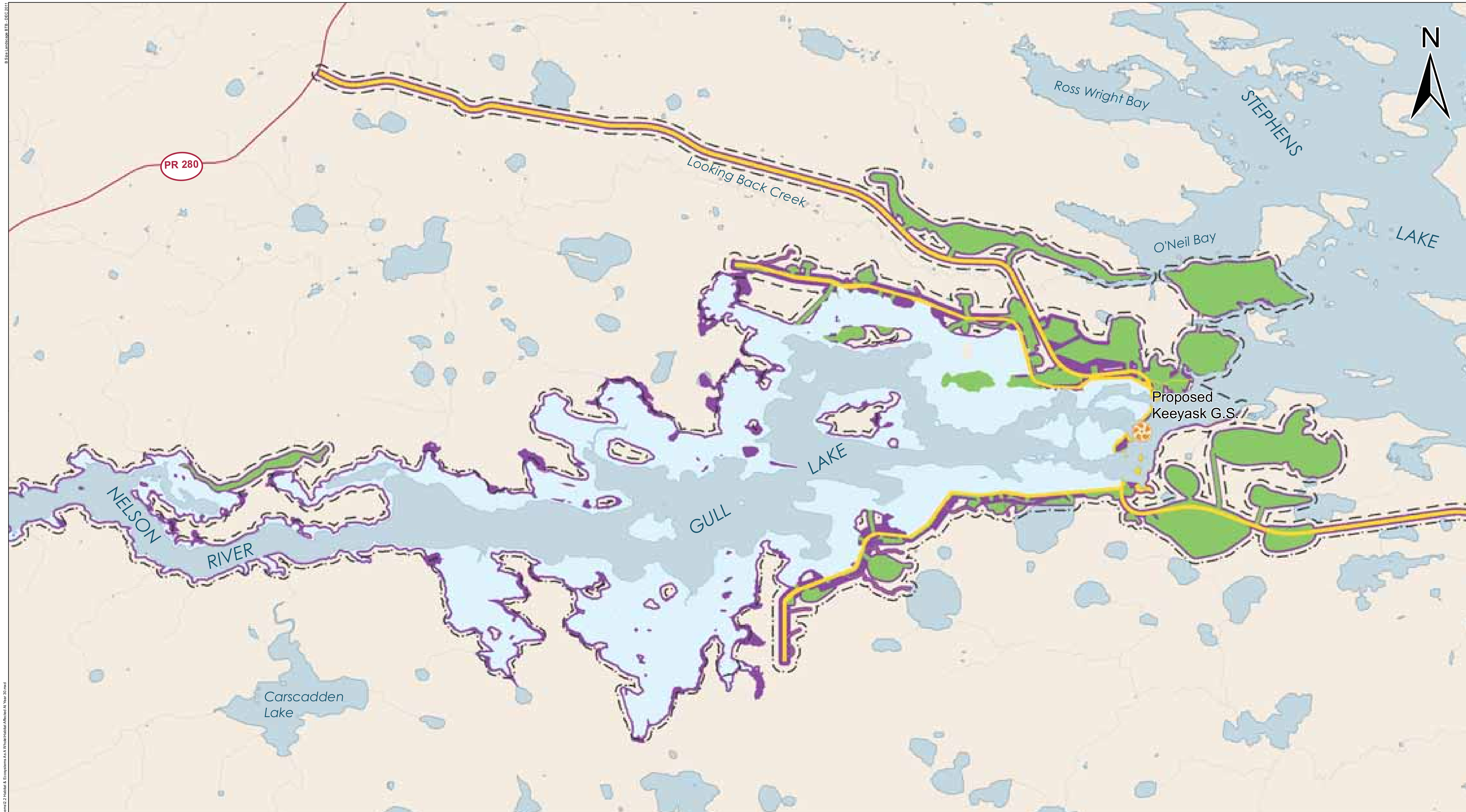
Legend

Priority Habitat Patches To Avoid
- Borrow Area N-6 Sensitive Site

Reservoir Area (159 m)
- Reservoir at Year 30

Study Areas
- Project Footprint During Construction and Operation
- Ecosystem Diversity Local Study Area
- Keeyask Principal Structures

Priority Habitat Site To Avoid
During Construction and Operation



KEEYASK
Hydropower Limited Partnership

DATA SOURCE:
Study areas, habitat and Nelson River shoreline - ECOSTEM Ltd.; Water - NTS; Roads and rail - Manitoba Conservation.

CREATED BY:
ECOSTEM Ltd.

COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	22-MAR-12	03-APR-12

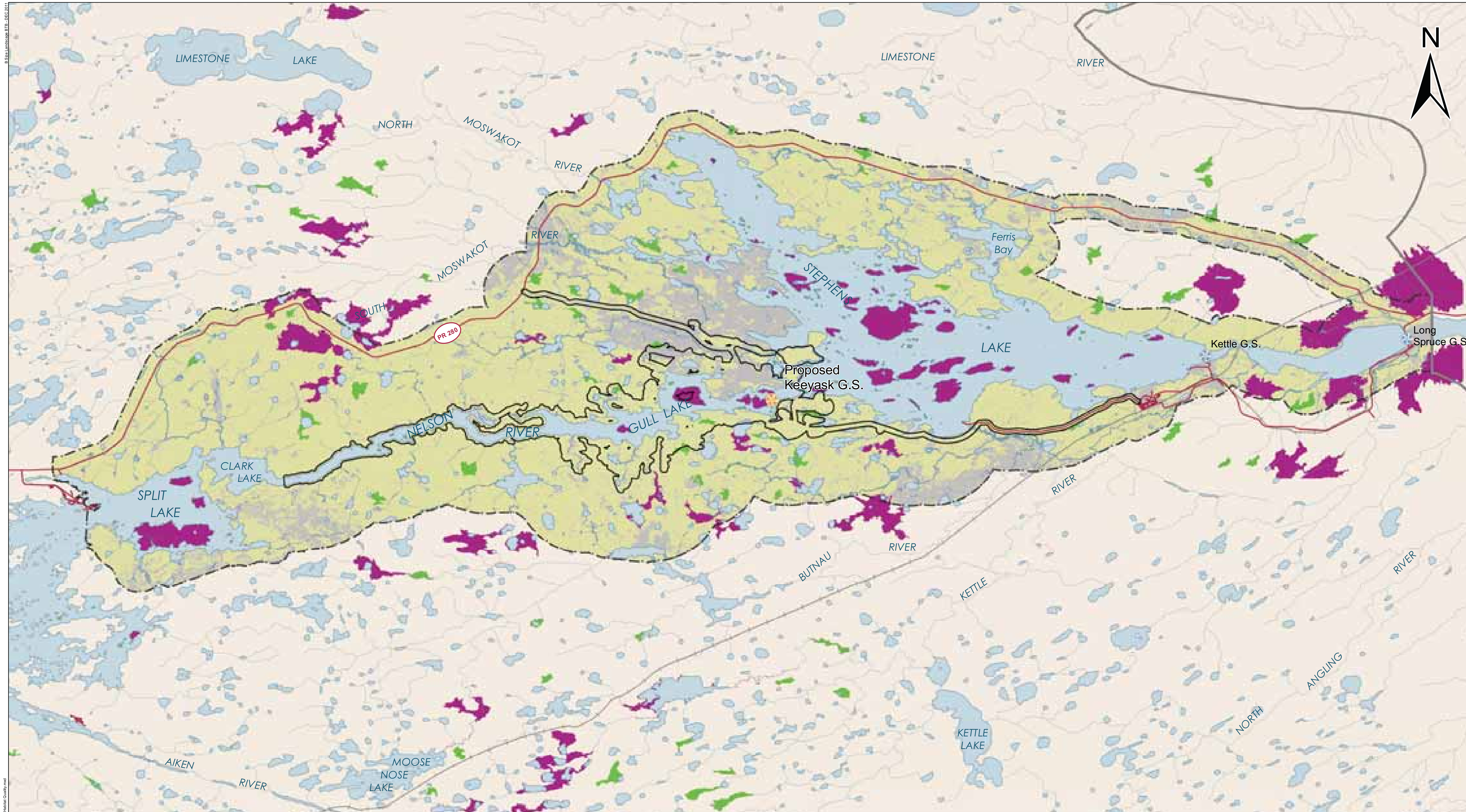
Scale	VERSION NO:	QA/QC:
0 0.9 1.8 Kilometres; 0 0.8 1.6 Miles	1.0	JWE/RDB/MWZ

Legend

Permanence of Habitat Effects
- Permanently Lost - Infrastructure
- Permanently Lost - Reservoir
- Rehabilitated, Unused or Disturbed Construction Areas
- Indirectly Altered Over the Long-Term

Study Areas
- Habitat Local Study Area

Habitat Affected at Year 30



KEEYASK
Hydropower Limited Partnership

DATA SOURCE:
Study areas, habitat data and Nelson River shoreline - ECOSTEM Ltd.; Water - NTS; Roads and rail - Manitoba Conservation.

CREATED BY:
ECOSTEM Ltd.

COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	23-MAR-12	18-MAY-12
0 2.5 5 Kilometres / 0 3 6 Miles	VERSION NO: 1.0	QA/QC: APPROVED

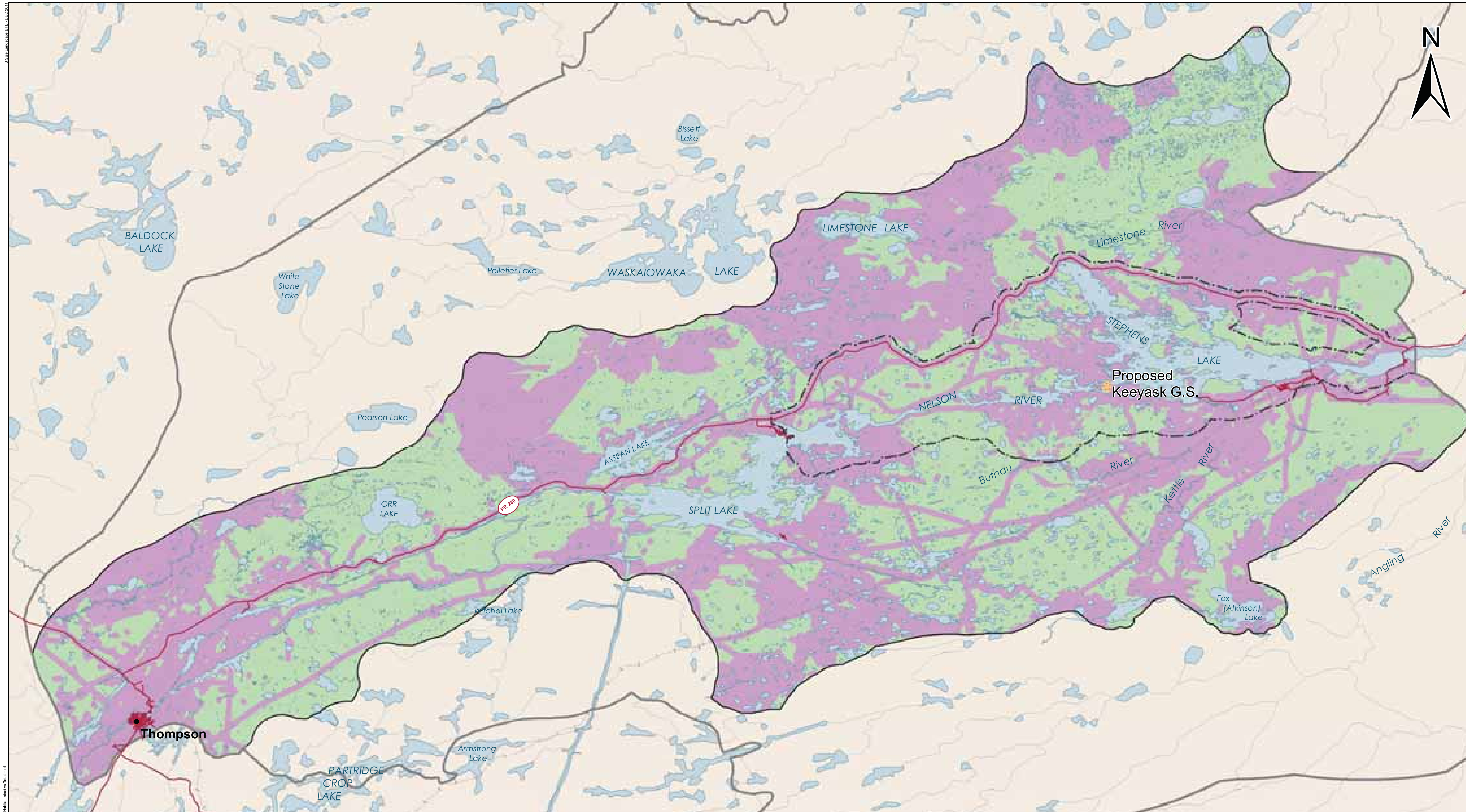
Legend

Caribou Habitat Quality
- Primary Calving Habitat
- Secondary Calving Habitat
- Winter Habitat
- Unsuitable Habitat

Study Areas
- Study Zone 2
- Caribou Local Study Area
- Caribou Regional Study Area

Caribou Habitat Quality

Map 6-66



KEEYASK
Hydropower Limited Partnership

DATA SOURCE:
Intact caribou areas and Nelson River shoreline - ECOSTEM Ltd.; Roads - Manitoba Conservation; Water and rail - NTS.

CREATED BY:
ECOSTEM Ltd.

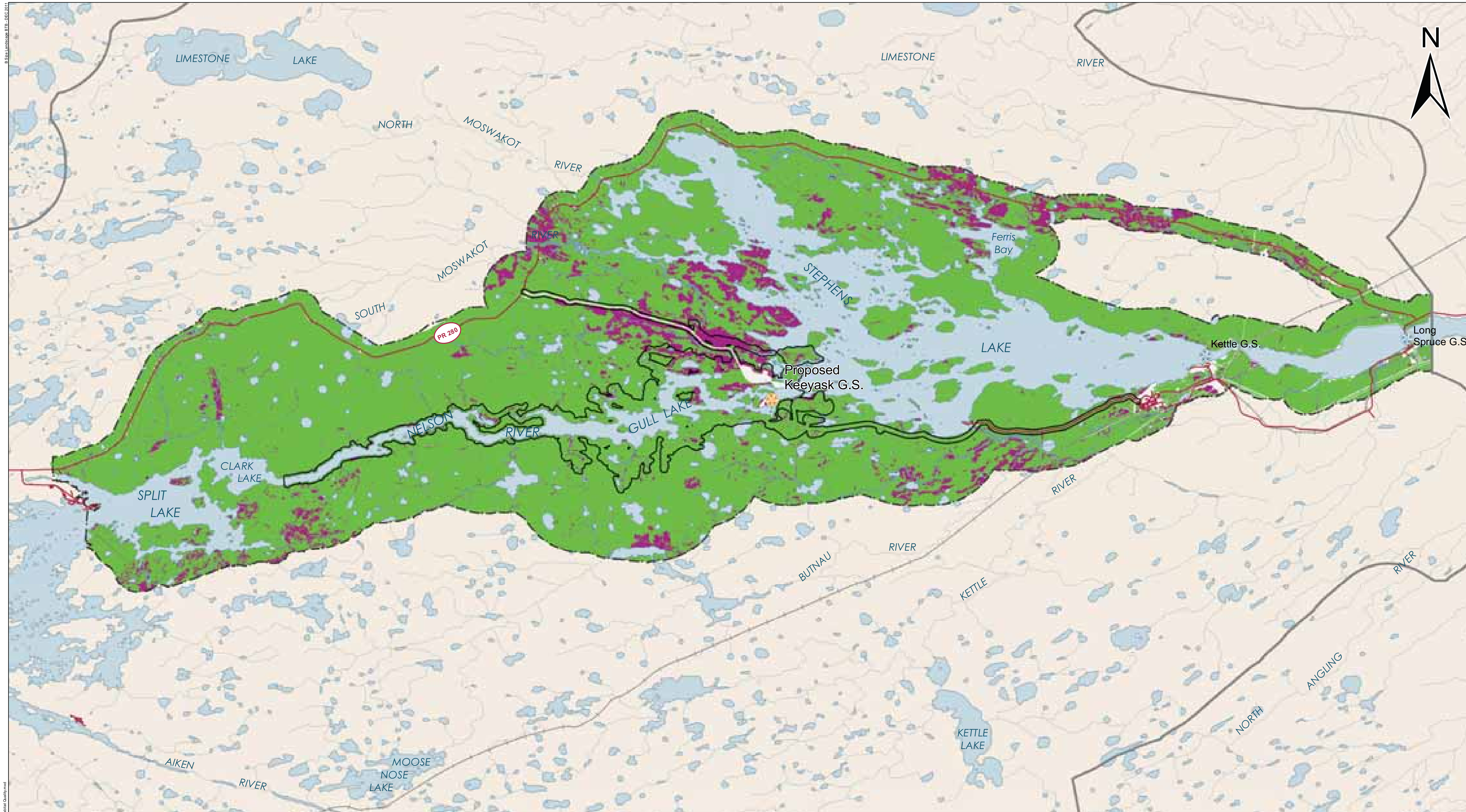
COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	23-MAR-12	18-MAY-12
0 5 10 Kilometres / 0 4 8 Miles	VERSION NO: 1.0	QA/QC: APPROVED

Legend
- Undisturbed Caribou Habitat
- Disturbed Caribou Habitat

Infrastructure
- Highway
- Rail

Study Areas
- Caribou Local Study Area
- Study Zone 5
- Caribou Regional Study Area

Undisturbed Caribou Habitat
in Study Zone 5



KEEYASK
Hydropower Limited Partnership

DATA SOURCE:
Study areas, habitat data and Nelson River shoreline - ECOSTEM Ltd.; Water - NTS; Roads and rail - Manitoba Conservation.

CREATED BY:
ECOSTEM Ltd.

COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	23-MAR-12	18-MAY-12
0 2.5 5 Kilometres / 0 3 6 Miles	VERSION NO: 1.0	QA/QC: APPROVED

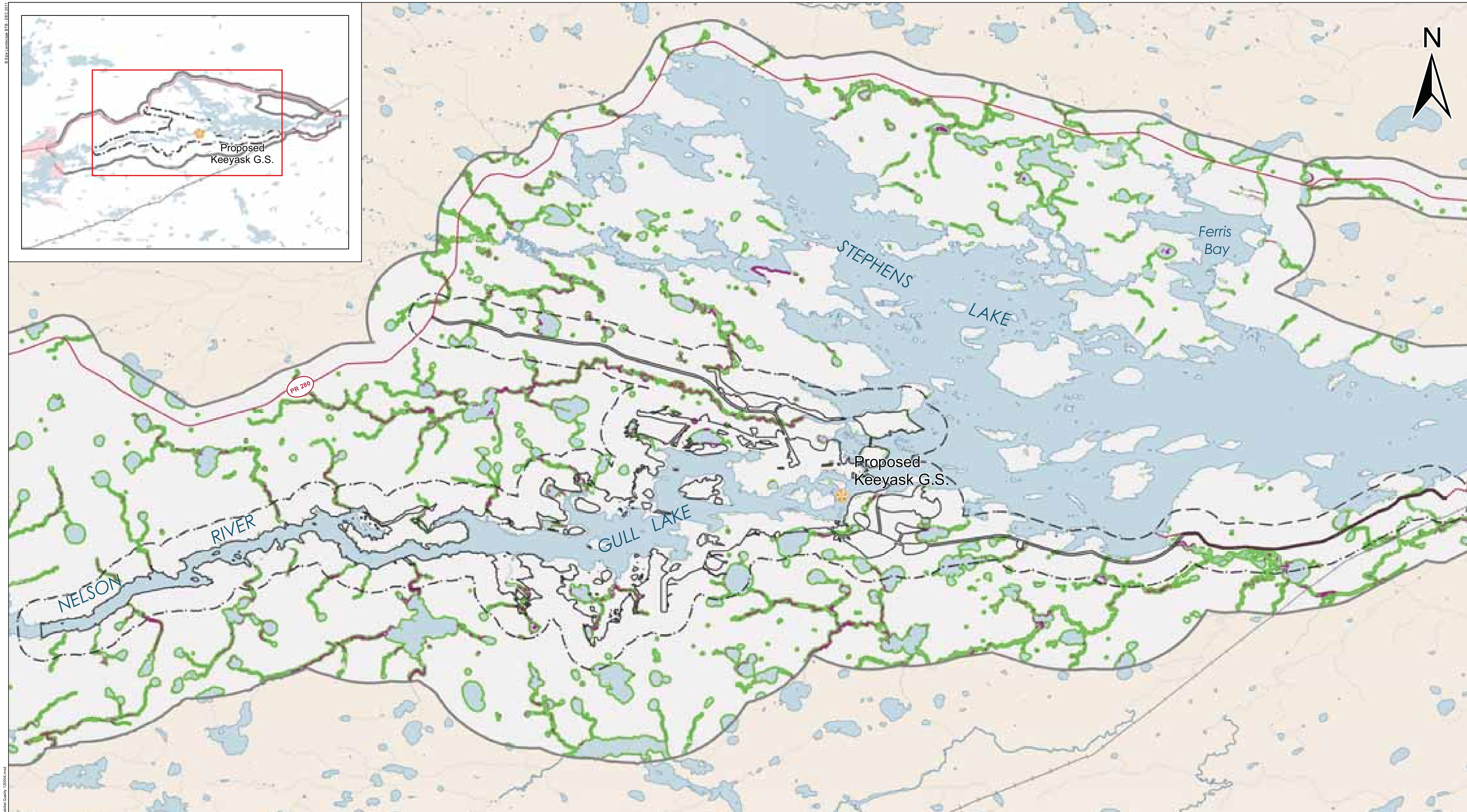
Legend

Moose Habitat Quality
- Primary Habitat
- Secondary Habitat
- Unsuitable Habitat

Study Areas
- Study Zone 2
- Moose Local Study Area
- Moose Regional Study Area

Moose Habitat Quality

Map 6-68



DATA SOURCE:
Study areas, habitat data and Nelson River shoreline - ECOSTEM Ltd.; Water - NTS; Roads and rail - Manitoba Conservation.

CREATED BY:
ECOSTEM Ltd.

COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	23-MAR-12	15-MAY-12
0 2 4 Kilometres / 0 2 4 Miles	VERSION NO: 1.0	QA/QC: APPROVED

Legend

Beaver Habitat Quality
- Primary Habitat
- Secondary Habitat
- Unsuitable Habitat

Study Areas
- Study Zone 1
- Beaver Local Study Area
- Beaver Regional Study Area

Note: Primary habitat size is slightly exaggerated to enhance visibility

Beaver Habitat Quality

KEEYASK
Hydropower Limited Partnership

DATA SOURCE:
Manitoba Hydro
Historic Resources Branch of Manitoba Culture, Heritage and Tourism

CREATED BY:
Northern Lights Heritage Services Inc.

COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	24-MAY-12	24-MAY-12
0 1 2 Kilometres / 0 0.6 1.2 Miles	VERSION NO: 1.0	QA/QC: APPROVED

Legend
- ABC ATK Identified Potential Burial Location
- Registered Burial Site (HbKu-24)
- Keeyask Principal Infrastructure Axis
- North Access Road
- Proposed Access Road

Identified Potential Burial Locations
on Gull Lake

Map 6-70

DATA SOURCE:
Manitoba Hydro,
Historic Resources Branch of Manitoba Culture, Heritage and Tourism

CREATED BY:
Northern Lights Heritage Services Inc.

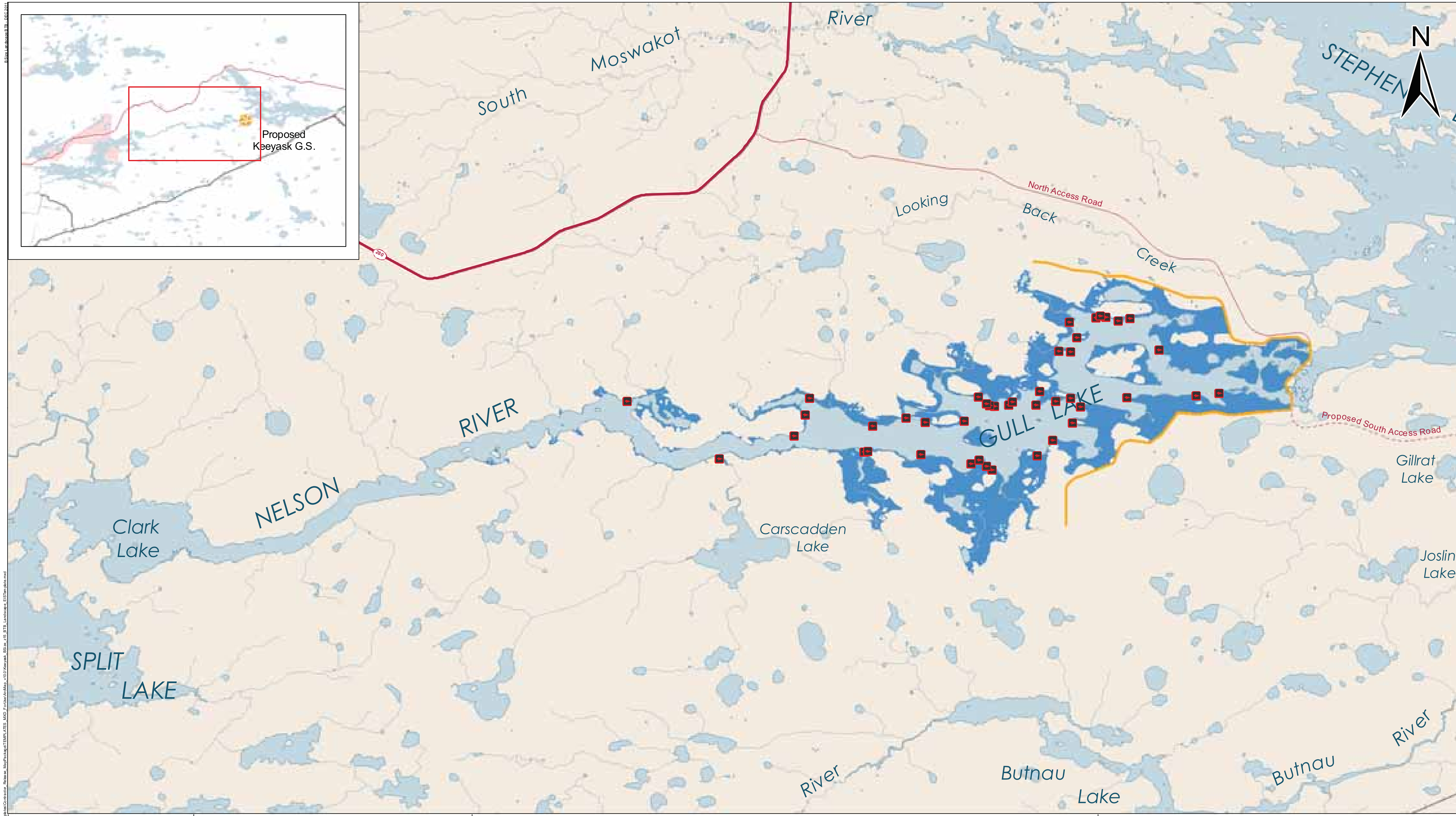
COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	24-MAY-12	24-MAY-12
0 0.7 1.4 Kilometres / 0 0.4 0.8 Miles	VERSION NO: 1.0	QA/QC: APPROVED

Legend

- Archaeological Site (Potentially Affected), 7
- Keeyask Principal Infrastructure Axis
- North Access Road
- Proposed South Access Road
- Borrow Material Source
- Keeyask Principal Infrastructure

Potentially Affected Archaeological Sites
Construction Phase

Map 6-71



DATA SOURCE:
Historic Resources Branch of Manitoba Culture, Heritage and Tourism
Manitoba Hydro, 0_a9de1/gull-ee-95perc-4327cms-rev3
0_a9dcb/pp-95perc-4327-159-shore-rev5

CREATED BY:
Northern Lights Heritage Services Inc.

COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	24-MAY-12	24-MAY-12
0 2 4 Kilometres / 0 1 2 Miles	VERSION NO: 1.0	QA/QC: APPROVED

Legend

- Archaeological Site (Potentially Affected), 43
- Keeyask Principal Infrastructure Axis
- North Access Road
- Proposed South Access Road
- Highway
- Existing Water Surface Area
- Initial Flooded Area (159 m)

Potentially Affected Archaeological Sites

Operation Phase

APPENDIX 6A

ENVIRONMENTAL STUDY REPORT LIST

Environmental Study Report List

Report Number	Report Title	Status	Date Completed
PHYSICAL ENVIRONMENT			
GN-9.1.1	Manitoba Hydro, 2009. Existing and Project Environment Flow Files. Keeyask Project Environmental Studies Program Report. 32 pp.	In preparation	
GN-9.1.2	Manitoba Hydro, 2009. Sensitivity of Water Regime Products to Inflows. Keeyask Project Environmental Studies Program Report. 42 pp.	In preparation	
GN-9.1.3	Manitoba Hydro, 2009. Existing and Project Environment Shoreline & Depth Effects Assessment. Keeyask Project Environmental Studies Program Report. 17 pp.	In preparation	
GN-9.1.4	Manitoba Hydro, 2009. Existing and Project Environment Velocity Regime Effects Assessment. Keeyask Project Environmental Studies Program Report. 17 pp.	In preparation	
GN-9.1.5	Manitoba Hydro, 2009. Existing and Project Environment Digital Terrain Models. Keeyask Project Environmental Studies Program Report. 20 pp.	In preparation	
GN-9.1.6	KGS Acres Ltd., 2011. Existing Environment Ice Processes. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro.	Completed	3/24/2011
GN-9.1.7	KGS Acres Ltd., 2011. Project Environment Ice Processes and Effects Assessment. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro.	Completed	3/24/2011
GN-9.1.8	Manitoba Hydro, 2009. Existing Environment Water Regime - Key Sites. Keeyask Project Environmental Studies Program Report. 305 pp.	In preparation	
GN-9.1.12	Manitoba Hydro, 2009. Project Environment - Water Level and Flow Regime at Key Sites and Effects Assessment. Keeyask Project Environmental Studies Program. 66 pp.	In preparation	
GN-9.1.13	Manitoba Hydro, 2009. Existing and Project Environment Water Surface Profiles Effects Assessment. Keeyask Project Environmental Studies Program Report. 19 pp.	In preparation	
GN-9.1.14	Manitoba Hydro, 2009. Existing and Project Environment Creek Hydraulics Effects Assessment. Keeyask Project Environmental Studies Program Report. 33 pp.	In preparation	

Environmental Study Report List

Report Number	Report Title	Status	Date Completed
GN-9.1.15	Manitoba Hydro, 2009. Existing and Project Environment Creek Hydrology. Keeyask Project Environmental Studies Program Report. 33 pp.	In preparation	
GN-9.1.16	KGS Acres Ltd., 2011. Ice Processes and Their Potential Link to Erosion – Existing Environment, Nelson River Outlet of Split Lake to Stephens Lake. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro.	Completed	3/24/2011
GN-9.1.17	KGS Acres Ltd., 2011. Post-Impoundment Velocity and Shear Stress Distributions. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro.	Completed	3/21/2011
GN-9.2.1	Ecostem Ltd., 2009. Composition and Distribution of Shoreline and Inland Peatlands in the Keeyask Forebay Area and Historical Trends in Peatland Disintegration. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. 99 pp.	In preparation	
GN-9.2.2	J.D. Mollard and Associates Ltd. and KGS Acres Ltd., 2008. Existing Environment Mineral Erosion. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. 72 pp.	In preparation	
GN-9.2.3	KGS Acres Ltd., 2011. Existing Environment Sedimentation. Draft report prepared for Manitoba Hydro by KGS Acres Ltd. and the University of Ottawa. 89 pp.	Completed	6/10/2011
GN-9.2.4	Ecostem Ltd., 2009. Projected Future Peatland Disintegration in the Proposed Keeyask Reservoir Area Without the Keeyask Project. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. pp. *Draft*.	In preparation	
GN-9.2.5	J.D. Mollard and Associates Ltd., 2008. Projected Future Mineral Erosion Without the Keeyask GS. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. 19 pp.	In preparation	
GN-9.2.6	KGS Acres Ltd., 2011. Projected Future Sedimentation Without the Keeyask Project. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. 15 pp.	Completed	3/11/2011
GN-9.2.7	Ecostem Ltd., 2009. Peatland Disintegration in the Proposed Keeyask Reservoir Area: Model Development and Post-Project Predictions. Keeyask Project Environmental Studies Program	In preparation	

Environmental Study Report List

Report Number	Report Title	Status	Date Completed
	Report prepared for Manitoba Hydro. 195 pp.		
GN-9.2.8	J.D. Mollard and Associates Ltd., 2011. Project Environment Mineral Erosion and Effects Assessment. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. pp.	In preparation	
GN-9.2.9	KGS Acres Ltd., 2009. Project Environment Sedimentation and Effects Assessment. Project Environmental Studies Program Report prepared for Manitoba Hydro. 99 pp.	In preparation	
GN-9.2.10	Manitoba Hydro, 2009. Estimate of Shoreline Erosion During Construction. Keeyask Project Environmental Studies Program Report. pp. *Draft*.	In preparation	
GN-9.2.11	KGS Acres Ltd., 2011. Estimate of Sedimentation in Stephens Lake During Construction. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. 82 pp.	In preparation	
GN-9.2.13	Ecostem Ltd., 2007. Study of Physical Properties of Peat: Lab Results – Particle Size Distribution and Specific Gravity. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. pp.	In preparation	
GN-9.2.14	KGS Acres Ltd., 2011. Study of Erosion Potential of Disposal Material. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro.	Completed	10/7/2011
GN-9.2.16	KGS Acres Ltd., 2012. Relationship of Total Suspended Solids and Turbidity in the Lower Nelson River near the Proposed Keeyask Generating Station. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. pp.	In preparation	
GN-9.2.17	KGS Acres Ltd., 2012. Cofferdam Erosion During Construction. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro.	Completed	4/9/2012
GN-9.2.18	KGS Acres Ltd., 2011. Peat Transport and Deposition Modelling. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro.	Completed	4/12/2011
GN-9.2.21	J.D. Mollard and Associates Ltd., 2010. Classification of Sediment Gradations Within Areas That Will Be Inundated During Staged Construction of the Keeyask GS. Keeyask Project Environmental	In preparation	

Environmental Study Report List

Report Number	Report Title	Status	Date Completed
	Studies Program Report prepared for Manitoba Hydro. pp.		
GN-9.2.22	Ecostem Ltd., 2011. Laboratory Estimation of Organic Sediment Settling Rates. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. pp.	In preparation	
GN-9.2.23	Tetr*ES* Consultants Inc., 2012. Estimation of Potential Organic Total Suspended Solids – Future With Project. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. pp.	In preparation	
GN-9.3.1	Tetr*ES* Consultants Inc., 2008. Keeyask Existing Environment Groundwater Regime. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. pp.	In preparation	
GN-9.3.2	Tetr*ES* Consultants Inc., 2008. Keeyask Predicted Future Groundwater Regime Without the Keeyask GS. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. 37 pp.	In preparation	
GN-9.3.3	Tetr*ES* Consultants Inc., 2008. Keeyask Predicted Future Groundwater Regime With the Keeyask GS. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. 90 pp.	In preparation	
GN-9.4.1	Tetr*ES* Consultants Inc., 2009. Water Temperature & Dissolved Oxygen Study – Existing Conditions. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. 119 pp.	In preparation	
GN-9.4.2	Tetr*ES* Consultants Inc., North/South Consultants Inc. and Manitoba Hydro, 2009. Water Temperature & Dissolved Oxygen Study – Future Without Project. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. 10 pp.	In preparation	
GN-9.4.3	Tetr*ES* Consultants Inc., North/South Consultants Inc. and Manitoba Hydro, 2011. Water Temperature & Dissolved Oxygen Study – Project Effects. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. 100 pp.	In preparation	
GN-9.5.1	Manitoba Hydro, 2009. Historical Climate Analysis. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. 29 pp.	In preparation	

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Report Number	Report Title	Status	Date Completed
GN-9.5.2	Manitoba Hydro, 2011. Future Climate Scenarios. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. 66 pp.	In preparation	
GN-9.5.5	The Pembina Institute, 2012. A Life Cycle Assessment of Greenhouse Gases and Select Criteria Air Contaminants. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. 89 pp.	Completed	02/16/2012
GN-9.5.6	Environnement Illimité Inc., 2012. Keeyask Environmental Impact Statement – Reservoir Greenhyouse Gases Technical Memo. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro.	Completed	03/08/2012
GN-9.5.7	Manitoba Hydro, 2008. Historical Flow Trend Analysis. Keeyask Project Environmental Studies Program.	In preparation	
AQUATIC ENVIRONMENT			
99-01	Remnant, R.A. and C.C. Barth. 2003. Results of Experimental Gillnetting on the Nelson River between Birthday and Gull Rapids, Manitoba, Fall 1999. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 75 pp. *Draft*.	Completed	12/2003
99-02	Zrum, L. and C.L. Bezte. 2003. Water Chemistry, Phytoplankton, Benthic Invertebrate, and Sediment Data for Gull Lake and the Nelson River between Birthday Rapids and Gull Rapids, Manitoba, Fall, 1999. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 66 pp. *Draft*.	Completed	12/2003
01-01	Zrum, L. and T.J. Kroeker. 2003. Benthic Invertebrate and Sediment Data from Split Lake and Assean Lake, Manitoba, Winter, 2001. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 78 pp. *Draft*.	Completed	12/2003
01-02	Barth, C.C., R.L. Bretecher, and J. Holm. 2004. Floy-tag Application and Recapture Information from the (Gull) Keeyask Study Area, 2001. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 88 pp. *Draft*.	Completed	11/2004
01-03	Barth, C.C., D.L. Neufeld, and R.L. Bretcher. 2003. Results of Fisheries Investigations Conducted in Tributaries of the Nelson River Between Birthday Rapids and Gull Rapids, Manitoba, Spring, 2001. Draft report prepared for Manitoba Hydro by	Completed	12/2003

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Report Number	Report Title	Status	Date Completed
	North/South Consultants Inc. 53 pp. *Draft*.		
01-04	Juliano, K.M. and L. Zrum. 2003. Zooplankton Data from Split, Clark, Gull, Stephens, and Assean Lakes, Manitoba, 2001. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 59 pp. *Draft*.	Completed	12/2003
01-05	Dunmall, K.M., J. Holm, and R.L. Bretcher. 2003. Results of Index Gillnetting Studies Conducted in Assean Lake, Manitoba, Summer 2001. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 70 pp. *Draft*.	Completed	12/2003
01-06	Dolce, L.T. and M.A. Sotiropoulos. 2004. Aquatic Macrophyte and Associated Epiphytic Invertebrate Data Collected in Gull Lake and Portions of the Nelson River Between Birthday Rapids and Gull Rapids, Manitoba, Fall 2001. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 56 pp. *Draft*.	Completed	1/2004
01-07	Dunmall, K.M., J.E. MacDonald, and R.L. Bretecher. 2004. Results of Summer Index Gillnetting Studies Conducted in Split Lake and Clark Lake, and Spring Investigations of Adult and Larval Fish Populations in Portions of the Burntwood River, Grass River, and Nelson River flowing into Split Lake, Manitoba, 2001. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 116 pp. *Draft*.	Completed	2/2004
01-08	Remnant, R.A., N.J. Mochnacz, and J.E. MacDonald. 2004. Results of Fisheries Investigations Conducted in the Assean River Watershed, Manitoba, Spring and Fall, 2001. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 106 pp. *Draft*.	Completed	10/2004
01-10	Pisiak, D.J., T. Kroeker, and R.A. Remnant. 2004. Results of Summer Index Gillnetting Studies in Stephens Lake, Manitoba, and Seasonal Investigations of Adult and Larval Fish Communities in the Reach of the Nelson River between Gull Rapids and Stephens Lake, 2001. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 110 pp. *Draft*.	Completed	10/2004
01-11	Sotiropoulos, M.A. and L.J. Neufeld. 2004. Benthic Invertebrate, Sediment, and Drifting Invertebrate Data Collected from the Gull (Keeyask) Study Area, Manitoba, Spring - Fall 2001. Draft report	Completed	10/2004

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Report Number	Report Title	Status	Date Completed
	prepared for Manitoba Hydro by North/South Consultants Inc. 138 pp. *Draft*.		
01-13	Remnant, R.A., C.R. Parks, and J.E. MacDonald. 2004. Results of Fisheries Investigations Conducted in the Reach of the Nelson River between Clark Lake and Gull Rapids (Including Gull Lake), 2001. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 154 pp. *Draft*.	Completed	10/2004
01-14	Barth, C.C. and N.J. Mochnacz. 2004. Lake Sturgeon Investigations in the Gull (Keeyask) Study Area, 2001. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 146 pp. *Draft*.	Completed	10/2004
01-15	Badiou, P.H., and H.M. Cooley. 2004. Water Chemistry, Phytoplankton, and Sediment Chemistry Data for the Nelson and Assean River Systems, Manitoba, 2001. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 210 pp. *Draft*.	Completed	10/2004
02-03	Barth, C.C., L.J. Neufeld, and J.R. Olynik. 2003. Movements of Northern Pike, Walleye, and Lake Whitefish Tagged with Radio and Acoustic Transmitters in the Gull (Keeyask) Study Area, 2001/2003. Draft report prepared for Manitoba Hydro by North/South Consultants. 137 pp. *Draft*.	Completed	12/2003
02-04	Juliano, K.M. and L. Zrum. 2004. Zooplankton Data from Split, Clark, Gull, Stephens, and Assean Lakes, and the Nelson River, Manitoba, 2002. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 65 pp. *Draft*.	Completed	1/2004
02-05	Holm, J., V.L. Richardson, and R.L. Bretecher. 2003. Results of Index Gillnetting Studies Conducted in Assean Lake, Manitoba, Summer 2002. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 80 pp. *Draft*.	Completed	12/2003
02-06	Hartman, E.J. and R.L. Bretecher. 2004. Results of Fisheries Investigations Conducted in the North Moswakot and South Moswakot Rivers, Manitoba, Fall 2002. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 69 pp. *Draft*.	Completed	1/2004
02-08	Mochnacz, N.J., C.C. Barth, and J. Holm. 2004. Results of Fisheries Investigations Conducted in the Aiken River and at the Mouth of the Ripple River, Manitoba, Spring 2002. Draft report	Completed	3/2004

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Report Number	Report Title	Status	Date Completed
	prepared for Manitoba Hydro by North/South Consultants Inc. 106 pp. *Draft*.		
02-09	Holm, J. and R.A. Remnant. 2004. Results of Summer Index Gillnetting Studies Conducted in Split Lake and Clark Lake, and Spring Investigations of Adult and Larval Fish Communities in Portions of the Burntwood, Grass, and Nelson Rivers Flowing into Split Lake, Manitoba, 2002. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 131 pp. *Draft*.	Completed	4/2004
02-10	Dolce, L.T. and M.A. Sotiropoulos. 2004. Aquatic Macrophyte and Associated Epiphytic Invertebrate Data Collected in Gull Lake and Portions of the Nelson River between Birthday Rapids and Gull Rapids, Manitoba, Fall 2002. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 57 pp. *Draft*.	Completed	3/2004
02-12	Juliano, K.M. and L.J. Neufeld. 2004. Benthic Invertebrate and Sediment Data from Split Lake and Assean Lake, Manitoba, Winter 2002. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 67 pp. *Draft*.	Completed	12/2004
02-13	Juliano, K.M. and L.J. Neufeld. 2005. Benthic Invertebrate, Sediment, and Drifting Invertebrate Data Collected from the Gull (Keeyask) Study Area, Manitoba, Spring - Fall 2002. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 161 pp. *Draft*.	Completed	1/2005
02-14	Badiou, P.H. and H.M. Cooley. 2005. Water Chemistry, Phytoplankton, and Sediment Chemistry Data for the Nelson and Assean River Systems, Manitoba, 2002. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 255 pp. *Draft*.	Completed	2/2005
02-15	Johnson, M.W. 2005. Results of Fish Community Investigations Conducted in the Assean River Watershed, Manitoba, Spring and Fall 2002. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 133 pp. *Draft*.	Completed	2/2005
02-16	Pisiak, D.J. 2005. Results of Summer Index Gillnetting Studies in Stephens Lake, Manitoba and Seasonal Investigations of Adult and Larval Fish Communities in the Reach of the Nelson River between Gull Rapids and Stephens Lake, 2002. Draft report prepared for Manitoba Hydro by North/South Consultants Inc.	Completed	1/2005

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Report Number	Report Title	Status	Date Completed
	179 pp. *Draft*.		
02-17	Richardson, V.L. and J. Holm. 2005. Results of Fish Community Investigations Conducted in Tributary Systems of the Nelson River between Birthday Rapids and Gull Rapids, 2002. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 98 pp. *Draft*.	Completed	1/2005
02-18	Holm, J., V.L. Richardson, and C.C. Barth. 2005. Floy-tag Application and Recapture Information from the Gull (Keeyask) Study Area, 2002. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 175 pp. *Draft*.	Completed	2/2005
02-19	Barth, C.C. 2005. Lake Sturgeon Investigations in the Keeyask Study Area, 2002. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 131 pp. *Draft*.	Completed	2/2005
02-20	Johnson, M.W. and C.R. Parks. 2005. Results of Fish Community Investigations Conducted in the Reach of the Nelson River between Clark Lake and Gull Rapids, 2002. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 222 pp. *Draft*.	Completed	8/2005
03-01	Ryland, D. and B. Watts. Fish Taste Studies for Tataskweyak Cree Nation. Draft report prepared for Manitoba Hydro by the University of Manitoba. 44 pp. *Draft*.	Completed	1/2004
03-02	Ryland, D. and B. Watts. Fish Taste Studies for Fox Lake Cree Nation. Draft report prepared for Manitoba Hydro by the University of Manitoba. 43 pp. *Draft*.	Completed	1/2004
03-03	Maclean, B.D. and D.J. Pisiak. 2005. Results of Fish Community Investigations Conducted at the Mouth of the Ripple River, Manitoba, Spring 2003. Year II. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 43 pp. *Draft*.	Completed	2/2005
03-05	Badiou, P.H., H.M. Cooley, and T. Savard. 2005. Water Chemistry Data for the Lower Nelson River System, Manitoba, 2003. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 219 pp. *Draft*.	Completed	12/2005
03-06	Murray, L., C.C. Barth, and J.R. Olynik. 2005. Movements of Radio- and Acoustic- Tagged Northern Pike, Walleye, and Lake Whitefish in the Keeyask Study Area: May 2002 to April 2003.	Completed	8/2005

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Report Number	Report Title	Status	Date Completed
	Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 125 pp. *Draft*.		
03-08	Barth, C.C. and L. Murray. 2005. Lake sturgeon Investigations in the Keeyask Study Area, 2003. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 127 pp. *Draft*.	Completed	10/2005
03-09	Pisiak, D.J. and E.J. Hartman. 2005. Results of Fish Community Investigations Conducted in the North Moswakot and South Moswakot Rivers, Manitoba, Spring and Fall 2003. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 157 pp. *Draft*.	Completed	9/2005
03-11	Kroeker, D.S. and W. Jansen. 2005. Results of Fish Community Investigations Conducted in Tributaries of the Nelson River between Clark Lake and Gull Rapids, Manitoba, 2003. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 72 pp. *Draft*.	Completed	1/2006
03-12	Maclean, B.D. and J.Holm. 2005. Results of Fish Community Investigations Conducted in the Mistuska River, Manitoba, Spring 2003. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 90 pp. *Draft*.	Completed	9/2005
03-13	Maclean, B.D. and D.J. Pisiak. 2005. Results of Fish Community Investigations Conducted in the Aiken River, Manitoba, Spring 2003, Year II. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 108 pp. *Draft*.	Completed	12/2005
03-14	Pisiak, D. 2005. Results of Summer Index Gillnetting Studies in Stephens Lake, Manitoba, and Seasonal Investigations of Fish Communities in the Reach of the Nelson River between Gull Rapids and Stephens Lake, 2003. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 313 pp. *Draft*.	Completed	10/2005
03-15	Holm, J. 2006. Floy-tag Application and Recapture Information from the Keeyask Study Area, 2003. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 244 pp. *Draft*.	Completed	9/2006
03-16	Dolce, L. T. and M.J. Burt. 2008. Aquatic Macrophyte and Associated Epiphytic Invertebrate Data Collected from the Keeyask Study Area, Manitoba, Late Summer 2003. Draft report prepared for Manitoba Hydro by North/South Consultants Inc.	Completed	2/2008

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Report Number	Report Title	Status	Date Completed
	111 pp. *Draft*.		
03-17	Gill, G. 2007. Invertebrate Drift and Plant Biomass Data from the Nelson River at Birthday Rapids, Gull Lake, Gull Rapids, and Kettle Generating Station, Manitoba, Summer and Fall 2003. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 72 pp. *Draft*.	Completed	11/2007
03-35	Maclean, B.D. and P. Nelson. 2005. Population and Spawning Studies of Lake Sturgeon (Acipenser fulvescens) at the Confluence of the Churchill and Little Churchill Rivers, Manitoba, Spring 2003. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 70 pp. *Draft*.	Completed	1/2006
03-36	Bretecher, R.L., G.C. Dyck, and R.A. Remnant. 2007. Results of Fish Community Investigations Conducted in the Reach of the Nelson River Between Clark Lake and Gull Rapids (Including Gull Lake), 2003. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 275 pp. *Draft*.	Completed	2/2007
03-37	Cooley, H.M. and M.W. Johnson. 2008. An Evaluation of Walleye Condition from Stephens Lake. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 59 pp. *Draft*.	Completed	3/2008
04-03	Holm, J. 2005. Results of Fish Community Investigations Conducted in Clark Lake, 2004. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 116 pp. *Draft*.	Completed	10/28/2005
04-04	Badiou, P.H., T. Savard, and H.M. Cooley. 2007. Water Chemistry and Phytoplankton data for the Lower Nelson River System, Manitoba, 2004. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 247 pp. *Draft*.	Completed	1/2007
04-05	BARTH, C.C. and K. AMBROSE. 2006. Lake Sturgeon Investigations in the Keeyask Study Area, 2004. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 105 pp. *Draft*.	Completed	1/2006
04-06	Cooley, H.M. and T.G. Savard. 2008. Results of Greenhouse Gas Sampling in the Keeyask and Conawapa Study Areas: 2001-2004. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 76 pp. *Draft*.	Completed	2/2008
04-07	T. Savard and H.M. Cooley. 2007. Turbidity Monitoring Data for	Completed	1/2007

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Report Number	Report Title	Status	Date Completed
	Clark and Gull Lakes, Fall 2004. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 51 pp. *Draft*.		
04-08	Holm, J. 2007. Floy-tag Application and Recapture Information from the Keeyask Study Area, 2004. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 148 pp. *Draft*.	Completed	1/2007
04-09	Johnson, M.W. 2007. Results of Fish Community Investigations Conducted in the Reach of the Nelson River Between Clark Lake and Gull Rapids (Including Gull Lake), 2004. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 159 pp. *Draft*.	Completed	1/2007
04-10	Johnson, M.W. and C.C. Barth. 2007. Results of Fish Community Investigations in the Kettle and Butnau Rivers, Manitoba, Spring 2004. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 59 pp. *Draft*.	Completed	1/2007
04-11	Holm, J., H.M. Cooley, and E. Shipley. 2007. Trace Elements in Fish from the Keeyask Study Area: Fall 2004. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 62 pp. *Draft*.	Completed	2/2007
04-12	Johnson, M.W. and B.D. Maclean. 2007. Results of Fish Community Investigations Conducted in the Mistuska River, Manitoba, Spring 2004. Year II. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 87 pp. *Draft*.	Completed	6/2007
04-13	Johnson, M.W. and B.D. Maclean. 2007. Results of Fish Community Investigations Conducted in the York Landing Arm of Split Lake and Its Major Tributaries, Manitoba, Fall 2004. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 74 pp. *Draft*.	Completed	5/2007
04-14	Pisiak, D.J. and B.D. Maclean. 2007. Population Studies of Lake Sturgeon (*Acipenser fulvescens*) in the Fox River, Manitoba, Summer 2004. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 42 pp. *Draft*.	Completed	4/2007
04-15	Neufeld, L. 2007. Benthic Invertebrate and Sediment, Data Collected from Littoral Zones in the Keeyask Study Area, Manitoba, Fall 2004. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 92 pp. *Draft*.	Completed	4/2007

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Report Number	Report Title	Status	Date Completed
04-16	MacDonald, J.E. 2007. Results of Fish Community Investigations in Gull Rapids and Stephens Lake, 2004. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 113 pp. *Draft*.	Completed	5/2007
04-17	Burt, M.J. and L.T. Dolce. 2008. Aquatic Macrophyte and Associated Epiphytic Invertebrate Data Collected from the Keeyask Study Area, Manitoba, Summer 2004. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 130 pp. *Draft*.	Completed	2/2008
04-18	Gill, G. 2007. Invertebrate Drift and Plant Biomass Data from the Nelson River at Birthday Rapids,Gull Rapids, and Kettle Generating Station, Manitoba, Summer and Fall 2004. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 91 pp. *Draft*.	Completed	11/2007
05-02	Holm, J. 2007. Floy-tag Application and Recapture Information from the Keeyask Study Area, 2005. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 56 pp. *Draft*.	Completed	4/2007
05-03	Murray, L. and C.C. Barth. 2007. Movements of Radio- and Acoustic- Tagged Northern Pike, Walleye, and Lake Whitefish in the Keeyask Study Area: May 2003 to August 2004 and a Summary of Findings from 2001-2005. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 111 pp. *Draft*.	Completed	4/2007
05-04	Jansen, W. and N. Strange. 2007. Mercury Concentrations in Fish From the Keeyask Project Study Area for 1999-2005. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 168 pp. *Draft*.	Completed	8/2007
05-05	Barth, C.C. and J.E. MacDonald. 2008. Lake Sturgeon Investigations in the Keeyask Study Area, 2005. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 63 pp. *Draft*.	Completed	3/2008
05-06	Mazur, K.M. and T.G. Savard. 2008. Proposed Keeyask Access Road Stream Crossing Assessment, 2004 and 2005. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 68 pp. 83 pp. *Draft*.	Completed	2/2008
06-02	Holm, J. 2007. Floy-tag Application and Recapture Information	Completed	4/2007

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Report Number	Report Title	Status	Date Completed
	from the Keeyask Study Area, 2006. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 61 pp. *Draft*.		
06-03	Savard, T. and H.M. Cooley. 2007. Dissolved Oxygen Surveys in the Keeyask Study Area: Winter 2005 and 2006. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 54 pp. *Draft*.	Completed	4/2007
06-04	MacDonald, J.E. 2008. Lake Sturgeon Investigations in the Keeyask Study Area, 2006. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 110 pp. *Draft*.	Completed	3/2008
06-05	Cassin, J. and R.A. Remnant. 2008. Results of Fish Spawning Investigations Conducted in Gull Rapids Creek, Pond 13, and Selected Tributaries to Stephens Lake, Spring 2005 and 2006. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 45 pp. *Draft*.	Completed	3/2008
06-06	MacDonald, J.E. 2007. Fish community assessments of selected lakes within the Split Lake Resource Management Area, 2004-2006. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 145 pp. *Draft*.	Completed	11/2007
06-07	Jansen, W. 2008. Infection Rate of the Parasite *Triaenophorus crassus* in Lake Whitefish from the Keeyask Study Area for 2003-2006. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 35 pp. *Draft*.	Completed	3/2008
06-08	Cooley, P.M. and L. Dolce. 2008. Aquatic Habitat Utilization Studies in Stephens Lake: Macrophyte Distribution and Biomass, Epiphytic Invertebrates, and Fish Catch-Per- Unit-Effort in Flooded Habitat. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 75 pp. *Draft*.	Completed	3/2008
06-09	Cooley, P.M. 2008. Carbon dioxide and methane flux from peatland watersheds and divergent water masses in a sub-arctic reservoir. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 45 pp. *Draft*.	Completed	3/2008
06-10	Capar, L.N. 2008. Benthic Invertebrate Data Collected from O'Neil Bay and Ross Wright Bay in Stephens Lake, Manitoba, Fall 2006. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 34 pp. *Draft*.	Completed	3/2008

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Report Number	Report Title	Status	Date Completed
06-11	Jansen, W. and N. Strange. 2009. Fish mercury concentrations from the Keeyask Project Study Area for 2006. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 68 pp. *Draft*.	Completed	7/2009
06-12	Larter, J.L. and P.M. Cooley. 2010. Substratum and Depth Distribution in Flooded Habitat of Stephens Lake, Manitoba, Thirty-Five Years after Impoundment. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 57 pp. *Draft*.	Completed	12/2010
06-13	Cooley, P.M., L. Dolce Blanchard, and J. Larter. 2009. The effect of local and regional watersheds on the spectral composition and attenuation of light and water quality parameters in the surface waters of Stephens Lake, Manitoba. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 51 pp. *Draft*.	Completed	5/2009
08-01	MacDonald, J.E. 2009. Lake Sturgeon Investigations in the Keeyask Study Area, 2007-2008. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 116 pp. *Draft*.	Completed	4/2009
08-02	Holm, J. 2009. Floy-tag Application and Recapture Information from the Keeyask Study Area, 2007 and 2008. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 63 pp. *Draft*.	Completed	4/2009
09-01	Holm, J. 2010. Results of Index Gillnetting Studies Conducted in the Keeyask Study Area, Summer 2009. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 110 pp. *Draft*.	Completed	10/2010
09-02	Holm, J. 2010. Floy-tag Application and Recapture Information from the Keeyask Study Area, 2009. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 48 pp. *Draft*.	Completed	10/2010
09-03	Michaluk, Y. and J.E. MacDonald. 2010. Lake Sturgeon Investigations in the Keeyask Study Area, 2009. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 83 pp. *Draft*.	Completed	12/2010
09-04	Savard, T. S. Hnatiuk-Stewart, and H.M. Cooley. 2010. Water Quality Data for the Lower Nelson River System, Manitoba, 2009. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 240 pp. *Draft*.	Completed	7/2010
09-05	Jansen, W. 2010. Fish Mercury Concentrations in the Keeyask	Completed	12/2010

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Report Number	Report Title	Status	Date Completed
	Study Area, 2009. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 42 pp. *Draft*.		
10-01	North/South Consultants Inc., 2011. Adult Lake Sturgeon Investigations in the Keeyask Study Area, Spring 2010. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. 78 pp. *Draft*	Completed	12/2011
10-02	North/South Consultants Inc., 2011. Results of Lake Whitefish Spawning Surveys in Ferris Bay and the North and South Moswakot Rivers, Fall 2010. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. 51 pp. *Draft*	Completed	11/2011
10-03	North/South Consultants Inc., 2011. Results of a Coarse Scale Habitat Inventory in the Upper Split Lake Area, Fall 2010. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. 75 pp. *Draft*	Completed	12/2011
10-04	North/South Consultants Inc., 2011. Floy-tag Application and Recapture Information from the Keeyask Study Area, 2010. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. 53 pp. *Draft*	Completed	12/2011
10-05	North/South Consultants Inc., 2011. Fish Community Assessment of Armstrong Lake,2010. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. 90 pp. *Draft*	Completed	12/2011
10-06	North/South Consultants Inc., 2011. Benthic Invertebrate Surveys in Gull Lake and Stephens Lakes, Fall 2010. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. 78 pp. *Draft*	Completed	12/2011
10-07	North/South Consultants Inc., 2011. Young-of-the-Year and Sub-Adult Lake Sturgeon Investigations in the Keeyask Study Area, Spring and Fall 2010. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. 60 pp. *Draft*	Completed	12/2011
TBA	Ambrose, K.M. and R.A. Remnant. 2011. Results of fish community investigations in Armstrong Lake, Manitoba, 2010. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. *Draft*	In preparation	
TBA	Capar, L.N., and F. Schneider-Vieira. 2011. Results of benthic	In	

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Report Number	Report Title	Status	Date Completed
	invertebrate sampling conducted in Gull and Stephens lakes, fall, 2010. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. *Draft*	preparation	
TBA	Henderson, L. M., C. C. Bart, J.E. MacDonald, and S.J. Garner. 2011. Results of a coarse scale habitat inventory in the upper Split Lake area, fall 2010. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. *Draft*	In preparation	
TBA	Henderson, L.M. and C.C. Barth. 2011. Young-of-the-year and subadult lake sturgeon investigations in the Keeyask Study Area, 2010. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. *Draft*	In preparation	
TBA	Holm, J. 2011. Floy-tag application and recapture information from the Keeyask Study Area, 2010. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. *Draft*	In preparation	
TBA	MacDonald, J.E. and C.C. Barth. 2011. Lake sturgeon investigations in the Keeyask Study Area, Spring 2010. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. *Draft*	In preparation	
TBA	Michaluk, Y. J.E. MacDonald, and C. C. Barth. 2011. Results of lake whitefish spawning surveys in Ferris Bay and the North and South Moswakot rivers, fall, 2010. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. *Draft*	In preparation	
TBA	North/South Consultants Inc., 2011. Adult Lake Sturgeon Investigations, 2011. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. *Draft*	In preparation	
TBA	North/South Consultants Inc., 2011. Floy-tag Application and Recapture Information from the Keeyask Study Area, 2011. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. *Draft*	In preparation	
TBA	North/South Consultants Inc., 2011. Lake Sturgeon Telemetry Juvenile, 2011. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. *Draft*	In preparation	
TBA	North/South Consultants Inc., 2011. Young-of-the-year and Sub-Adult Lake Sturgeon Investigations in the Keeyask Study Area, Spring and Fall 2011. Keeyask Project Environmental Studies	In preparation	

Environmental Study Report List

Report Number	Report Title	Status	Date Completed
	Program Report prepared for Manitoba Hydro. *Draft*		
Terrestrial Habitat and Ecosystems			
	Terrestrial habitats and ecosystems in the Lower Nelson River Region	In preparation	
	Responses of terrestrial habitats to reservoir flooding and water regulation in northern Manitoba	In preparation	
	Habitat relationships and wildlife habitat quality models for the Keeyask region		
FORESTRY			
01-16	Forestry Activities 2001. Draft report prepared for North/South Consultants Inc. by Plus4 Consulting Inc. and Resource Ecosystem Services. 49 pp.	Completed	12/1/2004
03-07	Forestry activities 2003. Draft report prepared for Manitoba Hydro by Plus4 Consulting Inc.	Completed	3/31/2006
TBA	Keeyask GS Forebay Clearing Plan Comparative Analysis; Hand Clearing Versus Machine Clearing (Draft). 2006 Draft report prepared for Manitoba Hydro by Plus4 Consulting Inc.	Completed	3/27/2006
	Plus4 Consulting Inc. and Ecostem Ltd., 2006. Keeyask Forebay Clearing Plan (Draft). Draft report prepared for Manitoba Hydro by Plus4 Consulting Inc.	Completed	2/22/2006
BIRDS, AMPHIBIANS AND REPTILES			
01-09	Tetr*ES* Consultants Inc., 2004. Avian field studies report, 2001. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. *Draft*	Completed	12/1/2004
02-11	Tetr*ES* Consultants Inc., 2005. Avian field studies report, 2002. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. 190 pp. *Draft*	Completed	3/9/2005
03-04	Tetr*ES* Consultants Inc., 2005. Avian field studies report, 2003. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. *Draft*	Completed	10/28/2005
04-01	Tetr*ES* Consultants Inc., 2005. Access road – Avian Field Studies report, 2004. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. 33 pp. *Draft*	Completed	10/28/2005

