Keeyask Generation Project

Terrestrial Effects Monitoring Plan

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KEEYASK
Hydropower Limited Partnership

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KEEYASK GENERATION PROJECT

TERRESTRIAL EFFECTS MONITORING PLAN

Prepared by

Keeyask Hydropower Limited Partnership

WINNIPEG, MANITOBA

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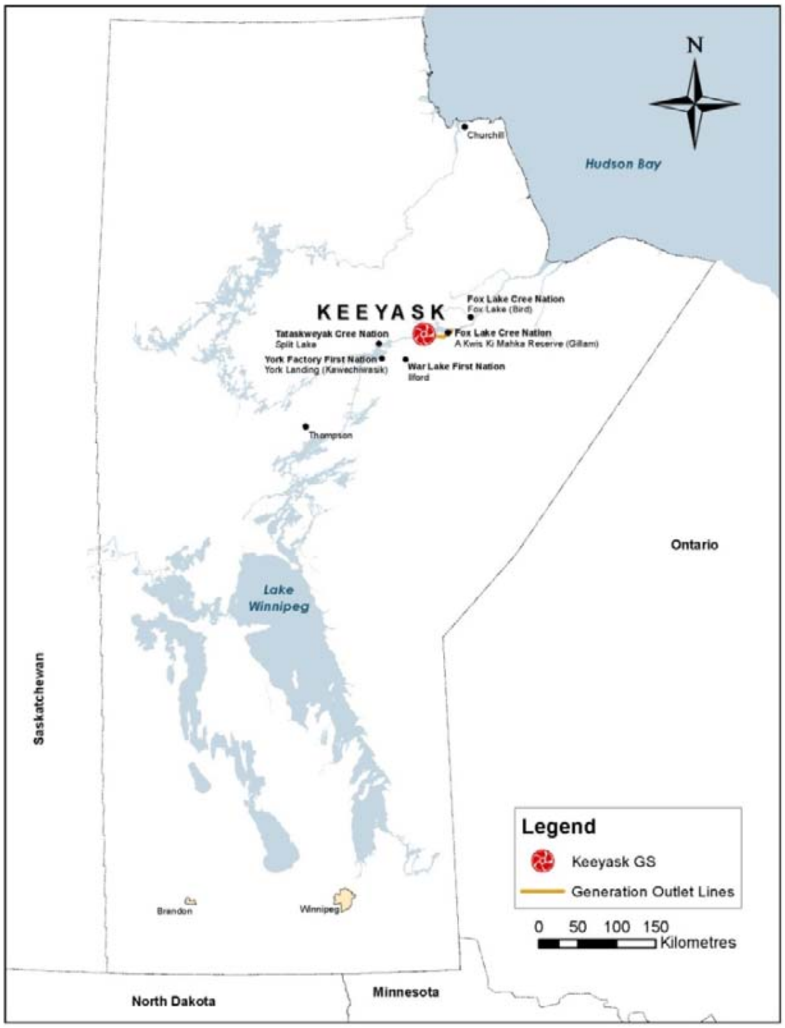
PREFACE

KEEYASK ENVIRONMENTAL PROTECTION PROGRAM

An Environmental Protection Program (the Program) has been developed to mitigate, manage and monitor potential environmental effects described in the *Keeyask Generation Project: Response to EIS Guidelines* during the construction and operation phases of the Keeyask Generation Project (the Project) shown on Map 1. The Program includes a collection of plans grouped in the following categories: Environmental Protection Plans, Environmental Management Plans and Environmental Monitoring Plans.



Map 1: Location of Keeyask Generation Project

Figure 1 lists all of the plans included in the Program. It also demonstrates how the Program will be managed. The Keeyask Hydropower Limited Partnership (the Partnership) has delegated authority to Manitoba Hydro to manage construction and operation of the Project including implementation of the Program. The organizational structure of the Partnership for this aspect of the Project includes a Monitoring Advisory

Committee (MAC), which includes participants from each of the Keeyask Cree Nations (KCNs) and Manitoba Hydro. Manitoba Hydro will be guided on the implementation of the Program by the MAC, the Partnership Board of Directors and ongoing discussion with Regulators.

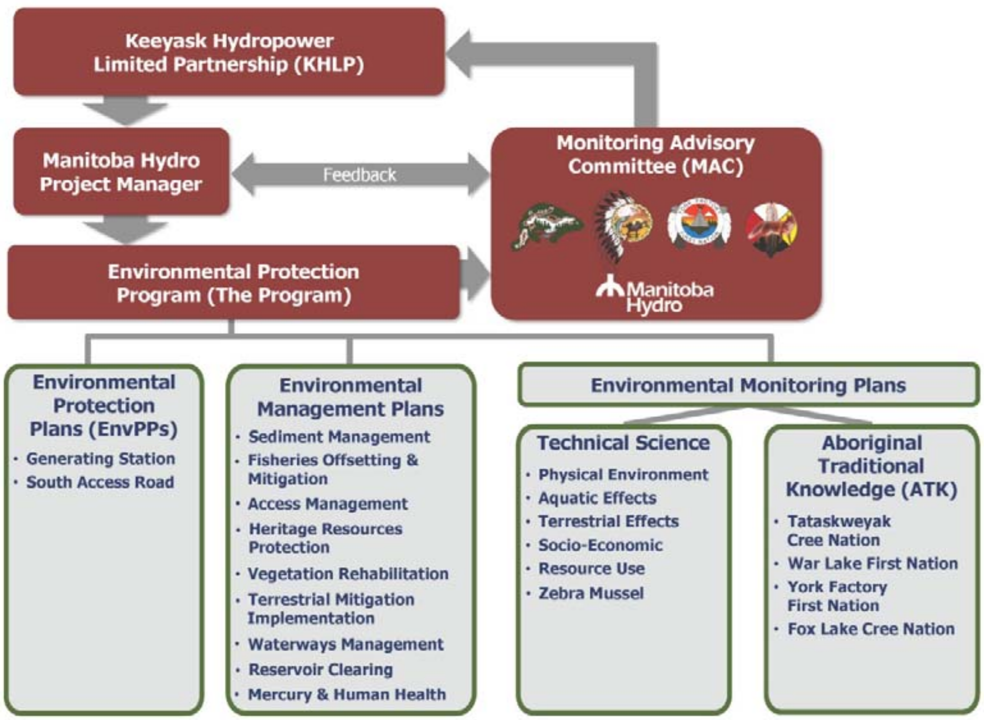


Figure 1: Environmental Protection Program

The Environmental Protection Plans (EnvPPs) 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 south access road. They are designed for use as reference documents providing the best management practices to meet or exceed regulatory requirements. EnvPPs are organized by construction activity, highlighting measures to reduce the impact of a specific work activity (e.g., tree clearing or material placement in water). Contractors' compliance with the EnvPPs is a contractual obligation. Under Manitoba Hydro's construction site management, a Site Environmental Officer will be responsible for monitoring compliance and determining when corrective actions are required.

The Environmental Management Plans focus on minimizing effects on specific environmental parameters. They outline specific actions that must be taken during construction and in some cases into the operational phase to mitigate Project effects. The management plans include monitoring to determine success of the actions taken and to determine other actions that need to be undertaken (adaptive management). Implementation of these plans will involve Manitoba Hydro's staff, the KCNs, specialized consultants and contractors under the direction of the Project Manager.

The Environmental Monitoring Plans are designed to measure the actual effects of the Project, test predictions or identify unanticipated effects. During the course of the environmental assessment, numerous requirements for monitoring were identified. There will be both technical science monitoring and Aboriginal Traditional Knowledge (ATK) monitoring undertaken. The technical science monitoring will be conducted by Manitoba Hydro and specialized consultants contracted by Manitoba Hydro, who will in turn hire members of the KCNs to work with them to fulfil the monitoring activities. Manitoba Hydro will also have contracts with each of the KCNs to undertake ATK monitoring of the project.

The activities that occur and the results generated from the Environmental Protection Program will be discussed at MAC meetings. The MAC is an advisory committee to the Partnership Board of Directors and will review outcomes of the programs and, if appropriate provide advice and recommendations to the Partnership on additional monitoring or alternative mitigation measures that may be required. The MAC will provide a forum for collaboration among all partners. 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, regulators and the general public.

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1.0 INTRODUCTION

This document describes the Terrestrial Effects Monitoring Plan (TEMP) for the Keeyask Generation Project (the Project), a 695-megawatt (MW) hydroelectric generating station at Gull (Keeyask) Rapids on the lower Nelson River in northern Manitoba. The Project is approximately 725 kilometres (km) northeast of Winnipeg, 35 km upstream of the existing Kettle Generating Station, where Gull Lake flows into Stephens Lake, 60 km east of the community of Split Lake, 180 km east-northeast of Thompson and 30 km west of Gilliam (Map 2).

The Project will involve the development of a number of permanent structures, including a powerhouse, spillway, dams, dykes and a reservoir. The initial reservoir area will be 93 km², including 45 km² of newly flooded lands. Once established, the reservoir will operate within a one-metre range. Other features to support construction of these major elements include access roads, borrow areas, excavated-material placement areas, boat launches, and a portage. Temporary support infrastructure includes camps, landfill, water- and sewage-treatment facilities, cofferdams, rock groins and an ice boom. Collectively, the areas where clearing, flooding and physical disturbances occur due to Project construction and operation is referred to as the Project Footprint.

The *Keeyask Generation Project: Response to EIS Guidelines* (EIS; KHLP 2012), submitted in July 2012, provides a description of the existing environment, a summary of predicted effects, and planned mitigation for construction and operation of the Project. Technical supporting information for the terrestrial environment, including a description of the environmental setting, effects and mitigation, and a description of proposed monitoring and follow-up programs is provided in the *Keeyask Generation Project Environmental Impact Statement: Terrestrial Environment Supporting Volume* (TE SV; KHLP 2012).

An ecosystem-based approach to the assessment of potential Project effects was used that recognizes the inter-connected webs of relationships among the organisms within this landscape, and how these organisms interact with their environment to operate as a functional unit which performs a wide range of ecosystem functions. At the same time, some components of Keeyask terrestrial ecosystems have been recognized as being of particular social or ecological interest as a result of, for example, being highly valued by communities, their rarity, their role in ecosystem function, or due to their protection under legislation. Key issues were identified during the assessments and in consultation with communities, resulting in the identification of Valued Environmental Components (VECs). Follow-up monitoring focuses on these VECs as particularly valuable indicators of the effectiveness of Project mitigation measures, and also tracks the effects on a number of other supporting topics of interest.

Terrestrial VECs identified in the EIS include: ecosystem diversity, priority habitat types, wetland function, fragmentation, priority plant species, Canada goose, mallard, bald eagle, at-risk bird species, caribou, moose and beaver.

Large wildfires during 2013 have had important implications for the design of the terrestrial monitoring studies. Some of the pre-Project data can no longer be used as intended for monitoring, because the burned areas have dramatically altered habitat and environmental conditions in large areas on the north and south sides of the Nelson River. Pre-project data from these areas, as well as from areas that were cleared after EIS studies were conducted, no longer constitute pre-Project data for a before-after study design. Study designs included in the TEMP consider this limitation.

1.1 OVERALL OBJECTIVES AND APPROACH

1.1.1 OVERALL OBJECTIVES

Monitoring is required to verify the short- and long-term effects of the Project's construction and operation on the terrestrial environment, including ecosystems, habitat, plants, amphibians, birds, and mammals. In particular, the objectives of terrestrial monitoring are to:

- determine the accuracy of key effects assessment predictions in the EIS;
- identify unexpected effects related to the Project;
- determine the effectiveness of mitigation measures;
- assess the need for additional mitigation or remedial actions if initial measures are not adequate;
- determine the effectiveness of any additional/adapted mitigation measure(s); and
- confirm compliance with any regulatory requirements, including Project approvals and environmental regulations.

1.2 APPROACH TO TERRESTRIAL MONITORING

Monitoring and follow-up during the Project construction and operation phases will focus on VECs as well as a number of other supporting topics. For example, monitoring will be carried out in situations where Aboriginal Traditional Knowledge (ATK) and technical assessments differ substantially, where a prediction has substantial uncertainty, or where a difference between predicted and actual residual effects could substantially alter the effects assessment conclusions.

The Keeyask Cree Nations (KCNs) have expressed concern about how the Project will affect mammal populations, and have suggested that effects may be greater than predicted in the EIS, particularly the effects on the harvest of caribou and moose (CNP 2012, FLCN 2012, YFFN 2012). They have noted that increased access to the Project area may increase harvest, including that by non-KCNs individuals, and that all harvesting needs to be sustainable. Given the importance of these species to the KCNs' culture and country foods supply, and that there is some level of uncertainty regarding the level of effects, long-term monitoring will be carried out for these species, and will be used to inform the Project's Resource Use Monitoring Plan (RUMP). In addition to the monitoring carried out under the TEMP, the KCNs' ATK monitoring plans may also describe and evaluate the terrestrial environment in relation to effects from the Project.

The approach to monitoring in the TEMP is adaptive, with provisions to review results and modify monitoring programs and mitigation measures, if and as required. For example, during the operation period, whether or not little brown myotis (bats) are found to be using Project infrastructure for roosting will determine the frequency of the follow-up monitoring required. During the construction phase, monitoring results will be reviewed to determine the need for adjustments to either the temporal and/or spatial scope of sampling, and to provide feedback to Project personnel if alterations to mitigation measures are required. During the operation phase, monitoring results will provide the basis for modifications to sampling plans (*e.g.,* a reduction in effort if effects are not observed, or design changes if effects are not adequately recorded by existing sampling plans), and the recommendation for modification or implementation of additional mitigation measures, if required. In general, monitoring will take place in the study zone most appropriate to the subject of study (see TE SV Section 1.3.5 and Map 3 in this TEMP for details). While operation monitoring may continue for an estimated 25 years after reservoir impoundment, the monitoring timeframe for particular components may be reduced if there are no unexpected observed effects, or if results indicate more rapid stabilization of shorelines or direct and indirect effects than expected.

1.2.1 REPORTING

Reports detailing results of terrestrial monitoring activities will be submitted on an annual basis to provide timely and regular updates and to facilitate modifications to the monitoring programs in accordance with monitoring results, as required. Reports will be generated annually for the KHLP each year when monitoring occurs, and will be provided to Manitoba Conservation and Water Stewardship (MCWS), as well as uploaded to the KHLP website (www.Keeyask.com).

In addition to annual reports summarizing activities and general findings, more comprehensive reports will be prepared at appropriate intervals during the construction and operation phases of the Project. These reports will consider, compile and analyze all years of monitoring conducted during the relevant period, and based on those results, make recommendations concerning the need for any changes to the mitigation or monitoring approach. These reviews will be scheduled at intervals appropriate to the particular VEC and to the monitoring regime established for it. Timing for these comprehensive reports is outlined in Sections 2.0 to 8.0 of this document.

1.3 OVERVIEW OF TERRESTRIAL EFFECTS

1.3.1 TERRESTRIAL EFFECTS

In general, potential terrestrial effects from the Project would include habitat loss, habitat change, fragmentation, noise and disturbance, and access-related effects (including mortality from harvest, accidents and increased predation). A condensed summary of some anticipated effects on the terrestrial environment and recommended mitigation measures follows (for more detail see the Keeyask EIS, Section 6.5.10, and the TE SV):

- **Ecosystem diversity:** Clearing, flooding, edge effects and reservoir-related groundwater changes will reduce the amount of and alter the nature of some priority habitat types. Mitigation measures will include: rehabilitation of the most affected priority habitat types; revegetation to minimize habitat disturbance, invasive plant spread and total habitat loss; and closure of trails and cutlines that are not existing resource-use trails or required for operation, where they intersect the Project Footprint.
- **Intactness:** Clearing, flooding, and reservoir expansion will reduce core area, while increased access may produce more access-related effects such as accidental fires and increased disturbance. Mitigation

measures will include the development of a rehabilitation plan and blocking of Project-related cutlines and trails that are not existing resource-use trails or required for operation.

- **Wetland function:** Clearing, flooding, reservoir expansion, and groundwater changes will result in a temporary loss of most Nelson River shoreline wetlands in Study Zone 2 (Map 3) and would result in the permanent loss of some important off-system wetlands without mitigation. As a mitigation measure, 12 ha of off-system marsh will be developed within Study Zone 2, and is described in the Terrestrial Mitigation Implementation Plan.
- **Priority plants:** Key effects will be the loss, alteration, and disturbance of plants and their habitats due to clearing, flooding, access-related effects, reservoir expansion and groundwater changes. If pre-clearing surveys identify provincially rare to very rare plant species that are not well represented in known locations outside the Project's zone of influence, discovered locations will be avoided or the individual plants will be removed and transplanted.
- **Invasive plants:** The main potential effect could be the introduction and further spread of invasive plant species. Mitigation measures will include revegetating cleared areas as soon as practicable with a non-invasive ground cover, using seed mixtures of native and non-invasive introduced plant species, and establishing containment and eradication programs quickly where problems with invasive plants are identified.
- **Amphibians**: Key potential effects include habitat alteration, fragmentation, and loss, as well as frog mortality related to road traffic and winter clearing activities. Mitigation measures will include sediment control to prevent sediment flow into wetlands from construction, the development of a marsh wetland, and enhancement of some of the decommissioned borrow areas to promote suitable amphibian habitat.
- **Canada goose:** Anticipated effects include avoidance of aquatic habitats due to construction noise and activity disturbance, decrease in the quality of staging habitat due to reservoir creation, and potential increased harvest due to increased access from new roads, trails and dykes. Mitigation will include retention of 100 m vegetated buffers around inland lakes near construction, and blocking of Project-related cutlines and trails that are not existing resource-use trails or required for operation.
- **Mallard:** Effects are associated with habitat loss and alteration as land is cleared for the reservoir and Project infrastructure, avoidance of habitat due to noise and activity, and potential increased harvest due to increased access from new roads, trails and dykes. Mitigation will include avoiding the sensitive bird breeding period for land clearing, retention of vegetated buffers around inland waterbodies, and installation of nesting tunnels in the created wetland to offset losses in upland nesting cover.
- **Bald eagle:** Land clearing for the reservoir and for Project infrastructure will result in the loss of some trees used for nesting and perching, while shoreline erosion and peatland disintegration will result in the loss of shoreline trees over the longer term. Mitigation will include land clearing outside the sensitive bird breeding period, buffers around active nests, and replacement of any bald eagle nests removed by Project clearing with artificial nesting platforms in suitable areas.
- **Olive-sided flycatcher:** The principal anticipated effect will be loss of breeding habitat due to land clearing, reservoir creation and shoreline erosion. Mitigation will include land clearing outside the sensitive bird breeding period, and the installation of perching poles to help to offset lost habitat.

- **Rusty blackbird:** The principal anticipated effect will be loss of breeding habitat due to land clearing, reservoir creation and shoreline erosion. Mitigation will include land clearing outside the sensitive bird breeding period. The development of a wetland will also create some foraging habitat.
- **Common nighthawk:** Land clearing will result in a temporary net gain in breeding habitat, while construction noise and activity may cause some individuals to avoid nesting areas near the Project during construction. Mitigation will include leaving portions of decommissioned borrow areas as bare ground, which is suitable nesting habitat.
- **Colonial waterbirds:** Some gull and tern breeding habitat will be affected by Project construction and flooded by creation of the reservoir. Mitigation will include deployment of tern nesting platforms and development of gull nesting habitat during the construction period, as well as construction of a suitable long-term nesting island to offset the loss of colonial breeding sites.
- **Caribou:** Potential effects during construction include habitat loss, increased linear development, sensory disturbance, increased mortality due to collisions with vehicles and access effects such as predation and hunting. Mitigation measures will include leaving potential future caribou calving islands (greater than 0.5 ha) in the reservoir undisturbed (i.e., not clearing trees), minimizing blasting activities to the extent practicable during the calving period, a Construction Access Management Plan, gates at the north and south dykes, and restricted use of firearms at camps and work sites. Potential effects during operation include loss of calving islands and altered movements from disturbance, as well as a decreased population in Study Zone 4 (Map 3). Mitigation measures will include blocking of Project-related cutlines and trails that are not existing resource-use trails or required for operation, rehabilitation of temporary cleared areas, and wildlife crossing signage for drivers along access roads.
- **Moose:** Habitat loss and alteration, including changes in calving habitat, as well as sensory disturbance and mortality through predation, hunting and collisions with vehicles, may result in a decreased population in Study Zone 5 (Map 3). Offset programs to improve KCNs Member access to harvest moose outside the immediately affected zone may affect populations beyond Study Zone 5. Mitigation measures will include rehabilitation of roadside ditches with non-attractant plant species, restricted use of firearms in camps and work sites, and implementation of the Cree Nation Partners Moose Harvest Sustainability Plan.
- **Beaver:** Clearing and reservoir creation will result in habitat loss, disturbance and mortality due to flooding, conflicts with humans, and predation. A decreased beaver population in Study Zone 3 (Map 3) is anticipated due to reduced habitat and increased mortality. Mitigation measures will include 100 m vegetated buffers at creeks, streams, ponds, and lakes outside the future reservoir area, as well as installation of beaver baffles to protect culverts and prevent removal of beaver that may be affecting Project infrastructure.
- **Regionally rare mammals:** There may be Project effects on wolverine, a species of special concern under the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), and little brown myotis, a bat listed by the *Species-at-Risk Act* (SARA) and the *Manitoba Endangered Species and Ecosystems Act* (MESEA) as endangered due to habitat loss, alteration of cover, and Project-related sensory disturbance. Increased access created through Project development could increase wolverine mortality. Mitigation

measures will include blocking of Project-related cutlines and trails that are not existing resource-use trails or required for operation, as well as the rehabilitation of temporarily cleared areas to native habitat types.

- **Large carnivores:** Wolves and black bears may be affected by the Project through habitat loss, alteration of cover, attraction to human activities, movement of prey such as moose due to sensory disturbances, and by access effects from harvest by resource users. Mitigation measures will include establishing 100 m buffers around active wolf and bear dens within Study Zone 1 (Map 3) where practicable; restricted use of firearms in camps and work sites, and the rehabilitation of roadside ditches with native plants of low food value for black bears.
- **Mercury in plants and wildlife:** During operation, wildlife that consume fish from within the reservoir are expected to accumulate increased levels of mercury, with concentrations in fish expected to peak within seven years post-flooding, and then slowly decline to pre-flooding levels (or be considered stable at a new background level) by year 30. Bird and most mammal species are not expected to show measurable effects at a local population level, but a small decline in the abundance of river otter found in Study Zone 4 (Map 3) is predicted.

1.4 MONITORING SCHEDULE

As some terrestrial environment components experience wide ranges of seasonal and year-to-year variation, and as some effects of the Project may only be detectable after a period of several years, the TEMP has been designed to be long-term. Some monitoring activities have been scheduled on an ongoing basis over the long-term (20–30 years post-impoundment), while others will be conducted on an 'as required' basis (*e.g.,* focused monitoring for specific construction activities with short-term impacts).

Pre-project data were collected as part of the Keeyask EIS studies. The majority of work for most study components was conducted between 2001 and 2011. In 2013, sampling was repeated for several study components to update databases prior to the start of construction, and some new survey work was undertaken on topics requiring more information (*e.g.,* for the design of appropriate mitigation measures).

The monitoring schedule is generally as follows (see also Tables 1 through 7 and details in individual monitoring sections):

- Construction – for the purposes of this document, the construction phase is defined as starting at the beginning of Project clearing and construction and continuing until the reservoir water level is raised to the full supply level (FSL), projected to be a period of approximately six years. Most monitoring during construction is closely linked to specific activities, but some broader-based monitoring is planned to provide continuity among databases established prior to construction and for components that will be monitored during the operation phase.
- Operation – for the purpose of this document, the operation phase will begin when the reservoir is impounded to the FSL. For many components, intensive monitoring will be conducted annually during the first three to five years of operation, when many of the operation-related effects will first occur and will be at the highest magnitude (*e.g.,* rates of peatland disintegration and organic sediment input into the aquatic system are considerably higher in the first few years compared to the rest of the operation phase).

The frequency of subsequent monitoring may be adjusted depending on results from this initial operation-phase monitoring.

Table 1: Schedule for the Terrestrial Plants, Habitat and Ecosystems monitoring during construction (2014-2019); commissioning (2020); and operation (2021+)

Year

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045
Habitat Clearing, Disturbance, and Intactness																																
Habitat Loss, Disturbance		+	+	+	+	+	+	+		+		+					+					+										+
Effects on Habitat (Long-term)								+		+		+					+					+										+
Habitat Rehabilitation																																
Prescriptions and Plant Survival	Monitoring occurs the year following rehabilitation																															
Habitat Recovery					Annually until target achieved																	+										+
Ecosystem Diversity																																
Priority Habitats		+	+	+	+	+	+	+		+		+					+					+										+
Intactness																																
Linear Density and Core Area								+		+		+					+					+										
Wetland Function																																
Wetland Loss and Disturbance		+	+	+	+	+	+																									
Long-term Effects on Wetlands								+		+		+		+			+					+										+
Fire Regime	Monitoring occurs the summer following a fire effect, if one occurs																															
Priority Plants																																
Provincially Rare Plants	+	+	+																													
Priority Plants								+				+					+															
Invasive Plants																																
Invasive Plant Spread and Control		+	+	+	+	+	+	+	+	+	+	+																				

= Assess monitoring requirements

Note: monitoring schedule is subject to change as per current construction schedule.

Table 2: Schedule for Amphibians and Birds monitoring during construction (2014-2019); commissioning (2020); and operation (2021+)

	Year																															
	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045
Amphibians and Birds																																
Amphibians																																
Habitat Effects												+					+					+										
Habitat Enhancement	Monitoring to occur in years 2, 4, 6, and 8 post-implementation																															
Canada Goose and Mallard																																
Habitat Effects		+		+		+						+		+		+		+		+												
Mallard Habitat Enhancement								Monitoring to occur 3 consecutive years once introduced, then every third year for 15 years																								
Colonial Waterbirds																																
Habitat Effects		+	+	+	+	+						+		+		+		+		+												
Habitat Enhancement		+	+	+	+	+		+	+	+			+			+			+			+										
Bald Eagle																																
Habitat Effects		+		+		+		+	+	+	+	+		+		+		+		+												
Habitat Enhancement		Monitoring to start once nesting platforms are implemented						+		+		+		+		+		+		+												

= Assess monitoring requirements

Note: monitoring schedule is subject to change as per current construction schedule.

Table 3: Schedule for the Birds monitoring during construction (2014-2019); commissioning (2020); and operation (2021+)

	Year																															
	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045
Birds (contd.)																																
Olive-sided Flycatcher																																
Sensory Disturbance		+	+	+	+	+			+	+	+	+			+			+			+											
Habitat Effects			+	+	+										+				+								+					
Habitat Enhancement	Monitoring to occur for three consecutive years once poles installed, then every third year until 15 years since installation																															
Rusty Blackbird																																
Sensory Disturbance		+	+	+	+				+	+	+	+			+			+			+											
Habitat Effects		+	+	+																												
Common Nighthawk																																
Habitat Effects			+	+	+																											
Habitat Enhancement	Monitoring to occur for three consecutive years once initiated, then every third year until sites overgrown or unutilized																															
Other Priority Birds																																
Yellow Rail	No fieldwork required. Data from other studies will be reviewed annually during construction and operation as available																															
Horned Grebe	No fieldwork required. Data from other studies will be reviewed annually during construction and operation as available																															
Ruffed Grouse			+			+			+																							
Barn Swallow	No fieldwork required. Data from other studies will be reviewed annually during construction and operation as available																															
Bank Swallow			+		+		+		+		+																					
Lighted Towers	Monitoring to occur for three consecutive years once installed and illuminated																															

= Assess monitoring requirements

Note: monitoring schedule is subject to change as per current construction schedule.

Table 4: Schedule for Caribou and Moose monitoring during construction (2014-2019); commissioning (2020); and operation (2021+)

	Year																															
	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045
Mammals																																
Caribou																																
Winter Abundance		+		+		+			+		+		+																			
Summer Residents	3 years of early winter reconnaissance aerial surveys, to be carried out during the construction phase																															
Sensory Disturbance		+		+	+	+		+		+		+		+		+		+		+		+										
Habitat Effects	No fieldwork required. Data from other studies will be reviewed annually during construction and operation as available																															
Mortality	No fieldwork required, but occasionally, field investigations may occur. Data from other studies will be reviewed annually during construction and operation as available																															
Moose																																
Population		+			+			+			+			+			+			+			+									
Habitat Effects	No fieldwork required. Data from other studies will be reviewed annually during construction and operation as available																															
Mortality	No fieldwork required. Data from other studies will be reviewed annually during construction and operation as available																															

= Assess monitoring requirements

Note: monitoring schedule is subject to change as per current construction schedule.

Table 5: Schedule for other Mammals monitoring during construction (2014-2019); commissioning (2020); and operation (2021+)

Year

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045
Mammals (contd.)																																
Beaver and Muskrat																																
Habitat Effects								+			+			+			+					+										
Mortality	Trapping monitoring to occur the three consecutive years prior to impoundment. Baffle monitoring during installation year plus three years post installation																															
Rare Mammals																																
Wolverine	No fieldwork required. Data from other studies will be reviewed annually during construction and operation as available																															
Bats		+		+		+																										
Wolf and Bear																																
Den Surveys	Monitoring to occur prior to clearing during sensitive denning periods																															
Human Wildlife Interaction	No fieldwork required. Data from other studies will be reviewed annually during construction and operation as available																															

= Assess monitoring requirements

Note: monitoring schedule is subject to change as per current construction schedule.

Table 6: Schedule for Mercury in Plants and Wildlife monitoring during construction (2014-2019); commissioning (2020); and operation (2021+)

Year

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045
Mercury in Plants and Wildlife																																
Plants*		+	+		+			+			+						+															
Waterfowl			Voluntary submission of samples														+															
Aquatic Furbearers					+	+	+	+	+	+	+	+	+	+ [a]			+			+			+			+			+			+
Caribou and Moose			Voluntary submission of samples														+															

= Assess monitoring requirements

[a] Monitoring will occur annually during operation until peak mercury levels are reached (expected ~2027); thereafter every three years until 30 years of operation or until pre-impoundment mercury levels are reached (or until levels are considered stable at a new background level).

* Voluntary sample submission may also occur during the construction period and during the first 10 years of operation.

Note: monitoring schedule is subject to change as per current construction schedule.

Table 7: Schedule for the Created Wetland monitoring

		Year Following Wetland Creation																								
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
	Wetlands Created																									
Created Wetlands																										
Implementation of Mitigation	Monitoring occurs the year of and the first two years after implementation																									
Efficacy of Mitigation		+		+		+																				
Wildlife at Created Wetlands						+			+			+			+											

= Assess monitoring requirements

Note: monitoring schedule is subject to change as per current construction schedule.

1.5 TEMP COMPONENTS AND RELATED PROGRAMS

The main Project effects on the terrestrial environment are summarized in Section 1.3. In addition to the TEMP, results from components of the Physical Effects Monitoring Plan (PEMP), the Resource Use Monitoring Plan (RUMP), and the KCNs' ATK monitoring plans will be used as important inputs in understanding the changes that occur to terrestrial habitat and wildlife.

1.5.1 SUMMARY OF TEMP COMPONENTS

The following is a brief summary of the major components of the TEMP. Detailed descriptions of planned monitoring are provided in Sections 2.0 to 8.0. Although plans are discussed for each component separately, results will be interpreted in an integrated manner in order to better understand observed environmental effects in an ecosystem context. In addition, if unanticipated effects are recorded in one component, results from another component may assist in interpreting and identifying whether modifications to mitigation are required.

1.5.1.1 TERRESTRIAL HABITAT AND ECOSYSTEMS

During the construction phase, direct habitat loss and disturbance will be measured in the Project Footprint, as well as the success of terrestrial habitat recovery in those areas designated for rehabilitation treatment. Priority habitat patches marked for avoidance will be monitored during clearing activities to promote the protection of key components of ecosystem diversity. Ground surveys will be used to confirm that trails slated to be blocked have been closed and initial revegetation efforts are adequate, and to confirm the effectiveness of construction measures to protect off-system marshes from Project-related erosion, siltation and hydrological changes. In the event of Project-related wildfire effects (*e.g.,* influences on fires stemming from Project roads or activities), monitoring of fires in the Project area will assess potential changes in the fire regime. Information collected from these studies will be used to produce a terrestrial footprint map for the construction phase and to verify predicted Project effects on ecosystem diversity, intactness and wetland function, which are the VECs for terrestrial habitat and ecosystems.

During the operation phase, direct and indirect habitat loss and change will also be measured periodically where ongoing effects are predicted. The terrestrial ecologist will produce a terrestrial footprint map for the operation phase, which will be compared to pre-Project conditions. Habitat rehabilitation will be measured to ascertain success in meeting rehabilitation targets. Monitoring of wetlands during the operation phase will document shoreline wetland development along the reservoir, and confirm Project effects on wetland composition. Information collected by studies will be used to verify predicted Project effects on ecosystem diversity, intactness and wetland function.

1.5.1.2 TERRESTRIAL PLANTS

Pre-clearing rare plant surveys will be conducted in areas within the Project Footprint that were not previously surveyed to determine the presence or absence of provincially rare to very rare species. Plants that are of importance to the KCNs will also be documented during the pre-clearing surveys. If such species are found, avoidance or transplanting measures would be undertaken.

During construction, monitoring of the introduction and spread of invasive plants will be undertaken to verify implementation of mitigation measures, and evaluate the need for further control measures. Information collected by studies will be used to verify predicted Project effects on the priority plants, which is the only plant VEC.

During the operation phase, known priority plant locations will be visited during the summer after construction is complete to confirm the amount of their habitat directly and indirectly affected. Sampling for invasive plants will be conducted during the initial years of operation to document potential spread of these species and determine the need for additional control and eradication programs. Information collected by studies will be used to verify predicted Project effects on the priority plants.

1.5.1.3 AMPHIBIANS

During the construction phase, amphibian surveys will be focused on monitoring the use of slash piles installed as part of the habitat effects study.

During the operation phase, monitoring will evaluate whether suitable habitat for amphibians was created in the new wetland area, calculate how much habitat was lost or altered due to the Project and show where primary and secondary amphibian habitat is still present within Study Zone 4.

1.5.1.4 BIRDS

Breeding bird studies during the construction period will focus on areas surrounding the Project Footprint where birds are likely to be affected by construction-related activities, ensuring that preferred habitats of species at risk are included. Helicopter surveys will also be undertaken to evaluate construction effects on bald eagle, waterfowl, and colonial waterbird nesting and foraging.

Bird monitoring surveys during Project operation will be conducted at sites previously sampled during pre-Project monitoring, at sites adjacent to principal structures and supporting infrastructure, and at additional sites in order to verify predicted effects of operation on bird species at risk, bald eagles, gulls/terns and other priority birds. For comparative purposes, reference sites comprised of habitats similar to those located in Study Zones 3 and 4 (Map 3) will also be sampled.