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Report Number	Report Title	Status	Date Completed
04-02	Tetr*ES* Consultants Inc., 2005. Amphibian and reptile field studies report 2001-2004. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. 27 pp. *Draft*	Completed	10/28/2005
05-01	Tetr*ES* Consultants Inc., 2006. Access road – Avian field studies report, 2005. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. 52 pp. *Draft*	Completed	3/31/2006
06-01	Tetr*ES* Consultants Inc., 2007. Access road – Avian field studies report, 2006. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. *Draft*.	Completed	3/28/2007
07-01	Tetr*ES* Consultants Inc., 2007. Avian field studies report, 2007. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. *Draft*.	Completed	12/2007
07-02	Tetr*ES* Consultants Inc., 2007. Amphibian and Reptile field studies report, 2007. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. *Draft*.	Completed	12/21/2007
11-01	Stantec Consultants Ltd. Avian 2011 Field Studies Report, 2011. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. *Draft*.	In preparation	
MAMMALS			
01-12	Patenaude, A. and R. Berger. 2004. Results of Mammal, Reptile & Amphibian Investigations in the Gull (Keeyask) Study Area, 2001. Draft report prepared for Manitoba Hydro by Wildlife Resource Consulting Services MB, Inc. 142 pp. *Draft*.	Completed	12/1/2004
02-07	Patenaude, A. and R. Berger. 2004. Results of Mammal Investigations in the Keeyask Study Area, 2002. Draft report prepared for Manitoba Hydro by Wildlife Resource Consulting Services MB, Inc. 162 pp. *Draft*.	Completed	3/15/2004
03-34	Patenaude, A., A. Kibbins, A. Walleyn and R. Berger. 2006. Results of mammal investigations in the Keeyask study area, 2003. Draft report prepared for Manitoba Hydro by Wildlife Resource Consulting Services MB, Inc. 246 pp. *Draft*.	Completed	1/23/2006
04-19	Kibbins, A. and R. Berger. 2007. Results of mammal investigations in the Keeyask study area, 2004. Draft report prepared for Manitoba Hydro by Wildlife Resource Consulting	Completed	1/8/2007

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Report Number	Report Title	Status	Date Completed
	Services MB, Inc. 64 pp. *Draft*.		
08-XX	Wildlife Resource Consulting Services MB, Inc. Keeyask Project Generating Station Caribou of the Lower Nelson River, Workshop Discussion Report. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. 21 pp. *Draft*.	Completed	12/31/2008
09-01	Knudsen, B., R. Berger, B. Kiss, S. Johnstone, J. Hopkins and J. Kelly. 2009. Split Lake Resource Management Area Moose Survey Stage 1 - March 2009. Draft report prepared for Manitoba Hydro by Knudsen Wildlife Management Systems and Wildlife Resource Consulting Services MB, Inc. 52 pp. *Draft*.	Completed	4/30/2009
10-01	Knudsen, B., R. Berger, S. Johnstone, B. Kiss, J. Paille and J. Kelly. 2010. Split Lake Resource Management Area Moose Survey 2009 and 2010. Draft report prepared for Manitoba Hydro by Knudsen Wildlife Management Systems and Wildlife Resource Consulting Services MB, Inc. 144 pp. *Draft*.	Completed	12/15/2010
HERITAGE			
N/A	Northern Lights Heritage Services Inc. Keeyask Powistick (Gull Rapids) Generating Station Cultural and Physical Heritage Area Characterization Study. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. *Draft*.	Completed	3/2001
A36-01	Northern Lights Heritage Services Inc. Keeyask Powistick (Gull Rapids) Heritage Resource Impact Assessment: 2001. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. *Draft*.	Completed	12/2001
A27-02	Northern Lights Heritage Services Inc. Gull Rapids (Keeyask) Generating Station: Heritage Resource Impact Assessment (Year I): Fox Lake Cree Nation (Interim Report). Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. *Draft*.	Completed	9/2002
02-04	Northern Lights Heritage Services Inc. Gull (Keeyask) Project Generating Station: Heritage Resource Impact Assessment Fox Lake Cree Nation. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. *Draft*.	Completed	2002
A10-03	Northern Lights Heritage Services Inc. Keeyask Project: Generating Station: Heritage Resource Impact Assessment: Gull	Completed	6/2003

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Report Number	Report Title	Status	Date Completed
	(Keeyask) Rapids Camp. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. *Draft*.		
A10-03	Northern Lights Heritage Services Inc. Keeyask Project: Generating Station: Heritage Resource Impact Assessment of Gull (Keeyask) Rapids. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. *Draft*.	Completed	11/2003
A10-03	Northern Lights Heritage Services Inc. Keeyask Project Heritage Resource Impact Assessment: Archaeological Survey of Stephen's and Fox (Atikinson) Lakes. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. *Draft*.	Completed	12/2003
A07-04	Northern Lights Heritage Services Inc. Keeyask Project Generating Station: 2004 Heritage Resource Impact Assessment Gull (Keeyask) Rapids. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. *Draft*.	Completed	11/2004
A07-04	Northern Lights Heritage Services Inc. Participatory Action Research, Tataskweyak Cree Nation Student Archaeological Program. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. *Draft*.	Completed	3/2005
A08-04	Northern Lights Heritage Services Inc. Keeyask Projects: Heritage Resource Impact Assessment: Archaeological Investigation at the Paradise Beach Site on Fox (Atkinson) Lake. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. *Draft*.	Completed	3/2005
A30-05	Northern Lights Heritage Services Inc. Gull (Keeyask) Project: Heritage Resource Impact Assessment. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. *Draft*.	Completed	12/2005
A31-05	Northern Lights Heritage Services Inc. Gull (Keeyask) Generating Station: Kettle Lake Comparison Study. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. *Draft*.	Completed	1/2006
A33-05	Northern Lights Heritage Services Inc. War Lake Archaeological Research Project (WARP) Archaeological Field Survey Report. Keeyask Project Environmental Studies Program Report prepared	Completed	4/2006

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Report Number	Report Title	Status	Date Completed
	for Manitoba Hydro. *Draft*.		
A31-06	Northern Lights Heritage Services Inc. Keeyask (Gull) Generating Station: Bryant's Point: Archaeological Field Investigation Component Heritage Resource Impact Assessment. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. *Draft*.	Completed	9/2006
A28-06	Northern Lights Heritage Services Inc. Archaeological Survey of the Northwest Arm of Stephens Lake, Manitoba. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. *Draft*.	Completed	12/2006
A31-06	Northern Lights Heritage Services Inc. Keeyask Projects: Archaeological Survey of Kettle Lake, Manitoba: Comparative Study for the Heritage Resource Impact Assessment (HRIA). Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. *Draft*.	Completed	1/2007
A30-06	Northern Lights Heritage Services Inc. Keeyask (Gull) Project: 2006 Fox Lake Comparative Study Component. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. *Draft*.	Completed	3/2007
A32-06	Northern Lights Heritage Services Inc. Keeyask Generating Station: Archaeological Field Investigation Component Clark Lake Archaeological Survey Heritage Resource Impact Assessment. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. *Draft*.	Completed	3/2007
A25-07	Northern Lights Heritage Services Inc. Keeyask Generating Station 2007 Archaeological Field Investigation Component Clark Lake Archaeological Survey Heritage Resource Impact Assessment. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. *Draft*.	Completed	2/2008
A25-07	Northern Lights Heritage Services Inc. Keeyask Generating Station 2007 Archaeological Field Investigation Component Carscadden Lake and Portage (Pisitif) Creek Archaeological Survey Heritage Resource Impact Assessment. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. *Draft*.	Completed	2/2008

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Report Number	Report Title	Status	Date Completed
A38-08	Northern Lights Heritage Services Inc. Archaeological Investigation of the Lower Odei & Burntwood Rivers Related to the Aboriginal Sturgeon Fishery. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. *Draft*.	Completed	10/2008
A34-08	Northern Lights Heritage Services Inc. Keeyask Generating Station 2008 Archaeological Field Investigation Component: Carscadden Lake Archaeological Survey Heritage Resource Impact Assessment (HRIA). Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. *Draft*.	Completed	1/2009
A30-08	Northern Lights Heritage Services Inc. 2008 Split Lake Archaeological Shoreline Survey. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. *Draft*.	Completed	3/2009
A35-08	Northern Lights Heritage Services Inc. Keeyask Generating Station 2008 Archaeological Field Investigation Component Clark Lake Archaeological Survey Heritage Resource Impact Assessment. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. *Draft*.	Completed	3/2009
A29-08	Northern Lights Heritage Services Inc. Keeyask Generating Station 2008 Archaeological Field Investigation Component Pointe West Site (HfKe-2) Formal Excavation. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. *Draft*.	Completed	4/2009
N/A	Northern Lights Heritage Services Inc. Keeyask Construction Power Transmission Line Cultural and Physical Heritage Area Characterization Study & Route Selection. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. *Draft*.	Completed	5/2009
A40-09	Northern Lights Heritage Services Inc. Keeyask Generation Project 2009: HRIA of Impervious and Granular Deposit Borrow Areas. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. *Draft*.	Completed	6/2009
A37-09	Northern Lights Heritage Services Inc. Keeyask Infrastructure Project 2009 HRIA Startup and Main Camp (Phase 1). Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. *Draft*.	Completed	8/2009

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Report Number	Report Title	Status	Date Completed
A18-09 & A5109	Northern Lights Heritage Services Inc. Keeyask Transmission Project 2009 Heritage Resource Impact Assessment. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. *Draft*.	Completed	10/2009
A41-09	Northern Lights Heritage Services Inc. Keeyask Generation Project 2009 Heritage Resource Impact Assessment: Monitoring of Drill Testing on Caribou Island. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. *Draft*.	Completed	11/2009
A42-09	Northern Lights Heritage Services Inc. Keeyask Generation Project 2009 HRIA of North and South Retaining Dykes. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. *Draft*.	Completed	11/2009
A32-09	Northern Lights Heritage Services Inc. Keeyask Generation Project 2009 Archaeological Field Investigations: Excavation of the Pointe West Site (HbKx-02), a Proxy Site Investigated for the Keeyask Generation Project HRIA. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. *Draft*.	Completed	3/2010
A21-10	Northern Lights Heritage Services Inc. Keeyask Generation Project 2010 Archaeological Survey of Cache Lake as part of the HRIA Process. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. *Draft*.	Completed	6/2011
A40-10	Northern Lights Heritage Services Inc. Keeyask Generation Project 2010: HRIA of William Smith Island & Selected Borrow Areas. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. *Draft*.	Completed	6/2011
A25-10	Northern Lights Heritage Services Inc. Keeyask Generation Project 2010 Archaeological Field Investigations: Excavation of the Pointe West Site (HbKx-02), a Proxy Site Investigated for the Keeyask Generation Project HRIA. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. *Draft*.	Completed	6/2011
A56-11	Northern Lights Heritage Services Inc. Keeyask Generation Project 2011 South Access Road Butnau River Crossing HRIA. Keeyask Project Environmental Studies Program Report prepared	Completed	11/2011

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Report Number	Report Title	Status	Date Completed
	for Manitoba Hydro. *Draft*.		
A17-11	Northern Lights Heritage Services Inc. Keeyask Generation Project 2011 HRIA North Shore Gull Lake and Selected Borrow Area Investigations. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. *Draft*.	MB Hydro Review	
A16-11	Northern Lights Heritage Services Inc. Keeyask Generation Project 2011 HRIA of Potential Burial Locations on Gull Lake and Caribou Island. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. *Draft*.	MB HYDRO Review	

APPENDIX 6B

POLICIES, STANDARDS AND GUIDELINES

Keeyask Hydropower Limited Partnership

PHYSICAL ENVIRONMENT

CLIMATE

Carter, T.R. June 2007. General Guidelines on the Use of Scenario Data for Climate Impact Adaptation Assessment. Version 2. Available at: http://www.ipcc-data.org/guidelines/TGICA_guidance_sdciaa_v2_final.pdf.

CEA Agency, 2003. Incorporation Climate Change Consideration in Environmental Assessment: General Guidance for Practitioners. Retrieved September 18, 2006 from http://www.ceaa-ace.gc.ca/012/014/index-e.htm.

Environment Canada, 2005. Calculation of the 1971 to 2000 Climate Normals for Canada. http://climate.weatheroffice.ec.gc.ca/prods_servs/normals_documentation_e.html#appendixa.

International Panel on Climate Change Task Group on Data and Scenario Support for Impact and Climate Assessment "General Guidelines in the Use of Scenario Data for Climate Change Adaptation Assessment (Carter 2007)

Intergovernmental Panel on Climate Change (IPCC). 2006. 2006 IPCC Guidelines for National Greenhouse Gas Inventories. Prepared by the National Greenhouse Gas Inventories Programme, Eggleston, H.S., Buendia L., Miwa K., Ngara T. and Tanabe K. (eds). Published: IGES, Japan.

IPCC. 2003. Good Practice Guidance for Land Use, Land-Use Change and Forestry. Penman J., Gytarsky M.,Hiraishi T., Krug, T., Kruger D., Pipatti R., Buendia L., Miwa K., Ngara T., Tanabe K., Wagner F. (eds). Intergovernmental Panel on Climate Change (IPCC), IPCC/IGES, Hayama, Japan

IPCC – TGICA, 2007: *General guidelines on the use of scenario data for climate impact and adaptation assessment. Version 2*. Prepared by Carter, T.R. Intergovernmental Panel on Climate Change, Task Group on Scenarios for Climate Impact Assessment, 71 pp.

Zhang, X., L.A. Vincent, W.D. Hogg, and A. Niitsoo, 2000. Temperature and Precipitation Trends in Canada during the 20th Century. Atmosphere-Ocean, 38, 395-429.

PHYSIOGRAPHY

Canadian Council of Ministers of the Environment (CCME). 1999. Canadian Environmental Quality Guidelines. Report ISBN 1-896997-34-1. Publication #1299. Winnipeg, Manitoba. (Updated periodically, see: http://www.cegg-rcqe.ccme.ca).

Mine Environmental Neutral Drainage (MEND). 1991. Acid Rock Drainage Prediction Manual, Project Report 1.16.1b by Coastech Research, MEND, Ottawa, Ontario.

Mine Environmental Neutral Drainage (MEND). 2000. Manual Volume 3 – Prediction. GA. Tremblay and C.M. Hogan (Eds). MEND report 5.4.2c.

Hayton, A., D. Persaud and R. Jaagumagi. 1992. Fill Quality Guidelines for Lakefilling in Ontario: Application of Sediment and Water Quality Guidelines to Lakefilling. Ont. Ministry of the Environment. Toronto. 20 pp.

SURFACE WATER AND ICE REGIME

Manitoba Surface Water Standards, Objectives and Guidelines. 2011. Manitoba Water Stewardship Report 2011-01. Available at http://digitalcollection.gov.mb.ca/awweb/pdfopener?smd=1&did=20421&md=1 [accessed May 30, 2011].

GROUNDWATER

Canadian Council of Ministers of the Environment (CCME). 1999. Canadian Environmental Quality Guidelines. Report ISBN 1-896997-34-1. Publication #1299. Winnipeg, Manitoba. (Updated periodically, see: http://www.cegg-rcqe.ccme.ca).

Health Canada. 2010. Guidelines for Canadian Drinking Water Quality. Prepared by the Federal-Provincial-Territorial Committee on Drinking Water of the Federal-Provincial-Territorial Committee on Health and the Environment. December 2010. Available at: http://www.hc-sc.gc.ca/ewh-semt/alt_formats/hecs-sesc/pdf/pubs/water-eau/2010-sum_guide-res_recom/sum_guide-res_recom-eng.pdf.

Moring, K.A. and Hutt N.M. 2006. Case studies and Guidelines for Drainage chemistry prediction. Proceedings of 12th BC MEND ML/ARD workshop. Vancouver, BC November 30 - December 1, 2005.

SURFACE WATER TEMPERATURE AND DISSOLVED OXYGEN

Williamson, D.W. 2002. Manitoba Water Quality Standards, Objectives, and Guidelines. Manitoba Conservation, Water Branch, Water Quality Management Section. November 2002

AQUATIC ENVIRONMENT

British Columbia Ministry of the Environment (BCMOE). 2009. Water Quality guidelines (criteria) reports. http://www.env.gov.bc.ca/wat/wq/wq_guidelines.html#approved. Accessed September 29, 2009.

Canadian Council of Ministers of the Environment (CCME). 1999. Canadian environmental quality guidelines. Canadian Council of Ministers of the Environment, Winnipeg, MB. Updated to 2012.

CCME (Canadian Council of Ministers of the Environment). 2004. Canadian water quality guidelines for the protection of aquatic life. Phosphorus: Canadian Guidance Framework for the Management of Freshwater Systems. In Canadian environmental quality guidelines. CCME, Winnipeg, MB.

DFO (Department of Fisheries and Oceans). 1986. Policy for the Management of Fish Habitat. Communications Directorate, Department of Fisheries and Oceans.

DFO. 1995. Freshwater intake end-of-pipe fish screen guideline. Communications Directorate, Department of Fisheries and Oceans.

DFO. 2007. Manitoba in-water construction timing windows for the protection of fish and fish habitat. Manitoba Operational Statement Version 3.0. 2 p.

DFO and Manitoba Natural Resources. 1996. Manitoba Stream Crossing Guidelines for Protection of Fish and Fish Habitat. Department of Fisheries and Oceans, Manitoba Department of Natural Resources, Winnipeg, Manitoba.

Health Canada. 2007. Human health risk assessment of mercury in fish and health benefits of fish consumption. Health Canada: Bureau of Chemical Safety, Food Directorate, Health Products and Food Branch Ottawa, Ont.; 69 pp.

Health Canada. 2011. Guidance for evaluating human health impacts in environmental assessment: Drinking and recreational water quality. Draft January 2011. 76 p. (note: this one isn't a guideline, standard or policy per se but you may want to include)

Health Canada. 2010. Guidelines for Canadian drinking water summary table. Prepared by the Federal-Provincial-Territorial Committee on Drinking Water of the Federal-Provincial-Territorial Committee on Health and the Environment. 15 p.

Health and Welfare Canada. 1992. Guidelines for Canadian recreational water quality. Health and Welfare Canada. 101 p.

Manitoba Water Stewardship (MWS). 2011. Manitoba Water Quality Standards, Objectives, and Guidelines. Water Science and Management Branch, MWS. MWS Report 2011-01, November 28, 2011. 67 p.

Persaud, D., R. Jaagumagi, and A. Hayton. 1993. Guidelines for the protection and management of aquatic sediment quality in Ontario. ISBN 0-7729-9248-7. Ontario Ministry of the Environment, Water Resources Branch, Toronto, ON.

Wheatley, B. 1979. Methylmercury in Canada; exposure of Indian and Inuit residents to methylmercury in the Canadian environment. Health and Welfare Canada, Medical Service Branch, Ottawa, Canada, 200 pp.

Wright, D.G., and Hopky, G.E. 1998. Guidelines for the use of explosives in or near Canadian fisheries waters. Canadian Technical Report of Fisheries and Aquatic Sciences No. 2107.

TERRESTRIAL ENVIRONMENT

HABITAT

Environment Canada. 2004. An Invasive Alien Species Strategy for Canada. Available from http://www.ec.gc.ca/Publications/26E24C67-2299-4E7A-8014-9FB6B80695C5/Final_IAS_Strategic_Plan_en.pdf [accessed 4 May 2012].

Committee on the Status of Endangered Wildlife in Canada. 2011. COSEWIC Status Reports. Available from http://www.sararegistry.gc.ca/search/advSearchResults_e.cfm?stype=doc&docID=18 [accessed 4 May 2012].

Environment Canada. 1991. Federal Policy on Wetland Conservation. Available from http://www.ec.gc.ca/Publications/default.asp?lang=En&xml=BBAAE735-EF0D-4F0B-87B7-768745600AE8 [accessed 4 May 2012].

Government of Manitoba. 1990. Applying Manitoba's Water Policies. 85 pp. Available from http://www.gov.mb.ca/waterstewardship/licensing/mb_water_policies.pdf [accessed 4 May 2012].

Manitoba Endangered Species Act (MESA). 1993. Manitoba Conservation. Updated 16 June 2011. Available from http://web2.gov.mb.ca/laws/statutes/ccsm/e111e.php [accessed 4 May 2012].

Department of Justice Canada. 2008. Species At Risk Act. Downloaded from: http://laws.justice.gc.ca/en/s-15.3/text.html.

Environment Canada. 1998. Wetlands Environmental Assessment Guideline. Available from http://www.ec.gc.ca/Publications/0D3880BC-9519-4FF9-A294-DCAF9E54C8B2/CWSwetlandsEAguide1998.pdf [accessed 4 May 2012].

Lynch-Stewart, P. 1992. No Net Loss - Implementing "No Net Loss" Goals to Conserve Wetlands in Canada. North American Wetlands Conservation Council (Canada). Sustaining Wetlands Issues Paper, No. 1992-2. Ottawa, ON. 35 p.

Cox, Kenneth W. and Allison Grose. 2000. Wetland Mitigation in Canada: A Framework for Application. Report No. 2000-1. Sustaining Wetlands Issues Paper Series. North American Wetlands Conservation Council (Canada). Ottawa, ON.

Environment Canada (Canadian Wildlife Service). 1996. The Federal Policy on Wetland Conservation: Implementation Guide for Federal Land Managers. Habitat Conservation Division. Ottawa, ON. 32 p.

Wetlands And Government- Policy And Legislation For Wetland Conservation.

Lynch-Stewart, P., Kessel-Taylor, I. and C. Rubec. 1999. Wetlands And Government: Policy And Legislation For Wetland Conservation in Canada. Published in partnership with the Canadian Wildlife Service, and Ducks Unlimited Canada. 57 pp.

Canadian Council of Forest Ministers. 1998. Canada Forest Accord. Available from http://www.manitobamodelforest.net/publications/Canada%20Forest%20Accord.pdf [accessed 4 May 2012].

Canadian Council of Forest Ministers. 1995. Defining Sustainable Forest Management: A Canadian Approach to Criteria and Indicators. Updated 25 November 2005. Available from http://www.ccfm.org/ci/defining1997_e.html [accessed 4 May 2012].

Government of Manitoba. 1994. Applying Manitoba's Forest Policies. Available from http://www.gov.mb.ca/conservation/susresmb/pdf/forestpol_0_38.pdf [accessed 4 May 2012].

The Montréal Process. 2009. Criteria and Indicators for the Conservation and Sustainable Management of Temperate and Boreal Forests. Fourth Edition. Available from http://www.rinya.maff.go.jp/mpci/2009p_4.pdf [accessed 4 May 2012].

Santiago Declaration on the Human Right to Peace. 2010. International Congress on the Human Right to Peace. Available from http://www.fes-madrid.org/media/1037_Human%20Right%20to%20Peace/Human%20Right%20to%20Peace_Santiago%20Declaration.pdf [accessed May 30, 2012].

Environment Canada. 1995. Canadian Biodiversity Strategy: Canada's Response to the Convention on Biological Diversity. Minister of Supply and Services Canada. Available from http://www.biodivcanada.ca/560ED58E-0A7A-43D8-8754-C7DD12761EFA/CBS_e.pdf [accessed 4 May 2012].

Minister of Supply and Services Canada. 1996. Guide on Biodiversity and Environmental Assessment. Prepared jointly with the Biodiversity Convention Office. Available from http://www.ceaa-acee.gc.ca/default.asp?lang=En&n=7392AC38-1 [accessed 4 May 2012].

Canadian Environmental Assessment Agency. 1996.

Federal Environmental Assessment Review Office. 1994. A Reference Guide for the Canadian Environmental Assessment Act: Addressing Cumulative Environmental Effects. Available from http://www.ceaa-acee.gc.ca/9742C481-21D8-4D1F-AB14-555211160443/Addressing_Cumulative_Environmental_Effects.pdf [accessed 4 May 2012].

Environment Canada. 2004. Environment Assessment Best Practice Guide for Wildlife at Risk in Canada. Available from http://www.ec.gc.ca/Publications/5407909E-10F6-4AFE-ACDF-75B9E820B4A1/CWSEAbestPracticeGuide2004.pdf [accessed 4 May 2012].

Environment Canada. Environmental Assessment Guideline for Forest Habitat of Migratory Birds CW-9760-B. 1998. Available from http://www.ec.gc.ca/Publications/EE79D1F4-BBF9-4FBF-8278-B907877E9CA3/EnvironmentalAssessmentGuidelineMigratoryBirds.pdf [accessed 4 May 2012].

Lynch-Stewart, P. 2000. Using Ecological Standards, Guidelines and Objectives for Determining Significance: An Examination of Existing Information to Support Significance Decisions Involving Wetlands. Available from http://www.ceaa.gc.ca/default.asp?lang=En&n=46DA6C97-1&offset=1&toc=hide [accessed 4 May 2012].

Canada Environmental Assessment Agency. 2012. Operational Policy Statement: Adaptive Management Measures under the Canadian Environmental Assessment Act. Available from http://www.ceaa-acee.gc.ca/default.asp?lang=En&n=50139251-1 [accessed 4 May 2012].

Canada Environmental Assessment Agency. 2007. Operational Policy Statement: Addressing Cumulative Environmental Effects under the Canadian Environmental Assessment Act. Available from http://www.ceaa-acee.gc.ca/default.asp?lang=En&n=1F77F3C2-1 [accessed 4 May 2012].

Hegmann, G., C. Cocklin, R. Creasey, S. Dupuis, A. Kennedy, L. Kingsley, W.Ross, H. Spaling and D. Stalker. 1999. Cumulative Effects Assessment Practitioners Guide. Prepared by AXYS Environmental Consulting Ltd. and the CEA Working Group for the Canadian Environmental Assessment Agency, Hull, Quebec.

CEAA. 1994: Addressing Cumulative Environmental Effects. Canadian Environmental Assessment Agency - Policy & Guidance - The Responsible Authority's Guide

CEAA. 1999 "Cumulative Effects Assessment Practitioners Guide", Hegmann, G., C. Cocklin, R. Creasey, S. Dupuis, A. Kennedy, L. Kingsley, W. Ross, H. Spaling and D. Stalker. Prepared by: The Cumulative Effects Assessment Working Group and AXYS Environmental Consulting Ltd. http://dsp-psd.pwgsc.gc.ca/Collection/En106-44-1999E.pdf

Federal Environmental Assessment Review Office. 2010. Reference Guide: Determining Whether A Project is Likely to Cause Significant Adverse Environmental Effects. Available from http://www.ceaa-acee.gc.ca/default.asp?lang=En&n=D213D286-1 [accessed 4 May 2012].

Terrestrial Invertebrates

Department of Justice Canada. 2008. Species At Risk Act. Downloaded from: http://laws.justice.gc.ca/en/s-15.3/text.html.

Manitoba Endangered Species Act (MESA). 1993. Manitoba Conservation. Updated February 2010. Available from http://web2.gov.mb.ca/laws/statutes/ccsm/e111e.php [accessed 25 February 2010].

Amphibians and Reptiles

Department of Justice Canada. 2008. Species At Risk Act. Downloaded from: http://laws.justice.gc.ca/en/s-15.3/text.html.

Manitoba Endangered Species Act (MESA). 1993. Manitoba Conservation. Updated February 2010. Available from http://web2.gov.mb.ca/laws/statutes/ccsm/e111e.php [accessed 25 February 2010].

The Wildlife Act and associated regulations and guidelines. Particularly 215/89

Birds

The Wildlife Act and associated regulations and guidelines

Migratory Birds Convention Act and its associated regulations and guidelines. Particularly C.R.C. c. 1035 Migratory Bird Regulations

Federal Species at Risk Act (SARA)

In addition to the aforementioned legislation, Project-related assessment of invertebrates, amphibians, reptiles and birds also complies with requirements of the *Manitoba Environment Act* and *Canadian Environmental Assessment Act*.

Mammals

Canadian Wildlife Service, Environment Canada First Edition: 27 February 2004, Environmental Assessment Best Practice Guide For Wildlife at Risk in Canada.

CEAA. 1994: Addressing Cumulative Environmental Effects. Canadian Environmental Assessment Agency - Policy & Guidance - The Responsible Authority's Guide

CEAA. 1999 "Cumulative Effects Assessment Practitioners Guide", Hegmann, G., C. Cocklin, R. Creasey, S. Dupuis, A. Kennedy, L. Kingsley, W. Ross, H. Spaling and D. Stalker. Prepared by: The Cumulative Effects Assessment Working Group and AXYS Environmental Consulting Ltd. http://dsp-psd.pwgsc.gc.ca/Collection/En106-44-1999E.pdf

Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 2003. Environment Canada. Available from http://www.cosewic.gc.ca/eng/sct5/index_e.cfm [accessed 25 February 2010].

Department of Justice Canada. 2008. Species At Risk Act. Downloaded from: http://laws.justice.gc.ca/en/s-15.3/text.html.

Environment Canada. 2008. Scientific review of the identification of critical habitat for woodland caribou (Rangifer tarandus caribou), Boreal population, in Canada. Environment Canada, Ottawa, Ontario. 72 pp. plus appendices.

Environment Canada and Parks Canada. 2010a. Addressing *Species at Risk Act* Considerations Under the Canadian Environmental Assessment Act for Species Under the Responsibility of the Minister responsible for Environment Canada and Parks Canada

Environment Canada and Parks Canada. 2010b. The *Species at Risk Act* Environmental Assessment Checklists for Species Under the Responsibility of the Minister responsible for Environment Canada and Parks Canada, Support Tool for the Required Information Elements Under the Species at Risk Act for Environmental Assessments Conducted Under the Canadian Environmental Assessment Act.

Environment Canada. 2011. Recovery strategy for the woodland caribou, boreal population (*Rangifer tarandus caribou*) in Canada [proposed]. *Species at Risk Act* Recovery Strategy Series. Environment Canada, Ottawa, Ontario. 55 pp.

Government of Canada. 2009. Species at Risk Public Registry. Available from http://www.sararegistry.gc.ca [accessed 30 November 2009].

Manitoba Conservation, Wildlife and Ecosystem Protection Branch. 2005a. Manitoba's Conservation and Recovery Strategy for Boreal Woodland Caribou (*Rangifer tarandus caribou*). Published by Manitoba Conservation, Wildlife and Ecosystem Protection Branch, Winnipeg. 20pp.

Manitoba Conservation, Wildlife and Ecosystem Protection Branch. 2009a.. Problem beaver management program 2009/10 directives from Manitoba Conservation [online]. Available from http://www.manitoba.ca/conservation/wildlife/problem_wildlife/pdf/beaver_subsidy.pdf [accessed 30 November 2009].

Manitoba Conservation, Wildlife and Ecosystem Protection Branch. 2009b. Draft policy directive: furbearer management [online]. Available from http://www.gov.mb.ca/conservation/wildlife/trapping/pdf/draft_fur_policy_procedure.pdf [accessed 20 January 2012].

Manitoba Conservation, Wildlife and Ecosystem Protection Branch. 2011a. 20112011a2011–2012 Trapping Guide [online]. Available from http://www.gov.mb.ca/conservation/wildlife/trapping/pdf/trapping_guide_2011_12_final.pdf [accessed 20 January 2012].

Manitoba Conservation, Wildlife and Ecosystem Protection Branch. 2011b. 2011–2012 Manitoba Hunting Guide [online]. Available from http://www.gov.mb.ca/conservation/wildlife/hunting/ [accessed 9 December 2011].

Manitoba Endangered Species Act (MESA). 1993. Manitoba Conservation. Updated February 2010. Available from http://web2.gov.mb.ca/laws/statutes/ccsm/e111e.php [accessed 25 February 2010].

Species at Risk Public Registry. 2007. Online at http://www.sararegistry.gc.ca/default_e.cfm. Accessed April 7, 2008.

Species at Risk Public Registry. 2010. Environment Canada. Available from http://www.sararegistry.gc.ca/default_e.cfm [accessed 25 February 2010].

SOCIO-ECONOMIC ENVIRONMENT

SOCIO-ECONOMIC

Bank of Canada. 2009. The consumer price index fact sheet [online]. Available from http://www.bankofcanada.ca/en/backgrounders/bg-i4.html [accessed April 20, 2010].

BRHA. 2009b. Determinants of health [online]. Available from http://www.brha.mb.ca/news/chapter%203%20burntwood.pdf [accessed November 17, 2011].

CEAA. 1994: Addressing Cumulative Environmental Effects. Canadian Environmental Assessment Agency - Policy & Guidance - The Responsible Authority's Guide

CEAA. 1999 “Cumulative Effects Assessment Practitioners Guide”, Hegmann, G., C. Cocklin, R. Creasey, S. Dupuis, A. Kennedy, L. Kingsley, W. Ross, H. Spaling and D. Stalker. Prepared by: The Cumulative Effects Assessment Working Group and AXYS Environmental Consulting Ltd. http://dsp-psd.pwgsc.gc.ca/Collection/En106-44-1999E.pdf

CEAA. 2006. Ministerial Guideline on Assessing the Need for and Level of Public Participation in Screenings under the Canadian Environmental Assessment Act. http://www.ceaa-acee.gc.ca

CEAA. 2008. Public Participation Guide. http://www.ceaa-acee.gc.ca

Government of Manitoba. 1997. Transportation planning policy: TP 1/98: A highway functional classification system for rural provincial highways in Manitoba –

Background/reference material [online]. Available from http://www.gov.mb.ca/mit/tspd/pdf/appendix_a_tp1_98.pdf [accessed February 1, 2012].

Government of Manitoba. 2007. Mercury in fish & guidelines for the consumption of recreational angled fish in Manitoba [online]. Available from http://www.gov.mb.ca/waterstewardship/fisheries/education/mercury_final_nov_2007.pdf [accessed January 30, 2012].

Government of Manitoba 2010f. Manitoba Highway Classification System [online]. Available from http://www.gov.mb.ca/mit/mcd/mcpd/mhcs.html [accessed October 2, 2010].

Health Canada. 20010. Toxicological Reference Values, Estimated Daily Intakes or Dietary Reference Values for Trace Elements. Last Updated September 2010. Developed by the Chemical Health Hazard Assessment Division, Bureau of Chemical Safety, Food and Health Products Branch, Health Canada, Ottawa, Ontario.

Health Canada. 2009a (draft). Federal Contaminated Site Risk Assessment in Canada – Part I: Guidance on Human Health Preliminary Quantitative Risk Assessment (PQRA). Contaminated Sites Division, Safe Environments Programme, Health Canada, Ottawa, ON.

Health Canada. 2009b. Federal Contaminated Site Risk Assessment in Canada – Part IV: Spreadsheet Tool for Human Health Preliminary Quantitative Risk Assessment (PQRA). Contaminated Sites Division, Safe Environments Programme, Health Canada, Ottawa, ON.

Health Canada. 2009c (draft). Federal Contaminated Site Risk Assessment in Canada, Part V: Guidance on Complex Detailed Quantitative Human Health Risk Assessment of Chemicals ($DQRA_{CHEM}$). Contaminated Sites Division, Safe Environments Programme, Health Canada, Ottawa, ON.

Health Canada. 2007. Human Health Risk Assessment of Mercury in Fish and Health Benefits of Fish Consumption. Chemical Health Hazard Assessment Division, Bureau of Chemical Safety, Food and Health Products Branch, Health Canada, Ottawa, Ontari

Health Canada, 2004. Canadian Handbook on Health Impact Assessment. Volume 3: The Multidisciplinary Team. Health Canada, Ottawa, Ontario.

Health Canada. 1998. Review of the Tolerable Daily Intake (TDI) for Methyl Mercury (MeHg). Bureau of Chemical Safety, Food Directorate, Health Canada, Ottawa Ontario. Dated: April 27, 1998.

Human Resources and Skills Development Canada. 2012. Indicators of well-being in Canada [online]. Available from http://www4.hrsdc.gc.ca/d.4m.1.3n@-eng.jsp?did=12 [accessed November 20, 2011].

Manitoba Water Stewardship. 2011. Manitoba Water Quality Standards, Objectives and Guidelines. Government of Manitoba: Winnipeg, MB.

Memorandum of Agreement, 1964. Department of National Health and Welfare, Canada and the Department of Health of the Province of Manitoba. Miller J.R., 1989.

Quigley, R.L., den Broeder, P., Furu, A., Bond, B., Cave and Bos, R. 2006. Health Impact Assessment International Best Practice Principles. Special Publication Series No. 5. Fargo, USA: International Association for Impact Assessment. 5-8 pp.

RNFB (Revised Northern Flood Basket). 2008a. Food price survey: Food mail program. June 9, 2008.

RNFB. 2008b. Price selection procedure for the revised northern food basket (2007). July 10, 2008.

Statistics Canada. 1996. Your guide to the consumer price index [online]. Available from www.statcan.gc.ca/imdb-bmdi/document/2301_D6_T9_V1-eng.pdf [accessed November 5, 2009].

WHO (World Health Organization). 2009. The Determinants of Health [online] Available at http://www.who.int/hia/evidence/doh/en [accessed October 23, 2009].

WHO. 2010. International statistical classification of diseases and related health problems [online]. Available from http://apps.who.int/classifications/icd10/browse/2010/en [accessed January 23, 2012].

RESOURCE USE

Canadian Environmental Assessment Agency 2004. Strategic environmental assessment: The cabinet directive on the environmental assessment of policy, plan and program proposals, Guidelines for Implementing the Cabinet Directive. Available from http://www.ceaa-acee.gc.ca/default.asp?lang=En&n=B3186435-1 [accessed April 25, 2012].

Canadian Environmental Assessment Agency 2010. Considering Aboriginal traditional knowledge in environmental assessments conducted under the *Canadian Environmental Assessment Act* – Interim Principles. Available from: http://www.ceaa-acee.gc.ca/default.asp?lang=En&n=4A795E76-1 [accessed April 25, 2012].

Federal Environmental Assessment Review Office 1994. A reference guide for the Canadian Environmental Assessment Act: Determining whether a project is likely to cause significant environmental effects. November 1994. Available from: http://www.ceaa-acee.gc.ca/D213D286-2512-47F4-B9C3-08B5C01E5005/Determining_Whether_a_Project_is_Likely_to_Cause_Significant_Adverse_Environmental_Effects.pdf [accessed April 25, 2012].

HERITAGE RESOURCES

Canadian Environmental Assessment Agency (CEAA). 1992. Canadian Environmental Assessment Act; An act to establish a federal environmental assessment process, 1992, c.37 [C-15.2].

Government of Manitoba. 1986. The Heritage Resources Act. C.C.S.M. c. H39.1. Queen's Printer, Winnipeg, MB.

Government of Manitoba. 1987 Policy Concerning the Reporting, Exhumation and Reburial of Found Human Remains. Queen's Printer, Winnipeg, MB.

Government of Manitoba. The Environment Act. 1987. C.C.S.M. c. E125 Online document available from http://web2.gov.mb.ca/laws/statutes/ccsm/e125e.php. [Accessed 2012].

Interagency Advisory Panel on Research Ethics. 2008. Draft 2nd Edition of the Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans. Ottawa, ON. (http://www.pre.ethics.gc.ca)

International Association for Impact Assessment (IAIA). 2010. Respecting Indigenous Peoples and Traditional Knowledge: International Best Practices Principles. Climate Change and Impact Assessment, IAIA Special Symposium, Denmark. October 25-26. (http://www.iaia.org/iaia-climate-symposium-denmark/indigenous-peoples-traditional-knowledge.aspx). [Accessed 2011].

Society for American Archaeology. Principles of Archaeological Ethics. (http://www.saa.org/AbouttheSociety/PrinciplesofArchaeologicalEthics/tabid/203/Default.aspx.) [Accessed 2012.]

UNESCO 2003 Convention for the Safeguarding of Intangible Cultural Heritage. United Nations. (http://www.unesco.org/culture/ich/index.php?lg=en&pg=00006). [Accessed 2011.]

APPENDIX 6C

IMPACT MATRIX

Illustrating the Potential Effects of the Keeyask Generation Project Activities by Phase on the Components of the Environment and Valued Environmental Components

Hydropower Limited Partnership

Project Phases Major Components or Activities	Environmental Components: Physical Components												Aquatic VECs					Terrestrial VECs													Socio-Economic VECs																Resource Use VECs			
	Climate	Air Quality	Noise	Physiography	Surface Water	Ice Regime	Shorline Erosion Processes	Sedimentation	Groundwater	Surface Water Temperature	Surface Water DO	Debris	Water Quality	Lake Sturgeon	Walleye	Northern Pike	Lake Whitefish	Ecosystem Diversity	Intactness	Wetland Function	Priority Plants	Canada Goose	Mallard	Bald Eagle	Olive-sided Flycatcher	Common Nighthawk	Rusty Blackbird	Caribou	Moose	Beaver	Employment Opportunities	Business Opportunities	Income	Cost of Living	Resource Economy	Housing	Infrastructure and Services	Land	Transportation and Infrastructure	Governance, Goals and Plans	Mercury and Health	Community Health	Public Safety and Worker Interaction	Travel, Access and Safety	Culture and Spirituality	Aesthetics	Domestic Fishing	Domestic Hunting and Gathering	Commercial Trapping	Heritage Resources VEC
Construction																																																		
Workforce requirements and presence of workforce														•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•			•		•	•		•		•	•		
Transport of workers, supplies and equipment																		•	•	•	•							•	•	•									•					•						
Purchase of equipment, supplies and services																															•	•	•																	
Site preparation (clearing and grubbing)	•	•	•	•				•					•					•	•	•	•							•	•	•					•			•				•			•	•		•	•	
Construction and use of camp and work areas	•	•	•	•				•					•					•	•	•	•	•	•	•	•	•	•	•	•	•					•			•				•			•	•		•	•	
Concrete batch plants and crushing operations	•	•	•					•					•	•	•	•	•											•	•	•								•				•								
Development of borrows, quarries, and EMPAs	•	•	•	•				•					•					•	•	•	•				•	•		•	•	•					•			•				•			•	•		•	•	
Water, wastewater and waste management											•		•	•	•	•	•										•			•								•				•				•				
Construction and use of south access road and haul trails	•	•	•	•				•					•		•	•		•	•	•	•	•	•	•	•	•	•	•	•	•					•			•	•			•		•	•	•		•	•	•
Use of the north access road	•	•	•															•	•	•	•	•	•	•	•	•	•	•	•	•					•				•					•	•			•	•	•
Construction of rock fill causeways to borrows G3 and G5	•	•	•	•	•	•	•	•					•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•					•			•				•		•	•	•	•	•		•
Construction and use of ice boom	•	•	•	•	•	•	•	•						•	•	•	•	•	•	•	•	•	•	•			•	•	•	•					•			•				•		•	•	•	•	•		•
Construction and removal of cofferdams, groins, and spurs	•	•	•	•	•	•	•	•					•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•					•			•				•		•	•	•	•			•
Blasting			•										•	•	•	•	•					•	•	•	•	•	•	•	•	•					•			•				•		•	•	•	•	•	•	
Construction of principal structures	•	•	•	•	•	•	•	•	•				•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•					•			•				•			•	•	•	•	•	•
River management					•	•	•	•	•	•	•	•	•					•	•	•	•	•	•	•			•			•					•			•				•		•	•	•	•	•	•	
Construction and use of boat launches and barge landings	•	•	•	•									•	•	•	•	•	•	•	•	•	•	•	•			•	•	•	•					•			•	•			•		•	•	•	•	•		•
Reservoir clearing	•	•	•	•								•	•					•	•	•	•	•	•	•	•	•	•	•	•	•					•			•				•		•	•	•	•	•	•	
Reservoir impoundment				•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•			•	•	•	•					•			•			•	•		•	•	•	•	•	•	•
Decommissioning of Temporary Infrastructure	•	•	•	•	•	•	•	•					.															•	•	•															•	•				
Operation																																																		
Workforce requirements and presence of workforce		•	•											•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•		•	•	•	•	•	•	•				•		•	•		
Purchase of equipment, supplies and services																															•	•	•																	
Income from equity investment																															•	•	•			•	•	•		•		•			•					
Regulation of flows					•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•			•	•	•	•					•							•		•	•	•	•	•		
Change in ice regime		•			•	•	•	•	•	•	•	•	•					•	•	•	•	•	•	•			•	•	•	•					•							•		•	•	•	•	•		
Flooding of terrestrial habitat	•			•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•					•						•	•		•	•	•	•	•	•	
Reservoir expansion	•			•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•					•						•	•		•	•	•	•	•	•	•
Project footprint	•			•	•	•	•	•	•	•	•	•		•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•					•										•	•	•	•	•	
Spillway operation			•		•	•						•	•	•	•	•	•	•	•	•	•	•	•	•			•			•					•							•		•	•	•	•	•		
Turbine operation			•		•	•				•				•	•	•	•							•											•												•	•		
Operation of boat launches, barge landing, and portage			•										•	•	•	•	•	•	•	•	•	•	•	•			•	•	•	•					•				•			•		•			•	•		•
Increased access		•	•											•	•	•	•	•	•	•	•	•	•					•	•	•					•				•					•	•	•	•	•	•	
Access road and stream crossing maintenance	•	•	•										•		•	•		•	•	•	•	•	•	•			•	•	•	•									•					•						
Water, wastewater and waste management											•		•	•	•	•	•					•	•	•			•			•																				
Principal structure maintenance	•																	•	•	•	•																													
Accidents/Malfunctions													•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•					•				•	•		•		•	•	•	•	•		

CHAPTER 7
CUMULATIVE EFFECTS ASSESSMENT

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7.0 CUMULATIVE EFFECTS ASSESSMENT

7.1 INTRODUCTION

This chapter presents the results of the cumulative effects assessment (CEA) of the Keeyask Generation Project (the Project). The CEA describes the incremental effects likely to result from the Project on the environment when the effects are combined with the effects of other past, present or future projects or human activities listed in this chapter:

- The adverse effects of the Project in combination with other past and current projects are summarized from Chapter 6; and
- These adverse effects of the Project are assessed in combination with other future projects and activities.

7.2 APPROACH

As reviewed in Chapter 5, the Project is the subject of two evaluations. The first was conducted by the Keeyask Cree Nations (KCNs) for their internal purposes; the second was prepared to comply with the federal and provincial environmental regulatory process:

- KCNs Evaluation Process:

  The KCNs evaluation process has been underway for more than a decade with the support of Manitoba Hydro. The process assisted the KCNs to understand the Project and its impacts on their communities and Members and to determine the conditions under which they would approve the Joint Keeyask Development Agreement and support the Project. The Project was evaluated by each of the KCNs in terms of their own worldview, values and experience with past hydroelectric development, as well as their relationships with Mother Earth (see Chapter 2 and the KCNs' Environmental Evaluation Reports which are provided to assist other people to understand their independent decisions to be Project proponents).

- Government Regulatory Assessment Process:

  Work by Manitoba Hydro and the KCNs on the government regulatory assessment process has also been underway for many years. The Keeyask environmental impact assessment is in accordance with the regulatory framework outlined in Section 1.3, guidance provided by federal and provincial regulatory agencies, and standard environmental assessment practice. The existing environment and the manner in which it functions, including the effects on it caused by past and current projects, was studied and analyzed using the scientific method (referred to as "technical information" in the environmental impact statement (EIS)), Aboriginal traditional knowledge (ATK) and local knowledge. The regulatory assessment then predicted the effects on this environment if the Project is developed, and mitigation was identified to reduce the severity of adverse effects as much as possible. A monitoring program will determine if the prediction of effects are accurate and if mitigation measures are working as expected; and, if not, will assist in identifying new mitigation measure to apply.

The CEA for the Project was conducted for the government regulatory assessment process with consideration of the guidance provided by the following:

- EIS Guidelines; and
- Review of other guidance documents for cumulative effects assessment (*e.g., Cumulative Effects Assessment Practitioners Guide*, Hegmann *et al* 1999; Operational Policy Statement, CEAA 2007).

In addressing cumulative effects, Hegmann *et al* (1999) state in the Canadian Environmental Assessment Agency's *Cumulative Effects Practitioners' Guide* that:

> "… an assessment of a single project (which is what almost all assessments do) must determine if that project is incrementally responsible for adversely affecting a VEC beyond an acceptable point (by whatever definition). Therefore, although the total cumulative effect on a VEC due to many actions (defined as projects and activities) must be identified, the CEA must also make clear to what degree the project under review is alone contributing to that total effect. Regulatory reviewers may consider both of these contributions in their deliberation on the project application."

In conducting a CEA, it is necessary to consider, but not necessary to assess the regulatory significance of, the effects of other past, current and future projects (*i.e.,* it is not necessary to assess the effects of such other projects as being, for example, significant or adverse). The CEA for the Project determines the extent to which the Project is expected to be incrementally responsible for adversely affecting a Valued Environmental Component (VEC) beyond an acceptable point, taking into account the overall suite of stresses on the selected VEC (including stresses from other projects and activities).

The effects of past and current projects and activities on the existing environment, including effects expected in the future without the Project, are described in Section 6.2, Existing Environment (see Table 7-1 for a list of these other projects and activities). The additional effects that the Project will cause on this existing environment are then assessed in the remainder of Chapter 6, Environmental Effects Assessment[1] and those VECs that will be adversely affected by the Project (after mitigation) in combination with past and current projects are identified.

Chapter 7's CEA begins by summarizing the effects of the Project in combination with other past and current projects (as assessed in Chapter 6). Chapter 7 then examines if these VECs will be further adversely affected by the Project in combination with other future projects and activities (see Table 7-2 for a list of the future projects and activities included in this CEA). Where VECs are further adversely affected by the Project in combination with other future projects and activities, the following steps are also taken in Chapter 7:

- Determine what, if any, additional mitigation may be required for these VECs to address the combined adverse effect of the Project with the further adverse effects of the identified future projects and activities and predict the residual effects of the Project in combination with the identified future projects and activities; and
- For each of these VECs, determine whether the regulatory significance of the Project's residual effects as assessed in Chapter 6 changes when they are combined with the effects of future projects and activities.

By focusing on individual environmental components, the VEC approach does not capture the broader concept of the Cree worldview, which emphasizes that all things are interconnected and should be viewed as a whole. An understanding of this worldview and the related KCNs' views regarding the cumulative effects of Project in combination with other past and current projects, as expressed by the KCNs who are directly affected by the Project, is provided in Chapter 2, Partners' Context, Worldviews and Evaluation Process (Section 2.2), and in the KCNs' Environmental Evaluation Reports. However, where ATK of specific environmental components was incorporated into the assessment, this is reflected in the CEA results.

[1] The temporal and spatial scope for the Chapter 6 assessment of Project effects on each VEC were defined as required to address CEA of the Project in combination with other past and current projects and activities.

7.3 PAST, CURRENT AND FUTURE PROJECTS AND ACTIVITIES

7.3.1 PAST AND CURRENT PROJECTS AND ACTIVITIES CONSIDERED IN THE CUMULATIVE EFFECTS ASSESSMENT

The Project is located in a region that has been greatly altered over the past 55 years by the development of the Lake Winnipeg Regulation Project (LWR), the Churchill River Diversion Project (CRD) and five generating stations. The Project is located on a reach of the Nelson River between the Kettle GS and the Kelsey GS where flows are regulated by the CRD and LWR. These alterations have replaced large rapids with dams, changed stretches of the river into reservoirs, diverted flows from the Churchill River into the Nelson River and reversed the seasonal flow pattern such that higher flows now occur in winter and lower flows in spring and summer. Past and current linear developments in the region, including upgrades to PR 280, may also overlap with the Project. Other agents of past and current change in the region that may overlap with the Project are mining, commercial forestry, commercial fishing of sturgeon and other activities as may be identified in the assessment of specific VECs (see Chapter 6).

Table 7-1 provides a list of the past and current projects and activities that are considered in the cumulative effects assessment for the Project. Additional information on the past and current projects and activities is provided in Section 6.2. Descriptions of past effects from the perspective of the KCNs are provided in Chapter 2 and in their individual KCNs Environmental Evaluation Reports. Additional information describing the individual past and current projects and activities considered in the cumulative effects assessment, including relevant maps, is also provided in Appendix 7A.

7.3.2 SUMMARY OF PROJECT PHYSICAL EFFECTS WITH PAST AND CURRENT PROJECTS/ACTIVITIES

As reviewed in Chapter 6 (Section 6.3), the Project will affect open water levels for about 41 km upstream of the Project and change a portion of this waterbody from a presently primarily riverine reach to a reservoir environment. About 45 km^2 of initial flooding is predicted. This inundation, along with ongoing erosion, will affect water quality, and terrestrial and aquatic habitat. Chapter 6 (Section 6.3) has described these effects in detail and the descriptions assisted in the evaluation of the VECs selected for CEA.

Table 7-1: Past and Current Projects and Activities Considered in the Cumulative Effects Assessment of the Project

Category	Projects Included	Summary Effects (see Chapter 6)
Manitoba Hydro generation-related developments	• Churchill River Diversion (CRD) • Lake Winnipeg Regulation (LWR) • Jenpeg, Kelsey, Kettle, Long Spruce, Limestone and Wuskwatim GSs (on Nelson and Burntwood rivers) • Kelsey re-runnering • Keeyask Infrastructure Project (KIP)	CRD and LWR as established in the 1970s have ongoing effects that overlap with Keeyask Project effects on the water regime, the related environment and local communities and peoples. Other generating stations, control structures and activities on the Nelson and Burntwood rivers (including Kelsey re-runnering) also have ongoing effects that overlap with the Project's effects. The north access road to the Project, including related temporary camp and work areas, that was licensed and constructed as part of KIP prior to the start of Keeyask construction have effects that overlap with the Project's effects on some components of the environment.
Linear development in the region	• Transmission lines, rail lines and highways, including upgrades to PR 280	Existing linear developments in the vicinity of the Project, including upgrades to PR 280, have ongoing effects (e.g., habitat disruption, fragmentation effects, increased access to resources, transportation safety) that overlap with the Project's effects on some components of the environment.
Other	• Mining (e.g., Vale) • Commercial forestry • Commercial fishing, including sturgeon • Other agents of change as may be identified in the assessment of specific VECs (see Chapter 6)	Other agents of change are identified in the assessment of specific VECs (see Chapter 6). Mining-related effects overlap with Project socio-economic effects in the Thompson area; minimal overlap of Project effects is expected with commercial forestry; commercial fishing has the potential to affect fish populations, and had a large effect on lake sturgeon populations prior to closure of the lake sturgeon commercial fishery in 1992.

In summary, the Project's effects on the physical environment are mainly associated with the construction footprint, the creation of a reservoir, and the associated hydraulic zone of influence on surface water and ice regimes upstream and downstream of the Project. The effects on the physical environment provide the context from which other environmental components (*e.g.*, aquatic and terrestrial) undertake their environmental assessment, including cumulative effects assessment.

7.3.3 Future Projects and Activities Considered in the Cumulative Effects Assessment of the Project

Table 7-2 provides a list of future projects and activities considered as part of this cumulative effects assessment. Additional information describing the individual future projects and activities considered in the cumulative effects assessment is also provided in Appendix 7A. Figure 7-1 summarizes the currently anticipated timing of construction of future projects in the vicinity of Gillam, including employment estimates.

7.3.4 Summary of Project Physical Effects with Future Projects/Activities

Two future Manitoba Hydro transmission projects Table 7-2 (the Bipole III Transmission Project and the Keeyask Transmission Project) are currently or will soon be subject to regulatory review. These will overlap in time and, to some extent, space with the Project. These future transmission projects are very different in nature from the Project and, with respect to the physical environment, there is sufficient spatial separation so that there is little or no overlap with effects of the Project in regard to erosion, noise, groundwater, and other physical environment effects of the Project. KCNs' perspectives (ATK based on past experience with Manitoba Hydro projects) indicate that the hydraulic zone of the Project effects may extend further than predicted in Chapter 6. Even if this extended zone is considered, there is little overlap of physical environment effects of the Project with those of these other future transmission projects.

In contrast, there would be some overlap with the release of sediment during in-stream construction activities of the Project and the potential future construction of the Conawapa GS if this proceeds for initial in-service in 2025. The incremental downstream effects of the Project during construction below Conawapa are expected to be minor and of short duration (one to three months per year for two years). The overlap effects on water quality are discussed in Section 7.5.1 “Aquatic Environment.”

The operations of the above future projects are not expected to cause measureable incremental changes to the Project effects on the physical environment.

Table 7-2: Future Projects and Activities in the Vicinity of Gillam Considered in the Cumulative Effects Assessment of the Project

Projects Included	Summary Effects
Bipole III Transmission Project (includes Keewatinoow Converter Station and Ground Electrode and Camp/Construction Power, Collector Lines and Existing Station Upgrades, Bipole III Transmission Northern Segment #1)	The Bipole III Transmission Project being planned and developed by Manitoba Hydro is currently being reviewed by regulators for a potential construction start in 2013 and in-service in 2017. Bipole III components in the Gillam area will have effects during construction and operation that overlap with Keeyask Generation Project effects on some components of the environment.
Keeyask Transmission Project (includes construction power to the Keeyask Generation Project, and Generation Outlet Transmission lines with switching station and three new transmission lines to convey power from Keeyask GS to Radisson Converter Station)	The Keeyask Transmission Project is being planned and developed in the Gillam area by Manitoba Hydro, with construction power development planned between mid-2014 and mid-2015 and other component developments planned between early 2017 and early 2020. Keeyask Transmission Project components will have effects during construction and operation that overlap with Keeyask Project effects on some components of the environment.
Gillam Redevelopment	Gillam redevelopment (2013 to 2019) includes the potential for new housing within the Town of Gillam.
Conawapa Generation Project (includes Camp)	Conawapa Generation Project is a potential development by Manitoba Hydro. If developed for initial in-service in 2025, construction could start in early 2017 for completion by late 2027. Conawapa Generation Project components may have effects during construction and operation that overlap with Keeyask Project effects on some components of the environment.

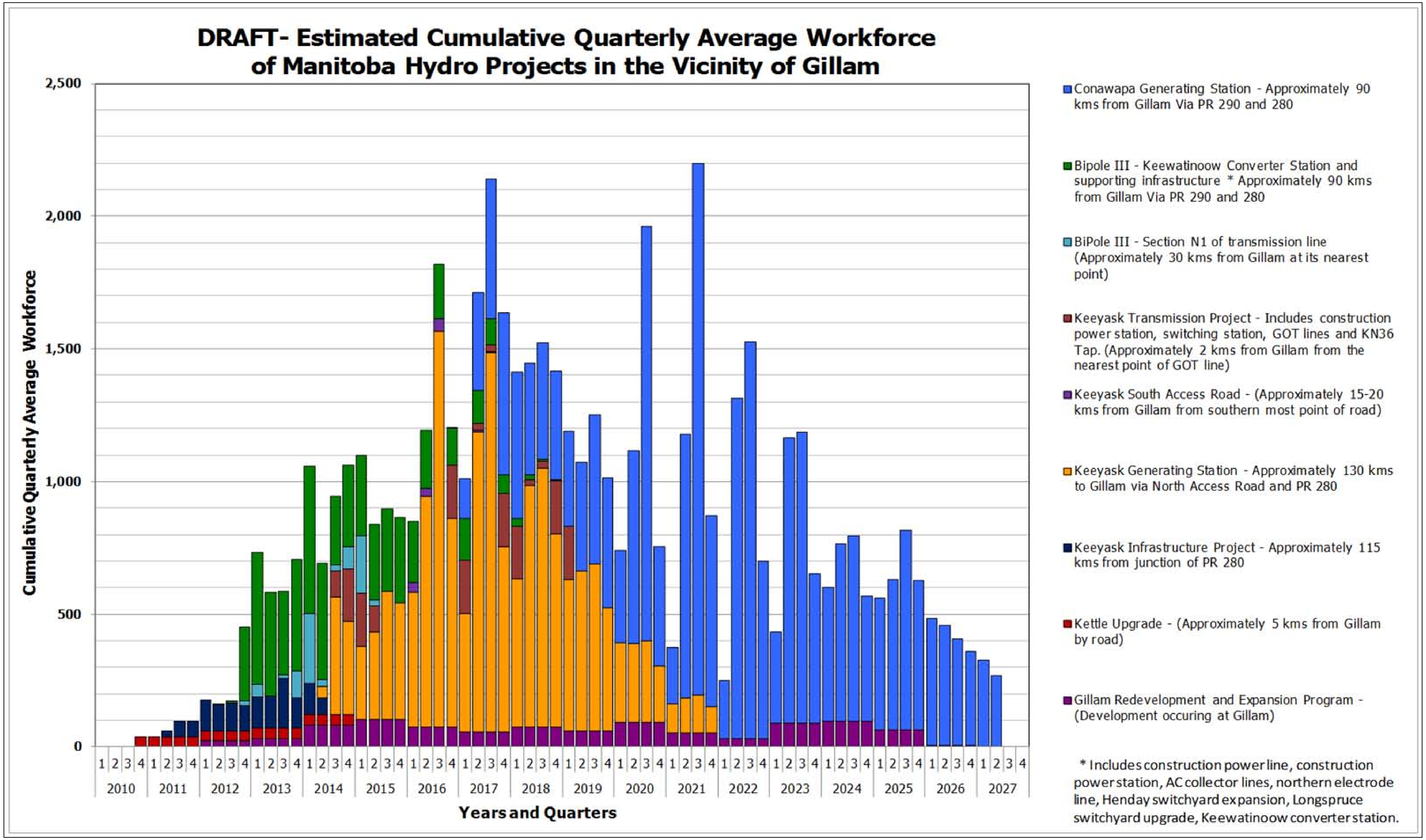

Figure 7-1: Major Construction Activity in the Gillam Area During Construction of the Keeyask Generation Project

Notes:

1. The estimates are quarterly average workforce requirements (averages within each quarter based on monthly information) based on information available at the time of compilation and are subject to change. In some instances the level of detail for the estimates vary and the footnotes below provide further details where necessary. Unless otherwise noted: the above information represents a forecast only, based on current regulations, present project plans, and experience with similar projects; contractors will determine specific job requirements when the project is being built; actual employment requirements will vary from the forecast presented. Unless otherwise noted, the above information indicates contractor site personnel (including supervisory and management positions); it also includes Manitoba Hydro site staff. The above forecasts do not include Manitoba Hydro Winnipeg office staff, or workforce for the construction of Substations and Transmission Lines.

2. Gillam Redevelopment and Expansion Program

- Estimated number of workers required per year. Assumes quarterly peak workforce is equal to number of workers required per year.

3. Kettle Upgrade

- Assumes peak quarterly workforce of 40 workers.

4. Keeyask Infrastructure Project

- The above forecasts are based on Manitoba Hydro's forecast of workforce and a construction schedule of November 2019 first unit in-service date.
- The Keeyask Infrastructure Project is expected to be completed by May 2014.

5. Keeyask Generating Station

- The above forecasts are based on KGS Acres and Manitoba Hydro's forecast of workforce and a construction schedule of November 2019 first unit in-service date.
- The Keeyask Generating Station project is expected to start in June 2014.
- The above forecast does not include the workforce for the South Access Road (SAR); SAR estimates are provided separately in the figure.

6. Keeyask South Access Road

- The above forecasts are based on KGS Acres and Manitoba Hydro's forecast of workforce and a construction schedule of November 2019 first unit in-service date.
- The Keeyask Generating Station project is expected to commence in June 2014.

7. Keeyask Transmission Project - Construction Power Station

8. Keeyask Transmission Project - Switching Station and GOT lines.

9. Bipole III

i. The following notes apply to N1 clearing and construction, Keewatinoow construction power line, Keewatinoow AC collector lines and the northern electrode line
   - Projections are extrapolated from Wuskwatim Transmission Line figures.
   - Projections based on a December 2012 construction start date.
   - Projections are assumptions only; each contractor will staff and schedule his/her section of the work as per their own preferences.
   - Breakdown is derived from Wuskwatim-Herblet actuals and then applied as a percentage to Bipole III projected figures
   - Estimate includes contractor workers and contractor supervisory positions and Manitoba Hydro workers and Manitoba Hydro supervisory positions.

ii. The following notes apply to Henday switchyard expansion, Long Spruce switchyard upgrades, and the Keewatinoow construction power station
   - Estimate includes contractor workers and contractor supervisory positions and Manitoba Hydro workers and Manitoba Hydro supervisory positions.

iii. Keewatinoow Converter Station
   - The above forecasts are based on Manitoba Hydro's forecast of workforce and a construction schedule based on an October 2017 BP III in-service date.

10. Conawapa Generating Station

- The above forecasts are based on KGS Acres and Manitoba Hydro's forecast of workforce and a construction schedule of May 2023 first unit in-service date, and was shifted to the current first unit in-service date of May 2025.
- The above information The above forecasts do not include Manitoba Hydro Winnipeg office staff, or workforce for the construction of Substations, Converter Station or Transmission Lines.

7.4 ASSESSMENT OF CUMULATIVE EFFECTS

The following sections present results of the CEA by environmental component for VECs that are adversely impacted by the Project:

- Biophysical Environment, organized separately by aquatic and terrestrial components; and
- Socio-economic Environment: organized separately by: infrastructure and services; personal, family and community life; and heritage resources.

All VECs examined in Chapter 6 were re-examined to determine if they should be included in the CEA for past and current projects and activities *(i.e.*, summary of assessment provided in Chapter 6) or for future projects and activities. The criteria for selection of the CEA VECs are as follows:

- There is an adverse effect on the VEC from the Project after mitigation, when considered in Chapter 6 in the context of past and present projects and activities (including those projects and activities identified in Table 7-1); and
- The adverse effect of the Project overlaps in space and time with the effects of one or more of the past and current projects and activities in Table 7-1 or the future projects or activities in Table 7-2.

Table 7-3 and Table 7-4 present the application of these criteria to biophysical and socio-economic VECs respectively. These tables identify:

- VECs adversely affected by the Project, and
- The other projects and activities (if any) which have effects on a VEC that overlap with adverse effects of the Project.

For each VEC, these tables distinguish overlaps with other past/current projects and activities (which were assessed in Chapter 6) from overlaps with other future projects and activities that are assessed in this Chapter 7.

7.5 BIOPHYSICAL ENVIRONMENT

Table 7-3 identifies the biophysical VECs included in the CEA *i.e.*, those VECs with an adverse effect from the Project (as assessed in Chapter 6) that overlaps spatially and temporally with effects from past/current projects or activities identified in Table 7-1, and/or with effects from future projects and activities identified in Table 7-2.

Table 7-3: Application of Cumulative Effects Assessment Criteria to Biophysical VECs

VECs Adversely Affected by the Project	Notes regarding Keeyask Effects	Overlap with Past/Current Projects or Activities	Overlap with Future Projects	Included (ü) in CEA for Future Projects or Activities
AQUATIC ENVIRONMENT				
Water Quality	Construction and operation phases	CRD, LWR,, hydroelectric stations developed on the Nelson and Burntwood rivers	Potential Conawapa GS	ü
Walleye	Construction phase	CRD, LWR, Kelsey GS (including re-runnering), Wuskwatim GS, Kettle GS, commercial fishery	No	
Northern Pike	Initial years of operation phase	CRD, LWR, Kelsey GS (including re-runnering), Wuskwatim GS, Kettle GS, commercial fishery	No	
Lake Whitefish	Construction phase	CRD, LWR, Kelsey GS (including re-runnering), Wuskwatim GS, Kettle GS, commercial fishery	No	
Lake Sturgeon	Construction phase	CRD, LWR, Kelsey GS (including re-runnering), Wuskwatim GS, Kettle GS, commercial fishery	No	
TERRESTRIAL ENVIRONMENT				
Habitat				
Ecosystem Diversity	Construction and operation phases	CRD, LWR, PR 280 upgrades, Keeyask Infrastructure project, Lower Nelson River generation projects, past transmission lines, mining activities, community development	Keeyask Transmission, Bipole III Transmission, Gillam Redevelopment	ü

Table 7-3: Application of Cumulative Effects Assessment Criteria to Biophysical VECs

VECs Adversely Affected by the Project	Notes regarding Keeyask Effects	Overlap with Past/Current Projects or Activities	Overlap with Future Projects	Included (ü) in CEA for Future Projects or Activities
Wetland Function	Construction and operation phases	CRD, LWR, PR 280 upgrades, Keeyask Infrastructure project, Lower Nelson River generation projects, past transmission lines, mining activities, community development	Keeyask Transmission, Bipole III Transmission, Gillam Redevelopment	ü
Intactness	Construction and operation phases	CRD, LWR, PR 280 upgrades, Keeyask Infrastructure project, Lower Nelson River generation projects, past transmission lines, mining activities, community development	Keeyask Transmission, Bipole III Transmission, Gillam Redevelopment	ü
Priority Plants	Construction and operation phases	CRD, LWR, PR 280 upgrades, Keeyask Infrastructure project, Lower Nelson River generation projects, past transmission lines, mining activities, community development	Keeyask Transmission, Bipole III Transmission, potential Conawapa Generation, Gillam Redevelopment	ü
Birds and Waterfowl				
Canada Goose	Construction and operation phases	CRD, LWR, Keeyask Infrastructure project, Lower Nelson River generation projects, past transmission lines	Keeyask Transmission and Bipole III Transmission projects, and potential Conawapa Generation Project	ü
Mallard	Construction and operation phases	CRD, LWR, Keeyask Infrastructure project, Lower Nelson River generation projects	Keeyask Transmission and Bipole III Transmission projects, and potential Conawapa Generation Project	ü

Table 7-3: Application of Cumulative Effects Assessment Criteria to Biophysical VECs

VECs Adversely Affected by the Project	Notes regarding Keeyask Effects	Overlap with Past/Current Projects or Activities	Overlap with Future Projects	Included (ü) in CEA for Future Projects or Activities
Bald Eagle	Construction phase (small, short-term noise related effects	CRD, LWR, Lower Nelson River generation projects, past transmission lines, Keeyask Infrastructure Project	Keeyask Transmission and Bipole III Transmission projects, and potential Conawapa Generation Project	No
Olive-sided Flycatcher	Construction and operation phases	LWR, PR 280 upgrades, Keeyask Infrastructure project, Lower Nelson River generation projects, past transmission lines, mining activities, community development	Keeyask Transmission and Bipole III Transmission projects	ü
Rusty Blackbird	Construction and operation phase	CRD, LWR, PR 280 upgrades, Keeyask Infrastructure project, Lower Nelson River generation projects, past transmission lines, mining activities, community development	Keeyask Transmission and Bipole III Transmission projects	ü
Common Nighthawk	Construction and operation phases	LWR, PR 280 upgrades, Keeyask Infrastructure project, Lower Nelson River generation projects, past transmission lines, mining activities, community development	Keeyask Transmission and Bipole III Transmission projects	ü
Mammals				
Caribou	Construction and operation phases	CRD, LWR, Kettle GS, Kelsey GS, Long Spruce GS, Limestone GS, KIP, transmission lines and highways, including upgrades to PR 280	Keeyask Transmission Project; Bipole III Transmission Project, potential Conawapa Generation Project, and Gillam redevelopment	ü

Table 7-3: Application of Cumulative Effects Assessment Criteria to Biophysical VECs

VECs Adversely Affected by the Project	Notes regarding Keeyask Effects	Overlap with Past/Current Projects or Activities	Overlap with Future Projects	Included (ü) in CEA for Future Projects or Activities
Moose	Construction and operation phases	CRD, LWR, Kettle GS, Kelsey GS, Long Spruce GS, Limestone GS, KIP, transmission lines and highways, including upgrades to PR 280	Keeyask Transmission Project; Bipole III Transmission Project, potential Conawapa Generation Project, and Gillam redevelopment	ü
Beaver	Construction and operation phases	CRD, LWR, Kettle GS, Long Spruce, GS Limestone GS, KIP, transmission lines and highways	Keeyask Transmission Project; Bipole III Transmission Project, and Gillam redevelopment	ü

7.5.1 AQUATIC ENVIRONMENT

The aquatic environment addresses environmental effects of the Project on the following VECs: water quality; walleye, northern pike, lake whitefish, and lake sturgeon.

7.5.1.1 EFFECTS OF PAST AND CURRENT PROJECTS AND ACTIVITIES

The aquatic environment in the lower Nelson River, including the area to be affected by the Project, has been substantially altered by past hydroelectric developments and continues to experience those effects today.

As discussed in Section 6.2 and in greater detail in the AE SV and the KCNs' Environmental Evaluation Reports, changes to the aquatic environment began with the first hydroelectric station, completed in 1961 at the Kelsey Rapids on the Nelson River upstream of Split Lake. The CRD and LWR, completed in the mid 1970s, altered the aquatic environment of the entire Nelson River. The reach of the river between Gull Rapids and Kettle Rapids was converted to a reservoir environment by construction of the Kettle GS, which was completed in 1974.

The most recent additions and alterations to existing hydroelectric developments are the construction of the Wuskwatim GS on the Burntwood River and re-runnering at the Kelsey GS on the Nelson River, both of which are directly upstream of Split Lake. The Cree world view that all parts of the environment are connected indicates that these would overlap with the effects of the Keeyask Project. The technical assessment of the spatial extent of effects of the Keeyask Project (Section 6.4) indicates that there is no overlap with these recent developments.

The Keeyask Infrastructure Project, which is being constructed adjacent to the Keeyask Generation Project, has minimal potential to affect surface waters, as the only watercourse crossings are a small unnamed stream and Looking Back Creek. Effects to Looking Back Creek are being avoided through the use of a clear span bridge. Other measures to manage sediment inputs from surface runoff and prevent the input of contaminants to surface waters are being employed during construction to avoid effects to water quality and aquatic biota (Keeyask Hydropower Limited Partnership 2009).

The following effects of past and current projects and activities, as they relate to each aquatic VEC affected by the Keeyask Project are summarized in Section 6.2.3.3 and discussed in detail in the AE SV (Sections 2.4 (water quality), 5.3 (walleye, northern pike, and lake whitefish) and 6.3 (lake sturgeon). The KCNs' Environmental Evaluation Reports provide information on the effects of past and current developments on the environment as a whole, including these VECs.

7.5.1.1.1 WATER QUALITY

The KCNs have noted a decline in water quality over decades and attributed this at least in part to CRD, LWR and the construction of individual generating stations. Increases in debris and sediment including silt and peat were noted on Split Lake, Clark Lake, Gull Lake and the Nelson River and water was stated to be more murky, dirty, muddy, and undrinkable throughout the system, including the Stephens Lake area before and more intensely after the Kettle GS was completed (Split Lake Cree Nation -Manitoba Hydro Joint Study Group 1996c). FLCN Members state that the decline in water quality in the Nelson River is an important cumulative impact that first began with the Kelsey GS (FLCN Environment Evaluation Report - *Draft*). At York Landing, residents have observed that water quality is getting worse each year with the dams (YFFN Evaluation Report (*Kipekiskwaywinan*)).

Technical information is very limited regarding Nelson River water quality pre-hydro development. Numerous technical analyses of changes to water quality as a result of CRD/LWR have been conducted and the results vary among studies, depending on the time periods analyzed; however, by the 1990s conditions in Split Lake appeared to have stabilized (AE SV Section 2.4). Water quality in Stephens Lake was affected in the initial years following construction of the Kettle GS, with increased concentrations of nutrients and total suspended solids, and periodic dissolved oxygen depletion but improved over time. At the present time, water quality within the river and lake sections of the lower Nelson River is moderately nutrient-rich, well-oxygenated, moderately soft to hard, and has a slightly alkaline pH. The majority of water quality parameters meet the Manitoba Water Quality Standards, Objectives and Guidelines (Section 6.2.3.3.2, see AE SV Section 2.4 for more information).

7.5.1.1.2 FISH

Though few specific observations are available with respect to fish distribution and abundance prior to completion of the Kelsey GS in 1961, KCNs Members state that fish were generally abundant throughout the lower Nelson River. In the post-Kelsey period, fish distributions are reported to have shifted in Split Lake (Split Lake Cree - Manitoba Hydro Joint Study Group 1996c). KCNs members have made observations with respect to declining lake whitefish, goldeye, mooneye and walleye in Split Lake and increases in sucker populations (Split Lake Cree - Manitoba Hydro Joint Study Group 1996c). Community Members have stated that following hydroelectric development, fish from the Nelson River, Split Lake and Stephens Lake are of poor quality and are described as being soggy, sour, discoloured, and generally unpalatable (CNP Keeyask Environmental Evaluation Report, FLCN 2010 Draft, YFFN Evaluation Report (*Kipekiskwaywinan*)).

Walleye, northern pike and lake whitefish

Technical studies conducted for this EIS found that walleye, northern pike, and lake whitefish in Split Lake, Gull Lake and Stephens Lake were abundant, with densities comparable to many off-system lakes. It is expected that the total number of these species in

Stephens Lake would have increased following construction of the Kettle GS, due to the greater amount of suitable habitat. Although no comparison to past conditions was provided, FLCN Members reported that walleye are abundant in Stephens Lake, Looking Back Creek and in Ferris Bay (FLCN 2010 Draft). As noted in AE SV (Section 5.3), methodological differences preclude the analysis of historic data to establish a clear trend of the effects of CRD and LWR to the fish communities.

The past and on-going commercial fishery in Split and Stephens lakes would have some effect on the populations of these species, though the extent is not known. However, given that catches are regulated by Manitoba Conservation and Water Stewardship, it is expected that harvest is sustainable.

Lake sturgeon

As summarized in Section 6.3.2.2.5, commercial fishing of lake sturgeon on the Nelson River severely depleted populations both upstream and downstream of the Kelsey GS. Precise estimates of commercial harvest for the area directly affected by the Keeyask GS are not available as catches were recorded by river reach, but interviews with resource users indicate a substantial commercial harvest in Gull Lake in the late 1950s and that harvest continued in Stephens Lake following construction of the Kettle GS into the 1980s.

In addition to harvest, lake sturgeon in the Nelson River have been adversely affected by hydroelectric development. Both CRD and LWR were reported to have caused a decline in lake sturgeon numbers (Split Lake Cree – Manitoba Hydro Joint Study Group 1996c). FLCN members stated that critical habitats were lost with each dam and fish could no longer move as freely within their natural habitat, as they were able to prior to dam construction (FLCN 2009 Draft). Technical studies have found that numbers of sturgeon have declined at all locations on the Nelson River where the construction of generating stations has altered habitat for specific life history requirements such as spawning. However, healthy sturgeon populations have been documented in areas affected by hydroelectric development where habitat to support all life history stages continued to be available (see examples in Table 6-16).

Due to historic declines and concerns about a continuing decline in population numbers, COSEWIC designated lake sturgeon in the Nelson River as endangered, and this species is currently being considered for listing under the *Species at Risk Act* (SARA).

7.5.1.2 SUMMARY OF CUMULATIVE EFFECTS OF THE PROJECT WITH PAST AND CURRENT PROJECTS AND ACTIVITIES

Predicted effects of the Keeyask GS project on the aquatic VECs in the context of past and current projects and activities are summarized in Section 6.4.3.1 (water quality), Section 6.4.6 (walleye, northern pike, lake whitefish and lake sturgeon). A detailed technical analysis is provided in the AE SV. The Cree worldview places equal importance on all components of the environment, as all parts are important and inter-related. A discussion of effects to the aquatic environment identified as particular concerns to the KCNs is provided in Section 6.4.2 and greater detail is provided in the KCNs' Environmental Evaluation Reports.

7.5.1.2.1 Water Quality

Construction of the Project will alter water quality in the immediate receiving environment of construction-related inputs (*e.g.*, nutrient concentrations will be elevated from input of treated sewage effluent), as well as causing more widespread increases in TSS during instream construction. The largest increases will occur in Stephens Lake immediately downstream of the construction site. During two years of instream Project construction, elevated TSS levels will extend through Stephens Lake and downstream for 1-3 months each year. The predicted increase in suspended sediment at the Kettle GS is less than 5 mg/L (typically less than 3mg/L), but may be somewhat higher for a few days when the river is closed off (Section 6.3.8.1). In most instances, the TSS increases will be within the Manitoba guidelines (*i.e.*, <5 mg/L). Elevated TSS levels are expected to extend downstream of the Kettle GS to the estuary, though increases are unlikely to have a measureable effect on the biota, given the short duration of larger inputs during river closure.

In the initial years of Project operation, water quality in nearshore areas of the reservoir, in particular in sheltered backbays, will be characterized by elevated levels of TSS, nutrients, metals and other parameters, and periodic dissolved oxygen depletion (in particular in winter under ice). Effects will diminish over ten to fifteen years. Total suspended solids concentrations will be lower in the mainstem of the reservoir and the south western portion of Stephens Lake than at present, and this effect will persist for the lifetime of the Project.

Members of the KCNs at workshops to discuss Project effects and mitigation have stated that effects to water quality are expected to occur upstream of the Keeyask reservoir in Split Lake and water quality is expected to be poor in all areas affected by the Keeyask GS.

7.5.1.2.2 Fish

Overall, it is expected that there will be negligible effects to fish from specific Project construction activities, due to the use of management measures such as restrictions on the timing of instream construction to avoid sensitive periods, control of adverse effects to water quality, conduct of fish salvage during dewatering, and adherence to guidelines for blasting and water withdrawal. There is the potential for increased harvest due to the presence of a workforce, but the implementation of the Access Management Plan during the construction phase is expected to limit the increase in harvest.

Effects related to habitat loss and alteration begin during construction and continue during operation and are discussed below.

WALLEYE, NORTHERN PIKE AND LAKE WHITEFISH

The key adverse effect on walleye and lake whitefish is the loss of spawning habitat at Gull Rapids. This habitat will not be available during all times of the construction phase, but will be replaced by constructed habitat during the operation phase. While spawning habitat for walleye and lake whitefish is available elsewhere in the Stephens Lake Area, along reefs in Stephens Lake and upstream in its tributaries and in Ferris Bay, there may be a reduction in year class strengths in Stephens Lake due to a reduction in the total amount of available spawning habitat during construction. During operation, populations of walleye and lake whitefish are expected to remain the same (Stephens Lake) or increase (Keeyask reservoir) due to the increase in the amount of foraging habitat.

No effects to northern pike due to habitat alteration during construction are expected. The key Project effects on northern pike include a short term loss of some habitat types in the reservoir during the first ten to fifteen years of operation. Optimal spawning and foraging habitat for northern pike occurs in the Nelson River along shorelines with aquatic plant growth. Foraging and spawning habitat will continue to be available in the reach of the Nelson River and its tributaries upstream of the flooded area in Gull Lake. Over the long term, there will be an increase in feeding and spawning habitat as conditions evolve in newly flooded areas of the reservoir.

As with water quality, Members of the KCNs at workshops to discuss Project effects and mitigation have stated that they expect a decline in the numbers and health of most fish species as a result of the Keeyask Project and that adverse effects will extend to Split Lake.

LAKE STURGEON

Given the current vulnerable state of lake sturgeon and adverse effects of past hydroelectric developments, considerable effort was expended in developing plans to mitigate effects to lake sturgeon habitat and support the existing population in the area that will be directly affected by the Project. In addition, measures will be implemented to increase the regional population.

During Project construction, the loss of Gull Rapids as spawning habitat will affect the lake sturgeon population in Stephens Lake. To avoid missing year classes, sturgeon will be stocked during this time. Beginning during construction and during initial impoundment to full supply level, sturgeon in Gull Lake may respond to the change in depth and velocity by moving either upstream of Gull Lake or downstream past the generating station. Although the loss of adults from the reservoir cannot be fully mitigated, stocking will be used to maintain the population in the reservoir, if emigration occurs. In addition, the trap/catch and transport program in Stephens Lake during the operation phase may identify some downstream migrants from Gull Lake that will be transported back upstream.

During Project operation, sturgeon in the Keeyask reservoir will be affected by habitat alterations that may reduce the amount of suitable spawning and young-of-the-year habitat.

These effects will be addressed through the construction of suitable replacement habitat, if monitoring indicates that available habitat is not suitable.

In Stephens Lake, the spawning habitat lost in Gull Rapids will be replaced by constructed habitat below the tailrace of the generating station.

Overall, no adverse residual effects on lake sturgeon populations due to Project operation are expected due to mitigation measures to provide habitat for all life history stages and the implementation of a stocking program in the Keeyask reservoir and Stephens Lake. In addition, the Partnership will implement a stocking program targeting areas where sufficient habitat exists to support larger populations than currently exist in the reach of the Nelson River between the Kelsey and Kettle GSs. This program is expected to result in an overall increase in the number of sturgeon in the region.

Apart from the programs implemented for the Project, there are also several initiatives that would affect the abundance of sturgeon in this area. Manitoba Hydro, TCN, WLFN, YFFN, FLCN, SFN, and the KHLP have negotiated a Lower Nelson River Sturgeon Stewardship Agreement, which has the goal to conserve and enhance the present population of lake sturgeon in the lower Nelson River from Kelsey GS to Hudson Bay. Aspects of this initiative should begin to be implemented in 2012. While the potential listing of sturgeon under SARA would be expected to increase lake sturgeon numbers, the implementation of the Lake Sturgeon Stewardship Agreement would provide a more effective initiative for sturgeon recovery. The agreement focuses on enhancing the overall population while considering existing and future uses for the river. In contrast, reducing the mortality of individuals within an overall population has become the focus of species listed under SARA in other jurisdictions.

7.5.1.3 Cumulative Effects of the Project including Future Projects and Activities

The future projects and activities considered in the Project cumulative effects assessment are listed in Table 7-2. With the exception of the potential Conawapa GS, these are land-based developments with limited potential to affect the aquatic environment, in particular if appropriate management measures are employed during construction and operation. Potential cumulative effects of the Project including future projects and activities are discussed below.

Overall, as described below, review of other projects that could overlap with the effects of the Keeyask Project does not indicate any with the potential to result in cumulative adverse effects that require further mitigation for the Keeyask Project or would alter the conclusion with respect to the regulatory significance of adverse effects of the Project to Aquatic VECs presented in Section 6.4.

7.5.1.3.1 WATER QUALITY

Future developments that will occur concurrent with the construction of the Keeyask GS are listed in Table 7-2. Primarily land-based developments, including the Keewatinoow Converter Station and associated facilities (e.g., construction camp), Bipole III, Keeyask Construction Power Station and Transmission Lines, Keeyask Switching Station and GOT Lines, and Gillam Redevelopment are not expected to affect water quality at Gull Rapids and in Stephens Lake because appropriate management measures will be applied to avoid releases of contaminants or inputs of other substances into streams that would eventually reach the Keeyask Project area.

In two years of Project instream construction, elevated TSS levels are expected to extend downstream past the Kettle GS and to the section of the river where the Conawapa GS is being constructed. During open water periods lasting 1-3 months (depending on year), the predicted increase in suspended sediment at the Kettle GS is less than 5 mg/L (typically less than 3mg/L), but may be somewhat higher for a few days when the river is closed off. Increases of similar or slightly less magnitude are expected to extend to the Conawapa site. It is expected that the cumulative effect of TSS inputs of the concurrent construction of the Keeyask and Conawapa projects will have no measureable adverse effects to aquatic biota at Conawapa and further downstream because inputs from both projects will be managed to maintain the overall increase within levels that would not have harmful effects. Construction personnel responsible for real-time monitoring of sediment increases from construction set out in the Sediment Management Plans for both Projects will communicate to achieve this objective.

As discussed in Section 6.4.3.1, the technical analysis of Project operation effects indicates short to medium term changes in the near shore environment of the reservoir and a long-term reduction in TSS levels in the mainstem of the reservoir and the south west section of Stephens Lake. None of the developments listed in Table 7-2 are expected to affect water quality in these areas as they are either downstream from the site (*i.e.*, the potential Conawapa GS), or management measures are expected to prevent effects to water quality (*i.e.*, transmission developments, Gillam Redevelopment).

7.5.1.3.2 FISH

As discussed for water quality, there is limited potential for the overlap of effects of the Project with future developments listed in Table 7-2.

Based on the technical analysis no adverse effects to fish populations are expected from the Project outside of the Keeyask reservoir and Stephens Lake. For lake whitefish, walleye and lake sturgeon, potential negative effects are restricted to the Project construction period, and are not expected to have a long-term effect on the population. Adverse effects to northern pike will occur during the first period of Project operation, but be of small magnitude and be restricted to the reservoir. Therefore, the technical analysis indicates that there are no adverse effects of the Project on fish populations that have the potential to overlap with those of other future developments.

Members of the KCNs at workshops to discuss Project effects and mitigation have stated that they expect a larger spatial and temporal extent of effects than indicated in the technical analysis summarized above, and also identified considerable uncertainty with the effectiveness of planned mitigation measures. However, even when considering a broader region (*e.g.*, Kelsey GS to the Nelson River estuary), the only other major instream project that would overlap with the effects of the Keeyask Project is the construction and operation of the potential Conawapa GS. It is expected that development of the potential Conawapa GS would be conducted to avoid significant adverse effects to fish populations. FLCN has stated that the number of fish harvested in the Conawapa area may increase. The mitigation plan for the potential Conawapa GS project will need to ensure that harvest is appropriately monitored and controlled.

7.5.2 TERRESTRIAL ENVIRONMENT

The terrestrial environment addresses environmental effects of the Project on the following VECs: ecosystem diversity, wetland function and intactness for ecosystems; priority plants for plants; Canada goose, mallard, bald eagle, olive-sided flycatcher, common nighthawk and rusty blackbird for birds; and caribou, moose and beaver for mammals. As reviewed in Table 7-3, the Project is expected to have adverse environmental effects on all of these VECs, and future projects are also expected to have effects that overlap with all of these VECs.

7.5.2.1 EFFECTS OF PAST AND CURRENT PROJECTS AND ACTIVITIES

The terrestrial environment in the area to be affected by the Project has been substantially altered by past hydroelectric developments, linear developments (including transmission lines, highways and rail lines), forestry and mining exploration, and other agents of change, and continues to experience those effects today.

The following effects of past and current projects and activities, which relate to the Regional Study Area for each terrestrial VEC, are reviewed in Chapter 6.

7.5.2.1.1 HABITAT, ECOSYSTEMS AND PLANTS

- Ecosystem diversity: The physical footprints of past and existing projects have removed approximately 5% of historical terrestrial habitat, which has reduced the total area of most, if not all, priority habitat types. Area losses have been relatively high for those types occurring on mineral sites, as these are the typical locations for roads, settlements and other infrastructure. Priority habitat types that tend to occur along the

Nelson River were also disproportionately affected by hydroelectric development, which flooded some reaches of the Nelson River and altered water regimes along its remaining length.

- Wetland function: Hydroelectric and public infrastructure development has reduced total wetland area as well as the amounts of moderate and high quality wetlands. Wetland composition was also altered by roads and other infrastructure that changed hydrology. All of the natural Nelson River shoreline wetlands have either been lost to flooding or altered by modified water and ice regimes. Off-system wetlands near the Nelson River were also affected by flooding and hydrological changes related to Nelson River water regulation.

- Intactness:[1] Past and existing linear features (*e.g.*, roads, railways, transmission lines) and other permanent infrastructure have reduced the intactness of the regional terrestrial ecosystem. Linear features have had a range of effects such as wildlife disturbance and increased wildlife mortality through improved access for people and predators. Improved access for people has also had a number of other effects such as more human-initiated fires and the spreading of invasive plants. Permanent human features have removed portions of core areas (*i.e.*, a large undisturbed area) and subdivided other core areas into smaller blocks. It is estimated that total core area in the Intactness Regional Study Area has been reduced to approximately 83% of land area.

- Priority plants: Past and existing human features have removed individual plants and their habitat and altered plant populations. Based on historical habitat effects, it is likely that plant species associated with mineral sites, the Nelson River shore zone and Nelson River shoreline wetland plants were more affected than species located in other areas.

7.5.2.1.2 Birds and Waterfowl

- Mallard: Effects on mallard of past and current projects include habitat loss or alteration and increased mortality from resource harvesting. Past and existing projects have contributed to increased water levels along the Nelson River, which has led to reduced availability of suitable mallard breeding and staging habitat in the back bays, inlets and creek mouths of the Nelson River. YFFN has indicated there are fewer geese and ducks in the Split Lake area because the shoreline habitat that they use has been flooded and eroded (YFFN Evaluation Report (*Kipekiskwaywinan*)). While mallard breeding and staging habitat is limited along the Nelson River, suitable habitat (e.g., creeks, creek mouths, inland lakes with marsh habitat) is widespread and abundant throughout inland areas of the Bird Regional Study Area.

- Canada goose: Effects on Canada goose of past and current projects include habitat loss or alteration and increased mortality from resource harvesting. As for mallard, past

[1] Intactness is the degree to which an ecosystem remains unaltered by human development and activities that remove habitat and increase fragmentation.

and existing hydroelectric projects have contributed to increased water levels along the Nelson River, which has led to reduced availability of suitable Canada goose staging habitat in the back bays, inlets and creek mouths of the Nelson River. The availability and quality of potential Canada goose staging habitat is highly variable along the Nelson River. In some years, low water levels have resulted in increased abundance of Canada geese in shallow back bays, inlets and creek mouths where suitable forage is available. In high water years, the quality of these areas, along with goose abundance, is reduced due to lack of exposed shoreline and preferred forage sources.

- Olive-sided flycatcher: The primary effect on olive-sided flycatcher from past and current projects has been habitat loss or alteration. The clearing of roads (*e.g.*, PR 280 and north access road) and transmission line right-of-ways (*e.g.*, KN 36), as well as cut lines, has reduced the availability of olive-sided flycatcher breeding habitat in the Bird Regional Study area. Past and existing hydroelectric projects have caused short-term increases in the availability of suitable foraging habitat by flooding treed areas. For a brief period, these dead standing trees provide important perch sites for olive-sided flycatchers foraging on flying insects. Suitable olive-sided flycatcher breeding habitat (*e.g.*, forest edge adjacent to bogs, beaver floods and burns) is widespread throughout the Bird Regional Study Area.
- Common nighthawk: The primary effect on common nighthawk from past and current projects has been long-term habitat loss or alteration. Forest clearing for the development of transmission right-of-ways, borrow pits, cut lines and trails has created new common nighthawk nesting habitat and enhanced that which already existed (*e.g.*, open, bare ground) within the Bird Regional Study Area. Long-term losses in common nighthawk nesting habitat have resulted from the development of permanent infrastructure including roads (*e.g.*, PR 280) and buildings. While these developments have resulted in the loss of some breeding habitat, they have contributed to increases in foraging opportunities through the creation of forest openings. Common nighthawk habitat is widespread throughout the region and not considered limited within the Bird Regional Study Area.
- Rusty blackbird: The primary effect on rusty blackbird from past and current projects has been habitat loss or alteration. Past and existing hydroelectric projects have contributed to habitat loss for this species (due to flooding of riparian habitats including treed areas on wet peatland). Land clearing associated with road and transmission line development has also contributed to the loss of some rusty blackbird breeding habitat, although to a lesser extent. Suitable alternate rusty blackbird breeding habitat is widespread throughout the Bird Regional Study Area.

7.5.2.1.3 Mammals

- **Caribou:** Effects of past and present projects on migratory caribou local movements and abundance in the Caribou Regional Study Area (Zone 6 in Map 6-28) include habitat loss, habitat alteration, and mortality risks associated with access, predation and resource harvest. Large and long-term population variability most likely resulted from natural shifts in range use and migration patterns that prevent over-utilization of food by caribou, habitat loss from large fires, changing snow fall and melt patterns, the timing and location of plant growth on the calving grounds, and long-term population cycles associated with food and predation. Habitat loss and access effects from past and present developments (*e.g.*, flooding of Stephens Lake, linear developments) can further depress populations that are periodically in decline from increased predation, and potentially from harvest over the entire migratory caribou range. KCNs Members have expressed concerns about the disappearance of large caribou herds in the region since the 1950s, and the limited return of caribou beginning in about the early 1990s and continuing today. Recent declines in migratory caribou and population sustainability are of further scientific attention and KCNs concern.

  Today, caribou populations occasionally mix in the Regional Study Area. Some KCNs distinguish a small group of woodland caribou from migratory barren-ground and coastal caribou herds in the Caribou Regional Study Area. Summer residents in the Stephens Lake area remain in the Regional Study area to calve, and are conservatively estimated to number 20 to 50 individuals. The long-term population trend of these animals is unclear given the recent return of caribou to this area, but these animals may have declined historically, as fewer caribou are now seen today. Similar to the technical scientific issues, the KCNs are concerned about past and present habitat loss, fragmentation, predation, harvest, changes in movement patterns, and accidental mortality of summer resident caribou attributed to development. Although past projects reduced winter habitat, and likely affected traditional movement corridors in the Local Study Area, primary calving habitat increased, *i.e.*, islands in lakes greater than 10 hectares (ha) in size or peatland complexes greater than 200 ha. Suitable calving habitat is not limited within the Regional Study Area, but it appears to be underutilized except for Stephens Lake which has become a highly productive calving and summering area for the small number of summer resident caribou. Range behaviour indicates that some summer resident caribou are coastal caribou.

  With the exception of recognized population ranges near Thompson, Manitoba, SARA-listed boreal woodland caribou have not been identified by the Provincial or Federal Governments in the Regional Study Area.

- **Moose:** Effects of past and present projects on moose include habitat loss and alteration and increased mortality from resource harvesting and predator access along linear features. Historically, moose occurred between Split Lake and Stephens Lake.

Following hydroelectric development, their presence on the shores of Split and Stephens lakes was diminished as a result of shoreline habitat loss and fluctuating water levels, and although animals are still hunted here, local resource users tend to go further afield to harvest animals. Today, moose appear to be common, widely distributed and clustered in the Moose Regional Study Area, particularly in burned areas, and the population appears to be increasing. Islands and shorelines continue to be important for calving and rearing, including those in Gull Lake and Stephens Lake. The KCNs are concerned about the sustainability of moose populations, and CNP is preparing a moose harvest sustainability plan to address this issue.

- Beaver: Effects of past and present projects on beaver include the loss and alteration of wetland habitat on the Nelson River system and increased mortality from resource harvesting and predator access along linear features. Historically, beaver were present on the Nelson River. Following hydroelectric development, their presence was diminished considerably as a result of habitat loss from flooding and fluctuating water levels, which continue to affect beaver today. The magnitude of decline in the beaver population is scientifically uncertain because large comparison rivers that are unaffected by hydroelectric development (*i.e.*, God's and Hayes rivers) tend to have fewer beaver; however, beaver are abundant in wetland habitat connected to these rivers. Today, beaver are still common and widely distributed in the Beaver Regional Study Area wherever there is suitable riparian habitat. The KCNs are concerned about beaver populations and the loss and alteration of wetland habitat on the Nelson River system.

7.5.2.2 SUMMARY OF CUMULATIVE EFFECTS OF THE PROJECT WITH PAST AND CURRENT PROJECTS/ACTIVITIES

The construction and operation of the Project was planned to minimize the effects to the terrestrial environment to the extent practicable.

The following effects of the Project, in combination with the effects of past and current projects and activities, are reviewed in Chapter 6 where relevant for terrestrial VECs.

7.5.2.2.1 HABITAT, ECOSYSTEMS AND PLANTS

- Ecosystem diversity: The Project would reduce the area of most priority habitat types, primarily through clearing, flooding, edge effects and reservoir-related groundwater changes. Due to a Project design process that carefully considered environmental effects (see Section 4.2.3 and the mitigation described in Section 6.5), it is predicted that Project effects on ecosystem diversity will be limited to relatively small area losses for most of the priority habitat types. Cumulative area losses for all priority habitat types are expected to remain in the small to moderate magnitude range.

- Wetland function: The Project would reduce total wetland area and alter wetland composition, primarily through clearing, flooding, edge effects and reservoir-related groundwater changes. Overall, the likely residual Project effects on wetland function are adverse but regionally insignificant because it is predicted that there is no net loss of high quality wetland area and the cumulative area losses for all of the low and moderate quality off-system wetland types remains well below 10% after mitigation.
- Intactness: The main Project effects on intactness are predicted to include a slight reduction in total linear feature density (positive effect) due to existing cutlines being replaced by Project features, and slight reductions (adverse effects) in total core area, average core area size and the size of the largest core areas. Overall, the likely residual Project effects on regional intactness are expected to be adverse but small because the Project Footprint is located in an area where intactness is already low due to past human activities.
- Priority plants: The Project would remove and alter individual plants, plant populations and their habitats. The Project is not expected to have significant adverse effects on priority plants. Species of high conservation concern are not expected to occur in the Plant Local Study Area. Effects on the species of particular interest to the KCNs are expected to be low because most of these species are widespread in appropriate habitats and the percentages of the known locations and available habitat affected by the Project are predicted to be low. For the remaining priority plant species, the Project would affect small proportions of their known locations and their habitats. In addition, the risk that invasive plants will crowd out priority species is minimized by precautionary and eradication measures included in the Environmental Protection Plans.

7.5.2.2.2 Birds and Waterfowl

- Mallard: The key residual Project effects on mallard in combination with past and current projects include the loss of some breeding habitat, decreased quality of staging habitats and increased mortality risk resulting from increased access (Section 6.5.7). Current breeding habitat for mallards is marginal along the Nelson River; optimal habitat occurs in inland areas (*e.g.*, lakes and creeks) where ponds, wetlands, shallow and creeks supporting emergent aquatic vegetation are available. Although these habitats are widespread throughout the Bird Regional Study Area, applied mitigation measures (*e.g.*, installation of artificial nest structures) will enhance these areas for breeding. Wetland enhancement measures will also benefit mallards by off-setting some of the losses in the quality of local staging habitats (*e.g.*, Gull Lake). The implementation of the Access Management Plan during the construction phase is expected to limit increases in hunter harvest due to increased access elsewhere. In order to reduce access to the Nelson River and inland lakes during operations, trails no longer required for construction or operation activities will be decommissioned.

- **Canada goose:** The key potential residual Project effects on Canada goose in combination with past and current projects are similar to those described for mallard (see above) with the exception that Canada goose breeding habitat will not be affected by the Project.
- **Olive-sided flycatcher:** The key residual Project effects on olive-sided flycatcher in combination with past and current projects are associated with the long-term loss of some breeding habitat. While mitigation measures involving the retention of trees in select areas of the reservoir back-bays may offset some of the losses in olive-sided flycatcher habitat, beaver activity and fire remain the main drivers of olive-sided flycatcher habitat creation in this area. Construction noise is expected to disturb some olive-sided flycatchers for the short-term; however, displacement of birds from their breeding territories is not expected due to their large home ranges.
- **Common nighthawk:** The key residual Project effects on common nighthawk in combination with past and current projects are associated with the long-term loss of some nesting habitat resulting from reservoir and infrastructure development. Retention of non-rehabilitated areas in decommissioned borrow sites will off-set some of the losses in nesting habitat resulting from the Project. Creation of forest openings at infrastructure sites may provide common nighthawk with foraging habitat, especially at infrastructure sites that use outdoor lighting (insect attractant). Foraging habitat (*e.g.*, forest openings including wetlands, lakes, burns) is widespread throughout the Bird Regional Study Area.
- **Rusty blackbird:** The key residual Project effects on rusty blackbird in combination with past and current projects are associated with the long-term loss of some nesting habitat resulting from reservoir and infrastructure development (*e.g.*, dykes or south access road). Construction noise may cause some blackbirds to avoid areas immediately adjacent to infrastructure sites, but only for the short-term.

7.5.2.2.3 MAMMALS

- **Caribou:** The main residual effects of the Project on caribou in combination with past and current projects are localized altered movements due to reduced intactness and sensory disturbance, distributional changes, and decreased populations due to decreased habitat and increased mortality. Most effects of the Project will be negligible to small, particularly since habitat currently appears to be underutilized, and affect two or more generations (*i.e.*, be long-term as defined in Chapter 5).

  Large variability in migratory caribou populations' ranges and migration routes will continue with the Project in response to natural shifts in range use and migration patterns that prevent an over-utilization of food, habitat effects from large fires, snow fall and melt patterns, the timing and location of plant growth on the calving grounds, and long-term population cycles associated with food and predation. These changes will be exacerbated to a small degree by the Project in combination with past and present human developments. Past and current project effects have resulted in moderate regional habitat losses and alterations but most of these changes are limited to habitat near the Nelson River. In comparison, habitat effects over large migratory caribou ranges are negligible to small. Potentially, and with moderate scientific certainty, habitat effects, additive mortality from resource harvest and increased predator access, accidental mortality, and localized movement effects, which cumulatively affect the regional caribou populations, have occurred only to a small degree in the Regional Study Area.

Summer resident caribou abundance, distribution and movements are likely to be altered by the Project during construction and operation, primarily as a result of calving habitat loss and alteration from groundwater and peatland disintegration. Fragmentation effects are predicted for the south access road. With mitigation, and as measured by population and habitat benchmarks and the thresholds described (Section 6.5.8), Project effects on summer resident caribou are highly likely to remain negligible to small in the Regional Study Area.

The small loss of calving habitat that will occur in the Local Study Area will in part be offset by an increase in the number of smaller islands in the Keeyask reservoir. Small changes in habitat are expected compared to its widespread regional availability and use by caribou. Wolf numbers are not expected to change given that no changes in the moose population are expected as a result of the Project. Predator hunting efficacy is not predicted to change because linear feature density will not change.

A negligible change in cumulative effects measures, including intactness (as measured by core habitat availability and size), and fragmentation (as measured by linear feature density), is expected as a result of the Project. Finally, resource harvesting is not expected to change, and it is most likely manageable with Provincial harvest regulations and policy if it does increase unexpectedly for caribou. Therefore, only a small cumulative effect for the regional caribou populations is anticipated from the Project in combination with past and present projects.

Scientific uncertainty exists where human disturbance could exacerbate long-term natural changes in populations and habitat, and where these on-going effects might be affected by climate change, could reduce habitat availability and limit distribution and abundance in caribou ranges. The KCNs predict that with more development, caribou will likely disappear from the area and not return for a long time. Caribou activity in the Keeyask region will be monitored (see Chapter 8).

- Moose: The main residual effects of the Project on moose in combination with past and current projects are altered movements, distributional changes, and a decreased population. Moose abundance, distribution and movements are likely to be changed in the Local Study Area by the Project during construction and operation, primarily as a result of habitat alterations along the Nelson River. With mitigation, and as measured by population and habitat benchmarks described (Section 6.5.8), it is highly likely that Project effects on moose will be negligible to small in the Regional Study Area. A small loss of calving habitat will occur in the Local Study Area, which in part would be offset by an increase in the number of smaller islands, and by at least one large island in the Keeyask reservoir. Small changes in habitat are expected compared to the regional availability. Gray wolf numbers are not expected to change given that no changes in the moose population are expected as a result of the Project. A negligible change in cumulative effects measures, including intactness and fragmentation, is expected as a result of the Project. Finally, although resource harvesting is not expected to increase with the offsetting program, opportunities and access have improved, and there could be an increase in licensed hunters in the region. These effects are manageable with the administration of a moose harvest sustainability plan for the Split Lake Resource Management Area and by Provincial harvest regulations. Therefore, only a small cumulative effect is anticipated for the regional moose population.

- Beaver: Beaver abundance is likely to decrease during construction and operation, primarily as a result of habitat loss and the removal of about 20 colonies near the Nelson River. Improved trapping access could reduce the population if local trapping efforts increase. Although habitat effects will be large primarily as a result of past projects in the Regional Study Area, beaver are resilient, have the ability to create habitat, and they reproduce and colonize rapidly. Overall, the beaver population is widely distributed and abundant throughout the Regional Study Area. Thus, Project effects on beaver will likely remain small and further changes in the Regional Study Area are highly unlikely to affect the sustainability of the beaver population. Trappers are stewards of their traplines, and are responsible for sustaining beaver populations on their Registered Traplines. Provincial furbearer management policies should be in place before the Project proceeds, and its application will further ensure that provincial harvest does not exceed sustainable levels, where trapping effort generally follows the price of fur.

7.5.2.3 CUMULATIVE EFFECTS OF THE PROJECT INCLUDING FUTURE PROJECTS / ACTIVITIES

Based on the regulatory assessment summarized in Table 7-3, adverse effects of the Keeyask Project are expected for all terrestrial VECs, and these adverse effects are also expected to overlap with the other future projects or activities listed in Table 7-2.

One or more of the reasonably foreseeable future projects listed in Table 7-2 would have spatial and temporal overlap with all of the terrestrial VECs. Details regarding these overlaps are discussed below.

Overall, as described below, review of other projects that could overlap with the effects of the Keeyask Project does not indicate any with the potential to result in cumulative adverse effects that require further mitigation for the Keeyask Project or would alter the conclusion with respect to the regulatory significance of adverse effects of the Project to Terrestrial VECs presented in Section 6.5.

7.5.2.3.1 HABITAT, ECOSYSTEMS AND PLANTS

- Ecosystem diversity: Residual Project effects on ecosystem diversity are expected to overlap with effects from Gillam Redevelopment and all of the transmission projects. These future projects will increase the amounts of habitat loss and alteration for all priority habitat types. Based on the anticipated locations of these projects, cumulative area losses for all priority habitat types are predicted to remain in the small to moderate magnitude range.
- Wetland function: Residual Project effects on wetland function are expected to overlap with effects from Gillam Redevelopment and all of the transmission projects. Based on their anticipated locations, these future projects are not expected to affect any high quality wetland areas (*i.e.*, off-system marsh). Wetland mapping demonstrates that Gillam Redevelopment and the Keeyask Transmission Project would not overlap high quality wetlands. Although detailed wetland mapping was not available for the Bipole III route, even if it does overlap off-system marsh, effects are likely to be negligible given that clearing occurs in winter, clearing is minimized in riparian zones and buffers are typically maintained where transmission rights-of-way overlap riparian zones. For the moderate and low quality wetland types, the additional affected areas are expected to range from nil to relatively small so that cumulative area losses are likely to remain in the small to moderate magnitude range.
- Intactness: Residual Project effects on intactness are expected to overlap with effects from Gillam Redevelopment and all of the transmission projects. Based on the anticipated locations of these other projects, total linear feature density would increase but still remain in the lower half of the moderate magnitude effects range (*i.e.*, between 0.40 km/km^2 and 0.60 km/km^2) for the Intactness Regional Study Area and within the small magnitude range for the Regional Study Area outside of the Thompson area. Although total core area would decline by approximately 135 km^2, the percentage of the Regional Study Area in core area is expected to remain higher than 80% of land area, which is well within the range for low magnitude core area effects (*i.e.*, 66% to 100% of land area).
- Priority plants: Residual Project effects on priority plants are expected to overlap with effects from Gillam Redevelopment, all of the transmission projects and potential Conawapa Generation Project. All of these future projects, except for the potential Conawapa Generation Project, are expected to remove individual plants and their habitat and alter plant populations. Transportation and increased activity along Highway 280 for the potential Conawapa Generation Project could spread invasive plants. Based

on the low potential for species of high conservation concern to occur in the Plant Regional Study Area and the known locations of the remaining priority plant species and their habitats, cumulative losses for all priority plants are predicted to remain in the nil to moderate magnitude range, depending on the species.

7.5.2.3.2 Birds and Waterfowl

- Mallard: Residual Project effects on mallard are expected to overlap with the effects of reasonably foreseeable future projects in the Bird Regional Study Area. Construction-related cumulative effects of the Project on mallard include additional loss or alteration of some mallard upland nesting habitat in areas where future project infrastructure occurs near wetlands, creeks and inland lakes, as well as increased mortality risk due to increased hunter access and/or transmission line strikes. Loss of foraging and brood-rearing habitat (*e.g.*, wetlands, creeks) is not anticipated to occur with future projects.
    - Loss or alteration of mallard nesting cover for the development of future transmission projects is expected to be small and unlikely to have an effect on the local breeding population of mallard.
    - Increased human access resulting from the development of future transmission projects will increase the mortality risk to mallards through increased harvest. Although mallards are agile flyers and able to avoid obstacles, presence of transmission lines in areas where mallards concentrate will increase mallard mortality risk. It is expected that deflectors would be installed on lines where this risk would be elevated in order to minimize potential for bird mortality.
- Canada goose: Residual Project effects on Canada goose are expected to overlap with the effects of reasonably foreseeable future projects in the Bird Regional Study Area. Project-related cumulative effects of the Project on Canada geese are associated with increased mortality risk resulting from increased hunter access and presence of transmission lines near areas that concentrate geese. It is expected that deflectors would be installed on lines where this risk would be elevated in order to minimize potential for bird mortality. These cumulative effects are not expected to have measurable effects on the local Canada goose population. Geese use of the Bird Regional Study Area is largely limited to within the migration periods, at which time they occur on parts of the Nelson River, including the larger inland lakes that occur throughout the region.
- Olive-sided flycatcher: Residual Project effects on olive-sided flycatcher are expected to overlap with the effects of reasonably foreseeable future projects in the Bird Regional Study Area. It is expected that the Project in combination with other future developments will result in the additional loss of some olive-sided flycatcher breeding habitat. Losses are expected to be minimal as land clearing will be minimized to the extent possible. The potential effects on olive-sided flycatcher of the Project in combination with other future projects will be minimized through the application of

mitigation measures including clearing outside of the bird nesting season and retaining vegetation buffers around lakes, wetlands and creeks located adjacent to infrastructure sites (proposed for both the Keeyask Infrastructure Project and Bipole III Transmission Project and anticipated in the preliminary planning of the Keeyask Transmission Project).

- Common nighthawk: Residual Project effects on common nighthawk are expected to overlap with the effects of reasonably foreseeable future projects in the Bird Regional Study Area. A relatively small amount of additional habitat would be adversely affected by development of the transmission projects in combination with the Project. Suitable common nighthawk breeding habitat will be lost to infrastructure development (*e.g.*, substations), however some will be gained and maintained through land clearing and vegetation control associated with the transmission line ROWs. Moderate increases in foraging habitat will also result as land is cleared in preparation of the transmission line ROWs. The cumulative effects on the local common nighthawk population of the Project in combination with transmission line projects are therefore expected to be positive.
- Rusty blackbird: Residual Project effects on rusty blackbird are expected to overlap with the effects of reasonably foreseeable future projects in the Bird Regional Study Area. It is expected that future developments in combination with the Project will result in the additional loss of some rusty blackbird breeding habitat through land clearing. Losses are expected to be minimal as land clearing will be minimized to the extent possible. The potential effects on rusty blackbird of the Project in combination with other future projects will be minimized through the application of mitigation measures, including clearing outside of the bird nesting season and retaining vegetation buffers around lakes, wetlands and creeks located adjacent to infrastructure sites (proposed for both the Keeyask Infrastructure Project and Bipole III and anticipated in the preliminary planning of the Keeyask Transmission Project).

7.5.2.3.3 MAMMALS

- Caribou: Residual Project effects on caribou are expected to overlap with the effects of reasonably foreseeable future projects including the potential Conawapa Generation Project, Bipole III Transmission Project, the Keeyask Transmission Project and Gillam redevelopment.

  The Beverly and Qamanirjuaq barren-ground caribou herds may be in decline. The potential decline is mainly attributed to climate change, human activities, loss of winter habitat due to forest fires, harvesting and predation. Although the herd may be shrinking and/or has been redistributed, recent reports indicate that Qamanirjuaq caribou are still plentiful (about 348,000 estimated population in 2008). The redistribution of Pen Islands coastal caribou has also been reported. A combination of causes for the change include increased mortality of animals due to differences in predation and hunting pressure across the traditional range, nutritional stress due to range deterioration, and redistribution of animals in response to habitat change or to disturbance among other hypotheses.

The Project is not anticipated to measurably affect caribou in the Regional Study Area. However, cumulative effects associated with future projects, including habitat loss and/or alteration, fragmentation, and access-related mortality from hunting and predation, could delay the cycle and recovery of wide-ranging caribou populations currently experiencing declines. Incremental changes in addition to the Project are highly unlikely to contribute measurably to a decline of the regional caribou population; especially with the mitigation measures associated with each individual project, or as these may be compared with the broader context of the range-wide requirements of coastal and barren-ground caribou beyond the Regional Study Area. Range-wide management efforts by Provincial and Federal Governments, and stakeholder representation on resource boards, including the Beverly and Qamanirjuaq Management Board, the Northeastern Caribou Committee, and the Split Lake, Fox Lake, and York Factory Resource Management Boards, are working to manage and monitor all risks associated with range-wide cumulative effects associated with harvestable caribou populations.

Incremental habitat fragmentation effects for summer resident caribou from the Project in combination with future projects are a concern within the Regional Study Area because of the scientific uncertainty associated with abundance and range use. For summer residents, the cumulative reduction in intactness (1%) is small compared to the Regional Study Area, and is highly unlikely to result in a measurable change to the population. While the Keeyask Transmission Project could result in one or more transmission line rights-of-way south of Stephens Lake, it is not likely to limit caribou from passing through the area and calving on islands in the lake. Less traffic on PR 280 is expected to improve the quality of adjacent caribou habitat and improve access to calving islands from the north shore. Existing human and fire disturbance in the Regional Study Area is already large, and may not be conducive to support a boreal woodland caribou population. The density of predators, however, is not expected to increase with a small increase in fragmentation because there is likely not enough caribou and moose biomass in the Regional Study Area to support a dense predator population. As such, incremental habitat fragmentation effects from future projects are more likely to have a small effect on the summer resident caribou population, whether they are coastal caribou, boreal woodland caribou, or both.

The management of access to and harvest of migratory coastal and barren-ground caribou in the lower Nelson River area has a high scientific and KCNs concern. Infrequent but potentially high harvest events, coupled with incremental habitat effects over a broad region, could result in a decrease and prolonged decline of coastal caribou populations in particular. Although this type of event is unlikely to occur under existing harvest regulations and the management of caribou populations by the Resource Management Boards and the Province, to decrease the risk of cumulative effects occurring, all Project-related caribou mortality in association with other effects will be monitored (see Chapter 8).

A plan is being developed to coordinate caribou monitoring activities among northern hydroelectric developments, as well as with government authorities and existing caribou committees and management boards.

- Moose: Residual Project effects on moose are expected to overlap with the effects of reasonably foreseeable future projects including the potential Conawapa Generation, Bipole III Transmission, Keeyask Transmission and Gillam redevelopment. Although the Split Lake Resource Management Area moose population appears to be secure, recent declines in the abundance of moose in western and eastern Manitoba have occurred, where it is thought that access and harvesting were the main issues affecting these moose. Although minor changes including habitat alteration are likely to occur with each project, access issues and sustainable moose harvest are of concern. TCN has prepared a Moose Harvest Sustainability Plan to guide the management of their Adverse Effects Agreement Access Program to ensure the sustainability of the moose population in the Split Lake Resource Management Area. The Province is responsible for managing the licensed harvest while recognizing the priority of Aboriginal harvesting rights.
- Beaver: Residual Project effects on beaver are expected to overlap with the effects of the transmission line projects and Gillam redevelopment. Regional beaver populations are highly likely to maintain viable levels. Beaver populations are most likely to remain sustainable because beaver are widely distributed and abundant in creeks, steams, ponds and lakes, they create their own habitat in most areas where water occurs, breed quickly and are under harvest management regulations. The regional population will most likely continue to be depressed on the Nelson River because of water level regulation, and because beaver are unlikely to successfully re-colonize new shoreline wetland habitat in the long-term. As such, the system will most likely remain as it is today, and continue to depend on future fur prices and harvest. No measurable residual cumulative effects of the Project in combination with other future projects are anticipated.

7.6 SOCIO-ECONOMIC ENVIRONMENT

Table 7-4 reviews the socio-economic environment VECs examined in Chapter 6, and identifies those VECs included in the CEA, *i.e.*, those VECs with an adverse effect from the Project (as assessed in Chapter 6) that overlaps spatially and temporally with effects from past/current projects or activities identified in Table 7-1, and/or with effects from future projects and activities identified in Table 7-2. VECs assessed in Chapter 6 with positive effects from the Project (*e.g.*, economy VEC s such as employment) or neutral effects from the Project after mitigation and compensation (e.g., resource use VECs such as domestic hunting and gathering, domestic fishing and commercial trapping) are not included in the CEA[1].

Socio-economic environment components and VECs primarily address people and communities in northern Manitoba that are impacted by the Project's effects on the biophysical environment (including effects that increase access to resources) and on local employment, business, infrastructure, services or other elements of local personal, family or community life, resource use and heritage resources. As such, these VECs represent different valued elements that affect the same people and communities – and there accordingly can be considerable overlap among VECs in the discussion of cumulative effects from past, current and future projects.

The socio-economic environment in the area to be affected by the Project has been substantially changed by past hydroelectric developments, linear developments (including transmission lines, highways and rail lines), forestry and mining exploration, and other agents of change, and continues to experience those effects today.

In addressing socio-economic, resource use and heritage resources effects on the KCNs communities and their Members, it is noted that each of the KCNs has entered into an adverse effects agreement with Manitoba Hydro to address known and foreseeable adverse effects of the Project on each respective Cree Nation. Each of the KCNs appointed representatives to work with Manitoba Hydro representatives to identify and recommend works and measures to "address and resolve all past, present and future Keeyask adverse effects" on their respective Cree Nations and their Members (TCN and Manitoba Hydro 2009; WLFN and Manitoba Hydro 2009; FLCN and Manitoba Hydro 2009). TCN, WLFN and FLCN based their decisions on adverse effects that are foreseen or could be reasonably foreseen with the exercise of due diligence. YFFN noted that this work was undertaken prior to the completion of the environmental impact statement and that the understanding of foreseeable Keeyask adverse effects was informed by past experiences with hydroelectric development and the environmental studies completed to March 2009. Each community held a referendum of its Members before signing the agreements.

The CEA analysis related to each socio-economic environmental component is provided below.

[1] Section 6.7 assesses the effects of the Project, in the context of other past and current projects, on three resource use VECs (domestic fishing, domestic hunting and gathering, and commercial trapping). The assessment concludes for each of these VECs, after considering positive versus negative effects, that the Project's effects on the VEC are neutral.

Table 7-4: Application of Cumulative Effects Assessment Criteria to Socio-Economic VECs

VECs Adversely Affected by the Project	Notes regarding Keeyask Effects	Overlap with Past/Current Projects or Activities	Overlap with Future Projects	Included (ü) in CEA for Future Projects or Activities
INFRASTRUCTURE AND SERVICES				
Housing	Construction phase – re: shortages in KCNs communities; shortages in temporary accommodation in Gillam and Thompson. Operation phase – shortages in Gillam	Kettle, Long Spruce, Limestone Mining and BRHA (for Thompson temporary accommodation)	Keeyask Transmission; Bipole III Transmission; potential Conawapa Generation Project; and Gillam Redevelopment	ü
Infrastructure and Services	Construction phase – re: shortages in KCNs communities and in Gillam	Kettle, Long Spruce, Limestone and KIP	Keeyask Transmission; Bipole III Transmission; potential Conawapa Generation Project; and Gillam Redevelopment	ü
Transportation Infrastructure	Construction phase – re: increased traffic wear and tear	Kettle re-runnering; KIP; other lineal development; mining	Keeyask Transmission; Bipole III Transmission; potential Conawapa Generation Project; and Gillam Redevelopment	ü
PERSONAL, FAMILY AND COMMUNITY LIFE				
Community health	Construction phase	Kettle, Long Spruce, Limestone generating stations	Keeyask Transmission; Bipole III Transmission; potential Conawapa Generation Project; and Gillam Redevelopment	ü
Mercury and Human Health	Operation Phase	Kettle	None	No

Table 7-4: Application of Cumulative Effects Assessment Criteria to Socio-Economic VECs

VECs Adversely Affected by the Project	Notes regarding Keeyask Effects	Overlap with Past/Current Projects or Activities	Overlap with Future Projects	Included (ü) in CEA for Future Projects or Activities
Public Safety and Worker Interaction	Construction phase	Kettle, Long Spruce, Limestone, current mining activities	Keeyask Transmission; Bipole III Transmission; potential Conawapa Generation Project; and Gillam Redevelopment	ü
Travel, Access and Safety	Construction phase (road, water and ice travel)	CRD, LWR, Kettle, KIP, mining activities	Keeyask Transmission; Bipole III Transmission; potential Conawapa Generation Project; and Gillam Redevelopment	ü
The Way the Landscape Looks	Construction and operation phases	CRD, LWR, Kettle GS, KIP, mining, other linear development, Kettle re-runnering	Keeyask Transmission; Bipole III Transmission; potential Conawapa Generation Project; and Gillam Redevelopment	ü
Culture and Spirituality	Construction and operation phases, particularly loss of rapids	CRD, LWR, Kettle GS, KIP and other linear development	Keeyask Transmission; Bipole III Transmission; potential Conawapa Generation Project; and Gillam Redevelopment	ü

Table 7-4: Application of Cumulative Effects Assessment Criteria to Socio-Economic VECs

VECs Adversely Affected by the Project	Notes regarding Keeyask Effects	Overlap with Past/Current Projects or Activities	Overlap with Future Projects	Included (ü) in CEA for Future Projects or Activities
HERITAGE RESOURCES				
Heritage Resources	Construction and operation phases	CRD, LWR, Kettle GS, KIP and other linear development	Keeyask Transmission Project	ü

7.6.1 EFFECTS OF PAST AND CURRENT PROJECTS AND ACTIVITIES

7.6.1.1 INFRASTRUCTURE AND SERVICES

Effects of past and current projects and activities are reflected in the current level of infrastructure and services as well as in the experience and expectations of local people with regard to the effects of similar major hydro-related and other construction projects. As reviewed in Table 7-4, based on the Chapter 6 assessment (which included consideration of cumulative effects related to past and current projects) the Project is expected to have adverse environmental effects on each of the following VECs:

- Housing: KCNs communities experience severe past and existing housing shortages, and housing capacity and temporary accommodation is also limited in Gillam; in Thompson, there tends to be a high demand for temporary accommodation related to other activities in that region (*e.g.*, Burntwood Regional Health Authority, Vale operations).
- Infrastructure and Services: Related infrastructure and services are already at capacity in KCNs communities and in Gillam. Past experience related to earlier hydro generation projects in this region (*e.g.*, Kettle and Long Spruce projects) has indicated increased service requirements related to social problems (*e.g.*, racism, alcohol abuse, family abuse) associated with interaction with project workers and the temporary infusion of income for local construction workers (see Chapter 6 and SE SV Section 4.3.3).
- Transportation Infrastructure: Existing infrastructure related to road, rail and air for movement of equipment, materials and people is geared to current and past requirements.