1.5.1.5 MAMMALS

Monitoring of caribou during the construction phase will aim to track vital measures of caribou populations (such as distribution, relative abundance, and movement), as well as provide information on effects to summer resident caribou calving and calf-rearing habitat. Moose monitoring during construction will track changes to habitat, sample vital measures of the moose population (*e.g.,* abundance, sex ratio), and collect activity, movement, and mortality data in areas with predicted Project effects. Moose monitoring carried out under the TEMP will be coordinated with moose monitoring occurring under the Cree Nation Partners (CNP) Moose Harvest Sustainability Plan, wherever possible. The removal of beaver and muskrat in the future reservoir area will be tracked during the construction phase, as well as beaver populations in Study

Zones 2 to 4 (Map 3). Presence of little brown myotis and wolverine in the Gull and Stephens lakes area will be evaluated during construction. Gray wolf and black bear distribution and abundance will also be monitored.

Monitoring of caribou during the operation phase will also aim to track vital measures of caribou populations, as well as provide information on effects on summer resident caribou calving and calf-rearing habitat. Moose monitoring during operation will continue to track changes to habitat in areas with predicted Project effects, sample vital measures of moose population, and collect activity, movement, and mortality data in areas with predicted Project effects. Monitoring of beaver populations will be undertaken at locations within Study Zones 1 to 4 and will be compared to abundance prior to construction. Presence of little brown myotis and wolverine in the Gull and Stephens lakes area will be evaluated during the initial years of operation. Gray wolf and black bear distribution and abundance will also be monitored.

1.5.1.6 MERCURY IN PLANTS AND WILDLIFE

During the construction and operation phases, mercury levels will be monitored in traditionally used terrestrial plant species, waterfowl, aquatic furbearers, as well as other game (caribou and moose) for which samples are voluntarily supplied by resource users from on- and off-system locations. The samplings for mercury in plants and wildlife has been designed to ensure thorough coverage during the operation period until maximum mercury levels would be reached, and then periodically thereafter until concentrations return to pre-impoundment levels (or are considered stable at a new background level).

1.5.1.7 CREATED WETLANDS

To replace the high-quality marsh wetland habitat that will be affected by Project development, 12 ha of off-system marsh habitat will be created during the construction phase of the Project. Initial monitoring efforts for the created wetlands will focus on the wetland installation itself (i.e., compliance monitoring), since several years are required before it can be determined whether vegetation and soil targets are on the desired development pathway. After the marsh wetland area is constructed, and after sufficient time passes for soils and vegetation to develop beyond the establishment stage, the created wetland monitoring focus will gradually shift to evaluating whether or not the soils and vegetation at the wetland site have met the prescribed habitat targets, and whether the created wetland area is being used by wildlife.

1.5.2 OTHER MONITORING RELEVANT TO THE TEMP

A Physical Environment Monitoring Plan (PEMP) will also be implemented to monitor immediate physical effects resulting from construction and operation of the Project. The PEMP will establish monitoring programs related to greenhouse gases, surface water and ice regimes, shoreline erosion and peatland disintegration.

Physical environment monitoring data that would be useful for the terrestrial habitat, ecosystems and plant monitoring would include water and ice regime data, air photos or remote sensing data, and information on areas where organic and mineral sediment deposition are occurring. Information on the operating water regime will also be required to understand the effects on wildlife species using islands in the Nelson River as breeding habitat, such as caribou and colonial waterbirds.

Two of the main objectives of the Project's Resource Use Monitoring Plan (RUMP) are to determine if the Keeyask workforce is hunting, fishing or gathering within or outside the Project site; and to document any changes to moose and caribou license demand, harvest patterns, and, if feasible, quantify harvests. This information, as it relates to terrestrial mammal and plant populations, will be of direct interest to a number of the terrestrial monitoring studies.

Aboriginal Traditional Knowledge (ATK) monitoring will also be undertaken for the Project by the KCNs. The KHLP's MAC will facilitate the sharing of information, so that the ATK and TEMP monitoring programs inform and complement one another, wherever possible.

2.0 TERRESTRIAL HABITAT AND ECOSYSTEMS

2.1 TERRESTRIAL HABITAT CLEARING, DISTURBANCE AND INDIRECT EFFECTS

2.1.1 INTRODUCTION

2.1.1.1 BACKGROUND

Habitat is the place where an organism or a population lives. Because all natural areas are habitat for something, "terrestrial habitat" refers to all land habitat for all species. Habitat for a particular species is identified with a species prefix, such as moose habitat, rusty blackbird nesting habitat or jack pine habitat.

Terrestrial habitat effects are of interest in their own right. The KCNs indicate that all terrestrial habitats are important. Terrestrial habitat is also a keystone driver for Project effects on terrestrial ecosystems and ecosystem functions. Mapped habitat attributes represent most of the major stand level ecosystem components (*e.g.,* vegetation and soils in a mapped habitat patch), biomass and controlling factors. Plants and animals use habitat for survival and reproduction. Most terrestrial environment effects predictions incorporate terrestrial habitat predictions in some fashion. For these reasons, terrestrial habitat monitoring provides an effective means for identifying anticipated and unexpected effects on the terrestrial environment.

2.1.1.2 ASSESSMENT SUMMARY

Direct Project effects will include loss, alteration and physical disturbance of habitat and ecosystems in the actual Project Footprint as well any undefined footprints that may ultimately occur outside of the Project Footprint, if any. These direct effects will create indirect effects, both within the Project Footprint and in some surrounding areas. That is, a Project impact will have a zone of influence surrounding its physical footprint. A particular indirect effect may be several stages removed from the direct Project effect.

As an example of an indirect effects pathway, clearing trees on permafrost soils will generally lead to higher soil temperatures, both within the cleared area and in adjacent areas. Vegetation clearing that creates large openings on treed peatlands with thick ground ice will generally lead to permafrost melting, followed by collapse of the soil surface to form craters, and then by the development of very wet peatland habitat and/or open water in the craters. In this situation, the direct effect on habitat is vegetation clearing, an initial indirect effect is soil warming which leads to the secondary indirect effect, permafrost melting, followed by the tertiary indirect effect, peatland surface collapse, and finally the ultimate indirect habitat effect, which is conversion to very wet peatland habitat and/or open water.

Indirect Project effects on vegetation, soils, animals and key ecological flows are expected to generally decline with distance from the Project Footprint. The EIS habitat and ecosystems effects assessment accounted for this pattern by using different zones of influence for stand and landscape level ecosystem attributes.

Improved access is another potentially important pathway for indirect Project effects since this will bring more equipment, material and/or people into an area, which could lead to increased resource harvesting or human-caused fires, among other things.

The EIS identified approximately 6,872 ha of terrestrial habitat within the potential construction Project Footprint. To predict potential construction effects on terrestrial habitat and ecosystems, the EIS followed the precautionary principle and erred on the side of overestimating anticipated effects. Using a 50 m buffer of the Project Footprint as the indirect effects zone ensured that all potential sensitive sites were included in the effects assessment. This buffer also provided a spatial allowance for disturbance that could not be planned prior to construction and for other Project impacts outside of the designated Project footprint. Cautiously assuming that all of this 50 m buffer is affected, the total amount of habitat that may be directly and indirectly affected by the Project during construction could increase to 8,927 ha, or less than 1%, of total terrestrial habitat in Study Zone 5 (i.e., the Keeyask Region).

This estimated total affected area is expected to be a substantial overestimate of habitat effects during construction for several reasons. First, it is anticipated that substantial portions of the potential borrow and disturbance areas will not be used. Also, the environmental protection plans (EnvPPs) include measures intended to minimize clearing and disturbance outside of the permanent Project components (e.g., in the remaining possibly disturbed areas), which should reduce the amount of habitat alteration and disturbance. Additionally, the 50 m buffer of the Project Footprint used to quantify indirect effects is an overestimate of the spatial extent of unplanned physical disturbance and indirect habitat effects.

For Project operation, initial flooding would be entirely contained within areas already affected during construction (i.e., reservoir clearing). The primary additional adverse effects during operation are reservoir expansion due to peatland disintegration and mineral bank erosion, groundwater-related habitat effects and additional edge effects. These effects will be somewhat offset by habitat rehabilitation efforts and any natural habitat regeneration that occurs in the disturbed and temporarily cleared areas. 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 to 545 ha of habitat, or 0.04% of the Keeyask Region,, after 30 years (see Section 6.5.3.1.3). Most of the reservoir-related habitat loss occurs during the first 15 years of operation.

Before considering mitigation, Project operation is predicted to permanently remove approximately 5,339 ha of terrestrial habitat in the first 30 years. Permanent infrastructure and initial flooding comprise 4,667 ha of this total. Subsequent reservoir expansion is predicted to convert an additional 671 ha of inland habitat to aquatic areas, with most of this habitat change occurring during the first 15 years. Habitat loss and alteration around the reservoir is predicted to continue for 50 to 100 years, but at declining and much lower rates.

The amount of permanent habitat alteration is highly uncertain because the actual locations and sizes of some Project features, such as borrow areas, will not be known until construction is well underway, and because the degree of habitat rehabilitation success and natural habitat recovery will not be known for many years into operation. Based on precautionary assumptions described in the EIS, it was estimated that the Project could permanently alter 2,580 ha of terrestrial habitat over the long-term. It was estimated that while approximately

1,497 ha of the terrestrial habitat affected during construction would remain altered after 30 years, most of this area could recover to native habitat by year 100.

In summary, before considering mitigation and recovery of temporarily affected habitat, approximately 9,416 ha of terrestrial habitat is predicted to be affected during the first 30 years of operation, 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, the Project would affect less than 1% of the historical areas of total terrestrial habitat and each of the common broad habitat types. 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.

Mitigation in addition to that already incorporated into the Project design, will include the following:

- The portion of borrow area N-6 identified as a sensitive site in the EIS will be avoided;
- 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 and those required for operation, 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.

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 the Project could increase the cumulative amounts of affected terrestrial habitat and the common habitat types to almost 6% of historical area, which is well below the 10% precautionary benchmark used to trigger adaptive management.

2.1.1.3 COMPONENTS THAT WILL BE MONITORED

The Habitat Loss and Disturbance study (Section 2.1.2) will focus on Project-related effects on stand level habitat composition due to habitat loss and disturbance. This study will map terrestrial habitat loss and alteration due to Project-related clearing, disturbance, roads and trails during construction.

The Long-Term Effects on Habitat study (Section 2.1.3) will monitor indirect Project effects on terrestrial habitat as well as natural recovery to native habitat in Project-affected areas and trails that intersect the Project Footprint. It will also map terrestrial habitat loss and on-system shoreline composition changes during operation. This study will commence at construction completion since habitat recovery and most indirect effects become visible during operation. The Terrestrial Habitat Rehabilitation study (Section 2.2) will provide terrestrial habitat rehabilitation data for this study.

This monitoring program will periodically update the detailed terrestrial habitat maps.

Information developed by this monitoring program will be the primary data source for the Ecosystem Diversity (Section 2.3) and Intactness (Section 2.4) monitoring programs, and an important data source for most other terrestrial monitoring programs.

2.1.2 HABITAT LOSS AND DISTURBANCE

2.1.2.1 INTRODUCTION

The goal of the Habitat Loss and Disturbance study is to determine direct Project effects on terrestrial habitat composition during construction.

2.1.2.2 OBJECTIVES

The objectives of this study are to:

- Quantify and situate terrestrial habitat loss and physical disturbance; and,
- Quantify and situate Project effects on terrestrial habitat composition during construction.

2.1.2.3 STUDY DESIGN

2.1.2.3.1 OVERVIEW

A statistical design is not required for this study. Field surveys and remote sensing data will be used to census all areas directly affected by the Project. While this study will collect most of the needed data, relevant data from other TEMP studies will contribute to periodic updates of the terrestrial habitat maps.

2.1.2.3.2 EXISTING DATA

Detailed habitat mapping for Study Zone 4 (Map 3) was completed during EIS studies. Approximately 115 fine habitat types were mapped at a scale of 1:15,000. More detailed shore zone habitat and off-shore marsh mapping was completed for areas along the Nelson River and a subset of off-system waterbodies. Coarse habitat mapping was completed for much of the remaining portion of Study Zone 5 by classifying Landsat satellite imagery.

The characteristics of each of the mapped habitat types, as well as the relationships between habitat components (e.g., soils, vegetation) and between drivers for habitat change (e.g., wildfire, permafrost melting), were derived from the analysis of vegetation, soil and environmental data. These data were collected at over 500 habitat plots, along over 540 km of habitat transects and at over 4,000 soil profile sample points in the Keeyask Region.

Direct and indirect Project effects were predicted by overlaying the Project Footprint and its maximum zone of indirect influence onto the detailed terrestrial habitat map. This facilitated area summaries by Project footprint type (e.g., access roads) or type of indirect effect (e.g., losses due to reservoir expansion, habitat alteration due to edge effects).

The Keeyask Infrastructure Project (KIP) monitoring program is documenting habitat loss and alteration resulting from the development of that project.

2.1.2.3.3 DESIGN

A combination of remote sensing, aerial surveys and ground surveys will be used to map Project-related clearing, disturbance, roads and trails. Helicopter-based aerial surveys will identify the extent of habitat loss and overstory alteration. Foot and vehicle-based ground surveys will identify understorey disturbance that is not visible from aerial surveys. A geographic information system (GIS) will spatially reference and store the information collected during field surveys. This information will be used to produce the *Keeyask Generation Project Terrestrial Footprint Map for Construction* and to notify Manitoba Hydro of any impacts outside of the planned Project Footprint. This clearing and disturbance map will be a critical input into planning the locations and nature of terrestrial habitat rehabilitation. The road and trail mapping will also be used to confirm the predictions regarding Project effects on intactness (see Section 2.3.2.3.10).

Within one year of construction phase completion, all of the data will be integrated into the *Keeyask Generation Project Terrestrial Footprint Map for Construction*, which will illustrate the actual amounts of terrestrial habitat clearing and disturbance. Following this, the detailed terrestrial habitat map will be updated to reflect current conditions.

2.1.2.3.4 PARAMETERS

The monitoring parameters are:

- Terrestrial areas cleared or physically disturbed, by habitat type and by Project feature; and,
- Length and width of roads and trails, by type.

2.1.2.3.5 BENCHMARKS

In the EIS, an effects benchmark for an indicator representing a VEC or supporting topic was a precautionary value, or range of values, that is well below the anticipated level of an ecological threshold. An effects benchmark value is set well below the point where a sudden, dramatic change in the VEC or supporting topic is expected to occur. A benchmark is the point at which the cumulative effects on a VEC or supporting topic are considered more seriously in conjunction with other factors (e.g., effect duration, ecological context) and other indicator measures, and when mitigation or adaptive management is often implemented to reduce the risk of an important adverse effect.

Using terrestrial habitat as an example, the benchmark value for a high magnitude effect on terrestrial habitat was 10% or more of pre-development native habitat cumulatively affected by all development in the Keeyask Region. This benchmark does not imply that there will be a sudden, dramatic change in ecosystem function once the 10% value is reached, but rather it is expected that ecosystem stress may start to occur once this value is reached and this stress will increase as habitat loss or alteration continues to increase.

The 10% loss of historical native habitat area will be used as the benchmark for cumulative effects on total terrestrial habitat and the common habitat types during Project monitoring. Adaptive management will be triggered if ongoing monitoring indicates that cumulative area losses for a priority habitat type could reach 10%. Adaptive management would likely consist of additional rehabilitation for the given habitat type. The EIS identified giving preference to rehabilitating the most affected priority habitat types as a mitigation measure.

2.1.2.3.6 STUDY AREA

Study Zone 2 is the study area (*i.e.*, areas within the Project Footprint and areas within 150 m of the Project Footprint; Map 3). Study Zone 2 extends more than 100 m beyond the expected spatial extent of Project-related terrestrial habitat change. The study area will be expanded if additional or unintended Project activities occur outside of this area.

2.1.2.3.7 SAMPLE LOCATIONS

This study will census Project impacts throughout Study Zone 2, and any additional unanticipated areas of Project clearing and disturbance that are detected during monitoring.

2.1.2.3.8 SAMPLING FREQUENCY AND SCHEDULE

Sampling will be conducted each year during construction, during the summer following the end of the construction phase and during years 1, 3, 5, 10, 15 and 25 of operation. Mapping is most frequent during the first ten years of operation since this is when the majority of reservoir expansion is expected to occur.

Sampling will generally occur once in late summer but this may vary depending on the timing and nature of Project construction that year.

2.1.2.3.9 FIELD AND LAB METHODS

The terrestrial ecologist will conduct aerial and ground surveys at the times identified in Section 2.1.3.3.8, to document terrestrial habitat change and any unanticipated effects. An aerial survey in a sampling year will document clearing progress, and note potential areas of understorey disturbance or unanticipated impacts. Information collected during the aerial survey will be used to plan a ground survey to investigate understorey conditions or unanticipated Project effects. During operation, low-level aerial surveys will be conducted along the Nelson River shoreline to map evolving shoreline attributes.

Project-related clearing, disturbance and other relevant conditions will be documented with geo-referenced photographs, marked-up maps and notes. Any unanticipated clearing or disturbance detected during field surveys will be reported to Manitoba Hydro. During construction, existing digital orthorectified imagery will be the base map for GIS-based mapping of the field data.

At the end of the construction phase, Project clearing and disturbance will be mapped using newly acquired digital imagery. Manitoba Hydro will develop this imagery from remote sensing data such as high-resolution satellite imagery or stereo photography acquired at a scale no smaller than 1:10,000. Remote sensing data will be acquired after the majority of Project-related clearing has been completed and shortly before reservoir impoundment. The digital orthorectified imagery provided by Manitoba Hydro will become the base map for GIS mapping of the field data. High-resolution multi-spectral satellite imagery will be used to update the mapping at years 1, 3, 5, 10 and 15 of operation.

2.1.2.3.10 ANALYSIS

Standard GIS methods will be used to tabulate Project clearing and disturbance by impact type (e.g., access roads, reservoir). These tabulations will only be for unanticipated clearing and disturbance until the end of construction since the detailed mapping of all clearing and disturbance will not occur until that time. The planned Project Footprint is larger than needed and accurate mapping of actual footprint boundaries and ground conditions requires digital orthorectified imagery. Changes to the Project Footprint and major indirect effects will be included in the periodic (Section 2.1.3.3.8) map updates during operation.

2.1.3 LONG-TERM EFFECTS ON TERRESTRIAL HABITAT

2.1.3.1 INTRODUCTION

In general, the indirect effects of construction clearing, reservoir flooding and other Project impacts on terrestrial habitat are not expected to become observable to a substantial degree until the operation phase. Native habitat restoration through natural vegetation regeneration and habitat rehabilitation will not be well established until many years into operation.

The Long Term Effects on Terrestrial Habitat monitoring will supplement information from the Habitat Loss and Disturbance study by examining how the Project affects habitat characteristics, particularly those that may only be visible from ground surveys. Of these, groundwater and edge effects are expected to be the most substantive and widespread components.

The goal of this study is to determine the nature of long-term Project effects on terrestrial habitat and the extent of native habitat recovery during operation.

2.1.3.2 OBJECTIVES

The objectives of this study are to:

- Map changes to on-system shoreline habitat composition during operation;
- Characterize Project-related groundwater and edge effects outside of areas affected by the Project's hydraulic zone of influence;
- Quantify and situate indirect Project effects on terrestrial habitat;
- Identify trails and Project-affected areas that are recovering to native habitat types;
- Quantify and situate areas recovering to native terrestrial habitat; and,
- Quantify and situate long-term Project effects on terrestrial habitat composition.

2.1.3.3 STUDY DESIGN

2.1.3.3.1 OVERVIEW

There are two components to this study. The first maps direct and indirect Project effects and successful habitat rehabilitation, while the second documents recovery to native habitat types and the nature of indirect Project effects on terrestrial habitat. This monitoring begins during operation since that is when these effects become observable to a substantial degree. The Wetland Function monitoring study (Section 2.5) will study changes to shore zone habitat and off-shore marsh in areas affected by flooding and water regulation.

With the exception of areas near the hydraulic zone of influence, indirect habitat effects are expected to extend less than 25 m from the edge of the actual Project Footprint. Ground surveys will document the nature of indirect effects in areas that should not be affected by Project-related flooding or water regulation. Ground surveys will also document natural habitat recovery in pre-existing cleared areas (e.g., exploration trails) in Study Zone 3.

2.1.3.3.2 EXISTING DATA

Section 2.1.2.3.2 outlines the existing data for this study.

2.1.3.3.3 DESIGN

A combination of remote sensing, aerial surveys and ground surveys will be used to map the spatial extent of Project-related indirect effects during operation. Helicopter-based aerial surveys will identify areas where ecosite and overstory vegetation type have changed. Foot, boat, and vehicle-based ground surveys will identify understorey alteration that is not visible from aerial surveys. A GIS will spatially reference and store the information collected during field surveys.

This information will be used to plan the locations for detailed habitat surveys for the second study component. In this component, an impact-trend by time design will be employed to document how vegetation, soil and other environmental conditions in the Project zone of influence are evolving, and how these attributes differ from those found in native habitat types. A stratified, random sample of habitat patches will be selected from within the Project's zone of influence, not including the hydraulic zone of influence (Map 4; hydraulic zone of influence effects will be monitored by the Long-Term Effects on Wetland Function study - Section 2.5.3). Results from EIS studies will provide reference data for the attributes associated with native habitat types.

The detailed terrestrial habitat map completed at the end of the construction phase (Section 2.1.2.3.9) will establish the baseline state for the operation phase. During operation, the evolving reservoir shoreline and its attributes (*e.g.,* shoreline location and bank material types) will be periodically mapped. Large-scale stereo photography acquired at the first reasonable opportunity in the growing season following reservoir impoundment will be used to map initial changes to terrestrial habitat due to reservoir flooding. Manitoba Hydro will acquire this photography during the growing season at a scale that is no smaller than 1:10,000. Digital orthorectified imagery developed from this stereo photography will be the base map for transferring flooding data into a GIS.

Subsequent shoreline and terrestrial habitat changes will be documented primarily through a combination of helicopter-based photography and/or high resolution multi-spectral satellite imagery. Habitat composition changes will be mapped after initial flooding by classifying high resolution multi-spectral satellite imagery (e.g., Worldview 2) and then enhancing this mapping with aerial and ground survey data. Ground surveys will be conducted in locations of particular interest to identify changes that may not be visible from remote sensing and aerial surveys.

Data collected by this study will be used to create the *Keeyask Generation Project Terrestrial Footprint Map for Operation* at years 1, 3, 5, 10, 15 and 25. In years 15 and 25, the timing of subsequent mapping will be determined based on trends observed up to that time.

The information gathered by this study will be used to periodically produce a *Keeyask Generation Project Terrestrial Footprint Map for Operation*. Results from the Wetland Function study (Section 2.5) will contribute wetland data for this mapping. The Terrestrial Habitat Rehabilitation study (Section 2.2) will provide information regarding assisted habitat recovery.

2.1.3.3.4 PARAMETERS

The monitoring parameters are:

- Nelson River shore zone attributes such as shoreline location, vegetation type, bank material, bank height and bank slope;
- Vegetation, soil and other environmental attributes in zone of indirect Project effects; and,
- Areas recovering to native habitat types by habitat type.

2.1.3.3.5 BENCHMARKS

Adaptive management will be triggered (likely in the form of additional rehabilitation) if ongoing monitoring indicates that cumulative area losses for total terrestrial habitat or a common broad habitat type could reach 10% of historical area.

2.1.3.3.6 STUDY AREA

Study Zone 2 is the study area (Map 3). Study Zone 2 generally extends more than 100 m beyond the expected spatial extent of Project-related terrestrial habitat change. The study area will be expanded if additional or unintended Project activities occur outside of this area.

2.1.3.3.7 SAMPLE LOCATIONS

Project-related indirect effects on terrestrial habitat, native habitat recovery in Project-affected areas and habitat composition trends will be documented through a combination of remote sensing, aerial surveys and ground surveys. Aerial surveys and associated ground truthing will census all areas within Study Zone 2, and any additional unanticipated areas of Project clearing, disturbance or indirect effects on terrestrial habitat that are detected during monitoring.

For the study component monitoring the nature of indirect effects, ground surveys will occur in areas not affected by the reservoir or water regulation. The Wetland Function study (Section 2.5) will study indirect habitat changes in the areas not included in this study.

A potential sample location consists of a land area with relatively homogenous ecosite conditions, overstory vegetation and a similar time since stand replacing disturbance, and that is at least one ha in size. A one ha patch size is the minimum needed to avoid having edges comprise all or a high proportion of the patch.

Sample locations will be selected as follows:

1. To identify the sampling units for the sampling frame:
    a. Select all mapped habitat patches from the detailed terrestrial habitat map that abut an actual Project impact area;

   b. Drop all patches that have less than 150 m frontage on the adjacent Project impact area and are less than 100 m deep in terms of perpendicular distance to the relevant Project impact area. This selection criterion ensures that subsamples can be placed in locations that are free from the confounding effects of different adjacent habitat types.

2. To identify the strata for random selection, classify the patches selected in Step 1 into broad habitat groups based on pre-Project habitat type, time since stand replacing disturbance (in age classes) and adjacent Project impact type;
3. Randomly select at least three patches from each of the strata defined in Step 2. The actual number of patches will be determined at year 5 of operation based on the actual conditions that develop to that time.

Some additional habitat monitoring to support wildlife monitoring will be needed. For example, some of the islands formed by reservoir flooding are expected to become caribou calving habitat. Vegetation and ecosite conditions on these islands will be surveyed to characterize their suitability as caribou calving habitat.

2.1.3.3.8 SAMPLING FREQUENCY AND SCHEDULE

Sampling timing is related to the anticipated time for effects to be manifested. Since direct and indirect Project-related effects and natural habitat recovery are expected to occur over many years, sampling outside of the reservoir-affected areas will occur in years 1, 3, 5, 10, 15 and 25 during operation. The stability of habitat composition will be reviewed in year 15 to determine if the sampling frequency should be modified for future years.

Sampling will occur between mid-July and late August, which is the period when most plants are fully leafed out in Study Zone 2.

2.1.3.3.9 FIELD AND LAB METHODS

Three belt transects will be systematically located within each sample location. The transects will be spaced 30 m apart and run perpendicular to the habitat patch frontage on the Project impact. The middle transect is located at the center of the Project impact frontage. This transect spacing produces independent subsamples of the habitat patch while the transect locations are far enough from the adjacent habitat patches to be uninfluenced by them. A transect will be shifted in the field if the systematic approach places it in pre-Project edge habitat that is very different from the rest of the frontage (so natural variability is not confounded with Project effects).

Since the anticipated distance of indirect effects is generally expected to be less than 25 m outside of reservoir-influenced areas, the transects will generally be 50 m long. The transects will be extended if conditions apparent during transect establishment suggest that indirect effects could extend further. An example of such a situation is where road construction has altered hydrology and this appears to have changed soil moisture for more than 10 m from the impact footprint edge. The ends of the transects will be recorded in a hand-held GPS and permanently marked to facilitate re-sampling in subsequent years.

Vegetation, soil and environmental attribute data will be collected along each transect, using a nested belt approach. The nesting for vegetation is: mature trees are sampled in a 10 m belt; tall shrubs, tree seedlings and tree saplings in a 2 m belt; and, low shrubs, forbs and mosses in a 1 m belt. Large downed woody material will be sampled at centerline intersections. Photos along the transect and of the canopy will be taken.

Soil profile sampling will occur outside of the 2 m belt but within the 10 m belt. Evidence of disturbance events within or near the tree belt will be recorded. Care will be taken to avoid disturbing areas inside of the 2 m belt.

2.1.3.3.10 ANALYSIS

Standard GIS methods will be used to map zones of Project-related indirect effects during operation. Habitat types used for the detailed and coarse terrestrial habitat mapping will be the same as those used in the EIS.

Plant nomenclature will follow Flora of North America (Flora of North America Editorial Committee 1993+) where volumes currently exist and the Manitoba Conservation Data Center elsewhere.

Changes to the attributes of each terrestrial habitat type will be identified using multivariate techniques such as ordination and cluster analysis. Starting in year 10 of operation, a time series analysis of changes to habitat composition will be completed using data collected to date. The specific techniques will be determined by the pattern of changes to that time and by the structure of the data. Statistical model and inferential assumptions will be tested during the analyses.

2.1.4 REPORTING

2.1.4.1 ANNUAL REPORTS

A report will be produced during the winter after each year when field studies occur, and will be submitted to MCWS the following spring, as per Environment Act License 3107, Clause 20.

Reports will summarize the activities and general findings of the monitoring during the preceding year. Basic descriptive statistics will be the level of data analysis for these reports. Any major unanticipated events or recommendations for changes to study design or mitigation will be noted.

2.1.4.2 SYNTHESIS AND RECOMMENDATIONS

Synthesis reports will be submitted in the spring after years 5, 10, 15 and 25 of operation. Synthesis reports will consolidate, analyze and evaluate all monitoring information gathered to date, including that produced by EIS and other monitoring studies. An integrated evaluation of the various pathways of effects on terrestrial habitat will be completed. Actual Project effects will be evaluated relative to the EIS predictions, and the cumulative effects assessment will be updated to reflect actual direct and indirect Project effects. These reports will also include recommendations for any needed modifications to subsequent study design or to mitigation.

The synthesis report following year 10 of operation will evaluate trends in terrestrial habitat composition change and make recommendations on the degree and timing of subsequent monitoring.

2.2 TERRESTRIAL HABITAT REHABILITATION

2.2.1 INTRODUCTION

2.2.1.1 BACKGROUND

Terrestrial habitat rehabilitation mitigates adverse Project effects on terrestrial habitat and plants (e.g., habitat loss, erosion, invasive plant spread), restores wildlife habitat and improves aesthetics, among other benefits. Terrestrial habitat will be rehabilitated in areas not required for Project operation and in some areas that are required for Project operation (e.g., ditches). Some of the planned rehabilitation addresses potential adverse Project effects on intactness by blocking or hindering access from Project areas to surrounding areas.

2.2.1.2 ASSESSMENT SUMMARY

Section 2.1.1.2 described anticipated Project effects on terrestrial habitat, associated mitigation and the anticipated degree of subsequent natural habitat recovery. Terrestrial habitat rehabilitation was identified as a mitigation measure for this and many other components of the terrestrial ecosystem (e.g., wildlife species). As an example, habitat rehabilitation is intended to maintain cumulative effects below 10% of historical area for some priority habitat types that already have cumulative effects approaching this benchmark. Rehabilitation efforts are expected to restore some of the native terrestrial habitat that was lost or disturbed during construction, and to revegetate temporary Project areas that must be maintained in non-native habitat types (e.g., grass cover in roadside ditches).

2.2.1.3 COMPONENTS THAT WILL BE MONITORED

Monitoring is needed to verify the implementation and effectiveness of terrestrial habitat rehabilitation measures. The Vegetation Rehabilitation Plan*,* which is part of the overall Environmental Protection Program, will initially be a framework document explaining the approach to rehabilitation and the possible treatments for specific areas. As areas become available for rehabilitation, sections will added to the document that identify the specific locations and nature of terrestrial habitat rehabilitation.

Terrestrial habitat rehabilitation monitoring will initially focus on verifying adequate implementation of rehabilitation efforts. As sufficient time elapses for habitat recovery, the monitoring focus will increasingly transition into verifying the ultimate success of the rehabilitation efforts.

2.2.2 REHABILITATION IMPLEMENTATION AND SUCCESS

2.2.2.1 INTRODUCTION

The Vegetation Rehabilitation Plan will set terrestrial habitat rehabilitation targets for areas to be rehabilitated, and provide rehabilitation prescriptions that are expected to achieve those targets over an appropriate length of time. The goal of this study is to verify whether each site has achieved, or is on a pathway to achieving, its rehabilitation targets.

2.2.2.2 OBJECTIVES

The objectives of this study are to:

- Confirm that trails intersecting the Project Footprint (except for existing resource-use trails and those required for operation) are blocked and initial revegetation efforts are adequate;
- Verify the implementation of rehabilitation prescriptions set out in the Vegetation Rehabilitation Plan;
- Confirm that the revegetated portions of the blocked trails are regenerating successfully and are expected to restore a habitat type similar to adjacent areas; and,
- Verify the effectiveness of rehabilitation efforts at restoring native habitat where this is the target prescription, and at restoring ecologically appropriate vegetation in the remaining areas.

2.2.2.3 STUDY DESIGN

2.2.2.3.1 OVERVIEW

This study will verify that rehabilitation is being implemented in accordance with the Vegetation Rehabilitation Plan. During the construction phase, the primary focus will be on the implementation of the rehabilitation prescriptions since several years are required before it can be determined whether vegetation and soil targets are on the desired recovery pathway.

As sufficient time passes for soils and vegetation to develop beyond the establishment stage, the monitoring focus will gradually shift to evaluating whether or not soils and vegetation have already met the prescribed habitat targets or, if not, they appear to be on a pathway towards achieving them.

2.2.2.3.2 EXISTING DATA

This subsection is not applicable for this study. The Vegetation Rehabilitation Plan will provide the required information.

2.2.2.3.3 DESIGN

All areas identified for rehabilitation in the Vegetation Rehabilitation Plan will be surveyed to confirm implementation of the rehabilitation prescriptions and to evaluate rehabilitation success. Systematically located transects will generally be used to document the implementation and effectiveness of rehabilitation efforts. Implementation surveys will confirm that rehabilitation prescription elements such as depth of site preparation, application of any prescribed soil amendments and planting density are in place. Rehabilitation success surveys will focus on properties related to soil development, survival of planted seedlings, formation of a natural ground cover and other critical precursors to regenerating the target habitat type.

2.2.2.3.4 PARAMETERS OF CONCERN

Parameters being measured are:

- Degree to which identified cutlines and trails that intersect the Project Footprint (excluding existing resource use trails and those required for operation) are blocked and revegetated;
- Percentage of area treated according to the prescriptions set out in the Vegetation Rehabilitation Plan;
- Site conditions and other factors that influence the restoration of native soils and vegetation; and
- Vegetation, soil and site conditions within each of the rehabilitation locations.

2.2.2.3.5 BENCHMARKS

The targets are that the rehabilitation prescriptions will be implemented as described in all areas, that 90% of rehabilitated areas will regenerate to the target habitat type and that all trails receiving treatments will be blocked and revegetated as prescribed. It is noted that, since some relevant site conditions will not be known until after the Vegetation Rehabilitation Plan site-specific prescription sections are completed, the plan will include provisions to refine prescriptions around the time of implementation, if needed, to accommodate unanticipated site conditions or logistical constraints.

2.2.2.3.6 STUDY AREA

The study area is all of areas identified in the Vegetation Rehabilitation Plan (which will include trails to be blocked and revegetated).

2.2.2.3.7 SAMPLE LOCATIONS

Surveys will occur in the rehabilitation locations identified in the Vegetation Rehabilitation Plan (which includes blocked trails and cutlines).

2.2.2.3.8 SAMPLING FREQUENCY AND SCHEDULE

In general, the rehabilitation implementation surveys will occur in the year following each year when rehabilitation efforts occur. Each rehabilitation location will be sampled annually for five years to confirm survival of plantings (*e.g.,* high plant mortality can occur during a hot, dry summer) and the persistence of other amendments (e.g., hydroseeding material). Rehabilitated borrow areas will be inspected annually for at least five years to confirm revegetation success; and rehabilitated areas where vegetation planted covers less than 50% of the area seeded after 5 years will be improved and replanted.