7.6.1.2 PERSONAL FAMILY AND COMMUNITY LIFE

Effects of past and current projects and activities are reflected in the experience and expectations of the KCNs Members and other local people with regard to the effects on personal, family and community life VECs of similar major hydroelectric-related and other construction projects, the community services currently available to address concerns related to such projects (particularly during construction), and the ongoing loss of cultural and physical landscape due to past hydroelectric developments affecting the lower Nelson River region.

As reviewed in Table 7-4, based on the Chapter 6 assessment (which included consideration of cumulative effects related to past and current projects) the Project is expected to have adverse environmental effects on each of the following VECs:

- Community Health: Past hydroelectric-related construction, with increased non-local construction workers coming into Gillam (and to some extent Split Lake), was seen to increase the potential for indirect adverse effects on local community health, including increases in communicable diseases, increased alcohol abuse and adverse interactions with community members such as women and youth.
- Public Safety and Worker Interaction: The KCNs have seen multiple hydroelectric development projects built and/or criss-cross their homeland since the mid-1950s (see Section 2 of the SE SV). As further noted in Chapter 6, based on experience with past hydroelectric project construction the KCNs, and TCN and FLCN Members in particular, have identified potential adverse effects of non-local construction worker interaction with community Members, especially direct effects on women and youth, as an important socio-economic concern associated with new major projects being developed in their traditional territories. In particular, many FLCN Members are to this day dealing with past loss, grief and anger related to adverse worker interaction effects of previous hydro projects (FLCN 2009 Draft).
- Travel, Access and Safety: In addition to increased road and air traffic during construction and the potential for increased traffic accidents, past local experience with hydroelectric-related projects notes adverse changes to water/ice-based travel as a result of these projects. This is of particular concern to YFFN in relation to travel safety on Split Lake.
- Culture and Spirituality (KCNs): The KCNs have expressed concern regarding the ongoing and extensive loss of cultural landscape and/or deterioration in overall Cree culture in relation to past hydroelectric development projects and activities in the Local Study Area including the creation of Stephens Lake and dramatic alteration of the lower Nelson River.
- The Way the Landscape Looks (Aesthetics): The Project is located in a region that has experienced considerable past hydroelectric development including several

generating stations, transmission lines, roads, cut trails and two converter stations which together have greatly altered the physical landscape (Split Lake Cree – Manitoba Hydro Joint Study Group 1996a and b). These changes include changes to the seasonal flows and water levels on the Nelson River due to the effects of the CRD and LWR projects, as well as loss of rapids and changes to local lakes as result of existing hydroelectric generation projects.

7.6.1.3 Heritage Resources

Effects of past and current projects and activities have had adverse effects on heritage resources (known and unknown) stemming from physical disturbance to the landscape, flooding and erosion. This includes losses from previous hydroelectric development projects such as the CRD, LWR, Kelsey and Kettle GSs and associated transmission projects within the Local and Regional Study Areas. Little intact archaeological evidence of past human occupation remains in the Local Study Area (see Chapter 6 and the Heritage Resources component of the SE SV for further details). In addition to the physical (and sensory) changes due to the effects of past and current projects and activities on the cultural landscape, the continuous loss of tangible heritage resources also erases features that may prompt memories of past cultural history.

7.6.2 Summary of Cumulative Effects of the Project with Past and Current Projects and Activities

The construction and operation of the Project has been planned to first minimize, and then mitigate the effects to the socio-economic environment to the extent practicable.

7.6.2.1 Infrastructure and Services

The following effects of the Project, in combination with the effects of past and current projects and activities, are reviewed in Chapter 6 where relevant for infrastructure and services VECs. The following section provides a summary of the cumulative effects of the Project with past and current projects and activities.

- **Housing:** As noted in Chapter 6, because in-migration of KCNs Members seeking Project employment is expected to be minimal, the Project is expected to have very small residual adverse effects on the KCNs housing during the construction phase. The recent experience with construction of the Wuskwatim Generation Project reinforces this conclusion.

- For Gillam and Thompson, the Project is expected to have small residual adverse effects on short-term accommodation (*i.e.*, motel and hotel beds) due to the influx of non-local construction workers seeking amenities during time off.
- For Thompson, the Project is also expected to have small residual effects on housing due to some KCNs Members relocating to Thompson to enhance their project-related employment prospects, while accessing educational and health services.
- It is anticipated that all residual effects will be limited in KCNs communities due to existing housing shortages, and in Thompson due to high demand for temporary accommodation related to other activities in the Local Study Area. In the case of Gillam, additional housing is already being developed and/or planned as part of the Gillam Land Use Planning process to meet the added requirements arising from future Manitoba Hydro projects in the Gillam region.

- Infrastructure and Services: As noted in Chapter 6 for the construction phase, the Project is expected to have small to moderate residual adverse effects on KCNs' infrastructure and services, and small residual adverse effects on Gillam and Thompson infrastructure and services, primarily focused on an increased need for social services and the RCMP. As indicated in Chapter 6, the Project is predicted to result in small residual adverse effects on infrastructure and services in Gillam only (including FLCN) during the operation phase.
  - Gillam is expected to be affected community during Keeyask construction and operation due to its proximity to various future projects and activities in the area. The Gillam Land Use Planning process currently underway has the ability to address joint planning and development issues within the community arising from the Project, and within the context of other future projects in the vicinity of Gillam.
  - These services are already at capacity in the KCNs communities and any net in-migration of KCNs Members during construction, even if limited, will place an increased demand on these services. The KCNs' AEAs have the potential to improve community infrastructure and services.
- Transportation Infrastructure: As noted in Chapter 6 for the construction phase, the Project is expected to have small residual adverse effects on the transportation infrastructure in the Local Study Area and Northern Region (*e.g.*, increased use of roads, rail and air for movement of equipment, materials and people to the Project site); with moderate residual adverse effects related to road travel safety. It is expected that existing road, rail and air infrastructure can handle the increase related to the Project.

7.6.2.2 PERSONAL FAMILY AND COMMUNITY LIFE

The following effects of the Project, in combination with the effects of past and current projects and activities, are reviewed in Chapter 6 where relevant for personal, family and community life VECs.

- **Community Health:** The Project's residual effects on KCNs and Gillam community health are considered to have small adverse effects (see Chapter 6) due to environmental change, public and transportation safety issues and stress of concern re: effects on the community from construction-related worker interactions.
- **Public Safety and Worker Interaction:** As indicated in Chapter 6, the Project is expected to have moderate adverse residual effects on public safety and worker interaction in the KCNs communities and in Gillam, including TCN and FLCN Members, and in Thompson.
    - o The assessment of effects that Project construction would have on the community of Gillam, KCNs Members and surrounding areas (*e.g.*, Split Lake and Thompson), as well as past construction activities is addressed in Chapter 6 (and Section 5 of the SE SV).
    - o As noted in Chapter 6, the number of visits to Gillam and other communities (including Split Lake) is hard to predict. Mitigation measures to reduce the number of visits, as well as an overall Manitoba Hydro strategy to address worker interaction have been incorporated into the assessment of the Project (see Chapter 6 and Section 5 of the SE SV for details).
- **Travel, Access and Safety:** As indicated in Chapter 6, residual effects from the Project on water and ice-based travel are expected to be adverse and small in magnitude during the construction phase; and moderate short-term adverse effects are expected to road travel during construction of the Project.
- **Culture and Spirituality (KCNs):** As reviewed in Chapter 6, residual adverse effects on culture and spirituality stemming from the Project (after mitigation and the AEAs in place) are considered to be small related to the loss of the rapids and cultural narrative associated with the changed landscape within the Local Study Area for both the construction and operation phases (see Chapter 2 re: *Askiy* and Chapter 6, Section 6.6.5.6). A key factor in this finding are the AEAs that each of the KCNs have already agreed to.
- **The Way the Landscape Looks (Aesthetics):** As reviewed in Chapter 6, the Project's adverse residual effects on the way the landscape looks (after mitigation and the AEAs being in place) are small in magnitude during construction and operation. A key factor behind this finding is that the Project is located in a region that has experienced considerable past hydroelectric development (as noted previously) which has greatly

altered the landscape; and that each of the KCNs have entered into AEAs with Manitoba Hydro to address adverse effects of the Project on each respective Cree Nation. Overall, the landscape will be altered on a permanent basis, including the loss of the Gull Rapids.

- Areas required for Keeyask construction, including access roads, which are no longer needed during the operation phase, will undergo site rehabilitation.
- A detailed decommissioning and rehabilitation plan for such infrastructure and land areas will be developed during the construction phase and provided to regulators for review and approval. Guiding principles for disturbed site rehabilitation are included in Section 7.3 of the JKDA, including use of local plant species to re-vegetate areas associated with the Project and the implementation of the KCNs' principles regarding respect for the land.

7.6.2.3 Heritage Resources

As indicated in Chapter 6, the regulatory assessment concludes that there will be moderate adverse effects on overall heritage resources (known and unknown) resulting from both the construction and operation phase of the Project. These effects will be within the Project construction site and the open water hydraulic zone of influence stemming from physical disturbance to the landscape, flooding and erosion. Archaeological sites that are to be protected through a mitigative buffer or avoidance will increase in sensitivity due to their increasing exclusivity.

7.6.3 Cumulative Effects of the Project including Future Projects and Activities

Based on the technical assessment summarized in Table 7-4 and detailed in Section 6.3, adverse effects of the Keeyask Project are expected to overlap with the other future projects or activities listed in Table 7-2.

Review of other future projects considered in the CEA that could overlap with the adverse effects of the Project indicates instances with the potential to result in cumulative effects on socio-economic VECs that require further mitigation and monitoring for the Project in combination with other future projects. Assuming that such further mitigation and monitoring occurs, the conclusions are not changed with respect to the regulatory significance of adverse effects of the Project on socio-economic VECs presented in Chapter 6.

7.6.3.1 INFRASTRUCTURE AND SERVICES

As Table 7-4 and Figure 7-1 illustrate, construction of the Keeyask Transmission Project, Bipole III Transmission, Gillam redevelopment, and the early years of the potential Conawapa Generation Project all overlap in time with the Keeyask construction period, creating overlapping effects on local housing, infrastructure and services, and transportation infrastructure. Spatial overlap within the socio-economic Local Study Area includes the Keeyask Transmission Project. Other developments may also occur in the area, including a planned Gillam housing expansion and redevelopment; although it is expected that many of these workers will be drawn from the local communities.

- Of particular note with regard to overlap of construction workers in the Gillam area, over 300 workers per quarter associated with components of the Bipole III and Keewatinoow Converter Station are needed in various years (*e.g.*, more than 300 per quarter (average) in 2014 with Q1 a high of over 900); and more than 250 per quarter (average) in 2015).
- Workers involved in the early stages of construction of the potential Conawapa Generation Project will overlap with the latter years of construction of Keeyask; these Conawapa workers will make use of facilities and services in Gillam (as it is the closest community with a range of amenities), exacerbating the demand for facilities and services.
- It is anticipated that the influx of non-local construction workers from other projects will exacerbate the additional pressure on community-based infrastructure and services, particularly emergency (*i.e.*, RCMP) and social services (*i.e.*, National Native Alcohol and Drug Abuse Program, Awasis, and family counselling) in Gillam.
- Operation staff for the Keewatinoow Converter Station and the potential Conawapa Generation Project are expected to be based in Gillam adding to the demands for infrastructure and services in this community.

More specific assessments of cumulative effects of the infrastructure and services VECs for the Project related to these other future projects are noted below:

- Housing: With severe housing shortages expected to continue in the KCNs communities, few non-resident KCNs Members are likely to relocate to the KCNs communities in conjunction with any of the future projects. Relocation to Thompson is less likely with the other future projects as they are further away from Thompson than Keeyask is; however, numbers cannot be predicted.

  All these projects require additional workforces with some workers likely drawn from local communities, and with a substantive portion of the workforce expected to be drawn from beyond the Local Study Area. This non-local workforce may place an increased demand for short-term accommodation in Gillam and Thompson. Expanding accommodation in Gillam will help deal with pressures on that community. Thompson is considerably further from the future projects than Keeyask which will reduce the number of off-hours visits to the City from workers related to those future projects. As well, the accommodation sector in Thompson is likely to be under less pressure and more able to cope with new demands than in recent years as Vale slows down its capital spending in the City and closes its nickel smelting and refining operation. Thompson has also recently added hotel capacity.

- **Transportation Infrastructure**: The key concern with these overlaps of other future projects with Keeyask construction relates to the additional wear and tear and traffic levels on PR 391 from Thompson to PR 280 and on PR 280 from the PR 391 junction to the junction of the north access road in the Local Study Area. For example, during 2017 and 2018, when Keeyask construction activity is at a high level, this route will also be handling substantial traffic from the later years of Keewatinoow Converter Station construction and the early years of potential Conawapa Generation construction. These higher traffic levels could accelerate the schedule for road refurbishment, maintenance and/or upgrades. It could also require special measures (*e.g.*, more frequent dust control) to avoid increased accident risks on this route. Manitoba Hydro and Manitoba Infrastructure and Transportation (MIT) will need to keep each other informed on a regular basis prior to and during periods of overlapping construction traffic to identify requirements for road improvements and traffic management.

  For sections of PR 280 beyond the north access road there will be increased traffic into Gillam; however, most of the increase is anticipated to be related to future projects. There will be some Keeyask-related Project traffic such as workers traveling to Gillam from the site for leisure activities. The number of visits is difficult to predict; however, this is expected to be small to negligible in comparison to the increased traffic associated with future projects. Any added mitigation would have to be determined in the cumulative assessment of the other future projects.

It is anticipated there will be a lesser effect on PTH 6 from Winnipeg to Thompson in the Northern Region for the following reason:

- The feasibility of an increased use of rail as a mode of transporting equipment and materials from the south to the Henday Rail Yard, which is located in the vicinity of the Keewatinoow Converter Station and the potential Conawapa Generation Project (Bipole III EIS); and
- The anticipation that MIT will be able to address increased traffic levels on PTH 6 through their regular highway maintenance and upgrade program given the long lead time notice.

In light of expected sizeable increases in traffic on PR 391 from Thompson to PR 280 and PR 280 to the junction of the north access road, the magnitude of the residual effects when taking into account cumulative effects may change from small to moderate for the short-term; however, this change related to cumulative effects would not modify the Chapter 6 regulatory significance determination for the Project's effects on the transportation infrastructure VEC.

Chapter 8 notes the monitoring necessary to track population changes, as well as the need to tie in any potential increased demand for housing with the land use planning process currently in place in Gillam. Manitoba Hydro is a proponent for these other major development projects in the socio-economic Local Study Area, and is involved in the community land use planning process for Gillam along with the Town and FLCN to address infrastructure and service requirements of future projects in the Gillam area. Implementation of the results of the planning process would enable the growth in demand for added infrastructure and services from future projects to occur in a timely manner with minimal disruptions. In this regard, there is an ability to plan and coordinate additional mitigation measures such as increasing the number of housing starts in Gillam, ongoing monitoring and coordination amongst all projects to reduce the likelihood of cumulative adverse effects. Beyond this joint community land use planning, no additional mitigation is required to address the cumulative effects related to the Keeyask Project.

Manitoba Hydro will continue to liaise with the Thompson Mayor and Council on future projects within the region to enable Thompson to plan for community growth (*e.g.*, housing and/or short-term accommodations). No additional mitigation is required.

In summary, the Chapter 6 assessment of significance for Keeyask Project effects on infrastructure and services VECs, which considered cumulative effects of past and current projects, is not changed by the above consideration of cumulative effects of other future projects.

7.6.3.2 PERSONAL FAMILY AND COMMUNITY LIFE

As reviewed in Table 7-4 and in the CEA review of infrastructure and services VECs (Section 7.6.3.1), Keeyask Project residual adverse effects during construction on several personal, family and community life VECs related to the KCNs and Gillam have the potential to interact cumulatively with adverse effects of other projects and activities planned during the Keeyask construction phase. As Figure 7-1 indicates, overlapping projects include the Keeyask Transmission Project, the Bipole III Transmission Project, the potential Conawapa Generation Project, and Gillam redevelopment. As reviewed in Figure 7-1 sizeable workforce will be required for these projects, with a substantive portion of the workforce expected to come from outside the Local Study Area (*e.g.*, non-local workers). The following identifies the key time periods when the construction workforce for the other projects is expected to add substantially to the number of workers who will be working on Keeyask construction (see Figure 7-1):

- Keeyask Project site preparation and supporting infrastructure in the early years of construction is expected to overlap with peak construction of the Keewatinoow Converter Station, Bipole III, Keeyask Transmission Project, and Gillam expansion.
- Keeyask Project main stages of construction in the middle years up to the first turbine being in service is expected to have a peak workforce of about 1600 workers in the summer. This is expected to overlap with a period of high level of construction for the Keewatinoow Converter Station, construction of the Keeyask Transmission Project, the early stage of the potential Conawapa Generation Project construction and Gillam expansion.
- Keeyask Project final stage of construction in the remaining few years is expected to overlap with the peak workforce for Conawapa of 2100 workers and the last phase of the Keeyask Transmission Project; all other future projects are anticipated to be completed by this time period.

The combination of these projects could be expected to multiply the number of visits by non-local construction workers to Gillam (and possibly throughout the Local Study Area) compared to the Keeyask Project alone and noticeably increase the potential for adverse interactions with community residents, including groups such as youth and women. Gillam is by far the closest community with relevant amenities for the other projects. The competition from Thompson is expected to be much less for these projects due to the much greater distance involved in going to Thompson.

Similarly, during the Keeyask operation phase there will be residual adverse effects on several personal, family and community life VECs related to FLCN and Gillam that have the potential to interact cumulatively with adverse effects of other future projects and activities planned.

More specific assessments of cumulative effects of personal, family and community life VECs for the Keeyask Project related to these other future projects are noted below:

- Community Health: It is anticipated that community health may be further adversely affected as future projects noted in Table 7-2 overlap with Keeyask construction. Temporal overlap between Keeyask operation and potential Conawapa construction and operation may also result in indirect adverse effects on community health.
    - The additional projects will increase the number of non-local construction workers coming into Gillam (and possibly other Local Study Area communities), thus increasing the potential for indirect effects on community health. Examples may include the potential for increases in communicable diseases, increased alcohol abuse and adverse interactions with community members such as women and youth. Monitoring of community health is the responsibility of government authorities (Manitoba Health and FNIHB); it is recommended that these authorities consider monitoring the number of incidents of communicable diseases, injury and

potential years of life lost in the Gillam area and develop communication strategies related to same.

  - Operation phase cumulative effects with other future projects may result through increased population growth in Gillam associated with these projects, and the potential increase in community health issues. It is anticipated that these adverse indirect cumulative effects will be small to negligible.

- **Public Safety and Worker Interaction:** The residual adverse effects of the Keeyask Project on this VEC have the potential to interact cumulatively with adverse effects of other projects and activities planned during the Keeyask construction phase.

  - Mitigation measures to reduce the number of worker visits, as well as an overall coordinated approach to address worker interaction have been incorporated into the assessment of the Keeyask Project (see Chapter 6 and Section 5 of the SE SV for details); these mitigation measures are also included in the Bipole III EIS, particularly in relation to the Keewatinoow Converter Station. These measures are equally applicable to any of the other future projects for development in the Gillam area.

  - Additional mitigation in the form of ongoing coordination with Manitoba Hydro, contractors, monitoring advisory committees, the RCMP and social groups will be necessary to reduce the risk of material adverse effects.

  - Ongoing monitoring will be a necessary component of all Manitoba Hydro projects and activities in the vicinity of Gillam in particular (and possibly throughout the Local Study Area). Further discussion with the RCMP is recommended to facilitate appropriate level of staffing and to determine how best to track incidents related to separate projects.

  Given the sizeable increase in the number of potential visits by non-local construction workers to Gillam (and possibly the Local Study Area) and added adverse interaction opportunities, the planning for each of the future construction projects in Table 7-2 will need to address incremental mitigation and monitoring as required and reviewed above. Coordinated planning in this regard will be facilitated to the extent that Manitoba Hydro is responsible for these various other future projects.

  Assuming that the above mitigation and monitoring occurs, the Chapter 6 assessment of significance for Keeyask Project effects on this VEC, which considered cumulative effects of past and current projects, is not changed by the above consideration of cumulative effects of additional future projects.

- **Travel, Access and Safety:** In terms of road travel safety, the expected increases in traffic due to cumulative effects of the Project (during the construction phase) with other future projects may result in overall moderate to large residual effects for a short period of project overlap; however, the significance rating for the Project effect on this

VEC as provided in Chapter 6 remains unchanged. With regard to open water and ice-based travel, the Project's effects are not expected to overlap spatially in any meaningful way with other future projects.

- Culture and Spirituality (KCNs): Future projects and activities noted in Table 7-2 will add to the physical alteration of the land and water in the KCNs traditional territories, affecting their stewardship relationship with *Askiy* (see Chapter 2). The additional loss of their cultural connections to *Askiy* is likely to accentuate the adverse effect experienced by KCNs Members. Manitoba Hydro will work with the KCNs, and others, so that that these future projects are planned, constructed and developed in a way that minimizes adverse effects as much as possible. Where appropriate, Manitoba Hydro will negotiate adverse effects agreements with affected KCNs and others prior to the start of construction for these projects. As with Keeyask, these agreements are intended to address known and foreseeable adverse effects of the projects on these communities, including those which may affect cultural identity. Based on these measures, the Chapter 6 assessment of significance for Keeyask Project effects on this VEC, which considered cumulative effects of past and current projects, is not changed by the above consideration of cumulative effects of other future projects.
- The Way the Landscape Looks (Aesthetics): There is spatial and temporal overlap between the Keeyask Project and the Keeyask Transmission Project for both the construction and operation phases (due to the long-term nature of physical changes to the landscape and features remaining on the landscape in perpetuity, *i.e.*, dam, dykes, north and south access roads and transmission lines). While these other projects will affect the way the landscape looks, their effects should be less prominent, albeit more geographically dispersed, than the Keeyask Project. Given an already highly disturbed visual landscape and the prospect of rehabilitation after decommissioning, the significance rating for Keeyask Project effects on this VEC in Chapter 6 (which included consideration of cumulative effects of past and current projects) is not changed after considering the cumulative effects of other future projects.

7.6.3.3 HERITAGE RESOURCES

Based on the technical assessment summarized in Table 7-4, adverse effects of the Keeyask Project are expected for the heritage resources VECs, and these adverse effects are also expected to overlap with at least some of the other future projects or activities listed in Table 7-2 during the construction phase.

As Table 7-4 indicates, the Keeyask Transmission Project will overlap in space and time with the Keeyask Project relative to heritage resources. The Keeyask Transmission Project will include additional clearing and disturbance to the physical landscape, with the potential for disturbing or unearthing unknown heritage resources.

- The Keeyask Transmission Project has undergone a heritage resources impact assessment (NLHS 2009) undertaken under *The Heritage Resources Act* to identify and address known heritage resources; and in the case of unknown heritage resources, the future project will include a Heritage Resources Protection Plan to address unearthing any unknown heritage resources.

Given the mitigation and monitoring that will be associated with both the Keeyask Project and the future Keeyask Transmission Project, no additional mitigation or monitoring will be required. The significance rating for Keeyask Project effects on this VEC in Chapter 6 (which included consideration of cumulative effects of past and current projects) is not changed after considering the cumulative effects of other future projects.

APPENDIX 7A
RELEVANT OTHER PROJECTS AND ACTIVITIES

INTRODUCTION

The following appendix material provides a brief description of past and current projects and activities and information on future projects and activities considered in the cumulative effects assessment. More information on these projects can be found on the Manitoba Hydro website (http://www.hydro.mb.ca/).

PAST AND CURRENT PROJECTS AND ACTIVITIES

MANITOBA HYDRO GENERATION – RELATED DEVELOPMENT IN NORTHERN MANITOBA

CHURCHILL RIVER DIVERSION

The Churchill River Diversion Project involved diverting flow from the Churchill River into the Burntwood-Nelson river system to increase power production at existing and future generating stations on these two rivers (see Map 7A-1). The diversion raised the level of Southern Indian Lake by approximately three meters, reduced flows on the Churchill River downstream of Missi Falls, and increased flows on the Rat River/Burntwood River/Nelson River system.

The Churchill River Diversion Project was announced in 1966 and received an interim license in 1972. Construction began in 1973 and the diversion was in operation by 1977. The three main components of the diversion plan included:

- A control dam at Missi Falls that raised the lake by three meters and controls the outflow of water from Southern Indian Lake.
- Excavation of a channel from South Bay of Southern Indian Lake to Issett Lake which created an outlet for the diverted Churchill River to flow into the Rat River/Burntwood River/Nelson River system.
- A control dam on the Rat River at Notigi that regulates the flow into the Burntwood-Nelson River systems.

Under the terms of the license, Manitoba Hydro is permitted to divert the river flow 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 license also stipulates that 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.

Two weirs have been built, one on the Nelson River system and another on the Churchill River, to partially mitigate changes in water levels caused by the Lake Winnipeg Regulation (LWR) and Churchill River Diversion (CRD) Projects, respectively. The Cross Lake Weir was constructed in 1991 to reduce the impacts caused by reversal of the historic pattern of water levels and fluctuations at Cross Lake. The weir at the Jenpeg Generating Station raised the minimum water level on Cross Lake by nearly 1.4 m during low flow conditions without raising water levels during floods in excess of the 1:100 year flood. This results in more moderate seasonal fluctuations than in the past. The effectiveness of the Cross Lake Weir continues to be monitored.

The weir on the Churchill River at Churchill was developed as part of a water level enhancement project to help offset reduced water levels resulting from the diversion of flows into the Burntwood-Nelson River system. 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. Following receipt of environmental approvals, construction of the weir and associated works began in the late spring of 1998 and was completed in the summer of 2000.

Lake Winnipeg Regulation

The Lake Winnipeg Regulation was developed to use Lake Winnipeg as a natural reservoir to regulate water flow for generating stations located on the Nelson River and also for flood and drought control (see Map 7A-1)[1].

The natural outflow of Lake Winnipeg into the Nelson River naturally increased in the summer and decreased in the winter, the opposite of energy requirements of the Province of Manitoba. Manitoba Hydro was granted a license in 1970 to regulate the outflow of Lake Winnipeg into the Nelson River. New channels were excavated and the Jenpeg Generating Station and Control Structure was constructed by late 1976. This new control structure allows Manitoba Hydro to adjust outflow patterns of Lake Winnipeg to meet the energy needs of the Province.

The three channels excavated were the 2-Mile Channel, 8-Mile Channel and the Ominawin Bypass Channel. They were excavated to a depth of 7.6 m for a total of 37.3 million m^3 of material excavated. The 2-Mile Channel was excavated to increase the natural outlet at Warren Landing. The 8-Mile Channel was excavated to increase water flow from Playgreen Lake. The Ominawin Bypass Channel was developed to avoid natural restrictions in the Ominawin Channel.

The Jenpeg Generating Station and Control Structure was constructed to regulate water in the main channel that provides outflow from Lake Winnipeg and to generate 135 megawatts of electricity from a 7.3 m operating head (waterfall). Construction was completed in 1979.

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[1] In print version, Appendix 7A Maps can be found in the accompanying Map and Figure Folio.

The Kiskitto Dam was developed to prevent water from the Nelson River from spilling into Kiskitto Lake. Water levels in Kiskitto Lake are regulated by inlet and outlet structures within their natural range to provide maximum benefit for fish, wildlife and recreational users. The Kiskitto Dam is 600m long and a maximum of 15m high with an additional 16 dykes totaling a length of 14km to prevent water from flowing directly from the Nelson River.

Construction began in 1991 on the Cross Lake Weir to raise the water levels on Cross Lake during low flow conditions. The construction included a rock weir and channel excavation at the outlet of Cross Lake for a total of $9.5 million.

Under the Lake Winnipeg Regulation license, Manitoba Hydro must regulate water levels between 216.7m (711 feet) and 217.9m (715 feet) above sea level. The licence allows Manitoba Hydro to set outflows as required for power production purposes along the Nelson River when the lake is level is between 216.7m and 217.9m. During periods of high inflow when water levels in Lake Winnipeg rise above 217.9m, Manitoba Hydro must maintain maximum outflow into the Nelson River to return the lake to below 217.9m. During periods of low inflow and drought, the water level of the lake may fall below 216.7m. When this occurs, Manitoba Conservation determines outflow from the lake. Eight separate locations on Lake Winnipeg are measured daily to determine the water level. The average level of the lake has not significantly changed following the regulation. Prior to 1976, the average water level was 713.4 feet above sea level while following the implementation of the Lake Winnipeg Regulation the average level of the lake has been 713.6 feet above sea level.

LOWER NELSON RIVER GENERATION PROJECTS

In association with the Lake Winnipeg Regulation and the Churchill River Diversion water management system, four large hydroelectric generating stations were developed between 1957 and 1995. The Kelsey and Kettle Generating Stations were built prior to the Lake Winnipeg Regulation and the Churchill River Diversion. The Long Spruce and Limestone Generating Stations were constructed after the water management systems implementation (see Map 7A-1).

The Kelsey Generating Station is located on the upper Nelson River close to where it enters Split Lake, 40 km south-west of the community of Split Lake. Kelsey was the first hydroelectric generating station built on the Nelson River in order to provide 100 MW of power to serve INCO's mining and smelting operations in Thompson. The Kelsey forebay raised water levels approximately 9.5 m above natural levels and flooded around 5,767 ha for 150 km along the upper Nelson River from Kelsey to Sipiwesk Lake.

The Kettle Generating Station is located at the Big Kettle Rapids (*Kitchi Askiko Powstik*) site, approximately 7 km northeast of the Town of Gillam. It was the first of four projects outlined in Phase One of the framework for northern hydro-electric development recommendations submitted by the Nelson River Programming Board in 1965 to meet the forecasted demand of electricity in Manitoba. The Kettle Generating Station construction activities took place over seven years from 1966 to 1974. The Kettle Generating Station has twelve generating units with a generating capacity of 1,232 MW. The station was fully operational in 1974. Construction of the Kettle Generating Station involved several projects that had effects on the local study area, such as construction of the Radisson Converter Station, transmission lines from Kelsey to Radisson, electrification and expansion of Gillam to accommodate the construction workforce, a new airstrip and a road. With the creation of the reservoir, water levels at the structure raised 30 m, flooded 21,000 ha and tripled the size of Moose Nose Lake, which was then renamed Stephens Lake.

The Long Spruce Generating Station is located approximately 27 km east of Gillam and 16 km downstream of the Kettle Generating Station on the Nelson River. Long Spruce was selected for hydroelectric development after Kettle Rapids to continue to meet the growing electrical demands in Manitoba. Construction activities took place over seven years from 1972 to 1979. At peak construction, 2,000 workers were employed on the Long Spruce Construction. The Long Spruce forebay was created in 1977, which raised the water level by about 26 m, flooding approximately 1,400 ha of land. The Long Spruce Generating Station has ten generating units with a generating capacity of 1,010 MW. Related project activities to the Long Spruce Generating Station included roads, a converter station and transmission projects, which in total affected approximately 9,300 ha of land.

The Limestone Generating Station is located approximately 6 km east of Fox Lake and 50 km northeast of Gillam. Construction of the Limestone Project began in 1976 with the development of a road, rail spur and construction of the Sundance town site. In 1979, construction was suspended as growth in electricity demand dropped. Construction activities were resumed in 1985 after a sale of power to the Northern States Power Corporation and took place over seven years. Power was first generated in 1990 and fully operational in 1992 when water levels at the station had been raised by 33.5 m. The Limestone Generating Station has ten generating units with a generating capacity of 1,340 MW. The Limestone Generating Station was developed as a run of the river station to minimize upstream effects. Increased water levels were mainly contained within the Nelson River banks resulting in 209 ha of flooding. Approximately 1,500 to 1,800 workers worked at Limestone during peak construction. Transmission projects associated with Limestone used approximately 1,100 ha of land. An all-weather road system was completed at this time from Thompson to Gillam.

WUSKWATIM GENERATING STATION PROJECT

The Wuskwatim Generation Project is currently under construction and involves the development of a 200 MW generating station, access road, construction camp, and other infrastructure. The Wuskwatim Generating Station is located at Taskinigup Falls on the Burntwood River, approximately 1.5 km downstream from the outlet of Wuskwatim Lake (see Map 7A-2). The Wuskwatim Generating Station includes a main dam, across Taskinigup

Falls, a powerhouse/service bay complex and a three-bay spillway built into the north bank of Taskinigup Falls. Using a low head design reduced flood impacts to less than 0.5 km^2.

The Wuskwatim Generating Station is anticipated to utilize the Churchill River Diversion flow that currently passes over the combined 22m elevation drop at Wuskwatim and Taskinigup Falls. The Wuskwatim Generating Station is expected to produce an average of about 1,550 GW.h of electricity per year that will be fed into the northern AC transmission system.

This location of the Wuskwatim Generation Project is within the Nelson House Resource Management Area. Manitoba Hydro and the Nisichawayasihk Cree Nation have jointly undertaken all the necessary engineering, environmental, consultation and other related activities to allow for the construction of the Wuskwatim Generation (and Transmission) Project. The Wuskwatim Generation Project is unique because it represents the first time Manitoba Hydro entered into an equity partnership with a First Nations community on a generating station project.

LINEAR DEVELOPMENT

PAST TRANSMISSION LINES

Manitoba Hydro's high-voltage transmission line system (see Map 7A-3) carries electricity from the generating stations in northern Manitoba to terminal 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.

Manitoba Hydro generates and transmits electricity as alternating current (AC) because of the relative ease of transforming voltages to the desired levels. It is more efficient and economical to transmit electricity as high voltage direct current (HVDC) for the long distances between the Nelson River generating stations and southern Manitoba, where most of the electricity is used. Manitoba Hydro's HVDC transmission system consists of two identical steel tower lines, Bipole I and Bipole II. They follow a 900 km route from Gillam through the Interlake area to Rosser, located 26 km from Winnipeg on the northwest side.

The Jenpeg Generating Station has a 230 kV transmission line to Ponton. The Kelsey Generating Station has three 138 kV AC transmission lines to Thompson, two 138 kV AC lines to Gillam (which feed Gillam, Ilford and Churchill) and one 138 kV AC line to Split Lake. The Kettle Generating Station has one 138 kV AC transmission line to the Radisson Converter Station where a ±450 kV DC line traverses to Winnipeg. The Limestone Generating Station has a 230 kV AC transmission line traversing to the Henday Converter Station and a 500 kV DC transmission line from the converter station to the Radisson

Converter Station. The Long Spruce Generating Station has a 230 kV AC transmission line to the Radisson Converter Station, a 230 kV AC transmission line to the Henday Converter Station and a ±450 kV DC line to the Dorsey Converter Station.

WUSKWATIM TRANSMISSION PROJECT

The operation of the Wuskwatim Generation Project required new transmission lines and substations to connect the new generating station to the existing Manitoba Hydro transmission system (see Map 7A-3).

The new transmission facilities include a 230 kV station at the Wuskwatim Generating Station site. This substation will collect the electricity from the generating station and transform it to a higher voltage for transmission to the existing hydroelectric transmission system. A second switching station (Birchtree Station) is located at the Local Government District of Mystery Lake, just south of the City of Thompson. A 230 kV transmission line connect the Wuskwatim Switching Station to the Birchtree Station. This line was responsible for providing power to the Wuskwatim GS during its construction. Two 230kV transmission lines connect the Wuskwatim and Herblet Lake Stations and one 230 kV transmission line connects Herblet Lake to the existing Ralls Island Station in The Pas.

Currently, construction of all transmission lines, with the exception of the collector lines from the Wuskwatim Generating Station to the Wuskwatim switching station, is now complete. Commissioning is under way and has been completed for the Wuskwatim transmission lines to Herblet Lake, as well as to Birchtree. The Herblet Lake to Ralls Island transmission line commissioning is expected to take place in July, 2012. Construction of the Wuskwatim collector lines is underway and scheduled to be completed in July, 2012.

KEEYASK INFRASTRUCTURE PROJECT

The Keeyask Infrastructure Project (KIP) is located approximately 730 km north (by air) from Winnipeg. KIP consists of the construction of new infrastructure components required to initiate the timely construction of the proposed Keeyask Generation Project, if and when it receives the necessary approvals (see Map 7A-4). KIP received approval under *The Manitoba Environment Act* License No. 2952 dated March 8, 2011 and is currently under construction. Construction consists of a new all-weather gravel access road extending approximately 25 km from Kilometre 174 on PR 280 to the proposed Keeyask Generating Station location at Gull Rapids. It also includes a clear-span bridge structure over Looking Back Creek, site development for a road start-up camp (to accommodate road construction personnel), and construction of the first phase of a main camp.

The corridor width of the road is approximately 100 m with the road being constructed from materials excavated within this corridor. The road will be approximately 1.5 m above existing grade level and will meet Manitoba Infrastructure and Transportation (MIT) standards. One stream crossing will use a single through-grade culvert at an unnamed tributary. A larger crossing at Looking Back Creek will use a clear span bridge.

The road start-up camp will be located at the approximate intersection of PR 280 and the north access road. A second start-up camp will be located at the bridge crossing at Looking Back Creek to house those involved in the construction of the bridge. The first phase of camp construction will include clearing and grubbing of areas, applying erosion and sediment controls, laying gravel and constructing a pad to allow placement of camp facilities. It is proposed that the Phase I construction activities will be complete by May 2012.

The KIP is estimated to provide 184 person-years of employment over the 3-year period, which began late 2011, with an average of 80 to 126 jobs at one time.

In the event that the Keeyask Generation Project does not proceed in the future, the proposed infrastructure would not be required and would be decommissioned. It is intended that decommissioning would return the environment to the pre-construction conditions to the extent reasonable and practicable. Decommissioning activities would include removal of the roadbed, clear-span bridge, culvert crossing and through-grade drains, and camp buildings and utilities. The roadbed and camp site would be re-graded and re-vegetated. A decommissioning plan would be prepared and submitted to the appropriate regulatory authorities for approval prior to implementation. Public notification of decommissioning and associated activities would also take place.

PR 280 Upgrades

PR 280 is a provincial road classified as a Secondary Arterial with an Average Annual Daily Traffic (AADT) volume of 130 to 186 vehicles per day. PR 280 (Map 7A-5) was built on rolling terrain with a road width of 9.8 m between PR 391 and Split Lake and a width of 7.3 m between Split Lake and the proposed Keeyask North Access Road.

Manitoba Hydro engaged Dillon Consulting Limited to perform a safety analysis on PR 280 and the potential impact of additional traffic on the roadway related to construction of the proposed Keeyask Generating Station. The finding was that PR 280 did not meet current Manitoba Infrastructure and Transportation (MIT) standards for alignment and cross section guidelines and that safety improvements should be considered prior to the construction of the generating station.

Manitoba Hydro and MIT signed a Memo of Understanding (MOU) in 2010 that MIT would provide the design specifications, construction standards, obtain all permits and environmental licenses, secure necessary right-of way and associated legal surveys while Manitoba Hydro would provide the planning, detailed design and construction management of the road upgrades. Manitoba Hydro and MIT also agreed to split the project costs 50/50.

Required upgrades to PR 280 were identified in 45 locations between PR 391 and the proposed Keeyask North Access Road by both Manitoba Hydro and MIT. Improvements included correcting excessive roadway gradients, sub-standard roadway widths and deficient crest and sag curves.

The upgrades were broken into two components:

- Crushing & stockpiling road aggregates and rock cuts; and
- Re-grading, re-aligning and re-surfacing.

The work was awarded as a Direct Negotiated Contract (DNC) to Amisk Construction Ltd., a joint venture between the Cree Nation Partners (CNP) and Sigfusson Northern Ltd. Crushing and stockpiling road aggregates and rock cuts began in 2010 and the re-grading, re-aligning and re-surfacing contract will be awarded in 2012. The total estimated cost of the upgrades is $28 million.

Mining Activities

Mining has played an important role in the development of some parts of the north and the mineral industry is Manitoba's second largest primary resource industry. Manitoba mines produce base and precious metals, such as nickel, copper, zinc and gold; specialty minerals like lithium, cesium and tantalum; and industrial minerals such as dolomite, spodumene, silver, gypsum, salt, granite, limestone, peat, lime, sand and gravel (Manitoba Minerals 2012).

The mineral industry was the primary reason for the development of the City of Thompson and Vale currently has a large nickel mine complex a few kilometres northeast of the city. Exploration is prevalent in the area and although there are no operating mines within the Local Study Area, there are several mining claims to the north of Split Lake. Manitoba Hydro has applied for a number of quarry leases along the proposed right of way for the north and south access roads.

An exploration license has been granted approximately 10 km NE of the Project Footprint on the north shore of Stephens Lake. In February 2008 a Mineral Exploration License for a 12,341 hectare area on the north side of Stephens Lake was granted to Exploratus Ltd. to conduct exploration in the area. Exploratus Ltd. primarily explores for gold, nickel, platinum and base metals (Business Week 2010; Credit Risk Monitor 2010). There has been no indication of any major discoveries (however, it is possible that, for business purposes such information may not be publicly disclosed). The anniversary date for the exploration license is February 2013.

Commercial Fishing

Commercial fishing in the Split Lake RMA began in the late 1950s and early 1960s. The early fishery primarily focused on lake whitefish and secondarily on pickerel (walleye) and jackfish (northern pike). Most of the production was from remote inland lakes that were fished predominantly in winter. By the late 1960s, the fisheries were converted to summer operations by using air transport to bring the fish to market. Split Lake has remained predominantly a summer fishery since the mid-1950s.

Increasing air transportation costs in the 1980s and 1990s led to a decline in the regional commercial fishery. The number of lakes fished decreased from 23 in the 1960s to just three in recent years.

Split Lake, Assean Lake, and Stephens Lake have been the only active commercial fisheries in the SLRMA since 1997. The Split Lake fishery accounted for over 96% of the fish production and value in the SLRMA between 1997 and 2008 (see Resource Use Section 1.3 of the SE SV). Split Lake has a 59,000 kg (129,800 lbs) round weight quota for pickerel, whitefish, northern pike, sauger and goldeye (see Resource Use Section 1.3 of the SE SV). Assean Lake has a 4,600 (10,120 lbs) quota for pickerel and jackfish. The Stephens Lake fishery operates under a special license for pickerel (no more than 500 lbs/day for 10 weeks annually). Current catches are regulated by Manitoba Conservation and Water Stewardship and are expected to be sustainable.

Commercial fishing for lake sturgeon in Manitoba gradually crept north along the shores of Lake Winnipeg during the late 1890s as various forms of transportation became available. Stimulated by high prices, lake sturgeon harvest reached the upper Nelson River area (in the vicinity of Sipiwesk Lake) in the early 1900s. Declining stocks in Lake Winnipeg prompted a province wide closure of the lake sturgeon fishery in 1911. When it reopened in 1916, the same year the HBC railway reached Gillam, lake sturgeon fishing was expanded farther down the Nelson River. Total production records are incomplete but prior to a 1931 closure, the estimated total harvest from the upper[1] and lower Nelson River reaches was 600,000 kg or 1.3 million pounds from which lake sturgeon populations have never recovered (see Resource Use Section 1.3 of the SE SV for sources and references). The commercial lake sturgeon fishery on the Nelson River was reopened for three additional periods (1937-1946, 1953-1960 and from 1970-1992 with a much reduced quota) each time requiring closure due to declining catches. Prior to 1970, lake sturgeon harvest records reported catch for both the upper and lower Nelson River reaches together after which five management zones were established. Zone 4 (Project area) harvest records from 1970-1987 indicated approximately 250-500 lake sturgeon may have been commercially harvested during this period (see AE SV Section 6.3). Interviews with resource users suggested that the actual catch may have been higher. The commercial lake sturgeon fishery was closed permanently in 1992.

Due to historic declines and concerns about a continuing decline in population numbers, COSEWIC designated lake sturgeon in the Nelson River as endangered, and this species is currently being considered for listing under the *Species at Risk Act* (*SARA*).

[1] At least 80% of the lake sturgeon production from the Nelson River was taken from a 160 km stretch of the river in the vicinity of Sipiwesk Lake upstream of the Kettle GS. This area is referred to as the upper Nelson River. The lower Nelson River refers to the Nelson River reaches downstream of the Kelsey GS to Hudson Bay.

Commercial lake sturgeon fishing also occurred on the Churchill River (near the mouth of the Little Churchill River) and intermittently on the Fox and Bigstone rivers which also are now closed.

COMMERCIAL FORESTRY

The forest industry has played an important part in the development of portions of northern Manitoba. As the industry modernized and mill capacities were increased at The Pas in the 1960's and 1980's, the Forest Management License (FML) #2 was also increased to include portions of the Nelson River Forest Section (NRFS), including Forest Management Units (FMU) 85, 87 and 89. These three FMUs overlap the western extremity of the Terrestrial Environment Regional Study Area.

As these areas are furthest away from the processing facilities at The Pas, past harvesting activities have been limited to the very south-western periphery of the Terrestrial Environment Regional Study Area. The global recession has hit the Manitoba forest industry particularly slowing harvest rates by up to 40% in FML #2 and forcing the shutdown of the sawmill at The Pas in 2009. This has resulted in a virtual stoppage of harvesting activities within the NRFS, that being a primary supply of sawlog material (Hunt *pers. comm.*, 2012).

If and when the forest industry recovers and the sawmill is re-started at The Pas, logging activities could resume in FMUs 85, 87 and possibly 89, however these areas remain the most distant from the processing facilities and are therefore among the least likely areas to be re-activated.

KELSEY RE-RUNNERING

The Kelsey Generating Station was designed and built in late 1950s primarily to serve INCO load. While the full generating potential based on the site and Nelson River flows was roughly 450MW, only a 7-unit 224 MW generating station was required to meet the design requirements for the INCO load. Consequently, the plant had historically operated at a relatively high capacity factor of 89% and spilled roughly 70% of the time.

Manitoba Hydro has considered a variety of expansion options to develop additional capacity at Kelsey over the past 30 years, including expansion of the powerhouse or replacement of the existing turbine runners with higher capacity turbines. The most attractive option from an economic perspective was re-runnering. In 2003, the Kelsey Re-runnering Project was approved in the capital plan, justified on the basis of required equipment overhauls to major mechanical and electrical components of the existing units in order to sustain reliable operation of the plant and minimize forced outages.

The Kelsey Re-Runnering Project would increase power production from Kelsey G.S. by adding up to 77 MW of capacity and 350 to 400 Gwh of average annual system energy production primarily through the increase of discharge capability of the generating station.

The increase in discharge capability captures the benefit from river flow that was previously spilled reducing the frequency of spill from 70% down to 35%, with all seven units re-runnered.

To date, five out of seven units have been completely overhauled with a sixth to be completed in Fall of 2012.

FUTURE PROJECTS AND ACTIVITIES

BIPOLE III

The proposed Bipole III and Keewatinoow Converter Station Project consists of building a new HVDC transmission line corridor from the new Keewatinoow converter station (northeast of Gillam) to the Riel Station located east of Winnipeg in order to increase system reliability and dependability. It includes two converter stations, two ground electrodes and transmission lines (see Map 7A-6). The system will be less vulnerable to power outages due to severe weather, fires or other unforeseen events with a second transmission corridor on the west side of the province, separate from Bipole I and II that run through the center of the province, and with a second converter station located in southern Manitoba.

The Bipole III Project includes 500-kilovolt HVDC transmission line with a total length of 1,384 km from north to south. A 66m right-of-way will be developed for the transmission line with average tower spacing approximately 480m, with a total of 3 to 4 steel towers per mile. Self-supporting towers will be used in agricultural areas to reduce agricultural operation effects. Guyed towers will be constructed in forested areas and areas compatible with this type of tower.

The Keewatinoow converter station is located approximately 63 km northeast of Gilliam and 268 km northeast of Thompson. The southern converter station is located at the Riel Station site east of Winnipeg. The Keewatinoow converter station will convert AC power to DC power for transmission, as DC power is more efficient over long distances. The Riel converter station will invert the DC power back to AC power for end use. One ground electrode will be located near each converter station.

Several 230 kV transmission line interconnections will be added to tie the new northern converter station to the existing northern AC system.

Construction of Bipole III and the converter stations are expected to create numerous employment and economic opportunities. The construction workforce at peak construction on the transmission line will be 700-900 employees for approximately 1,200 person years and 500-700 employees for both converter stations for approximately 1,600 person years. Construction contracts will give preference to local, Aboriginal and Manitoba businesses. Employment and on-the-job training will be encouraged for locals, Aboriginals and Manitobans.

On December 1, 2011 an Environmental Impact Statement (EIS) for Bipole III and the Keewatinoow Converter Station was submitted to Manitoba Conservation. Comments and public hearings will be held by the Manitoba Clean Environment Commission. Assuming regulatory approval, the project is anticipated to start construction in 2013 and in-service by 2017.

KEEYASK TRANSMISSION PROJECT

The proposed Keeyask Transmission Project will include the construction and operation of transmission facilities to transport electrical energy from the proposed Keeyask Generating Station into the Manitoba Hydro northern collector system (see Map 7A-7 and Map 7A-8). Completion of the Project is currently anticipated for early 2020.

The Project consists of two main components:

- 138 kV Construction Power transmission lines and a transformer station at the Generating Station site; and
- Generation Outlet Transmission, Keeyask Switching Station and upgrades to the existing Radisson converter station.

This Project involves constructing a 21-km, single-circuit, 138-kV, steel-lattice transmission line to connect the proposed Keeyask Generating Station site construction power transformer station, located on the north side of the Nelson River, with the existing Manitoba Hydro 138 kV transmission line KN 36 in order to provide construction power for the development of the generating station.

A single-circuit, 138 kV transmission line (about 41 km) will be advanced from the Radisson Converter Station to the Keeyask Construction Power transformer station site, as a source of backup power to the construction power source.

The Project will also involve developing four 138-kV unit lines from the Keeyask Generating Station to the proposed Keeyask Switching Station (approximately 4 km.), and two additional 138 kV lines from the proposed Keeyask Switching Station, to the Radisson Transformer Station which will tie the Keeyask Generating Station site into the northern collector system. These three 138-kV transmission lines are known, collectively as the Generation Outlet Transmission lines. Project completion is currently planned for early 2020.

Once the Keeyask Generating Station is commissioned, a portion of the proposed Keeyask Construction Power transformer station and the 138 kV transmission line from KN 36 will remain in place to provide emergency power for a “black start” of the Keeyask GS. A portion of the Construction Power transformer station will be salvaged.

It is expected that the Keeyask Transmission Project will involve a regulatory review under *The Manitoba Environment Act* starting in the fall of 2012.

CONAWAPA GENERATING STATION

The potential Conawapa Generating Station will be the largest hydro-electric project built on the Nelson River in northern Manitoba. The project will be located on the Lower Nelson River approximately 30 km downstream from the Limestone Generating Station and 90 km northeast of the town of Gillam in the Fox Lake Resource Management Area (see Map 7A-1).The Conawapa site is located at a narrow section of the Nelson River, 670m wide, near Horseshoe Bay. The river bottom is limestone and rises up to create a shelf. The river banks are approximately 50m high and fairly steep at this location, the nearly 30 km forebay and reservoir will be most contained within the natural river banks, limiting the net flooded area to about 5 km^2. The difference in water levels between the forebay and downstream of the generating station will be 30 to 31 m. During construction, structures will need to be recessed into the north bank to accommodate the river diversion requirements.

The Conawapa Generating Station will have ten turbine generators. The generating station powerhouse will be approximately 70 m wide and 310 m long and will be designed for a water flow of 5,000 to 5,500 m^3 per second. Water flow will be controlled by wicket gates during normal operation and vertical lift gates in the intake for maintenance and/or emergency situations. A seven-bay concrete overflow spillway will be used during construction and high flow conditions after the project is completed. The spillway will be approximately 120 m wide and 115 m long with each gate measuring at 13 m wide and 17 m high.

Construction is expected to take approximately 8 to 8.5 years once regulatory approvals and licenses are received with the earliest potential in-service start date in 2025. Approximately, 840,000 m^3 of concrete, 186,000 tonnes of cement and 40,000 tonnes of reinforcing steel will be required to construct the Conawapa Generating Station structures. Approximately 13,000 person years of direct and indirect employment is expected to be generated during construction.

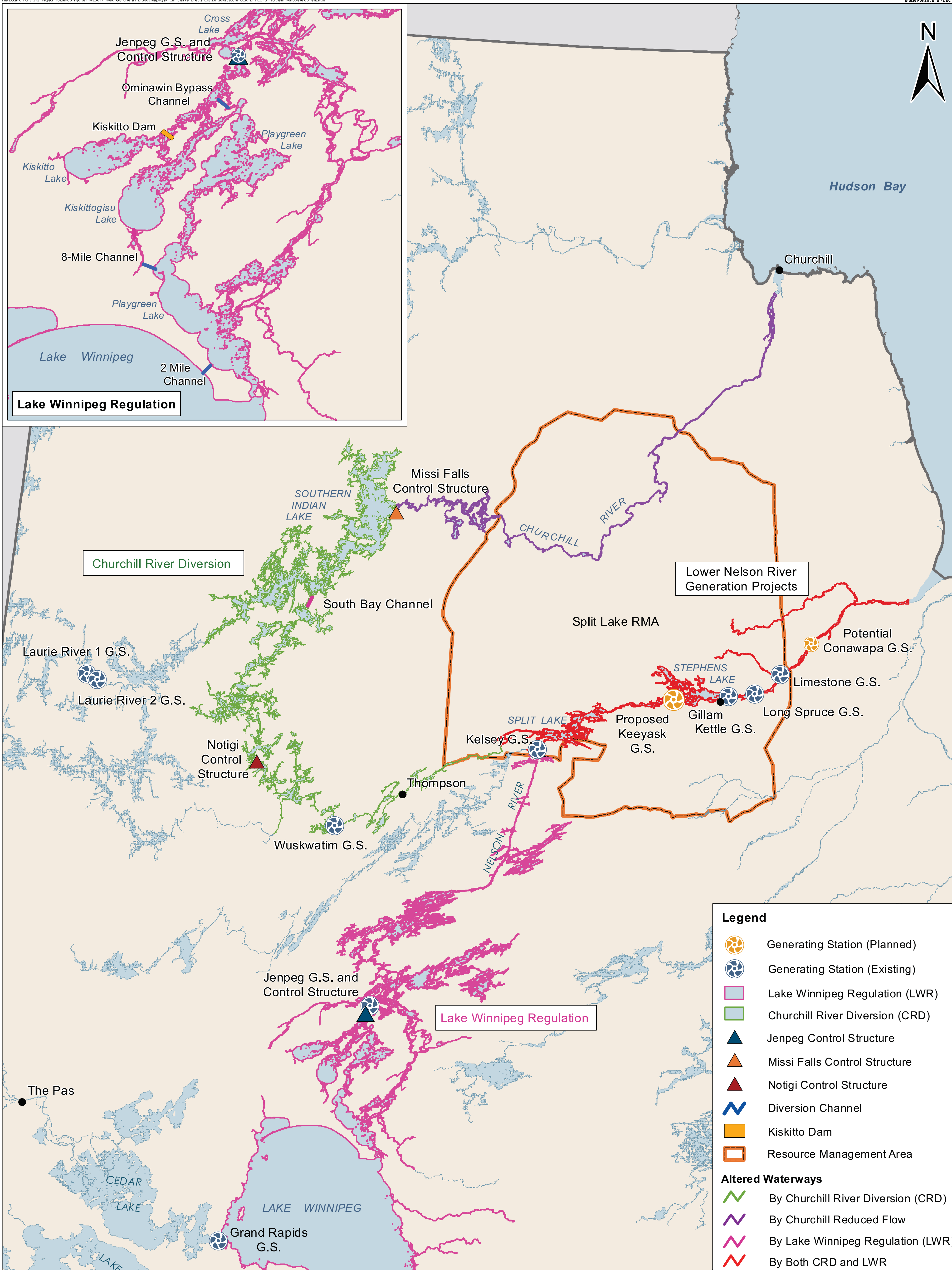
Once in-service, the Conawapa Generating station is expected to produce 1485-megawatts, enough power to service 700,000 homes.

GILLAM REDEVELOPMENT

The mandate of the Gillam Redevelopment & Expansion Program is to repair existing 1970's infrastructure and build new infrastructure in anticipation of additional staffing required for northern projects. The infrastructure development under the Gillam Redevelopment & Expansion Program will recognize Gillam's future as an increasingly important northern hub for Manitoba Hydro. The Gillam Redevelopment & Expansion Program will focus on renovating and expanding Gillam incorporating qualities of permanence and durability to match the northern generating stations.

The Gillam Redevelopment & Expansion Program consists of numerous housing and infrastructure projects needed to accommodate the anticipated increase of Gillam's population as a result of expected new northern Project operational staff and their families. Population increase will also come from general town growth and from FLCN Members returning home to their traditional territory. It is estimated that Gillam will experience increasing population growth over the next 10 to 15 years.

The program may be deployed in phases to ensure that Gillam Redevelopment and Expansion proceeds in areas of priority, matches available funds and is coordinated with other major Project schedules.



KEEYASK Hydropower Limited Partnership

DATA SOURCE:
Manitoba Hydro, Province of Manitoba

CREATED BY:
Stantec Consulting Ltd.

COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	17-FEB-12	14-MAY-12
0 25 50 Kilometres / 0 20 40 Miles	VERSION NO: 1.0	QA/QC: APPROVED

Hydro Development in Northern Manitoba

Map 7A-1

KEEYASK Hydropower Limited Partnership

DATA SOURCE: Manitoba Hydro, Government of Canada

CREATED BY: Stantec Consulting

COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	15-FEB-12	27-APR-12
0 10 20 Kilometres / 0 10 20 Miles	VERSION NO: 1.0	QA/QC: APPROVED

Legend

- Generating Station (Planned)
- Generating Station (Existing)
- Community

Transmission Line (Existing)

- +/- 500 kV HVDC Line
- 230 kV Line
- 138 kV Line
- 115 kV Line

Wuskwatim Transmission Project

Map 7A-2

File Location: G:_GIS_Project_Folder\00_Hydro\111420017_Kysk_GS_Overall_EIS\ArcMap\Kysk_Cumulative_Effects_EIS\20120425\Core_CEA_EFFECTS_MBHydroTransmissionLineNetwork.mxd

B Size Portrait BTB - DEC 2011

KEEYASK
Hydropower Limited Partnership

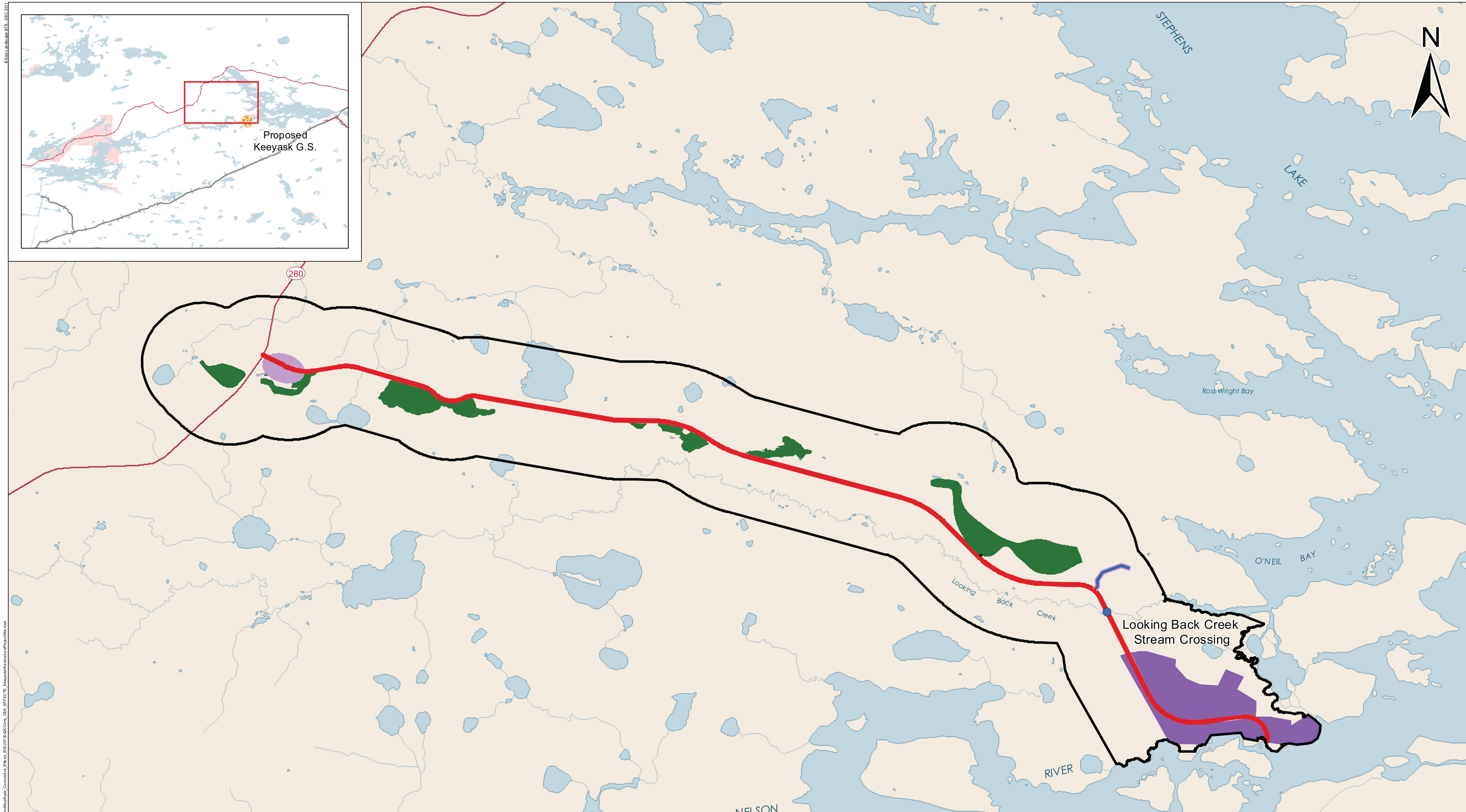
DATA SOURCE:
Manitoba Hydro, NTS (Government of Manitoba)

CREATED BY:
Stantec Consultants

COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z14N	15-JAN-10	19-JUN-12
0 30 60 Kilometres / 0 25 50 Miles	VERSION NO: 1.0	QA/QC: APPROVED

Manitoba Hydro Transmission Line Network

Map 7A-3



DATA SOURCE:
Manitoba Hydro, Government of Canada, Stantec Consulting Ltd., ECOSTEM Ltd.

CREATED BY:
Stantec Consulting Ltd.

COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	13-FEB-12	27-APR-12
0 0.85 1.7 Kilometres 0 0.7 1.4 Miles	VERSION NO: 1.0	QA/QC: APPROVED

Legend

- Stream Crossing
- Local Study Area

Project Footprint Components

- Road
- Start-Up Camp Footprint
- Main Camp and Other Infrastructure
- Borrow Area
- Main Camp Wells and Access

Keeyask Infrastructure Project Site

Map 7A-4

DATA SOURCE:
Manitoba Hydro, Government of Manitoba

CREATED BY:
Stantec Consulting Ltd.

COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	15-FEB-12	30-MAY-12
0 5.5 11 Kilometres / 0 5 10 Miles	VERSION NO: 1.0	QA/QC: APPROVED

Legend

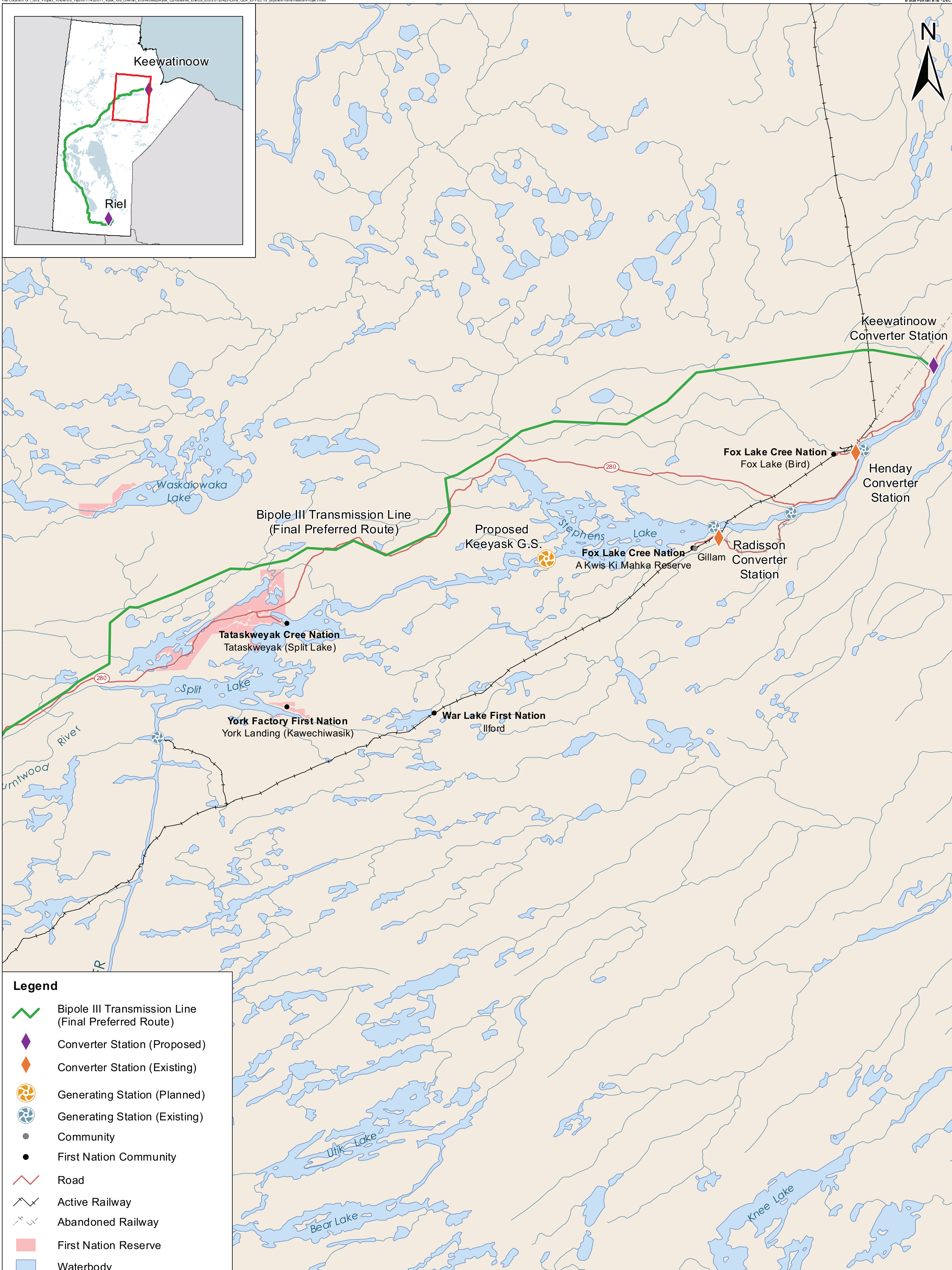
- Generating Station (Planned)
- First Nation Community
- First Nation Reserve
- PR 280 Upgrade Segment

Provincial Road 280 Upgrade

Map 7A-5

File Location: G:_GIS_Project_Folder\00_Hydro\111420017_Kysk_GS_Overall_EIS\ArcMap\Kysk_Cumulative_Effects_EIS\20120425\Core_CEA_EFFECTS_BipoleIIITransmissionProject.mxd

B Size Portrait BTB - DEC 2011



KEEYASK Hydropower Limited Partnership

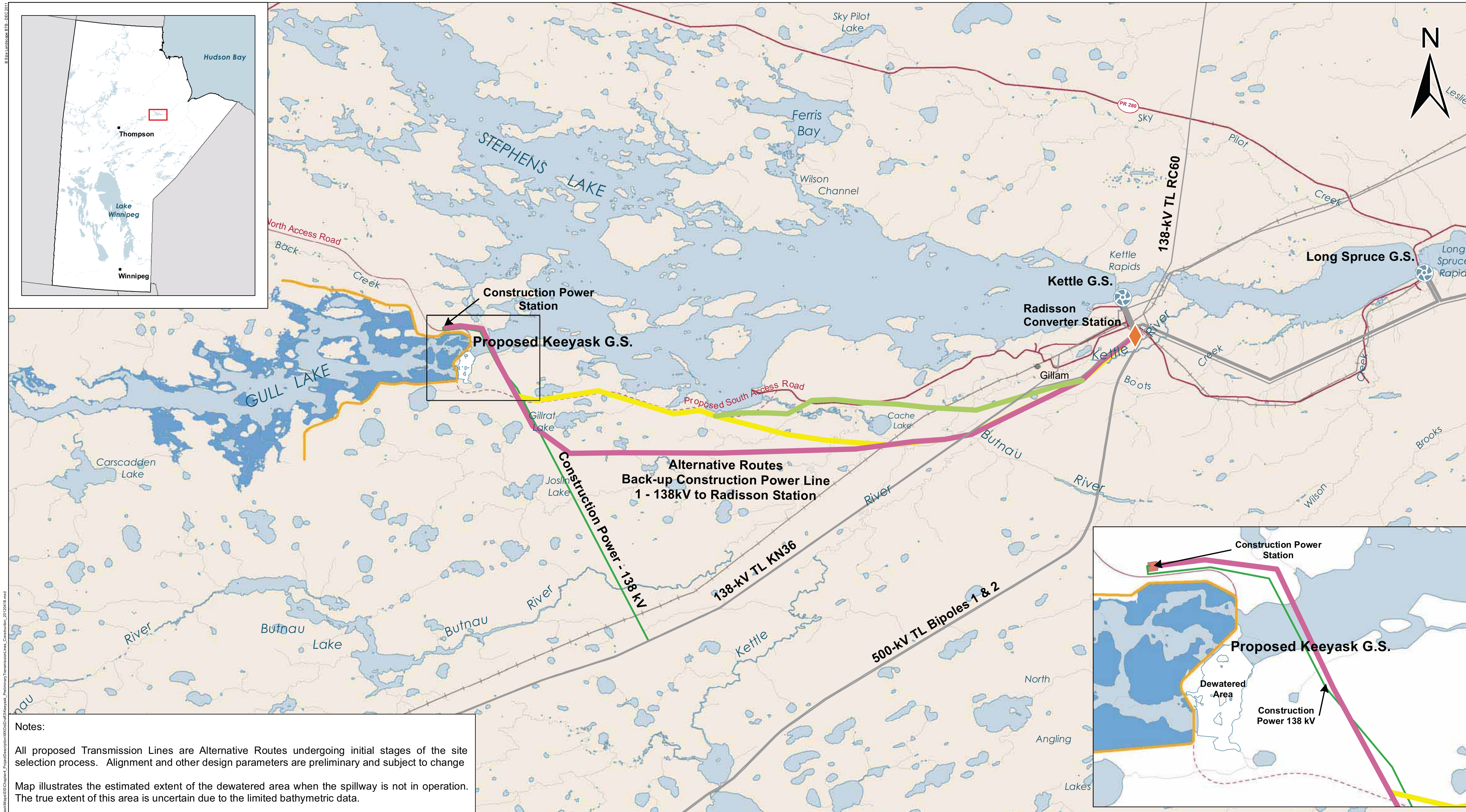
DATA SOURCE:
Manitoba Hydro, NTS (Government of Manitoba)

CREATED BY:
Stantec Consultants

COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	15-FEB-12	30-MAY-12
0 9 18 Kilometres / 0 7 14 Miles	VERSION NO: 1.0	QA/QC: APPROVED

Northern Extents of Bipole III Transmission Project

Map 7A-6



Notes:

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

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

KEEYASK Hydropower Limited Partnership

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

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

COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	13-FEB-12	24-APR-12
0 2.5 5 Kilometres / 0 1 2 Miles	VERSION NO: 2.0	QA/QC: APPROVED

Legend

- Transmission Line (Existing)
- Construction Power Line (Proposed)

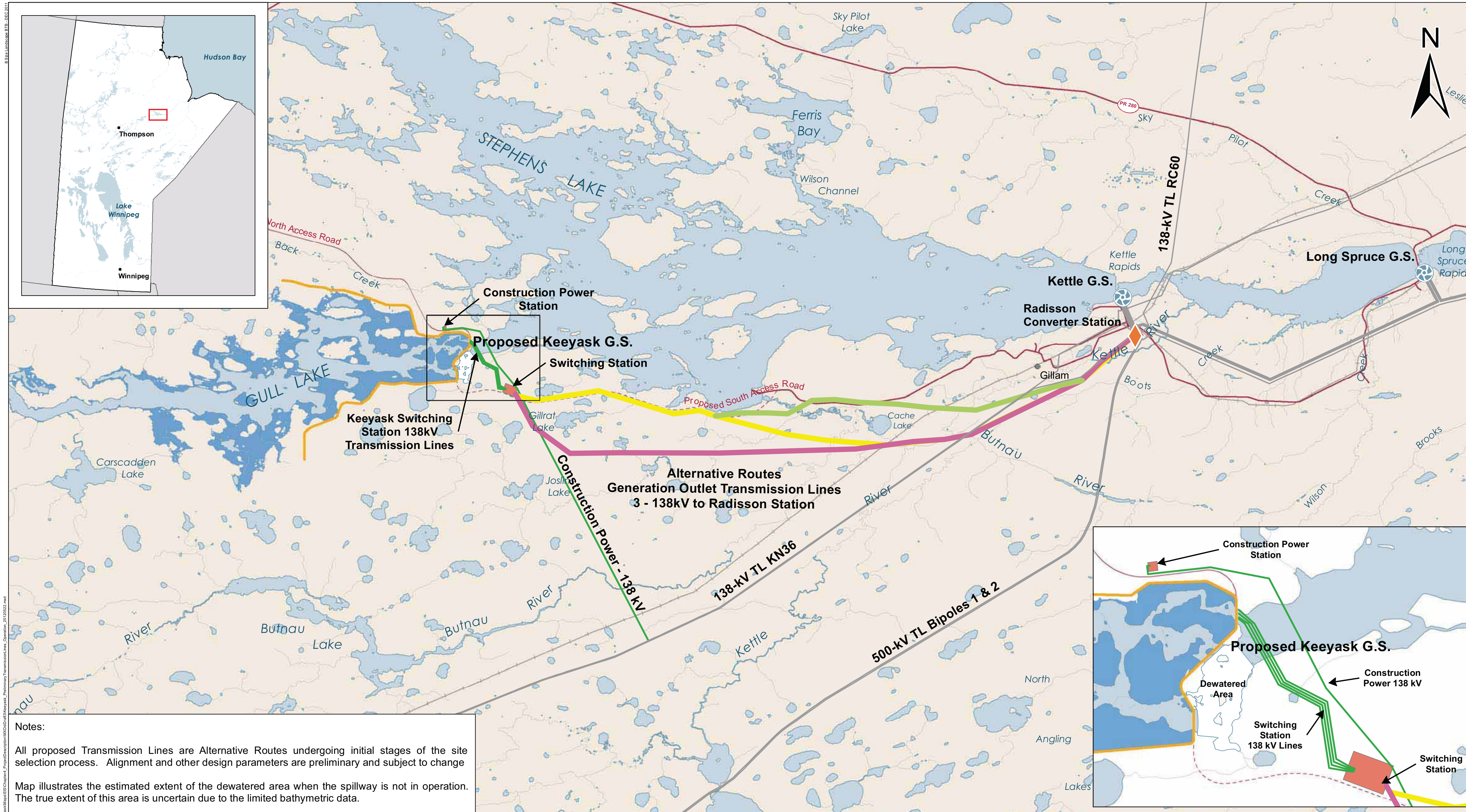
Back-up Construction Power Transmission Line

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

Keeyask Construction Power Project

Preliminary Transmission Corridors During Construction

Map 7A-7



Notes:

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

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

KEEYASK
Hydropower Limited Partnership

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

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

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

Legend

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

Keeyask Transmission Project

Preliminary Transmission Corridors During Operation

Map 7A-8

CHAPTER 8

MONITORING AND FOLLOW-UP

CHAPTER 8
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8.0 MONITORING AND FOLLOW-UP

The Keeyask Hydropower Limited Partnership (the Partnership) is committed to constructing and operating the Keeyask Generation Project (the Project) in a manner that facilitates the long-term integrity and productivity of the economy, environment, and natural resources, and that safeguards human health. Manitoba Hydro's continual improvement of environmental performance is demonstrated through the company's Environmental Management System, which is ISO 14001 certified. The Keeyask Cree Nations (KCNs) share a worldview that includes a responsibility to care for and protect *Askiy* - the word used by the *Ininewak* for the whole of the land, water, animals and plants, including medicines, people, all other creatures and the interconnections between all things. The KCNs' shared worldview and the Manitoba Hydro environmental commitments are described in Chapter 2: Partners' Context, Worldviews and Evaluation Process.

An Environmental Protection Program (the Program), comprised of three different types of plans (Environmental Protection Plans, Environmental Management Plans and Environmental Monitoring Plans), is being developed to mitigate, manage and monitor potential environmental effects during the construction and operation phases of the Project. While the description of the existing environment is based on measurement and observation, the description of effects and the mitigation designed to address adverse effects are predictions based on technical scientific studies and analysis, professional experience and Aboriginal traditional knowledge (ATK). Monitoring is required to determine if the predictions are correct and if the mitigation packages are working as anticipated. The Program will be used to test predictions made in this Environmental Impact Statement (EIS). If unexpected effects are detected through monitoring, the Program will outline the process for determining what actions, including adaptive management where possible, will be taken.

The Program facilitates the ability of the Partnership (and its contractors) to meet the environmental commitments set out in this EIS and the regulatory requirements.

8.1 INTRODUCTION AND APPROACH

The EIS guidelines require a description of a follow-up program to be undertaken to test and respond, if necessary, to predictions and the effectiveness of mitigation in reducing environmental and social effects of the Project. The purpose of this Chapter is to outline such a program and describe how it will be implemented and how information resulting from the program will be applied.

This chapter provides the reader with information of the planned Environmental Protection Program and its associated plans that describe extensive monitoring and follow-up activities associated with the construction and operation of the Project.

8.1.1 OVERVIEW OF THE PROGRAM

The Project is a large, complex development that has been the subject of over a decade of study and planning, including both its engineering design and its potential effects on the environment. The planning phase also includes ways to prevent, mitigate or compensate for adverse effects the Project might bring forth. Predictions of effects have been made based on technical science and ATK, and mitigation plans have been developed to address potential adverse effects of the development. These predicted potential effects and planned mitigation measures have been set out in Chapters 6 and 7. The environmental assessment has been comprehensive and has utilized the best scientific practice and ATK, comprised of generations of knowledge and experience. However, due

> to factors such as the complexities of ecosystems and difficulties predicting details of future development, all environmental assessments (EA) involve some level of uncertainty regarding the identification of environmental effects, the assessment of their significance and the effectiveness of mitigation measures. The Act implicitly recognizes uncertainty by requiring a follow-up program for all projects that undergo an assessment by comprehensive study or a review panel[1].

The monitoring and follow-up process addresses areas where uncertainty exists in the predictions, including those areas where there are differences between the predictions based on technical analysis and ATK. Variations in predicted and actual results identified through monitoring will be assessed by the Partnership and regulatory authorities for follow-up actions such as mitigation adjustments and adaptive management.

The development of the Program is an incremental process culminating with incorporation of terms and conditions of the environmental licence and other regulatory approvals into the appropriate plans. As a result, details associated with the Program components will be provided subsequent to the submission of this EIS. This chapter provides an outline of the Program. The form of the Program is illustrated below in Figure 8-1.

[1] CEAA Operational Policy Statement: Adaptive management Measures under the *Canadian Environmental Assessment Act*.

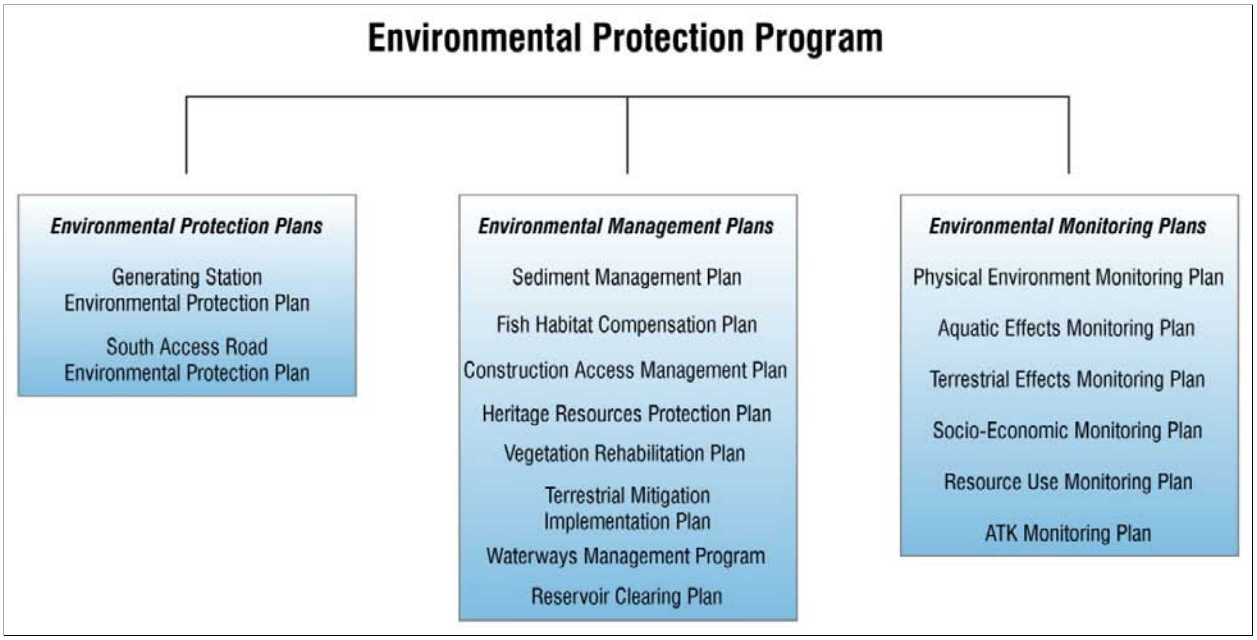

Figure 8-1: Environmental Protection Program

8.1.2 APPROACH OF ENVIRONMENTAL PROTECTION PROGRAM

The Program described in this chapter is based on the assessment information provided in Chapters 6 and 7 and associated supporting volumes, construction and operational activities and regulatory requirements. The preliminary plans developed as part of the Program will undergo regulatory review. Input received during the regulatory review process will be incorporated into the documents prior to their being finalized.

The Program includes the "who, what, when, where and how" aspects of protecting and monitoring the environment within the area affected by the Project. Responsibility for implementation of the Program is a delegated responsibility from the Partnership to Manitoba Hydro.

The Program will contain three different types of plans:

- Environmental Protection Plans (EnvPPs), which provide detailed, site-specific environmental protection measures to be implemented by the contractors and construction staff to minimize environmental effects from construction of the generating station and the south access road;
- Environmental Management Plans, which are focused on specific environmental issues, such as sediment management, access management, fish habitat and heritage resources. The plans often include both mitigation and monitoring to determine if the mitigation implemented is successful; and

- Environmental Monitoring Plans, which describe the activities to be undertaken for monitoring the effects of construction and operational activities on the biophysical, physical and socio-economic environments.

Each plan includes an implementation strategy. Depending upon the plan, the implementation strategy may include contractual arrangements, training, compliance inspections and communication of results.

8.1.2.1 ENVIRONMENTAL PROTECTION PLANS

An EnvPP provides detailed site-specific environmental protection procedures to be implemented by the construction team or operational personnel during various phases of the Project. They are designed for use as reference documents providing the best management practices to meet or exceed regulatory requirements. The purpose of EnvPPs is to guide construction and operational activities to have the least adverse effect on the environment and to remain within limits set by various environmental guidelines, regulations and approvals. EnvPPs are organized by construction component, highlighting measures to reduce the impact of a specific work activity (*e.g.*, tree clearing or cofferdam construction). Environmental Protection Plans will be in place for construction of the generating station and the south access road.

The Partnership requires all contractors and site staff to work in compliance with the EnvPP. The contents of the EnvPP include, but are not necessarily limited to the following:

- Mitigation measures – includes those measures outlined in Chapters 6 and 7, licence requirements and other sources that apply to construction;
- Erosion and sediment control measures – engineering drawings and/or specifications for materials and methods to be applied to prevent erosion and sediment input from land into water;
- Timing restrictions – restrictions on construction activities (*e.g.*, blasting) for wildlife nesting, calving and spawning;
- Environmental sensitivity maps – detailed maps of the construction area that show setback distances from environmental features that are particularly sensitive (*e.g.*, caribou calving areas and rare habitat features). They provide a visual tool for the contractors that assist them in applying appropriate mitigation to reduce negative effects;
- Emergency response plan – spill containment equipment, clean up and communication protocols;
- Regulatory guidance documents – pertinent federal and provincial guidelines for work being undertaken;
- Permits, licences, and authorizations received; and

- Inspection sheets – an environmental officer will monitor contractors' compliance with the mitigation measures.

8.1.2.2 ENVIRONMENTAL MANAGEMENT PLANS

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 eight environmental management plans will be developed for the Project:

- Sediment Management Plan – Describes procedures to measure the concentration of suspended sediments in the Nelson River due to construction of the Project during in-stream construction and Project commissioning, as well as prescribing actions to be taken if total suspended solids (TSS) due to the Project exceed target levels.
- Fish Habitat Compensation Plan – Describes works to be installed that compensate for the loss of fish habitat due to the Project and monitoring and follow up activities to determine the success of the structures and modifications if required.
- Construction Access Management Plan – Describes specific measures that will be undertaken to ensure the safe, coordinated access for authorized users during construction to protect the area's natural resources, including limiting worker impact on the surrounding area, heritage resources, local communities, fisheries, and wildlife resources.
- Heritage Resource Protection Plan – Describes procedures for responding to heritage resources or human remains found during construction and operation of the Project.
- Vegetation Rehabilitation Plan – Describes where Project areas not needed for operation will be decommissioned and rehabilitated.
- Terrestrial Mitigation Implementation Plan – Describes how the mitigation measures outlined particularly in the terrestrial section of Chapter 6 will be implemented, including wetland restoration or creation plans and bird nesting structures, *etc*.
- Waterways Management Program – A Program created as part of the JKDA committing the Keeyask Hydropower Limited Partnership to activities during both pre and post-flooding to have a multi-purpose boat patrol to monitor shoreline and waterway activities, provide for safe travel and plan and implement protective measures for historic resources.

- Reservoir Clearing Plan – A Program created as part of the JKDA that describes in detail the areas that will be flooded in the reservoir that must be cleared of trees prior to impoundment and the methods to be undertaken to do so.

8.1.2.3 ENVIRONMENTAL MONITORING PLANS

Environmental monitoring plans are designed to measure the actual effects of the Project, test predictions or identify unanticipated effects. They will also include monitoring commitments made to regulatory authorities. During the course of the environmental assessment, various requirements for monitoring were identified. The Project-specific monitoring plans are developed and presented in the context of the environmental components: physical, aquatic, terrestrial and socio-economic environments and resource use. The monitoring plans will cover the construction phase and continue into the operation phase as appropriate.

The following environmental monitoring plans will be developed (more specific details are provided in Section 8.2):

- Physical Environment Monitoring Plan – Describes monitoring for the effects on physical environmental components such as water regime, erosion and sedimentation.
- Aquatic Effects Monitoring Plan – Describes monitoring for the effects on aquatic environmental components such as water quality, aquatic habitat, lower trophic levels, and fish community.
- Terrestrial Effects Monitoring Plan – Describes monitoring for the effects on terrestrial environmental components such as birds, amphibians, wildlife, plants and terrestrial habitat.
- Socio-Economic Monitoring Plan – Describes monitoring for the effects on components such as employment, business opportunities, traffic, and safety.
- Resource Use Monitoring Plan – Describes monitoring of effects to resource use (this plan will consist largely of a compilation of monitoring activities done as other parts of the program, *e.g.*, reporting on ice conditions (Physical Environment Monitoring Plan and how it affects resource users).
- ATK Monitoring Plans – Describes monitoring by and for the KCNs communities related to the effects on their relationship with *Askiy*.

8.1.2.4 MONITORING PRINCIPLES

In order to achieve a level of consistency and appropriate focus, the development and implementation of monitoring plans will be guided by the following principles:

- KCNs involvement and ATK will be utilized along with technical science and recognized as an integral component of the monitoring (see Section 8.2.7);
- Monitoring design will include, where applicable, the nature of potential adaptive management measures;
- Monitoring activities will make use of both qualitative and quantitative methodologies as appropriate; and
- Where monitoring reveals that a prediction is incorrect or that mitigation measures are not working as designed, appropriate follow-up action will be initiated and continued until the situation is deemed to be stable/satisfactory by the Partnership and the regulators.

Although monitoring activities will be developed related to needs identified for specific Valued Environmental Components (VECs) or supporting topics, efforts will be made to facilitate efficient implementation by:

- Setting practical temporal and spatial scope for the monitoring based on the effects of the Project; and
- Building strategic and logistical efficiencies into fieldwork and data collection activities to serve multiple monitoring programs.

8.1.3 ADAPTIVE MANAGEMENT

In the context of the Project, adaptive management is a planned process for responding to uncertainty or to an unanticipated or underestimated Project effect. It is the application of information learned from monitoring actual Project effects and comparing them with predicted effects. If there is a variance between the actual and the predicted effects, a determination will be made as to whether modifications are required in existing mitigation measures, other actions are necessary to address the variance or, in cases where there may be no mitigating options available, the appropriate information is disseminated in a timely manner.

Where appropriate, potential adaptive management activities are included in the monitoring and management plans that are being developed as a part of the Environmental Protection Program or through an on-going process during monitoring in consultation with regulators.

The EA undertaken for the Project has utilized technical science and ATK, most prominently from the four KCNs whose current and traditional homelands are in the Keeyask area. Mitigation measures have been carefully planned and designed to prevent or reduce, to the extent practical, adverse effects from the Project. As noted previously, however, there are uncertainties associated with predicted effects and the effectiveness of planned mitigation measures. To address these uncertainties many of the predictions and mitigation measures are supported by monitoring to enable verification of the predictions and timely response when actual results differ from the predictions.

Where there is a reasonable understanding of an area of uncertainty such that a choice was made between two or more potential outcomes, it is reasonable to have prepared, in advance, a conceptually appropriate response should one of the optional outcomes occur. However, in other cases, the effects will be unforeseen and the response will be designed upon receipt and analysis of the data/information resulting from the monitoring. In a few cases, especially in areas of greater certainty, the monitoring is for information and communication purposes and there may be no potential adaptive management opportunities available.

Examples of each of these situations are set out below:

1. The following are examples of predetermined adaptive measures:
    - Terrestrial habitat – For rehabilitated areas that are not regenerating as anticipated, additional and/or different rehabilitation prescriptions will be applied.
    - Suspended sediment – Construction activities will be modified or temporarily suspended if suspended sediment concentrations increase above specified limits.
    - Lake sturgeon spawning structure – If the structure is not as effective as anticipated, alternative measures such as redesigning or providing additional spawning areas would be implemented.
    - Lake sturgeon stocking program – The number and/or age of fish released and the location where they are released could be modified, if required.
    - Colonial waterbirds – The use of tern nesting structures and any new/enhanced nesting islands by waterbirds will be monitored and, if required, the number and location of nesting structures will be adjusted and the enhancement of other existing islands/reefs will be considered.
2. The following are examples of adaptive management to be designed based on monitoring:
    - Fish passage – Fish will be moved upstream past the generating station as part of the planned trap/catch and transport program and their movements monitored. Modifications to this program cannot be determined until information on fish movements both downstream and upstream of the generating is obtained, including the response of the fish that are transported as part of the trap/catch and transport program.
    - Employment – Concerns respecting employment will be reviewed by the Advisory Group on Employment, which may make recommendations to the Project Manager and, if deemed necessary by the Partnership, to determine if any new measures are appropriate.

- o Worker interaction – Should interaction between the construction workforce and local population be identified as a problem, the Partnership will work with the appropriate local authorities to evaluate the situation and develop strategies to reduce the likelihood of future occurrences.

3. The following are examples of monitoring with no probable adaptive measures available:

   - o Methylmercury in fish in the reservoir and Stephens Lake – Concentrations of methylmercury will be measured so that increases and eventual decreases can be recorded, but there is no means by which elevated levels can be changed. Results will be communicated to resource users and health service providers, so that consumption of fish from these areas can be modified appropriately.
   - o Water quality effects in the flooded areas during operation – There is uncertainty in the magnitude of predicted increases in sediments, nutrients, and metals, and decreases in dissolved oxygen in the terrestrial flooded area. Water quality will be monitored to improve predictive ability for future projects and assist in interpreting effects to the biological community; however, these effects to water quality cannot be mitigated.
   - o Dissolved oxygen and temperature – If dissolved oxygen concentrations are lower and temperatures are higher than predicted in back bays of the reservoir, no practical means are available to improve conditions.

8.2 OVERVIEW OF MONITORING ACTIVITIES

8.2.1 PHYSICAL ENVIRONMENT MONITORING

The expected changes in the physical environment resulting from the construction and operation of the Project are described in Section 6.3. There are uncertainties in the predictive models and the effectiveness of planned mitigation measures. KCNs are also uncertain about the effectiveness of the planned mitigation measures and ATK anticipates a larger spatial extent of effects, extending upstream to Split Lake and downstream to the Nelson River estuary. For these reasons, a comprehensive Physical Environment Monitoring Plan as outlined in Table 8-1 and Table 8-2 will be implemented during construction, the initial operating period (considered to be the first five to ten years) and beyond if necessary to verify predicted results and the effectiveness of planned mitigation measures. Specific monitoring requirements and the need to continue or discontinue any monitoring during construction and the initial operating period, or over a longer period, will be routinely assessed based on monitoring results and programs adjusted accordingly.

Table 8-1: Monitoring and Follow-Up Plans for the Physical Environment

Supporting Topic or VEC	Issue / Rationale	Monitoring	Timelines
Climate (supporting topic)	• To verify GHG emissions from the Project.	• CO_2 and CH_4 GHG emissions from the reservoir will be monitored once the reservoir is fully impounded.	During the initial operating period.
Water regime (supporting topic)	• To verify results of water level predictions. • To verify predictions on depth and velocity.	• Monitoring of water levels at various locations upstream and downstream of Keeyask. • Monitoring of water depth and velocity under a variety of flow conditions during open water upstream and downstream of Keeyask	During construction and operation. During the initial operating period.
Ice regime (supporting topic)	• To verify results of ice regime predictions.	• Annual observation of ice formation and breakup upstream and downstream.	During construction and initial operating period.
Shoreline erosion (peat and mineral) (supporting topic)	• To verify results of erosion modeling, rates and locations of peat resurfacing, shoreline peat land breakdown, and shoreline recession.	• Monitoring of shoreline erosion and peat breakdown.	During construction and the initial operating period.
Sedimentation (supporting topic)	• To verify sedimentation predictions.	• Monitoring of sediment parameters (*e.g.*, suspended sediment, turbidity, bedload) upstream and downstream of Keeyask. • Monitoring of sediment deposition upstream and downstream of Keeyask.	During construction and the initial operating period.

Table 8-2: Monitoring and Follow-Up Plans for Physical Environment Parameters Conducted to Support Other Monitoring Programs*

Supporting Topic or VEC	Issue/Rationale	Monitoring	Timelines
Woody debris (supporting topic)	• Debris may pose a potential risk to the safety of river travel and other activities.	• Monitoring of debris in the waterways to record the amount of debris being removed and the locations from which it was removed by the Waterways Management Program (WMP).	During construction and operation.
Dissolved oxygen and water temperature (supporting topic)	• To verify predictions of dissolved oxygen and water temperature in backbays.	• Monitoring of DO and water temperature in the reservoir mainstem and flooded backbays and downstream of Keeyask.	During the initial operating period.
Total dissolved gas pressure (supporting topic)	• To verify the predicted effect of the Project on total dissolved gas pressure.	• Monitoring of total dissolved gas pressure upstream and downstream of Keeyask under a variety of flow conditions.	During the initial operating period.

*Note: These physical environment parameters are being collected solely to support other monitoring programs and will not be reported in physical environment reports.

8.2.2 AQUATIC ENVIRONMENT MONITORING

Predicted changes and planned mitigation for the aquatic environment are described in Section 6.4. In general, predicted changes in the technical assessment are based on models and observed changes in other reservoirs. Adverse effects are expected primarily within the reservoir, with fewer changes predicted downstream in Stephens Lake. Based on planned mitigation, it is expected that, in the long term, the aquatic environment will be productive and support VEC fish species upstream and downstream of the GS. However, given uncertainties in the predictive models and planned mitigation measures, conditions during construction and operation need to be monitored, and mitigation measures modified if required. ATK anticipates a much larger spatial extent of effects, extending upstream to Split Lake and downstream in the Nelson River past the Kettle GS. In addition, the KCNs are not confident that the reservoir will evolve to be a productive environment, and have expressed uncertainty as to the effectiveness of planned mitigation measures. For these reasons, monitoring for certain components of the aquatic environment will be extended beyond the area where effects are predicted in the technical assessment.

As described in the AE SV, the Aquatic Effects Monitoring Plan provides a detailed description of the rationale, schedule, sampling locations and sampling methodology for the technical monitoring that is proposed for the Project. This plan will be implemented in consultation with regulators, in particular DFO and MCWS, and it is expected that it will change based on regulatory review and on-going review of monitoring results. A description of the ATK-based monitoring is provided in Section 8.2.7. A brief summary of the AEMP is provided in Table 8-3.

Table 8-3: Monitoring and Follow-Up Plans for the Aquatic Environment

Supporting Topic or VEC	Issue/Rationale	Monitoring	Timelines
Water quality (VEC)	• To address the effectiveness of management measures (*e.g.*, sediment management plan) during construction. • To verify that predicted effects in the reservoir are not greater than anticipated and that effects do not extend upstream of the reservoir or downstream of the GS (apart from reduced suspended sediment concentrations).	• Sampling at sites along the Nelson River from immediately downstream of the Kelsey GS to downstream of the Kettle GS. • In addition, targeted sampling programs in relation to specific activities (instream construction) and site-specific effects (*e.g.*, inputs from flooded terrain).	Multiple times each year during construction and during the initial 10 years after full supply level is reached; less frequently for the following 20–30 years, depending on results.
Aquatic habitat (Supporting Topic)	• To verify modeled predictions for post-Project habitat, in particular in relation to sensitive or highly altered habitats (*e.g.*, lake sturgeon spawning and young-of-the year habitat, terrestrial flooded areas). • To confirm that conditions on constructed habitat areas are suitable and do not deteriorate over time (*e.g.*, potential for sedimentation).	• Sampling in flooded terrestrial and aquatic habitat for changes in substrate type and the development of rooted aquatic plant beds. • Monitoring in the main channel and on constructed habitats for changes in substrate type.	Annually for the first three years after full supply level is reached, and then at least every five years for the following 20- 30 years, depending on results.

Table 8-3: Monitoring and Follow-Up Plans for the Aquatic Environment

Supporting Topic or VEC	Issue/Rationale	Monitoring	Timelines
Aquatic vegetation, phytoplankton, zooplankton and macro-invertebrates (Supporting Topic)	• To confirm predicted response of biota to construction activities (*e.g.*, sediment inputs). • To determine whether plants and invertebrates colonize the flooded areas as predicted. Productivity may be limited by habitat conditions in the initial years after full supply level is reached.	• Sampling downstream of in-stream construction activities. • Sampling at all habitat types in the reservoir after full supply level is reached, in particular in flooded areas.	Annually of selected components during instream construction and the first three years after full supply level is reached and then at least every five years for the following 20-30 years, depending on results.
Fish community (Supporting Topic) (additional monitoring for VEC species listed below)	• To provide information on responses to specific construction activities (*e.g.*, sediment inputs, blasting). • To provide information on the fish community within the reservoir, and in Split and Stephens lakes. • Determine effectiveness of mitigation and compensation measures. • To address concerns of the KCNs, all fish species (as well as general fish health) in the reservoir will be monitored.	• Sampling in relation to specific environmental changes during construction (*e.g.*, fish would be sampled upstream and downstream of the construction site for analysis of gill histology if peak sediment inputs exceed target levels). • Monitoring the relative abundance and composition of the fish community, as well as indicators of fish health after full supply level is reached.	During construction, in relation to specific activities that may affect fish distribution and health. Annually during the first three years after full supply level is reached and then at least every five years for the following 20-30 years, depending on results.

Table 8-3: Monitoring and Follow-Up Plans for the Aquatic Environment

Supporting Topic or VEC	Issue/Rationale	Monitoring	Timelines
Lake sturgeon (VEC)	• To address uncertainties with respect to the behavioural response of sturgeon to disturbances during construction and the initial period of reservoir creation. • To assess the need for further mitigation with respect to fish passage. • To determine whether predicted effects to spawning activity and young-of-the-year survival occur during construction and after full supply level is reached and record performance of constructed habitat. • To determine whether the reservoir and Stephens Lake provide suitable habitat for sub-adult and adult lake sturgeon, as predicted in the EIS. • To determine the survival of stocked fish. • To determine whether predicted positive effects to the regional sturgeon population occur.	• Monitoring movement of adult lake sturgeon using long-term telemetry tags, including individuals transported from Stephens Lake to the reservoir. • Monitoring of fish behaviour immediately downstream and upstream of the GS to provide information for the modification of upstream and downstream fish passage methods, if required. • Monitoring of the frequency and survival of fish passing the station via the turbines or spillway. • Sampling for spawning and young-of-the-year sturgeon in predicted locations after full supply level is reach, including constructed habitats. Continue year-class strength monitoring in Gull and Stephens lakes. • Sampling of sub-adult and adult lake sturgeon and measurement of relative abundance, condition and other indicators of fish health, and population size. • Marking and sampling of stocked fish. • Sampling to estimate population size in the region (Kelsey GS to Kettle GS).	Varying frequency depending on the program. Annually of selected components during in-stream construction and the first three years after full supply level is reached and then at least every five years for the following 20-30 years, or longer, depending on the program and results. Monitoring of lake sturgeon populations will continue in conjunction with mitigation programs such as stocking until stocking/habitat mitigation create self-sustaining populations.

Table 8-3: Monitoring and Follow-Up Plans for the Aquatic Environment

Supporting Topic or VEC	Issue/Rationale	Monitoring	Timelines
Lake whitefish, walleye (pickerel), and northern pike (jackfish) (VEC) Note that these species are also addressed in the fish community, above).	• To verify that habitat to support spawning is available in the reservoir and downstream, and that constructed habitat is functioning as intended. • To assess the need for further mitigation with respect to fish passage.	• Monitoring for spawning activity/larval fish, at locations where these would be expected to occur post-Project, including on constructed habitats. • Monitoring of fish movements, including individuals transported from Stephens Lake to the reservoir. • Monitoring of fish behaviour immediately downstream and upstream of the GS to provide information for the modification of upstream and downstream fish passage methods, if required. • Monitoring of the frequency and survival of fish passing the station via the turbines or spillway.	Sampling for spawning and larval fish would occur at a minimum every two years during construction and annually during the first three years after full supply level is reached and then at a minimum every five years for the following 20-30 years, depending on results. Fish movement studies would occur for the first five years after full supply level is reached; further monitoring would depend on results and subsequent development of fish passage.

Table 8-3: Monitoring and Follow-Up Plans for the Aquatic Environment

Supporting Topic or VEC	Issue / Rationale	Monitoring	Timelines
Mercury in fish flesh (Supporting Topic)	• To verify predicted increases in mercury levels in fish in the Keeyask reservoir and Stephens Lake and address uncertainties regarding the duration and magnitude of increases. • Results will be used in health communications undertaken in mercury-in-food programs outlined in the Socio-Economic and Resource Use mitigation sections in Chapter 6.	• Monitoring of mercury levels in selected fish species in the Keeyask reservoir and Stephens Lake. • To address concerns of the KCNs, sampling will also be conducted in Split Lake and tributaries such as the Aiken River where no increase is predicted.	Annually after full supply levels are reached until maximum levels are recorded and then every three years thereafter until concentrations reach stable levels.

8.2.3 TERRESTRIAL ENVIRONMENT MONITORING

Monitoring will be required to verify the long-term effects of the Project on the terrestrial environment. As outlined in Table 8-4, the recommended monitoring and follow-up includes both VECs and some supporting topics during the construction and operation phases. While this table provides a preliminary summary of the topics requiring monitoring, information on the methods and procedures are outlined in the Terrestrial Environment Supporting Volume and will be provided in further detail in a Terrestrial Effects Monitoring Plan.

Monitoring is planned for situations where ATK and technical assessments differ, where a prediction has substantial uncertainty, or where a difference between predicted and actual residual effects could substantially alter the effects assessment.

Table 8-4: Monitoring and Follow-Up Plans for the Terrestrial Environment

Supporting Topic/ VEC	Issue/Rationale	Monitoring	Timelines
Terrestrial Habitat and Ecosystems			
Terrestrial habitat (Supporting Topic)	• To verify the predicted amounts and composition of direct and indirect habitat loss, alteration and disturbance during construction and operation.	• Measure direct habitat loss and disturbance, by habitat type, in the Project Footprint.	Once at the end of construction.
		• Measure indirect habitat loss and change, by habitat type, in areas where indirect effects are predicted to occur.	Periodically during first 30 years of operation, with frequency decreasing over time.
		• Monitor under storey vegetation and soil effects in areas where indirect effects are predicted to occur.	Periodically during first 30 years of operation, with frequency decreasing over time.
	• To verify the effectiveness of rehabilitation efforts in temporarily cleared or modified areas.	• Collect vegetation and soils data in the rehabilitated areas to assess degree of habitat recovery.	Periodically after regeneration is implemented, until vegetation is successfully established.
Ecosystem Diversity (VEC)	• To verify that the priority habitat patches that are to be avoided are not disturbed.	• Monitor to confirm avoidance of priority habitat patches.	Regularly during clearing activities.
Fire regime (Supporting Topic)	• To confirm the Project does not create large accidental fires.	• In the event that any accidental Project-related fires occur, document the amount and composition of affected habitat and subsequent regeneration.	Contingent upon the nature of the event, if it occurs.

Table 8-4: Monitoring and Follow-Up Plans for the Terrestrial Environment

Supporting Topic / VEC	Issue / Rationale	Monitoring	Timelines
Intactness (VEC)	• To confirm that portions of trails that are blocked and revegetated are successfully regenerating.	• Collect vegetation data in the rehabilitated portions of linear features to assess degree of vegetation regeneration.	Periodically after regeneration is implemented.
	• To verify Project effects on linear feature density and core area abundance.	• Measure linear features associated with Project development.	Once at end of construction.
		• Monitor the contribution of habitat recovery to increased core area using terrestrial habitat monitoring data.	Once after revegetation is successfully established.
Wetland function (VEC)	• To verify predicted Project effects on wetlands.	• Monitor the amount and composition of inland wetland loss and alteration.	See Terrestrial Habitat Monitoring Section.
		• Sample shoreline wetlands in areas that may be indirectly affected by groundwater changes and edge effects.	Periodically during first 30 years of operation, with frequency declining as reservoir expansion slows.
	• To verify effectiveness of wetland mitigation measures.	• Collect vegetation, soils and other environmental data in the wetland mitigation areas to assess degree of wetland development.	Periodically after measures are implemented, as needed to assess success of wetland establishment.

Table 8-4: Monitoring and Follow-Up Plans for the Terrestrial Environment

Supporting Topic/ VEC	Issue/Rationale	Monitoring	Timelines
TERRESTRIAL PLANTS			
Priority plants (VEC)	• To verify that the priority plant patches that are to be avoided are not disturbed.	• Monitor to confirm avoidance of priority plant patches.	Regularly during clearing activities.
	• To verify predicted effects on priority plant species.	• Monitor effects on priority plants and their habitat using terrestrial habitat monitoring data.	See Terrestrial Habitat Monitoring Section.
Invasive plants (Supporting Topic)	• To verify that mitigation measures limit the further introduction and spreading of invasive non-native plants.	• Conduct invasive plant surveys within and near to the Project Footprint.	Periodically during construction and first five years of operation.
AMPHIBIANS			
Priority amphibians (Supporting Topic)	• To verify predicted effects of the Project on amphibians.	• Monitor changes in the distribution of amphibians within the Regional Study Area.	Annually during the first three years of operation and periodically until shoreline wetland habitat re-establishes.
BIRDS			
Mallard and Canada Goose (VECs)	• To verify predicted effects of the Project on waterfowl.	• Monitor to assess abundance and distribution of waterfowl within the Regional Study Area.	Annually during the first three years of operation, and periodically until shoreline wetland habitat re-establishes.
	• To verify success of nesting platforms/boxes to enhance mallard breeding habitat in suitable wetlands.	• Monitor success of nesting platforms/boxes.	Annually during the first two years of deployment.

Table 8-4: Monitoring and Follow-Up Plans for the Terrestrial Environment

Supporting Topic/ VEC	Issue/Rationale	Monitoring	Timelines
Bald Eagle (VEC)	• To verify predicted effects of the Project on bald eagle.	• Monitor to assess the distribution and abundance of bald eagles along the Nelson River.	Annually during the first three years of operation.
	• To verify success of any nesting platforms established to replace nests disturbed by the Project.	• Monitor to assess the effectiveness of any installed nesting platforms.	Annually for the first three years following platform installation.
Olive-sided Flycatcher (VEC), Rusty Blackbird (VEC), Common Nighthawk (VEC), and Other Species at Risk (Supporting Topic).	• To verify the predicted effects of the Project on bird species at risk.	• Monitor listed species' abundance and distribution within the Regional Study Area.	Annually during construction and for the first three years of operation.
Colonial waterbirds (Supporting Topic)	• To verify the predicted effects of the Project on colonial waterbirds.	• Monitor abundance and distribution of colonial waterbirds within the Regional Study Area.	Annually during the first three years of operation.
	• To verify the effectiveness of mitigation measures to offset losses in colonial waterbird breeding habitat.	• Monitor the effectiveness of mitigation measures implemented for colonial waterbirds.	Annually during the first three years of operation or until mitigation measures are deemed to be successful.

Table 8-4: Monitoring and Follow-Up Plans for the Terrestrial Environment

Supporting Topic / VEC	Issue / Rationale	Monitoring	Timelines
Ruffed grouse (Supporting Topic)	• To verify the predicted effects of the Project on ruffed grouse.	• Monitor ruffed grouse abundance and distribution along north and south access roads and in other suitable ruffed grouse habitat located within the Regional Study Area.	Annually during construction. Annually during the first three years of operation, and periodically until disturbed habitat re-establishes.
MAMMALS			
Caribou (VEC)	• To address uncertainties with respect to cumulative effects and the viability of caribou populations in the lower Nelson River region.	• Monitoring vital measures of caribou populations including productivity, mortality and recruitment using sample counts and records from the lower Nelson River Area.	Regularly during construction and continuing for up to 30 years of operation, depending on results.
	• To verify direct and indirect predicted effects to summer resident caribou and habitat and evaluate performance of mitigation measures.	• Sampling, site records and mapping for summer resident caribou calving and rearing habitat effects in areas associated with Project effects.	Regularly during construction and continuing for up to 30 years of operation, depending on results.
	• To address uncertainties associated with productivity, distribution, movements and accidental caribou mortality.	• Collect caribou activity, movements, and mortality data in areas where effects are predicted to occur.	Regularly during construction and continuing for up to 30 years of operation, depending on results.

Table 8-4: Monitoring and Follow-Up Plans for the Terrestrial Environment

Supporting Topic/ VEC	Issue/Rationale	Monitoring	Timelines
Moose (VEC)	• To determine whether predicted effects to moose habitat occur and to evaluate performance of mitigation measures.	• Sampling, site records and mapping for moose habitat effects in predicted locations.	Regularly during construction and continuing for up to 30 years of operation, depending on results.
	• To address uncertainties associated with productivity, distribution and accidental moose mortality.	• Collect moose activity, movements, and mortality data in areas where effects may occur.	Regularly during construction and continuing for up to 30 years of operation, depending on results.
	• To address uncertainties with respect to the redistribution of harvest effort affecting the viability of moose in Split Lake Resource Management Area.	• Monitor vital measures of moose population including productivity, mortality and recruitment using sample counts and records from the Split Lake Resource Management Area. • Use special moose management units, harvest strategies and models to project the future population and adjust protocols as needed.	Regularly during construction and continuing for up to 30 years of operation, depending on results.

Table 8-4: Monitoring and Follow-Up Plans for the Terrestrial Environment

Supporting Topic/ VEC	Issue/Rationale	Monitoring	Timelines
Beaver (VEC)	• To verify whether predicted effects to regional beaver population occur.	• Monitor beaver population in locations within the Project Footprint and the Regional Study Area post-impoundment using counts.	Regularly during construction and continuing for up to 15 years of operation, depending on results.
		• Monitor the removal of beaver (and muskrat) during reservoir clearing and adjusting protocol as needed.	Regularly during reservoir clearing activities.
	• To address uncertainties of future habitat quality in the reservoir, wetland mitigation areas, and adjacent creeks.	• Monitor habitat changes during operation using mapping.	Periodically during operation, for up to 15 years.
Rare or Regionally Rare Species (Supporting Topic)	• To address uncertainties with respect to the behavioural response of little brown myotis and wolverine associated with Project disturbances.	• Monitor little brown myotis and wolverine abundance in the Gull and Stephens lakes area using sample counts and marking measures.	Annually during construction, annually during the first five years of operation, and then every five years for up to 30 years of operation, depending on results.

Table 8-4: Monitoring and Follow-Up Plans for the Terrestrial Environment

Supporting Topic/ VEC	Issue/Rationale	Monitoring	Timelines
Gray Wolf and Other Predators (Supporting Topic)	• To address uncertainties with respect to the behavioural response of predators associated with disturbances and habitat effects.	• Monitoring gray wolf and black bear distribution and abundance using sample counts and marking measures.	Annually during construction, annually during the first five years of operation, and then every five years until caribou and moose monitoring is concluded.
Other Mammals (Supporting Topic)	• To confirm effects predictions where problem wildlife control measures are implemented in construction camps and worksites.	• Monitor relocation and mortality of black bear, gray wolf, red fox, arctic fox and beaver using site records.	Regularly during construction.
Mercury in Wildlife (Supporting Topic)	• To verify predicted increases and address uncertainties regarding duration of mercury levels in country foods and top-level predators during operation.	• Monitor mercury levels in beaver, muskrat, river otter and mink, and in other wild game samples voluntarily supplied in the Keeyask and Stephens Lake areas, and in nearby off-system areas where no increase in mercury levels is predicted.	Annually during operation until maximum levels are reached and then every three years until concentrations reach pre-impoundment levels (up to 30 years).

8.2.4 SOCIO-ECONOMIC ENVIRONMENT MONITORING

Monitoring of socio-economic effects will be organized into a coordinated Socio-Economic Monitoring Plan (SEMP), the details of which will be developed after the Project has been filed. It will be adjusted upon receipt of the Project's approvals and licence to incorporate any required terms of the license. The program will define in detail the process, scope, methods, documentation and application of the socio-economic monitoring for the Project. It will be part of a larger strategy to identify where the proposed approaches to conducting the Project and mitigating its effects may have to be adjusted in order to address observed Projects effects that do not align with what had been predicted. This adaptive management approach will be inherent in the design and implementation of the SEMP.

The plan will be designed to satisfy licence conditions and to address monitoring proposals set out in the EIS.

The SEMP will be developed by the Partnership with representatives of the KCNs expected to play a central role in its development and implementation.

Table 8-5 summarizes the monitoring and follow-up programs for the socio-economic environment; more information is provided in the Socio-Economic Supporting Volume under each VEC.

Table 8-5: Monitoring and Follow-Up Plans for the Socio-Economic Environment

Supporting Topic or VEC	Issue / Rationale	Monitoring	Timelines
Economy[1]			
Employment and Training Opportunities (VEC)	• To determine overall employment outcomes of Project construction, with particular emphasis on Aboriginal and northern resident employment outcomes. • To determine extent to which recipients of pre-Project training (HNTEI) participated in Keeyask construction jobs, and received on the job training.	• Track total opportunity available including the amount (*e.g.*, total person years) and type (*e.g.*, job classification) of work available, and the total number of hires and total number of employees. Breakdown by Aboriginal, non-Aboriginal, northern, Manitoban and CBN region. • Collect trainee status by on-site contractors and Manitoba Hydro, including information on trainee participation in HNTEI pre-Project training, trainee designation and apprenticeship level at the point of hire, at the point of separation and at any point during employment when reclassification occurs.	During the construction period.
Business Opportunities (VEC)	• To track construction business outcomes of Project construction, with particular focus on the KCNs, Aboriginal and northern business participation, and to understand any indirect business opportunities generated as a result of Project-related expenditures in Gillam, Thompson and the KCNs communities.	• Track direct purchases made by the Partnership. At the peak of the General Civil Contract, undertake a Key Person Interview program in Thompson, Gillam and each of the KCNs communities to ascertain any indirect business opportunities generated as a result of the Project. • Conduct KPIs of key participants involved in managing the DNCs.	Annually during construction. Business Survey: Yr 3 or 4: mid-way through the general civil contract, coinciding with peak construction activity.

[1] Socio-economic monitoring is not required for Economy VECs Cost of Living and Resource Economy during the Construction phase. Monitoring for Economy VECs is not required during the operation phase.

Table 8-5: Monitoring and Follow-Up Plans for the Socio-Economic Environment

Supporting Topic or VEC	Issue/Rationale	Monitoring	Timelines
Income (VEC)	• To determine the levels of employment income generated by Project construction, particularly for KCNs and CBN region employees.	• Estimate total labour income generated by the Project based on total person-years of employment generated by the Project and applicable wage rates from the BNA. Break down of labour income by the KCNs, CBN region, Aboriginal, non-Aboriginal, northern, Manitoban.	During the construction period.
Population, Infrastructure and Services[1]			
Population (Supporting Topic)	• Confirm extent of Project-induced in-migration in the KCNs communities and Gillam. • Confirm EA prediction that there is minimal Project-induced in-migration in the KCNs communities and Gillam.	• Track overall trends in the population of Gillam and the KCNs communities, including in- and out-migration. If construction related in-migration is greater than anticipated, undertake KPIs to understand the influence of the Project on population.	During the construction period.
	• Population growth in Gillam in response to operation employment will increase the demand for housing, infrastructure and services.	• Monitor population change in Gillam to enable service providers and community planning process to plan and respond to anticipated change.	During the operation period (first five years).
Housing (VEC)	• To confirm EA prediction of minimal demand on housing in KCNs communities and Gillam due to the Project. • To determine any Project effects on infrastructure and provision of services.	• Gillam: Demand for housing is considered in the Gillam Land Use Planning process. Monitor population changes in Gillam. See above. • KCNs: Conduct a one-time set of KPI's with representatives of the Housing Authorities in the KCNs. Monitor population changes. See above.	During the construction period.

[1] Monitoring is not required for Population, Infrastructure and Services VECs of Land and Transportation Infrastructure during the construction phase; and for Land during the operation phase.

Table 8-5: Monitoring and Follow-Up Plans for the Socio-Economic Environment

Supporting Topic or VEC	Issue/Rationale	Monitoring	Timelines
Housing – Gillam (VEC)	• Increases in population in Gillam re: operation employment; part of planning process.	• Demand for housing is considered in the Gillam Land Use Planning process. Monitor population changes in Gillam. See above.	During the operation period (first five years).
Infrastructure and Services - KCNs (VEC)	• To confirm EA prediction of minimal effect on KCNs infrastructure and services due to the Project.	• Conduct a one-time set of KPIs with contractors and service providers in the KCNs communities.	2^{nd} or 3^{rd} year of construction period.
Infrastructure and Services – Gillam (VEC)	• To understand the effects from an influx of non-local construction workers on demand for infrastructure and services. • Increases in population in Gillam re: operation employment; part of planning process.	• Work with Manitoba Hydro, Town of Gillam and Fox lake Cree Nation to assess related effects from an influx of workers. • Assess demand on infrastructure and services in Gillam to feed into ongoing community planning process.	During the construction period. During the operation period (first five years).
Transportation Infrastructure (VEC)	• Concerns about the predicted effects on open water levels at Split Lake that could affect ferry service, landing sites and the winter road.	• Monitor water levels at Split Lake and inform TCN and YFFN of the results.	During the operation period– annually.

Table 8-5: Monitoring and Follow-Up Plans for the Socio-Economic Environment

Supporting Topic or VEC	Issue / Rationale	Monitoring	Timelines
Personal, Family and Community Life – Construction Phase[1 2]			
Public Safety and Worker Interaction (VEC)	• There is potential for adverse interactions between non-local construction workers and TCN and FLCN Members and Gillam residents. • Mechanism to help identify incidents and enable process to address problems with construction workforce.	• Manitoba Hydro, working with FLCN and TCN (where appropriate) will determine the best mechanism to track the number and type of adverse incidents on a regular basis, including possible discussion with local justice and social agencies in the gathering of data. • Work closely with RCMP in Thompson, Gillam and other KCNs communities.	During the construction period.
Travel, Access and Safety (VEC)	• Community concern regarding increased traffic on PR 280. • Community concern regarding ice and open water travel. • To monitor the safety of open water, ice crossing and ice trails. • Travel, access and safety are concerns for KCNs Members who use Split and Gull lakes for traditional activities. • To monitor the safety of open water, ice crossing and ice trails	• **Road travel** – Track statistics collected by MIT on traffic-related incidents and complaints on PR280. • **Ice and Open water travel** – Monitoring from Split Lake to Stephens Lake is contained under the Waterways Management Program Phase I (Sch. 11-2 of the JKDA). • Monitoring from Split Lake to Stephens Lake is contained under the Waterways Management Program Phase II (Sch. 11-2 of the JKDA).	During the construction period. During the operation period.

[1] Socio-economic monitoring for the Personal Family and Community Life VECs Community Health, Mercury and Human Health and the Way the Landscape Looks (Aesthetics) is not required during the construction phase. The Way the Landscape Looks is expected to be addressed in the ATK monitoring program.

[2] Monitoring for the Personal Family and Community Life VECs Governance, Goals and Plans, Community Health, Public Safety / Worker Interaction and The Way the Landscape Looks (Aesthetics) is not required during the Operation Phase. Governance, Goals and Plans and the Way the Landscape Looks are expected to be addressed through the ATK monitoring program.

Table 8-5: Monitoring and Follow-Up Plans for the Socio-Economic Environment

Supporting Topic or VEC	Issue / Rationale	Monitoring	Timelines
Culture and Spirituality (VEC)	• Uncertain how much the construction phase of the Project will affect culture of KCNs. • Uncertain about how employment experience during Project construction will affect the culture of workers and their families.	• Adverse Effects Agreements have been negotiated with each of the KCNs based on each community's assessment of the Project's potential effects, including any interference with its traditional customs and practices. On an annual basis, each community undertakes its own internal evaluation of the AEA offsetting programs and determines whether they continue to address the adverse effects of the Project. If required, these agreements provide flexibility for the AEA offsetting programs to be modified to more adequately address Project effects as they are experienced.	KCNs community Review and Evaluation: During the construction period.
		• Conduct a worker and family survey of a sample of KCNs workers employed on Project construction and their families to assess employment experience such as cross-cultural awareness training, work and camp life, counselling, ceremonies, effects on family, community life and traditional life.	Worker family survey in the third year of construction.
	• Uncertain how much operation of the Project will affect the culture of KCNs.	• As noted above under construction, the AEAs have been negotiated with each of the KCNs and include an annual evaluation; as well as flexibility to modify the AEA offsetting programs to more adequately address Keeyask Generation Project effects as they are experienced.	Operation period.