Recovery success surveys will commence starting two years after rehabilitation of a broad area is complete (e.g., a borrow area). The frequency and timing of surveys will be scheduled based on results from the rehabilitation implementation surveys and the habitat type (e.g., recovery to a shrubland is expected to be more rapid than recovery to a peatland forest). Annual surveys will continue at each location until it appears that vegetation and soils are on track to achieve the rehabilitation targets set out in the Vegetation Rehabilitation Plan. Additional surveys will be conducted in years 15 and 25 of operation to provide a comprehensive evaluation of success to date.

2.2.2.3.9 FIELD AND LAB METHODS

In general, transects will be systematically located within the site. The specific transect layout will depend on the rehabilitation prescription and the shape and layout of the site. This information will not be available until specific locations and rehabilitation prescriptions for these locations are incorporated into the rehabilitation plan, which will happen in a progressive manner as Manitoba Hydro determines that an area is not required for Project operation.

The terrestrial ecologist will record rehabilitation success using relevant attributes. Seedlings for all target plant species will be tallied. Recorded information will include attributes such as: plant species, seedling vigor, whether the seedling is planted or naturally regenerating, soil conditions, stem density, vegetation cover, and soil profile development. The use of geo-referenced photographs, marked-up maps and notes, and a GIS will aid in this process.

To confirm that the cutlines and trails intersecting the Project Footprint have been adequately blocked and revegetated, the terrestrial ecologist will conduct ground surveys each year that expansion of the Project Footprint intersects additional cutlines and trails, and during the summer following the end of the construction phase. The field data will be mapped in a GIS, using the *Keeyask Generation Project Terrestrial Footprint Map for Construction* as the base map. Any inadequately blocked cutlines or trails will be reported to Manitoba Hydro.

2.2.3 REPORTING

2.2.3.1 ANNUAL REPORTS

A report will be produced during the winter after each year when field studies occur, and will be submitted to MCWS the following spring, as per Environment Act License 3107, Clause 20.

Reports will summarize the activities and general findings of the monitoring during the preceding year. Basic descriptive statistics will be the level of data analysis for these reports. Any major unanticipated events or recommendations for changes to study design or mitigation will be noted.

2.2.3.2 SYNTHESIS AND RECOMMENDATIONS

A synthesis report will be produced after construction completion and at years 5, 10, 15 and 25 of operation. Synthesis reports will consolidate, map, analyze and evaluate all monitoring information gathered to date. Actual terrestrial habitat recovery pathways will be compared with the targets set out in the Vegetation Rehabilitation Plan. The report will evaluate whether rehabilitation targets set out in the Vegetation Rehabilitation Plan are being met and, if not, will prescribe additional and/or alternative rehabilitation. An integrated analysis of the factors contributing to rehabilitation success will be included. If the terrestrial ecologist finds deviations from predictions, or if unforeseen conditions arise, the report will also make recommendations for alterations or enhancements to the rehabilitation plan, monitoring programs, or to mitigation measures.

2.3 ECOSYSTEM DIVERSITY

2.3.1 INTRODUCTION

2.3.1.1 BACKGROUND

Ecosystem diversity refers to the number of different ecosystem types, and their size distribution, within a defined geographic area. Maintaining native ecosystem diversity is fundamental to maintaining many ecosystem functions and overall terrestrial ecosystem health. Of special concern are those ecosystem types that are particularly important in the regional context because, for example, they are species rich, structurally complex or regionally rare.

Ecosystem diversity was selected as a VEC for the environmental assessment to provide information on ecosystem diversity, partial information on plant species diversity and serve as a proxy for other ecosystem components and functions. The ecosystem diversity VEC evaluated inland ecosystem diversity since the wetland function VEC addressed shoreline wetland ecosystems.

2.3.1.2 ASSESSMENT SUMMARY

Ecosystem diversity is measured from terrestrial habitat mapping. Habitat mapping is often used as a proxy for ecosystem mapping. Attributes included in the terrestrial habitat mapping (Section 2.1.2.3.2) serve as a good representation for stand level ecosystems because they include most of the major ecosystem components, biomass and attributes that drive ecosystem change.

Habitat composition and priority habitat types were the EIS indicators for effects on ecosystem diversity. Habitat composition provides an overall representation of ecosystem diversity. Priority habitat types are those native habitat types that are particularly important for ecological and/or social reasons. Specifically, priority habitat types are the native inland broad habitat types that are regionally rare or uncommon, highly diverse (*i.e.*, species rich and/or structurally complex), highly sensitive to disturbance, have a high potential to support rare plants and/or are highly valued by people. The wildlife assessments addressed habitat types that are especially important to wildlife. The ecosystem diversity assessment included all priority habitat types except for the especially important shoreline wetland types, which were addressed by the wetland function VEC.

The potential Project effects pathways described in Section 2.1.1.2 also apply to ecosystem diversity since the ecosystem diversity indicators are measured from the terrestrial 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.

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. 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. For white birch mixedwood vegetation on all ecosites, Project construction could affect nearly 8% of its total area, including the largest known stand in the Keeyask Region (N-6 borrow area).

Project effects on most priority habitat types could increase slightly during operation. During operation, reservoir expansion, additional edge effects and groundwater-related habitat effects will be the primary pathways for additional adverse Project effects on ecosystem diversity. These increases will be somewhat offset by elimination of temporary construction effects through natural habitat recovery and assisted habitat rehabilitation.

Mitigation for ecosystem diversity effects not already incorporated into the Project design includes:

- The portion of borrow area N-6 identified as the N-6 sensitive site in the EIS 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 planned Project Footprint will be minimized to the extent practicable;
- Disturbance of areas adjacent to the planned Project Footprint will be avoided to the extent practicable;
- Rehabilitation efforts under the Vegetation Rehabilitation Plan will give preference to rehabilitating the most affected priority habitat types using approaches that "go with nature";
- Rehabilitation efforts under the Vegetation Rehabilitation Plan will continue until all necessary rehabilitation is completed; and,
- Except for existing resource-use trails and those required for operation, 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 2.5) and the clearing and disturbance minimization measures in the EnvPPs could further limit actual Project effects on ecosystem diversity.

After considering mitigation, Project effects on ecosystem diversity are expected to increase cumulative effects to between 5.0% and 9.9% of estimated historical area for 40 priority habitat types.

2.3.1.3 COMPONENTS THAT WILL BE MONITORED

The Ecosystem Diversity monitoring program includes a single study that periodically evaluates changes to ecosystem diversity based on effects to the priority habitat types.

2.3.2 PRIORITY HABITATS

2.3.2.1 INTRODUCTION

Priority habitat monitoring includes verifying mitigation compliance and determining effects on ecosystem diversity, particularly the priority habitat types.

The goal of this study is to determine the nature of Project effects on ecosystem diversity.

2.3.2.2 OBJECTIVES

The objectives of this study are to:

- Confirm that the N-6 sensitive site identified in the EIS is not disturbed;
- Determine the degree to which the other priority habitat patches and other environmentally sensitive terrestrial sites identified in the EnvPP (excluding sites whose condition is being monitored by another program) are disturbed;
- Quantify and situate the amounts and locations of priority habitat types affected by the Project; and,
- Quantify and situate Project effects on ecosystem diversity.

2.3.2.3 STUDY DESIGN

2.3.2.3.1 OVERVIEW

Compliance monitoring relating to the first two objectives will occur at all of the potentially affected priority habitat patches.

Actual Project effects on ecosystem diversity will be documented from mapping produced by other monitoring programs. The Terrestrial Habitat Clearing and Disturbance monitoring study (Section 2.0) will provide the majority of the required information. The extent of priority habitat rehabilitation will be evaluated during the operation phase to allow adequate time for regeneration.

2.3.2.3.2 EXISTING DATA

Section 2.1.2.3.2 outlines the existing data for this study.

2.3.2.3.3 DESIGN

A statistical design is not required for this monitoring program. Both compliance and Project effects monitoring are censuses of the target population.

Ground surveys will be conducted each year during construction to confirm the priority habitat patches marked for avoidance are not disturbed.

Changes to ecosystem diversity will be quantified and situated from the detailed terrestrial habitat mapping produced primarily by the Terrestrial Habitat Clearing, Disturbance and Indirect Effects study (Section 2.0), the Terrestrial Habitat Rehabilitation study (Section 2.2), and the Wetland Function study (Section 2.5).

2.3.2.3.4 PARAMETERS

Parameters being measured are:

- Whether or not a priority habitat patch marked for avoidance is disturbed and, if so, the nature of the disturbance;

- Areas and locations of cleared, disturbed or altered priority habitats by type;
- The extent and nature of the disturbance of priority habitat types;
- Areas and locations of rehabilitated native terrestrial habitat by habitat type; and,
- Amounts and locations of priority habitat, by habitat type.

2.3.2.3.5 BENCHMARKS

The EIS evaluated the acceptability of residual Project effects on ecosystem diversity 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 of the stand level habitat types from the Keeyask Region was deemed an unacceptable Project effect.

For the habitat composition and priority habitat type indicators, the approach was the same as that described for terrestrial habitat composition in Section 2.1.2.3.5; that is, a 10% loss of historical area for a priority habitat type was the benchmark that triggered management concern.

Ecosystem diversity effects monitoring will use the same benchmarks as were used in the EIS (KHLP, 2012).

2.3.2.3.6 STUDY AREA

Study Zone 2 is the study area (*i.e.*, areas within the Project Footprint and areas within 150 m of the Project Footprint; Map 3). Study Zone 2 extends more than 100 m beyond the generally expected spatial extent of Project-related terrestrial habitat change. The study area will be expanded if additional or unintended Project activities occur outside of this area.

2.3.2.3.7 SAMPLE LOCATIONS

All priority habitat patches and other applicable sensitive terrestrial sites identified in the EnvPPs, with the exception of those whose condition is being monitored by another TEMP program, will be sampled (Map 5).

All areas within the study area will be monitored for effects on ecosystem diversity. The information developed by the Terrestrial Habitat Clearing and Disturbance study (Section 2.0), the Terrestrial Habitat Rehabilitation study (Section 2.2) and the Wetland Function study (Section 2.5) will provide the required data.

2.3.2.3.8 SAMPLING FREQUENCY AND SCHEDULE

The priority habitat patches to avoid, and the other marked environmentally sensitive sites, will be sampled each year when Project construction occurs near the sites, and in the year following construction completion. Surveys will generally occur in late summer or early fall.

The ecosystem diversity mapping will be updated during the winter after construction completion and in years 1, 3, 5, 10, 15 and 25 of operation, which coincides with the timing of detailed terrestrial habitat mapping updates.

2.3.2.3.9 FIELD AND LAB METHODS

Visits to confirm the priority patches have been avoided will record conditions in those designated patches using reconnaissance surveys, geo-referenced photographs, marked-up maps and notes. All of the field data will be mapped in a GIS using the digital orthorectified imagery as the base maps.

Manitoba Hydro will provide detailed construction clearing schedules to support field survey planning. Manitoba Hydro environmental site staff will ensure all priority habitats to be avoided are adequately marked in a given area prior to construction activities commencing.

2.3.2.3.10 ANALYSIS

For compliance monitoring, the level of analysis will be tabulations and descriptions of priority habitat patches marked for avoidance and, if any, the nature of disturbance.

For Project effects monitoring, analysis involves straightforward summaries of changes to indicator values using standard GIS methods.

2.3.3 REPORTING

2.3.3.1 ANNUAL REPORTS

A report will be produced during the winter after each year when field studies occur, and will be submitted to MCWS the following spring, as per Environment Act License 3107, Clause 20.

Reports will summarize the activities and general findings of the monitoring during the preceding year. Basic descriptive statistics will be the level of data analysis for these reports. Any major unanticipated events or recommendations for changes to study design or mitigation will be noted.

2.3.3.2 SYNTHESIS AND RECOMMENDATIONS

A synthesis report will be produced after construction completion and at years 3, 5, 10, 15 and 25 of operation. Synthesis reports will consolidate, map, analyze and evaluate all monitoring information gathered to date studies. Actual Project effects on ecosystem diversity will be compared with the EIS predictions. If there are substantive adverse deviations from predictions, or if unforeseen conditions arise, the report will also make recommendations for alterations or enhancements to the rehabilitation plan, monitoring programs, or to mitigation measures. Additional rehabilitation will likely be prescribed for a priority habitat type if the cumulative effects on that type are approaching 10% of pre-development area. These reports will also include recommendations for any needed modifications to subsequent study design. The year 15 and 25 reports will evaluate whether additional ecosystem diversity monitoring is needed and, if so, recommend a schedule.

2.4 INTACTNESS

2.4.1 INTRODUCTION

2.4.1.1 BACKGROUND

Intactness is the degree to which an ecosystem remains unaltered by human development and other activities that remove habitat and increase fragmentation. Fragmentation is a landscape-level process in which human features (such as cutlines and roads) progressively subdivide habitat blocks into smaller and more isolated fragments. Among other things, fragmentation reduces the size of large unaltered areas (i.e., core areas), creates edges, isolates habitat and reduces connectivity. Some wildlife species that are sensitive to human disturbance require large core areas.

Intactness was selected as a VEC because it is an umbrella indicator for many ecosystem processes and wildlife species, and provides a good indication for overall effects on regional ecosystem health. Additionally, there is concern among the KCNs that the construction of roads, camps and transmission lines will disrupt habitat and migratory paths of wildlife.

2.4.1.2 ASSESSMENT SUMMARY

Linear feature density and core area abundance were the indicators used for intactness in the Project EIS. Measured indicator attributes for linear feature density were total linear feature density (*i.e.*, km of all human linear features per square km of land area), transportation density and linear density by feature type. Core area indicator attributes included total core area as a percentage of land area, the total number of core areas by size class and the sizes of the largest core areas.

Intactness was relatively high in the Keeyask Region in 2010. This reflected the fact that most of the land area is undeveloped and existing development is concentrated along PR 280 and the Nelson River.

In terms of the linear features contribution to reducing intactness, total linear feature density was a relatively low 0.45 km/km^2 in the Keeyask Region. Cutlines, which are expected to have the lowest degree of ecological effects, made the largest contribution to this total (0.30 km/km^2). The Thompson area contributed a large proportion of the total linear length. Whereas the Thompson area comprised only 15% of the Keeyask Region, it included 38% of the linear features.

Core areas larger than 200 ha accounted for 84% of regional land area, with the three largest core areas contributing over half of the total core area. The largest core area (270,769 ha) was located north of Provincial Road (PR) 280 between Split Lake and the Long Spruce Generating Station. The second largest core area (181,147 ha) was located north of PR 280 between Split Lake and Thompson.

Mitigation to reduce adverse Project effects on intactness includes:

- Clearing and disturbance within the planned Project Footprint will be minimized to the extent practicable;
- Disturbance of areas adjacent to the planned Project Footprint will be avoided to the extent practicable;

- Except for existing resource-use trails and those required for operation, 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 spread, accidental fires and other access-related effects;
- A rehabilitation plan will be developed that gives preference to rehabilitating the most affected priority habitat types using approaches that "go with nature"; and,
- The rehabilitation plan initiated during construction will extend into the operation phase, and continue until all necessary rehabilitation is completed.

After considering mitigation and the effects of other past and existing human features, residual Project effects on regional intactness are expected to include slight reductions in total linear feature density (as existing cutlines are covered by Project features such as reservoir flooding), total core area, average core area size and the sizes of some of the largest core areas.

2.4.1.3 COMPONENTS THAT WILL BE MONITORED

Intactness monitoring will focus on the net effects, over time, of two opposite trends. The expanding reservoir will cover some linear features and reduce the sizes of some core areas. At the same time, vegetation regeneration in some portions of existing and Project-related linear features could increase intactness by converting these linear features back into native habitat.

The intactness monitoring program includes a single study, Linear Density and Core Area (Section 2.4.2), that periodically evaluates changes to intactness using information produced by other TEMP programs.

Mitigation compliance and effectiveness is monitored by the Terrestrial Habitat Clearing, Disturbance and Indirect Effects study (Section 2.0) and the Terrestrial Habitat Rehabilitation study (Section 2.2).

2.4.2 LINEAR DENSITY AND CORE AREA

2.4.2.1 INTRODUCTION

The goal of this study is to verify the nature of Project effects on intactness.

2.4.2.2 OBJECTIVES

The objectives of this study are to:

- Quantify and situate Project-related changes to linear density and core area; and,
- Verify net Project effects on intactness.

2.4.2.3 STUDY DESIGN

2.4.2.3.1 OVERVIEW

Actual Project effects on intactness will be documented from information provided by the Terrestrial Habitat Clearing, Disturbance and Indirect Effects study (Section 2.0) and the Terrestrial Habitat Rehabilitation study (Section 2.2). A particular focus during construction will be on confirming that trails intersecting with the Project Footprint that are not resource-use trails or required for operation are blocked. The extent of habitat rehabilitation within linear features and temporary Project Footprint components will be evaluated during the operation phase to allow adequate time for regeneration.

2.4.2.3.2 EXISTING DATA

Detailed human footprint mapping, including linear features, was completed for Project EIS studies. Core areas were the areas remaining after a disturbance buffer was applied to these features. Linear densities were calculated by major feature type (e.g., road, railway line). Natural vegetation regeneration in existing cutlines was evaluated by a survey of 883 km of cutlines older than 10 years. This study found that approximately 35% of cutlines had regenerated to the degree that they likely no longer functioned as travel corridors for people or predators. Monitoring under the KIP is updating the human footprint mapping to reflect actual changes related to this project.

2.4.2.3.3 DESIGN

A statistical design is not required for this monitoring program since the Project effects monitoring is a census of the target population.

Project-related changes to intactness will be quantified and situated from mapping produced by other monitoring programs.

2.4.2.3.4 PARAMETERS

Parameters being measured are:

- Project-related changes to linear feature density, by broad feature type; and
- Project-related changes to the number, size and locations of core areas.

2.4.2.3.5 BENCHMARKS

The EIS evaluated the acceptability of residual Project effects on intactness based on total linear feature density, total core area as a percentage of land area, the total number of core areas by size class and the sizes of the largest core areas. Total linear feature density values greater than 0.60 km/km^2 in the Keeyask Region was the benchmark that triggered management concern, while the analogous benchmark for total core area percentage was less than 40% of land area.

The core area and linear density monitoring will use the same benchmarks as were used in the EIS.

2.4.2.3.6 STUDY AREA

Study Zone 2 is the study area (*i.e.*, areas within the Project Footprint and areas within 150 m of the Project Footprint; Map 3). Study Zone 2 extends more than 100 m beyond the generally expected spatial extent of Project-related terrestrial habitat change. The study area will be expanded if additional or unintended Project activities occur outside of this area.

2.4.2.3.7 SAMPLE LOCATIONS

There are no sample locations since other studies are providing the required data.

2.4.2.3.8 SAMPLING FREQUENCY AND SCHEDULE

There is no fieldwork for this study.

2.4.2.3.9 FIELD AND LAB METHODS

There is no fieldwork for this study.

The GIS methods will be the same as used for EIS analysis. All Project-related linear and polygonal human features will be mapped by the Terrestrial Habitat Clearing, Disturbance and Indirect Effects study (Section 2.0), as will natural habitat recovery in Project features and existing cutlines. The Terrestrial Habitat Rehabilitation study (Section 2.2) will map habitat recovery in rehabilitated areas and blocked trails.

2.4.2.3.10 ANALYSIS

Linear density will be reported by major types. Total linear feature density for a particular geographic area is the total length of all linear features in km divided by the total land area in square kilometers. Transportation density is the road and rail line component of this total.

Core areas are the residual areas left after applying a disturbance buffer to human footprints and that meet minimum size and shape requirements. To reflect differences in the typical disturbance distance of different types of human features, low-use linear features (transmission lines, trails, dykes and cutlines) will be buffered by 200 m, while railways, all types of roads and settlements will be buffered by 500 m. Core areas are the residual polygons remaining after the following are removed from land area: (i) human features and their disturbance buffers; (ii) polygons that are never wider than 350 m; and, (iii) polygons smaller than 200 ha in size. Since some species or ecosystem processes may require larger core areas, changes to core area indicator attributes using a 1,000 ha minimum core area size and effects on the largest core areas will also be evaluated.

2.4.3 REPORTING

2.4.3.1 ANNUAL REPORTS

A report will be produced during the winter after each year when field studies occur, and will be submitted to MCWS the following spring, as per Environment Act License 3107, Clause 20.

Reports will summarize the activities and general findings of the monitoring during the preceding year. Basic descriptive statistics will be the level of data analysis for these reports. Any major unanticipated events or recommendations for changes to study design or mitigation will be noted.

2.4.3.2 SYNTHESIS AND RECOMMENDATIONS

A synthesis report will be produced after construction completion and at years 3, 5, 10 and 15 of operation. Synthesis reports will consolidate, map, analyze and evaluate all monitoring information gathered to date studies. Actual Project effects on intactness will be compared with the EIS predictions. If there are substantive adverse deviations from predictions, or if unforeseen conditions arise, the report will also make recommendations for alterations or enhancements to the rehabilitation plan, monitoring programs, or to mitigation measures. These reports will also include recommendations for any needed modifications to subsequent study design. The year 15 report will evaluate whether additional intactness monitoring is needed and, if so, recommend a schedule.

2.5 WETLAND FUNCTION

2.5.1 INTRODUCTION

2.5.1.1 BACKGROUND

A wetland is a land ecosystem where periodic or prolonged water saturation at or near the soil surface is the dominant driving factor shaping soil attributes and vegetation composition and distribution. Wetland functions are the natural properties or processes that are associated with wetlands, stated in ways that describe what they do for the ecosystem. Among other things, wetlands convert sunlight into vegetation, create soil, 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 creating good areas to hunt moose and waterfowl. Several medicinal and country food plant species used by Members of the KCNs are either exclusively or most commonly found in wetlands (*e.g.,* sweet flag, tamarack).

2.5.1.2 ASSESSMENT SUMMARY

Wetlands comprise approximately 90% of the land area in the Keeyask Region. The region is essentially one large wetland complex that is dotted with mineral-capped ridges and hills. Bogs comprise 91% of the wetland area, followed by fen (8% of wetland area) and marsh (1% of wetland area). The majority of wetlands in the Keeyask Region are in a relatively natural condition. The main exception is wetlands along the Nelson River, which have been dramatically altered by past hydroelectric development. All of the pre-development Nelson River shoreline wetlands were either lost to flooding or have been altered by modified water and ice regimes. In the Gull reach of the Nelson River, marsh and riparian peatlands were virtually confined to inlets and sheltered bays.

Since wetlands are a type of terrestrial habitat, the potential pathways for Project effects on wetland function are the same as those described in Section 2.1.1.2. Of these pathways, changes to water and ice regimes, reservoir expansion and groundwater changes are more influential for Project effects on wetlands.

The EIS evaluated effects on wetland function by assigning a wetland quality score to each mapped wetland, and by giving special treatment to particularly important wetlands. The assigned wetland quality score reflected the anticipated degree to which a particular wetland type normally performs the range of wetland functions, after adjusting for human influences on the wetland's ability to perform those functions. Particularly important wetlands were any wetland sites in the Keeyask Region that have been identified as being globally, nationally or provincially significant by government or international agencies. Regionally important wetlands were those that had a high overall wetland quality score.

There are no globally, nationally or provincially significant wetlands in the Keeyask Region. Off-system marsh is the only particularly important wetland type in the region, primarily due to its rarity and its role as high quality habitat for some wildlife species.

The wetland function assessment assumed that all of the wetlands inside and within 50 m of the Project Footprint would be lost during construction. This was a cautious overestimate of wetland loss and alteration for the reasons described in Section 2.1.1.2, and based on observations from proxy areas such as Stephens Lake (*i.e.*, the Kettle Generating Station reservoir), which have been exposed to hydroelectric development for more than 25 years.

The Project Footprint includes approximately 5,785 ha of off-system wetlands. The majority of off-system wetlands in the Project Footprint and the anticipated zone of indirect effects are wetland types that are common in the Keeyask Region and/or of relatively low quality.

The effect of Project construction on Nelson River shoreline wetlands is uncertain. Recent prolonged high water levels have apparently removed all shoreline wetlands in the Keeyask reach. If water levels tend to remain above median levels, then construction effects on Nelson River shoreline wetlands may be negligible.

Project operation is expected to improve conditions for Nelson River shoreline wetlands over time. Based on observations from Stephens Lake, it is expected that Nelson River shoreline wetlands that are removed or altered by Project construction and flooding would be replaced by wetlands that eventually develop along the reservoir shoreline during the operation phase. This is expected to occur because the Project would reduce the existing high monthly and annual variability in water elevations in the Keeyask reach of the Nelson River, 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.

Mitigation in addition to that already incorporated into the Project design and to reduce effects on terrestrial habitat and ecosystem diversity, will include the following:

- Implement measures to protect against erosion, siltation and hydrological alteration in utilized construction areas that are within 100 m of any off-system marsh that is outside of the Project Footprint;
- Develop 12 ha of the off-system marsh wetland type within or near Study Zone 2; and,
- 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.

After considering mitigation, the Project is expected to:

- Have no effects on globally, nationally and/or provincially significant wetlands;
- Increase the amount of Nelson River shoreline wetlands in the Keeyask reach relative to what is typically there now;
- Create no net area loss for off-system marsh;
- Have no effects for five wetland types; and,
- For the remaining wetland types, remove or alter between 0.2% and 1.6% of historical wetland area, depending on the wetland type.

After considering these remaining Project effects in combination with the effects of other past and current projects and activities, it is predicted that the Project would not increase historical effects on Nelson River wetlands, off-system marsh or five wetland types. The Project would increase historical effects on the remaining wetland types to between 1.7% and 6.5% of estimated historical area, which are considered to be moderate magnitude effects.

2.5.1.3 COMPONENTS THAT WILL BE MONITORED

Similar to the Terrestrial Habitat Clearing, Disturbance and Indirect Effects study (Section 2.0), separate studies will monitor direct Project effects on wetlands during construction (Wetland Loss and Disturbance study; Section 2.5.2) and long-term direct and indirect Project effects on wetland function (Long-Term Effects on Wetlands study; Section 2.5.3). The efficacy of measures implemented to create 12 ha of off-system marsh will be evaluated by the Creation Wetlands study (Section 8.1).

2.5.2 WETLAND LOSS AND DISTURBANCE

2.5.2.1 INTRODUCTION

The Wetland Loss and Disturbance study will map wetland loss and disturbance due to Project-related clearing, disturbance, roads and trails during construction. While this study will make use of the same terrestrial habitat mapping used for the Habitat Loss and Disturbance study (Section 2.1.2), the presented results will differ since they address wetland quality in addition to wetland composition. The focus of this study is on direct effects during construction because most indirect effects are manifested over many years, and because important drivers for effects on wetland function (e.g., flooding, water regulation) do not occur until operation.

This study will also monitor the implementation of mitigation intended to minimize construction effects on existing off-system marshes outside of the permanent Project Footprint that may be affected by construction activities.

The goal of this study is to determine direct Project effects on wetland function during construction.

2.5.2.2 OBJECTIVES

The objectives of this study are to:

- Verify the implementation and effectiveness of off-system marsh protection measures; and,
- Quantify and situate direct Project effects on wetland function during construction based on wetland quality scores.

2.5.2.3 STUDY DESIGN

2.5.2.3.1 OVERVIEW

There are two components to this study. Ground surveys will monitor mitigation measures intended to minimize construction effects on off-system marshes outside of the Project Footprint. The second component will convert the detailed terrestrial habitat mapping produced by other monitoring programs into direct effects on wetland function during construction.

2.5.2.3.2 EXISTING DATA

Section 2.1.2.3.2 outlined the existing data for this study.

2.5.2.3.3 DESIGN

A statistical design is not required for this study as all relevant areas will be censused.

Ground surveys will be conducted to verify the implementation and effectiveness of off-system marsh protection measures included in the EnvPPs (as implemented by site environmental staff). All works and potentially affected marsh areas will be visited.

Since wetlands are a type of terrestrial habitat, the detailed terrestrial habitat mapping completed for the Habitat Loss and Disturbance study (Section 2.1.2) will be the primary data source for confirming actual Project effects on wetland function. This mapping will be enhanced with results from the off-system marsh protection monitoring.

2.5.2.3.4 PARAMETERS

The monitoring parameters are:

- Nature of measures implemented to control Project-related erosion, siltation, and surface hydrological alteration to off-system marshes outside of the permanent Project Footprint that may be affected by construction activities;
- Observed erosion, siltation, and surface hydrological alteration in the relevant off-system marshes; and,
- Areas, locations and nature of effects on wetlands, by wetland type.

2.5.2.3.5 BENCHMARKS

For the first study objective, the benchmark is that erosion, siltation, and surface hydrological alteration measures have been implemented at all off-system marshes outside of the permanent Project Footprint that may be affected by construction activities.

For the second study objective, the EIS evaluated the acceptability of residual Project effects on wetland function based on how the particularly important wetlands would be affected, and on the cumulative historical area losses for each of the remaining native wetland types. Substantial effects on any existing globally, nationally and/or provincially significant wetland were to be avoided. For the particularly important wetland types in the Keeyask Region, a net area loss was to be avoided. For the remaining native wetland types, the approach was the same as that described for terrestrial habitat in Section 2.1.2.3.5. That is, a 10% loss of historical area for one of these wetland types was the benchmark that triggered management concern.

Wetland function effects monitoring will use the same benchmarks as were used in the EIS.

2.5.2.3.6 STUDY AREA

Study Zone 2 is the study area (*i.e.*, areas within the Project Footprint and within 150 m of these areas; Map 3). Study Zone 2 extends more than 100 m beyond the generally expected spatial extent of Project-related terrestrial habitat change. The study area will be expanded if additional or unintended Project activities occur outside of this area.

2.5.2.3.7 SAMPLE LOCATIONS

All off-system marshes that may be exposed to Project-related erosion, siltation or surface hydrological alteration (Map 6) will be surveyed.

The entire study area will be monitored for direct effects on wetland function. The Habitat Loss and Disturbance study (Section 2.1.2) and the off-system marsh protection component of this study will provide the required data.

2.5.2.3.8 SAMPLING FREQUENCY AND SCHEDULE

Off-system marsh protection surveys will be conducted in each year during construction. Surveys will generally occur in summer but may be adjusted to coincide with major mitigation installations or major rainfall events.

There is no fieldwork for the wetland function mapping component of this study since another TEMP study provides the required data.

2.5.2.3.9 FIELD AND LAB METHODS

Surveys to document compliance with and effectiveness of the off-system marsh protection measures will record conditions in the relevant marshes and their habitat using reconnaissance surveys, geo-referenced photographs, marked-up maps and notes. The nature of works to control Project-related erosion, siltation, and surface hydrological alteration will be recorded, as will any erosion, siltation, or surface hydrological alteration. Manitoba Hydro will be informed in the event that any such construction effects are observed. All of the field data will be mapped in a GIS using the digital orthorectified imagery as the base maps.

Manitoba Hydro will provide detailed construction schedules to support field survey planning.

There is no field or lab work for the wetland function mapping component of this study.

2.5.3 LONG-TERM EFFECTS ON WETLANDS

2.5.3.1 INTRODUCTION

In general, the indirect effects of construction clearing, reservoir flooding, water regulation and other Project impacts on wetlands are not expected to become observable to a substantial degree until well into the operation phase.

Indirect effects on inland shore zone habitat are expected to generally extend less than 25 m from the edge of the actual Project Footprint. Historical air photo analysis of areas affected by Kelsey, Kettle and Long Spruce generating station flooding and water regulation indicated that inland habitat effects such as tree mortality or vegetation composition change typically extended less than 25 meters inland from the initial flooding shoreline, with the vast majority extending less than 50 meters. Localized areas where confirmed effects extended more than 75 m inland comprised less than 2% of shoreline length. The overall mean width of potential effects over the entire searched shoreline length was less than 15 m even assuming a 5 m effect even where none was observed. Note that the distance of indirect inland effects is relative to the current shoreline position, which may be moving inland in locations where reservoir expansion is occurring.

As described in Section 2.5.1.2, the Project is expected to increase the amounts of Nelson River shoreline wetland and offshore marsh over time.

The goal of this study is to evaluate long-term Project-related effects on wetland function. Its focus is on effects within the Project's hydraulic zone of influence (
Map 4) since these predictions had lower certainty than other wetland predictions, the relevant wetland area is relatively large and effects in this zone are expected to be positive relative to pre-Project conditions.

This monitoring begins during operation since that is when indirect effects become observable to a substantial degree.

The information gathered by this study will contribute to periodic updates to the detailed terrestrial habitat mapping produced by the Terrestrial Habitat Clearing, Disturbance and Indirect Effects study (Section 2.1.3).

2.5.3.2 OBJECTIVES

The objectives of this study are to:

- Determine the characteristics of shoreline and offshore wetlands developing within the Project's hydraulic zone of influence;
- Quantify and situate Project-related changes to shoreline and offshore wetland composition in the Project's hydraulic zone of influence;
- Characterize the nature of Project-related groundwater and edge effects to inland habitat near the hydraulic zone of influence;
- Quantify and situate areas developing into native wetland types; and,
- Quantify and situate long-term Project effects on wetland function.

2.5.3.3 STUDY DESIGN

2.5.3.3.1 OVERVIEW

There are two components to this study. The first documents habitat attributes in affected shore zone wetlands, and how closely these attributes approximate those found in comparable native wetland types. The second component translates the periodically updated detailed terrestrial habitat mapping into effects on wetland function.

2.5.3.3.2 EXISTING DATA

Section 2.1.2.3.2 outlined the existing data for this study.

2.5.3.3.3 DESIGN

An impact-trend by time design will be employed to document habitat evolving within the hydraulic zone of influence (

Map 4). A stratified, random sample of shore zone, offshore and peat island habitat patches will be selected from within the Project's hydraulic zone of influence and monitored for wetland development. Results from EIS studies will provide reference data for the attributes associated with native and pre-Project Nelson River wetland types.

A combination of remote sensing, aerial surveys and ground surveys will be used to document habitat attributes in the affected shore zone wetlands. Mapping produced by the Terrestrial Habitat Clearing, Disturbance and Indirect Effects study (Section 2.0), as well as notes gathered during the associated helicopter-based aerial surveys will be used to select the locations for the permanent monitoring transects that will document evolving habitat attributes.

For the effects on wetland function component, detailed mapping produced by the Terrestrial Habitat Clearing, Disturbance and Indirect Effects study (Section 2.0) will be used to periodically map and quantify changes to wetland function. Results from the shore zone habitat characterization component of this study may identify new terrestrial habitat types.

2.5.3.3.4 PARAMETERS

The monitoring parameters are:

- Vegetation, soil and other environmental attributes;
- Zonation of vegetation and soil types through the shore zone;
- Factors that have a substantial influence on habitat composition along a given transect, and at different shoreline segments; and,
- Areas, locations and nature of effects on wetlands, by wetland type.

2.5.3.3.5 BENCHMARKS

See Section 2.5.2.3.5 for benchmarks.

2.5.3.3.6 STUDY AREA

Study Zone 2 is the study area (*i.e.*, areas within the Project Footprint and areas within 150 m of the Project Footprint; Map 3). Study Zone 2 extends more than 100 m beyond the generally expected spatial extent of Project-related terrestrial habitat change. The study area will be expanded if additional or unintended Project activities occur outside of this area.

2.5.3.3.7 SAMPLE LOCATIONS

For the study component monitoring the nature of habitat attributes in developing wetlands, permanent sample locations will be established within the Project's hydraulic zone of influence (Map 6). The Long-Term

Effects on Terrestrial Habitat study (Section 2.1.3) will address indirect and long-term habitat changes in the areas not covered by this study.

A sample location consists of a shoreline segment or offshore shallow water patch exposed to relatively homogenous drivers for wetland development. To be included in the sampling frame, a shoreline segment must be at least 80 m long while an offshore patch must be at least 0.5 hectare in size. These minimums are needed to avoid having edges comprise all or a high proportion of the sampling unit, which would confound the analysis of typical characteristics for a wetland type.

Shore zone sample locations will be selected as follows:

1. To identify the sampling units for the sampling frame:
    a. Using the detailed terrestrial habitat map, select all shore zone habitat patches that occur along the shoreline within the Project's hydraulic zone of influence;
    b. Drop all patches that include less than 80 m of shoreline.
2. To identify the strata for random selection, classify each patch into a broad habitat group based on relatively homogenous drivers for wetland development. The broad habitat groups used for the stratification will be determined at the start of operation based on the actual shoreline position formed by initial flooding; and,
3. Randomly select at least three patches from each of the strata defined in the previous step. The actual number of patches will be determined at the start of operation based on the actual shoreline position formed by initial flooding.

Offshore marsh and peat island sampling will begin in year 5 of operation because patch boundaries will be highly dynamic during the first five years of operation. The year 5 detailed terrestrial habitat map (Section 2.1.3) will be used to identify habitat patches and the broad habitat strata. Sample locations will be selected in year 5 using a stratified, random approach similar to that used for shore zone habitat.

Sampling is not required for the wetland function mapping component of this study.

2.5.3.3.8 SAMPLING FREQUENCY AND SCHEDULE

Permanent transect sampling will be conducted in years 1, 3, 5, 7, 10, 15 and 25 after reservoir impoundment. The stability of wetland composition will be reviewed in year 15 to determine if the sampling frequency should be modified for subsequent years.

Sampling will occur between mid-July and late August, which is the period when most plants are fully leafed out.

Sampling to support the wetland function mapping will be completed by the Long-Term Effects on Terrestrial Habitat study (Section 2.1.3).

2.5.3.3.9 FIELD AND LAB METHODS

Field methods will be consistent with those employed for EIS studies. Two parallel belt transects spaced 20 m apart will be systematically located at the center of each sample location. Given the minimum shore segment length of 80 m, this positioning ensures the transects are far enough from the adjacent habitat patches to be largely or completely uninfluenced by their confounding effects.

Transects will be positioned perpendicular to the shoreline. Transects will originate well into the inland edge and extend offshore to the deep end of the sub-littoral zone. This positioning captures the anticipated zone of indirect inland habitat effects as well as all of the terrestrial water depth duration zones.

Since the anticipated distance of indirect inland effects is generally expected to be less than 25 m, the origin of each transect will typically be set 50 m inland from the initial shoreline position. Transect origins will be placed further inland at locations that are expected to undergo more than 5 m of shoreline recession, with the increase in distance being based on shoreline recession predictions. In the event that actual recession is occurring further than predicted, a transect origin will be extended further inland in subsequent sample years.

Vegetation, soil and environmental attribute data will be collected along each transect. From the deep end of the sub-littoral zone to the inland edge, all attributes will be sampled within a 1 m wide belt.

Inland edge habitat will be sampled using a nested belt approach. The nesting for vegetation is: mature trees are sampled in a 10 m belt; tall shrubs, tree seedlings and tree saplings in a 2 m belt; and low shrubs, forbs and mosses in a 1 m belt. Large downed woody material will be sampled at centerline intersections. Photos will be taken along the transect and of the canopy. Soil profile sampling will occur outside of the 2 m belt but within the 10 m belt. Evidence of disturbance events within or near the tree belt will be recorded. Care will be taken to avoid disturbing areas inside of the 2 m belt.

A willow zone plot will be established if a band of willows (*Salix* spp.) is present along the shoreline between the transects. The willow zone plot will extend between the two transects and be as deep as the willow band at the location. The percent cover of the tall shrub community will be estimated for each species present.

2.5.3.3.10 ANALYSIS

Plant nomenclature will follow Flora of North America (Flora of North America Editorial Committee 1993+) where volumes currently exist and Manitoba Conservation Data Center elsewhere.

Changes to the attributes of each terrestrial habitat type will be identified using multivariate techniques such as ordination and cluster analysis. Starting in year 10 of operation, a time series analysis of changes to habitat composition will be completed using data collected to date. The specific techniques will be determined by the pattern of changes to that time and by the structure of the data. Statistical model and inferential assumptions will be tested during the analyses.

2.5.4 REPORTING

2.5.4.1 ANNUAL REPORTS

A report will be produced during the winter after each year when field studies occur, and will be submitted to MCWS the following spring, as per Environment Act License 3107, Clause 20.

Reports will summarize the activities and general findings of the monitoring during the preceding year. Basic descriptive statistics will be the level of data analysis for these reports. Any major unanticipated events or recommendations for changes to study design or mitigation will be noted.

2.5.4.2 SYNTHESIS AND RECOMMENDATIONS

A synthesis report will be produced at years 3, 5, 10, 15 and 25 of operation. Synthesis reports will consolidate, map, analyze and evaluate all monitoring information gathered to date studies. A wetland quality map for Study Zone 4 will be produced after construction completion. Actual Project effects on wetland function will be compared with the EIS predictions. If there are substantive adverse deviations from predictions, or if unforeseen conditions arise, the report will also make recommendations for alterations or enhancements to the rehabilitation plan, monitoring programs, or to mitigation measures. These reports will also include recommendations for any needed modifications to subsequent study design. The year 15 and 25 reports will evaluate whether additional wetland function monitoring is needed and, if so, recommend a schedule.

2.6 FIRE REGIME CHANGES

2.6.1 INTRODUCTION

2.6.1.1 BACKGROUND

Wildfire is the keystone driver for terrestrial ecosystems in the boreal biome. A fire regime is the overall pattern, type, intensity, frequency and seasonality of fires that prevails in an area. Many boreal plant and animal species are adapted to a particular fire regime.

Fire regime is included in the terrestrial monitoring because human induced changes to the fire regime can affect many ecosystem patterns and processes, including wildlife distribution and abundance. For example, more frequent of larger fires could reduce the amount of available caribou habitat. Humans can alter the fire regime in several ways such as suppressing natural fires, accidentally starting large fires or constructing features that alter natural fire behaviour (e.g., roads or reservoirs may stop a fire).

2.6.1.2 ASSESSMENT SUMMARY

Potential Project effects on the fire regime are associated with features or activities that could change fire frequency, size, severity and/or behavior. Better access and more traffic and people could lead to a higher number of large and/or severe wildfires, increased fire severity or increased fire frequency, among other things. Project features such as the reservoir, windrowed debris or permanent access roads could alter fire behaviour. If such effects occur, they could alter vegetation, facilitate spreading invasive species and/or have other effects on terrestrial ecosystem health.

There are no defined components of the Project that are expected to cause fires. Burning of brush piles produced by reservoir clearing will occur in the winter. Measures to minimize the risk of starting a peat fire include burning material in the winter when the ground is frozen, and burning in areas selected to minimize the risk of peat fires. Windrows and other Project features may be too small to impede the spread or alter the behaviour of a large wildfire. The Nelson River is already wide enough to be a fire break for some fires.

Mitigation to minimize the risk of Project-related fire regime effects will include the following:

- Fire control precautions include roving fire patrols, fire suppression training for personnel and maintaining fire suppression equipment, infrastructure, and fire detection sensors in the generating station work area;
- Except for existing resource-use trails and those required for operation, 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;
- Public access to the Project will be restricted at PR 280 and the Butnau dyke during construction; and,
- Fire control precautions such as maintaining fire suppression equipment in the generating station area, water trucks, as well as fire procedure manuals and emergency response crews.

During operation, wildfires resulting from improved access on PR 280 would be addressed by Manitoba Conservation and Water Stewardship (MCWS) based on the policies in place at the time.

Overall, the likely residual Project effects on the fire regime are expected to be adverse but negligible assuming that the fire prevention measures are effective. It is expected that any accidental Project-related fires will be extinguished before they become large. There is a risk that better public access could increase the number of human-caused fires during the operation phase.

2.6.1.3 COMPONENTS THAT WILL BE MONITORED

Although the Project is not expected to either create large accidental fires or substantially alter fire behaviour, a single additional large and/or severe fire could alter habitat composition over the long-term, which could affect many of the terrestrial environment predictions. Therefore, a study will monitor the occurrence and nature of Project-related fire regime effects.

2.6.2 FIRE REGIME EFFECTS

2.6.2.1 INTRODUCTION

Monitoring Project effects on the fire regime will determine if there have been any such effects and, if so, how these effects alter the Project effects predictions. Since it is the larger fires that establish the regional fire regime, this study will focus on fires larger than 30 ha.

2.6.2.2 OBJECTIVES

The overall objectives of this monitoring program are to:

- Determine if the Project creates any fires larger than 30 ha;
- Determine if the Project has altered the behaviour, frequency and/or severity of fires started by non-Project sources; and
- Evaluate how any unanticipated Project-related fire effects alter the EIS predictions.

2.6.2.3 STUDY DESIGN

2.6.2.3.1 OVERVIEW

Since substantial Project-related fire regime effects are not anticipated, this monitoring study would only include fieldwork and reporting if the Project creates an accidental wildfire or peat fire, or if a non-Project fire spreads into the Project Footprint area.

2.6.2.3.2 EXISTING DATA

Not applicable for this study.

2.6.2.3.3 DESIGN

Monitoring Project effects on the fire regime will occur in two stages. First, it will be determined whether the Project has caused a fire, or if the Project has altered the behavior of fires started by other sources (*e.g.,* slash produced from clearing could affect fire behavior by allowing a naturally occurring fire to spread through areas that might otherwise serve as a fire break). In the unanticipated event that such effects occur, field surveys will be conducted to evaluate how these effects alter the Project effects predictions.

2.6.2.3.4 PARAMETERS OF CONCERN

Parameters being measured in the unanticipated event that there are Project-related fire effects:

- Number, type and extent of fires caused or influenced by the Project; and
- Areas and types of habitat affected, and the nature of effects on vegetation, soils and permafrost.

2.6.2.3.5 BENCHMARKS

Not applicable for this study.

2.6.2.3.6 STUDY AREA

If the Project causes any fires or alters the behavior of natural fires, then the fire boundaries will determine the study area boundaries.

2.6.2.3.7 SAMPLE LOCATIONS

Sample locations will be determined by the boundaries of Project-related fire effects, if they occur.

2.6.2.3.8 SAMPLING FREQUENCY AND SCHEDULE

Sampling frequency and schedule will be determined by the timing and nature of Project-related fire effects, if they occur.

Ground surveys of the relevant burns, if any, will be conducted during the summer following the fire.

2.6.2.3.9 FIELD AND LAB METHODS

Determining whether the Project has caused any fires or altered the behavior of natural fires will be accomplished by two means. First, by reviewing fire reports and/or mapping produced by Manitoba Hydro and MCWS to determine whether these sources have identified fires that may have started as a result of Project features or activities. Second, by searching for very recent burns while conducting helicopter-based aerial surveys for the Terrestrial Habitat Clearing, Disturbance and Indirect Effects study (Section 2.1.3).

If any new burns are detected in the study area, then Manitoba Hydro and/or MCWS will be contacted to determine the date and the cause of the fire. Manitoba Hydro will provide fire incident reports that document the timing and extent of any fires that start as a result of Project features or activities.

If it is determined that a Project-related fires large than 30 ha or fire effects have occurred, the terrestrial ecologist will map the affected area boundaries and the nature of effects using information from Manitoba Hydro, satellite imagery and/or aerial surveys. This information will be used to plan ground surveys of the burned areas. The layout of the ground studies will be determined when surveys are required since their design depends on the size and the nature of the effects.

2.6.3 REPORTING

2.6.3.1 ANNUAL REPORTS

A report will be produced during the winter after each year when field studies occur, and will be submitted to MCWS the following spring, as per Environment Act License 3107, Clause 20.

Reports will summarize the activities and general findings of the monitoring during the preceding year. Basic descriptive statistics will be the level of data analysis for these reports. Any major unanticipated events or recommendations for changes to study design or mitigation will be noted.

2.6.3.2 SYNTHESIS AND RECOMMENDATIONS

A synthesis report will be produced after construction completion and at year 15 of operation. Synthesis reports will consolidate, map, analyze and evaluate all monitoring information gathered to date studies. If there are substantive adverse deviations from predictions, or if unforeseen conditions arise, the report will also make recommendations for alterations or enhancements to monitoring programs and/or to mitigation measures. These reports will also include recommendations for any needed modifications to subsequent study design. The year 15 report will evaluate whether additional fire regime monitoring is needed and, if so, recommend a schedule.

3.0 TERRESTRIAL PLANTS

3.1 PRIORITY PLANTS

3.1.1 INTRODUCTION

3.1.1.1 BACKGROUND

Terrestrial plants perform key functions in 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 plant tissue. Some terrestrial plant species are particularly important for ecological reasons (*e.g.*, rare species) and/or social reasons (*e.g.*, food and cultural importance to the Keeyask Cree Nations (KCNs)).

Priority plants are defined as those plants that are particularly important for ecological and/or social reasons. Priority plants are the native plant species that are highly sensitive to Project features, make high contributions to ecosystem function and/or are of particular interest to the KCNs.

The KCNs have noted a variety of plants of traditional importance that are present in the Project area, including *wihkis* (sweet flag), cranberries, Labrador tea, and white birch.

A plant species is considered to be highly sensitive to human features if it is globally, nationally, 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. Plant species that are critical for the survival and/or reproduction of an animal species are addressed in the relevant wildlife sections of the TEMP.

3.1.1.2 ASSESSMENT SUMMARY

Since plants form the vegetation component of terrestrial habitat, the pathways for Project effects on priority plants are the same as those described for terrestrial habitat in Section 2.1.1.2.

Potential Project effects on priority plants include removing and disturbing individual plants and plant populations as well as removing, altering or disturbing their habitats.

Project effects on endangered or threatened plant species during construction are not expected since none of these species are either known to occur or expected to occur within the Project zone of influence. Project effects on provincially very rare plant species are not expected since none were found during extensive field studies in the Keeyask Region, and Project effects on their anticipated habitats are expected to be nil or low, depending on the species. Effects on the remaining priority plants should be low because the Project is expected to affect low percentages of their known locations or available habitat.

Mitigation for priority plant effects in addition to that already incorporated into the Project design 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; and

- Except for existing resource-use trails and those required for operation, 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.

After considering mitigation, 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 Project zone of influence. For the remaining species, the Project is expected to affect low percentages of their known locations and/or available habitat. 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 Project affects low percentages of their known locations and available habitat.

3.1.1.3 COMPONENTS THAT WILL BE MONITORED

Because it is possible that existing locations of provincially very rare to rare plant species were not found during EIS studies, the Provincially Very Rare and Rare Plant Mitigation study (Section 3.1.2) will conduct additional searches and, in the unlikely event any of these species are found, prescribe appropriate mitigation.

The Priority Plants and Their Habitats study (Section 3.1.3) will verify actual Project effects on known priority plant locations and priority plant habitats.

3.1.2 PROVINCIALLY VERY RARE AND RARE PLANTS MONITORING

3.1.2.1 INTRODUCTION

Provincially very rare to rare plant monitoring includes pre-clearing searches for these species in areas of the Project zone of influence that were not previously surveyed, and, in the event rare plant locations are identified, prescribing and monitoring appropriate mitigation.

Pre-clearing rare plant surveys will be conducted in portions of the Project zone of influence that were not previously surveyed and have the highest potential for supporting provincially very rare to rare species. In the unlikely event that a provincially very rare to rare species is discovered within these areas 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.

3.1.2.2 OBJECTIVES

The objectives of this study are to:

- Determine if any provincially very rare or rare plants occur within the Project zone of influence; and,
- In the unlikely event that a provincially very rare or rare plant is discovered:
  - Confirm that any identified locations are well marked for avoidance where avoidance is practicable;

- Develop a transplanting plan for provincially very rare plant locations where avoidance is not practicable; and,
- Monitor the survival and vigor of all plants in any identified locations.

3.1.2.3 STUDY DESIGN

3.1.2.3.1 OVERVIEW

Ground surveys will be conducted for provincially very rare to rare plant species in the Project zone of influence. Plants that are of importance to the KCNs will also be documented during the pre-clearing surveys. If such a species is discovered, then additional searches will occur, if required, to determine if there at least 20 known healthy patches of this species in the Keeyask Region but outside of Study Zone 2. In the event that 20 locations are not found, the discovered locations will be avoided where practicable. Where avoidance is not practicable, transplanting prescriptions will be provided. Plant health in any avoided or transplant locations will be monitored.

3.1.2.3.2 EXISTING DATA

The majority of the information used for the terrestrial plants assessment came from a wide range of EIS studies that included a large number of sample locations. Studies were initiated in 2001 and continued to 2011, with most field data collected from 2003 to 2009. Data collection efforts were highest in Study Zone 2 and decreased with distance from it.

Herbarium records and the Manitoba Conservation Data Centre also provided species observations for the region. Data from non-Project studies conducted northeast of the Keeyask Region were also used to determine species distributions and habitat associations.

3.1.2.3.3 DESIGN

Based on reasonable potential to occur in the Keeyask Region and the documented number of species locations, the provincially very rare to rare plant species of highest conservation concern for monitoring are elegant hawk's-beard (*Crepis elegans*), small grass-of-parnassus (*Parnassia palustris* var. *parviflora*), slender-leaved sundew (*Drosera linearis*), ground fir (*Diphasiastrum sitchense*) and swamp lousewort (*Pedicularis macrodonta*). In addition to these species, qualified botanists will watch for all potentially occurring provincially very rare to rare species and plant species at risk while conducting field surveys.

Searches will be conducted in portions of the Project zone of influence that were not previously surveyed and have the highest potential for supporting provincially very rare to rare plant species. Infrastructure areas will be the primary focus in the initial years and reservoir areas in subsequent years. The pre-identified habitat patches will be subsampled using a combination of systematic and meandering transects.

In the unlikely event that a provincially very rare or rare plant is discovered, and avoidance of its location is not practicable, searches for additional species locations within the Keeyask Region but outside of Study Zone 2 will be conducted. Initially, searches will extend into Study Zone 3. If these searches do not increase the total number of discovered patches to at least 20, then searches will move into Study Zone 4. Further searching may be abandoned if there is apparently suitable habitat in Study Zone 3 but no additional patches are found. The approach to identifying habitat patches to search, and subsampling within them, will be the same as that used with the Project zone of influence.

If 20 locations are not found outside of Study Zone 2, a transplanting prescription will be produced for the locations within the Project zone of influence. Depending on the condition of the plants or on the species, "transplanting" may consist of propagating cuttings or establishing new plants from seed.

3.1.2.3.4 PARAMETERS

Parameters being measured are:

- Locations and sizes of provincially very rare and rare plant patches that are located in the Project Footprint;
- For each detected species, the number of known locations outside of Study Zone 2;
- For each transplant that occurs, the survival and vigor of transplanted plants; and,
- Degree of disturbance and plant health in any plant patches that are marked for avoidance.

3.1.2.3.5 BENCHMARKS

For any discovered species that does not have at least 20 locations within the Keeyask Region outside of Study Zone 2, every discovered location will be addressed with either avoidance or transplanting. For transplants, the target is at least 90% survival at the plant and the patch levels.

3.1.2.3.6 STUDY AREA

The study area is Study Zone 2 (*i.e.*, within the Project Footprint and immediately adjacent areas; Map 3). The study area will be expanded if monitoring information (*e.g.,* Section 2.1.1) identifies terrestrial habitat effects outside of this area.

3.1.2.3.7 SAMPLE LOCATIONS

Known habitat associations of the provincially very rare or rare plant species that could potentially occur in the Project zone of influence will be used to identify the stand level habitat types with the highest potential for hosting these species. Using the detailed terrestrial habitat map, all habitat patches from these habitat types that are situated with the Project zone of influence, and were not already surveyed during EIS studies, will be selected for sampling. An exception is shallow lakes will not be surveyed for small pondweed or Robbins pondweed since the EIS analysis concluded that these species are regionally common. Map 7 shows the areas where the provincially very rare or rare plant surveys will occur.

Several transects will be surveyed in each habitat patch. Depending on the size and shape of the habitat patch, one or two parallel transects will run lengthwise through the patch. Meandering surveys will also occur through areas deemed by the botanist to have potential for harboring the target plant species.

3.1.2.3.8 SAMPLING FREQUENCY AND SCHEDULE

Sampling in the planned Project footprint areas will occur annually, as required, during the first three years of construction. Sampling in potentially disturbed footprint areas will occur each year prior to when construction clearing will occur. Sampling will generally occur in the spring to mid-summer, or as needed if very rare or rare species are found, and as the exact timing of Project construction is determined.

3.1.2.3.9 FIELD AND LAB METHODS

A qualified botanist will conduct the ground searches for rare plants. Systematic and meandering searches will be conducted within the pre-identified habitat patches.

All discovered species patches will be documented with geo-referenced photographs, marked-up maps and notes. Recorded information will include attributes such as plant species, plant vigor, site conditions and habitat associations. Any discovered patches of provincially very rare and rare species will be flagged. The locations and sizes of the plant patches will be mapped in a GIS. The locations of any provincially very rare or rare species will be reported to Manitoba Hydro.

In the event that any plants or plant patches are marked for avoidance or transplanted, ground surveys of each location will be conducted each subsequent summer to monitor avoidance as well as the condition of the plants.

Manitoba Hydro will provide construction activity progress reports as needed to plan field surveys. In the event that any rare plant patches are identified for avoidance or transplanting, Manitoba Hydro will complete the transplanting, clearly mark the patches and direct the contractor to avoid the marked patches.

3.1.2.3.10 ANALYSIS

The level of analysis will generally be tabulations and descriptions of discovered plants and their habitats and, if any, the nature of mitigation and its success.

3.1.3 PRIORITY PLANTS AND THEIR HABITATS

3.1.3.1 INTRODUCTION

As described in Section 2.1.1.2, a major proportion of the Project zone of influence included in the EIS assessment will likely not be affected by the Project, primarily because it includes potential disturbance areas and the spatial extent of indirect effects was cautiously overestimated.

The goal of this study is to verify actual Project effects on priority plants.

3.1.3.2 OBJECTIVES

The objectives of this study are to:

- Confirm Project effects on known priority plant locations; and,
- Quantify and situate Project effects on priority plant habitats.

3.1.3.3 STUDY DESIGN

3.1.3.3.1 OVERVIEW

Actual Project effects on priority plants will be monitored by ground surveys and through mapping produced by other monitoring programs. Ground surveys will periodically evaluate the state of known priority plant locations within the Project zone of influence. The proportions of priority plant habitats affected by the Project will be calculated from the mapping and information produced by the Terrestrial Habitat Clearing, Disturbance and Indirect Effects study (Section 2.0) and the Wetland Function study (Section 2.5).

3.1.3.3.2 EXISTING DATA

See Section 3.1.2.3.2.

3.1.3.3.3 DESIGN

A statistical design is not required for this monitoring program since the monitoring includes a census of the target population.

The actual Project infrastructure, borrow areas and flooding footprints mapped by the Terrestrial Habitat Clearing, Disturbance and Indirect Effects study (Section 2.0) will identify locations lost to these impacts. All of the remaining known priority plant locations will be periodically evaluated through ground surveys.

Effects on priority plant habitats will be situated and quantified by applying the priority plant habitat associations used for EIS analysis to the post-Project terrestrial habitat map that is periodically updated by another TEMP study (Section 2.0).

3.1.3.3.4 PARAMETERS

Parameters being measured for each priority plant species are:

- The number of known locations affected by the Project; and,
- The locations and amounts of their habitat directly and indirectly affected by the Project.

3.1.3.3.5 BENCHMARKS

The EIS evaluated the acceptability of residual Project effects on priority plants based on the degree of concern regarding the species. Effects on a globally rare, nationally rare or provincially very rare plant species should be avoided. For the remaining species, the percentage of known locations and/or their available habitat that could be affected by the Project was used. The benchmarks for these species was less than 5% of their known locations or 10% of their habitat would be affected by the Project. Species that essentially are as common as their habitats were indirectly assessed through the priority habitat component of the ecosystem diversity VEC assessment and the terrestrial habitat supporting topic assessment.

Priority plant monitoring will use the same benchmarks as were used in the EIS.

3.1.3.3.6 STUDY AREA

Study Zone 2 is the study area (*i.e.*, areas within the Project Footprint and areas within 150 m of the Project Footprint). Study Zone 2 extends more than 100 m beyond the generally expected spatial extent of Project-related effects on priority plants. The study area will be expanded if additional or unintended Project activities occur outside of this area.

3.1.3.3.7 SAMPLING FREQUENCY AND SCHEDULE

Known priority plant locations identified for ground surveys will be visited once during the summer following construction completion to document construction phase effects. Ground surveys will also be conducted during years 5 and 10 of operation. The timing of subsequent surveys will be determined by how closely actual direct and indirect Project effects areas coincide with EIS predictions. Sampling will generally occur in mid to late summer.

No additional fieldwork is planned for the remaining components of this study because all of the required information is provided by the Terrestrial Habitat Clearing, Disturbance and Indirect Effects study (Section 2.0) and the Wetland Function study (Section 2.5).

3.1.3.3.8 SAMPLE LOCATIONS

All known priority plant locations will be sampled except for those that other TEMP studies have confirmed as being within Project infrastructure or reservoir areas (Map 8).

3.1.3.3.9 FIELD AND LAB METHODS

Visits to evaluate the status of known priority plant patches in the Project zone of influence but outside of the cleared and flooded areas will record conditions in the plant patches with geo-referenced photographs, marked-up maps and notes.

Manitoba Hydro will provide detailed construction clearing schedules to support field survey planning.

All of the field data will be mapped in a GIS using the digital orthorectified imagery as the base maps.

3.1.3.3.10 ANALYSIS

For effects on known priority plant locations, the level of analysis will be tabulations and descriptions of affected locations.

For Project effects on priority plant habitats, analysis involves straightforward summaries of location and area changes using standard GIS methods.

3.1.4 REPORTING

3.1.4.1 ANNUAL REPORTS

A report will be produced during the winter after each year when field studies occur, and will be submitted to MCWS the following spring, as per Environment Act License 3107, Clause 20.

Reports will summarize the activities and general findings of the monitoring during the preceding year. Basic descriptive statistics will be the level of data analysis for these reports. Any major unanticipated events or recommendations for changes to study design or mitigation will be noted.

3.1.4.2 SYNTHESIS AND RECOMMENDATIONS

A synthesis report will be produced after construction completion and at years 5 and 10 of operation. Synthesis reports will consolidate, map, analyze and evaluate all monitoring information gathered to date studies. Actual Project effects on priority plants will be compared with the EIS predictions. If there are substantive adverse deviations from predictions, or if unforeseen conditions arise, the report will also make recommendations for alterations or enhancements to the rehabilitation plan, monitoring programs, and/or to mitigation measures. These reports will also include recommendations for any needed modifications to subsequent study design. The year 10 report will evaluate whether additional priority plant monitoring is needed and, if so, recommend a schedule.

3.2 INVASIVE PLANTS

3.2.1 INTRODUCTION

3.2.1.1 BACKGROUND

Invasive plants are defined as those plants that are growing outside of their country or region of origin and are out-competing or even replacing native plants. This definition captures invasive plants that are native to Canada but not typically found in the Keeyask Region. Additionally, introduced plant species that are not generally invasive may out-compete native species under some local conditions or may do so in the future with changing climate.

Invasive plants are of concern because they can crowd out other plant species and, in extreme cases, change vegetation composition or other ecosystem attributes. Invasive plants may spread through natural means such as prolific seed dispersal by water, wind, birds or other animals or through changes in hydrologic regimes which favour establishment in new areas. Human activities are a major contributor to the introduction and/or spreading of invasive plants.

There is a need to document the degree to which the Project contributes to the spreading of any invasive or non-native plant species, and to assess the effectiveness of measures to limit the introduction and spreading of these species.

3.2.1.2 ASSESSMENT SUMMARY

Past and current projects and activities, as well as natural dispersal processes, have introduced and will continue to introduce and spread invasive plants into Study Zone 2. The Project could further spread invasive plants already in Study Zone 2 and/or introduce new invasive plant species.

Invasive species 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 a large area 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 footwear or vehicles and/or propagules being transported on construction equipment moved from distant areas. A severe accidental Project-related fire could create ideal conditions for some invasive species 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.

Nineteen invasive terrestrial plant species have been detected in the Project area. The risk that any of these species will become a problem in Study Zone 2 is low over the short-term. Field studies conducted near existing developments in northern Manitoba, which included several generating stations, indicated invasive plants have been largely confined to human disturbed areas and have not been crowding out native plant species in adjacent native habitat. This could change with changing climate.

Mitigation measures specifically targeted towards minimizing the risk of introducing, spreading or promoting invasive plants includes:

- Temporarily cleared areas will be revegetated or treated with a non-invasive ground cover as soon as practicable during construction;
- Contractors utilizing equipment and machinery that was recently used more than 150 km from the Project area will wash that equipment and machinery prior to transport to the Project area;
- Contractors will be educated about the importance of cleaning their vehicles, equipment and footwear before travelling to the area;
- Where seeding is used as a rehabilitation or erosion control measure, the seed mixture will only contain native species and/or non-invasive introduced plant species;
- Containment, eradication, and/or control programs will be implemented if monitoring identifies problems with invasive plants within the Project zone of influence; and,
- Except for existing resource-use trails and those required for operation, 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.

It is anticipated that mitigation measures will minimize the risk that the Project will introduce or spread invasive plants, and provide the 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 Project zone of influence.

3.2.1.3 COMPONENTS THAT WILL BE MONITORED

The Invasive Plant Spread and Control study (Section 3.2.2) will determine the degree to which the Project contributes to introducing and spreading invasive and non-native plants. It will also evaluate the effectiveness of mitigation measures.

3.2.2 INVASIVE PLANT SPREAD AND CONTROL

3.2.2.1 INTRODUCTION

This study includes two components. The first component will monitor invasive plant distribution and abundance in Project areas. In the event that control or eradication programs are needed, the second study component will provide relevant recommendations and monitor their effectiveness.

The implementation and effectiveness of trail blocking will be monitored by the Terrestrial Habitat Clearing, Disturbance and Indirect Effects study (Section 2.0) and the Terrestrial Habitat Rehabilitation study (Section 2.2).

3.2.2.2 OBJECTIVES

The overall objectives of this monitoring program are to:

- Verify that appropriate seed mixtures were used where seeding is implemented as a rehabilitation or erosion control measure;
- Document the degree of invasive plant introduction and spread;
- Document if invasive plant introduction and/or spread occurs;
- Recommend appropriate control and eradication programs; and,
- Verify the efficacy of any programs implemented to control or eradicate invasive plants.

3.2.2.3 STUDY DESIGN

3.2.2.3.1 OVERVIEW

Invasive plant distribution and abundance changes will be monitored in areas where Project activities or features could introduce or spread invasive plants. Incidental observations will also be recorded during other terrestrial habitat, ecosystem and plant field studies.

If the event that patches are discovered, the need for control or eradication measures will be evaluated and, if needed, a prescription will be developed. The efficacy of these prescriptions will be monitored.

3.2.2.3.2 EXISTING DATA

The data identified in Section 3.1.2.3.2 also documents invasive plants.

3.2.2.3.3 DESIGN

Ground surveys will be conducted in areas where Project clearing or hydrological alterations have occurred. Areas will be subsampled using a combination of systematic and meandering transects.

In the event that areas are identified for control or eradication measures, ground surveys will be conducted to confirm implementation of the prescription and verify its efficacy. The layout of these surveys will be designed at that time based on the nature of the site and the control/eradication prescription.

3.2.2.3.4 PARAMETERS OF CONCERN

Parameters being measured are:

- Locations and sizes of invasive plant patches by species; and,
- Locations and nature of control or eradication measures.

3.2.2.3.5 BENCHMARKS

The target is to eradicate any species in the Project area that is moderately to highly invasive in the Keeyask Region, and to minimize the cover of the less invasive or non-native species.

3.2.2.3.6 STUDY AREA

Field studies will be confined to Study Zone 2 because Project activities that could introduce or spread invasive plants are expected to predominantly occur inside this area. While there is a possibility that vehicles travelling to the Project area may spread invasives while en route, this will not be monitored.

3.2.2.3.7 SAMPLE LOCATIONS

Along the access roads, a 200 m transect will be surveyed every 2 km, keeping in mind that some stops may need to be skipped during some construction years due to safety considerations. The subsampling intensity may be increased if there are widespread observances of invasive or non-native species along the access road.

Several transects will be surveyed in other cleared areas. One transect will follow a route near the perimeter of the clearing while a second will run through the center of the site. Additional meandering surveys will also occur through areas deemed by the botanist to have potential for harboring invasive or non-native plants.

For areas experiencing hydrological alteration, the survey transects will be customized to the features in a manner such that transects provide visual coverage for at least 25% of the affected area.

3.2.2.3.8 SAMPLING FREQUENCY AND SCHEDULE

Sampling will be conducted every summer during construction and during the first five years of operation. If there is evidence of Project-related spreading of invasive plants, or that control/eradication measures are not sufficiently effective, then additional fieldwork may need to be conducted in subsequent years.

During construction, a survey will be conducted in early summer and then again in late summer. Two surveys are needed each year to facilitate a rapid response to an observed invasive plant concern, and to confirm adequate implementation of control measures since the previous survey. One annual survey will be conducted each year of operation sampling unless the construction synthesis report (Section 3.2.3.1) indicates that two surveys are still required.

3.2.2.3.9 FIELD AND LAB METHODS

A qualified botanist will conduct the ground searches for invasive and non-native plants. All discovered species patches will be flagged and documented with geo-referenced photographs, marked-up maps and notes. Recorded information will include attributes such as plant species, plant vigor, site conditions and the possible source of the introduction or spreading. The locations and sizes of invasive plant patches will be mapped in a GIS. Control or eradication recommendations will be developed for observed invasive plant patches, and provided to Manitoba Hydro for implementation.

3.2.2.3.10 ANALYSIS

The level of analysis will generally be tabulations and descriptions of discovered invasive or non-native plant patches and their habitats, the locations and nature of any control/eradication measures and the efficacy of these measures. More complex analyses may be provided in the event that major control/eradication measures are required.

3.2.3 REPORTING

3.2.3.1 ANNUAL REPORTS

A report will be produced during the winter after each year when field studies occur, and will be submitted to MCWS the following spring, as per Environment Act License 3107, Clause 20.

Reports will summarize the activities and general findings of the monitoring during the preceding year. Basic descriptive statistics will be the level of data analysis for these reports. Any major unanticipated events or recommendations for changes to study design or mitigation will be noted.