Table 8-5: Monitoring and Follow-Up Plans for the Socio-Economic Environment

Supporting Topic or VEC	Issue / Rationale	Monitoring	Timelines
Mercury and Human Health (VEC)	• Increase in mercury levels in country foods used by local communities; mitigation component.	• Mercury monitoring undertaken under the Aquatic and Terrestrial Monitoring Programs re: country foods. • Collection on voluntary basis of samples of wild game, waterfowl and plants for mercury testing to confirm mercury concentrations remain acceptable for domestic consumption. • Conduct periodic survey of consumption of country food in KCNs communities.	Post-impoundment: on annual basis or until mercury levels return to baseline conditions. For food consumption survey, every five years starting in 2022.

8.2.5 RESOURCE USE MONITORING

Many of the monitoring needs for resource use overlap with monitoring for other environmental components due to resource user reliance on fish (Section 8.2.2), plants (Section 8.2.3), birds (Section 8.2.3) and mammals (Section 8.2.3) for domestic and commercial pursuits and the ability to safely access resource harvest areas (Section 8.2.6).

Though all KCNs Members have been provided substitute opportunities to participate in AEA offsetting programs in unaffected locations, it is expected that domestic resource use will continue to be practiced in the resource use Local Study Area by authorized KCNs resource users. The Keeyask Generation Project Construction Access Management Plan (Construction AMP) is expected to limit workforce fishing and prohibit harvest of wildlife by not allowing recreational vehicles (*i.e.,* ATVs and boats) and firearms on the Project site (as per Keeyask Camp Rules). The Construction AMP will also prevent unauthorized use of the area by the public. Despite these measures, KCNs concerns remain with respect to workforce harvest competing for domestic resources. Hunting of wildlife resources will be prohibited on site by the construction workforce, therefore only workforce harvest of fish will be monitored.

Harvesting activities conducted by domestic resource users authorized to harvest within the Project site will be monitored at the north and south access gates. Annual interviews will also be conducted with the Environmental Officer (see Section 8.3.2 for definition) to investigate and monitor any fish harvest by construction workers.

In the resource use Regional Study Area, where increasing domestic resource use is expected from AEA offsetting program participation, monitoring traditionally practiced by KCNs resource users is expected to result in sustainable use of resources. The CNP have also developed moose and fish harvest sustainability plans to address the long-term sustainability of these species in the Split Lake RMA in cooperation with the Split Lake Resource Management Board.

Increasing populations in Gillam in the operations phase may increase recreational resource use, which is expected by the KCNs to compete for domestic resources. Monitoring of non-Aboriginal recreational harvest undertaken by Gillam residents is not proposed, as this is a provincial management responsibility. Local resource management boards (Split Lake, York Factory and Fox Lake), which are comprised of representatives from First Nations, Provincial Government and Manitoba Hydro, are expected to provide the venue for communication on resource harvesting conflicts and allow for appropriate responses to potential increases in recreational resource use during construction and operation. It should be noted that after conservation, domestic resource by Aboriginal people is given priority by provincial management agencies when allocating resources for harvest.

Resource use observations and ATK may be communicated through the ATK monitoring site visits as part of ATK monitoring programs (Section 8.2.7).

Table 8-6 provides a summary of monitoring and follow-up program timelines for issues that may affect resource use and associated environmental components.

Table 8-6: Monitoring and Follow-Up Program for Resource Use

Supporting Topic or VEC	Issue / Rationale	Monitoring	Timelines
Domestic Fishing (VEC)	• To determine if the construction workforce is increasing competition for fish resources that, in turn, would affect domestic fishing success.	• As part of the resource use monitoring plan, ongoing access gate monitoring will document harvest within the Project site. • Annual interviews with the Environmental Officer will investigate and monitor workforce harvest.	During the construction period.
Domestic Fishing (VEC)	• To understand changes to the quality and availability of fish resources for domestic use.	• See aquatic environment monitoring plan for fish abundance (fish community and lake sturgeon) and quality monitoring (mercury in fish flesh). • See socio-economic monitoring plans (mercury and human health).	During the operation period.
Domestic Fishing (VEC); Domestic Hunting and Gathering (VEC)	• To address resource user safety and access to domestic harvest locations as potentially affected by changing water and ice conditions in the local study area.	• Waterways Management Program will monitor issues relating to travel, access and safety.	During the construction and operation periods.
Domestic Hunting and Gathering (VEC)	• To understand if construction and operation disturbances will reduce local study area wildlife abundance, in turn, potentially affecting hunting success.	• See terrestrial monitoring plans (moose, caribou, beaver, mallard and Canada goose) population monitoring.	During the construction and operation periods.

8.2.6 HERITAGE RESOURCES MONITORING

As outlined in Chapter 6, heritage resources are at risk during construction and operation phases of the Project. Mitigation measures, as outlined in the Heritage Resources Protection Plan and periodic shoreline surveys implemented with the Waterways Management Program, will assist in protecting or removing existing heritage resources when avoidance or buffering of these sites may not be possible. Environmental Officers will be trained to identify heritage resources and offer proper courses of action, which will include contacting the Project Archaeologist and appropriate government authorities. When required, the Project Archaeologist will implement prescribed archaeological protection measures. However, uncertainty exists as to the effect on undiscovered heritage resources over the duration of the Project's lifespan. The KCNs communities have provided information on the presence of burial locations within the Gull Lake area, which have not yet been physically located. On-going monitoring as a mitigation measure is a viable solution for unknown heritage resources and/or burial locations.

Table 8-7: Monitoring and Follow-Up Program for Heritage Resources

Supporting Topic or VEC	Issue/Rationale	Monitoring	Timelines
Heritage Resources (VEC)	• Loss of heritage resources, unknown heritage resources and/or burials; mitigation component. • Reclamation of disturbed sites along shorelines. • Protection and preservation of heritage resources.	• As part of the Waterways Management Program (JKDA, Schedule 11-2), monitor shoreline, plan and implement the remaining protection and preservation measures at high priority, spiritually and culturally significant, historical or heritage sites. • Implement Heritage Resources Protection Plan upon potential discovery of heritage resources or human remains.	• During the construction period Continual involvement of Environmental Officers. • Periodic shorelines surveyed, as required. • During the operation Phase: Periodic shorelines surveyed, as required.

8.2.7 ABORIGINAL TRADITIONAL KNOWLEDGE MONITORING PROGRAMS

Each of the KCNs is working with Manitoba Hydro (on behalf of the Partnership) to develop community-specific ATK monitoring programs for the Keeyask Generation Project. These ATK monitoring programs will be based on Cree perspectives and understandings about the potential effects of the Project, and related activities will take place at key milestones during the Project's construction and operation phases. KCNs involvement in Project monitoring will facilitate capacity building by providing employment and training opportunities for KCNs Members in environmental and socioeconomic monitoring over the life of the Project and into the future.

It is expected that ATK monitoring will involve the development and implementation of annual monitoring programs based on construction and/or operational activities and related community concerns about potential effects. As part of these programs, the following types of activities are anticipated:

- Site visits by Elders, resources users and others to observe and communicate conditions on lands and waters before, during and following key Project milestones. The results of these site visits will ensure that ATK is an integral part of assessing the accuracy of predictions in the Project EIS, and the efficacy of mitigation measures. The involvement of youth will also ensure that the ATK held by Elders and resources users is passed on to the next generation, and that there is long-term continuity in the monitoring programs.
- Community-based activities to monitor socio-economic Project effects on the personal, family and community lives of Members, and the effectiveness of related mitigation measures. This could include working directly with community agencies to ensure a coordinated response to Project effects at the community level and activities such as conducting workshops and key-person interviews.
- The involvement of community Members in scientific-based monitoring programs. The KCNs will continue to be actively involved in the development of scientific monitoring programs through their participation in the Partnership through the Monitoring Advisory Committee (MAC) and the Board of Directors. Community Members will also continue to work on field programs with the scientific monitoring team.
- Facilitating communication among Hydro and its Partner communities through various forums, such as open houses, for the purpose of keeping community Members updated on Project activities, adverse effects, and proposed mitigation strategies.

8.3 ENVIRONMENTAL PROTECTION PROGRAM IMPLEMENTATION

As noted previously, the Environmental Protection Program is multi-faceted and includes implementation of an Environmental Protection Plan, management plans, additional Project mitigation activities outlined in the EIS and ongoing Project monitoring. Various aspects of these activities will take place prior to and during Project construction and many will continue into Project operation.

Manitoba Hydro, acting on behalf of the Partnership, is responsible for overall implementation of the Environmental Protection Program. In this capacity, Manitoba Hydro will be guided both by discussions with the KCNs through the Project's MAC and the Partership Board of Directors, and ongoing communication with Regulators.

The following sections describe implementation of the various activities to be undertaken as part of the Environmental Protection Program, starting with a focus on the communication mechanisms in place to ensure ongoing involvement of regulators and the KCNs.

8.3.1 PARTNERSHIP AND REGULATORY COMMUNICATION

8.3.1.1 WORKING AS PARTNERS

The Partnership is committed to environmental stewardship and have agreed that long-term success of the Environmental Protection Program requires equal consideration of both ATK and technical science. Although Manitoba Hydro is responsible for construction and operation of the Keeyask Generation Project, the Partnership has put mechanisms in place to ensure that all partners are involved in implementing the Program and reviewing Program outcomes. There are two key mechanisms in place to accomplish this goal: 1) the Keeyask MAC and the Partnership Board of Directors; and 2) ATK monitoring to be undertaken by each of the KCNs. Together, it is anticipated that these two activities will improve understanding and respect among the partners, foster an environment of sharing and collaboration in undertaking environmental stewardship activities and lead to the implementation of a more robust environmental protection program.

The MAC is an advisory committee to the Partnership Board of Directors and will review the outcomes of programs outlined in the Environmental Protection Program and, if appropriate, may provide advice and recommendations to the Partnership on additional or alternative mitigation measures that may be required. The committee will be comprised of Manitoba Hydro representatives involved in the Environmental Protection Program and participants from each of the KCNs. It is anticipated that the outcomes of both the technical science and ATK monitoring programs, as well as those of other aspects of the

Environmental Protection Program, will be reviewed and discussed at the MAC. In this way, the MAC will provide a forum for ensuring collaboration among all partners on these activities and an opportunity to review and discuss outcomes from both a western science and ATK perspective. On behalf of the Partnership, the MAC will also ensure that the outcomes of the Environmental Protection Program are communicated more broadly on an annual basis to Members of the KCNs communities, regulators and the general public.

8.3.1.2 WORKING WITH REGULATORS

Licences and regulatory approvals for the proposed Project require environmental and compliance monitoring and production of monitoring reports. Regulatory authorities will be notified by the Project Manager or by a delegate about situations where the environment is affected that were not previously predicted. Full cooperation will be given to environmental regulators conducting inspections and a Project staff member will be available to escort the regulator around the construction site and answer questions and discuss concerns as required.

8.3.1.3 REPORTING

In fulfillment of the Project *Environment Act* licence and *Fisheries Act* authorization requirements, reports will be submitted by Manitoba Hydro (on behalf of the Partnership) to Manitoba Conservation and Water Stewardship and Fisheries and Oceans Canada in accordance with the schedule outlined in these approvals. Reports that will be prepared include:

- A compliance monitoring report in connection with the EnvPP;
- Technical reports of the activities and results of the monitoring plans including the outcomes of both ATK and western scientific monitoring; and
- In addition to the reports prepared for the regulator a summary document of all monitoring activities will be prepared annually by the Partnership for the KCNs and the general public.

8.3.2 ENVIRONMENTAL PROTECTION PLAN IMPLEMENTATION

For the Keeyask Generation Project two EnvPPs are being prepared to assist in reducing the impact of construction activities. One plan will cover the work associated with the generating station and the other is for the South Access Road. Manitoba Hydro's Construction Manager is ultimately responsible for ensuring that the Project is compliant with the EnvPPs and all regulatory requirements. An Environmental Officer will monitor and report on contractors' compliance with the EnvPPs.

8.3.2.1 TENDERS AND CONTRACTS

All environmental requirements, including the EnvPP, will be included in the tender packages and the binding construction contracts for the Project work. This will require contractors to budget and base their work on meeting the environmental requirements and conducting activities in an environmentally acceptable manner. The selected contractors will be required to comply with and implement the plans.

8.3.2.2 TRAINING AND ORIENTATION

Prior to construction, an environmental orientation program will be developed and delivered to contractors and Manitoba Hydro Project personnel so they are aware of the environmental requirements and sensitivities associated with the Project. They will be familiar with components of the Environmental Protection Program, particularly the EnvPP, as it has direct implications on day-to-day work. Periodic update sessions will occur during construction on specific environmental issues.

The Environmental Officer will receive specific training to fulfill the position including use of the EnvPP, how to perform inspections, reporting incidents and routine reporting, the protocol for emergency response, as well as what resources are available if an environmental issue arises.

8.3.2.3 INSPECTION AND COMPLIANCE

Environmental inspection is an essential function in environmental protection and implementation of mitigation measures. The Environmental Officer will be responsible for undertaking compliance monitoring of the work site to confirm that activities are not in contravention with regulatory requirements or the EnvPP. The inspector will visit work sites daily and record all inspection activities. Any incidents of concern or non-compliance will be recorded and reported so that appropriate action to rectify the problem is implemented.

8.3.2.4 WORKING WITH CONTRACTORS

Meetings will be held regularly with the Project Manager, Resident Engineer, Environmental Officer and contractors to discuss environmental issues and what needs to be done to protect the environment as construction progresses. Compliance with the EnvPP and regulatory requirements will also be included in these meetings.

8.3.2.5 WORK STOPPAGES

Construction activities may be stopped in the event unexpected effects are occurring to the environment or when mitigation measures are proving to be insufficient to prevent a potential effect. For example, if a heritage resource is discovered, work in the immediate area must be stopped and the find reported.

The Project Manager, Resident Engineer, and Environmental Officer will all have authority to issue stop work orders. The contractor can also voluntarily stop work where circumstances indicate that some environmental damage or harm to heritage resources could result from continuation of a particular activity. Work will not resume until the situation has been assessed and resolved.

8.3.3 IMPLEMENTATION OF MANAGEMENT PLANS

All of the various management plans will be the responsibility of Manitoba Hydro to implement. Various environmental staff both at the construction site and in the Winnipeg office, under the direction of the Project Manager, will be assigned to oversee the implementation of the plans and make the necessary arrangements to have the required processes, procedures, equipment and human resources in place to have them fulfilled.

The plans will each have their own schedule for implementation based on how they are linked to construction activities; the Construction Access Management Plan will be implemented from the first day of construction until it is complete, *i.e.*, the Sediment Management Plan will be operational in advance of any in-stream construction activities in the Nelson River; the Reservoir Clearing Plan will be implemented in the three years prior to impoundment of the reservoir; and the Vegetation Rehabilitation Plan will be activated when areas that have been cleared for construction activities are no longer required.

8.3.4 MONITORING IMPLEMENTATION

The Partnership is proposing to undertake comprehensive monitoring for construction and into operations. Monitoring is outlined in Section 8.2 above and includes both technical, western-science based monitoring and ATK-based monitoring.

The KCNs will be involved in implementation of these monitoring programs in two ways: leading the ATK monitoring program, and working side-by-side with scientists as part of technical science based monitoring. Manitoba Hydro will be responsible for making the arrangements to have the scientific expertise required to carry out the monitoring in place, primarily through contractual arrangements with consulting companies. Manitoba Hydro will oversee the monitoring activities to ensure that the work is being conducted in accordance with the finalized, regulator approved plans.

CHAPTER 9

SUSTAINABLE DEVELOPMENT

Hydropower Limited Partnership

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9.0 SUSTAINABLE DEVELOPMENT

9.1 INTRODUCTION AND PURPOSE

This chapter considers the Keeyask Generation Project (the Project) in the context of sustainable development. It considers the Project relative to the Keeyask Cree Nations' (KCNs) involvement and to federal, provincial and Manitoba Hydro's goals, principles and guidelines for sustainable development.

9.2 CONTEXT FOR SUSTAINABLE DEVELOPMENT

"*Our Common Future*," the 1987 report of the World Commission on Environment and Development, more commonly known as the Bruntland Commission, popularized "sustainable development" as both a phrase and a concept. The definition coined by that commission has remained as the most common definition among the many that have been framed since:

"Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It contains within it two key concepts:

- "The concept of needs, in particular the essential needs of the world's poor, to which overriding priority should be given; and
- "The idea of limitations imposed by the state of technology and social organization on the environment's ability to meet present and future needs."

As a concept, sustainable development has relevance to most major developmental and planning decisions in that it integrates social, environmental and economic considerations into decision making. Since 1987, much thought and debate has been focused on how to implement this concept in diverse circumstances and geographic regions.

Both the federal and provincial governments have instituted sustainable development as policy goals for future development in Canada and Manitoba, respectively. To this end the Government of Canada has embedded the goal of achieving sustainable development into the "Preamble" and "Purposes" sections of the *Canadian Environmental Assessment Act* (CEAA; s.c. 1992, c.37) and has enacted a *Federal Sustainable Development Act (FSDA)*. The Government of Manitoba has enacted the *Sustainable Development Act* for the same purpose within the province. Each of these acts sets out principles and guidelines or goals to guide the implementation of sustainable development. Manitoba Hydro has also adopted a sustainable development policy and a set of principles and guidelines that guide its activities.

9.2.1 KEEYASK CREE NATIONS PRINCIPLES AND INVOLVEMENT

The World Commission on Environment and Development put forward the proposition that the empowerment of vulnerable indigenous people is a touchstone of a sustainable development policy (United Nations World Commission on Environment and Development 1987)[1]. The Commission was concerned that the gradual advance of development into remote regions would increase the vulnerability of indigenous people as they were often left out of the processes of economic development. The Keeyask Cree Nations (KCNs), in each of their respective Environmental Evaluation Reports, have shared their perspectives about how past hydroelectric projects have affected their communities.

In contrast to the past, the Project puts into practice the proposition of greater empowerment of local indigenous people. The KCNs Partners have been directly involved in planning the Project and the environmental impact assessment, emphasizing the importance of respecting Mother Earth in a manner consistent with their Cree worldview. As expressed in their philosophy of *mino pimatisiwin* (or "living the good and honourable life"), everything is interrelated and must be respected. Each KCN received funding to undertake its own evaluation of the Project and to involve its community in the decision as to whether or not to become a partner in the initiative. The KCNs' Environmental Evaluation Reports speak to a desire to restore harmony and balance with Mother Earth, to protect the environment, which is broadly defined to include people's wellbeing, to maintain and enhance their culture and traditions, and to provide greater hope and opportunities for future generations. The decision to support the Project was difficult, requiring much study, discussion and soul searching. Ultimately, the decision to proceed was based on evaluations of social, economic and environmental considerations, and a focus on both present and future generations to whom the benefits of the Project would accrue. In deciding to proceed with the Project, the KCNs saw an opportunity for current and future generations to benefit economically and to build their communities' capacity and self-sufficiency, while respecting and maintaining their Cree values, teachings, identity, culture and traditional knowledge.

As partners, the KCNs have been influential in identifying and advocating for measures to lessen the adverse environmental effects of the Project, and they will undertake appropriate activities, including rituals and ceremonies to show respect and give thanks to *Askiy* at major Project milestones. The Adverse Effects Agreements (AEAs) will provide continued access to healthy country foods and programs to maintain and strengthen their traditions and culture. The KCNs will also have a hands-on role in monitoring and follow-up activities, opportunities for training and employment on the Project and in the operation of existing hydroelectric projects, and a continuing role as board members of the Partnership, and they will receive long-term income from their investment in the Project. All of this is consistent with the World Commission's view of the role of indigenous people in sustainable development.

[1] Our Common Future; United Nations World Commission on Environment and Development, 1987, page 116 (Chapter 4, paragraph 78).

Consistent with their Cree worldview, the KCNs established the following Principles for Respect for the Land, to be followed in the construction and operation of the Project, and had these principles embedded into the Joint Keeyask Development Agreement (JKDA):

Principles Regarding Respect for the Land

- Adopting measures that increase, to the extent ecologically reasonable, the abundance of species and/or growing conditions for species that have special social or economic importance for the Keeyask Cree Nations.
- Employing strategies that "go with" rather than "go against" nature, as they have a much higher probability of success.
- Planting species and promoting site conditions that are widespread in the sub-region in which the Keeyask Project is located, rather than planting species and promoting site conditions that may be popular in more southern areas.
- Being respectful of the Keeyask Cree Nations' traditional relationships with the land.

For a more in-depth description of the KCNs worldview, Project evaluation and decision-making, see Chapter 2, the KCNs' Environmental Evaluation Reports, and the video, *Keeyask – Our Story*.

9.2.2 THE KEEYASK GENERATION PROJECT AND THE FEDERAL SUSTAINABLE DEVELOPMENT STRATEGY – GOALS

The Federal Sustainable Development Strategy (FSDS) is mandated by the *Federal Sustainable Development Act*, which received Royal Assent on June 26, 2008. The FSDA responds to a number of international commitments Canada has made to produce such a strategy, including at the Earth Summit in Rio de Janeiro, Brazil, in 1992 and at the 2002 World Summit on Sustainable Development in Johannesburg, South Africa.

The purpose of the FSDA is "to provide the legal framework for developing and implementing a Federal Sustainable Development Strategy that will make environmental decision-making more transparent and accountable to Parliament." The basic principle is that the Government of Canada accepts that sustainable development is based on an ecologically efficient use of natural, social and economic resources and acknowledges the need to integrate environmental, economic and social factors in the making of all decisions by government. In October 2010, the report titled "Planning for a Sustainable Future: A Federal Sustainable Development Strategy for Canada" was published. The Federal Sustainable Development Goals are set out below, followed by a description of how the Project addresses each goal.

Goal 1 – Climate Change: *Reduce greenhouse gas emission levels to mitigate the severity and unavoidable impacts of climate change.*

The Project will contribute to substantial reductions in greenhouse gases (GHG) by displacing fossil fuel electricity generation.

A detailed Life Cycle Assessment was conducted by the Pembina Institute in order to estimate the GHG emissions resulting from the construction, land use change, operation, and decommissioning of the Project. The resulting emissions are extremely low relative to other forms of generation. An equivalent amount of electricity, produced by a combined cycle natural gas generating station during one year of operation would result in more than double the entire life cycle emissions estimated to be associated with the Keeyask Project over a 100 year period. Since the Project will displace gas and coal generation, primarily in the U.S. Midwest, it will contribute to substantial GHG reductions. The Project is estimated to displace 30 million tonnes carbon dioxide equivalent during the first 10 years of operation.

Goal 2 – Air Pollution: *Minimize the threats to air quality so that the air Canadians breathe is clean and supports healthy ecosystems.*

There are very few air emissions from a hydroelectric generating station; compared to coal and gas fired generating stations, emissions from Keeyask would be considered minimal.

Goal 3 – Water Quality: *Protect and enhance the quality of water so that it is clean, safe and secure for all Canadians and supports healthy ecosystems.*

While the creation of the reservoir will result in some long-term effects to water quality, the area will generally remain suitable for aquatic life. As well, a series of good construction methods – *e.g.*, the use of double-sided cofferdams that will reduce the release of fine sediments into the water – will help maintain water quality and avoid /minimize adverse effects to aquatic life.

Goal 4 – Water Availability: *Enhance information to ensure that Canadians can manage and use water resources in a manner consistent with the sustainability of the resource.*

Manitoba Hydro has been studying northern rivers and streams for over four decades and, in conjunction with KCNs, has undertaken Project specific studies for more than a decade. This has added numerous data to pre-existing information.

Goal 5 – Wildlife Conservation: *Maintain or restore populations of wildlife to healthy levels.*

Maintaining and restoring wildlife populations in the area have been major components of the planning and environmental assessment of the Project. Through a combination of mitigation measures that includes habitat replacement, a hatchery and stocking programs, the existing stocks of lake sturgeon should not only be maintained but improved. As well, mammal resources are not likely to be significantly affected by the Project, and Cree Nation Partners (CNP) are developing moose and fish harvest sustainability plans to address long term sustainability of those resources in the Split Lake Resource Management Area. Caribou will be monitored to guide programs to maintain the sustainability of the regional populations.

Goal 6 – Ecosystem / Habitat Conservation and Protection: *Maintain productive and resilient ecosystems with the capacity to recover and adapt; and protect areas in ways that leave them unimpaired for present and future generations.*

Special efforts have been undertaken to avoid or minimize Project effects to habitat and ecosystem intactness and to replace the loss of important habitat types; for example, sensitive terrestrial habitat sites were avoided to the extent feasible when routing roads and locating borrow and excavated material placement areas.

Overall, the likely Project related effects on ecosystem diversity are expected to be adverse but regionally acceptable because no stand level habitat types are lost, the distribution of area amongst the stand level habitat types is not expected to change substantially and the cumulative area losses for all of the priority habitat types remains below 10%.

Goal 7 – Biological Resources: *Sustainable production and consumption of biological resources are within ecosystem limits.*

The Project is being planned consistent with the need for sustainable production and consumption of biological resources. For example, sustainable harvest plans for moose and fish are being developed by CNP for the Split Lake Resource Management Area, which is consistent with the TCN Access and Healthy Food Fish programs under the TCN AEA and the Improved Access Program and the Community Fish Program under the WLFN AEA.

Goal 8 – Greening Government Operations: *Minimize the environmental footprint of government operations.*

Although not a government operation, a number of measures have been taken to minimize the Project footprint. The best example of this approach was the decision to reduce the size of the Project. At one time, a high-head project with over 180 km^2 of initial flooding was under consideration; in contrast, the Project now being proposed by the Partnership will produce 45 km^2 of initial flooding.

9.2.3 KEEYASK AND MANITOBA SUSTAINABLE DEVELOPMENT PRINCIPLES AND GUIDELINES

In 1998, the Province of Manitoba enacted the *Sustainable Development Act* to “create a framework through which sustainable development will be implemented in the provincial public sector and promoted in private industry and in society generally” (Government of Manitoba 1998). Attached as schedules to the Act was a set of Principles and Guidelines of Sustainable Development to guide the behaviour and decision making of all government departments, agencies and Crown corporations.

9.2.3.1 PRINCIPLES OF SUSTAINABLE DEVELOPMENT

The following sets out these Principles, and how the Project has been planned and designed and will be constructed and operated in conformity with the province's directive.

Integration of Environmental and Economic Decisions: *Economic decisions should adequately reflect environmental, human health and social effects. Environmental and health initiatives should adequately take into account economic, human health and social consequences.*

The Project has been designed to provide long term electricity benefits to Manitoba and export customers and to enhance quality of life through the provision of clean affordable energy. Hydroelectric energy is a much cleaner, healthier option than coal and gas, the main alternatives for generating electricity in the mid-continent market area.

The Project is being designed and will be constructed using methods to minimize effects on the environment and the local KCNs communities, and to maximize economic and social benefits for the communities, northern Manitoba, and the whole province. Job training, increased employment, and the associated improvement in the standard of living are positive, long lasting social outcomes. As an example of the attention given to human and social consequences, programs under the AEAs provide the KCNs with programs to address cultural objectives and access to a healthy food supply consistent with their traditional lifestyle.

Stewardship: *The economy, the environment, human health and social well-being should be managed for the equal benefit of present and future generations. Manitobans are caretakers of the economy, the environment, human health and social well-being for the benefit of present and future generations. Today's decisions are to be balanced with tomorrow's effects.*

The Project, by design, will provide hydroelectric energy benefits, including reduced greenhouse gas emission benefits, for many generations into the future. From a regional perspective, the KCNs have been very involved in planning the Project and in the environmental assessment and they will continue to have a direct role in the monitoring and follow-up programs. Intergenerational benefits are a mainstay of the KCNs' decision to participate in the Partnership. At the same time, the KCNs are equally attentive to applying their worldview to avoid and reduce environmental effects and demonstrate respect to Askiy. Partnership income will be beneficial to generations of KCNs community Members, and will provide sustained revenues to the broader Manitoba economy. Stewardship of the environment will continue through ongoing monitoring and follow-up programs involving KCNs communities and Manitoba Hydro, and AEA programs will enhance the cultural identity and connection to the land of present and future generations which in turn will contribute to social well being.

Shared Responsibility and Understanding: *Manitobans should acknowledge responsibility for sustaining the economy, the environment, human health and social well-being, with each being accountable for decisions and actions in a spirit of partnership and open cooperation. Manitobans share a common economic, physical and social environment. Manitobans should understand and respect differing economic and social* *views, values, traditions and aspirations. Manitobans should consider the aspirations, needs and views of the people of the various geographical regions and ethnic groups in Manitoba, including Aboriginal peoples, to facilitate equitable management of Manitoba's common resources.*

The processes for developing the Project have included the development of a partnership that is intended, in part, to meet the societal, cultural, economic and employment aspirations of the local KCNs communities, which include the continuation of traditional and cultural practices, as well as a deeper integration into the regional and provincial economy. Discussions leading to the formation of the Partnership and the planning and environmental assessment activities have led to a growing understanding and respect for the different values, and worldviews of Manitoba Hydro and the KCNs.

Prevention: *Manitobans should anticipate, and prevent or mitigate, significant adverse economic, environmental, human health and social effects of decisions and actions, having particular careful regard to decisions whose impacts are not entirely certain but which, on reasonable and well-informed grounds, appear to pose serious threats to the economy, the environment, human health and social well-being.*

Early discussions with TCN, followed by discussion with all KCNs, resulted in Project design parameters aimed at minimizing environmental disruption. Adverse effects agreements entered into with each of the KCNs established mechanisms to avoid, offset and mitigate Project effects on the communities. As a result, each community endorsed its agreement. The AEA offsetting programs, direct costs and residual compensation in each agreement addresses and resolves all past, present and known or anticipated Project effects on the collective rights and interests of the respective Cree Nation and its Members and on the exercise of Aboriginal and Treaty rights by the Cree Nation and its Members.

As well, extensive technical and ATK studies have been undertaken to predict potential environmental effects of the Project and to develop plans to mitigate those effects. Monitoring and other follow-up programs will continue as required to test predictions and make adjustments as necessary.

Conservation and Enhancement: *Manitobans should: Maintain the ecological processes, biological diversity and life-support systems of the environment; harvest renewable resources on a sustainable yield basis; make wise and efficient use of renewable and non-renewable resources; and enhance the long-term productive capability, quality and capacity of natural ecosystems.*

These concepts have been a primary focus of the Project planning and design. Implementation measures have emerged through the environmental assessment and the Partnership's consultation processes. Examples for maintaining biological diversity and life-support systems include wetland development, rehabilitation of important habitat types, and avoiding effects on fire regimes. As well, CNP is developing sustainable harvesting plans for fish and moose in the Split Lake Resource Management Area, where the Project is located. The Project uses water, a renewable resource, in a sustainable manner, while providing the province and others with electricity that minimizes environmental effects and is cost effective relative to other options.

Rehabilitation and Reclamation: *Manitobans should: Endeavour to repair damage to or degradation of the environment; and consider the need for rehabilitation and reclamation in future decisions and actions.*

Once the Project is constructed, areas no longer required for operations will be decommissioned and rehabilitated. A hydroelectric generating station may operate almost in perpetuity. If decommissioning is required at some future date, it will be undertaken according to the legislative requirements existing agreements and industry standards prevalent at the time. KCNs Principles Regarding Respect for the Land, set out in Section 9.2.1., also speak to rehabilitation and reclamation.

Global Responsibility: *Manitobans should think globally when acting locally, recognizing that there is economic, ecological and social interdependence among provinces and nations, and working cooperatively, within Canada and internationally, to integrate economic, environmental, human health and social factors in decision-making while developing comprehensive and equitable solutions to problems.*

The Project will contribute to substantial reductions in greenhouse gases (GHG) by displacing fossil fuel electricity generation.

A detailed Life Cycle Assessment was conducted by the Pembina Institute in order to estimate the GHG emissions resulting from the construction, land use change, operation, and decommissioning of the Project. The resulting emissions are extremely low relative to other forms of generation. An equivalent amount of electricity, produced by a combined cycle natural gas generating station during one year of operation would result in more than double the entire life cycle emissions estimated associated with the Keeyask Project over a 100 year period. Since the Project will displace gas and coal generation, primarily in the U.S. Midwest, it will contribute to substantial GHG reductions. The Project is estimated to displace 30 million tonnes carbon dioxide equivalent during the first 10 years of operation.

9.2.3.1.1 GUIDELINES OF SUSTAINABLE DEVELOPMENT

The following are the Manitoba Guidelines of Sustainable Development (Manitoba Conservation n.d.) and a description of how the Project has been planned and designed and will be constructed and operated in conformity with the province's directive.

Efficient Use of Resources: *Encouraging and facilitating development and application of systems for proper resource pricing, demand management and resource allocation together with incentives to encourage efficient use of resources; and employing full-cost accounting to provide better information for decision makers.*

The Project is an efficient use of a renewable resource to produce electricity, and it compares favourably to gas and coal which are the main sources of electricity in the mid-continent market area. The Project has been planned and designed with mitigation, compensation and enhancement measures to reduce adverse environmental and social impacts and maximize benefits. By incorporating these measures into the Project's capital and operating budgets, the Project costs closely reflect the full societal cost of the Project. Compared to earlier approaches to hydroelectric development, this approach increases the per unit cost of

Project power, but it also results in a more sustainable project. The integration of environmental and social costs of the Project is also a critical element in full-cost accounting.

The Project will also pay water power rentals charged by the Province as part of its resource pricing policies.

The Project will be operated as part of Manitoba Hydro's integrated generation and northern collector system, allowing for peak efficiency and optimum water usage for all plants.

Public Participation: *(a) Establishing forums which encourage and provide opportunity for consultation and meaningful participation in decision-making processes by Manitobans; (b) Endeavouring to provide due process, prior notification and appropriate and timely redress for those adversely affected by decisions and actions; and (c) Striving to achieve consensus amongst citizens with regard to decisions affecting them.*

Discussions that began between TCN and Manitoba Hydro in the 1990s, and were later expanded to the other KCNs, resulted in the establishment of the Partnership. In addition to the discussions that led to the development of the Partnership, the communities have been closely involved with Manitoba Hydro in the environmental impact statement. These discussions and consultations have helped to shape the final design for the Project and monitoring of its effects. A Public Involvement Program (see Chapter 3) has been developed and implemented to reach interested Manitobans representing other communities and organizations.

Access to Information: *(a) Encouraging and facilitating the improvement and refinement of economic, environmental, human health and social information; and (b) Promoting the opportunity for equal and timely access to information by all Manitobans.*

In addition to the ongoing communication among the KCNs and Manitoba Hydro, each of the KCNs undertakes on-going communication with its Members. The Partnership is undertaking a Public Involvement Program for other communities and interested Manitobans, and relevant information is also made available to the public through the regulatory review process.

Integrated Decision Making and Planning: *Encouraging and facilitating decision making and planning processes that are efficient, timely, accountable and cross-sectoral and which incorporate an inter-generational perspective of future needs and consequences.*

The Partnership has established a governance structure that includes KCNs representation. As part of this structure, the communities have had direct involvement in the environmental assessment and will continue to have a strong role with their Aboriginal traditional knowledge (ATK) in the monitoring and follow-up programs.

Each partner concerns itself with the short and long-term benefits and costs of the Project. Multi-generational benefits are key to the commitment of the KCNs' participation in the Project.

Waste Minimization and Substitution: *(a) Encouraging and promoting the development and use of substitutes for scarce resources where such substitutes are both environmentally sound and economically viable; and (b) Reducing, reusing, recycling and recovering the products of society.*

While opportunities to recycle wastes in remoter northern areas are limited, waste generated by the Project will be minimized and waste materials will be recycled to the extent practical, and the remaining waste will be disposed of in accordance with license and regulatory requirements.

Research and Innovation: *Encouraging and assisting the researching, development, application and sharing of knowledge and technologies which further our economic, environmental, human health and social well-being.*

A great deal of research, study and sharing of knowledge has contributed to the current plans for the Project. Associated with the environmental assessment processes, there have been many technical and ATK studies related to wildlife (including caribou), fish populations (including sturgeon), social and economic conditions, heritage resources, history and culture that will be part of the record of the Project and will be of ongoing benefit far beyond their use in the EIS for the Project. For example, thousands of cultural artifacts, some as old as 4000 to 5000 years, have been recovered and preserved during the Project planning phase and will be accessible to the KCNs (and the public), enhancing cultural memory and identity. Through the Project, the communities have undertaken many of their own studies and reports that have resulted in a clear enunciation of their Cree worldview. Monitoring activities, involving ATK and technical science will continue through the construction and operation phases.

9.2.3.2 THE KEEYASK GENERATION PROJECT AND MANITOBA SUSTAINABILITY INDICATORS

The "2009 Provincial Sustainability Report for Manitoba" established categories of indicators within each of the three sustainable development "dimensions" (natural environment, economic and social well being) and indicators within each category. For each indicator, the province, after application of the appropriate criteria, determined and reported a province-wide trend for the indicator with respect to its sustainability; *e.g.*, stable, inconclusive, changing, variable, negative, positive, and other determinations as appropriate (Manitoba Conservation 2009).

Table 9A-1 in Appendix 9A utilizes the information and conclusions in the EIS to determine whether the Project will affect the Manitoba Government's reported sustainability trends.

9.2.4 THE KEEYASK GENERATION PROJECT AND MANITOBA HYDRO'S SUSTAINABLE DEVELOPMENT PRINCIPLES

In 1993, the Corporation adopted 13 sustainable development principles based on the principles and guidelines of sustainable development adopted by the Manitoba Round Table on Environment and Economy.

The policy and the 13 principles represent a guiding influence for Manitoba Hydro's decisions, actions and day-to-day operations. The general partner of the Partnership will operate within the Manitoba Hydro principles and guidelines of sustainable development.

The following illustrates how the Project is consistent with these 13 principles.

Stewardship of the Economy and the Environment: *Recognize its responsibility as a caretaker of the economy and the environment for the benefit of present and future generations of Manitobans. Meet the electricity needs of present and future Manitobans in a manner that ensures the long-term integrity and productivity of our economy, our environment and our natural resources, and safeguards our human health.*

Consistent with the KCNs' commitment to caring for *Askiy* and Manitoba Hydro's commitment to sustainable development, the Project has been designed to minimize adverse effects and maximize benefits to local and regional residents. Manitoba Hydro and the KCNs have planned the Project together and completed more than a decade of both ATK and technical studies to predict and mitigate adverse effects and enhance Project benefits.

These efforts have improved the Project in a number of ways. Bio-physical effects have been substantially reduced by: choosing a "low head" rather than a "high head" design, thereby reducing the amount of flooding required; siting and arranging the infrastructure utilizing environmental as well as engineering criteria; clearing the reservoir before impoundment to decrease floating debris and other environmental impacts; setting strict operating regimes to minimize reservoir elevation variation; and undertaking extensive mitigation measures to protect fish and terrestrial species. Activities such as the development of a partnership, extensive preconstruction consultations and studies, joint planning within the partnership, designing social and cultural mitigation measures, extensive use of ATK, and the use of AEAs and offset measures combine to reduce socioeconomic and cultural impacts from the Project. Through job training programs, preferential hiring, directly negotiated contracts, and equity participation with the KCNs, benefits to local and regional communities have been enhanced.

These mitigation, compensation and enhancement measures have been incorporated into the Project's capital and operating budgets, resulting in Project costs that reflect closely the full societal cost of the Project.

Compared to earlier approaches to hydroelectric development, this approach increases the per unit cost of Project power, but it also results in a more sustainable project. The integration of environmental and social costs of the Project is also a critical element in full-cost accounting.

Shared Responsibility: *Ensure that Manitoba Hydro's employees, contractors, and agents are aware of our sustainable development policies and guiding principles and encourage them to act accordingly. Encourage the Corporation's employees to share their knowledge of the concepts and practical application of sustainable development.*

All contractors and workers on the site will be provided with Project-relevant information that incorporates the application of the principles. Partnership oversight of the Project will include compliance measures associated with regulatory and policy standards for Project construction and operation as well as in the associated monitoring and follow-up programs.

Integration of Environmental and Economic Decisions: *Treat technical, economic and environmental factors on the same basis in all corporate decisions, from initial planning to construction to operations to decommissioning and disposal. To the extent practical, include environmental costs in economic and financial analysis.*

A major example of this integration is the Project design. The Project incorporates mitigation, compensation and enhancement measures to reduce adverse environmental and social impacts and maximize benefits. By incorporating these measures into the Project's capital and operating budgets, the Project costs closely reflect the full societal cost of the Project.

Economic Enhancement: *Enhance the productive capability and quality of Manitoba's economy and the well-being of Manitobans by providing reliable electrical services at competitive rates.*

Hydroelectric development is a principal contributor to Manitoba's economy. The Project will generate revenues through power sales locally and to the US. Earnings will flow to the Partner communities as well as to the province through Manitoba Hydro. External power sales allow for sustainable low rates within the province, providing affordable electricity to the citizens of Manitoba and competitive advantage to the business community.

Efficient Use of Resources: *Encourage the development and application of programs and pricing mechanisms for efficient and economic use of electricity by our customers. As well, efficient and economic use of energy and materials will be encouraged throughout all our operations.*

Although Manitoba Hydro has exceptionally low domestic electricity rates which tends to encourage consumption, Manitoba Hydro also has an exceptionally strong program to explicitly encourage customers to be efficient in the use of electricity. In fact, the Manitoba Hydro Power Smart Program is recognized as a national leader for transforming the market through its ongoing commitment to promote energy efficient products and practices.

Prevention and Remedy: *To the extent practical, anticipate and prevent adverse environmental and economic effects that may be caused by Corporate policies, programs, projects and decisions rather than reacting to and remedying such effects after they have occurred. Purchase, where practical, environmentally sound products taking into account the life cycle of the products.*

Address adverse environmental effects of Corporate activities that cannot be prevented by:

- *First, endeavouring, wherever feasible, to restore the environment to pre-development conditions or developing other beneficial uses through rehabilitation and reclamation;*
- *Second, striving to replace the loss with substitutes that would enhance the environment and/or associated resource uses while offsetting the type of damage experienced; and*
- *Third, making monetary payments for compensable damages on a fair, equitable and timely basis.*

A number of measures have been taken to prevent and minimize adverse effects, the most substantial being to reduce the size of the Project. At one time, a high head project with 180 km^2 of initial flooding was under consideration; in contrast, the current Project that will result in 45 km^2 of initial flooding. As another example, a combination of habitat enhancement measures and a fish stocking program that includes a fish hatchery will enhance the population of lake sturgeon in the Project area. As another example of anticipating and remedying effects before they occur, AEAs with the KCNs were negotiated as proactive measures in advance of the development, and programs under those agreements will address effects on resource users.

Efforts have been made to avoid many effects, and once construction is completed, temporary facilities and structures not required for the operations phase will be decommissioned.

Conservation: *To the extent practical, plan, design, build, operate, maintain and decommission Corporate facilities in a manner that protects essential ecological processes and biological diversity. Give preference, where practical, to projects and operating decisions that use renewable resources or that extend the life of supplies of non-renewable resources.*

Both ATK and over a decade of technical studies have contributed to the design of the Project in a manner that will avoid or reduce adverse effects and protect essential ecological processes and biological diversity. Hydropower utilizes a renewable resource, thus assisting in the conservation of non-renewable resources such as gas or coal that otherwise would be used to generate the electricity being produced at the Project.

Waste Minimization: *Manage all wastes arising from Corporate activities by:*

- First, endeavouring to eliminate or reduce the amount generated;
- Second, striving to fully utilise reuse and recycling opportunities; and
- Third, disposing of remaining waste in an environmentally sound manner.

While opportunities for recycling are limited in remote northern areas, waste generated by the Project will be minimized and waste materials will be recycled to the extent practical. All other waste will be disposed of in an environmentally sound manner and in accordance with regulatory requirements.

Access to Adequate Information: *Share relevant information on a timely basis with employees, interested people and governments to promote a greater understanding of Manitoba Hydro's current and planned business activities and to identify impacts associated with the Corporation's plans and operations.*

Project information has been and will continue to be shared with interested parties dedicated websites, meetings, open houses and newsletters. Project information is also available at government registries.

Participation of the partners on the board of the general partner and in three ongoing committees (Construction Advisory Committee, Monitoring Advisory Committee and the Advisory Group on Employment) will be mechanisms for current and accurate information to the KCNs.

Public Participation: *Provide opportunities for input by potentially affected and interested parties when evaluating development and program alternatives and before deciding on a final course of action.*

KCNs undertook their own evaluations of the Project and their representatives were included in Partnership decisions. Discussion with the local communities began in the early 1990s and has resulted in a partnership with four First Nations and Manitoba Hydro participating in the Project. Ongoing communications have been undertaken within the communities. A Public Involvement Program has also been developed and has been implemented to reach the interested public in Manitoba. Information gleaned from these discussions and proponent consultations have improved the design and will be reflected in the construction of the Project.

This information was also used in determining and assessing environmental effects as part of the environmental assessment and in the design of mitigation and monitoring measures.

Understanding and Respect: *Strive to understand and respect differing social and economic views, values, traditions and aspirations when deciding upon or taking action. Give preference to those alternatives which best fulfil Corporate objectives while minimizing infringement on the ability, rights, and interests of others to pursue their aspirations.*

The Project proponent is a partnership comprising Manitoba Hydro and the KCNs. Considerable effort has been made in forging constructive relationships between Manitoba Hydro and the KCNs, including facilitating community studies aimed at understanding history, community history, and more importantly the Cree worldview and ATK. This growing understanding has had a major impact on Project design, construction and operation. It has also led to specific arrangements through community-specific AEAs.

Scientific and Technological Innovation: *Research, develop, test and implement technologies, practices and institutions that will make electrical supply and services more efficient, economic and environmentally sound.*

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 Project to reduce 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 the Project results in several advantages for fish passage survivability compared to other turbine styles. 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 low rotational speeds associated with large diameter vertical shaft turbines also result in greater fish survivability. To reduce the risk of striking or impingement injuries, runner blades incorporate a thicker rounder leading edge, the gaps between wicket gates and both the bottom ring and head cover were minimized, and the wicket gate overhang was also minimized. To reduce turbulence levels experienced by fish passing through the turbines, 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.

This is the first time that Manitoba Hydro has included these variables relevant for fish survival as part of the evaluation in the initial turbine design selection process, and as a priority for further turbine design development. Although there are many variables to consider beyond those relevant for fish survival (particularly efficiency and cost), the objective for the Project turbines is to achieve a minimum survival rate of 90%. Based on the Franke formula (Aquatic Environment Support Volume, Appendix 1A) for estimating the probability of survival of fish passed through turbines, fish up to 500 mm passing through the turbines will have a survival rate of over 90%.

Global Responsibility: *Recognize there are no political and jurisdictional boundaries to our environment, and that there is ecological interdependence among provinces and nations. Consider environmental effects that occur outside of Manitoba when planning and deciding on new developments and major modifications to facilities and to methods of operation.*

The Project will contribute to substantial reductions in greenhouse gases (GHG) by displacing fossil fuel electricity generation.

A detailed Life Cycle Assessment was conducted by the Pembina Institute in order to estimate the GHG emissions resulting from the construction, land use change, operation, and decommissioning of the Project. The resulting emissions are extremely low relative to other forms of generation. An equivalent amount of electricity, produced by a combined cycle natural gas generating station during one year of operation would result in more than double the entire life cycle emissions estimated associated with the Keeyask Project over a 100 year period. Since the Project will displace gas and coal generation, primarily in the U.S. Midwest, it will contribute to substantial GHG reductions. The Project is estimated to displace 30 million tonnes carbon dioxide equivalent during the first 10 years of operation.

9.3 CONCLUSIONS RE: THE KEEYASK GENERATION PROJECT AND SUSTAINABILITY

This analysis demonstrates that the Project is consistent with the KCNs, federal, provincial, and Manitoba Hydro approaches to sustainable development.

In addition to the specific analysis related to the goals, principles and guidelines of sustainable development, several general conclusions about the Project emerge, from the perspective of the three pillars of sustainable development:

ECONOMY

- National
  - Increased tax revenue will accrue to the federal government from employment and business opportunities resulting from the Project; and
  - The Project is a model of First Nation and corporate partnership in new renewable resource development.
- Provincial
  - Increased employment opportunities and resultant employment income associated with the Project will stimulate the provincial economy during construction and operation;
  - Increased revenues from power sales will generate income into Manitoba Hydro, a provincial Crown corporation, and benefit Manitoba ratepayers over the long life of the Project;
  - Increased revenue from water power rights associated with the Project will generate ongoing revenue for the province over the life of the Project;
  - Employment income and business development associated with the Project will generate revenue for the province;
  - Over 4000 person-years of employment income and substantial business opportunities will decrease welfare/social assistance reliance, especially in northern Manitoba; and
  - Employment training has already benefitted hundreds of workers, the results of which will be long lasting skilled labour, transferrable to other projects in the future.
- Regional
  - Local indigenous (KCNs) people will have an opportunity to benefit economically through their ownership position in the Project and through training, employment and business opportunities;

- Local indigenous people (KCNs) are also participating in the governance of a major hydroelectric project being developed in their ancestral homelands;
- The costs of the many measures to avoid or mitigate adverse effects and to enhance social benefits have been integrated into the design of the Project. As a result, these costs have been internalized into the Project (moving an otherwise external social cost into a corporate internal cost);
- Employment opportunities and associated training and economic benefits have increased for workers throughout northern Manitoba;
- Economic activity associated with the Project will increase opportunities for regional commercial and industrial businesses; and
- There will be long-term population growth with well paid operational positions at the generating station.

SOCIAL

- The Partnership is an example of consistency with the World Commission proposition that empowerment of vulnerable indigenous people is a touchstone of sustainable development policy.
- Funds were provided to each KCN to undertake its own evaluation of the Project and conduct referendums on whether to support the Project. The KCNs' Environmental Evaluation Reports speak to a desire to restore harmony and balance with *Askiy*, to protect the environment which is broadly defined to include people's wellbeing, to maintain and enhance their culture and traditions, and to provide greater hope and opportunities for present and future generations.
- As partners the KCNs have been influential in identifying and advocating for measures to lessen the adverse environmental effects of the Project, and they will undertake appropriate ceremonies to show respect and give thanks to *Askiy* at major Project milestones.
- The AEAs will provide the KCNs with access to healthy country foods and programs to maintain and strengthen their traditions and culture.
- Benefits associated with their partnership in a major development will contribute to independence of northern remote FN communities.

ENVIRONMENT

- As the first step in environmental stewardship, the Project has been planned to avoid or reduce long-term environmental effects. For example, through the planning process, the Project was reduced from a 1150 MW generating station that would have flooded 183 km^2, to a smaller 695 MW station that will flood 45 km^2.

- Special attention has been given to sensitive species and habitats. One example is lake sturgeon, a species designated as endangered by COSEWIC and being considered for designation under the Species at Risk Act. Through a combination of mitigation measures that include habitat enhancement, a fish hatchery and stocking program, the objective is not only to maintain existing stocks but to improve the species' population.
- Attention has been given to sustainable resource use in the planning and design of the Project. Maintaining and restoring wildlife populations in the area have been major components of the planning and environmental assessment. Through a combination of mitigation measures the existing stocks of lake sturgeon should not only be maintained but improved. Fish and moose harvest sustainability plans are being developed by CNP to guide the sustainable harvest of fish and moose in the Split Lake Resource Management Area (SLRMA). Moose and caribou monitoring will be conducted to promote future sustainability of the regional populations.
- Consistent with federal and provincial government efforts to reduce GHG emissions, the Project will contribute to a substantial reduction in greenhouse gases by displacing electricity generated from coal or gas, which could produce more than 200 x's more GHGs than Keeyask over its productive lifetime.

APPENDIX 9A

EFFECT ON MANITOBA GOVERNMENT SUSTAINABILITY INDICATOR TRENDS

KEEYASK
Hydropower Limited Partnership

EFFECT ON MANITOBA GOVERNMENT SUSTAINABILITY INDICATOR TRENDS

The “2009 Provincial Sustainability Report for Manitoba”[1] established categories of indicators within each of the three sustainable development “dimensions” (natural environment, economic and social well being) and indicators within each category. For each indicator, the province, after application of the appropriate criteria, determined and reported a province-wide trend for the indicator with respect to its sustainability; *e.g.*, stable, inconclusive, changing, variable, negative, positive, and other determinations as appropriate.

The two left hand columns in the following table comprise information directly from the 2009 Sustainability Report. The right hand column is the proponent’s comments respecting the Project’s impact on the provincial trend. Although the sustainability trends were established and reported on a provincial basis, the table provides regional information as required.

[1] http://www.gov.mb.ca/conservation/pdf/sustainabilty_report_2009.pdf

Table 9A - 1: Keeyask Generation Project Effect on Manitoba Government Sustainability Indicator Trends

Category	Indicator From MB 2009 Sustainability Report	Province-wide Trend from MB 2009 Sustainability Report	Predicted Effect of Keeyask Generation Project on Manitoba Trend
NATURAL ENVIRONMENT FRAMEWORK			
Biodiversity	Natural lands and protected areas	Stable	No predicted effect
	Wildlife species and ecosystems at risk	Inconclusive	No predicted effect on mammal resources
Fish	Fish species biodiversity and population	Changing	Minimal effect Positive effect on lake sturgeon in the lower Nelson River, when regional mitigation and enhancement measures are considered.
	Commercial fish harvest	Variable, depending on fishery	Minimal effect
Forests	Forest type and age class	Stable	Minimal effect
	Forest renewal	Stable	No predicted effect
Air	Air quality	Stable- Winnipeg, Brandon and Flin Flon	Short term local adverse effect, no effect on local or regional air quality in long term.
Water	Water quality	Stable	Negative effect on some back bays on the reservoir for 10-20 years after impoundment. No marked adverse effect on region.
	Water allocation and consumption	Stable	No predicted effect
Climate Change	Average annual and seasonal temperature	Negative	No predicted effect

Table 9A - 1: Keeyask Generation Project Effect on Manitoba Government Sustainability Indicator Trends

Category	Indicator From MB 2009 Sustainability Report	Province-wide Trend from MB 2009 Sustainability Report	Predicted Effect of Keeyask Generation Project on Manitoba Trend
	Total annual and seasonal precipitation	Inconclusive	No predicted effect
	Greenhouse gas emissions	Stable	Positive – The Project will contribute towards global reductions in GHG emissions.
ECONOMIC FRAMEWORK			
Economic performance	Real gross domestic product per capita	Positive	Positive
	Gross domestic product by sector	Positive	Positive
Agricultural sustainability	Total net farm income	Variable	No predicted effect
	Farm structure	Increasing consolidation	No predicted effect
	Adoption of sustainable agricultural management practices	Positive	No predicted effect
Mining	Mineral exploration	Positive	No predicted effect
	Mineral reserves	Stable	No predicted effect
	Mineral production	Positive	No predicted effect
Energy efficiency and conservation	Energy intensity	Positive	No predicted effect
	Renewable energy consumed versus total energy consumed	Positive	Positive

Table 9A - 1: Keeyask Generation Project Effect on Manitoba Government Sustainability Indicator Trends

Category	Indicator From MB 2009 Sustainability Report	Province-wide Trend from MB 2009 Sustainability Report	Predicted Effect of Keeyask Generation Project on Manitoba Trend
Consumption and waste management	Waste disposal	Negative	No predicted effect
	Waste recycled or used	Negative	NTD – Needs answer
Employment	Labour force trends	Positive	Positive – Substantial local and regional employment opportunities during 8.5-year construction phase. - Enhanced skilled workforce.
	Labour force opportunities	Positive	Positive – 4,218 person-years of employment during 8.5-year construction phase. Substantial proportion of total Project employment is expected to be northern Aboriginal employment (34-51%). 46 long-term jobs are associated with operation of the Keeyask Generation Station, and 182 KCNs jobs for 20 years are also provided for in the JKDA.

Table 9A - 1: Keeyask Generation Project Effect on Manitoba Government Sustainability Indicator Trends

Category	Indicator From MB 2009 Sustainability Report	Province-wide Trend from MB 2009 Sustainability Report	Predicted Effect of Keeyask Generation Project on Manitoba Trend
	Building and maintaining vibrant communities	Stable/positive	Positive for KCNs during construction phase due to employment and Direct Negotiation Contract benefits. Positive for the KCNs during the operation phase as a result of partnership income, which can contribute to increased self-sufficiency and provisions for Hydro jobs. AEA programming/initiatives reflect and respond to the KCNs' concerns, goals, and interests; for example, access programs contribute to strengthening traditional uses of lands within the Split Lake RMA that are away from the Nelson River. Participation in the Partnership contributes toward the sense of involvement by the KCNs in development within their vicinity. Positive for Gillam during operation phase as the community is planning for growth.
Education	Readiness for school	Positive	No predicted effect
	Literacy and numeracy – youth, adult	Stable	Positive effect. Community based pre-Project training included educational upgrading programs.

Table 9A - 1: Keeyask Generation Project Effect on Manitoba Government Sustainability Indicator Trends

Category	Indicator From MB 2009 Sustainability Report	Province-wide Trend from MB 2009 Sustainability Report	Predicted Effect of Keeyask Generation Project on Manitoba Trend
	High school and post-secondary education completion	Increasing – high school Stable -- post secondary	Positive - Community based pre-Project training included trades and business management training programs. To encourage continuing education, a Manitoba Hydro Keeyask Leadership Scholarship has been established to be awarded to one grade 12 graduating student from each community who is pursuing post secondary education and has shown exemplary leadership. This annual scholarship will be continued for seven generations.
	Academic achievement and socio-economic status	Variable	Positive – Project has the opportunity to increase socio-economic status through employment income for construction workers (including Aboriginal workers who are the subject of preferential hiring provisions in the collective agreement governing the construction project). The Project is expected to contribute to long-term partnership income earned by the KCNs.
SOCIAL WELL BEING FRAMEWORK			
Demographic	Population growth	Positive	No predicted effect on Manitoba trend; localized population growth associated with 46 long term positions to be located in Gillam.
	Migration to Manitoba from other jurisdictions	Positive	No predicted effect.

Table 9A - 1: Keeyask Generation Project Effect on Manitoba Government Sustainability Indicator Trends

Category	Indicator From MB 2009 Sustainability Report	Province-wide Trend from MB 2009 Sustainability Report	Predicted Effect of Keeyask Generation Project on Manitoba Trend
Equity and rights	Low income	Positive	Positive – well-paying opportunities in construction and operation phases; substantial local and regional employment opportunities during 8.5 year construction phase. Forty-six long-term jobs are associated with operation of the Keeyask Generation Station.
	Income inequality	Positive	Positive – northern Aboriginal employment in well-paying operations jobs. KCNs partnership income could raise overall standard of living and degree of self-sufficiency in KCNs communities.
	Income dependency	Positive	Positive – northern Aboriginal employment in well-paying operations jobs will contribute to reduced income dependency on government transfers for those employed. KCNs partnership income is likely to raise overall standard of living and degree of self-sufficiency in KCNs communities.
	Community supported living	Positive	No predicted effects.
Community and culture	Community engagement	Positive	Positive – KCNs communities engaged as partners in Project planning, decision-making and economic expansion.
	Heritage conservation	Positive	Variable – loss of heritage resources in Project footprint; increased knowledge, identification and protection of heritage resources through fieldwork associated with the Project (that counterbalances the loss of heritage resources through construction).

Table 9A - 1: Keeyask Generation Project Effect on Manitoba Government Sustainability Indicator Trends

Category	Indicator From MB 2009 Sustainability Report	Province-wide Trend from MB 2009 Sustainability Report	Predicted Effect of Keeyask Generation Project on Manitoba Trend
	Language diversity	Positive	Positive – for KCNs communities, Cree language programs are part of adverse effects agreements that are intended to strengthen Cree culture and language.
Governance	Voting rates	Positive	No predicted effect.
	Progress toward debt repayment	Positive	Positive – substantial water rental and capital tax payments to provincial government.
Health	Health status	Stable	Stable – KCNs AEAs and partnership income as well as overall employment opportunities for Manitobans provide the favourable conditions to improve overall health status. Medium-term elevated mercury levels to be offset by other sources of domestic fish via programs in most AEAs. In addition, consumption guidelines and measures to encourage domestic consumption of low-mercury fish are intended to mitigate mercury changes in fish.
	Access and quality of care	Stable	No predicted effect
Justice	Crime rate	Inconclusive	Inconclusive

CHAPTER 10

CONCLUSIONS

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10.0 CONCLUSIONS

10.1 INTRODUCTION

The Keeyask Hydropower Limited Partnership (the Partnership) has put forward the Keeyask Generation Project (the Project) for authorization in accordance with the *Canadian Environmental Assessment Act* (S.C. 1992, C. 37) and *The Environment Act* (Manitoba). The Partnership is comprised of four limited partners (Cree Nation Partners, representing Tataskweyak Cree Nation and War Lake First Nation; York Factory First Nation; Fox Lake Cree Nation; and Manitoba Hydro) and one general partner (5900345 Manitoba Ltd., a company owned by Manitoba Hydro).

Each of the Keeyask Cree Nations (KCNs) has previously undertaken its own evaluation of the Project. The Partnership has now produced a comprehensive environmental impact statement (EIS) in accordance with the requirements of the federal and provincial regulatory processes. The EIS includes an executive summary, this Response to EIS Guidelines, the KCNs' Environmental Evaluation Reports and a video, *Keeyask: Our Story*. The evidence presented in the Keeyask EIS demonstrates that the Project meets and exceeds the criteria by which the federal and provincial governments are to determine whether the Project will be approved.

10.2 FEDERAL CRITERIA

A primary purpose of the federal Act is "to ensure that projects are considered in a careful and precautionary manner before federal authorities take action in connection with them, in order to ensure that such projects do not cause significant adverse environmental effects." Consistent with the act, the Canadian Environmental Assessment Agency issued guidelines that directed the Partnership:

- To focus its assessment on valued environmental components (VECs); and
- To determine if the Project will cause a "significant" adverse effect, based on the effect's magnitude; geographic extent; timing, duration and frequency; reversibility; ecological and social context; level of confidence and probability; and existing environmental standards, guidelines or objectives.

Thirty-eight VECs were selected for the assessment and, following mitigation, none of the residual adverse effects exceeded the regulatory test for significance. That same conclusion held when the cumulative effects of the Project were considered in combination with the effects of past, current and future projects that overlap temporally and spatially with the Project.

One of the VECs – lake sturgeon – deserves special mention. Lake sturgeon are culturally and spiritually important to the Cree people and have special status as a heritage species in Manitoba. They have been designated as endangered by the Committee on the Status of Endangered Wildlife in Canada and are being considered for listing under the federal *Species at Risk Act*. They are also vulnerable to the effects of hydroelectric development. As a result, the Partnership has given the species special attention. New spawning habitat will be created to replace habitat being lost because of the Project, and a stocking program will be implemented. Stocking programs have been successful in re-establishing sturgeon populations in many other locations, and early results from the upper Nelson River appear positive. As a result, the Partnership is confident that similar results can be attained in the Keeyask area and is committed to utilizing an adaptive management approach to sturgeon stewardship with the objective of enhancing the sturgeon population in the lower Nelson River.