3.2.3.2 SYNTHESIS AND RECOMMENDATIONS

A synthesis report will be produced after construction completion and at year 5 of operation. Synthesis reports will consolidate, map, analyze and evaluate all monitoring information gathered to date studies. Actual Project effects on invasive and non-native plants will be compared with the EIS predictions. If there are substantive adverse deviations from predictions, or if unforeseen conditions arise, the report will also make recommendations for alterations or enhancements to the rehabilitation plan, monitoring programs, and/or to mitigation measures. These reports will also include recommendations for any needed modifications to subsequent study design or to mitigation. The year 5 report will evaluate whether additional invasive plant monitoring is needed and, if so, recommend a schedule.

4.0 AMPHIBIANS

4.1 INTRODUCTION

4.1.1 BACKGROUND

Few frog species range into the boreal forest region of northern Manitoba. Species such as boreal chorus frog and wood frog (both found in the Project area) appear to be secure, while many other frog species are experiencing widespread declines throughout the world due to a number of factors including habitat loss, air and water-borne pollutants, disease and climate change.

Frogs and their populations are considered suitable environmental indicators due to their two-phase life cycle (including both aquatic and terrestrial habitats) and semi-permeable skin. Frogs have very thin permeable skin and thus are vulnerable to desiccation and the uptake of environmental pollutants from the aquatic and terrestrial habitats upon which their lifecycles depend. As a result, studies of amphibians have become increasingly important because they are considered indicators of ecological change. Because amphibian populations remain relatively localized, they can respond to environmental change quickly.

Amphibian population monitoring is being implemented to verify whether potential Project-related effects, such as the long-term loss or degradation of breeding habitat, are affecting the abundance and/or distribution of amphibians in the local area (Study Zone 3).

4.1.2 ASSESSMENT SUMMARY

Boreal chorus frog (*Pseudacris triseriata*) and wood frog (*Rana sylvatica*) were the only amphibian species found during EIS field surveys. Although the Project falls within the northern range limit of the northern leopard frog (*Lithobates pipiens*), this species was not observed during environmental surveys or incidentally. Elders have indicated that northern leopard frog was once abundant, but disappeared from the area in the late 1970s. One northern leopard frog was detected south of the Limestone Generating Station in 2004 during Conawapa environmental studies, but this species has not been observed since.

Boreal chorus and wood frogs were usually found at every suitable breeding pond sampled for the Project EIS studies, with at least one species at every pond. Throughout Study Zone 3, small populations of boreal chorus frogs and wood frogs breed within ponds, flooded creek mouths, bays and inlets. They forage in grassy, wet areas (e.g., along cutlines, wetland margins, moist forest). As the Project is developed, the small and widely dispersed frog populations occurring within the Project Footprint area could experience a long-term loss of some breeding, foraging and overwintering habitat.

The north and south access roads may fragment some potential amphibian habitat, and may create a barrier that could result in reduced frog movements between habitats.

Use of access roads by construction vehicles and heavy equipment may result in the mortality of a small proportion of the local frog population. Frogs could be at an increased risk of vehicle collisions in areas where amphibian habitat occurs near roads. Due to the low abundance and widespread distribution of amphibians within Study Zone 3, concentrated frog dispersal patterns across roads or other infrastructure sites are not expected.

Pollution (e.g., toxic chemicals, petroleum, salts and sediment) from vehicle emissions and road runoff are other factors that may influence the health of local frog populations utilizing wetlands or creeks adjacent to roads.

During the construction phase, petroleum (e.g., gasoline, diesel, oil) spills or leaks may contaminate surrounding waterbodies and/or soils in areas where frogs forage, breed, and overwinter. While the effect of such events on frogs would generally be small and site-specific if they occur on terrestrial habitat, these effects have the potential to be larger if hazardous materials spill or leak into a waterbody that supports frog populations. The potential for adverse effects of spills on amphibians will be mitigated through the implementation of measures for the transportation, storage and disposal of petroleum products outlined in the EnvPP.

Boreal chorus frogs and wood frogs are widespread throughout the Study Zone 3, occurring as small populations where suitable breeding conditions exist (e.g., in ponds, and fens with open water). Even with the implementation of mitigation measures, there will be some boreal chorus frog and wood frog mortality, and some amphibian habitat will be lost or degraded as a result of land clearing and construction activities.

Creation of the reservoir will increase the total amount of shoreline edge; however, this habitat is likely to consist of newly submerged vegetation, turbid waters, and large numbers of predatory fish. Such habitat is suboptimal for amphibians in general.

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 Keeyask Region and the Project effects area representing a small portion of that overall area.

The KIP monitoring results suggest that the majority of the areas previously sampled along the north access road still support both boreal chorus frogs and wood frogs, even during ongoing construction.

4.1.3 COMPONENTS THAT WILL BE MONITORED

Amphibian monitoring will focus on boreal chorus frogs and wood frogs, as these were the only two species found in Study Zone 4 during 13 years of field surveys. Leopard frog monitoring will be initiated if a local population is incidentally detected.

Since there is high confidence in the prediction that Project effects on amphibians will be within the range of natural variability, amphibian monitoring will be more focused and less intensive than most other monitoring programs. Monitoring will focus on quantifying and situating Project-related changes to available breeding habitat (Habitat Effects study; Section 4.2), and on the efficacy of mitigation intended to enhance frog habitat (Habitat Enhancement study; Section 4.3). Project effects on frog distribution and abundance will be inferred from these studies and from data incidentally collected by other monitoring programs.

Because frogs are both susceptible to disease outbreaks and can be sensitive bioindicators, uninjured dead or dying frogs found during field studies will be collected and sent away for histological analysis.

4.2 HABITAT EFFECTS

4.2.1 INTRODUCTION

Boreal chorus and wood frog breeding habitat consists of surface water that is present long enough for eggs to metamorphose into tadpoles and then adults. Both species are usually finished breeding by July, after which the adults move into wetland edges or adjacent damp forests to forage on insects, arachnids, slugs, worms, and snails. Juvenile frogs move into adjacent wetland margins and forests by about August. Since frogs are susceptible to desiccation, most adults forage within 100 m of water. Juvenile frogs disperse up to about 1 km in search of new ponds. Both frog species spend the winter under leaf litter and woody debris on the forest floor, often short distances from their breeding areas.

In the boreal forest, typical breeding habitat for boreal chorus and wood frogs is waterbodies that do not support predatory fish and are surrounded by treed areas. Any waterbody that holds water throughout the breeding period may be used.

Suitable boreal chorus and wood frog breeding habitat occurs throughout the Keeyask Region. Breeding habitat is typically associated with isolated waterbodies (e.g., small lakes, wetlands, ponds) or wet peatland areas where there are numerous shallow small ponds. Predatory fish are generally not found in these conditions. During EIS studies, frogs were also observed in the shallow pools and the waters of sedge/grass-filled bays and inlets along the Nelson River. Prior to KIP construction, foraging frogs were observed along the north access road route in some of the low-lying wet areas located along the esker and within the shrub and grass-dominated wet areas in cutlines atop the esker. Along the south access road route, frogs have been observed breeding in small, grassy ponds located on mineral soils adjacent to the Butnau Dyke, and in small ponds located near creeks.

To quantify and situate boreal chorus and wood frog habitat, the EIS identified the following terrestrial habitat and surface water types as breeding habitat:

- Isolated waterbodies less than or equal to 5 ha in size; and,
- Peatlands that often include patches of water.

Using this classification, primary and secondary habitat for boreal chorus and wood frogs is widespread in Study Zone 4. This model identified 7,867 ha of primary breeding habitat in Study Zone 4. Of this total, 1,084 ha is in Study Zone 3 and 352 ha is in the 150 m buffer of the Project Footprint. The model also identified 5,226 ha of secondary breeding habitat in Study Zone 4. Of this total, 1,276 ha is in Study Zone 3 and 354 ha is in the 150 m buffer of the Project Footprint. Given that the ponds used by frogs are often smaller than the minimum polygon size in the terrestrial habitat mapping, the amount of native habitat was likely underestimated by a substantial margin.

The goal of the habitat effects monitoring is to evaluate how the Project changes the distribution and abundance of habitat for boreal chorus and wood frogs.

4.2.2 OBJECTIVES

The objectives of the boreal chorus and wood frog habitat effects monitoring study are to:

- Verify the habitat association assumptions that were used to predict Project effects on boreal chorus and wood frog habitat;
- Evaluate whether the wetlands that form in depressions created by Project features become suitable habitat for boreal chorus and wood frogs;
- Quantify how much habitat is lost or altered due to the Project; and,
- Quantify and situate primary and secondary habitat in Study Zone 4.

4.2.3 STUDY DESIGN

4.2.3.1 OVERVIEW

There are two components to this study. The first component validates and refines the existing boreal chorus and wood frog habitat quality model. The second component applies the refined model to the post-Project terrestrial habitat map (which includes surface water types) to quantify and situate primary and secondary boreal chorus and wood frog habitat.

For the first component, the EIS used an expert information model to classify terrestrial habitat and surface water types into primary, secondary and unsuitable habitat for boreal chorus and wood frogs. This expert information model was developed from field data collected in the Keeyask Region, relevant scientific literature and professional judgement.

This study will validate and refine the expert information habitat quality model using data collected in an appropriate range of habitat types. Data collection will focus on the potential habitats created by the Project since there is high confidence in the types of native habitat used by boreal chorus and wood frogs in the Keeyask Region. Other monitoring studies (e.g., olive-sided flycatcher sensory disturbance study) and studies conducted since the EIS analysis was completed (e.g., KIP monitoring, Project pre-construction monitoring) provide data for native breeding habitat types.

Following model refinement, the habitat quality model will be applied to the post-Project terrestrial habitat map to quantify and situate primary and secondary habitat. Permanent and temporary habitat loss due to Project infrastructure and indirect Project effects on terrestrial habitat and surface water types that are inputs into the habitat quality model will be determined from the Terrestrial Habitat Clearing, Disturbance and Indirect Effects study (Section 2.1). This general approach will also determine alterations to the quantities and qualities of various frog habitat types.

4.2.3.2 EXISTING DATA

Frog occurrence and habitat data were collected at over 1,400 locations in Study Zone 4 during the 2001 to 2013 breeding seasons. Boreal chorus and/or wood frogs were detected at a minimum of 10% of these locations (includes repeat observations for locations sampled in more than one year). Detection tended to be very low because these surveys were conducted during breeding bird point counts, and not at night, which would have substantially improved frog detections.

Boat and ground based surveys were conducted in a variety of habitat types. In 2001 through 2003, boat-based surveys for frogs took place at 69 stops on Gull Lake and on the Nelson River, between Birthday Rapids and Gull Rapids. Ground based surveys for frogs conducted during breeding bird point count surveys occurred at 197 stops in 2001, 226 stops in 2002, 337 stops in 2003, and 58 stops in 2004. Surveys were also conducted along proposed access road routes and adjacent areas near Gull Lake and the north arm of Stephens Lake (a proxy site for the future reservoir) in 2005 (62 stops), 2006 (118 stops) and 2007 (126 stops). Survey transects were primarily located within and adjacent to areas that could be affected by the Project and representing the various habitat types. Common habitat types had the most plots, while less common habitat types had fewer plots.

Remote recording units were deployed between 2009 and 2011 at wetlands, creeks, and inland lakes not previously sampled during breeding bird point count surveys.

During road surveys designed for frogs, both species were found at 18 of the 19 stops and boreal chorus at the remaining stop. Both species were also found at the 19 wetlands surveyed. Due in part to their longer breeding period, boreal chorus frogs were detected more frequently than wood frogs, which have a brief spring breeding period (i.e., typically a few days to a couple of weeks depending on temperature).

In 2013, amphibian surveys for the KIP were conducted along the north access road (27 stops), Butnau road (10 stops), and Provincial Road 280 (20 stops) for comparison. Surveys were also conducted at 38 wetlands in the Keeyask Region from May 24 to 27. Of the 27 stops, 97% had one or both of the frog species present.

4.2.3.3 DESIGN

This is a population and habitat patch level resource selection study. This study is not determining the specific environmental attributes that boreal chorus and wood frogs are using (e.g., do they lay eggs in water, eat a variety of insects, avoid waterbodies with predatory fish) since this is already well established in the literature. Rather, it is testing which of the mapped terrestrial habitat and surface water patch types best incorporate these attributes based on demonstrated higher proportional use.

All other things being equal, boreal chorus and wood frogs are expected to be found in a higher proportion of their preferred habitat types compared with less preferred types, and to be absent or highly infrequent in unsuitable areas. A stratified, random sample of available habitat types created by the Project will be classified into used versus unused based on species detections during the fieldwork. Stratification involves classifying available habitat into major subtypes to provide replication for the major factors affecting habitat attributes. The stratification and fieldwork will occur during the operation phase since this is the earliest time when the full complement of Project-created habitat types will be present and can be mapped to create appropriate strata.

Data for Project-created frog habitat will be gathered over three years during operation, with each location being sampled in one year only. An annual random sample captures year-to-year variability in habitat use. Each location will be visited three times during the breeding season to increase detection probability and distinguish frequent use from transient or atypical use.

Suitable data from other studies will also be used where appropriate. For example, TEMP bird studies will provide reference data for this study because all of the rusty blackbird and many of the olive-sided flycatcher sample locations will be situated near open water. Stationary audio recorders deployed by these bird studies will be programmed to record sounds during the peak frog calling periods each day. Hand held and additional stationary audio recorders will be used at the remaining sample locations.

Pre-Project data from Project-affected sites will contribute to the evaluation of how Project features alter habitat quality and change effective habitat during the breeding season.

A power analysis using results to date will be conducted winter following the third sample year to determine if additional samples are needed to validate and refine the habitat quality model.

The refined boreal chorus and wood frog habitat quality model will be applied to the terrestrial habitat map, which will be periodically updated to reflect direct and indirect Project effects. See Section 2.0 for the design of the Terrestrial Habitat Clearing, Disturbance and Indirect Effects study.

4.2.3.4 PARAMETERS

The monitoring parameters are:

- Call density;
- Habitat attributes of the sample location;
- The amounts of primary and secondary habitat that are directly and indirectly affected by the Project; and,
- The amounts and locations of primary and secondary habitat in Study Zone 4.

4.2.3.5 BENCHMARKS

Benchmarks are not applicable for the first two study objectives since they are determining habitat associations or habitat use.

Regarding the latter two objectives, the EIS only provided habitat benchmark values for VECs. The general approach for wildlife VECs was that a 10% cumulative loss of historical area for the species' habitat was the benchmark that triggered management concern. This same benchmark will be used for amphibian habitat effects monitoring.

4.2.3.6 STUDY AREA

Data collection will occur within Study Zone 3 since this extends well beyond the potential Project footprint. Periodic mapping of available habitat will be for Study Zone 4.

4.2.3.7 SAMPLE LOCATIONS

A sample location consists of a habitat patch that is large enough to support a conspecific group of breeding frogs. These patches will generally be mixtures of different terrestrial habitat and surface water types.

Sample locations for Project-created habitat will be selected as follows:

1. To identify the sampling units for the sampling frame, classify Project-created patches of open water and adjacent land into major habitat types based on the environmental attributes that influence boreal chorus and wood frog local abundance. The resulting classes are the strata for random selection;
2. From each of the strata identified in Step 1, randomly select at least three sampling units for sampling during the first year of sampling. If this produces less than 50 samples, then increase the number of samples per stratum to achieve a minimum total sample size of 50;
3. Repeat Steps 1 and 2 for the second year of sampling; and,
4. Repeat Steps 1 and 2 for the third year of sampling.

Step 1 is completed each sample year to account for habitat change over time, particularly in areas affected by the reservoir. All such sample locations are expected to be within Study Zone 2 (Map 3).

Sample locations for native habitat will consist of all locations from other studies that provide suitable frog presence-absence data (designs for the relevant monitoring studies typically provide representative samples). All such sample locations are expected to be within Study Zone 4 (Map 3).

A power analysis completed during the winter after the third year of sampling will determine whether a larger total sample size is needed for model refinement and validation.

4.2.3.8 SAMPLING FREQUENCY AND SCHEDULE

The specific years when sampling occurs will be determined based on the actual year when the reservoir reaches full supply level. Since reservoir expansion is predicted to be rapid during the initial years of operation and a number of years is required for suitable wetland attributes to develop in other Project-created features, the first year of sampling will be five years after the reservoir reaches full supply level. The second and third sample years will be 10 and 15 years, respectively, after full supply level is reached.

Each sample location will be sampled in one year only.

The number of times each sample location is visited during the breeding season will depend on whether hand held or stationary audio recorders are used. For hand held recorders, each location will be visited three times during the breeding season, with each visit being separated by at least 10 days. For stationary recorders, a recorder will be left in place for at least two weeks. Although specific dates can change from year to year depending on temperature, the approximate dates will be from April 25 to June 10.

4.2.3.9 FIELD AND LAB METHODS

Stationary or hand-held audio recorders will record frog calls. Since the recorders are expected to capture a high proportion of most of the selected habitat patches, the biologist or stationary recorder will be positioned at a central location on the waterbody shoreline within the habitat patch. Calls will be recorded between 10:00 p.m. and 2:00 a.m.

In the lab, the recorded data will be screened for boreal chorus, wood and northern leopard frog calls using sound analysis software (e.g., Adobe Audition 2.0). An hourly and daily sample of the frog recordings will be selected for further processing and analysis. The amplitude (i.e., decibels) statistics of each call is extracted from the recordings.

Regionally rare bird species songs and calls detected in the frog audio recordings will also be included in the data extraction to provide data for other studies (e.g., yellow rail, rusty blackbird).

4.2.3.10 ANALYSIS

The sample locations are the replicates, habitat patch type is the treatment and native versus human-affected is the primary covariate in the analysis. The audio detection areas, which are expected to capture a high proportion of most of the sampled habitat patches, are the subsamples.

Analysis methods will be determined by the actual structure of the field data. Some of the habitat association method possibilities include ANOVA, logistic regression and generalized linear models. Some of the validation method possibilities include confusion matrices, Kappa statistics and receiver operating characteristic curves. Statistical model and inferential assumptions will be tested during the analysis.

For the Project-affected and available habitat mapping component of this study, the validated and refined habitat quality model will be applied to the terrestrial habitat map that is periodically produced by the Terrestrial Habitat Clearing, Disturbance and Indirect Effects study (Section 2.1).

4.3 HABITAT ENHANCEMENT

4.3.1 INTRODUCTION

The Terrestrial Mitigation Implementation Plan includes the installation of wood chip or slash piles that are retained as a mitigation measure for improving cover or shelter for frogs in areas that have been cleared for the Project. Wood chip or slash piles may benefit amphibians by providing nursery cover, a source of food for juvenile frogs, winter cover, and may temporarily enhance habitat connectivity between breeding ponds and upland foraging habitat if vegetation and woody debris is limited. Conversely, as slash piles may prevent the re-establishment of vegetation in borrow areas from acidic leachates or by shading plants, the size and number of slash piles used to provide nursery cover and enhance connectivity between ponds will be minimized and positioned carefully in the area.

This mitigation measure is anticipated to provide temporary habitat, especially for juvenile frogs. Suitable frog habitat will develop as the slash piles deteriorate and a mature plant community re-establishes over the borrow area reclamation period.

The goal of the habitat enhancement monitoring is to assess the efficacy of using woodchip or slash piles to provide temporary cover and shelter for juvenile wood and boreal chorus frogs.

4.3.2 OBJECTIVES

The objective of the boreal chorus and wood frog habitat enhancement monitoring study is to:

- Evaluate whether the wood chip or slash piles become suitable nursery habitat for juvenile boreal chorus and wood frogs.

4.3.3 STUDY DESIGN

4.3.3.1 OVERVIEW

There is one component to this study. The Habitat Enhancement study will monitor the use of wood chip or slash piles identified in the Terrestrial Mitigation Implementation Plan by boreal chorus frogs and wood frogs. Data collection will focus on the frog response to the potential habitat developed in borrow areas.

The use of wood chip or slash piles to enhance nursery habitat is a novel management prescription. Limited data are available elsewhere for similar measures in North America. There is a moderate level of uncertainty as to whether managed wood piles can benefit local frog populations. A forestry study in the boreal mixedwood forest region of Alberta described the biodiversity aspects of wood-residue piles unique to field portable-chipper sites. Juvenile boreal chorus and wood frogs were detected as part of the biota in aspen piles, along with numerous invertebrates and vascular plants. This study hypothesized that the moist environment that contained numerous insect species provided foraging habitat for frogs and predator protection.

4.3.3.2 EXISTING DATA

Frog occurrence and habitat data are described in Section 4.2.3.2.

4.3.3.3 DESIGN

Since this technique is not established in the literature, this is a proof of concept intervention study. This study will determine if frogs will use constructed slash piles and, if so, the specific environmental attributes of used versus unused piles.

Slash piles will not be placed in borrow areas that do not contain wetlands, or are not adjacent to wetlands, as they will not be used by frogs for breeding. Each wood chip or slash pile created for frogs will be sampled for frogs and habitat attributes. All wood chip or slash piles installed to provide nursery habitat will be sampled. The fieldwork will occur during the construction and operation phases, as wood chip or slash piles are installed in borrow areas that are being decommissioned.

Data for Project-created habitat will be gathered over three years, with each location being sampled each year. Thereafter, each location will be sampled once every three years until such time as the wood chip or slash pile degenerates, or, it is no longer being used by frogs. Each location will be visited three times during the nursery and fall movement season in July and August to increase detection probability and distinguish frequent use from transient or atypical use. The composition, size and distribution of the wood chip or slash piles will be monitored according to the schedule established during the Terrestrial Rehabilitation Implementation and Success study (Section 2.2).

Suitable data from other studies will also be used where appropriate. For example, frog habitat effects studies will provide reference data for this study because many of the frog sample locations will be situated near water or adjacent upland habitat.

4.3.3.4 PARAMETERS

The monitoring parameters are:

- Number of wood frogs and boreal chorus frogs at the sample location; and,
- The amounts, locations and habitat attributes of the constructed wood chip or slash piles.

4.3.3.5 BENCHMARKS

Benchmarks are not applicable to this study since it is evaluating whether or not wood chip or slash piles become frog habitat.

4.3.3.6 STUDY AREA

Data collection will occur within Project borrow areas that contain or are adjacent to wetlands, which are expected to be within the limits of Study Zone 2.

4.3.3.7 SAMPLE LOCATIONS

A sample location consists of a constructed wood chip or slash pile. The actual locations will determined by the Terrestrial Mitigation Implementation Plan. All sample locations will be sampled in each year of sampling.

4.3.3.8 SAMPLING FREQUENCY AND SCHEDULE

The specific years when sampling occurs will be determined based on the actual year when slash piles are constructed in the borrow areas that are being decommissioned.

Each sample location will be sampled in years 2, 4, 6 and 8 following the year they are constructed.

Each sample location will be visited three times during the nursery season and three times during the fall movement period. Although specific dates can change from year to year depending on temperature, the approximate dates will be between July 1 and August 31. Each visit will be separated by at least 10 days.

4.3.3.9 FIELD AND LAB METHODS

Pit fall traps will be used to live-trap frogs. Traps will be checked daily for a three-day period, and frogs that are trapped will be released unharmed each day. After each sample period, pit fall traps will be closed to prevent further captures until it is re-opened during the next site visit. One pit fall trap will be established at every wood chip or slash pile. Data collected will include species, age and condition. Incidental take that may include insects will be collected, preserved and donated to the Manitoba Museum.

Frogs observed incidentally on slash piles or while walking between sample sites will also be recorded.

The composition, size and distribution of the wood chip or slash piles will be measured and mapped by the terrestrial ecologist.

Dead frogs will be collected opportunistically, if detected in Study Zone 1 if the cause of death is not known (e.g., if the frog is entirely intact it will be collected; partially depredated frogs will not be collected). Specimens will be put into a plastic bag, labelled with the collection location, date, time and circumstances surrounding the collection. Frogs will be stored in a freezer. If any dead frogs are collected, they will be submitted to the Provincial pathology laboratory for a necropsy.

4.3.3.10 ANALYSIS

Basic descriptive statistics will generally be the level of data analysis. Presence/absence analysis, frequency and abundance will be used to describe the local boreal chorus frog and wood frog populations at the sample locations. An index of abundance over time will be developed to demonstrate the utility of wood chips or slash piles in borrow areas. Maps of slash pile locations and frog presence will be used to examine distribution.

4.4 REPORTING

4.4.1 ANNUAL REPORTS

A report will be produced during the winter after each year when field studies occur, and will be submitted to MCWS the following spring, as per Environment Act License 3107, Clause 20.

Reports will summarize the activities and general findings of the monitoring during the preceding year. Basic descriptive statistics will be the level of data analysis for these reports. Any major unanticipated events or recommendations for changes to study design or mitigation will be noted.

4.4.2 SYNTHESIS AND RECOMMENDATIONS

A synthesis report will be produced after the fourth year of field studies, which is expected to occur around year 15 of operation. This report will consolidate, analyze and evaluate all monitoring information gathered to date, including that produced by other monitoring programs. The synthesis report will also include recommendations for any needed modifications to subsequent study design or to mitigation. The operation synthesis report will make recommendations regarding the need for any further monitoring.

5.0 BIRD MONITORING

5.1 INTRODUCTION

Birds play an important role in the boreal ecosystem. They act as seed dispersers and as indicators of ecosystem health. They control insect populations and are food for other animals. Some species of ducks, geese, and upland game birds (e.g., grouse) are harvested for food by humans and some species such as the bald eagle are highly valued by First Nations people.

Monitoring will be employed to verify Project effects on birds, especially where moderate scientific uncertainty exists (see Keeyask Generation Station EIS, TE Volume 6, Section 6.4.5). Recommended monitoring and follow-up relates primarily to the bird VECs (Canada goose, mallard, bald eagle, olive-sided flycatcher, rusty blackbird and common nighthawk), other priority birds (colonial waterbirds, ruffed grouse) and other species listed under the Manitoba *Endangered Species and Ecosystems Act* (MESEA), federal *Species at Risk Act* (SARA), or the Committee on the Status of Endangered Species in Canada (COSEWIC).

This section outlines the Project effects pathways and mitigation measures that are common to most of the bird monitoring programs.

5.1.1 PROJECT EFFECTS PATHWAYS

Potential Project effects on birds relate mainly to habitat change, Project-related disturbances, and access effects. Land clearing in the Project footprint (e.g., reservoir) will affect breeding habitat and other habitat (e.g., staging habitat) in Study Zones 2 or 3. Sensory disturbances due to construction activity (e.g., blasting, machinery, traffic on the access roads) will likely result in temporary avoidance of otherwise suitable habitat by some individuals, which is also referred to as a loss of effective habitat.

In addition to sensory disturbance, Project-related disturbances could include accidental spills or leaks resulting in contaminated habitat, which would affect water quality and food sources (e.g., plants). Collisions with vehicles and the radio communications tower could increase bird mortality along the access roads and the generating station, and increased access to formerly remote areas could increase hunting pressure on harvested species.

5.1.2 MITIGATION

Mitigation measures identified to address Project-related effects on several bird species include the following:

- Undertaking clearing outside of the sensitive breeding period (April 24 – August 25) to the extent practicable to minimize disturbance to breeding birds;
- Carrying out pre-clearing nest surveys if a situation arises where clearing needs to be undertaken between April 24 and August 25. If an active nest is found in an area where habitat destruction activities are to take place, species appropriate setbacks will be put in place in most instances and the setbacks will be held until the young have fledged;

- Ensuring blasting plans developed with the General Civil Contractor (GCC) for Project construction give consideration to timing of blasting, number of blasts and maximum charge sizes per delay, drill and blast pattern, and any new blasting technologies that may become available;
- Blocking Project-related cutlines and trails, except for existing resource-use trails and those required for operation, 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
- Ensuring no chemical vegetation control is utilized during construction clearing.

5.2 CANADA GOOSE AND MALLARD

5.2.1 INTRODUCTION

5.2.1.1 BACKGROUND

Canada goose and mallard are VECs. The KCNs have identified these species as an important source of food. As such, monitoring of Canada goose and mallard abundance and distribution will occur.

Canada geese are 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 flocks of migrant geese. Potential construction-related Project effects on Canada goose are expected to be temporary avoidance of foraging habitat during migration due to sensory disturbances (*e.g.,* construction-related noise and blasting). Inundation of shallow areas (*e.g.,* back bays, inlets, and creek mouths of Gull Lake) is anticipated to affect use of the area by Canada goose until new shorelines and suitable habitats re-establish. As such, monitoring of Canada goose abundance and distribution will occur and seek to identify any changes attributable to construction and operation activities.

Potential construction-related effects to mallard populations are expected to be temporary reduction of effective nesting and foraging habitat near wetlands, creeks and lakes due to sensory disturbances (*e.g.,* construction-related noise and blasting), and long-term loss and degradation of some upland nesting habitat due to land clearing activities.

Canada goose and mallard are addressed in the same study due to their similar habitat requirements and field methods.

5.2.1.2 ASSESSMENT SUMMARY

Construction activities are not anticipated to result in the loss or alteration of Canada goose breeding habitat as optimal Canada goose breeding habitat does not occur within the Keeyask Region.

Increased access has the potential to lead to increased hunting pressure on geese staging (during spring and fall migration seasons) within the area.

The residual effects of Project construction on Canada geese include the indirect loss 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 extent, and short-term.

Reservoir impoundment will result in the long-term loss and degradation of potential Canada goose staging and foraging habitat that occurs in shallow bays, inlets and creek mouths of Gull Lake and parts of the Nelson River (between Gull Lake and Birthday Rapids). In low water years, these areas provide productive staging habitat for migrating geese and other species of waterfowl.

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 extent, and long-term.

The residual Project effects on Canada geese are associated with some noise disturbance during construction phase and a reduction in quality of staging habitats in Gull Lake and parts of the Nelson River. These effects are expected to be adverse, small in magnitude, medium in extent, and long-term.

The residual effects of Project construction on mallard are associated with loss and degradation of 1,716 ha of upland nesting cover. Sensory disturbances near wetlands, creeks and lakes may reduce the amount of effective habitat available for staging, nesting and foraging, although the amount of nesting and foraging habitat impacted would be very small. Residual construction-related effects are expected to be adverse, small in magnitude, small in extent, and long-term.

The residual effects of Project operation on mallard are associated with habitat loss and degradation resulting from reservoir filling and increased mortality risk resulting from increased access to some inland lakes, creeks, and wetlands. Residual operation-related effects are expected to be within the natural variability of mallard populations in the Keeyask Region.

Canada geese use the area to stage in the spring and fall while travelling between their winter and summer ranges. Staging in early spring will typically take place in open water wetlands such as marsh and shoreline wetlands with nearby emergent grasses and sedges and other open-water areas in spring and fall. Individuals may stage for as little as one night or up to several weeks, depending on various conditions. A small proportion of individuals stay and breed in the Keeyask Region, while the large majority continue to their nesting grounds further north. Breeding and nesting will take place in wetland habitat such as marsh, fen and shoreline wetlands and less frequently near other types of waterbodies such as lakes and rivers.

Mallards also use the area to stage during their spring and fall migrations. Like Canada geese, wetlands and shallow open water areas are preferred. The majority of mallard breeding and nesting habitat is located further south in the prairie regions of North America. However, wetlands in the boreal region are regionally important and provide some nesting habitat for mallards, particularly during dry years on the prairies.

5.2.1.3 COMPONENTS THAT WILL BE MONITORED

The EIS predicted that Project-related changes to habitat availability will be the main driver for pathways of effects on Canada goose and mallard, and that residual Project effects in combination with other projects are expected to be small in magnitude and well below the ecological benchmarks for cumulative effects. This monitoring program's emphasis will be on measuring how Project-related changes to habitat influence Canada goose and mallard distribution and abundance since the overall risk for unanticipated or unexpectedly large adverse Project effects is low.

The Habitat Effects study (Section 5.2.2) will monitor habitat and relative bird abundance in various habitat types to address the habitat pathways of effects on Canada goose and mallard distribution and abundance.

Sensory disturbance is not being monitored as a study. Canada goose and mallard are extremely adaptable to human features. Additionally, the Habitat Effects study will provide data to evaluate whether locations in proximity to the Project are being used.

The Mortality study (Section 5.2.3) will evaluate whether increased hunting pressure is reducing Canada goose and mallard abundance due to Project-related improved access or habitat changes. This study will also evaluate accidental mortality from sources such as collisions with vehicles and the radio communication tower. The radio communication tower is included in this study even though is not a substantial concern as it can be monitored with minimal effort using information collected by other studies.

Compliance monitoring relating to pre-clearing nest searches and installation of mallard nesting tunnels is described in the Terrestrial Mitigation Implementation Plan.

The Habitat Enhancement study (Section 5.2.4) will evaluate the efficacy of mallard nesting tunnels.

Information from all terrestrial, aquatic and resource use monitoring programs will be periodically consolidated, analyzed and evaluated in a synthesis report to provide an integrated comparison of predicted and actual Project effects on Canada goose and mallard. The analysis completed for the synthesis report (Section 5.2.5.1) will provide an integrated evaluation of Project effects on Canada goose and mallard distribution and abundance, the availability of suitable habitat, efficacy of nesting tunnels and sensory disturbance effects on habitat effectiveness.

5.2.2 HABITAT EFFECTS

5.2.2.1 INTRODUCTION

The availability of suitable shelter and foraging habitats during the breeding season is the driver expected to have the greatest influence on Canada goose and mallard distribution and abundance in the Keeyask Region. Other drivers potentially influencing distribution and abundance, and in no particular order of importance, but to a much lesser degree include:

- Amount and distribution of terrestrial nesting habitat;
- Mortality as a result of collisions with transmission lines, communication towers, or vehicle traffic;
- Sensory disturbance from construction and other vehicle traffic;
- Predation by other birds (e.g., raptors) or mammals (e.g., red fox);
- Increased hunting pressure as a result of better access;
- Increased uptake of methylmercury from reservoir inundation;
- Potential for contamination of habitat as a result of petroleum product spills; and,
- Changes in availability of staging habitat.

Except for sensory disturbance, Project influences on all of the non-habitat drivers are expected to be very low to nil.

While the availability of suitable staging habitat contributes to the continent-wide health of the waterfowl species including Canada goose and mallard, the amount of staging habitat is relatively low in the Keeyask Region. For Canada goose, the amount of on-system staging habitat varies from year to year depending on water levels.

5.2.2.1.1 CANADA GOOSE

Canada goose is a grazer of upland plants (e.g., grasses) and occasionally of emergent (e.g., sedges) and submergent plants and seeds. Water is used for predator protection and, where suitable plants are present, for foraging. Canada geese will use open land areas adjacent to water for staging or breeding. This includes peat islands in waterbodies, particularly if they provide adequate sedge cover for foraging.

According to the literature, Canada geese are generally found in and near wetlands and waterways. They inhabit the tundra, the boreal forest, prairies, parklands, and urban areas. Individuals gather at staging and stopover areas during the spring and autumn migration.

Canada goose is most abundant in the Keeyask Region during the spring and fall migration periods, stopping over before making their way northward to their preferred breeding grounds (e.g., the Hudson Bay Lowlands). Compared with major staging areas in northern Manitoba, Even the highest densities of staging geese are low in the Keeyask Region compared with other major staging areas in northern Manitoba.

Staging Canada geese are most abundant along the Nelson River, particularly in the Gull Lake area, during the spring and fall migration periods. The availability of on-system staging areas for Canada geese is dependent upon water levels. 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, however, these areas disappear during high water years. 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.

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. Both the YFFN and FLCN also refer to Members hunting geese in the spring.

Although some geese breed within the Keeyask Region, most geese observed during summer surveys were non-breeders. The pre-Project Keeyask EIS studies suggest that Gull Lake and parts of the Nelson River have value as stopover sites for migrating geese but are of low-value as breeding areas for geese. Canada geese used the food-rich bays, inlets and creek mouths of Gull Lake and the Nelson River throughout the breeding season. While some Canada geese breed in Study Zone 3 (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 Keeyask Region and availability of adequate forage (e.g., sedge) along the Nelson River is limited, especially in years when river water levels are above average.

The EIS determined that optimal Canada goose breeding habitat is not present in the Keeyask Region, and that use of the area by geese would decreased due to Project-related reductions in the quality of staging habitats along the Nelson River.

5.2.2.1.2 MALLARD

Mallards are considered an upland-nesting species that uses creeks and creek mouths for brood-rearing and foraging. Mallards feed on aquatic plant material (e.g., pondweed, sedges) and aquatic insects (e.g. amphipods) in shallow water.

Mallards are one of the earliest arrivals to the boreal forest in the spring. Due to their early arrival, staging habitat will predominantly be open water, ideally slack or slow moving open water. In the spring, mallards are generally metabolizing the energy reserves they acquired further south so foraging habitat is not as critical. In the fall, marshes are used by staging mallards. At this time of year mallards are trying to build their reserves for the migration south so foraging habitat is more important than during spring staging. Wetlands that have open water (i.e., not totally vegetated) are likely a preferred staging habitat in the spring and fall.

Mallards are one of the earliest nesting duck species in the boreal region. Most breeding mallards arrive and initiate clutches in May. They are primarily a ground-nesting species. While mallards generally nest within 300 m of water in the boreal region, they will also nest almost anywhere where it is dry enough; they are extremely adaptable and hardy. Mallard hens brood their young primarily within marshes, and prefer deep marshes on larger lakes, creeks and ponds with stable water levels. In cases where the first nesting attempt fails, up to 50% of females will re-nest.

Of the aquatic environments surveyed within the Keeyask Region, including the Nelson River and small, off-system, inland lakes, Clark Lake consistently supported the highest average densities of mallards throughout the migration and breeding seasons. In the spring, average mallard densities were nearly two-fold higher on Clark Lake than on Gull Lake and the Nelson River area west of Birthday Rapids (and east of Clark Lake). By summer, mallard densities usually decreased in other areas surveyed (e.g., Gull Lake), yet remained high on Clark Lake. While some mallards may breed at Gull Lake and along parts of the Nelson River to Birthday Rapids, the low populations and numbers of broods observed during summer surveys indicate that other areas in the region have more optimal breeding habitat (e.g., Clark Lake).

Although mallards used the food-rich bays, inlets and creek mouths of Gull Lake and the Nelson River throughout the spring, the highest mallard densities at Gull Lake were associated with the fall migration period, especially during years with low water levels.

The results of field studies and ATK agree that water levels appear to have a large influence on the abundance and distribution of waterfowl along the Nelson River. YFFN has indicated fewer ducks in the Split Lake area because the shoreline habitat that they use has been flooded and eroded. FLCN states that "after hydro flooding and the loss of stable shorelines the number of nesting waterfowl declined.

To quantify and situate mallard breeding habitat, the EIS identified the following terrestrial habitat and surface water types as breeding habitat:

- Optimal brood-rearing habitat occurs along sluggish, sedge-filled creeks and to a lesser degree along sedge-filled edges of inland lakes; and,
- Nesting habitat is typically within 300 m of some of the inland lakes, wetlands and creeks.

Breeding habitat is expected to include all staging habitat.

Using this classification, the EIS predicted that the Project would remove 2,958 ha, or 1.3%, of the breeding habitat in the Keeyask Region, and decrease the availability and quality of staging habitat.

The goal of this study is to evaluate how the Project changes the amounts and locations of staging, breeding and brood-rearing habitat for Canada goose and mallard.

5.2.2.2 OBJECTIVES

The objectives of the Canada goose and mallard Habitat Effects monitoring are to:

- Verify the key habitat association assumptions that were used to predict Project effects on breeding and staging habitat for Canada goose and mallard; and,
- Quantify how much staging/breeding and brood-rearing habitat is lost or altered due to the Project.

5.2.2.3 STUDY DESIGN

5.2.2.3.1 OVERVIEW

There are two components to this study. The first component validates and refines the habitat quality model that the EIS used to predict effects on Canada goose and mallard habitat availability. The second component applies the refined model to the post-Project terrestrial habitat map (which includes surface water types) to quantify and situate breeding and staging habitat for Canada goose and mallard. This mapping will be used in conjunction with aerial survey results to evaluate Project effects on Canada goose and mallard distribution and relative abundance in Study Zone 4. In this study, relative abundance refers to the expected relative density of the species in each of the breeding and staging habitat types. These habitats are mapped by applying a habitat quality model to the mapped terrestrial habitat types and surface water types.

The expert information model used in the EIS to classify terrestrial habitat and surface water types into primary, secondary and unsuitable habitat was developed from field data collected in the Keeyask Region, relevant scientific literature and professional judgement. This Habitat Effects study will validate and refine the expert information habitat quality model using data collected in an appropriate range of habitat types.

Following model refinement, the habitat quality model will be applied to the post-Project terrestrial habitat map to quantify and situate primary and secondary habitat. Permanent and temporary habitat loss due to Project infrastructure and indirect Project effects on terrestrial habitat and surface water types that are inputs into the habitat quality model will be determined from the Terrestrial Habitat Clearing, Disturbance and Indirect Effects monitoring (Section 2.1). This general approach will also determine alterations to the quantities and qualities of various breeding and staging habitat types.

5.2.2.3.2 EXISTING DATA

Canada goose and mallard abundance and habitat data were collected from 2001 to 2014 for environmental assessment associated with the Keeyask Generation and Transmission Projects. Nelson River surveys were conducted in each of these years from Split Lake to the Limestone Generating Station. Off-system surveys were conducted along selected larger lakes and waterways.

Boat-based surveys were conducted in spring, summer, and fall 2001 to 2003, and in 2011. A total of 833 km was surveyed in 2001, 294 km in 2002, 220 km in 2003, and 156 km² in 2011. Helicopter surveys were conducted in 2001 to 2003, 2006, 2011, and 2013. A total of 2,110 km of shoreline was surveyed in 2001, 889 km in 2002, 2,523 km in 2003, 201 km in 2006, 1,708 km² in 2011, and 439 km in 2013.

Regional waterfowl population estimates from the U.S. Fish and Wildlife Service's annual waterfowl breeding pair surveys in Stratum 24 provide background information for trends and annual variability in regional waterfowl populations.

5.2.2.3.3 DESIGN

This is a population and habitat patch level resource selection study. This study is not determining the specific environmental attributes that Canada goose or mallard use (e.g., do they nest on the ground near water, use water for predator protection or eat sedges) since this is already well established in the literature. Rather, this study is testing which of the mapped terrestrial habitat and surface water patch types best incorporate these attributes based on demonstrated higher proportional use.

All other things being equal, Canada geese, or mallards, are expected to be found in a higher proportion of their preferred habitat types compared with less preferred types, and to be absent or highly infrequent in unsuitable areas. A stratified, random sample of available habitat types will be classified into used versus unused based on species detections during the fieldwork. Stratification for random sampling involves classifying waterbody shorelines into the major subtypes (e.g., waterbody size, adjacent or not adjacent to the 2013 burns, on-system versus off-system) of predicted primary, secondary and unsuitable habitat patches using the expert information model. Including the major subtypes provides replication for the major factors affecting habitat attributes. A random sample will be obtained from each of the resulting strata with the exception that all sample units in the Keeyask hydraulic zone of influence will be sampled. Presence-absence and Canada goose/mallard density by habitat type will be used to assign habitat quality rankings to each stratum.

Aerial surveys will be conducted to determine abundance, distribution, and habitat use by Canada goose and mallard in areas affected by the Project and in suitable reference areas. Project affected areas include all areas within 100 m of the actual Project footprint at the time of sampling. Reference areas for on-system habitat include other reaches of the Nelson River from the Kelsey generating station downstream to the Limestone generating station. Reference areas for native habitat include the off-system waterbodies (which includes lakes, ponds, rivers, streams).

Aerial surveys will be conducted over multiple years to capture interannual variability. Each survey location will be visited three times during the spring staging/breeding, brood-rearing, and fall staging periods to increase detection probability and distinguish frequent use from transient or atypical use.

The expert information model will be validated and refined after construction phase data collection is complete. Since the conditions created by Keeyask reservoir and water regulation may create novel breeding habitat types, this refined model will be once again validated and refined around year 15 of operation.

The validated and refined habitat quality model will be applied to the terrestrial habitat map, which will be periodically updated to reflect direct and indirect Project effects. See Section 2.2.0 for the design of the Terrestrial Habitat Clearing, Disturbance and Indirect Effects study.

5.2.2.3.4 PARAMETERS

The monitoring parameters are:

- Number of Canada geese and mallards;

- Number of breeding pairs;
- Number of broods;
- Habitat attributes of sample locations;
- Amounts of staging and breeding habitat that are directly and indirectly affected by the Project; and,
- Total amounts of staging and breeding habitat in Study Zone 4.

5.2.2.3.5 BENCHMARKS

Benchmarks are not applicable for the first study objective since it is verifying habitat associations.

Regarding the latter two objectives, the Project assessment for birds used a 20% loss of existing habitat area as the benchmark that triggered management concern. Habitat effects monitoring will use the same benchmarks as were used in the EIS.

5.2.2.3.6 STUDY AREA

Data collection will occur within Study Zone 5. While periodic mapping of available habitat will be for Study Zone 4, collecting data in Study Zone 5 simultaneously provides for a broader range of habitat types for the random selection and the documentation of species abundance trends in the broader region.

5.2.2.3.7 SAMPLE LOCATIONS

A sample location consists of a 500 m long shoreline segment and the areas that are within 150 m on the water side of the segment. The 500 m segment length represents the minimum length needed to provide sufficient habitat to support a mallard family during the breeding season. While of lesser importance for the design, it also represents a sufficiently large area to support Canada goose and mallard staging during the spring and fall migrations. The 150 m buffer represents the maximum reliable detection distance for a low altitude helicopter-based survey.

Sample locations for Project-created habitat will be selected as follows:

- Sample all sampling units within limits of the predicted hydraulic zone of influence. These units will change from construction to operation since reservoir impoundment changes the shoreline position.

Sample locations for the reference sampling frame will be selected as follows:

1. Classify waterbodies in Study Zone 5 into the major subtypes of primary, secondary and unsuitable habitat patches by applying the expert information habitat quality model to the terrestrial habitat map (which includes surface water types);
2. From each of the strata identified in step 1, randomly select at least three waterbodies for sampling during that year. Survey the entire waterbody shoreline;

Map 9 shows the waterbodies selected by this approach. The same waterbodies are sampled each year that data collection occurs.

A power analysis completed during the winter after the third year of construction sampling will determine whether a larger total sample size is needed in subsequent years for model validation.

5.2.2.3.8 SAMPLING FREQUENCY AND SCHEDULE

Helicopter-based surveys will occur in years 2, 4 and 6 of construction and in years 5, 7, 9, 11 and 13 of operation. Operation phase sampling starts in year five because the reservoir is predicted to undergo substantial expansion during the first five years of operation. The synthesis analysis (Section 5.2.5.2) will evaluate the need to continue sampling after year 13.

During each sampling year, surveys will be carried out five times, during the spring/breeding, brood-rearing, and fall-staging periods. Spring and fall staging surveys will each be conducted once per year, while breeding and brood-rearing surveys will be conducted three times per year to increase detection probability and distinguish frequent use from transient or atypical use. The approximate starting dates for the Canada goose and mallard spring and fall staging periods are May 1 and September 1, respectively, while the approximate dates for the brood-rearing period range from about June 1 to July 31. Each visit will be separated by at least 20 days. These dates are approximate due to annual climatic changes that may alter migration and nest initiation timing.

5.2.2.3.9 FIELD AND LAB METHODS

Helicopter-based bird survey procedures that will be used during construction monitoring are as follows:

- Flights will occur when wind speeds are less than 25 kph.
- A helicopter equipped with bubble-windows in the rear will travel at approximately 80 km/hr at an altitude of approximately 20-30 m and follow the general contours of waterbodies.
- A three-person crew (in addition to the pilot) will conduct the surveys. Two observers, on the left side of the aircraft (front and rear seats), will record all waterfowl observed using a dependent double-observer technique. The front-seat observer will record all waterfowl observed and indicate this through the aircraft's communication system to the rear-seat observer. The rear-seat observer will record all waterfowl not observed by the front-seat observer. An additional third observer will be present on the right side (rear seat) of the aircraft and record waterfowl opportunistically.
- A time-stamped GPS track will be recorded for the duration of each flight that will provide positional data for all observations.
- Species, sex, and flock arrangement (e.g., pair [drake and hen], flock of three drakes and two hens, etc.) will be recorded, as well as opportunistic observations of other waterbird species (e.g., loons, grebes, cranes, etc).

5.2.2.3.10 ANALYSIS

The sample locations are the replicates, habitat patch type is the treatment and native versus human-affected is the primary covariate in the analysis (i.e., do the same mapped habitat types exhibit use differences if they are on the regulated system). There are no subsamples since aerial surveys will observe the entire sample location.

Collected data will be used to estimate the relative abundance (determined by calculating the number of birds observed divided by the area surveyed) and distribution of Canada geese using Study Zone 4 during the migration and brood-rearing periods. In order to identify if Project construction is having an effect on Canada geese, data will be compared to pre-Project Canada goose data gathered within the same survey area.

Analysis methods will be determined by the actual structure of the field data. Possibilities for model validation methods include confusion matrices, Kappa statistics and receiver operating characteristic curves. Statistical model and inferential assumptions will be tested during the analysis.

For the Project-affected and available habitat mapping component of this study, the validated habitat quality model will be applied to the terrestrial habitat map periodically produced by the Terrestrial Habitat Clearing, Disturbance and Indirect Effects study (Section 2.1).

5.2.3 MORTALITY

5.2.3.1 INTRODUCTION

While Project features such as new roads and the reservoir may increase hunting pressure by creating access to previously inaccessible areas, reservoir flooding and the more limited water level range will eliminate some previously used hunting areas. The net effect on Canada goose and mallard mortality is expected to be low, but that prediction has moderate uncertainty. The Project may also create some accidental mortality from sources such as collisions with vehicles and the radio communication tower.

The goal of this study is to evaluate how Project-related changes to access and accidental mortality affect Canada goose and mallard abundances.

5.2.3.2 OBJECTIVES

The objectives of this monitoring study are to:

- Evaluate how the Project alters hunting mortality; and,
- Qualitatively estimate how Project-related accidental mortality affects abundance.

5.2.3.3 STUDY DESIGN

5.2.3.3.1 OVERVIEW

Project-related changes in hunting-related Canada goose and mallard mortality will be qualitatively evaluated from information provided by the Habitat Effects aerial surveys, the Resource Use Monitoring Plan for voluntarily reported construction harvest and ATK monitoring. Hunting blind locations will be recorded during aerial surveys, and their number and locations will be monitored during construction and operation. ATK monitoring may provide information on the amount of accessibility provided by the Project, as well as changes to preferred hunting locations as a result of habitat changes. A study design is not required for the Resource Use Monitoring Plan studies and ATK monitoring components of the mortality study.

Accidental mortality is included in this monitoring study even though it is not a substantial concern because it can be monitored with minimal effort using information collected by other studies. Qualitative estimates for how Project-related accidental mortality affects Canada goose and mallard abundance will use information gathered by other studies and site reports (e.g., Bird Collisions with Lighted Towers study, see Section 5.9). A study design is not required for this component of the mortality study.

5.2.3.3.2 EXISTING DATA

A small number of incidental observations of hunting blinds have been recorded to date. Waterfowl blinds are usually located in small lakes and wetland edges.

5.2.3.3.3 DESIGN

Hunting blinds observed during aerial surveys and other monitoring studies will be incidentally recorded. The aerial surveys conducted for the Habitat Effects study (Section 5.2.2) will likely provide the majority of the data used by this study. Information already produced by other studies in the Keeyask area will be searched for information regarding the number and locations of hunting blinds. The recording of hunting blinds as incidental observations will be an element of all TEMP studies that include aerial surveys. Some blinds may be detectable from high resolution imagery being collected by the monitoring for other purposes.

5.2.3.3.4 PARAMETERS

The monitoring parameters are:

- Number and locations of hunting blinds; and,
- Reported harvest levels.

5.2.3.3.5 BENCHMARKS

Benchmarks are not applicable to this study as it is qualitatively evaluating mortality. The integrated analyses completed for the synthesis report will consider the implications of observed mortality in its evaluation of Project effects on Canada goose and mallard distribution and abundance.

5.2.3.3.6 STUDY AREA

Data incidentally collected anywhere within Study Zone 5 will be used to monitor Project effects and to control for regional changes in hunting effort.

5.2.3.3.7 SAMPLE LOCATIONS

There are no sample locations since other terrestrial monitoring studies are providing the required data.

5.2.3.3.8 SAMPLING FREQUENCY AND SCHEDULE

This element is not applicable as the study relies on incidental data.

5.2.3.3.9 FIELD AND LAB METHODS

This element is not applicable as the study relies on incidental data.

5.2.3.3.10 ANALYSIS

This element is not applicable as the study relies on incidental data. Basic descriptive statistics will be used to qualify some elements such as the number of hunting blinds collected during other studies.

5.2.4 HABITAT ENHANCEMENT

5.2.4.1 INTRODUCTION

The Terrestrial Mitigation Implementation Plan includes the installation of a small number of mallard nesting tunnels to be placed in the wetland enhancement area. Although upland nesting cover for mallards is generally not considered to be limiting in boreal Manitoba, the use of mallard nesting tunnels in the newly developed wetland enhancement area will provide some temporary nesting habitat until vegetation becomes established in this area.

The goal of the habitat enhancement monitoring is to assess whether local mallard nesting habitat is improved with the use these nesting tunnels.

5.2.4.2 OBJECTIVES

The objective of the habitat enhancement monitoring study is to:

- Evaluate whether nesting tunnels are used successfully by mallard.

5.2.4.3 STUDY DESIGN

5.2.4.3.1 OVERVIEW

There is one component to this study. The Habitat Enhancement study will monitor the use of five nesting tunnels identified in the Terrestrial Mitigation Implementation Plan. Data collection will focus on mallard response to the potential nesting habitat developed in the wetland enhancement area.

The use of mallard tunnels to enhance nesting habitat is a novel management prescription for the northern boreal forest. Mallard nest tunnels are typically used in the Prairies, in areas where upland nesting cover has been substantially reduced as a result of agricultural practices. Their application in boreal environments is limited to the boreal transition zone, where mallard occupancy rates are found to be very low. Based on this information, only a small number of ‘test’ nest tunnels will initially be deployed and monitored within the marsh wetland enhancement area.

5.2.4.3.2 EXISTING DATA

Mallard occurrence and habitat data are described in Section 5.2.2.3.2.

5.2.4.3.3 DESIGN

There is one component to this study. Since this technique is not established for northern boreal forest environments, this is a proof of concept intervention study. This study will determine if mallards use constructed nesting tunnels in a constructed wetland.

Each nesting tunnel that is installed in the wetland will be sampled for mallard use. The fieldwork will occur after the wetland enhancement area is completed.

As it may take one or two years for mallards to find and use the tunnels, data for the Habitat Enhancement study will be gathered over three years, with each tunnel being sampled each year. Thereafter, each tunnel will be sampled once every three years. Each tunnel will be visited four times during the nesting period in May to July to increase detection probability. Late season visits will be conducted to evaluate nesting success.

5.2.4.3.4 PARAMETERS

The monitoring parameters are:

- Occupancy of nesting tunnels,
- Nest success; and,
- The number and location of nesting tunnels.

5.2.4.3.5 BENCHMARKS

If monitoring results reveal occupancy results >50% in the wetland enhancement area, additional tunnels may be added in other wetland areas near the Project.

5.2.4.3.6 STUDY AREA

Data collection will occur in the wetland enhancement area in Study Zone 2 (Map3).

5.2.4.3.7 SAMPLE LOCATIONS

The sample location consists of a nesting tunnel.

All nesting tunnels will be sampled in each year of study.

5.2.4.3.8 SAMPLING FREQUENCY AND SCHEDULE

The specific years when sampling occurs will be determined based on the actual year when the nesting tunnels are introduced into the wetland enhancement area.

Each sample location will be sampled over three years, and thereafter, each location will be sampled once every three years for 15 years.

Each sample location will be visited four times during the nesting season. Although specific dates can change slightly from year to year, the approximate dates will be from May 15 to July 15. Nesting tunnels will be checked about every 10 days until they appear to be unoccupied.

5.2.4.3.9 FIELD AND LAB METHODS

Nests in nesting tunnels will be monitored by checking them for an attending hen. If a hen is observed in the nesting tunnel it will be assumed that an active nest is present and precautions will be taken to avoid disturbing the hen if she is present (e.g., observations made at a distance with binoculars). The nest will be checked as prescribed until the nesting tunnel appears to be unoccupied. When the tunnel is no longer occupied it will be checked for signs of predation (e.g., broken eggshells) or a successful hatch (e.g., egg membranes in the bottom of the nest).

Other waterfowl species observed incidentally at the sampling locations or using the nesting tunnels will also be recorded.

5.2.4.3.10 ANALYSIS

Basic descriptive statistics will generally be the level of data analysis. Presence/absence analysis, frequency of nesting tunnel use and frequency of nesting success will be used to describe the success of the treatment. An index of nesting success over time will be developed to demonstrate the utility of nesting tunnels. Maps of the tunnel locations and mallard presence will be used to examine distribution.

5.2.5 REPORTING

5.2.5.1 ANNUAL REPORTS

A report will be produced during the winter after each year when field studies occur, and will be submitted to MCWS the following spring, as per Environment Act License 3107, Clause 20.

Reports will summarize the activities and general findings of the monitoring during the preceding year. Basic descriptive statistics will be the level of data analysis for these reports. Any major unanticipated events or recommendations for changes to study design or mitigation will be noted.

5.2.5.2 SYNTHESIS AND RECOMMENDATIONS

A synthesis report will be produced after construction completion and at year 15 of operation. Synthesis reports will consolidate, analyze and evaluate all monitoring information gathered to date, including that produced by other monitoring studies. These reports will also include recommendations for any needed modifications to subsequent study design or to mitigation. The operation synthesis report will make recommendations regarding the need for any further monitoring.

5.3 COLONIAL WATERBIRDS

5.3.1 INTRODUCTION

5.3.1.1 BACKGROUND

Colonial waterbirds are a group of birds loosely defined as species that breed in large aggregations and feed or nest in aquatic habitats, but there are many exceptions. Several taxonomic groups are lumped into this definition, including albatrosses, petrels and shearwaters, flamingos, bitterns, egrets, herons, ibises and storks, pelicans and cormorants, and gulls and terns. These medium and large-sized migrant birds inhabit a large variety of marine, lake and river environments, wetlands and forests in North America.

Seven species of colonial waterbird occur in the Keeyask Region, including ring-billed gull, herring gull, Bonaparte's gull, common tern, black tern, Caspian tern, American white pelican and double-crested cormorant. Ring-billed gull and common tern are the two priority species featured in the Keeyask EIS.

Gulls and terns use reefs and islands for nesting, and are often seen foraging for food in rivers, lakes and wetlands. Ring-billed gull is abundant and widespread. Common tern is observed uncommonly in the Keeyask Region.

Gulls and terns are afforded protection under the Migratory Birds Convention Act. These species are important to local people. Ring-billed gull and common tern use rare environmental features (e.g., rocky reefs and islands), which may limit the range of breeding populations in the Keeyask Region.

Colonial waterbird monitoring is important because there is a potential for substantial Project effects and a moderate degree of uncertainty remains concerning the effects predictions. Also, the efficacy of the mitigation measures is uncertain. Species such as gulls and terns can be indicators for change in an ecosystem, as they are often clustered together or use specialized habitats in their range.

5.3.1.2 ASSESSMENT SUMMARY

Predicted Project effects on colonial waterbirds include effects mainly associated with sensory disturbance during construction. Operational effects include removal and/or degradation of breeding and foraging habitat.

Development of cofferdams and inundation of islands, reefs and gravel shorelines during the construction of the Keeyask Generating Station would reduce the availability of nesting habitat for both gulls and terns. Gulls and terns foraging within the Gull Rapids area during Keeyask Generation Station construction will be sensitive to equipment noise and blasting disturbances. These disturbances are expected to affect gull and tern foraging efficiency by interrupting forage activities and/or forcing birds to avoid portions of the Gull Rapids area where noise and blasting is most frequent and disruptive. Sensory disturbances may also reduce the reproductive success of gulls and terns that remain nesting on exposed reefs if birds flush from nests and leave eggs or hatchlings vulnerable to weather. 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. For example, shoreline and island nesting abundance in areas along the Nelson River is strongly influenced by changes in water levels. During high water years (e.g., 2011), the abundance of birds were low and were unlikely to be nesting due to flooded habitats.

During operation, gull and tern breeding and foraging habitat located at Gull Rapids, Gull Lake and parts of the Nelson River upstream to Birthday Rapids will be flooded. Areas of the river that support fast flowing water and gull and tern foraging activities (between Gull Lake and Birthday Rapids) would be lost during the filling of the reservoir.

The flooding of shorelines and adjacent habitat would adversely affect gulls that forage and/or loaf along shoreline habitat (e.g., ring-billed gulls). It is anticipated that the new shoreline associated with the future Keeyask reservoir would consist of various substrates including disintegrating peatland. Since peat shorelines are less optimal for gulls than mineral shorelines, it is anticipated that gulls would experience a loss of suitable shoreline habitat within the reservoir area.

Since terns require clear water within which to forage, increased water turbidity resulting from shoreline erosion and peatland disintegration may reduce foraging efficiency over the short-term. Over time, water clarity would eventually improve with the settling of suspended sediments. For terns, the effect of increased turbidity in the reservoir is likely to be offset by the foraging opportunity created in the tailrace area below the Keeyask Generating Station.

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. Following the implementation of the mitigation measures, residual Project effects are expected to occur within the natural variability of gull and tern population in the Keeyask Region.

While land clearing activities on islands in the Nelson River may temporarily create gull and tern nesting habitat, sensory disturbances would likely disrupt or limit nesting, loafing or foraging activities at these sites.

The development of roads and the installation of a communications tower could create hazards for accidental collision mortality. Accidental mortality is not predicted to contribute substantially to potential population effects.

Mitigation measures should offset some of the losses in colonial waterbird habitat. In addition to the general mitigation measures described for all birds in Section 5.0, the following mitigation measures will be implemented to minimize or avoid potential effects on colonial waterbirds:

- A gull and tern control program will be implemented each year in which construction is scheduled to occur in close proximity to traditional gull/tern nesting habitat;
- In conjunction with the gull and tern control program, the Partnership will make sure there is other appropriate habitat available in the area for nesting and breeding. In subsequent years of construction, when in-stream construction activities start to span the width of the river, created gull nesting habitat and artificial gull/tern nesting platforms, designed to provide replacement habitat, will be installed at a nearby location in an area not affected by construction activity;
- If this monitoring program confirms that it is warranted and feasible, a constructed island will be developed in the new reservoir in relatively close proximity to the Generating Station. It would be constructed in an area of relatively shallow water (i.e., on a high point of land) prior to filling the

reservoir. Construction of the island would involve the placement of granular material suitable for nesting habitat, with the sides of the island being heavily rip-rapped to protect against ice damage;

- Islands upstream of Gull Rapids will be enhanced to make them more suitable for colonial bird nesting; and
- Traffic signage will be installed indicating reduced vehicle speed over the Keeyask Generating Station and at other potentially sensitive waterbody crossing sites.

Other drivers that will continue to influence colonial waterbird breeding and nesting habitat include:

- Changes to the water regime by hydroelectric development or beaver activity that may cause the disappearance of nesting islands and the creation of new islands;
- Land clearing that may increase the amount of suitable nesting habitat and provide alternate nesting habitat where existing colonies have been disturbed;
- Sensory disturbance from roads that may cause loss and/or alteration of foraging and breeding habitat by deterring colonial waterbirds from staging and nesting; and
- Forest fires that make habitat unsuitable following a burn.

5.3.1.3 COMPONENTS THAT WILL BE MONITORED

The availability of suitable breeding habitat is the driver expected to have the greatest influence on colonial waterbird distribution and abundance in the Keeyask Region. Breeding habitat components include the nesting, shelter, foraging and loafing habitats used during the breeding season. Of these components, nesting habitat is the most limiting in the Keeyask Region.

Other drivers and stressors potentially influencing distribution and abundance, but to a much lesser degree include:

- Predation by other birds (e.g., raptors) or mammals (e.g., red fox);
- Mortality as a result of collisions with vehicle traffic or Project structures;
- Mortality from extreme weather events;
- Project-related hydrological or other changes that alter insect community composition; and,
- Sensory disturbance from equipment, blasting and other human activities that may cause individuals to avoid nesting within and adjacent to infrastructure and activity zones, or to reduce foraging time in preferred habitats within these zones.

Except for sensory disturbance, Project influences on all of the non-habitat drivers are expected to be very low to nil.

On this basis, and because the EIS predicted that residual Project effects are expected to occur within the natural variability of gull and tern populations in the Keeyask Region, monitoring studies for colonial waterbirds will focus on verifying the Project effects predictions that have the greatest potential for altering the EIS conclusions if inaccurate. The associated concerns are:

- How much breeding habitat is lost or altered due to the Project activities; and,
- How do Project-related sensory disturbance and changes to habitat influence the distribution and abundance of colonial waterbirds.

The Habitat Effects study (Section 5.3.2) will quantify and situate Project-related changes to habitat availability and how these changes affect colonial waterbird distribution and abundance. This study will also monitor sensory disturbance.

The Habitat Enhancement study (Section 5.3.3) will verify the efficacy of the colonial waterbird habitat enhancement measures described in the Terrestrial Mitigation Implementation Plan (e.g., creating gull nesting habitat and installing artificial tern nesting platforms).

Accidental mortality from sources such as collisions with vehicles and the communication tower is also included in this monitoring program even though is not a substantial concern since it can be monitored with minimal effort using information collected by other studies. Qualitative estimates for how Project-related accidental mortality affects colonial waterbird abundance will use information gathered by other studies and site reports (e.g., Bird Collisions with Lighted Towers study; see Section 5.9). A study design is not required for this component of the colonial waterbird monitoring program.

All of the above colonial waterbird studies contribute information to the overall assessment of how the Project is affecting colonial waterbird distribution, abundance and habitat.

5.3.2 HABITAT EFFECTS

5.3.2.1 INTRODUCTION

The availability of suitable breeding habitat is expected to have the greatest influence on colonial waterbird distribution and abundance in the Keeyask Region (Section 5.5.2.1). Breeding habitat must provide suitable sites for nesting, food, loafing and shelter. Nesting habitat in proximity to preferred feeding areas is expected to be the most limiting factor in the Keeyask Region.

Habitat effects monitoring for colonial waterbirds will focus on ring-billed gull and common tern since these two species account for 95% of the individuals observed from this group that were identified to species in Study Zone 4. This percentage is probably higher because 89% of observed gulls were not identified to species, but were likely ring-billed gulls. Nearly all tern observations were likely common tern. Observations of other colonial waterbirds including herring gull, Bonaparte's gull, Caspian tern, and black tern will be recorded during monitoring and this study will be modified to specifically address them if unanticipated adverse effects are found.

5.3.2.1.1 RING-BILLED GULLS

Ring-billed gulls nest on barren islands separated from other land areas by fast moving water because these conditions provide predator protection for their eggs and young. Bare ground, stumps, and boulders are used for nesting, perching or loafing. Ring-billed gulls are known to nest on a variety of substrates and travel up to 31 km from breeding colonies to foraging sites. They feed primarily on fish, invertebrates (e.g., aquatic insects, clams) and carrion along the Nelson River. They are opportunistic, stealing food from other animals and scavenging along shorelines.

According to the literature, ring-billed gulls are generally found where islands with sparse vegetation cover exist in waterways.

In the Keeyask Region, gulls were the most abundant waterbird observed using rapids, shorelines, and nesting islands within the Nelson River. Gull Lake, Gull Rapids, and parts of the Nelson River to Clark Lake provide both foraging and nesting opportunities for gulls. Gull colonies were located on the exposed ice-scoured rocky reefs at Gull Rapids, which have supported between 800-1,500 pairs of ring-billed gulls and herring gulls. Upstream areas including the rocky island near Birthday Rapids, has supported over 1,500 nesting pairs of gulls. Studies in 2013 recorded approximately 3,000 nesting pairs with a further 500 nesting pairs at other locations along the survey route. Gulls were also present on an island in the north arm of Stephens Lake, on an island in Bissett Lake, and on an island at the confluence of the Churchill and Little Churchill rivers.

The loss of nesting islands/reefs for both gulls and terns at Gull Rapids may potentially be offset if the Keeyask Generating Station operation results in changes in the Nelson River water regime that expose rocky reefs downstream of the Keeyask Generating Station and the newly exposed reefs are surrounded by flowing water.

To quantify and situate ring-billed gull breeding habitat, the EIS classified the following conditions as breeding habitat:

- Exposed ice-scoured rocky reefs with a nearby food source (e.g., fish); and,
- Rocky islands surrounded by deep water.

This classification, or expert information model, indicated that breeding habitat for ring-billed gull is not widespread within Study Zone 4. Specific islands were mapped in the system, but the total areas of primary or secondary breeding habitat was not calculated.

Gulls foraging within the Gull Rapids area during construction will be sensitive to equipment noise and blasting disturbances. These disturbances are expected to affect their foraging efficiency by interrupting forage activities and/or forcing birds to avoid portions of Gull Rapids area where noise and blasting is most frequent and disruptive. Noise and activity along the north and south access roads is not anticipated to have any effect on the few gulls that nest or forage on waterbodies within 1 km of the roads.

5.3.2.1.2 COMMON TERN

Common terns nest on barren islands separated from other land areas by fast moving water for the same reasons as ring-billed gulls. Bare ground, rock, gravel, stumps, boulders and man-made objects (e.g., buoys, floating rafts) are used for perching or loafing. Common terns are known to nest on rocky island substrates and travel up to 20 km from breeding colonies to foraging sites. They feed primarily on small fish up to 150 mm long. Terns are small fish and invertebrate prey specialists, and prefer to forage within a radius of up to 6 km from their colony. Terns are more specific in their breeding requirements, which make them less adaptable when suitable colonial breeding sites are lost or taken over by expanding gull populations. If forced to nest along the periphery of gull colonies, tern nests become highly vulnerable to the effects of fluctuating water levels.

In the Keeyask Region, common terns were observed using reefs and islands within the Nelson River. Reefs and islands provide both foraging and nesting opportunities for gulls. Common tern colonies were located on the exposed ice-scoured rocky reefs at Gull Rapids, which have supported about 100 pairs of terns. Upstream areas including the rocky island near Birthday Rapids and Split Lake, has supported about 60 nesting pairs of terns reported in 2013.