10.3 PROVINCIAL CRITERIA

The intent of the provincial Act is "to develop and maintain an environmental protection and management system in Manitoba which will ensure that the environment is protected and maintained in such a manner as to sustain a high quality of life, including social and economic development, recreation and leisure for this and future generations."

The evidence presented in the EIS demonstrates that the Project will certainly contribute to social and economic development while maintaining a system of environmental protection and management. The following is a summary of this evidence:

- Many potential environmental effects were avoided with the selection of a Project that minimizes the amount of flooding, which is a primary pathway to other environmental effects:
    - For example, the Project has been downsized from a 1150 MW high-head concept that would have initially flooded over 180 km^2 to a 695 MW low-head project that will initially flood 45 km^2.
- A decade-long environmental assessment process has been undertaken to identify potential adverse effects and develop appropriate mitigation measures;
- An extensive monitoring program will be applied to compare actual effects against the predictions that were based on technical scientific studies, professional judgement, and Aboriginal traditional knowledge; and
- Many adaptive management strategies have been identified, should the monitoring program indicate such strategies are required.

In addition to managing adverse effects, the Project will provide a number of environmental benefits. For example, the Project's hydroelectricity will produce fewer greenhouse gases in a century of operation than an equivalent coal thermal station would produce in 100 days and a gas thermal station in half a year. The Project will also contribute to the Manitoba economy as a preferred source of low-emitting, renewable energy, as well as a source of over 4,000 person-years of construction employment during the eight year construction period; and more broadly to the Canadian economy.

The Project will also contribute to the social and economic development of local communities and the northern region. For example:

- The four local Cree Nations (*i.e.*, the KCNs) are partners in the Project, sharing in its governance and future returns on investment;
- A number of contracts will be directly negotiated with businesses controlled by the KCNs;
- Qualified Aboriginal and other northern workers will be given preference for jobs to construct the Project; and
- Agreements negotiated with the four local Cree Nations address adverse effects on each Nation's collective rights and interests and the exercise of Treaty and Aboriginal rights by their Members:
  - The core of each agreement is a set of Offsetting Programs, the overall purpose of which is to provide appropriate replacements, substitutions or opportunities to offset unavoidable adverse effects on the practices, customs and traditions integral to their distinctive cultural identity.

10.4 THE PRECAUTIONARY APPROACH

The concept of using a precautionary approach has been an implicit foundation in the planning and design of the Project, using both technical science and Aboriginal traditional knowledge (ATK). Alternative reservoir levels and general arrangements were evaluated during the initial stages of project planning. Some alternatives would avoid or reduce potential effects, while others would have cost less per unit of power but would have had more adverse effects. Taking the precautionary approach, the alternatives that would avoid or lessen adverse effects were selected. Once the fundamentals of the Project were defined, the Partnership continued to take a precautionary approach in designing the Project.

One example was the decision to clear the entire reservoir area before impoundment. Another example was the decision to minimize the operational range of the reservoir to one meter, which is very small for a hydroelectric station of this magnitude.

A third example of the use of the precautionary principle was an output from discussions with the Department of Fisheries and Oceans (DFO) regarding fish passage. Approximately 10 years of study on fish movements indicated that fish did not need to move up over the dam to fulfill any of their life cycle requirements (e.g., spawning) and considerable effort was therefore placed on developing sufficient habitat in upstream and downstream areas to support local fish populations. However, through discussions with DFO a decision was made to commit to implementing fish passage at the Project using trap and transport and also to design the Project so it could be retrofitted to accommodate other fish passage options in the future, if follow-up monitoring indicates it is required.

While the precautionary approach has been used in many Project-related decisions to avoid adverse effects in the absence of scientific knowledge, it is important to stress that the Project has benefitted from more than 10 years of both scientific study and discussions and input from the local Cree Nations in sharing their ATK. In addition, potential effects have been avoided and mitigation measures identified and incorporated in the Project's plans, and a program of monitoring and adaptive management will be implemented.

10.5 KEEYASK CREE NATIONS' EVALUATIONS OF THE PROJECT

As noted in the EIS, the Project is actually the subject of two evaluation processes. In addition to the government regulatory environmental assessment process, each of the KCNs has also undertaken its own environmental evaluation process. In the KCNs' process, each of the KCNs, financially assisted by Manitoba Hydro, evaluated the impact of the Project on its communities and Members in terms of its own worldview, values and experience with past hydroelectric development. This assisted each Cree Nation when deciding to participate in the Partnership; in becoming partners, they also committed their support to the Partnership's application for regulatory approval of the Project. In voting to approve the Joint Keeyask Development Agreement, the KCNs expressed the hope – a realistic hope based on careful evaluation – that the Project will help to improve their home ecosystem's ability to sustain them physically and culturally and to restore harmony and balance to relationships and their lives; and that the Project will provide opportunities for current and future generations while respecting and caring for *Askiy*.

10.6 CONCLUDING STATEMENT

The Keeyask Generation Project will cause numerous and widespread environmental and social effects, some of which would have had the potential to be significant. However, using past experience, Aboriginal traditional knowledge and leading scientific and engineering techniques, the Keeyask Hydropower Limited Partnership has mitigated, remediated and/or compensated for these effects, such that the Partnership is confident the Project should proceed. The Project will also produce substantial environmental, social and economic benefits, all of which are consistent with the principles of sustainability established by the Governments of Canada and Manitoba. The Project will contribute to reductions in greenhouse gases and increases in lake sturgeon populations; it will provide training and employment for hundreds of Aboriginal and northern workers; it will enable the Keeyask Cree Nations Partners to build capacity and profit from construction contracts and their investment as equity partners; and it will produce clean renewable energy for Manitobans and export markets. As such, the Partnership believes the Project should be granted regulatory approval to proceed.

REFERENCES

LITERATURE CITED

AE SV (Aquatic Environment Supporting Volume). 2012. Keeyask Generation Project Environmental Impact Statement. Aquatic Environment Supporting Volume.

Abraham, K. F., and Thompson, J. E. 1998. Defining the Pen Islands caribou herd of southern Hudson Bay. Rangifer Special Issue No. 10: 33-40 pp.

Abraham, K.F., Pond, B.A., Tully, S.M., Trim, V., Hedman, D., Chenier, C., and Racey, G.D. 2012. Recent changes in summer distribution and numbers of migratory caribou on the southern Hudson Bay coast. Rangifer Special Issue No. 20: 269-276 pp.

Adelson, N. 2000. Being alive well: Health and the politics of Cree well-being. University of Toronto Press: Toronto, ON.

Alaska Department of Fish and Game. 2008. Grouse: Wildlife Notebook Series [online]. Available from www.adfg.state.ak.us/pubs/notebook/bird/grouse/php [accessed February 8, 2012].

Altman, B., and Sallabanks. R. 2000. Olive-sided Flycatcher (*Contopus cooperi*). In The birds of North America, No 502. Edited by A. Poole and G. Gill. The Birds of North America Inc., Philadelphia, PA.

Athabasca Landscape Team. 2009. Athabasca Caribou Landscape Management Options Report, Alberta Caribou Committee, Edmonton, AB.

Auer, N.A. 1996. Response of spawning lake sturgeons to change in hydroelectric facility operation. Transactions of the American Fisheries Society 125: 66–77 pp.

Ayles, H., Brown, S., Machiak, K., and Sigurdson, J. 1974. The fisheries of the lower Churchill lakes, the Rat-Burntwood lakes and the upper Nelson lakes: present conditions and the implications of hydro-electric development. In Lake Winnipeg, Churchill and Nelson Rivers Study Board, 1971-75. Technical report, Appendix 5, Volume 2, Section I.

Banfield, A. F. W. 1987. The mammals of Canada. University of Toronto Press, Toronto, ON.Barclay, R. M. R., and Cash, K.J. 1985. A non-commensal maternity roost of the little brown bat (*Myotis lucifugus*). Journal of Mammalogy 66(4): 782-783 pp.

Barr, J. 1986. Population dynamics of the Common Loon (*Gavia immer*) associated with mercury-contaminated waters in northwestern Ontario. Canadian Wildlife Service Occasional Paper No. 56. Hull, QC.

Bartonek, J.C. 1972. Summer foods of American wigeons, mallards, and a green-winged teal near Great Slave Lake, N.W.T. The Canadian Field-Naturalist 86: 373-376 pp.

Bateman, L. 2005. A history of electric power in Manitoba [online]. Available from http://www.ieee.ca/canrev/cr49/pages22-25.pdf [accessed June 28, 2012].

Bechard, M., Perkins, D., Kaltenecker, G., and Alsup, S. 2009. Mercury Contamination in Idaho Bald Eagles, *Haliaeetus leucocephalus*. Bulletin of Environmental Contamination and Toxicology 83(5): 698-702 pp.

Bellrose, F.C. 1976. Ducks, geese and swans of North America. Stackpole Books, Harrisburg, PA.Berkes, F. 2008. Sacred ecology: traditional ecological knowledge and resource management, 2nd ed. Taylor and Francis, New York, NY.

Betcher, R., Grove, G., and Pupp, C. 1995. Groundwater in Manitoba: Hydrogeology, Quality Concerns, Management. Saskatoon, Saskatchewan. NHRI Contribution No. CS-93017 March 1995. Also available at http://www.gov.mb.ca/waterstewardship/reports/groundwater/hg_of_manitoba.pdf [accessed June 2, 2012]

Bird Life International. 2011. Common Tern: Fact Sheet [online]. Available from http://www.birdlife.org/datazone/speciesfactsheet.php?id=3270 [accessed December, 20 2011].

Block, D. 2001. Growth estimates, habitat use and ecology of the lake sturgeon, *Acipenser fulvescens* Rafinesque, from Round Lake and mature reservoirs in the Winnipeg River. M.Sc. Thesis, Department of Zoology, The University of Manitoba, Winnipeg, MB.

Boonstra, R., Krebs, C. J., and Stenseth, N. C. 1998. Population cycles in small mammals: the problem of explaining the low phase. Ecology 79(5): 1479–1488 pp.

Boutin, S., and Birkenholz, D. E. 1998. Muskrats. In Wild furbearer management and conservation in North America. Edited by M. Novak, J. A. Baker, M. E. Obbard, and B. Malloch. Ontario Ministry of Natural Resources, Peterborough, ON. 314-325 pp.

Bowman, J., Ray, J. C., Magoun, A. J., Johnson, D. S., and Dawson, .F. N. 2010. Roads, logging, and the large-mammal community of an eastern Canadian boreal forest. Canadian Journal of Zoology 88: 454-467 pp. doi:10.1139/Z10-019

Boyle, S., and Owens, S. 2007. North American beaver (*Castor canadensis*): a technical conservation assessment USDA Forest Service, Rocky Mountain Region [online]. Available from http://www.fs.fed.us/r2/projects/scp/assessments/northamericanbeaver.pdf [accessed February, 3 2010].

Braune, B. 1987. Comparison of Total Mercury Levels in Relation to Diet and Moult for Nine Species of Marine Birds. Archives of Environmental Contamination and Toxicology 16(2): 217-224 pp. doi: 10.1007/BF01055802

Bretecher, R.L., and MacDonell, D.S. 2000. Lower Nelson River forebay monitoring program 1999. North/South Consultants Inc., Winnipeg, MB.

BRHA (Burntwood Regional Health Authority). 2008. 2007-2008 Annual Report: Northern Health in Northern Hands. Burntwood Regional Health Authority, Thompson, Manitoba. 12-15 pp.

Brody, A. J., and Pelton, M. R. 1989. Effects of roads on black bear movements in western North Carolina. Wildlife Society Bulletin 15: 5–10 pp.

Bushman, B.J. 1993. Human aggression while under the influence of alcohol and other drugs: An integrative research review. Current Directions in Psychological Science 2 (5): 148-152 pp.

Buskirk, S. W., and Ruggiero, L. F. 1994. The scientific basis for conserving forest carnivores: American marten, fisher, lynx, and wolverine in the western United States. United States Department of Agriculture Forest Service General Technical Report RM-254, Fort Collins, CO.

Canadian Dam Association 2007. Dam Safety Guidelines [online]. Available from http://www.cda.ca/cda_new_en/publications/dam%20safety/dam%20safety.html [accessed June 18, 2012].

Canadian Environmental Assessment Act, S.C. 1992, c. C-37.

Cane, J.H., and Tepedino, V.J. 2001. Causes and extent of declines among native North American invertebrate pollinators: detection, evidence, and consequences [online]. Conservation Ecology 5(1). Available from http://www.consecol.org/vol5/iss1/art1/ [accessed June 11, 2011].

Carbyn, L. N. 1998. Gray wolf and red wolf. In Wild furbearer management and conservation in North America. Edited by M. Novak, J. A. Baker, M. E. Obbard, and B. Malloch. Ontario Ministry of Natural Resources, Peterborough, Ontario. 359–376 pp.

Carter, T.R. 2007. General Guidelines on the Use of Scenario Data for Climate Impact Adaptation Assessment. Version 2 [online]. Available at: http://www.ipcc-data.org/guidelines/TGICA_guidance_sdciaa_v2_final.pdf [accessed June 18, 2012].

CCFM (Canadian Council of Forest Ministers). 1995. Defining sustainable forest management: a Canadian approach to criteria and indicators. Natural Resources Canada, Canadian Forest Service, Ottawa, ON.

CCME (Canadian Council of Ministers of the Environment). 1999. Canadian environmental quality guidelines. Canadian Council of Ministers of the Environment, Winnipeg, MB. Updated to 2012.

CCREM (Canadian Council of Resource and Environment Ministers). 1987. Canadian water quality guidelines. Canadian Council of Resource and Environment Ministers, Winnipeg.

CEAA (Canadian Environmental Assessment Agency). 2003. Incorporating Climate Change Considerations in Environmental Assessment: General Guidance for Practitioners Report [online]. Available at http://www.ceaa.gc.ca/A41F45C5-1A79-44FA-9091-D251EEE18322/Incorporating_Climate_Change_Considerations_in_Environmental_Assessment.pdf [accessed February 17, 2012]. Catalogue No. En106-50/2003E-PDF. ISBN 0-662-35454-0CEAA. 2012. Final Environmental Impact Statement Guidelines for the Keeyask Generation Project Proposed by the Keeyask Hydropower Limited Partnership [online]. Available from http://www.ceaa.gc.ca/050/documents/56642/56642E.pdf [accessed June 6, 2012]. Canadian Environmental Assessment Registry Reference Number: 11-03-64144

CINE (Centre for Indigenous Peoples' Nutrition and Environment). 2006. Benefits of traditional foods [online]. Available from http://www.mcgill.ca/cine/research/canada/food/benefits/ [accessed July 12, 2011].

Chapin, T. D., Harrison, D. J., and Katnik, D. D. 1998. Influence of landscape pattern on marten. Conservation Biology 12(6): 1327–1337 pp.

Chermack S.T., Giancola P.R., and Dingell, J.D. 1997. The relation between alcohol and aggression: An integrated biopsychosocial conceptualization. Clinical Psychology Review 17 (6): 621-649.

Clevenger, A.P., Chruszcz, B., and Gunson, K. 2001. Drainage culverts as habitat linkages and factors affecting passage by mammals. Journal of Applied Ecology 38: 1340-1349.

Clevenger, A. P., Chruszcz, B., and Gunson, K. E. 2003. Spatial patterns and factors influencing small vertebrate fauna road-kill aggregations. Biological Conservation 109: 15–26 pp.

CMHC (Canadian Mortgage and Housing Corporation). 2007. Canadian Housing Observer 2007. Canada Mortgage and Housing Corporation, Ottawa, ON.CMHC. 2008. Canadian Housing Observer 2008. Canada Mortgage and Housing Corporation, Ottawa, ON.

CNP (Cree Nation Partners). 2010a. Keeyask EIS – Socio-economic baseline conditions, draft technical memorandum. Economy: Tataskweyak Cree Nation. Split Lake, MB.

CNP. 2010b Keeyask EIS – Socio-economic baseline conditions, draft technical memorandum. Governance, health, travel access and community life: Tataskweyak Cree Nation. Split Lake, MB.

CNP. 2010c. Keeyask EIS – Socio-economic baseline conditions, draft technical memorandum. Population, infrastructure and services: Tataskweyak Cree Nation. Split Lake, MB.

CNP. 2010d Keeyask EIS – Socio-economic baseline conditions, draft technical memorandum. Economy: War Lake First Nation. Ilford, MB.

CNP. 2010e Keeyask EIS – Socio-economic baseline conditions, draft technical memorandum. Governance, health, travel access and community life: War Lake First Nation, Ilford, MB.

CNP. 2010f. Keeyask EIS – Socio-economic baseline conditions, draft technical memorandum. Population, infrastructure and services: War Lake First Nation. Ilford, MB.

CNP Keeyask Environmental Evaluation Report. 2012. Keeyask Environmental Evaluation: A report on the environmental effects of the proposed Keeyask Project on Tataskweyak Cree Nation and War Lake First Nation. January 2012.

CNP, YFFN and FLCN. Keeyask Cree Nations and Manitoba Hydro Aboriginal Traditional Knowledge Workshop 2011. Workshop. Winnipeg, Manitoba, June 06, 2011.

Coady, J. W. 1982. Moose (*Alces alces*). In Wild mammals of North America: biology, management, and economics. Edited by J. A. Chapman and G. A. Feldhamer. Johns Hopkins University Press, Baltimore, MD. 902–922 pp.

Colescott, J. H., and Gillingham, M. P. 1998. Reaction of moose (*Alces alces*) to snowmobile traffic in the Greys River Valley, Wyoming. Alces 34(2): 329–338 pp.

Conrad, K.F., Woiwod, I.P., Parsons, M., Fox, R., and Warren, M.S. 2004. Long-term population trends in widespread British moths. Journal of Insect Conservation 8(2-3): 119-136 pp. doi:10.1023/B:JICO.0000045810.36433.c6

Cook, D. B., and Hamilton, W. J. J. 1944. The ecological relationship of red fox food in eastern New York. Ecology 24: 94–104 pp.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2003. COSEWIC assessment and update status report on the wolverine *Gulo gulo* in Canada [online]. Available from http://www.sararegistry.gc.ca/virtual_sara/files/cosewic/sr_wolverine_e.pdf [accessed August, 22 2011]. CW69-14/329-2003E-PDF

COSEWIC. 2006. COSEWIC assessment and status report on the Rusty Blackbird *Euphagus carolinus* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. CW69-14/495-2006E-PDF.

COSEWIC. 2007. COSEWIC assessment and status report on the Olive-sided Flycatcher *Contopus cooperi* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. CW69-14/536-2008E-PDF

COSEWIC. 2012. Candidate Wildlife Species: Overview and Rationale [online]. Available from http://www.cosewic.gc.ca/eng/sct3/index_e.cfm#2 58904 [accessed March 2, 2012].

Cox, G.W. 2010. Bird Migration and Global Change. Island Press, Washington, D.C.

Crête, M., and Courtois, R. 1997. Limiting factors might obscure population regulation of moose (Cervididae: *Alces alces*) in unproductive boreal forests. Journal of Zoology 242: 765-781 pp.

Curtis, P. D., and Jensen, P.G. 2004. Habitat features affecting beaver occupancy along roadsides in New York State. Journal of Wildlife Management 68(2): 278–287 pp.

Darcy, W. R., and Pruitt, W. O. Jr. 1984. Habitat use, movements and grouping behaviour of woodland caribou, *Rangifer tarandus caribou*, in southeastern Manitoba. Canadian Field-Naturalist 98: 184-190 pp.

Des Granges, J., Rodrigue, J., Tardif, B., and Laperle, M. 1998. Mercury Accumulation and Biomagnification in Ospreys (*Pandio haliaetus*) in the James Bay and Hudson Bay Regions of Quebec. Archives of Environmental Contamination and Toxicology 35(2): 330-341 pp.

Des Granges, J., Rodrigue, J., Tardif, B., and Laperle, M. 1999. Breeding Success of Osprey under High Seasonal Methylmercury Exposure. In Mercury in the Biogeochemical Cycle: Natural Environments and Hydroelectric Reservoirs of Northern Quebec. Edited by M. Lucotte, R. Schetagne, N. Therien, C. Langlois, and A. Tremblay. Springer, New York, NY.

DesLandes, J., Guénette, S., Prairie, Y., Roy, D., Verdon, R., and Fortin, R. 1995. Changes in fish populations affected by the construction of the La Grande complex (Phase I), James Bay region, Québec. Canadian Journal of Zoology 73: 1860-1877 pp.

DFO (Fisheries and Oceans Canada). 1995. Freshwater Intake End-of-Pipe Screen Guidelines [online]. Available from http://www.dfo-mpo.gc.ca/library/223669.pdf [accessed June 13, 2012].

DFO. 2010. Recovery potential assessment of lake sturgeon Nelson River Population DU3. DFO Canadian Science Advisory Secretariat Science Advisory Report 2010/050.

Diamond, A.W. 1991. Assessment of the risks from tropical deforestation to Canadian songbirds. Trans. 56th North American Wild. and Nat. Res. Conf. 177-194 pp.

Dillon Consulting Ltd. 2011. Gillam Background Study: Final Report. Prepared for the Town of Gillam by Dillon Consulting Ltd. June 2011. Available from www.gillamdevelopmentplan.com/pdfs/Background%20Study.PDF [accessed online April 23, 2012].

Dillon Consulting. 2012. Town of Gillam Development Plan 2011-2040: Beautiful by Nature, Diverse by Culture, Vibrant by Design. January 2012. Available online: http://www.gillamdevelopmentplan.com/ [accessed May 1, 2012]

Ducks Unlimited. 2010. Using Buffers to Assess Waterfowl Nesting Habitat for Boreal Waterfowl. Literature Review by James Kenyon, Ducks Unlimited.

Dussault, C., J.P. Ouelett, R. Courtois, J. Huot, L. Breton, and Jolicoeur, H. 2005. Linking moose habitat selection to limiting factors. Ecography 28: 619-628 pp.

Dussault, C., Oullet, J.P., Laurian, C., Courtois, R. Poulin, M, and Breton, L. 2007. Moose movement rates along highways and crossing probability models. Journal of Wildlife Management 71(2): 338–2345 pp.

Dzus, E., Ray, J., Thompson, I., and Wedeles, C. 2010. Caribou and the National Boreal Standard: Report of the FSC Canada Science Panel [online]. Available from http://www.fsccanada.org/docs/science%20panel%20recommendations%20report.pdf?LanguageID=EN-US [accessed June 19, 2012].

Eadie, W. R. 1943. Food of the red fox in southern New Hampshire. Journal of Wildlife Management 7: 74–77 pp.

Ellis, D.H., Ellis, C.H., and Mindell, D.P. 1991. Raptor responses to low level jet aircraft and sonic booms. Environmental Pollution 74: 53-83 pp.

Environment Canada. 2010. Planning for a Sustainable Future: A Federal Sustainable Development Strategy for Canada [online]. Available from http://www.ec.gc.ca/dd-sd/F93CD795-0035-4DAF-86D1-53099BD303F9/FSDS_v4_EN.pdf [accessed June 18, 2012].

Environment Canada. 2011. Recovery strategy for the woodland caribou, boreal population (*Rangifer tarandus caribou*) in Canada [proposed]. *Species at Risk Act* Recovery Strategy Series. Environment Canada, Ottawa, Ontario.

Errington, P. L. 1963. Muskrat populations. Iowa State University Press, Ames, Iowa.

Federal Sustainable Development Act, S.C. 2008, c. C-33.

Ferron, J., and Ouellet, J. P. 1992. Daily partitioning of summer habitat and use of space by the snowshoe hare in boreal forest. Canadian Journal of Zoology 70: 2178–2183 pp.

Festa-Bianchet, M., Ray, J. C., Boutin, S., Côté, S. D., and Gunn, A. 2011. Conservation of caribou (*Rangifer tarandus*) in Canada: an uncertain future. Canadian Journal of Zoology 89: 419–434 pp.

Fisher, J. T., and Wilkinson, L. 2005. The response of mammals to forest fire and timber harvest in the North American boreal forest. Mammal Review 35: 51–81 pp.

FLCN (Fox Lake Cree Nation). 1997. Fox Lake First Nation: Forgotten Nation in the Shadow of Dams: Grievance statement. Fox Lake Cree Nation, MB.

FLCN. 2008. Preliminary Sturgeon TK Study (Draft). Prepared by: Leslie Agger, support from: Dr. Terry Dick and Lorne Hanks. Fox Lake Cree Nation, MB.

FLCN. 2009. Ninan: The story of the Fox Lake Cree (Draft). Fox Lake Cree Nation, MB.

FLCN. 2010. Keeyask Traditional Knowledge Report (Draft). Prepared by W. Ross, FLCN Negotiations. October 2010.

FLCN. 2012. Fox Lake Aski Keskentamowin Keeyask Powistik 2012 (Draft). Submitted March 26, 2012.

FLCN Environment Evaluation Report (Draft). 2012. Fox Lake Cree Nation Environment Evaluation Report (Draft). Draft submitted by: Fox Lake Cree Nation – Negotiations. June 7, 2012.

FLCN and Manitoba Hydro. 2009. The Agreement between Fox Lake Cree Nation and Manitoba Hydro dated the 28th day May, 2009 – Partnership development agreement [online]. Available from http://www.hydro.mb.ca/projects/keeyask/fox_lake_aea.pdf [accessed February 1, 2012].

FLCN KPI Program 2009-2010: Community-based research undertaken with Fox Lake Community Coordinator and Community Researcher that included a series of key person interviews and workshops with key community members and youth.

Fleming, R..A., and Candau, J.N. 1998. Influences of Climatic Change on Some Ecological Processes of an Insect Outbreak System in Canada's Boreal Forests and the Implications for Biodiversity. Environmental Monitoring and Assessment : 49 (2-3). 235-249 pp.

Forbes, G. 2012. Technical Summary and Supporting Information for an Emergency Assessment of the Little Brown Myotis *Myotis lucifugus* [online]. Available at http://www.sararegistry.gc.ca/virtual_sara/files/cosewic/ca_petite_chauvesouris_little_brown_myotis_0212_e.pdf [accessed May 10, 2012]

Forman, R. T. T., and Alexander, L.E. 1998. Roads and their major ecological effects. Annual Review of Ecology and Systematics 29: 207–202 pp.

Forman, R. T. T., and Deblinger, R. D. 2000. The ecological road-effect zone of a Massachusetts (U.S.A.) suburban highway. Conservation Biology 14: 36–46 pp.

Fraser, H.S. 1985. A journey north: The great Thompson nickel discovery. Inco Limited, Manitoba Division, Thompson, MB.

Frey, N., and Conover, M. R. 2006. Habitat use by meso-predators in a corridor environment. Journal of Wildlife Management 70: 1111–1118 pp.

Frick, W., Pollock, J., Hicks, A., Langwig, K., Reynolds, S., Turner, G., Butchkoski, C., and Kunz, T. 2010. An emerging disease causes regional population collapses of a common North American bat species. Science 329: 679–682 pp.

Fur Institute of Canada. 2003. Trappers: stewards of the land. Fur Institute of Canada, Ottawa, ON.

Gaines, M. S., and McClenaghan, L. R. Jr. 1980. Dispersal in small mammals. Annual Review of Ecology and Systematics 11: 163-196 pp.

Gengenbach, H. 2003. Binding Memories: women as makers and tellers of history in Magude, Mozambique. New York: Columbia University Press, New York, NY.

Gibbs, J. P. 1998. Distribution of woodland amphibians along a forest fragmentation gradient. Landscape Ecology 13: 263–268 pp.

Gibbs, J. P. 2000. Wetland loss and biodiversity conservation. Conservation Biology 14(1): 314-317 pp.

Gillam KPI Program 2009-2010: Research undertaken by InterGroup Consultants that included a series of key person interviews with a cross-section of community representatives.

Goddard, J. 1970. Movements of moose in a heavily hunted area of Ontario. Journal of Wildlife Management 34: 439–445 pp.

Godfrey, W.E. 1986. Birds of Canada. National Museum of Natural Sciences and National Museums of Canada. Ottawa, ON.Goudie, R. I., and Jones, I. L. 2004. Dose-response relationships of harlequin duck behaviour to noise from low-level military jet over-flights in central Labrador. Environmental Conservation (2004) 31: 289-298 pp.

Government of British Columbia. 2002. Ministry of Water, Land and Air Protection. British Columbia Frogwatch Program Fact sheet. Available from http://www.gov.bc.ca/wld/frogwater/whoswho/factshts.htm [accessed May 2010].

Government of Canada. 1991. The Federal Policy on Wetland Conservation. Canadian Wildlife Service, Environment Canada. Minister of Supply and Services Canada, Ottawa, ON.

Government of Manitoba. 2010a. Manitoba's highway renewal plan [online]. Available from http://www.gov.mb.ca/highways/introduction/index.html [accessed May 31, 2010].

Government of Manitoba. 2012. Mineral education [online]. Available from http://www.manitoba.ca/iem/mrd/min-ed/minfacts/ [accessed May 22, 2012].

Greenberg, R., and Droege, S. 1999. On the decline of the Rusty Blackbird and the use of ornithological literature to document long-term population trends. Conservation Biology. 13: 553-559 pp.

Griffiths, M., and Woynillowicz, D. 2003. Oil in troubled water: Reducing the impact of the oil and gas industry on Alberta's water resources. Prepared by the Pembina Institute for Appropriate Development.

HTFC (Hilderman Thomas Frank Cram). 2008. Gillam land use requirements availability study (draft). December 18, 2008.

Hanson, A., Swanson, L., Ewing, D., Grabas, G. Meyer, S., Ross, L., Watmough, M., and Kirby, J. 2008. Wetland Ecological Functions Assessment- An Overview of Approaches. Technical Report Series Number 497, Environment Canada, Atlantic Region.

Harris, M. 1994. Cultural materialism is alive and well and won't go away until something better comes along. In Assessing Cultural Anthropology. Edited by R. Borofsky. McGraw-Hill.

Hash, H.S. 1998. Wolverine. In Wild Furbearer Management and Conservation in North America. Edited by J. Bedford and G. Thompson. Ontario Fur Managers Federation, Peterborough, ON. 574-585 pp.

Hayeur, G. 2001. Summary of knowledge acquired in northern environments from 1970 to 2000. Hydro-Québec, Montreal, September 2011.

Health Canada. 2003. Health Policy Research, Issue 5. Closing the Gap on Aboriginal Health. Available from Health Canada. ISSN 1499-3503.

Hegmann, G., Cocklin, C., Creasey, R., Dupuis, S., Kennedy, A., Kingsley, L., Ross, W., Spaling, H., and Stalker, D. 1999. Cumulative effects assessment practitioners guide. Prepared by AXYS Environmental Consulting Ltd. and the CEA Working Group for the Canadian Environmental Assessment Agency, Hull, QC. Available from the Canadian Environmental Assessment Agency. En106-44/1999E

Hill, E. P. 1982. Beaver. In Wild mammals of North America: biology, management, and economics. Edited by J A. Chapman and G.A. Feldhamer. Johns Hopkins University Press, Baltimore, Maryland. 256–281 pp.

Hirai, T. 1998. An evaluation of woodland caribou calving habitat in the Wabowden area, Manitoba. M.N.R.M. thesis, Natural Resources Institute, The University of Manitoba, Winnipeg. MB.

Houts, M. E. 2001. Modeling gray wolf habitat in the northern Rocky Mountains. M.A. thesis, Department of Geography, The University of Kansas, Lawrence, KS.

HRB (Historic Resources Branch, Manitoba Culture, Heritage and Tourism). 1990. Land-Based Development Projects and the Screening Criteria Used to Evaluate Their

Impacts on Archaeological Heritage Resources. Guidelines for Conducting a Heritage Resource Impact Assessment Module III. Manuscript on file with Historic Resources Branch, Winnipeg, MB.

Humphrey, S.R. 1982. Bats (*Vespertilionidae* and *Molossidae*). In Wild mammals of North America: biology, management, and economics. Edited by J A. Chapman and G.A. Feldhamer. Johns Hopkins University Press, Baltimore, MD. 52-70 pp.

IAP2 (International Association for Public Participation). 2012. Core Values for the Practice of Public Participation [online]. Available from http://iap2canada.ca/Default.aspx?pageId=994361 [accessed June 13, 2012].

INAC (Indian and Northern Affairs). 2006a. Tataskweyak Cree Nation – Registered population, First Nation profiles. Obtained from INAC on January 20, 2010

INAC. 2006b. War Lake First Nation – Registered population, First Nation profiles. Obtained from INAC on January 20, 2010

INAC. 2006c. Fox Lake Cree Nation – Registered population, First Nation profiles. Obtained from INAC on January 20, 2010

INAC. 2006d. York Factory First Nation – Registered population, First Nation profiles. Obtained from INAC on January 20, 2010

IPCC (Intergovernmental Panel on Climate Change). 2006. 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Prepared by the National Greenhouse Gas Inventories Programme. Edited by H.S. Eggleston., L. Buendia, K. Miwa, T. Ngara, and K. Tanabe. Institute for Global Environmental Strategies, Hayama, Japan.

ISCM (Invasive Species Council of Manitoba). 2012a. Invasive Aquatic Species List [online]. Available from http://invasivespeciesmanitoba.com/site/index.php?page=aquatic-species [accessed May 11, 2012].

ISCM. 2012b. Invasive plants and animals in Manitoba. [online]. Available from http://www.invasivespeciesmanitoba.com/site/index.php [accessed May 11, 2012].

Irwin, L. J. 1975. Deer-moose relationships on a burn in northeastern Minnesota. The Journal of Wildlife Management 39: 653–662 pp.

ISO (International Organization for Standardization). 2006. 14040:2006. ISO, Environmental Management - Life Cycle Assessment - Principles and framework [online]. Available from http://www.iso.org/iso/catalogue_detail?csnumber=37456 [accessed June 20,2012].

Jalkotzy, M.G., Ross, P.I., and Nasserden, E.M.D. 1997. The effects of linear developments on wildlife: a review of selected scientific literature. Prepared for Canadian Association of Petroleum Producers. Calgary, AB [online]. Available at http://www.kora.ch/malme/05_library/5_1_publications/I_and_J/Jalkotzy_et_al_

1997_The_effect_of_linear_development_on_wildlife_-_review.pdf [accessed August 18 2011].

James, A. R. C., and Stuart-Smith, A. K. 2000. Distribution of caribou and wolves in relation to linear corridors. Journal of Wildlife Management 64: 154-159 pp.

Jansen, W., and Cooley, M. 2012. Measurements of total dissolved gas pressure and water mercury concentrations in the vicinity of Gull Rapids and the Kelsey and Limestone Generation Stations in 2011. A report to Manitoba Hydro by North South Consultants Inc.

Johnson, M.W., MacDonell, D.S., and Maclean, B. 2004. Lower Nelson River aquatic studies: Limestone and Long Spruce forebays index gillnetting studies, summer 2003. North/South Consultants Inc., Winnipeg, MB.

Johnston, T.A., Bodaly, R.A., and Mathias, J.A. 1991. Predicting fish mercury levels from physical characteristics of boreal reservoirs. Canadian Journal of Fisheries and Aquatic Sciences 48: 1468–1475 pp.

Joyce, T. L., and Mahoney, S. P. 2001. Spatial and temporal distributions of moose-vehicle collisions in Newfoundland. Alces 29: 281–291 pp.

Keeyask Hydropower Limited Partnership. 2009. Keeyask Infrastructure Project Environmental Assessment Report [online]. Available from http://keeyask.com/wp/wp-content/uploads/2009-07-31a-EA-Report.pdf [accessed June 12, 2012].

Keeyask Hydropower Limited Partnership. 2011. Keeyask Generation Project: Major Projects Management Office Project Description. July 2011.

Kelly, J. F., Bridge, E.S., and Hamas, M.J. 2009. Belted Kingfisher (*Megaceryle alcyon*). In The Birds of North America [online] Edited by A. Poole. Ithaca: Cornell Lab of Ornithology. Available from http://bna.birds.cornell.edu/bna/species/084 doi:10.2173/bna.84

Kelsall, J. P. 1968. The migratory barren-ground caribou of Canada. Queen's Printer and Controller of Stationery, Ottawa, ON.

KGS-Acres. 2010. Forecasts of traffic attributed to Keeyask and Conawapa GS projects memorandum GN-5.25, Rev 0.

Kinley, T. A., and Apps, C. D. 2001. Mortality patterns in a subpopulation of endangered mountain caribou. Wildlife Society Bulletin 29: 158-164 pp.

Kirk, J.L., and St. Louis, L. 2009. Multiyear total and methylmercury exports from two major sub-Arctic rivers draining into Hudson Bay, Canada. Environmental Science and Technology 43: 2254-2261 pp.

Klassen, R.W. 1983. Lake Agassiz and the Late Glacial History of Northern Manitoba. In Glacial Lake Agassiz, J. T. Teller and L. Clayton ed., Geological Association of Canada Special Paper 26. University of Toronto Press, Toronto, ON. 97-115 pp.

Kling, G.W., Hayhoe, K., Johnson, L.B., Magnuson, J.J., Polasky, S., Robinson, S.K., Shuter, B.J., Wander, M.M., Wuebbles, D.J., Zak, D.R., Lindroth, R.L., Moser, S.C., and Wilson, M.L. 2003. Confronting Climate Change in the Great Lakes Region: Impacts on our Communities and Ecosystems. The Union of Concerned Scientists, Cambridge, MA, and The Ecological Society of America, Washington, D.C.

Koehler, G. M., and Brittell, J. D. 1990. Managing spruce-fir habitat for lynx and snowshoe hares. Journal of Forestry 88: 10-14 pp.

Kolenosky, G. B., and Strathearn, S. M. 1998. Black bear. In Wild furbearer management and conservation in North America. Edited by M. Novak, J. A. Baker, M. E. Obbard, and B. Malloch. Ontario Ministry of Natural Resources, Peterborough, Ontario. 626-641 pp.

Koonz, W. 1992. Amphibians in Manitoba. In Declines in Canadian amphibian populations: designing a national monitoring strategy. Edited by C. Bishop and K. Pettit. Occasional Paper Number 76, Canadian Wildlife Service, Ottawa, ON. 19-20 pp.

Kozel, R. M., and Fleharty, E. D. 1979. Movements of rodents across roads. The Southwest Naturalist 24: 239–248 pp.

Krawchuk, B.P., and Snitowski, A. 2008. Manitoba Ambient Air Quality: Annual Reports for 2003, 2004 and 2005. Report No. 2008-01 [online]. Available from http://www.gov.mb.ca/conservation/pollutionprevention/airquality/pdf/2003_05_ambient_air_quality_annual_report.pdf [accessed February 17, 2012].

Krebs, J., Lofroth, E., and Parfit, I. 2007. Multiscale habitat usage by wolverines in British Columbia, Canada. Journal of Wildlife Management. 71: 2180-2192 pp.

Krefting, L. W. 1974. Moose distribution and habitat selection in north central North America. Naturalist Canada 101: 81-100 pp.

Lackey, M.A. 2010. Avian response to road construction noise with emphasis on the endangered golden-cheeked warbler. M.Sc. thesis, Texas A and M University, College Station, Texas.

LaResche, R. E., Bishop, R. H., and Coady, W. J. 1974. Distribution and habitats of moose in Alaska. Naturalist Canada 101: 143–178 pp.

Larsen, T. L., and Ripple, W. J. 2004. Modeling gray wolf (*Canis lupus*) habitat in the Pacific Northwest, U.S.A. Journal of Conservation Planning 2: 30-61 pp.

Larivière, S., and Messier, F. 2000. Habitat selection and use of edges by striped skunks in the Canadian prairies. Canadian Journal of Zoology 78: 366-372 pp.

Laurian, C., Dussault, C., Ouellet, J.-P., Courtois, R., Poulin, M., and Breton, L. 2008. Behavior of moose relative to a road network. Journal of Wildlife Management 72: 1550–1557 pp.

Lawrence, D.P. 2004. The significance of social and economic impacts in environmental assessment [online]. In Canadian Environmental Assessment Agency (CEAA); Research and development monograph series. Available from http://www.ceaa.gc.ca/default.asp?lang=En&n=CD221BCC-1&offset=1&toc=sh [accessed June 12, 2012].

Lewis, S.A., and Furness, R.W. 1991. Mercury Accumulation and Excretion in Laboratory Reared Black-Headed Gull *Larus ridibundus* Chicks. Archives of Environmental Contamination and Toxicology. 21(2): 316-320 pp.

MacDonell, D.S. 1997. The Nelson River lake sturgeon fishery, from the perspective of the Bayline communities of Pikwitonei, Thicket Portage, and Wabowden. M.N.R.M. thesis, Natural Resource Institute, The University of Manitoba, Winnipeg, MB. 173 pp.

Mammals Working Group. 2010. Meeting. Attended by CNP, YFFN, FLCN, Manitoba Conservation, Manitoba Hydro, Stantec, WRCS and JORO. Winnipeg, Manitoba, December 9, 2010.

Mammals Working Group. 2011. Meeting. Attended by CNP, YFFN, FLCN, Manitoba Hydro, ECOSTEM, Stantec, and WRCS. Winnipeg, Manitoba. June 28, 2011.

Mammals Working Group. 2012. Meeting. Attended by CNP, YFFN, FLCN, Manitoba Hydro, WRCS, Stantec. Winnipeg, Manitoba, January 24, 2012.

Manitoba Conservation. 1997. Department Annual Reports: State of the Environment. Moving Towards Sustainable Development Reporting [online]. Available from http://www.gov.mb.ca/conservation/annual-reports/soe-reports/soe97/soe97.html [accessed June 20, 2012].

Manitoba Conservation. 2009. Provincial Sustainability Report for Manitoba [online]. Available from http://www.gov.mb.ca/conservation/pdf/sustainabilty_report_2009.pdf [accessed June 18 2012].

Manitoba Conservation, Data Centre. 2012a. Occurrence of Species by Ecoregion: Hayes River Upland [online]. Available from http://www.gov.mb.ca/conservation/cdc/ecoreg/hayesriver.html [accessed May 17 2012].

Manitoba Conservation, Data Centre. 2012b. Occurrence of Species by Ecoregion: Churchill River Upland [online]. Available from http://www.gov.mb.ca/conservation/cdc/ecoreg/churchill.html [accessed May 17 2012].

Manitoba Conservation, Pollution Prevention. 2005. Objectives and Guidelines for Various Air Pollutants: Ambient Air Quality Criteria [online]. Available from www.gov.mb.ca/conservation/pollutionprevention/airquality/aq-criteria/ambientair_e.html [accessed June 20 2012].

Manitoba Conservation, Wildlife and Ecosystem Protection Branch. 2005a. Manitoba's Conservation and Recovery Strategy for Boreal Woodland Caribou (*Rangifer tarandus caribou*). Manitoba Conservation, Wildlife and Ecosystem Protection Branch, Winnipeg, MB.

Manitoba Conservation, Wildlife and Ecosystem Protection Branch. 2005b. Wildlife and vehicles, high risk areas for deer/wildlife-vehicle collisions in rural Manitoba - calendar year 2005 [online]. Available from http://www.gov.mb.ca/conservation/wildlife/problem_wildlife/wildlife_vehicle_rural.html [accessed June 18 2010].

Manitoba Conservation, Wildlife and Ecosystem Protection Branch. 2009. Draft policy directive: furbearer management [online]. Available from http://www.gov.mb.ca/conservation/wildlife/trapping/pdf/draft_fur_policy_procedure.pdf [accessed January 20, 2012].

Manitoba Conservation, Wildlife and Ecosystem Protection Branch. 2011. 2011–2012 Manitoba Hunting Guide [online]. Available from http://www.gov.mb.ca/conservation/wildlife/trapping/pdf/trapping_guide_2011_12_final.pdf [accessed January, 20 2011].

Manitoba Conservation, Wildlife and Ecosystem Protection Branch. n.d.a. Gray (timber) wolf fact sheet [online]. Available from http://www.gov.mb.ca/conservation/wildlife/mbsp/fs/grwolf.html [accessed May 27, 2010].

Manitoba Conservation, Wildlife and Ecosystem Protection Branch. n.d.b. Black bear fact sheet [online]. Available from http://www.gov.mb.ca/conservation/wildlife/mbsp/fs/blbear.html [accessed November 30, 2009].

Manitoba Conservation, Sustainable Resource and Policy Management. n.d. Principles and Guidelines of Sustainable Development [online]. Available from http://www.gov.mb.ca/conservation/susresmb/principles-susdev/ [accessed June 18, 2012].

Manitoba Health. 2006. Population Report: 2005-2006 [online]. Available from https://www.gov.mb.ca/health/population/2006/index.html [accessed June 20, 2012].

Manitoba Historical Society. 2010. The Hudson Bay Railway [online]. Available from http://www.mhs.mb.ca/docs/transactions/3/hudsonbayrailway.shtml [accessed January, 31 2012].

Manitoba Hydro. 1993. Nelson River Studies Gull Generating Station Summer 1990 and Winter 1990/91 Subsurface Investigation Report 93-4. Volume 1 of 3.

Manitoba Hydro. 1986. Limestone Generating Station: Environmental Impact Study – Final Report. Prepared by MacLaren Plan Research Inc. and InterGroup Consultants Ltd.

Manitoba Hydro. 2011a. Bipole III Transmission Project. Caribou Technical Report. Prepared by Joro Consultants Inc., Winnipeg, MB.Manitoba Hydro. 2011b. Wuskwatim Generation Project. Mammal Monitoring Investigations for the Wuskwatim Generation Project Pre-construction and Construction Report (2004-2009). Prepared for Manitoba Hydro, Winnipeg by Wildlife Resource Consulting Services MB Inc., May 2011.

Manitoba Hydro. 2011c. Bipole III Project Environmental Impact Statement Chapter 6: Existing Environment. Manitoba Hydro, Winnipeg, MB.Manitoba Hydro. 2011d. Pointe du Bois Spillway Replacement Project: Environmental Impact Statement. Manitoba Hydro, Winnipeg, MB.

Manitoba Hydro and NCN (Nisichewayesik Cree Nation). 2003. Wuskwatim Environmental Impact Statement. April 2003.

Manitoba Natural Resources and DFO. 1996. Manitoba Stream Crossing Guidelines for the Protection of Fish and Fish Habitat [online]. Available from http://www.gov.mb.ca/waterstewardship/fisheries/habitat/sguide.pdf [accessed June 13, 2012].

Marjakangas, A., and Kiviniemi, S. 2005. Dispersal and migration of female Black Grouse *Tetrao tetrix* in eastern central Finland. Ornis Fennica 82: 107-116 pp.

McClure, C. J. W., Rolek, B.W., McDonald, K., and Hill, G.E. 2012. Climate change and the decline of a once common bird. Ecology and Evolution: 2(2). 370-378 pp.

McCracken, J. 2008. Are Aerial Insectivores Being Bugged Out? In BirdWatch Canada. Winter 2008. Issue Number 42 [online]. Available from http://www.bsc-eoc.org/download/BWCwi08.pdf [accessed June 20,2012].

Meehl, G.A., Stocker T.F., Collins, W.D., Friedlingstein, P., Gaye, A.T., Gregory. J.M., Kitoh, A., Knutti, R., Murphy, J.M., Noda, A., Raper, S.C.B., Watterson, I.G., Weaver, A.J., and Zhao, Z.-C. 2007. Global Climate Projections. In Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Edited by S. Solomon, D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor, and H.L. Miller. Cambridge University Press, Cambridge, United Kingdom and New York, NY.

Mech, L. D. 1980. Age, sex, reproduction, and spatial organization of lynxes colonizing northeastern Minnesota. Journal of Mammalogy 61: 261-267 pp.

Mech, L. D., Fritts, S.H., Radde, G. L., and Paul, W. T. 1988. Wolf distribution and road density in Minnesota. Wildlife Society Bulletin 16: 85-87 pp.

Melquist, W. E., and Dronkert, A. E. 1998. River otter. In Wild furbearer management and conservation in North America. Edited by M. Novak, J.A. Baker, M.E. Obbard, and B. Malloch. Ontario Ministry of Natural Resources, Peterborough, ON. 626-641 pp.

Mergler, D., Anderson, H.A. Chan, L. H. M., Mahaffey, K.R., Murray, M., Sakamoto, M., and Stern, A.H. Methylmercury Exposure and Health Effects in Humans: A Worldwide Concern. Ambio 36(1): 3-11 pp.

Miller, D. R., and Robertson, J. D. 1967. Results of tagging caribou at Little Duck Lake, Manitoba. Journal of Wildlife Management 31: 150-159 pp.

Miller, P., and Ehnes, J.W. 2000. Can Canadian approaches to sustainable forest management maintain ecological integrity? In Ecological integrity: Integrating environment, conservation and health. Edited by D. Pimentel, L. Westra and R. F. Noss. Island Press, Washington, D.C. 157-175 pp.

Mladenoff, D. J., Sickley, T. A., Haight, R. G., and Wydeven, A. P. 1995. A regional landscape analysis and prediction of favorable gray wolf habitat in the northern Great Lakes region. Conservation Biology 9 (2): 279-294 pp.

Mowat, G., Poole, K. G., and O'Donoghue, M. 1999. Ecology of lynx in northern Canada and Alaska. In Ecology and conservation of lynx in the United States. United States Department of Agriculture Forest Service Rocky Mountain Research Station General Technical Report RMRS-GTR-30WWW. 265-306 pp.

Murray, D. L., Cox, E. W., Ballard, W. B., Whitlaw, H. A., Lenarz, M. S., Custer, T. W., Barnett, T., and Fuller, T. K. 2006. Pathogens, nutritional deficiency, and climate influences on a declining moose population. Wildlife Monographs 166: 1-30 pp. doi:10.2193/0084-0173(2006)166[1:PNDACI]2.0.CO;2.

MWS (Manitoba Water Stewardship). 2011a. Manitoba Water Quality Standards, Objectives, and Guidelines. Water Science and Management Branch, MWS. MWS Report 2011-01, July 4, 2011.

MWS. 2011b. Manitoba Water Quality Standards, Objectives, and Guidelines. Water Science and Management Branch, MWS. MWS Report 2011-01, November 28, 2011.

Naiman, R. J., Melillo, J. M., and Hobbie, J. E. 1986. Ecosystem alteration of boreal forest streams by beaver (*Castor canadensis*). Ecology 67(5): 1254-1269 pp.

Nalcor Energy. 2009. Existing mercury concentrations in osprey and ecological risk assessment. Mercury, Report 3 of 5, Environmental Impact Statement for the Lower Churchill Hydroelectric Generation Project.

National Wetlands Working Group. 1997. The Canadian Wetland Classification System. 2nd Ed. Edited by B.G. Warner and C.D.A. Rubec. Wetlands Research Centre, University of Waterloo, Waterloo, ON. Natural Resources Canada. 2008. Earthquake map of Canada: Earthquakes in or near Canada, 1627 - 2010 [online]. Available at http://www.earthquakescanada.nrcan.gc.ca/historic-historique/caneqmap-eng.php [accessed March, 2010].

NatureServe. 2011. NatureServe Explorer: An online encyclopedia of life. Version 7.1. [online]. Available at http://www.natureserve.org/explorer. [Accessed December 15, 2011].

NCN (Nisichewayesik Cree Nation). 2011 Wuskwatim News Letter. Wuskwatim Implementation Office, Nelson House, MB.

Nielsen, E. C.S. Churcher, G. E. Lammers. 1988. A woolly mammoth (*Proboscidea, Mammuthus primigenius*) molar from the Hudson Bay Lowland of Manitoba. Canadian Journal of Earth Sciences 25: 933-938 pp.

NLHS (Northern Lights Heritage Services Inc.). 2001a. Keeyask Powistick (Gull Rapids) Generating Station Cultural and Physical Heritage Area Characterization Study. Manuscript on file Northern Lights Heritage Services Inc. Winnipeg, MB.

NLHS. 2001b. Keeyask Powistick (Gull Rapids) Heritage Resource Impact Assessment: 2001. Manuscript on file Northern Lights Heritage Services Inc., Winnipeg, MB.

NLHS. 2002a. Gull Rapids (Keeyask) Generating Station: Heritage Resource Impact Assessment (Year I): Fox Lake Cree Nation (Interim Report 02-01). Manuscript on file Northern Lights Heritage Services Inc. Winnipeg, MB.

NLHS. 2002b. Gull (Keeyask) Project Generating Station: Report # 02-04 Heritage Resource Impact Assessment Fox Lake Cree Nation (Final Report). Manuscript on file Northern Lights Heritage Services Inc. Winnipeg, MB.

NLHS. 2003a. Keeyask Project: Generating Station: Heritage Resource Impact Assessment: Gull Rapids Camp. Manuscript on file Northern Lights Heritage Services Inc. Winnipeg, MB.

NLHS. 2003b. Keeyask Project: Generating Station: Heritage Resource Impact Assessment of Gull (Keeyask) Rapids. Manuscript on file Northern Lights Heritage Services Inc., Winnipeg, MB.

NLHS. 2003c. Keeyask Project Heritage Resource Impact Assessment: Archaeological Survey of Stephen's and Fox (Atikinson) Lakes. Manuscript on file Northern Lights Heritage Services Inc., Winnipeg, MB.

NLHS. 2004a. Keeyask Project Generating Station: Heritage Resource Impact Assessment Gull (Keeyask) Rapids. Manuscript on file Northern Lights Heritage Services Inc., Winnipeg, MB.NLHS. 2005a. Gull (Keeyask) Project: Generating Station: Heritage Resource Impact Assessment. Manuscript on file Northern Lights Heritage Services Inc., Winnipeg, MB.

NLHS. 2005b. Participatory Action Research, Tataskweyak Cree Nation Student Archaeological Program. Manuscript on file Northern Lights Heritage Services Inc., Winnipeg, MB.

NLHS. 2005c. Keeyask Projects: Heritage Resource Impact Assessment: Archaeological Investigation at the Paradise Beach Site on Fox (Atkinson) Lake. Manuscript on file Northern Lights Heritage Services Inc., Winnipeg, MB.

NLHS. 2006a. Gull (Keeyask) Project: 2005 Kettle Lake Comparison Study. Manuscript on file Northern Lights Heritage Services Inc., Winnipeg, MB.

NLHS. 2006c. Keeyask (Gull) Project: Bryant's Point Component Archaeological Field Investigation Component Heritage Resource Impact Assessment. Manuscript on file Northern Lights Heritage Services Inc., Winnipeg, MB.

NLHS. 2006d. Archaeological Survey of the Northwest Arm of Stephens Lake, Manitoba. Manuscript on file Northern Lights Heritage Services Inc. Winnipeg, MB.

NLHS. 2007a. Keeyask Projects: 2006 Archaeological Survey of Kettle Lake, Manitoba, Comparative Study for the Heritage Resource Impact Assessment. Manuscript on file Northern Lights Heritage Services Inc. Winnipeg, MB.

NLHS. 2007b. Keeyask (Gull) Project: 2006 Fox Lake Comparative Study Component. Manuscript on file Northern Lights Heritage Services Inc. Winnipeg, MB.

NLHS. 2007c. Keeyask Generating Station: Archaeological Field Investigation Component Clark Lake Archaeological Survey. Manuscript on file Northern Lights Heritage Services Inc. Winnipeg, MB.

NLHS. 2008a. Keeyask Generating Station 2007 Archaeological Field Investigation Component Clark Lake Archaeological Survey, Heritage Resource Impact Assessment. Manuscript on file Northern Lights Heritage Services Inc. Winnipeg, MB.

NLHS. 2008b. Keeyask Generating Station 2007 Archaeological Field Investigation Component Carscadden Lake and Portage (Pisitif) Creek; Archaeological Survey Heritage Resource Impact Assessment. Manuscript on file Northern Lights Heritage Services Inc. Winnipeg, MB.

NLHS. 2009a. Keeyask Generating Station 2008 Archaeological Field Investigation Component: Carscadden Lake Archaeological Survey Heritage Resource Impact

Assessment (HRIA). Manuscript on file Northern Lights Heritage Services Inc. Winnipeg, MB.

NLHS. 2009b. Keeyask Generating Station 2008 Archaeological Field Investigation Component Clark Lake Archaeological Survey Heritage Resource Impact Assessment. Manuscript on file Northern Lights Heritage Services Inc. Winnipeg, MB.

NLHS. 2009c. Keeyask Generating Station 2008 Archaeological Field Investigation Component Pointe West Site (HbKx-2) Formal Excavation. Manuscript on file Northern Lights Heritage Services Inc. Winnipeg, MB.

NLHS. 2009d. Keeyask Infrastructure Project 2009 HRIA Startup and Main Camp (Phase 1). Manuscript on file Northern Lights Heritage Services Inc. Winnipeg, MB.

NLHS. 2009e. Keeyask Generation Project 2009 HRIA of Impervious and Granular Borrow Areas. Manuscript on file Northern Lights Heritage Services Inc. Winnipeg, MB.

NLHS. 2009f. Keeyask Generation Project 2009 Monitoring of Drill Testing on Caribou Island. Manuscript on file Northern Lights Heritage Services Inc. Winnipeg, MB.

NLHS. 2009g. Keeyask Generation Project 2009 HRIA of North and South Retaining Dikes. Manuscript on file Northern Lights Heritage Services Inc. Winnipeg, MB.NHLS. 2009h. Keeyask Transmission Project Heritage Resource Impact Assessment Study. October 2009. Northern Lights Heritage Services.

NLHS. 2009i. Keeyask Heritage Handbook. Manuscript on file with Northern Lights Heritage Services, Winnipeg MB.NLHS. 2010a. Keeyask Generation Project 2009 Archaeological Field Investigations: Excavation of the Pointe West Site (HbKx-02), a Proxy Site Investigated for the Keeyask Generation Project HRIA. Manuscript on file Northern Lights Heritage Services Inc. Winnipeg, MB.NLHS. 2010b. Keeyask Generation Project 2010 Archaeological Survey Investigations: Cache Lake Heritage Resource Impact Assessment. Manuscript on file Northern Lights Heritage Services Inc. Winnipeg, MB.NLHS. 2011a. Keeyask Generation Project 2010: Archaeological Field Investigations: Borrow Areas and William Smith Island. Manuscript on file Northern Lights Heritage Services Inc. Winnipeg, MB.NLHS. 2011b. Keeyask Generation Project 2010 Archaeological Field Investigations: Excavation of the Pointe West Site (HbKx-02), a Proxy Site Investigated for the Keeyask Generation Project HRIA. Manuscript on file Northern Lights Heritage Services Inc. Winnipeg, MB.NLHS. 2011c. Keeyask Generation Project 2011 South Access Road Butnau River Crossing HRIA. Manuscript on file Northern Lights Heritage Services Inc. Winnipeg, MB.

NMEDC (Northern Manitoba Economic Development Commission). 1992. Northern Manitoba: A benchmark report. Thompson, MB.

Noss, R. F., Quigley, H. B., Hornocker, M. G., Merrill, T., and Paquet, P. C. 1996. Conservation biology and carnivore conservation in the Rocky Mountains. Conservation Biology 10(4): 949-963pp.

NRPI (National Pollutant Release Inventory). 2009. National, Provincial and Territorial Emissions Summaries for Key Air Pollutants [online]. Available from www.ec.gc.ca/inrp-npri [accessed June 19, 2012].

NSC (North/South Consultants Incorporated). 2009. Limestone Generating Station: aquatic environment monitoring - a synthesis of results 1985-2003. North/South Consultants Inc., Winnipeg, MB.

NSC and Normandeau Associates Incorporated. 2009. Survival and movement of fish experimentally passed through a re-runnered turbine at the Kelsey Generating Station, 2008. A report prepared for Manitoba Hydro by North/South Consultants Inc., Winnipeg, MB and Normandeau Associates Inc.

NWT (Northwest Territories). 2012. Environment and Natural Resources, State of the Environment Report. http://www.enr.gov.nt.ca/_live/pages/wpPages/soe_wildlife_biodiversity.aspx, [Accessed 2012].

Oehler, J. D., and Litvaitis, J. A. 1996. The role of spatial scale in understanding responses of medium-sized carnivores to forest fragmentation. Canadian Journal of Zoology 74: 2070-2079 pp.

Paradiso, J. L., and Nowak, R. M. 1982. Wolves *Canis lupus* and allies. In wild mammals of North America: biology, management, and economics. Edited by J. A. Chapman and G.A. Feldhamer. Johns Hopkins University Press, Baltimore, MD. 232-325 pp.

Parker Nash, R., and Auerhahn, K. 1998. Alcohol, drugs, and violence. Annual review of Sociology. 24: 291-311 pp. doi:10.1146/annurev.soc.24.1.291

Payne, N. F. 1989. Population dynamics and harvest response of beaver. Fourth Eastern Wildlife Damage Control Conference.

PD SV (Project Description Supporting Volume). 2012. Keeyask Generation Project Environmental Impact Statement. Project Description Supporting Volume.

Penner, L.A., and Boals, R.G. 2000. A numerical model for predicting shore erosion impacts around lakes and reservoirs. In Proceedings: 3rd Annual Canadian Dam Association Conference, Regina SK. 75-84 pp.

Person, D. K., and Russell, A. L. 2008. Correlates of mortality in an exploited wolf population. Journal of Wildlife Management 72 (7): 1540-1549 pp.

PE SV (Physical Environment Supporting Volume). 2012. Keeyask Generation Project Environmental Impact Statement. Physical Environment Supporting Volume.

Petch, V. 1999. Criteria and indicators for naturalized knowledge. Framework and workshop proceedings prepared for the Prince Albert Model Forest and the Naturalized Knowledge Working Group. 5-19 pp.

Petch, V. 2003. Archaeological Evidence of Pre-Contact Seasonal Movement Between Fox and Gull Lakes in Northern Manitoba, Preliminary Report. Paper presented at the Manitoba Archaeological Society Conference, Winnipeg, MB November 1, 2003.

Peterson, R. T. 2002. Birds of Eastern and Central North America. 5th ed. Houghtom Mifflin Company, Boston, Massachusetts. 132-167 pp.

Petit, D.R., J.F. Lynch, R.L. Hutto, J.G. Blake and R.B. Waide. 1993. Management and conservation of migratory landbirds overwintering in the neotropics. In Status and management of neotropical migratory birds. Edited by D.M. Finch and P.W. Stangel.. USDA Forest Service General Technical Report RM-229. 70-92 pp.

Phillips, R. L., Berg, W. E., and Siniff, D. B. 1973. Moose movement patterns and range use in northwestern Minnesota. Journal of Wildlife Management 37(3): 266–278 pp.

Pisiak, D.J. 2009. Limestone Generating Station forebay movements study: 2005-2007 synthesis report. North/South Consultants Inc., Winnipeg, MB.

PI SV (Public Involvement Supporting Volume). 2012. Keeyask Generation Project Environmental Impact Statement. Public Involvement Supporting Volume.

Poulin, R.G., S.D. Grindal, and R.M. Brigham. 1996. Common nighthawk (*chordeiles mino*r). In the birds of North America, No. 213. Edited by A. Poole and F. Gill.. The Academy of Natural Sciences, Philadelphia, PA, and the American Ornithologists' Union, Washington, D.C.

Preble, E. A. 1902. A biological investigation of the Hudson Bay region. North American Fauna No. 22. United States Department of Agriculture, Washington, D.C.

Prentice, S. 2007. Less access, worse quality: New evidence about poor children and childcare in Canada. Journal of Children and Poverty. 13 (1): 57-73 pp.

Preston, W. B. 1982. The amphibians and reptiles of Manitoba. Manitoba Museum of Man and Nature, Winnipeg, MB.

Prevett, J., I. Marshall and V. Thomas. 1985. Spring foods of Snow and Canada Geese at James Bay. Journal of Wildlife Management. 49(3): 558-563 pp.

Quaternary Consultants. 1991. Preliminary Archaeological Reconnaissance of the Gull Lake/Gull Rapids Area. Prepared for Manitoba Hydro, Winnipeg, MB.

Quigley, R.L., den Broeder, P., Furu, A., Bond, B., Cave and Bos, R. 2006. Health Impact Assessment International Best Practice Principles. Special Publication Series No. 5. Fargo, USA: International Association for Impact Assessment. 5-8 pp.

Rabení, C.F., Doisy, K.E., and Zweig, L.D. 2005. Stream invertebrate community functional responses to deposited sediment. Aquatic Science 67: 395-402 pp.

Raphael, D. 2004. Social Determinants of Health in Canada: Canadian Perspectives. Canadian Scholars' Press, Toronto: ON.

Resource Tourism Operators Act, S.M. 2002, c. C-46.

Rettie, W. J., and Messier, F. 2000. Hierarchical habitat selection by woodland caribou: its relationship to limiting factors. Ecography 23: 466–478 pp.

RNFB (Revised Northern Flood Basket). 2008a. Food price survey: Food mail program. June 9, 2008.

RNFB. 2008b. Price selection procedure for the revised northern food basket (2007). July 10, 2008.

Rosell, F., O. Bozsér, O., Collen, P., and Parker, H. 2005. Ecological impact of beavers *Castor fiber and Castor canadensis* and their ability to modify ecosystems. Mammal Review 35 (3 and 4): 248–276 pp.

Rosenberg, D.M., and A.P. Wiens. 1978. Effects of sediment addition on macrobenthic invertebrates in a northern Canadian river. Water Research 12: 753-763 pp.

RRCS (Renewable Resources Consulting Services Limited). 1994. A review of the literature pertaining to the effects of noise and other disturbance on wildlife. Technical Report No. 7. EIS: military flight training. Department of National Defence. 155 pp.

Rupp, T. S., Olson, M., Adams, L. G., Dale, B. W., Joly, K., Henkelman, J., Collins, W. B., and Starfield, A. M. 2006. Simulating the influences of various fire regimes on caribou winter habitat. Ecological Applications 16(5): 1730–1743 pp.

Rusch, D. H., S. Destefano, M. C. Reynolds and D. Lauten. 2000. Ruffed Grouse (*Bonasa umbellus*) [online]. In The Birds of North America Online. Edited by A. Poole. Ithaca: Cornell Lab of Ornithology. Available from http://bna.birds.cornell.edu/bna/species/515 doi:10.2173/bna.515

Salmo Consulting Inc. Diversified Environmental Services, GAIA Consultants Inc. Forem Technologies Ltd. and AXYS Environmental Consulting Ltd. 2003. CEAMF Study: Volume 2. Cumulative Effects Indicators, Thresholds and Case Studies. The BC Oil and Gas Commission and the Muskwa Kechika Advisory Board.

Salmo Consulting Inc., Axys Environmental Consulting Ltd., Forem Technologies and Wildlife and Company Ltd. 2004. Deh Cho Cumulative Effects Study Phase 1: Management Indicators and Thresholds. Prepared for: Deh Cho Land Use Planning Committee. Fort Providence, NWT.

Scheuhammer, A. M., Meyer, M. W., Sandheinrich, M. B., and Murray, M. W. 2007. Effects of methylmercury on the health of wild birds, mammals, and fish. Ambio 36(1): 12-18 pp.

Schieck, J.O., and Hannon, S.J. 1989. Breeding site fidelity in willow ptarmigan: the influence of previous reproductive success and familiarity with partner and territory. Oecologia 81: 465-472 pp.

Schoen, J. W. 1990. Bear habitat management: a review and future perspective. International Conference on Bear Research and Management 8: 143–154 pp.

Schroeder, M.A. 1985. Behavioural differences of female Spruce grouse undertaking short and long migrations. Condor 85: 281-286 pp.

Semple, R.K., and Barr, W. 1982. Northern Development and the Environment: Proceedings of the 5th Annual Meeting of the Prairie Division of the Canadian Association of Geographers, Saskatoon, September 1981. 1-78 pp.

Service Canada, Manitoba Labour Market Information Team. 2009a. Labour market bulletin, April 2009 [online]. Available from www.servicecanada.gc.ca/eng/mb/2009/LMB0409.pdf [accessed November 4, 2009].

SE SV (Socio-Economic Environment, Resource Use and Heritage Resources Supporting Volume). 2012. Keeyask Generation Project Environmental Impact Statement. Socio-Economic Environment, Resource Use and Heritage Resources Supporting Volume.

Sheridan, G.J., and P.J. Noske. 2007. A quantitative study of sediment delivery and stream pollution from different forest road types. Hydrological Processes 21: 387-398 pp.

Shoesmith, M. W., and Storey, D. R. 1977. Movements and associated behaviour of woodland caribou in central Manitoba. Manitoba Department of Renewable Resources and Transportation Services, Research MS Rep. 77(15): 24 pp.

Smith, J. 1974. Proscription of Cross-Cousin Marriage among the Southwestern Ojibwa. 1974. American Ethnologist. 1(4): 751-762 pp.

Smith, R.E., Veldhuis, H., Mills, G.F., Eilers, R.G., Fraser, W.R., Lelyk, G.W. 1998. Terrestrial Ecozones, Ecoregions, and Ecodistricts of Manitoba: an ecological stratification of Manitoba's natural landscape. Land Resource Unit, Brandon Research Centre, Research Branch, Agriculture and Agri-Food Canada.

Smith, D. W., and Peterson, R. O. 1991. Behavior of beaver in lakes with varying water levels in northern Minnesota. Environmental Management 15(3): 395–401 pp.

Split Lake Cree – Manitoba Hydro Joint Study Group. 1996a. Analysis of Change: Split Lake Cree Post Project Environmental Review. Support from William Kennedy

Consultants Ltd. and InterGroup Consultants Ltd. Split Lake Cree – Manitoba Hydro Joint Study Group; vol. 1 of 5.

Split Lake Cree – Manitoba Hydro Study Group. 1996b. History and First Order Effects: Split Lake Cree post project environmental review. Support from William Kennedy Consultants Ltd. and InterGroup Consultants Ltd. Split Lake Cree – Manitoba Hydro Joint Study Group: Volume 2 of 5.

Split Lake Cree – Manitoba Hydro Joint Study Group. 1996c. Environmental Matrices: Summary of Manitoba Hydro Impacts - Split Lake Cree Post Project Environmental Review. Support from William Kennedy Consultants Ltd. and InterGroup Consultants Ltd. Split Lake Cree - Manitoba Hydro Joint Study Group; vol. 3 of 5.

Split Lake Resource Management Board. 1994. Moose Conservation Plan 1993/94. Split Lake, Manitoba.

Stevens, D. R. 1970. Winter ecology of moose in the Gallatin Mountains, Montana. Journal of Wildlife Ecology 34 (1): 37–46 pp.

Statistics Canada. 2002. 2001 CSD Profiles of Manitoba. Beyond 20/20 CD-ROM. Data adapted by InterGroup Consultants Ltd.

Statistics Canada. 2007. 2006 CSD Profiles of Manitoba. Beyond 20/20 CD-ROM. Data adapted by InterGroup Consultants Ltd.

Statistics Canada. 2011. 2001 Census of Canada: Aboriginal population profiles [online]. Available from http://www12.statcan.gc.ca/english/profil01/AP01/Index.cfm?Lang=E [accessed September 7, 2011].

Steffler, J. 2008. Aboriginal peoples: A young population for years to come. Hope or heartbreak: Aboriginal youth and Canada's future. Horizons Policy Research Initiative 10(1): 13-20 pp.

Storch, A.J., Chapman, C.G., and Jones, T.A. 2008. Report A: White sturgeon mitigation and restoration in the Columbia and Snake rivers upstream from Bonneville Dam: Annual Progress Report, April 2007 - March 2008. In Evaluate the success of developing and implementing a management plan for enhancing production of white sturgeon in reservoirs between Bonneville and McNary dams: An update of abundance, life history parameters, and population dynamics of white sturgeon in John Day Reservoir, and a summary of annual recruitment of age-0 white sturgeon in four Columbia River reservoirs. Edited by C. Mallette. Prepared for US Department of Energy, Bonneville Power Administration, and Environment Fish and Wildlife, Portland, OR.

Storch, I. 2000. Grouse Action Plan 2000-2004. Available from www.gct.org.uk/gsg/grousesp/willow.htm [accessed May 2010].

Sustainability Manitoba. Undated. Applying Manitoba's Water Policies [online]. Available from http://www.gov.mb.ca/waterstewardship/licensing/mb_water_policies.pdf [accessed June 17, 2012].

The Sustainable Development Act, C.C.S.M. 1997, c. S-270, s. 2

TCN (Tataskweyak Cree Nation). 2000a. Tataskweyak Cree Nation terrestrial animal habitats in Gull area (map). Contact Hobbs and Associates for Map. Tataskweyak Cree Nation, MB.

TCN. 2000b. Tataskweyak Cree Nation traditional pursuits within Gull area (map). Contact Hobbs and Associates for Map. Tataskweyak Cree Nation, MB.

TCN and Manitoba Hydro. 2009. TCN adverse effects agreement [online]. Available from http://www.hydro.mb.ca/projects/keeyask/tataskweyak_aea.pdf [accessed October 26, 2011].

TCN, WLFN, YFFN, FLCN and the Manitoba Hydro-Electric Board. 2009. Joint Keeyask Development Agreement [online]. Available from http://www.hydro.mb.ca/projects/keeyask/pdf/JKDA_090529.pdf [accessed June 7, 2012].

TE SV (Terrestrial Environment Supporting Volume). 2012. Keeyask Generation Project Environmental Impact Statement. Terrestrial Environment Supporting Volume.

Thiel, R. P. 1985. Relationship between road densities and wolf habitat suitability in Wisconsin. American Midland Naturalist 113: 404-407 pp.

Thomas, D. C., and Gray, D. R. 2002. Update COSEWIC status report on the woodland caribou *Rangifer tarandus caribou* in Canada. Committee on the Status of Endangered Species in Canada, Ottawa, ON.

Thurber, J. M., Peterson, R. O., Drummer, T. D., and Thomas, S. A. 1994. Gray wolf response to refuge boundaries and roads in Alaska. Wildlife Society Bulletin 22: 61-68 pp.

Thompson, J.E., and Abraham, K.F. 1994. Range, seasonal distribution and population dynamics of the Pen Islands caribou herd of southern Hudson Bay: final report. Ontario Ministry of Natural Resources, Moosonee, ON.

City of Thompson. 2010. Thompson and Planning District Sustainable Community Plan [online]. Prepared by AECOM. Available from http://www.thompson.ca/index.aspx?page=167 [accessed January 15, 2012].

Thompson KPI Program. 2008-2010. Research undertaken by InterGroup Consultants that included a series of key person interviews with a cross-section of community representatives.

Transportation Association of Canada. 2005. National Guide to Erosion and Sediment Control on Roadway Projects [online]. Available from http://www.tac-atc.ca/english/projects/enviro-practice.cfm [accessed on June 13, 2012].

Transport Canada. 2011. Urban Transportation Emission Calculator – Fuel Efficiency by Vehicle Class [online]. Available from http://wwwapps.tc.gc.ca/Prog/2/UTEC-CETU/FuelEfficiency.aspx?lang=eng [accessed June 20, 2012].

Travel Manitoba. 2011. Travel Manitoba Business Plan 2011to 2014. [online]. Available fromhttp://www.travelmanitoba.com/TI/About/ReportsandPublications/BusinessPlan/&node=5090 [accessed April 30, 2012].

U.S. EPA (Environmental Protection Agency) Office of Noise Abatement and Control. 1978. Protective Noise Levels: Condensed Version of EPA Levels Document EPA 550/9-79-100.

U.S. EPA. 1995. Compilation of air pollutant emission factors, Volume 1: Stationary point and area sources. AP 42, Fifth Edition [online]. Available from http://www.epa.gov/ttn/chief/ap42/index.html [accessed June 15, 2012].

U.S. Army Corps of Engineers. 1993. HEC-6, Scour and deposition in rivers and reservoirs: user's manual (Version 4.1) [online]. Available from http://www.hec.usace.army.mil/software/legacysoftware/hec6/hec6.htm [accessed June 20, 2012].

Vitt, D.H., Halsey, L.A., and Zoltai, S.C.. 1994. The bog landforms of continental western Canada in relation to climate and permafrost patterns. Arctic and Alpine Research 26: 1-13 pp.

Wagner, D. 1991. The "1-in-20 rule" for plant collectors. Plant Science Bulletin 37(2):11

Wilson Scientific Consulting Inc. 2012. Human Health Impact Assessment of the Mercury from the Proposed Keeyask Generation Project (Draft). Prepared by Wilson Scientific Consulting Inc., Vancouver, BC for InterGroup Consultants Ltd.

World Commission on Environment and Development. 1987. Report of the World Commission on Environment and Development: Our Common Future. Oxford University Press, Oxford, UK.

World Health Organization (WHO). 2009. Health impact assessment: The Determinants of Health [online]. Available from http://www.who.int/hia/evidence/doh/en [accessed December 15, 2009].

WLFN (War Lake First Nation). 2002. War Lake OWL process: Keeyask Project, July 2002. War Lake First Nation, Ilford, MB.

WLFN and Manitoba Hydro-Electric Board. 2009. Adverse Effects Agreement [online]. Available from http://www.hydro.mb.ca/projects/keeyask/war_lake_aea.pdf [accessed June 12, 2012].

Witmer, G, W., Martin, S. K., and Sayler, R. D. 1998. Forest carnivore conservation and management in the Interior Columbia Basin: issues and environmental correlates. United States Department of Agriculture Forest Service, Pacific Northwest Research Station General Technical Report PNW-GTR-420. Portland, Oregon, USA. 54 pp.

Wren, C. D. 1986. A review of metal accumulation and toxicity in wild animals. Environmental Research 40: 210-244 pp.

Wright, D.G., and Hopky, G.E. 1998. Guidelines for the use of explosives in or near Canadian fisheries waters. Canadian Technical Report of Fisheries and Aquatic Sciences 2107: iv + 34 pp.

Wright, J. P., Jones, C. G., and Flecker, A. S. 2002. An ecosystem engineer, the beaver, increases species richness at the landscape scale. Oecologia 132: 96–101 pp.

Wright, J.V. 1996. The Grant Lake Site, Keewatin District, N.W.T. National Museum of Man Mercury Series. Archaeological Survey of Canada, Paper No. 47. Ottawa.

Wund, M.A. 2006. Variation in the echolocation calls of little brown bats (*Myotis lucifugus*) in response to different habitats. American Midland Naturalist 156: 99-108 pp.

Yanes, M., J. M. Velaso and F. Suarez. 1995. Permeability of roads and railways to vertebrates: The importance of culverts. Biological Conservation, 71: 217-222 pp.

YFFN. 2010. Community History Report: York Factory First Nation traditional values, occupancy and community history project. Final Report. March 2010. Future Development Office, York Landing, MB.

YFFN (York Factory First Nation) Evaluation Report (*Kipekiskwaywinan*): Our Voices . 2012. Support from Hilderman, Thomas, Frank, Cram and Northern Light Heritage Services. York Landing, MB. June 2012.YFFN and HTFC. 2002. Initial Community-based Environmental Overview, Proposed Keeyask Hydro Project. Final Report. May 2002, Copyedit June 2011. York Landing, MB.

YFFN and HTFC. 2004a. Socio-Economic Baseline and Sustainability Indicators, York Factory First Nation – 2004. Final Report September 2004. York Landing, MB.

YFFN and HTFC. 2004b. Community-identified Socio-Economic Conditions and Future Priorities: A Background Report- Environmental Assessment Proposed Keeyask Project. Final Report April 2004. York Landing, MB.

YFFN and Manitoba Hydro. 2009. YFFN adverse effects agreement [online]. Available from http://www.hydro.mb.ca/projects/keeyask/york_aea.pdf [accessed October 26, 2011].YFFN KPI Program 2009-2010: Community-based research undertaken with York Factory Community Coordinator and Community Researchers that included a series of key person interviews and workshops on a variety of topics.

PERSONAL COMMUNICATIONS

Bazin, Ron. 2012. Conversation and emails with James Ehnes from May 15 to 17, 2012.

Beardy, Larry. 2011. TCN Member. Letter to Ryan Kustra, Manitoba Hydro. November 18, 2011.

Hunt, D. 2011, 2012. Superintendent, Forestry and Planning. Woodlands Division, Tolko Industries (Manitoba) Ltd. The Pas, Manitoba.

Manitoba Hydro. Telephone, email and personal communications. 2011 and 2012.

MacDonald, Don. 2009. Fisheries Manager, Manitoba Conservation and Water Stewardship. Workshop with Don MacDonell and Gaylen Eaton, North/South Consultants Inc., Thompson, MB, February 18, 2009.

Ouskan, Kenneth. 2011. Field Assistant during boat-based surveys at Gull Lake. Bird, Manitoba. Conversations with Leane Wyenberg and Angèle Watrin Prodaehl, Stantec Consulting Ltd., Gillam, Manitoba, June, 2011.

Suffron, Ryan. 2009. Executive Director, Manitoba Lodge and Outfitters Association. In-person interview with Gaylen Eaton, North/South Consultants Inc., and Kristin Kent, InterGroup Consultants Ltd., Winnipeg, MB, August 5, 2009.

Tetrault, T. 2011. Gillam Childcare Facility. Personal Communication with D. McGregor of InterGroup Consultants on July 21, 2011.

Whitaker, John. 2012a. CNP Advisor. Telephone conversation with Gaylen Eaton, North/South Consultants Inc., Winnipeg, MB, May 7, 2012.

Whitaker, John. 2012b. CNP Advisor. Telephone conversation with North/South Consultants Inc., Winnipeg, MB, June 25, 2012.

GLOSSARY

GLOSSARY

Abiotic: A nonliving physical or chemical attribute of a system, *e.g.*, light, temperature, wind patterns, rocks, soil, pH, pressure, *etc.*

Aboriginal traditional knowledge (ATK): 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 Agency).

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

Acoustic-transmitter: A transmitter that emits signals detected by stationary or mobile acoustic receivers; used to track movements of fish when surgically implanted in the abdomen.

Acute toxicity: The ability of a substance to cause severe biological harm or death soon after a single exposure or dose. Also, any poisonous effect resulting from a single short-term exposure to a toxic substance.

Adaptive management: Involves the implementation of new or modified mitigation measures over the life of a project to address its unanticipated environmental effects (*Canadian Environmental Assessment Act*).

Adult sturgeon: Lake sturgeon 834 mm long or greater (fork length) were assumed to be adults where sexually maturity was not evident at the time of sampling. This benchmark was based on sexual maturity data collected during the spawning season from a well-studied lake sturgeon population on the Lower Nelson River.

Advect: A horizontal movement of a mass of fluid, such as ocean or air currents; can also refer to the horizontal transport of something such as sediment.

Agreement-in-Principle (AIP): The agreement in principle made between Manitoba Hydro and TCN dated October 17, 2000. WLFN signed the AIP in July 2003.

Algae (a; al): A group of simple plant-like aquatic organisms possessing chlorophyll and capable of photosynthesis; they may be attached to surfaces or free-floating; most freshwater species are very small.

Allocation: For the purposes of the EIS, a parcel of land assigned to an outfitter or lodge operator to carry out their guiding services.

Alluvial: Pertaining to of composed of alluvium; clay, silt, sand, gravel, or similar detrital material deposited by running water.

Alpha diversity: The diversity within a particular area or ecosystem, and is usually expressed by the number of species (*i.e.*, species richness) in that ecosystem.

Alternating current (AC): An electric current that reverses its direction (positive/negative values) at regular intervals. See direct current.

Amphibians: Cold-blooded animal of the Class Amphibia that typically lives on land but breeds in water (*e.g.*, frogs, toads, salamanders).

Amphipod: A shrimp-like crustacean most often found in marine or fresh water environments, but also represented by terrestrial species (sand fleas).

Analytical detection limit: The lowest concentration of a substance that can be confidently measured using a particular analytical procedure.

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

Annelid: Segmented worms, such as earthworms and leeches, found in most wet environments.

Anoxic: Absence of oxygen.

Apprentice: A person who is learning a trade from a skilled employer, having agreed to work for a fixed period at low wages.

Apprenticeship: A system of training and certification in established trades — a way for people to obtain the credentials required for work in many important skilled trades. Apprenticeship is also a training model that combines on-the-job learning with the learning of theory.

Aquatic: Living or found in or near water.

Aquatic environment: All organic and inorganic matter and living organisms and their habitats that are related to or are located in or on the water, beds, or shores of a water body.

Aquatic peatland: Peatland that borders a water body or waterway. The portion adjacent to the water is usually floating.

Aquifer: An underground bed or layer of earth, gravel or porous stone that yields water.

Arboreal: Of or relating to trees.

Archaeology: The science and/or methods concerned with the recovery, description, analysis and explanation of the physical remains of past human cultures.

Area of special interest: An official designation of the Province of Manitoba that identifies "candidate sites" which have not been protected in any formal manner but have a high potential to protect groupings of enduring features and associated natural and cultural values.

Arthropod: The largest group within the animal kingdom, containing several million species; characterised by a rigid external skeleton and paired jointed legs.

Assimilation: The process of absorbing nutrients into the body after digestion.

Autotroph: An organism capable of synthesizing its own nutritional organic substances from inorganic compounds, such as CO_2, green plants, algae, and certain bacteria..

Availability (economic context): For those who are interested in work on the construction site, there are factors which may limit their availability to take advantage of these opportunities. These could include the extent to which a candidate maintains their status in the job referral system (there is a need to renew status every 6 months or the profile is considered dormant), the ability of the contractor to contact a referred candidate, a candidate's interest in the specific job opportunity once contacted, and the ability of the candidate to make arrangements to get to the job site.

Backbay: Area in a river or stream isolated from the main flow where water velocities are typically low or nonexistent.

Backflooding: Intentionally flooding the work area behind a cofferdam to minimize erosion during cofferdam removal.

Backwater effect: In hydrologic terms, the effect that a dam or other obstruction has in raising the surface of the water upstream from it.

Bank recession: Rate at which the bank erodes inland.

Bankfull: Water surface elevation at which a stream first overflows its natural banks.

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

Base metal: A metal that is common and not considered precious (*e.g.*, iron, nickel, lead, zinc).

Basin: A distinct section of a lake, separated from the remainder of the lake by a constriction.

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

Bathymetry: Measurements of water depth of a lake or river.

Bayline: Refers to communities along the Hudson Bay railroad from Thompson to Churchill.

Bed load: Sediment or other material that slides, rolls, or bounces along the streambed or channel bed of flowing water.

Bed material: Soil material that makes up the bed of the river or lake.

Bed material transport: Sediment particles transported on or near the streambed by rolling, sliding or bouncing.

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

Bench Mark (BM): A point of known or assumed elevation used as a reference in determining other elevations.

Benthic: Relating to the bottom of a waterbody (*e.g.*, lake).

Benthic invertebrate: An animal lacking a backbone that lives on or in the bottom sediments of a waterbody (*e.g.*, mayfly, clam, aquatic earthworm, crayfish).

Benthivore: An animal that feeds on organisms that live on the lake or river bottom (*e.g.*, aquatic insects, molluscs, crustaceans and worms).

Berm: A flat strip of land, raised bank, or terrace bordering a river or canal.

- a path or grass strip beside a road.
- an artificial ridge or embankment, such as one built as a defense against tanks: *berms of shovelled earth*
- a narrow space between a ditch and the base of a parapet.

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.

Bioaccumulate: The accumulation of substances, such as methylmercury, in an organism or part of an organism. Bioaccumulation occurs when a substance is absorbed by an organism at a greater rate than it is lost.

Bioavailability: The availability of substances to be accumulated by biota.

Biodiversity: The variability among living organisms from all sources, including, without limiting the generality of the foregoing, terrestrial and marine and other aquatic ecosystems and the ecological complexes of which they form a part and includes the diversity within and between species and of ecosystems (Canadian Environmental Assessment Agency).

Biological (biochemical) oxygen demand (BOD): A test used to measure the level of pollution in water by determining how much dissolved oxygen is consumed by microorganisms (*e.g.*, bacteria) as they break down organic matter (*e.g.*, plants).

Biomagnification: The increasing concentration of a substance, such as a toxic chemical, in the tissues of organisms at successively higher levels in a food chain.

Biomass: For the purposes of this EIS, the total mass of all living material in a specific area, habitat or region.

Biophysical land classification: A delineation of distinct areas on a map based on soil, surficial deposits, landforms, permafrost and water.

Biota: The animal (fauna) and plant (flora) life of a region.

Black-start: Is the process of restoring electricity to the generation and transmission system during a system wide blackout or outage where 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 stand-by 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.

Blanket peatland: Bog, fen or mixtures of these types with peat of intermediate thickness (*i.e.*, up to approximately 2 m thick) and a featureless surface that cover gentle slopes.

Bog: A type of peatland that receives nutrient inputs from precipitation and dryfall (particles deposited from the atmosphere) only. Sphagnum mosses are the dominant peat forming plants. Commonly acidic and nutrient poor.

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 area: 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').

Boulder: The largest of rock particles, having a diameter greater than 256 mm.

Broad habitat type: The third coarsest level in the hierarchical habitat classification used for the terrestrial assessment. From coarsest to finest, the levels in the habitat classification system are land cover, coarse habitat type, broad habitat type and fine habitat type.

Buffer: An area surrounding a defined geographic area, usually created by locating a line a fixed distance around the area of interest.

Bulkhead gate: 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 Burntwood Nelson Agreement (BNA) is the collective 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 below for definition of collective agreement.)

Cache: A hiding place for concealing and preserving provisions.

Capacity factor: The ratio of average load of a plant or machine, to its maximum capacity rating.

Caribou calving and rearing habitat complex: A habitat mosaic that includes a cluster of islands on lakes or a cluster of islands in peatlands that are comprised mainly of raised peatland areas with black spruce trees surrounded by expansive wetlands or treeless areas. These mosaics or complexes are suitable habitats for summer resident caribou to calve, and/or to raise calves, between May and August. Water or wet habitats provide caribou with increased security and isolation from predators.

Cascade: A small waterfall or series of small waterfalls

Catch-per-unit-effort (CPUE): The number or weight of fish caught in a given time period with a specific equipment.

Chironomid: Non-biting midges that, in their larval form, are members of the benthic macroinvertebrate community.

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

Cladocerans: Small crustaceans that are members of the zooplankton community; commonly known as water fleas.

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.

Climate scenario: A plausible and often simplified representation of the future climate, based on an internally consistent set of climatological relationships, that has been constructed for explicit use in investigating the potential consequences of anthropogenic climate change, often serving as input to impact models. Climate projections often serve as the raw material for constructing climate scenarios, but climate scenarios usually require additional information such as the observed current climate. A "climate change scenario" is the difference between a climate scenario and the current climate.

Climax: The culminating, self-replacing seral stage in plant succession that is relatively stable and persists for long periods relative to other seral stages.

Coarse habitat: The second coarsest level in the hierarchical habitat classification used for the terrestrial assessment. From coarsest to finest, the levels in the habiat classification system are land cover, coarse habitat type, broad habitat type and fine habitat type used for the terrestrial assessment.

Coarse habitat mosaic: Combination of habitat types for the purpose of analysis of data collected on mammal tracking transects.

Coarse habitat type: The second coarsest level in the hierarchical habitat classification used for the terrestrial assessment. From coarsest to finest, the levels in the habitat classification system are land cover, coarse habitat type, broad habitat type and fine habitat type used for the terrestrial assessment.

Cobble: Rocks larger than gravel but smaller than boulders, having a particle diameter between 64 and 256 mm.

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.

Commercial fishing: A fishery where the catch is sold.

Commercial trapping: The capture of furbearers for the sale of furs.

Community: In ecology, a community is an ecological unit composed of a group of organisms or a population of different species occupying a particular area, usually interacting with each other and their environment. For people, a community is a social group of any size, whose members reside in a specific locality.

Compensation agreement: An agreement between a resource developer and a party affected by their development to provide compensation for damages caused by the development.

Concentration: The density or amount of a material suspended or dissolved in a fluid (aqueous) or amount of material in a solid (*e.g.*, sediments, tissue).

Concrete aggregate: Crushed rock or gravel of varying size used in the production of concrete. Aggregate is mixed with sand, cement, and water and other additives to produce concrete.

Conductivity: A measure of the ability of a solution to conduct electrical flow; units are microSiemens per centimetre.

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

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

Copepods: Small crustaceans that are members of the zooplankton community.

Country food: Traditional diet of Aboriginal people, particularly those living in northern regions, includes various forms of meat, fish, waterfowl and berries that can be hunted, fished and gathered from the land.

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

Cryosol: A soil order in the Canadian System of Soil Classification that includes soils having permafrost within 1 m of the surface or within 2 m if the pedon (the smallest unit or volume of soil that contains all the soil horizons of a particular soil type) has been strongly cryoturbated (disturbed as a result of freeze–thaw processes) laterally within the active layer, as indicated by disrupted, mixed, or broken horizons. Cryosols have a mean annual temperature <0°C.

Cumulative effect (impact): The effect on the environment, which results when the effects of a project combine with those of the past, existing, and future projects and activities; the incremental effects of an action on the environment when the effects are combined with those from other past, existing and future actions.

Dabbling duck: Various species of ducks that feed in shallow water, such as mallards, teals and northern shovelers.

Debris: Any material, including floating or submerged items (*e.g.*, driftwood, plants), suspended sediment or bed load, moved by flowing water.

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.

Deleterious: Harmful.

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, and year).

Deposition: Deposition is the process of settling of sediment particles from a state of suspension in water column as a result of reduction in flow velocity or increase in sediment concentration without corresponding increase to the discharge.

Designated trade: 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 experience. Carpenters and electricians are examples of occupations in the designated trades.

Detritivore: An organism that feeds upon decomposing organic matter.

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

Direct negotiated contract (DNC): A type of contract that is non-tendered and directly negotiated between parties.

Dispersal: The spread of animals, plants, or seeds to new areas.

Dissolved oxygen (DO): Oxygen molecules (O2) dissolved in water.

Domestic fishing (harvest): The harvest of natural resources for personal use or consumption (*i.e.*, not sold).

Draft tube: The part of the water passage immediately downstream of a turbine runner, through which the water is directed into the tailrace.

Driver: Any natural or human-induced factor that directly or indirectly causes a change in the environment.

Driving factor: Any natural or human-induced factor that directly or indirectly causes a change in the environment.

Dyke: An earth embankment constructed to contain the water in the reservoir and limit the extent of flooding.

Ecological reserves: Established under the *Ecological Reserve Act* of Manitoba, ecological reserves are areas created to preserve unique and rare examples of plants, animals and geological features.

Ecosite type: A classification of site conditions that have important influences on ecosystem patterns and processes. Site attributes that were directly or indirectly used for habitat classification included moisture regime, drainage regime, nutrient regime, surface organic layer thickness, organic deposit type, mineral soil conditions and permafrost conditions.

Ecosystem: A dynamic complex of plant, animal and micro-organism communities and their non-living components of the environment interacting as a functional unit (Canadian Environmental Assessment Agency).

Eco–tourism: Viewing or studying fish, wildlife or a natural area; recreational or adventure activities such as canoeing, hiking and horseback riding that take place in a natural area.

Ecozone: A classification system that defines different parts of the environment with similar land features (geology and geography), climate (precipitation, temperature, and latitude), and organisms.

Edge effect: The effect that an abrupt transition between two different adjoining ecological communities has on organisms and environmental conditions in the transition between communities, as well as the effects on organisms and environmental conditions adjacent to the abrupt transition.

Effect: Any change that the Project may cause in the environment. More specifically, a direct or indirect consequence of a particular Project impact [ref]. The impact-effect terminology is a statement of a cause-effect relationship. A terrestrial habitat example would be 10 ha of vegetation clearing (*i.e.*, the impact) leads to habitat loss, permafrost melting, soil conversion, edge effects, *etc.* (*i.e.*, the direct and indirect effects).

Effective habitat: Habitat that is available to support individuals within a wildlife population after subtracting habitat alienated by human influences (*e.g.*, sensory disturbances). Human influences do not include physical habitat losses.

Emigration: Movements of an organism away from their natural environment into another geographical area.

Empirical: Pertaining to, or founded upon, experiment or experience; depending upon the observation of phenomena.

Employment rate: The percentage of the total population 15 years of age and over that was employed in the week (Sunday to Saturday) prior to Census Day (June 4, 1991; May 15, 2001; May 16, 2006).

Endangered: A species facing imminent extirpation or extinction (COSEWIC).

Entrainment: 1) A process by which sediment from a surface is incorporated into a fluid flow (such as water) as part of the operation of erosion; and 2) Fish (larval or adult) that are drawn into a current and cannot escape.

Environment: The components of the Earth, including 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 a) and b) (Canadian Environmental Assessment Agency).

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 (Canadian Environmental Assessment Agency).

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 (Canadian Environmental Assessment Agency)."

Environmental impact assessment (EIA): See *Environmental Assessment*.

Environmental officer: The person doing environmental inspections of the Keeyask site on behalf of the KHLP, pursuant to the EnvPPs.

Environmental protection plan (EnvPP): A practical tool that describes the actions required to minimize environmental effects before, during and after Project implementation. The plan may include details about the implementation of the mitigation measures identified in the environmental assessment, such as who is responsible for implementation, where the measures are intended to be implemented, and within what timeframe (Canadian Environmental Assessment Agency); description of what will be done to minimize the effects before, during and after project construction and operation. This includes protection of the environment and mitigation of effects from project activities.

Erodibility coefficients: A numerical parameter that represents the susceptibility of mineral soils to wave erosion. It is usually determined empirically as the gradient of the linear relationship between effective wave energy and volumetric erosion rate at sites where historical erosion has been monitored.

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.

Esker: A narrow ridge of sand or gravel, usually deposited by a stream flowing in or under glacial ice.

Eutrophic: Having waters or soils rich in phosphates, nitrates and organic nutrients that promote a proliferation of plant life, including algae.

Evapotranspiration: The process by which water is transferred to the atmosphere through evaporation, such as plants emitting water vapour from their leaves.

Existing environment: The present condition of a particular area; generally included in the assessment of a project or activity prior to the construction of a proposed project or activity.

Fecal coliform bacteria: Include genera such as *Escherichia* and *Klebsiella*, are indicators of organisms from the intestinal tracts of humans and other animals, used to represent the potential presence of pathogens.

Fen: Peatland in which the plants receive nutrients from mineral enriched ground and/or surface water. Water chemistry is neutral to alkaline. Sedges, brown mosses and/or Sphagnum mosses are usually the dominant peat forming vegetation.

Fetch: Length of water surface exposed to wind during generation of waves.

Fine habitat: The most detailed level in the hierarchical habitat classification used for the terrestrial assessment. From coarsest to finest, the levels in the habitat classification system are land cover, coarse habitat type, broad habitat type and fine habitat type.

Fingerlings: A young fish that has finished absorbing its yolk sac and is approximately three to four months old.

Fire regime: The frequency, size, intensity, severity, patchiness, seasonality and type (*e.g.*, ground versus canopy) of fires in the Fire Regime Area.

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).

Forage fish: Small, schooling fish that are typically eaten by larger fish. Typically less than 150 mm as adults (*e.g.*, minnows, darters, sculpins, stickleback).

Forage(ing): To locate, capture, and eat food.

Forebay: Impoundment area immediately upstream from a dam or hydroelectric plant intake structure that forms the downstream portion of the reservoir.

Fragmentation: 1) Refers to the extent to which an area is broken up into smaller areas by human features and how easy it is for animals, plant propagules and other ecological flows such as surface water to move from one area to another. Fragmentation can isolate habitat and create edges, which reduces habitat for interior species and may reduce habitat effectiveness for other species. 2) The breaking up of contiguous blocks of habitat into increasingly smaller blocks as a result of direct loss and/or sensory disturbance (*i.e.*, habitat alienation). Eventually, remaining blocks may be too small to provide usable or effective habitat for a species. (Cumulative Effects Assessment).

Frazil ice: Fine, small, needle-like structures of thin, flat circular plates of ice formed in super-cooled, turbulent water.

Freshet: The flood of a river from heavy rain or melted snow.

Full supply level (FSL): The normal maximum controlled level of the forebay (reservoir).

Furbearer: Refers to those mammal species that are trapped (*e.g.*, marten, fox, *etc.*) for the useful or economic value of their fur.

Gathering: Collecting plants for medicinal and dietary purposes and other natural products such as firewood, driftwood or feathers for cultural purposes.

Generator: Machine that coverts mechanical energy into electrical energy.

Geological overburden: Material overlying a useful mineral deposit or desired bedrock anchor.

Glacial till: An unsorted, unstratified mixture of fine and coarse rock debris deposited by a glacier.

Glaciofluvial: Pertaining to streams fed by melting glaciers, or to the deposits and landforms produced by such streams.

Glaciolacustrine: Pertaining to lakes fed by melting glaciers, or to the deposits forming therein

Gradient: The rate at which a water level increases or decreases over a specific distance.

Granular: Composed of granules or grains of sand or gravel.

Granular fill: Fill material including sand and gravel.

Greenhouse gas (GHG): Gases emitted from a variety of sources and processes, said to contribute to global warming by trapping heat between the earth and the atmosphere;
(a) carbon dioxide, (b) methane,(c) nitrous oxide, (d) hydrofluorocarbons,
(e) perfluorocarbons, (f) sulphur hexafluoride, (g) any other gas prescribed by regulation.

Groin: A rock fill structure extending out into a river or lake from the bank or shore. Used to protect the bank from erosion.

Gross Domestic Product: The gross national product excluding the value of net income earned abroad.

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.

Habitat: The place where a plant or animal lives; often related to a function such as breeding, spawning, feeding, *etc.*

Habitat alteration: Changes in one or more terrestrial habitat attributes that are large enough to convert a habitat patch to a different fine habitat type.

Habitat disturbance: Changes in one or more terrestrial habitat attributes that are too small to convert a habitat patch to a different fine habitat type (*e.g.*, a machine trail through a habitat patch).

Habitat loss: Conversion of terrestrial habitat into a human feature or an aquatic area.

Habitat suitability index (HSI): A numerical index ranging from zero to 1.0 representing the capacity of a given habitat to support a selected species. A value of 1.0 represents optimal conditions for that species while a value of zero represents unsuitable conditions. HSI models are based on hypothesized species-habitat relationships rather than statements of proven cause and effect relationships. Such models serve as a basis for improved decision making and increased understanding of species-habitat relationships.

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.

Hard water: Water that contains calcium carbonate at a concentration of 121 mg/L or higher. Water with a calcium carbonate concentration of 61-120 mg/L is considered moderately hard/soft.

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.

Herbivore: An animal that feeds predominantly on plants.

Hibernaculum (plural hibernacula): For the purposes of the EIS, shelter occupied in the winter by a dormant animal.

Host animal / host plant: An animal or plant that nourishes and supports a parasite; the host does not benefit and is often harmed by the association.

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 model: Refers to the use of mathematical or physical techniques to simulate existing hydraulic systems and make projections related to hydraulic variables (*i.e.*, water levels, flows and velocities).

Hydraulic zone of influence (HZI): 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.

Hydroelectric: Electricity produced by converting the energy of falling water into electrical energy (*i.e.*, at a hydro generating station).

Hypoxic: A deficiency of oxygen.

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.

Ice regime: A description of ice on a water body (*i.e.*, lake or river) with respect to formation, movement, scouring, melting, daily fluctuations, seasonal variations, *etc.*

Impermeable: Relating to a material through which substances, such as liquids or gases, cannot pass.

Impervious core: A zone of low permeability material (usually glacial till) in an earth dam, used to reduce leakage through the dam.

Impingement: Trapping of fish against the trash racks at the water intakes.

Impoundment: The containment of a body of water by a dam, dyke, powerhouse, spillway or other artificial barrier.

In situ: In place; undisturbed. An *in situ* environmental measurement is one that is taken in the field, without removal of a sample to the laboratory.

Incidental take: The accidental harming or destruction of a wildlife species or its habitat by humans (*e.g.*, the inadvertent destruction of a nest).

Inflow: The water flowing into a water body (lake, reservoir, *etc.*)

Inland peatland: A peatland that is beyond the direct influence of a water body's water regime and ice regime.

Intermediate head: A generating station design that has an intermediate forebay elevation compared to other options (usually low or high head).

Intermittently-exposed zone (IEZ): The zone that is routinely dewatered downstream of a generating station (*i.e.*, within the 5th and 95th percentile flows).

Invertebrates: Organisms lacking a backbone or vertebral column.

Invertivore: A species that feeds on invertebrates.

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.

Journeyperson: Someone who has completed an apprenticeship and is fully certified in a trade or craft, but not yet a master.

Keeyask Environmental and Regulatory Protocol (the Protocol): The environmental and regulatory protocol for the finalization of the Environmental Impact Assessment and the EIS and the submission of the EIS to Regulatory Authorities, substantially in the form attached as Schedule 3-1 to the JKDA.

Key person interview (KPI): Interview with an individual whose knowledge, creativity, inspiration, reputation, and/or skills are critical to the credibility of a study.

Labour force: The employed are persons having a job or business, whereas the unemployed are without work, are available for work, and are actively seeking work. Together the unemployed and the employed constitute the labour force. Persons not in the labour force are those who, during the reference week, were unwilling or unable to offer or supply labour services under conditions existing in their labour markets (this includes persons who were full-time students currently attending school).

Lacustrine: Of or having to do with lakes, and also used in reference to soils deposited as sediments in a lake.

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.

Land cover: The most general level in the hierarchical habitat classification used for the terrestrial assessment. From coarsest to finest, the levels in the habitat classification system are land cover, coarse habitat type, broad habitat type and fine habitat type.

Landscape: The ecological landscape as consisting of a mosaic of natural communities; associations of plants and animals and their related processes and interactions.

Larva (ae; al): The young, immature form of an insect or animal.

Lentic: Pertaining to very slow moving or standing water, as in lakes or ponds.

Life history stages: For the purposes of the EIS, the different developmental phases in a fish's life including: egg, larva, young-of-the-year, sub-adult and adult.

Life stage (of animals): One of the stages of life beginning with birth and progressing through larval or juvenile phases to sub-adult and adult phases.

Littoral zone: Area on or near the shore of a body of water.

Lodge: An accommodation facility of a permanent or semi-permanent nature that accommodates nine or more persons. In general ecological usage, this term can refer to the den of certain animals, such as the dome-shaped structure built by beavers.

Lotic: Pertaining to rapidly moving fresh water.

Macroinvertebrate: Small animals without backbones living on or in the substrata of lakes and rivers that are retained by a 500 μm mesh size. Macroinvertebrates retained on 500 μm sieves are important food items to vertebrates (particularly fish) and useful bioindicators of environmental change.

Macrophyte(s): Multi-celled aquatic and terrestrial plants.

Mainstem: The unimpeded, main channel of a river.

Mark-recapture studies: Fish are captured, marked a Floy® tag, and then subsequent rounds of fishing are conducted to recapture the marked fish. Data are used to determine species population size and movements.

Mass wasting: A general term of the dislodgement and downslope transport of soil and rock material under the direct application of gravitational body stresses. Includes slow displacements, such as creep and rotational slump failures, and rapid movements, such as rock and soil falls, rock slides, and debris flows.

Member: For the purposes of the EIS, means a person who is a "member of a band" as defined in subsection 2(1) of the *Indian Act* (Canada).

Mesoeutrophic: Moderately eutrophic (see eutrophic).

Mesotrophic: Description of a waterbody, typically a lake, characterized by moderate concentrations of nutrients (*i.e.*, nitrogen and phosphorus) and resulting significant productivity.

Metalloids: An element with the properties of metals and non-metals.

Methylmercury: An organic form of mercury that is able to concentrate in animal tissue.

Migration: The movement of an individual or group of individuals from one area to another.

Mineral erosion: Wearing away of minerals due to wind and water processes.

Mineral soil: Naturally occurring, unconsolidated material that has undergone some form of soil development as evidenced by the presence of one or more horizons and is at least 10 cm thick. If a surface organic layer (*i.e.*, contains more than 30% organic material or 17% organic carbon by weight) is present, it is less than 20 cm thick.

Mitigation: A means of reducing adverse Project effects. Under the *Canadian Environmental Assessment Act* and in relation to a project, 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."

Monitoring: Measurement or collection of data to determine whether change is occurring in something of interest. The primary goal of long term monitoring of lakes and rivers is to understand how aquatic communities and habitats respond to natural processes and to be able to distinguish differences between human-induced disturbance effects to aquatic ecosystems and those caused by natural processes; continuing assessment of conditions at and surrounding the action. This determines if effects occur as predicted or if operations remain within acceptable limits, and if mitigation measures are as effective as predicted.

Movement: For the purposes of the EIS, the act of individual or populations of animals moving from one habitat to another for spawning, foraging, overwintering, escape from predation, *etc.*

Nearshore: Aquatic habitat occurring at the interface between a lake or stream and adjacent terrestrial habitat; usually includes aquatic habitat up to 3 m in depth; shallow underwater slope near to shore.

Non-designated trade: Jobs that are directly involved with the construction of the Project, but do not have formal apprenticeship programs leading to a Journeyperson certification. Examples of non-designated trades are labourers, heavy equipment operators, vehicle drivers (teamsters), rebar workers and cement masons. Training and work experience requirements can range from basic on-the-job training for entry level positions to more than 3 years of formal training and professional experience to be fully qualified for the most highly-skilled positions.

Northern Aboriginal residents: Is a defined term in the Burntwood Nelson Agreement (BNA) generally referring to status Indians, Métis, non-status Indians and Inuit who qualify as **Northern Residents**. Northern Residents are defined as a person who has resided in northern Manitoba (north of the boundary set out in Schedule 12-5 to the BNA for (a) a period of five years accumulatively or more; and (b) a period of six consecutive months or more, immediately prior to being referred to employment or re-employment.

Northern Flood Agreement (NFA): An agreement signed in 1977 by Manitoba Hydro, the governments of Canada and Manitoba, and the Northern Flood Committee on behalf of five affected Cree Nations regarding the effects of the Churchill River Diversion and Lake Winnipeg Regulation.

Offshore: Aquatic habitat not adjacent to terrestrial habitat; usually includes aquatic habitat greater than 3 m in depth.

Off-system: Water body or waterway outside of the Nelson River hydraulic zone of influence.

Oligotrophic: Description of a waterbody, typically a lake, or terrestrial site characterized by extremely low concentrations of nutrients (*i.e.*, nitrogen and phosphorus) which typically leads to low primary productivity.

Organic: The compounds formed by living organisms.

Organism: An individual living thing.

Outflow: The water flowing out of a water body (lake, reservoir, *etc.*).

Overburden: Soil (including organic material) or loose material overlaying bedrock.

Overtopping: When the water level rises above the top of a barrier (*e.g.*, a cofferdam) allowing water to flow over the barrier.

Overwinter(ing): The survival of fish through the winter beneath ice cover.

Palatability: A substance (*e.g.*, water or fish flesh) that is agreeable to the palate or taste.

Parameter: Characteristics or factor; aspect; element; a variable given a specific value.

Park reserve: A temporary designation under the *Manitoba Provincial Parks Act* to ensure that the lands under consideration for Provincial Park status are not otherwise allocated or used while planning and consultation is taking place.

Participation rate: For the purposes of the EIS, the percentage of the potential labour force that was in the labour force in the week (Sunday to Saturday) prior to Census Day (June 4, 1991; May 15, 2001; May 16, 2006).

Parturition: The process of giving birth.

Pathway diagram: A simple diagrammatic representation of a potential cause-effect relationship between two related states or actions that illustrates an impact model. Pathway diagrams take network diagrams one-step further by evaluating each linkage and assessing the cause-effect relationship in the context of a scientific hypothesis.

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, 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.

Peat: Material consisting of non-decomposed and/or partially decomposed organic matter, originating predominantly from plants.

Peat plateau bog: Ice-cored bog with a relatively flat surface that is elevated from the surroundings and has distinct banks.

Peat resurfacing: Process whereby all or portions of a peat mat that was submerged by flooding detaches and floats to the water surface.

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.

Percentage point: The unit for the arithmetic difference of two percentages (*i.e.*, there is a 5 percentage point difference between 5% and 10%).

Percentile: Part of the "ile" family that signposts positions on a scale of numbers. The top percentile on, say, the distribution of income, is the richest 1% of the population.

Periphyton: Assemblage of microorganisms, including algae, that grow on submerged surfaces.

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.

Person-years: A measure of the amount of work that could be available during a specific time period or for a specific type of work. One person-year approximates the amount of work that one worker could complete during twelve months of full-time employment.

pH: Method of expressing acidity or basicity of a solution. pH is the logarithm of the reciprocal of the hydrogen ion concentration, with a pH of 7.0 indicating neutral conditions. Ph values of less than seven are acidic.

Phyla: Taxonomic rank below the group known as a "Kingdom" and above that of a "Class"; a group of organisms with a certain degree of morphological or developmental similarity and/or with a certain degree of evolutionary relatedness.

Physiography: Physical geography, *i.e.*, the study of physical features of the surface of the Earth.

Phytoplankton: Algae suspended in the water column.

Piscivorous: An organism that feeds predominantly upon fish, including many species of birds, mammals and other fish.

Pollution: 1) Any human alteration of the natural environment producing a condition that is harmful to living organisms. 2) Any solid, liquid, gas, smoke, waste, odour, heat, sound, vibration, radiation, or a combination of any of them that is foreign to or in excess of the natural constituents of the environment, and (a) affects the natural, physical, chemical, or biological quality of the environment, or (b) is or is likely to be injurious to the health or safety of persons, or injurious or damaging to property or to plant or animal life, or (c) interferes with or is likely to interfere with the comfort, well being, livelihood or enjoyment of life by a person.

Population: For the purposes of the EIS, a group of interbreeding organisms of the same species that occupy a particular area or space.

Post-project: The actual or anticipated environmental conditions that exist once the construction of a project has commenced.

Potential labour force: In general, the number of individuals in a population 15 years of age and older.

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 shield: Bedrock formed in the Precambrian Era, which began with the consolidation of the earth's crust and ended approximately 4 billion years ago.

Primary habitat: For purposes of the EIS, the preferred habitat of a particular species.

Primary producers: A group of organisms that possess chlorophyll and conduct photosynthesis to meet their energy requirements for survival, growth and reproduction. They form the base of the food chain.

Priority habitat: A native broad habitat type that is regionally rare or uncommon, highly diverse (*i.e.*, species rich and/or structurally complex), highly sensitive to disturbance, highly valued by people and/or has high potential to support rare plant species.

Priority mammal / priority species: A species or group of species that is particularly important for ecological/social reasons.

Probable maximum flood: 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.

Productivity: Rate of formation of organic matter over a defined period; this can include the production of offspring.

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.

Protected area: As defined by the World Conservation Union, a protected area is an area of land and/or sea especially dedicated to the protection and maintenance of biological diversity, and of natural and associated cultural resources, and managed through legal or other effective means.

Provincial park: Crown lands designated under the *Manitoba Provincial Parks Act*.

Push-up: A dome-shaped resting and feeding station built by muskrats by pushing vegetation and mud above holes in ice.

Quarry: An open pit where rock is mined for use as a building material at the construction site.

Quarterly employment: employment occurring during a quarterly time period within a year (*e.g.*, first quarter from January through March; second quarter from April through June; third quarter from July through September; fourthquarter from October through December).

Rapids: A section of shallow, fast moving water in a stream made turbulent by totally or partially submerged rocks.

Raptor: Any of the group known as "birds of prey," including eagles, hawks, owls, vultures and falcons.

Reach: A section, portion or length of stream or river.

Rearing: The raising of young.

Recreational fishing: Fishing activity where the primary intent is enjoyment; angling

Recruitment: The number of new juvenile fish reaching a size/age where they represent a viable target for the commercial, subsistence or sport fishery for a given species.

Regime: The frequency, size, intensity, severity, patchiness, seasonality and sub-type of a periodic event or continual fluctuation.

Rehabilitation: To restore a disturbed structure, site or land area to good condition, useful operation or productive capacity.

Relief: Variation in elevation on the surface of the earth.

Reptile: Cold-blooded animal of the Class Reptilia that includes tortoises, turtles, snakes, lizards, alligators and crocodiles.

Reservoir: A body of water impounded by a dam and in which water can be stored for later use. The reservoir includes the forebay.

Resident: For the purposes of the EIS, 1) Person living in Manitoba for the last consecutive six months; 2) With respect to wildlife, resident refers to a dwelling-place, such as a den, nest or other similar area or place, that is occupied or habitually occupied by one or more individuals during all or part of their life cycles, including breeding, rearing, staging, wintering, feeding or hibernating (Canadian Environmental Assessment Agency).

Residual effect: An actual or anticipated Project effect that remains after considering mitigation and the combined effects of other past and existing developments and activities.

Resource use: Subsistence and economic activities that make use of the resources derived from the natural environment.

Riparian: Along the banks of rivers and streams.

Riverine: Relating to, formed by, or resembling a river including tributaries, streams, brooks, *etc.*

Rockfill: Fill material typically consisting of excavated and crushed rock or blast rock that is used to provide mass to a structure while protecting it from erosion.

Rollway: The concrete portion of the spillway that water flows over when the spillway is in operation.

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 habitat: Useable or alternative habitat for a given species, typically lower in quality than primary habitat.

Sediment(s): Material, usually soil or organic detritus, which is deposited in the bottom of a waterbody.

Sedimentation: A combination of processes, including erosion, entrainment, transportation, deposition and the compaction of sediment.

Sediment budget: An accounting of the erosion, storage and transport processes of soil and sediment in drainage basins or smaller landscape units.

Sediment oxygen demand (SOD): The dissolved oxygen demand from the sediments or substrate of lakes and rivers.

Seral: Referring to the series of plant communities that succeed one another before a stable, or climax, plant community, is reached.

Service bay: An open area of the powerhouse where turbines and generator equipment are assembled during construction, and later, where maintenance and repairs are done to major generating components.

Service gate: Gates that are used to dewater a unit to allow inspections, maintenance and repairs to occur within the water passage.

Severance line: Under the *Water Power Act*, severance line describes the land and the works within it that are associated with a project licensed under this Act. This means that everything within these boundaries may be taken over by the Province of Manitoba in the event that the license should be terminated. The Crown also has an obligation to ensure that any additional rights granted on these lands do not prejudicially interfere with Manitoba Hydro's ability to operate and maintain its license.

Shear stress: Stress caused by forces operating parallel to one another but in opposite directions.

Shore zone: Areas along the shoreline of a waterbody including the shallow water, beach, bank and immediately adjacent inland area that is affected by the water body.

Significance: For the purposes of the assessment for regulators in the EIS of residual effects of the Project on VECs, a measure of how adverse or beneficial a residual effect is expected to be; significant adverse environmental effects are those residual effects that are predicted to cause significant adverse environmental effects as defined under the *Canadian Environmental Assessment Act*; significant positive effects are those residual effects that would cause a beneficial change that is measureable or obvious.

Silt: A very small rock fragment or mineral particle, smaller than a very fine grain of sand and larger than coarse clay; usually having a diameter of 0.002 to 0.06 mm; the smallest soil material that can be seen with the naked eye.

Socio-economic impact assessment (SEIA): Provides detailed information about effects, both positive and negative, that a proposed project may have on people, their lifestyles and their communities. In particular, effects that flow from biophysical effects are included. Often, effects that flow from other aspects of a project (*e.g.*, employment and business opportunities) are also discussed. An SEIA also provides ways to address effects that are likely to be adverse, from the point of view of an affected population, and to enhance those effects perceived to be positive. Residual effects, cumulative effects and monitoring are also included. A SEIA is often part of the environmental impact assessment (EIA) for a proposed project.

Soft water: Water that contains calcium carbonate at a concentration of 60 mg/L or less. Water with a calcium carbonate concentration of 61-120 mg/L is considered moderately hard/soft.

Specific conductance: Conductivity expressed at a standard temperature of 25°C.

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.

Sporadic (ally): For the purposes of the EIS, the occurrence of isolated patches, 10–35% of a geographic region.

Staging: The tendency of migratory organisms to stop temporarily (stage) at a site during migration; staging areas are stop-over sites where, for example, fish will rest and occasionally forage in preparation for imminent spawning or migratory birds will rest, forage, and/or moult along the course of a migration route.

Stand level habitat type: A relatively uniform area in terms of vegetation, vegetation age, soils and topography that ranges from approximately one to one hundred hectares in size.

Steady-state: A stable condition that does not change over time or in which change in one direction is continually balanced by change in another.

Stewardship: Refers to general environmental care and protection.

Stocking program: Fish that are raised in captivity (generally from eggs and sperm collected from wild fish [brood stock]) are released into a designated water body to meet one or more specific management objectives. These management objectives can include population restoration, population enhancement, and/or establishment of a fishery.

Stratification: Arrangement of a body of water into two or more horizontal layers of differing characteristics (*e.g.*, temperature, pH, dissolved oxygen).

Stratigraphy: Scientific study of rock strata, especially the distribution, deposition, correlation and age of sedimentary rocks. Also can refer to the layering of materials or soil horizons at a location.

Study area: The geographic limits within which effects on a VEC (valued environmental component) or key topic is assessed.

Sub-adult: For purposes of the EIS, a fish that is older than one year but has not reached sexual maturity. Lake sturgeon sub-adults measured between 200 and 833 mm long (fork length) based on sexual maturity data collected during the spawning season from a well-studied lake sturgeon population on the lower Nelson River.

Substrate(s)/Substrata: The material forming the streambed; also solid material upon which an organism lives or to which it is attached. See also bed material.

Supporting topic: A key topic that has a lower degree of concern than the Valued Environmental Components and improves the reliability of the assessment.

Surcharge: A condition in a forebay or reservoir 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.

Suspended sediment concentration: Measure of the amount of sediment in a unit of water usually expressed in terms of milligrams of dry sediment measured down to approximately 1micron (0.001 mm) in a litre of water.

Switching station: An area that typically contains electrical equipment that is used in the transmission of electricity.

Tailrace: A channel immediately downstream from a powerhouse that directs the water away from the turbine and into the river channel.

Tailwater: The water in the tailrace, or the level of the water in the tailrace.

Taxa: Plural of taxon.

Taxon: A group of organisms that are treated as a classification unit. Usually a taxon is given a name and a rank, although neither is a requirement.

Taxonomy: The classification of organisms in a hierarchical system or in taxonomic ranks (*e.g.*, order, family, genus, species) based on shared characteristics or relationships inferred from the fossil record or established by genetic analysis.

Telemetry: Automatic transmission and measurement of data from remote sources by wire or radio or other means.

Terrestrial habitat: The land areas where plants and animals live. The terrestrial habitat section classifies and maps habitat based on plants, standing and fallen dead trees, soils, ground ice, groundwater, surface water, topography and disturbance (*e.g.*, fire) conditions.

Thalweg: The deepest part of the channel of a river or stream.

Thermal ice cover: An ice cover that forms where velocities are low.

Topography: General configuration of a land surface, including its relief and the position of its natural and manmade features.

Total dissolved solids (TDS): Measure of the amount of material dissolved in water (primarily inorganic salts).

Total Kjeldahl nitrogen (TKN): Total concentration of nitrogen in the form of ammonia and organic nitrogen. As determined by the Kjeldahl test.

Total sediment load: Measure of the total sediment being transported in suspension and on the bed.

Total suspended solids (TSS): Solids present in water that can be removed by filtration consisting of suspended sediments, phytoplankton and zooplankton.

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.

Trap-nights: The number of traps in a small mammal trapping block or trap set multiplied by the number of nights the traps were set at that location; *e.g.*, 100 traps x 3 nights = 300 trap nights.

Trash rack: A grid of metal bars placed in front of the intake to prevent larger objects from entering the turbine and damaging the units.

Trophic: In ecology, **trophic level** describes an organism's position in the food chain.

Tundra: Treeless plain characteristic of arctic and subarctic regions, with permanently frozen subsoil and dominant vegetation of mosses, lichens, herbs, and dwarf shrubs.

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: For the purpose of the EIS, the lack of certainty or a state of having limited knowledge where it is difficult or impossible to exactly describe an existing state or a future outcome, or there is more than one possible outcome. In environmental assessment, uncertainty is not knowing, with high confidence, 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."

Unemployment rate: The percentage of the labour force in the week (Sunday to Saturday) prior to Census Day (June 4, 1991; May 15, 2001; May 16, 2006) that was unemployed.

Upland: Any area that does not qualify as a wetland because the associated water regime is not wet enough to be associated with wetlands. For the purposes of this document, upland is ground elevation at a distance from a waterbody or watercourse.

Valued Environmental Component (VEC): Is an element of the environment identified as having scientific, social, cultural, economic, historical, archaeological or aesthetic importance. The value may be determined on the basis of cultural ideals or scientific concern (adapted from CEAA).

Velocity: A measurement of speed of flow.

Veneer bog: Bog with thin surface peat (*i.e.*, less than 1.5 thick) that generally occurs on gentle slopes and contain discontinuous permafrost.

Wage economy: Portion of the economy dominated by the monetary flows and the exchange of money for labour and good and services.

Water quality: Measures of substances in the water such as nitrogen, phosphorus, oxygen and carbon.

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.*

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.

Water table: The level below the surface where the soil is saturated by groundwater.

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.

Wetland: Land that is wet for all or part of the year, including areas where the water is up to 2 m deep. Water saturation is the dominant factor determining the nature of soil development and the types of plant and animal communities living in the soil and on its surface. Marshes and peatlands are types of wetlands.

Wildlife management area (WMA): Crown lands set aside for the better management, conservation and enhancement of the wildlife resources of the province.

Yearlings: In regards to fish that are one year old and less than two years old.

Young-of-the-year (YOY): Fish less than one year of age.

Zooplankton: Floating or swimming invertebrates that live in the water column.