To quantify and situate common tern breeding habitat, the EIS classified the following conditions as breeding habitat:

- Small islands and reefs between Gull Rapids and Birthday Rapids; and
- Islands within 9 km of primary forage areas (e.g., rapids or areas of fast-flowing water).

This classification, or expert information model, indicated that breeding habitat for common tern is not widespread within Study Zone 4. Specific islands were mapped in the system, but the total areas of primary or secondary breeding habitat was not calculated.

Terns are expected to have a similar sensitivity to Project-related noise and activity as gulls.

The primary goal of the habitat effects monitoring is to evaluate how the Project changes the distribution and abundance of ring-billed gull and common tern breeding habitat. The second goal of this study is to evaluate how the Project changes ring-billed gull and common tern habitat effectiveness due to sensory disturbance. Habitat effectiveness is measured using changes to the distribution and relative abundance of ring-billed gulls and common terns in the vicinity of Project noise.

5.3.2.2 OBJECTIVES

The objectives of this study are to:

- Verify the habitat association assumptions that were used to predict Project effects on ring-billed gull and common tern habitat;
- Quantify how much primary and secondary breeding habitat are lost or altered due to the Project;
- Evaluate how sensory disturbance from construction activities and the gull and tern control program influences the distribution and relative abundance of ring-billed gull and common tern; and,
- Evaluate how Project-related sensory disturbance alters habitat effectiveness in areas outside the gull and tern control area.

5.3.2.3 STUDY DESIGN

5.3.2.3.1 OVERVIEW

There are three components to this study. The first component validates and refines the expert information habitat quality models used in the EIS to predict effects on ring-billed gull and common tern breeding habitat availability. The second component applies the refined habitat quality models to the post-Project terrestrial habitat map (which includes surface water types) to quantify and situate breeding habitat for ring-billed gull and common tern. The third component evaluates how sensory disturbance and use of deterrents under the gull and tern control program causes individuals to avoid or less frequently use otherwise suitable breeding habitat (i.e., reduced habitat effectiveness). Results from all three study components are integrated to evaluate Project effects on the distribution and relative abundance of ring-billed gull and common tern.

The expert information model used in the EIS to identify suitable breeding habitat was developed from field data collected in the Keeyask Region, relevant scientific literature and professional judgement. This Habitat Effects study will validate and refine the expert information habitat quality model using data collected in an appropriate range of habitat types.

The refined habitat quality models will be applied to the post-Project terrestrial habitat map (which includes surface water types) to quantify and situate breeding habitat for ring-billed gull and common tern. The Project effects on terrestrial habitat and surface water types that are inputs into the habitat quality model will be determined from the Terrestrial Habitat Clearing, Disturbance and Indirect Effects monitoring (Section 2.1).

Project-related sensory disturbance effects on ring-billed gull and common tern will be monitored during construction and the initial years of operation. The sensory disturbance component of this study will use these data collected to validate and refine the habitat quality model to qualitatively evaluated the nature of sensory disturbance for gulls and terns. Adjustments will be made to the breeding habitat map to account for reduced habitat effectiveness due to sensory disturbance.

Aerial survey results obtained by this study will also provide an indication of changes to colonial waterbird distribution and abundance in the study area.

5.3.2.3.2 EXISTING DATA

Colonial waterbird occurrence and habitat data were collected from 2001 to 2014 for environmental assessment studies associated with the Keeyask Generation and Transmission Projects. Helicopter-based surveys were conducted in 2001 to 2003, 2006, 2011, and 2013. A total of 2,110 km of shoreline was surveyed in 2001, 889 km in 2002, 2,523 km in 2003, 201 km in 2006, 1,708 km^2 in 2011, and 439 km in 2013. Nelson River surveys were conducted in each of these years from Split Lake to the Limestone Generating Station. In July 2007, and aerial survey of 540 km of lakes and rivers focused specifically on identifying the presence of, and potential for, other gull or tern colonies over a larger area. Throughout all study years, Gull Rapids and the Kettle GS tailrace supported the highest densities of waterbirds, consisting mainly of gulls and terns foraging in the rapidly moving water, while remaining areas supported less than 1/10th the density of birds observed at Gull Rapids. The highest concentrations of gulls and terns were observed breeding on reefs and islands in Gull Rapids (upwards of 3,500 pairs of gulls and 100 pairs of terns).

5.3.2.3.3 DESIGN

HABITAT ASSOCIATIONS

The habitat quality model validation and refinement is a population and habitat patch level resource selection study. This study is not determining the specific environmental attributes that ring-billed gull or common tern use (e.g., do they nest on rocky islands or on gravel substrates, use water for predator protection or eat small fish) since this is already well established in the literature. Rather, this study is testing which of the mapped terrestrial habitat and surface water patch types best incorporate these attributes based on demonstrated higher proportional use.

All other things being equal, ring-billed gulls (or common terns) are expected to be found in a higher proportion of their preferred habitat types compared with less preferred types, and to be absent or highly infrequent in unsuitable areas. A stratified, random sample of available habitat types will be classified into used versus unused based on species detections during the fieldwork. Stratification for random sampling involves classifying islands and water features into the major subtypes (e.g., waterbody size class, on-system versus off-system) of predicted primary, secondary and unsuitable habitat patches (i.e., the sampling units) using the expert information model. Including the major subtypes provides replication for the major factors affecting habitat attributes. A random sample will be obtained from each of the resulting strata with the exception that all sampling units in the Keeyask hydraulic zone of influence will be sampled. Presence-absence and bird density by habitat type will be used to assign habitat quality rankings to each stratum.

Existing data will be supplemented with aerial surveys conducted to determine abundance, distribution, and habitat use by ring-billed gull or common tern in areas affected by the Project and in suitable reference areas. Project affected areas include all areas within 200 m of the planned Project footprint at the time of sampling. Reference areas for on-system habitat include other reaches of the Nelson River from the Kelsey dam downstream to the Limestone dam. Reference areas for native habitat include off-system waterways and waterbodies.

Aerial surveys will be conducted to capture interannual variability. Each survey location will be visited three times during the breeding period to increase detection probability and distinguish frequent use from transient or atypical use.

The expert information model will be validated and refined after construction phase data collection is complete. Since mineral or peat islands formed or protected by the Keeyask reservoir and water regulation may create novel breeding habitat types during operation, the habitat quality model will be validated and refined again around year 15 of operation.

The validated and refined habitat quality model will be applied to the terrestrial habitat map, which will be periodically updated to reflect direct and indirect Project effects. See Section 2.2.0 for the design of the Terrestrial Habitat Clearing, Disturbance and Indirect Effects study.

SENSORY DISTURBANCE

In principle, the sensory disturbance monitoring is a dose-response study. The “dose” is the degree of sensory disturbance and the “response” is either colonial waterbird avoidance or less frequent use of otherwise suitable habitat. Both the dose and response levels are expected to decrease with distance from Project feature.

It is not possible to implement a strong dose-response study design (e.g., impact-gradient by time) because available nesting habitat does not exist relatively continuously in relation to the Gull Rapids area, which is where the construction activities that may affect nesting and foraging is located. In 2011, as an example, the next nearest gull or tern colony from the Project Footprint was 15 km from Gull Rapids, which is well beyond the anticipated zone of sensory disturbance. Known nesting and foraging areas for sizable colonies are currently widely separated on the Nelson River based on the locations of barren islands and rapids. Including the Gull Rapids area, there are three tern breeding locations and five gull breeding locations from Clark Lake to the Long Spruce dam. Additionally, construction noise effects will be confounded by the implementation of deterrent measures under the gull and tern control program, used to discourage colonial waterbirds from nesting in active construction areas near Gull Rapids.

On this basis, the sensory disturbance component of this study will compare pre- and post-Project nesting and foraging locations, and the relative abundance of gulls and terns at each of these locations, using data collected for the habitat quality model validation. This approach will evaluate the extent to which colonial waterbirds displaced from the Gull Rapids traditional nesting sites are able to find alternative nesting and foraging areas.

5.3.2.3.4 PARAMETERS

The monitoring parameters are:

- Number of gulls and terns;
- Number of breeding pairs;
- Nesting success;
- Habitat attributes of sample locations;
- Amounts and distribution of nesting and foraging habitat that are directly and indirectly affected by the Project; and,
- Total amounts of nesting and foraging habitat in Study Zone 4.

5.3.2.3.5 BENCHMARKS

Benchmarks are not applicable for the first study objective since it is documenting habitat associations.

Regarding the latter three objectives, the general EIS approach for bird species was that a 20% loss of existing habitat area for the species was the benchmark that triggered management concern. Colonial waterbird habitat effects monitoring will use the same benchmarks as were used in the EIS. Reductions to habitat effectiveness due to sensory disturbance will be factored into the habitat loss calculations.

5.3.2.3.6 STUDY AREA

Data collection will occur within Study Zone 5 to simultaneously provide for a broader range of habitat types for the native habitat component of the habitat quality model validation and for the documentation of species abundance trends in the broader region. Periodic mapping of available habitat will be for Study Zone 4.

5.3.2.3.7 SAMPLE LOCATIONS

A sampling unit for the habitat quality model validation consists of an island, rapids, waterfalls or open-water area. To test for the possible unanticipated situation where some birds are foraging far away from the preceding features, the centerline of large lakes and wide rivers will identify a sampling unit. The same sampling units are used for the sensory disturbance analysis.

Sample locations will be selected as follows:

1. To identify the sampling units for the sampling frame, classify lakes in the eastern half of Study Zone 5 into major types (e.g., waterbody size class, on-system versus off-system). All sampling units (i.e., islands, fast moving water areas) within each waterbody are sampled. The sampling unit size is variable, depending on the size of the islands or rapid water areas. The islands and water areas are post-classified into primary, secondary and unsuitable habitat types by applying the expert information habitat quality model to the terrestrial habitat map (which includes surface water types); and,
2. From each of the strata identified in step 1, randomly select at least three waterbodies for sampling. Include all sampling units within the predicted hydraulic zone of influence.

The lakes selected for the Canada goose and mallard surveys will also be used for this study during the first year of sampling. Map 10 shows the waterbodies selected by this approach.

The same lakes are sampled each year that data collection occurs, with the exception that field surveys during the first sample year will identify lakes that do not have potential nesting and foraging areas. These lakes will be dropped from subsequent years.

A power analysis completed during the winter after the third year of construction sampling will determine whether a larger total sample size is needed in subsequent years for model validation.

5.3.2.3.8 SAMPLING FREQUENCY AND SCHEDULE

Helicopter-based surveys for the habitat associations and sensory disturbance studies will generally be conducted in the same years as the Canada goose and mallard surveys, which are planned for years 2, 4 and 6 of construction and in years 5, 7, 9, 11 and 13 of operation. If a gull and tern control program is in place during years 3 and 5 of construction, sensory disturbance surveys will also occur in these years. Operation phase sampling starts in year five because the reservoir is predicted to undergo substantial expansion and change during the first five years of operation. The synthesis analysis (Section 5.7.4.2) will evaluate the need to continue sampling after this time.

Each survey location will be visited a minimum of three times during the breeding period to increase detection probability and distinguish frequent use from transient or atypical use (in years when a gull and tern control program is in place, surveys will occur four times during the breeding period in the Gull Rapids area). The approximate dates for the gull and tern breeding period are May to early August. Each visit will be separated by at least 10 days.

5.3.2.3.9 FIELD AND LAB METHODS

Gull and tern nesting islands will be sampled primarily using a helicopter observer counts, and high resolution photography and/or videography. In addition to the pilot, two observers and one crew chief will participate in the survey to improve detectability. In addition to a photograph being taken at each location, double counting system (i.e., where each observer on a single side of the aircraft counts birds and species independently) will be used to estimate bird numbers. In some cases, occupancy by gulls or terns will be measured using a UAV equipped with a camera and/or video capabilities. Islands will be approached as near as possible according to Environment Canada guidelines for the protection of seabird colonies and helicopter safety regulations. Photographs and/or high quality video will be taken of each nesting island using a digital camera with georeferencing capabilities.

Attributes of the islands and fast moving water areas where gulls or terns are observed will be recorded with notes and georeferenced photos.

In the lab, gull and tern abundance will be estimated for each island and reef, with bird counts, nest counts, egg counts (if feasible), chick counts and species identification verified upon analysis of photographs.

5.3.2.3.10 ANALYSIS

For the habitat quality model validation, the sample locations are the replicates, habitat patch type is the treatment and native versus human-affected is the primary covariate in the analysis (i.e., do the same mapped habitat types exhibit use differences if they are on the regulated system). There are no subsamples since aerial surveys will observe the entire sampling unit.

Island types include bedrock, mineral, peat or constructed. Degree of vegetation cover is a covariate.

For the sensory disturbance analysis, the sensory disturbance areas and the unaffected areas are the two treatments, the sample locations are the replicates, distance from sensory disturbance footprint is the dose gradient and breeding habitat type is the primary covariate in the analysis.

Analysis methods will be determined by the actual structure of the field data. Possibilities for model validation include confusion matrices, Kappa statistics and receiver operating characteristic curves. Statistical model and inferential assumptions will be tested during the analysis.

For the Project-affected and available habitat mapping component of this study, the validated habitat quality model will be applied to the terrestrial habitat map periodically produced by the Terrestrial Habitat Clearing, Disturbance and Indirect Effects study (Section 2.1).

5.3.3 HABITAT ENHANCEMENT

5.3.3.1 INTRODUCTION

Three species of colonial waterbirds breed near the Project site on rocky islands and reefs in the Nelson River: ring-billed gull, herring gull and common tern. To ensure there is other appropriate nesting and breeding habitat available for these species, the Partnership is creating areas with suitable nesting habitat. Created gull nesting habitat and artificial tern nesting platforms, designed to provide replacement habitat, will be installed at a nearby location in an area not directly affected by construction activity.

Two artificial tern nesting platforms will be prepared to serve as common tern nesting islands during the construction period. Nesting platforms for terns will be deployed within Gull Lake in accessible areas that provide some protection from wave action and currents, such as back bays and inlets.

A new gull nesting area will be developed during the first year of construction along the south shore of William Smith Island. The area (approximately 1.5 ha in size) will be cleared of existing vegetation, covered with rocky substrate and supplemented with boulders and driftwood to appear similar in structure and appearance to natural nesting sites

A constructed island will be developed in the new reservoir in relatively close proximity to the generating station. It will be constructed in an area of relatively shallow water (i.e., on a high point of land) prior to filling the reservoir. Construction of the island would involve the placement of granular material suitable for nesting habitat. A portion of William Smith Island will be prepared and enhanced to serve as a permanent gull/tern nesting island in the newly developed reservoir. This island will be a minimum of 1 ha in size and comprised of rocky substrate and gravel to provide permanent, long-term nesting habitat for gulls and terns displaced from Gull Rapids and Birthday Rapids.

5.3.3.2 OBJECTIVES

The objectives of monitoring colonial waterbird habitat enhancements are to:

- Evaluate the effectiveness of measures taken to attract colonial waterbirds to the constructed habitat replacement area/structures;
- Evaluate the effectiveness of measures taken to attract colonial waterbird breeding pairs to the constructed habitat replacement area/structures;
- Evaluate the effectiveness of measures taken to ensure the success of colonial waterbird nests and colonies; and,
- Inform decisions on how best to modify mitigation measures, if needed.

5.3.3.3 STUDY DESIGN

5.3.3.3.1 OVERVIEW

Monitoring of constructed mitigation measures will occur in Gull Lake, Stephens Lake and/or inland lakes where measures are implemented and, depending upon location, will employ a combination of automated cameras installed at constructed mitigation areas (*e.g.,* created nesting habitat,, floating platforms) and/or ground, boat, Unmanned Aerial Vehicle (UAV) or helicopter based surveys. Information gathered on gull and tern abundance, including the presence of eggs, chicks, and fledglings will be used to assess the effectiveness of constructed habitat replacement structures.

Observed gull populations at Gull Rapids have ranged from 800 to 3500 nesting pairs, and about 100 pairs of common terns. Since some of the birds displaced from Gull Rapids may find nesting habitat in alternate areas, not all birds may require artificial nesting platforms or constructed nesting habitat on William Smith Island. For this reason, constructed habitat will be designed to support at least 50% of the maximum observed pre-Project gull and tern population (*i.e.*, 1,750 gull and 50 tern pairs). As platforms or constructed island habitat may not be accepted by many waterbirds as suitable nesting structures initially, it is expected that the success of constructed habitat would be less in the first year or two of their implementation. After three years of monitoring, if platforms and constructed island use is at capacity and aerial monitoring reveals that nesting has not occurred in alternate areas of the region, deployment of additional platforms or cleared island areas will be considered.

5.3.3.3.2 EXISTING DATA

Gull and tern data are described in Section 5.3.2.3.2.

5.3.3.3.3 DESIGN

Rocky reefs and islands are currently being used by both gulls and terns in the Keeyask Region. Artificial nesting platforms have proven to be successful for colonial waterbird species in a number of locales throughout North America. Since this technique is not established for northern boreal forest riverine environments, this is a proof of concept intervention study. This study will determine if common tern and ring-billed gull use constructed breeding platforms and cleared island areas for nesting habitat. The development of these habitats also serve as proxy habitats for other species that have bred occasionally in the area (e.g., herring gull), and may benefit colonial waterbirds that were observed previously in the region (i.e., American white pelican), but no nesting has been observed.

There are two components to this study. The first component evaluates the use and success of common tern breeding platforms and the created gull nesting habitat on William Smith Island in the Gull Rapids area. The second component applies this information to the development of future nesting islands constructed in the Keeyask reservoir. Results from all study components are integrated to evaluate Project effects on the distribution and relative abundance of ring-billed gull and common terns.

Each area that receives a treatment of nesting platforms or clearing as nesting habitat will be sampled for colonial waterbird use. The fieldwork will occur after the nesting habitats are completed in spring 2015.

As it may take one or more years for colonial waterbirds to find and use these constructed habitats, data for the Habitat Enhancement study will be gathered over the entire construction period, with each location being sampled each year. In keeping with Environment Canada's recommendations to minimize disturbance to breeding colonial waterbirds, each location will be visited twice during the nesting period in May to July to evaluate occupancy and nesting success. Daily and continuous monitoring of gulls and terns will occur unobtrusively using remote trail cameras over the entire nesting period. As the breeding and nesting period can vary depending on the weather, local population aerial survey dates will be informed with the use of remote cameras.

During the operations phase, the permanent enhanced nesting island will be monitored initially for three years after it is created. To establish long-term occupancy and nesting success rates, it will be monitored every three years thereafter up to year 15 of operation.

Project-related habitat effects on ring-billed gull and common tern will be monitored during construction and operation. Adjustments will be made to the breeding habitat map in Section 5.3.3.2 to account for the effectiveness of artificial nesting platform and island nesting habitats.

Ground, boat, UAV and/or helicopter aerial survey results obtained by this study will also provide an indication of changes to colonial waterbird distribution and abundance in the study area.

5.3.3.3.4 PARAMETERS

The monitoring parameters are:

- Occupancy of constructed mitigation measures as breeding sites for colonial waterbirds displaced from Gull Rapids;
- Nesting success; and,

- Number and location of constructed mitigation measures.

5.3.3.3.5 BENCHMARKS

Since this is a novel approach for northern boreal forest environments and the specific measures are still being determined, benchmarks will be developed after two years of implementation.

5.3.3.3.6 STUDY AREA

Surveys will occur in areas where alternate or enhanced habitat has been made available or created for colonial waterbirds (Study Zone 3).

5.3.3.3.7 SAMPLE LOCATIONS

Monitoring of constructed mitigation measures will occur where these measure are implemented in Gull Lake and Gull rapids.

5.3.3.3.8 SAMPLING FREQUENCY AND SCHEDULE

In keeping with Environment Canada's recommendations to minimize disturbance to breeding colonial waterbirds, monitoring of constructed mitigation measures will occur in about the third week of June (~June 20th) to capture the peak incubation period for ring-billed gull and common tern. A second overflight to confirm the continued occupancy of the created habitat area and platforms by the colonies will occur in July.

Additional monitoring will occur using non-invasive methods (*e.g.,* through a review of ongoing images collected and remotely downloaded from cameras located on floating nesting platforms on the created gull nesting area on William Smith Island). Since birds may require one or two breeding seasons before accepting the floating platforms as breeding habitat, monitoring the effectiveness of these measures will occur annually for the entire construction period following their implementation.

The development of an enhanced permanent gull nesting island during the construction phase operational phase will occur annually during operation for the first three years, and every third year thereafter until year 15 of operation.

5.3.3.3.9 FIELD AND LAB METHODS

Cameras will be deployed on constructed habitat throughout the breeding period in order to capture evidence of nesting, chick-rearing and fledging activities. In keeping with Environment Canada's recommendations, the effectiveness of mitigation measures employed for this Project will be measured based on their occupancy by gulls and terns through the use of a UAV equipped with a camera and/or video capabilities or, secondarily, by helicopter using photography and/or videography.

5.3.3.3.10 ANALYSIS

Basic descriptive statistics will generally be the level of data analysis. Presence/absence analysis, frequency of platform and created habitat island use and frequency of nesting success will be used to describe the success of the treatment. An index of nesting success over time will be developed to demonstrate the utility of these prescriptions. Maps of the habitats and occupancy will be used to examine distribution.

Information gathered during the aerial colonial waterbird surveys will be used to inform all decisions on if and how the artificial nesting platforms and the created habitat gull nesting area on William Smith island should be modified. For example if platform use is less than expected and aerial surveys indicate that gull and tern populations have relocated to alternate nesting areas, decisions will be made regarding the continuation of the program.

5.4 BALD EAGLE

5.4.1 INTRODUCTION

5.4.1.1 BACKGROUND

The bald eagle (*Haliaeetus leucocephalus*) is a large raptor that ranges throughout North America, and is one of nineteen raptor species that potentially occur in the Keeyask Region. Mature adults are easily identified by their white head and tail feathers contrasted against their blackish-brown coloured bodies. Their habitat mainly consists of forested areas along large waterbodies, which are used for nesting and foraging. Bald eagle nests are often located along waterbodies, consisting of a large platform of sticks that may be reused for multiple years. Nearby waterbodies provide bald eagles with fish, their main prey, but a wide-variety of other foods are also consumed, which are predated or scavenged.

Bald eagles are the most common and abundant raptor species to inhabit areas along the Nelson River. The highest densities observed within the Keeyask Region were in areas between Birthday Rapids and Clark Lake, and in areas downstream of the Kettle and Long Spruce generating stations. The area immediately downstream of a generating station can provide increased fish foraging opportunities due to the turbulent water present. This species is important to local people.

Bald eagle monitoring is important because there is a potential for substantial Project effects on the nesting local population. The efficacy of the mitigation measures is uncertain, but there is a high level of certainty concerning the use of foraging areas near the Keeyask dam once it is constructed. Species such as bald eagle can be indicators for change in an ecosystem, as they often use specialized habitats in their range.

5.4.1.2 ASSESSMENT SUMMARY

Predicted Project effects on bald eagle include effects mainly associated with habitat change and sensory disturbances during construction. Operational effects include habitat change for perching, nesting and foraging sites, with a redistribution of the local population as the Keeyask reservoir becomes operational.

The main drivers of change and stressors to the bald eagle in the Keeyask Region include the sizes of lake and rivers, prey abundance, land clearing, creation of linear features, increased vehicle traffic, increased sensory disturbance, forest fires, and climate change. These drivers and stressors have the potential to influence the fitness of individuals or to modify bald eagle habitat, which may affect fitness. Other drivers on the populations include predation, increased mercury from forage fish, disease and parasites, accidents, and extreme weather events.

Land clearing for the Project will result in the loss of trees used by bald eagles for perching and nesting. Most of the key perching and nesting trees for bald eagle occur immediately adjacent to the Nelson River shoreline and several nests will be removed.

Sensory disturbances during construction may disrupt bald eagle nesting and foraging activities.

The loss of some fast-flowing areas in the Nelson River are expected to cause a redistribution of bald eagles that use habitat in the reservoir. The creation of the tailrace is anticipated to offset this habitat loss and attract bald eagles to the area. Some effective habitat may be lost during construction near Gull Rapids due to sensory disturbance. Overall, The Project is predicted to increase bald eagle habitat by 380 ha (0.03% of habitat in Study Zone 5). Reservoir flooding and expansion will increase the amount of riparian habitat available to bald eagles for nesting and foraging. This will offset the perching and nesting habitat lost from clearing and flooding.

Peatland disintegration during operation and is expected to result in the loss of perching and nesting habitat along the river. This loss is expected to have small effects other perching and nesting habitat will be available along the newly created reservoir shoreline.

As a result of reservoir expansion and the flooding of terrestrial habitat, mercury levels within the reservoir are anticipated to rise. As fish are the main prey, there is potential for methylmercury to accumulate in bald eagles. Predictive models indicated that no measureable effects are expected on the bald eagle population as a result of increased mercury concentrations on bald eagle foods in the reservoir.

Mitigation measures may help offset some of the habitat losses resulting from the Project. In addition to the general mitigation measures for other migratory birds listed in Section 5.1.2, specific mitigation measures for the bald eagle will include:

- Maintaining 200 m buffers around active bald eagle nests to minimize disturbance;
- Removal of established nesting trees that are in danger of toppling into the reservoir, outside of bald eagle nesting season;
- Removal of road-killed animals, to reduce chances of attracting bald eagles to the roadside resulting in vehicle collisions; and,
- Construction of artificial nesting platforms to replace any bald eagle nests affected by Project development.

No residual effects of Project operation on bald eagle are expected.

5.4.1.3 COMPONENTS THAT WILL BE MONITORED

Since there is high confidence in the prediction that Project effects on bald eagle will be small in magnitude, and that the longer reservoir shoreline will likely increase habitat availability in Study Zone 4, bald eagle monitoring will be more focused and less intensive than many other monitoring programs. Monitoring will focus on quantifying and situating Project-related changes to available nesting habitat, and on the efficacy of mitigation intended to enhance bald eagle nesting habitat. Section 5.4.2 describes the Habitat Effects study while Section 5.4.3 describes the Habitat Enhancement study. Accidental mortality will be monitored using incidentally collected data, and information from environmental site staff. The analysis completed for the synthesis report (Section 5.4.3.6) will provide an integrated evaluation of Project effects on bald eagle distribution and abundance, and the availability of suitable habitat.

5.4.2 HABITAT EFFECTS

5.4.2.1 INTRODUCTION

The availability of nesting habitat is the driver expected to have the greatest impact on bald eagle abundance and distribution in the Keeyask Region. The loss of habitat within the reservoir and loss of effective habitat near the construction site may cause changes in bald eagle distribution and/or result in reduced abundances. Other factors that may affect abundance and distribution to a lesser degree include:

- Accidental mortality resulting from vehicle collisions, collision with towers, transmission lines, etc.;
- Disease and parasites;
- Predation of nests and young; and,
- Mortality resulting from extreme weather events.

The effects of collisions and predation are expected to be very low. Extreme weather events, and disease and parasites may have an intermediate effect on bald eagle populations.

Bald eagles use tall trees along large waterbodies for nesting, roosting, and perching. Trees are required to be a minimum of 25 cm in diameter and bald eagle habitat must contain at least six trees per hectare that are 40 cm in diameter or greater. These large trees will serve as platforms for nests, and provide perching sites with a wide field of view for foraging.

Approximately 11 active bald eagle nests occur on the Nelson River in Study Zone 4 between Split Lake and Gull Rapids. Six of the nests occurred between Birthday Rapids and Gull Rapids. Three of these nests are anticipated to be lost during Project clearing. To mitigate this, artificial nesting platforms are to be constructed to offer alternative nesting locations. These nesting platforms will be monitored to verify use and nesting success.

Habitat classification indicated approximately 34,354 ha of bald eagle breeding and perching habitat within Study Zone 5. Within this area, an average density of 0.8 bald eagles/km^2 was found along the Nelson River.

The goal of this monitoring study is to evaluate how the Project changes the amounts and locations of bald eagle nesting habitat.

5.4.2.2 OBJECTIVES

The objectives of this study are to:

- Identify bald eagle nest locations, and characterize the associated habitat conditions; and,
- Quantify how much breeding habitat is lost or altered due to the Project.

5.4.2.3 STUDY DESIGN

5.4.2.3.1 OVERVIEW

There are two components to this study. The first component confirms the habitat quality model used in the EIS to predict effects on bald eagle nesting habitat availability. The second component applies the refined model to the post-Project terrestrial habitat map (which includes surface water types) to quantify and situate nesting habitat. This mapping will be used in conjunction with bird observations from aerial nesting surveys to evaluate Project effects on bald eagle distribution and relative abundance in Study Zone 4. These habitats are mapped by applying a habitat quality model to the mapped terrestrial habitat types and surface water types.

5.4.2.3.2 EXISTING DATA

Bald eagle abundance and habitat data were collected from 2001 to 2014 for environmental assessment and monitoring studies associated with the Keeyask Generation and Transmission Projects. Boat-based surveys were conducted in spring, summer, and fall 2001 to 2003, and in 2011. A total of 833 km was surveyed in 2001, 294 km in 2002, 220 km in 2003, and 156 km² in 2011. Helicopter surveys were conducted in 2001 to 2003, 2001, 2011, and 2013. A total of 2,110 km of shoreline was surveyed in 2001, 889 km in 2002, 2,523 km in 2003, 201 km in 2006, 1,708 km² in 2011, and 439 km in 2013. No boat- or helicopter-based surveys were conducted for the Keeyask Infrastructure Project (KIP) monitoring. Bald eagles were regularly observed during field surveys, and were the most common raptor species.

5.4.2.3.3 DESIGN

Since bald eagle nesting requirements are well established, this study will focus on identifying bald eagle nest locations in the study area and then confirming habitat associations from those data.

Existing data will be supplemented with aerial surveys conducted to determine bald eagle abundance, distribution, and habitat use in areas affected by the Project and in suitable reference areas. Project affected areas include all areas within 200 m of the actual Project footprint at the time of sampling. Reference areas for on-system habitat include other reaches of the Nelson River from the Kelsey dam downstream to the Limestone dam. Reference areas for native habitat include the off-system waterways and waterbodies.

Aerial surveys will be conducted over multiple years to capture interannual variability. Surveys will occur three times per year during the breeding period to increase detection probability and distinguish frequent use from transient or atypical use. The early July survey will assess reproductive success (*i.e.*, number of chicks observed) at active eagle nests prior to fledging period (mid-July to August).

The expert information model will be confirmed after construction phase data collection is complete. Since the conditions created by Keeyask reservoir and water regulation may create novel breeding habitat types, the habitat quality model will be confirmed once again around year 15 of operation.

5.4.2.3.4 PARAMETERS

The monitoring parameters are:

- Number of birds;

- Number of breeding pairs;
- Number of active and inactive nests, and reproductive success;
- Habitat attributes of the nesting locations;
- Amount of nesting habitat that is directly and indirectly affected by the Project; and,
- Total amounts of nesting habitat in Study Zone 4.

5.4.2.3.5 BENCHMARKS

Benchmarks are not applicable for the first study objective since it is documenting habitat associations.

Regarding the second objective, the general EIS approach for bird species was that a 20% loss of existing habitat area for the species was the benchmark that triggered management concern. Bald eagle habitat effects monitoring will use this as the benchmark for habitat effects.

5.4.2.3.6 STUDY AREA

Data collection will occur within Study Zone 5. Periodic mapping of available habitat will be for Study Zone 4. The Nelson River will be surveyed from the upstream limits of Split Lake downstream to the Kettle generating station.

5.4.2.3.7 SAMPLE LOCATIONS

A sample location consists of a 500 m long shoreline segment and the areas that are within 100 m of both sides of the segment. Sampling will occur along the shore zone of the Nelson River within the study area, and along the shore zone of large off-system lakes and rivers. A stratified, random sample of off-system lakes and rivers will provide reference locations. The strata will be identified by grouping lakes and rivers into major subtypes based on size class, off-system versus on-system and geographic zone. The lakes and rivers selected for this study will be the subset of those used for the Canada goose and mallard surveys that meet the minimum size criterion. Map 11 shows the waterbodies selected by this approach. The same lakes and rivers are sampled each year that data collection occurs.

5.4.2.3.8 SAMPLE FREQUENCY AND SCHEDULE

Helicopter-based surveys will occur in years 2, 4 and 6 of construction and in years 1 to 5, 7, 9, 11 and 13 of operation. The synthesis analysis (Section 5.4.3.6) will evaluate the need to continue sampling after year 13.

Each survey location will be visited three times during the breeding period to increase detection probability and distinguish frequent use from transient or atypical use. The approximate dates for nesting range from early May to the end of August. The approximate dates of the surveys will be May 15, June 15 and July 15 of each sampling year.

5.4.2.3.9 FIELD AND LAB METHODS

A helicopter will be used to sample shorelines along predetermined pathways that may contain bald eagle nests. Nests will be sampled during daylight hours. In order to minimize disturbance to breeding eagles, flight heights will be adjusted to 80 m in areas where nests are observed.

Helicopter-based bird survey procedures that will be used during construction and operational monitoring are as follows:

- Flights will occur when wind speeds were less than 25 kph.
- Flights will be conducted at approximately 80 kph at an altitude of approximately 40 m agl.
- A three-person crew (in addition to the pilot) will conduct the surveys. In order to maximize detection of all birds along the helicopter flight path, two observers will be positioned on opposite sides of the helicopter (one in the front seat adjacent to the pilot and one in the rear seat, behind the pilot). The front observer will dictate all observations detected on the left side of the helicopter (including areas immediately below the helicopter) to a crew member seated in the left rear seat (primary recorder). The crew member seated in the rear right will observe and record all birds detected within sight along the right side of the helicopter.
- The helicopter will fly between 50 m and 100 m from waterbody shorelines such that when surveying the area, the front seat observer will have a clear view of the trees along the shoreline, while the second observer (located in the rear seat, behind the pilot) will be able to view the open water habitat, or where the sample streams are narrow, have a clear view of the opposite shoreline trees.

A time-stamped GPS track will be recorded for the duration of each flight that will provide positional data for all observations. The number of nests, adult bald eagles, eggs, chicks, fledglings and/or immature birds will be counted along the flight path. Georeferenced photographs of all active and inactive eagle nests will be taken during each visit. Attributes of the nesting trees and shoreline segment will be recorded with notes and photos.

Other birds of prey species observed incidentally at the sampling locations will also be recorded.

In the lab, photographs will be reviewed to confirm occupancy, and verify the number of eggs or chicks in the nest.

5.4.2.3.10 ANALYSIS

The sample locations are the replicates, native versus human-affected is the treatment and relevant environmental attributes are the primary covariates in the analysis. There are no subsamples since aerial surveys will observe either the entire shoreline segment.

Analysis methods will be determined by the actual structure of the field data. Possibilities for model confirmation include ANOVA, confusion matrices, Kappa statistics and receiver operating characteristic curves. Statistical model and inferential assumptions will be tested during the analysis. The expert information habitat quality model will be refined if needed, as indicated by the confirmatory analysis.

For the Project-affected and available habitat mapping component of this study, the habitat quality model will be applied to the terrestrial habitat map periodically produced by the Terrestrial Habitat Clearing, Disturbance and Indirect Effects study (Section 2.1).

5.4.3 HABITAT ENHANCEMENT

5.4.3.1 INTRODUCTION

The Terrestrial Mitigation Implementation Plan states that all raptor nests observed to be active in a given year through annual summer aerial surveys, and are affected by Project development, will be replaced with artificial nest platforms in appropriate sites along the Nelson River. Although nesting trees are generally not considered to be limiting in boreal Manitoba, large trees used by eagles tend to be rare in the Keeyask area. The use of bald eagle nesting platforms will provide some temporary nesting habitat. Since peatland disintegration and mineral erosion along shorelines is anticipated to continue following reservoir creation, shoreline trees used for nesting by raptors will likely continue to be lost over time (*i.e.,* toppling at sites immediately adjacent to the waterway). The use of artificial nesting platforms could be also be used in areas where this occurs.

The goal of the habitat enhancement monitoring is to evaluate whether local bald eagle nesting habitat is maintained with the use these nesting platforms.

5.4.3.2 OBJECTIVES

The objectives of the bald eagle nesting platform enhancement monitoring study is to:

- Identify the locations of active bald eagle nests that require relocation because they are in areas potentially affected by Project clearing activities;
- Assess the locations of bald eagle nests that may require relocation because they are in danger of toppling due to peatland disintegration; and,
- Evaluate whether installed artificial nesting platforms are used successfully by bald eagle in the Keeyask area.

5.4.3.3 STUDY DESIGN

5.4.3.3.1 OVERVIEW

There is one component to this study. The Habitat Enhancement study will monitor the use of bald eagle nest replacement platforms identified in the Terrestrial Mitigation Implementation Plan. Data collection will focus on bald eagle response to the potential nesting habitat developed along the Nelson River in response to removal during construction and toppling due to reservoir expansion during operation.

The use of artificial nesting platforms to enhance or maintain nesting habitat may be a novel management prescription for the northern boreal forest, but it is a common technique used in Manitoba and elsewhere in North America. Platforms are typically used in riverine and lake environments where large trees have been substantially reduced.

5.4.3.3.2 EXISTING DATA

Bald eagle occurrence and habitat data are described in Section 5.4.2.3.2. Based on recent surveys, it is anticipated that Project clearing will require the removal of up to five raptor nests (all bald eagle) located along the shores of the Nelson River.

5.4.3.3.3 DESIGN

Since this technique is not established for northern boreal forest environments, this is a proof of concept compliance monitoring study. This study will determine if bald eagles use constructed nesting platforms as replacement habitat along the Nelson River.

Each natural nest that is removed receives a treatment of a replacement platform, and these will be sampled for bald eagle use. All platforms installed to provide nesting habitat will be sampled. The fieldwork will occur after the platforms are constructed and during the nesting season. The exact number and location will be verified as nests are removed by Project development, or as nests may topple during future reservoir expansion. Operation monitoring will determine if additional nests need to be removed and relocated to more suitable areas.

Data for the Habitat Enhancement study will be gathered over all construction years, with each location being sampled each year. Thereafter, each location will be sampled once every two years during operations. Each location will be visited three times during the nesting period in May to July to increase detection probability, and to assess nesting success.

Data for the potential toppling of nest trees during future reservoir expansion will be collected during the bald eagle Habitat Effects study (Section 5.4.2).

5.4.3.3.4 PARAMETERS

The monitoring parameters are:

- The number and location of nesting platforms; and
- Site occupancy and nest success.

5.4.3.3.5 BENCHMARKS

Since there is a reasonable expectation that constructed nesting habitat will be used by bald eagles, the benchmarks are that at least 50% of the constructed nesting platforms are used for nesting and that at least 50% of the nesting pairs have young that fledge.

5.4.3.3.6 STUDY AREA

Data collection will occur wherever platforms are required in Study Zone 4.

5.4.3.3.7 SAMPLE LOCATIONS

The sample location consists of a shore zone area with a nesting platform.

All nesting platforms will be sampled in each year of study.

5.4.3.3.8 SAMPLING FREQUENCY AND SCHEDULE

The specific years when sampling occurs will be determined based on the actual year when the nesting platforms are installed during construction, and if they are required during operation.

Each sample location will be sampled over all construction years, and thereafter, each location will be sampled once every two years for 13 years.

Each sample location will be visited three times during the nesting season. Although specific dates can change slightly from year to year, the approximate dates will range from May 15 to July 15. Nesting platforms will be checked once early during nesting season to determine occupancy, once after chicks are expected to hatch, and finally, prior to when the eaglets are expected to fledge.

Nesting platforms may be checked periodically during other studies on an incidental basis.

5.4.3.3.9 FIELD AND LAB METHODS

The use of nesting platforms by bald eagles will be monitored by helicopter, using methods described for the bald eagle Habitat Effects study (Section 5.4.2) . Number of birds observed, including number of chicks per nest will be recorded. Georeferenced photographs of all nesting platforms will be taken during each over-flight.

Birds of prey observed incidentally at the sampling locations will also be recorded.

5.4.3.3.10 ANALYSIS

Basic descriptive statistics will generally be the level of data analysis. Presence/absence analysis, frequency of nesting platform use and frequency of nesting success will be used to describe the success of the treatment. An index of nesting success over time will be developed to demonstrate the utility of nesting platforms. Maps of the platform locations and bald eagle presence will be used to examine distribution.

5.4.3.4 REPORTING

5.4.3.5 ANNUAL REPORTS

A report will be produced during the winter after each year when field studies occur, and will be submitted to MCWS the following spring, as per Environment Act License 3107, Clause 20.

Reports will summarize the activities and general findings of the monitoring during the preceding year. Basic descriptive statistics will be the level of data analysis for these reports. Any major unanticipated events or recommendations for changes to study design or mitigation will be noted.

5.4.3.6 SYNTHESIS AND RECOMMENDATIONS

A synthesis report will be produced after construction completion and at year 15 of operation. Synthesis reports will consolidate, analyze and evaluate all monitoring information gathered to date, including that produced by other monitoring studies. These reports will also include recommendations for any needed modifications to subsequent study design or to mitigation. The operation synthesis report will make recommendations regarding the need for any further monitoring.

5.5 OLIVE-SIDED FLYCATCHER

5.5.1 INTRODUCTION

5.5.1.1 BACKGROUND

Olive-sided flycatcher is a medium sized neotropical migrant songbird which inhabits coniferous or mixedwood forests in North America. It is a stocky flycatcher with a stout bill. Olive sided-flycatchers are often seen perching high atop dead snags or tall live trees while foraging for food, typically within or near wetlands, forest edges and burned forest. This species has been infrequently observed in the Keeyask Region.

As a species at risk, olive-sided flycatcher is afforded protection under the federal *Species at Risk Act* (SARA; listed as threatened) and the *Manitoba Endangered Species and Ecosystems Act* (MESEA listed as threatened). The olive-sided flycatcher, which is important to local people, is currently experiencing widespread declines throughout its range.

Olive-sided flycatcher monitoring is important because there is a potential for substantial Project effects and a moderate degree of uncertainty remains concerning the effects predictions. Species at risk can be indicators for change in an ecosystem, as they are often either low in numbers and/or at the edge of their range.

5.5.1.2 ASSESSMENT SUMMARY

The main drivers of change and stressors for olive-sided flycatcher in the Keeyask Region include fire, beaver activity, land clearing, sensory disturbances and climate change. Changes to any of these factors have potential to affect the local and regional olive-sided flycatcher populations, primarily through habitat change, or indirectly by affecting the fitness of individuals. Other drivers and stressors that could influence habitat quality or individuals to a lesser degree include extreme weather events, accidents, predation, disease and parasites. The availability of suitable breeding habitat is expected to have the greatest influence on olive-sided flycatcher distribution and abundance in the Keeyask Region.

The potential pathways for Project effects on olive-sided flycatcher are the same as those described for all birds in Section 5.0. However, no access effects are anticipated as olive-sided flycatcher is a listed species at risk and is not harvested.

Predicted Project effects on olive-sided flycatcher include the loss or alteration of approximately 352 ha (3.7%) of available primary breeding habitat and 1,172 ha (14.6%) of available secondary breeding habitat in the Keeyask Region as land is cleared (e.g., reservoir, dykes, south access road and trails). Reservoir flooding and expansion from peatland disintegration and mineral bank erosion will also produce a long-term loss of olive-sided flycatcher breeding habitat. Over time, vegetation edge effects along permanent openings and changes to vegetation resulting from reservoir-related changes in groundwater will contribute to the loss and alteration of some additional olive-sided flycatcher habitat. The loss of flycatcher habitat is expected to have a small adverse effect on local olive-sided flycatcher populations. This amount of population change is not anticipated to have a measureable effect on the regional flycatcher populations as other suitable sparsely treed habitats (e.g., burns) occur within the Keeyask Region.

Edges suitable for foraging may be created where Project clearing in treed areas creates openings that are close to riparian habitat. While land clearing activities may create some foraging habitat for olive-sided flycatchers, sensory disturbance in those areas may render them unsuitable in the near term. Changes to forest structure, hydrology or wetlands may also impact insect prey populations, thereby reducing habitat quality. Project-related clearings such as cutlines, borrow areas and access roads create more edge habitat, some of which may be used by olive-sided flycatcher. Although less likely, operational sensory disturbances in and adjacent to clearings could decrease habitat suitability in the long-term.

The development of roads and the installation of a communications tower could create hazards for olive-sided flycatcher movements. Mortalities from vehicle collisions and communications tower strikes have the potential to affect the local population. Because olive-sided flycatchers are expected to forage above traffic-level height, mortality from this source should be negligible. Tower collisions are also unlikely events as olive-sided flycatcher migration pathways are not present in the region.

Mitigation measures should offset some of the Project-related losses in olive-sided flycatcher habitat. In addition to the general mitigation measures described for all birds in Section 5.1.2, the following mitigation measures will be implemented to minimize or avoid potential effects on olive-sided flycatcher:

- Some of the treed areas located within the future reservoir back bays may be retained to offset some of the losses of olive-sided flycatcher habitat; and,
- During Project construction, perching structures will be installed in borrow areas no longer required for construction, that retain water (sources of invertebrates for olive-sided flycatchers).

Other drivers that will continue to influence olive-sided flycatcher breeding habitat include fires and beaver activity. While the 2013 wildfire temporarily removed some primary and secondary habitat, it has also created additional primary olive-sided flycatcher habitat. This habitat type is likely to improve in the near term before becoming less suitable in the long-term. Future fires will continue to influence olive-sided flycatcher habitat. Beaver activity continuously shifts the locations of breeding habitat patches for olive-sided flycatcher.

5.5.1.3 COMPONENTS THAT WILL BE MONITORED

The availability of suitable breeding habitat (which includes nesting, shelter and foraging habitats used during the breeding season) is the driver expected to have the greatest influence on olive-sided flycatcher distribution and abundance in the Keeyask Region. Other drivers potentially influencing olive-sided flycatcher distribution and abundance, but to a much lesser degree include:

- Predation by other birds (e.g., gray jay, raptors) or mammals (e.g., red squirrel);
- Mortality as a result of collisions with vehicle traffic or Project structures;
- Mortality from extreme weather events;
- Malnutrition from arriving in the Keeyask Region after the spring insect hatch;
- Project-related hydrological or other changes that alter insect community composition; and,

- Sensory disturbance from equipment, blasting and other human activities that may cause individuals to avoid nesting within and adjacent to infrastructure and activity zones, or to reduce foraging time in preferred habitats within these zones.

Except for sensory disturbance, Project influences on all of the non-habitat drivers are expected to be very low to nil.

On this basis, and because the EIS predicted that residual Project effects will be small in magnitude and cumulative effects will be below the ecological benchmarks, monitoring studies for olive-sided flycatcher will focus on verifying the Project effects predictions that have the greatest potential for altering the EIS conclusions if inaccurate. The associated concerns include:

- Determining how sensory disturbances influence the distribution of olive-sided flycatchers;
- Quantifying how much breeding habitat is lost or altered due to the Project activities; and,
- Evaluating how Project-related changes to habitat influence the distribution and abundance of flycatchers.

The Sensory Disturbance study (Section 5.5.2) will evaluate how sensory disturbance alters habitat effectiveness and olive-sided flycatcher distribution. The Habitat Effects study (Section 5.5.3) will evaluate habitat effects in terms of habitat availability and how changes to habitat availability affect olive-sided flycatcher distribution and abundance.

The Habitat Enhancement study (Section 5.5.4) will verify the efficacy of the olive-sided flycatcher habitat enhancement measures described in the Terrestrial Mitigation Implementation Plan (i.e., installing perch structures in decommissioned borrow areas).

Accidental mortality from sources such as collisions with vehicles and the communication tower is also included in this monitoring program even though is not a substantial concern as it can be monitored with minimal effort using information collected by other studies. Qualitative estimates for how Project-related accidental mortality affects olive-sided flycatcher abundance will use information gathered by other studies and site reports (e.g., Bird Collisions with Lighted Towers study, see Section 5.9). A study design is not required for this component of olive-sided flycatcher monitoring.

Compliance monitoring relating to pre-clearing nest searches is described in the Avian Management Plan, implemented under the Project's Generating Station and South Access Road Construction Environmental Protection Plans (EnvPPs).

Relevant olive-sided flycatcher information obtained by all terrestrial and resource use monitoring will be periodically consolidated, analyzed and evaluated in a synthesis report to provide an integrated comparison of predicted and actual Project effects on olive-sided flycatcher.

5.5.2 SENSORY DISTURBANCE

5.5.2.1 INTRODUCTION

The goal of this study is to determine if olive-sided flycatcher distribution and relative abundance change in the vicinity of the Project due to sensory disturbance.

5.5.2.2 OBJECTIVES

The objectives of this study are to:

- Evaluate how sensory disturbance from the access roads and generating station area influences olive-sided flycatcher distribution and relative abundance; and,
- Evaluate how Project-related sensory disturbance alters habitat effectiveness.

5.5.2.3 STUDY DESIGN

5.5.2.3.1 OVERVIEW

Sensory disturbance effects on olive-sided flycatcher distribution and relative abundance will be monitored in proximity to Project features. Monitoring focuses on the features that create sensory disturbance throughout construction and/or operation. Other Project features and activities are too intermittent to be monitored effectively for a regionally rare species. The access roads represent the greatest anticipated source of sensory disturbance for olive-sided flycatcher, and one that continues over the long term.

During construction, the footprints included in the sensory disturbance monitoring are the north and south access roads as well as the construction and work areas associated with the generating station. During operation, monitoring will be limited to the north and south access roads since sensory disturbance from the generating station is expected to be too low to be discerned from natural variability.

5.5.2.3.2 EXISTING DATA

Olive-sided flycatcher occurrence and habitat data were collected from 2001 to 2014 for environmental assessment and monitoring studies associated with the Keeyask Infrastructure Project (KIP), Generation and Transmission Projects. During this time, over 1,400 point-count plots were surveyed, with some plots being surveyed in multiple years. Point-counts were conducted at 197 stops in 2001, 226 stops in 2002, 336 stops in 2003, 58 stops in 2004, 135 stops in 2005, 118 stops in 2006, and 126 stops in 2007. In 2012, point-count surveys were conducted at 37 stops, 19 of which were in olive-sided flycatcher habitat. In 2013, point-counts were conducted at 121 stops, 60 of which were in olive-sided flycatcher habitat. Point counts were conducted at 71 stops in 2011 and 2012 and at 80 stops in 2013 for the KIP monitoring. These data were collected as an element of bird community studies located a variety of habitat types (typically with several plots in a single stand) as well as for a focused olive-sided flycatcher study. Virtually all of the plots were in Study Zone 4, with the majority in Study Zone 3. For all studies, data were collected during the breeding season using point count surveys. Standard data collection protocols for point-count sampling were employed. Olive-sided flycatchers were detected at 3% of these plots, with some plots contributing a presence in more than one year.

Many of the plots with olive-sided flycatcher observations situated west of Stephens Lake were either burned in the 2005 and 2013 fires, cleared during KIP construction or will be cleared during Project construction.

5.5.2.3.3 DESIGN

The sensory disturbance monitoring is a dose-response study. The "dose" is the degree of sensory disturbance and the "response" is either olive-sided flycatcher avoidance or less frequent use of otherwise suitable habitat. Both the dose and response levels are expected to decrease with distance from Project feature.

An impact-gradient by time design will be employed to estimate the spatial extent and degree of sensory disturbance on the distribution of individuals near the access roads and generating station. Locations along PR 280 and Butnau Road will also be sampled to provide additional treatment replication and a wider range of sensory disturbance levels for estimating the dose-response relationship, and to test for longer-term habituation to sensory disturbance.

Stationary audio recorders will be situated in pair nesting territories. These units will record and locate bird calls at least 500 m from the access road, which extends more than 100 m beyond the anticipated zone of sensory disturbance. A recorder will remain in a set location for at least two weeks during the breeding season. Bird response to sensory disturbance will be estimated by mapping call density as a function of distance from the relevant Project footprint.

The audio recorders will also measure sensory disturbance levels (i.e., the "dose"). It is anticipated that the recorders can detect road-related noise levels to periodically quantify the magnitude and duration of audio disturbance from the road. Motion and sound activated audio recorders will be placed at strategic locations relative to sample locations and Project features. Audio recorders mounted on tripods will be placed at strategic locations relative to sample locations and Project features to quantify the degree and duration of selected audio disturbances. At the Project features test sites, audio recorders will be calibrated with standardized noise levels. Distance to the Project features and environmental parameters that affect noise (e.g., wind direction, vegetation cover) will be measured at each location. These characteristics will allow for the development of sound magnitude and duration curves. To characterize visual disturbance, strategically located trail cameras will generate traffic counts as a proxy for road activity levels (these cameras will also provide data for other wildlife studies). Audio disturbance and road activity level data also control for differences in overall sensory disturbance level at different impact locations.

Audio recording will continue for the duration of the breeding season because road-related noise and visual disturbance levels are not constant from day to day and because a bird's behavioural response may change over the breeding season. Birds may initially avoid areas near the roads but then return to some areas if habituation occurs. It is possible that some pair nesting territories will straddle the access road since olive-sided flycatchers will readily cross natural openings of this size.

Audio recording will continue throughout most of the construction phase and intermittently during the operation phase to physically control for year-to-year variability in sensory disturbance regime and olive-sided flycatcher behavioral responses, and to test for possible behavioral changes over longer periods of time.

To control for natural spatial and temporal variability, reference sample locations will be established in comparable unaffected breeding habitat based on similarity with the most influential drivers for olive-sided flycatcher distribution and abundance. A pilot study will determine the optimal method for selecting reference locations.

A pilot study will be conducted during the 2015 breeding season for two reasons. First, this is a relatively novel approach to evaluating sensory disturbance to a regionally rare bird species. Second, pre-Project data are not suitable for estimating optimal sample size and recorder placement.

During the pilot study, qualified birders will visit potential nesting pair sites selected through a paired impact-reference design to determine whether sufficient nesting pairs appear to be present to implement the desired impact-gradient by time design. In the event this is the case, then the number of audio recorders required to implement the paired impact-reference design will be requisitioned and placed in the field starting in the 2016 breeding season. A power analysis using the 2016 field data will determine the number and locations of audio recorders to be employed during the subsequent breeding season. Since the pilot study design will estimate variances needed for a multi-year design from a single year study, there may be substantive design changes for the subsequent monitoring which can use multiple years of data for statistical analysis and inference. A power analysis using results to date will be conducted each winter following a sample year to determine the optimal number of audio recorders and their locations for the subsequent breeding season.

In the event that the pilot study determines there are likely too few nesting pairs to implement the impact-gradient by time design, a weaker dose-response design will be developed based on pilot study results.

5.5.2.3.4 PARAMETERS

The monitoring parameters are:

- Olive-sided flycatcher call density as a function of distance to relevant footprint;
- Intensity, duration and frequency of Project-related noise levels (in decibels); and,
- Access road traffic counts.

5.5.2.3.5 BENCHMARKS

Benchmarks are not applicable for the first study objective since it is documenting habitat associations and the zone of sensory disturbance. Reductions to habitat effectiveness due to sensory disturbance will be factored into the habitat loss calculations, after which the habitat effects benchmarks (Section 5.5.3.3.5) will be applied.

5.5.2.3.6 STUDY AREA

Data collection will occur within Study Zone 4, predominantly within Study Zone 3. Study Zone 3 extends well beyond the anticipated zone of Project-related sensory disturbance. Study Zone 4 includes PR 280 and Butnau Road and some potential reference sample locations.

5.5.2.3.7 SAMPLE LOCATIONS

For the pilot study, the items constituting the target population for Project impacts (i.e., the sampling frame) are breeding pairs with nesting territories that extend into a 100 m buffer of the relevant Project footprint. The 100 m buffer provides for some current habitat avoidance due to existing sensory disturbance, as well as for subsequent habituation.

The Project impacts sampling frame is constructed as follows:

1. Select primary habitat patches extending at least 500 m from the north and south access roads and the generating station area.
    - This distance is 200 m greater than the anticipated zone of influence to confirm actual sensory disturbance zone width and to allow for nesting territory shifts in response to sensory disturbance.
2. Determine if an olive-sided flycatcher nesting pair is present.
3. Create a list of the locations with nesting pairs. These are the sampling units for the sampling frame.
4. Complete a stratified, random selection of 11 locations from the sampling frame:
    - Stratification is by impact type (i.e., north access road, south access road, generating station area);
    - Include at least three replicates for each impact type;
    - If insufficient locations are available for the generating station footprint then the total sample size will be maintained by selecting additional locations along the access roads.
5. If this approach produces less than 11 impact sample locations, then a qualified biologist will stop every 300 m along the access roads to detect additional olive-sided flycatcher territories.

Additional impact locations will also be situated along PR 280 and Butnau Road to test for long-term habituation to sensory disturbance, to provide a broader range of sensory disturbance levels for estimating the dose-response relationship and to increase total sample size. PR 280 and Butnau Road provide a strong contrast in levels of sensory disturbance due to the high difference in traffic volumes. Sample locations will be selected using the same selection methods as for the north and south access roads. Ideally, five sample locations will be established on PR 280 and on Butnau Road for the pilot study, bringing the total “treated” sample size to 21.

Each of the selected impact sample locations an unaffected primary habitat patch will be paired with a reference sample location based on similarity with the most influential drivers for olive-sided flycatcher distribution and abundance. A reference location will be: the primary breeding habitat patch that is closest to the selected impact location; encompasses a similar habitat mixture; and, is sufficiently separated to be an independent sample. Map 12 shows the habitat patches and roadside locations available for the pilot study surveys.

All sample locations will be sufficiently separated in space to be independent samples of pair home ranges during the nesting period.

Results from the pilot study will determine the study design for the subsequent breeding season. Each winter following a sample year, a power analysis using results to date will determine whether modifications to the study design are needed for subsequent monitoring.

5.5.2.3.8 SAMPLING FREQUENCY AND SCHEDULE

Provided there are enough breeding pairs to implement the desired sampling design, sampling during construction will occur annually for five years to physically control for year-to-year variability in sensory disturbance and behavioral responses, and for possible behavioral changes over longer periods of time. Some of the sample years may not be consecutive.

Sampling will likely occur annually in years two to five of operation, and then every third year until year 15. Results from the construction phase will determine the actual monitoring schedule for the first five years of operation.

After year five of operation, all results to date will be used to determine the actual monitoring schedule for subsequent years. After the final planned year of operation phase monitoring, an evaluation of results to date will determine if additional monitoring is recommended and, if so, during which years.

Audio recorders will be stationary for at least two weeks during the breeding season (June 1 to July 10). Recorders may be moved to other sample locations to optimize the number of recorders and/or to increase the sample size. Determining the minimum stationary period and the number of audio samples per day will be elements of the power analyses.

5.5.2.3.9 FIELD AND LAB METHODS

PILOT STUDY

To identify the pair nesting territories for inclusion in the impacts sampling frame (Step 2 in Section 5.5.2.3.7), a qualified biologist will go to pre-identified impact location stops. At each stop, the biologist will face the primary habitat patch and listen for olive-sided flycatchers for 10 minutes, recording the estimated direction and distance to each call during that time (the loud and distinctive olive-sided flycatcher call can be heard up to 300 m). If this approach produces an insufficient number of impact sample locations, then a qualified biologist will stop every 300 m along the access roads to detect additional olive-sided flycatcher territories.

At each impact location where an olive-sided flycatcher is detected, the biologist will move into the habitat patch and map the existing territory using a modified spot mapping method to confirm the territory shape in relation to the relevant footprint. A singing olive-sided flycatcher will be approached as soon as it is heard. Using binoculars to spot the individual, bird behaviours (e.g., singing, calling, feeding) will be recorded. After the bird moves towards another location within its territory, the perch tree will be marked using GPS, and the bird will then be followed. The same technique will be used to find other perch trees. A minimum of six locations per day will be mapped. Each olive-sided flycatcher territory will be visited on at least two different days within a five-day period to determine the approximate boundary of the nesting territory. If olive-sided flycatcher densities are sufficient, counter-singing and pursuits will also be mapped to separate individuals from adjacent territories.

For reference sample locations, a qualified biologist will go to the center of the pre-identified candidate breeding habitat patch between 4:30 a.m. and 10:30 a.m. to determine if olive-sided flycatcher are using the area. Sample times will be adjusted slightly (i.e., earlier or later) depending on time of local sunrise. At each candidate reference location, the biologist will listen for olive-sided flycatchers for 10 minutes, recording the estimated direction and distance to each call during that time. If an olive-sided flycatcher is detected, the biologist will employ the modified spot mapping method described in the previous paragraph. The objective is to map the pair territory shape relative to the edge of unsuitable habitat. If the first candidate reference location does not have a breeding pair, then the biologist will move to the next nearest candidate with a habitat mixture similar to the impact location.

The nesting territory searches will occur between 4:30 a.m. and 10:30 a.m., but will be adjusted according to local sunrise.

SUBSEQUENT STUDIES

In the event that the pilot study determines there are likely sufficient nesting pairs to implement the impact-gradient by time design, the nesting pair territories mapped in 2015 will be revisited to confirm that these sites have nesting pairs in 2016. Unoccupied territories will be replaced using the methods described in Section 5.5.2.3.7.

Three microphone array audio recorders will be placed centrally in the selected nesting territories at distances of 100 m, 300 m and 500 m from the relevant Project footprint. These positions will provide complete audio coverage for a 200 m wide band extending 600 m from the relevant footprint, which captures approximately 12 ha (a typical olive-sided flycatcher pair territory is about 20 ha). Point counts outside of the audio recording area will be conducted during the audio recording period. These point counts will confirm that the pair is still using the habitat patch and determine if their territory has shifted such that one or more audio recorders should be repositioned.

For each reference location, three microphone array audio recorders will be placed at distances of 100 m, 300 m and 500 m from a non-habitat patch edge such that they are centrally located through the long side of the habitat patch.

In the lab, the recorded data will be screened for olive-side flycatcher songs and calls using sound analysis software (e.g., Adobe Audition 2.0). An hourly and daily sample of the olive-sided flycatcher recordings will be selected for further processing and analysis. The amplitude (i.e., decibels) statistics of each song is extracted from the microphone array recordings. Summary statistics and triangulation will be used to estimate the direction and distance to the bird given that the bird call was recorded from the fixed and known location of the audio recording unit. Multiple spatial positions of each flycatcher within its territory will be mapped using GIS software.

Frog calls and other regionally rare bird species calls and songs detected in the audio recordings will also be included in the data extraction to provide data for other studies (e.g., frogs, yellow rail, common nighthawk, rusty blackbird).

5.5.2.3.10 ANALYSIS

The sensory disturbance areas and the unaffected areas are the two treatments, the sample locations are the replicates, frequency, intensity and duration of sensory disturbance is the dose gradient and breeding habitat type is the primary covariate in the analysis. Intensity of auditory disturbance as a function of distance will be interpolated from sound recordings, fitting the appropriate non-linear model to the data.

The analysis methods and inferential approach will be determined by the final sampling design, the shape of the temporal dose-response curves and the structure of the datasets used for analysis. Possible methods include dose–response regressions and structural equations modeling. The possibilities increase as additional years of data become available. Covariates for olive-sided flycatcher distribution and abundance will be included in the analysis to account for confounding factors and natural variation as far as possible. Statistical model and inferential assumptions will be tested during the analyses.

5.5.3 HABITAT EFFECTS

5.5.3.1 INTRODUCTION

The availability of suitable breeding habitat is expected to have the greatest influence on olive-sided flycatcher distribution and abundance in the Keeyask Region (Section 5.5.2.1). Breeding habitat must provide suitable sites for nesting, food and shelter.

Olive-sided flycatcher use living conifers for nesting and shelter. Dead standing trees are used as perches that permit 360 degree viewing of aerial insects (e.g., bees, wasps, ants), a preferred food source for flycatchers.

According to the literature, olive-sided flycatchers are generally found where older coniferous or spruce dominated mixedwood forest occurs adjacent to open areas that support dead standing trees such as regenerating burns (5 to 15 years old), wetlands, ponds, beaver floods, lakes, marshes, muskegs, fens and swamps. Although they prefer older forests, they will also use younger forests that are adjacent to open areas. Stands with semi-open canopy are preferred. Right-of-way clearings and cutlines can also provide foraging habitat.

The majority of olive-sided flycatchers observed during field studies in the Keeyask Region occurred in areas supporting mature black spruce or tamarack forest adjacent to beaver floods, creeks, lakes and recent burns.

To quantify and situate olive-sided flycatcher habitat, the EIS identified the following terrestrial habitat and surface water types as breeding habitat:

- old and mature spruce dominated coniferous or mixedwood forests with open or semi-open canopies;
- areas within 50 m of the edge of an open area such as regenerating burn (5 to 15 years old), beaver pond with snags, water body, bogs, muskeg, open area with snags and lakes with dead standing trees;
- areas within 50 m of poor or rich wooded fen and wooded swamp; and,
- areas with tall trees (including dead standing trees) where they can perch to forage.

This classification, or expert information model, indicated that primary and secondary breeding habitat for olive-sided flycatcher is widespread within Study Zone 4. Of the 7,867 ha of primary breeding habitat within Study Zone 4, 1,084 ha is within Study Zone 3 and 352 ha is within the 150 m buffer of the Project Footprint. The expert information model also identified 5,226 ha of secondary breeding habitat within Study

Zone 4. Of this total, 1,276 ha is within Study Zone 3 and 354 ha is in the 150 m buffer of the Project Footprint. Study Zone 2 includes the Project Footprint and a 150 m buffer of it.

Since the EIS was completed, wildfires during 2013 burned a large portion of the study area, creating considerable additional primary habitat for olive-sided flycatcher.

The goal of the habitat effects monitoring is to evaluate how Project-related changes to the locations and amounts of breeding habitat could potentially change olive-sided flycatcher distribution and abundance within Study Zone 4.

5.5.3.2 OBJECTIVES

The objectives of the olive-sided flycatcher habitat effects monitoring study are to:

- Verify the habitat association assumptions that were used to predict Project effects on olive-sided flycatcher habitat;
- Quantify how much primary and secondary breeding habitat are lost or altered due to the Project; and,
- Evaluate how Project-related changes to habitat influence the potential distribution and relative abundance of olive-sided flycatcher within Study Zone 4.

5.5.3.3 STUDY DESIGN

5.5.3.3.1 OVERVIEW

There are three components to this study. The first component is validating and refining the existing habitat quality model. The second component applies the refined model to the post-Project terrestrial habitat map (which includes surface water types) to quantify and situate primary and secondary olive-sided flycatcher breeding habitat. The final component translates habitat changes into potential changes to olive-sided flycatcher distribution and relative abundance.

Regarding the first component, the EIS used an expert information model to classify terrestrial habitat and surface water types into primary, secondary and unsuitable habitat for olive-sided flycatcher. This expert information model was developed from field data collected in the Keeyask Region, relevant scientific literature and professional judgement. This model will be replaced with a statistically derived multivariate habitat quality model in 2016. This study will validate the statistically derived habitat quality model using data collected in an appropriate range of habitat types.

Following this, the validated, and possibly refined, statistically derived habitat quality model will be applied to the post-Project terrestrial habitat map to quantify and situate primary and secondary breeding habitat. Permanent and temporary breeding habitat loss due to Project infrastructure and indirect Project effects on terrestrial habitat and surface water types that are inputs into the habitat quality model will be determined from Terrestrial Habitat Clearing, Disturbance and Indirect Effects study (Section 2.1). This general approach will also determine alterations to the quantities and qualities of various breeding habitat types.

For olive-sided flycatcher distribution and abundance effects, the potential distribution of olive-sided flycatcher in Study Zone 4 will be temporarily or permanently reduced where Project clearing occurs. The reduction to the areas available for olive-sided flycatcher may be less than the entire clearing footprint, as this species can make use of newly created edges. The Terrestrial Habitat Clearing and Disturbance study mapping (see Section 2.0 for the design) will identify reductions to potential distribution created by habitat removal due to Project clearing. Changes to the locations, quantity and quality of available habitat will be used to determine changes to the potential distribution and relative abundance of olive-sided flycatcher.

5.5.3.3.2 EXISTING DATA

As noted in Section 5.5.2.3.2, olive-sided flycatcher occurrence and habitat data were collected at over 1,400 bird listening points in Study Zone 4 during the 2001 to 2014 breeding seasons. Sampling was conducted in a variety of habitat types using several sampling designs. Common habitat types had the most plots, while less common habitat types had fewer plots. Some rarer habitat types (e.g., those with jack pine, tamarack, trembling aspen and white birch) had proportionally more sampling to identify rare, uncommon or unique bird species and/or species assemblages.

5.5.3.3.3 DESIGN

This is a population and habitat patch level resource selection study. This study is not determining the specific environmental attributes that olive-sided flycatchers use (e.g., do they nest in conifers, use snags or eat flying insects) since this is already well established in the literature. Rather, the study is testing which of the mapped habitat patch types (i.e., mixtures of terrestrial habitat and surface water) best incorporate these attributes based on demonstrated higher proportional use.

All other things being equal, olive-sided flycatchers are expected to be found in a higher proportion of their preferred habitat types compared with less preferred types, and to be absent or highly infrequent in unsuitable areas. A stratified, random sample of available habitat types will be classified into used versus unused based on species detections during the fieldwork. Stratification for random sampling involves classifying Study Zone 4 into the major subtypes (e.g., "adjacent to open water", "within a burn" and "forest opening" categories) of predicted primary, secondary and unsuitable habitat patches using the statistical habitat quality model. Including the major subtypes provides replication for the major factors potentially affecting habitat quality. A random sample of at least three locations will be obtained from each of the resulting strata.

Data will be gathered over three years during construction, with each location being sampled in one year only. An annual random sample captures year-to-year variability. Each location will be visited three times during the breeding season to increase detection probability and distinguish frequent use from transient or atypical use. During operation, data will be gathered along the reservoir in three years.

Suitable existing data that is not used to develop the statistically derived habitat quality model will supplement the validation data collected by this study. Suitable data from other studies will also be used where appropriate.

The validated habitat quality model will be applied to the terrestrial habitat map, which will be periodically updated to reflect direct and indirect Project effects. See Section 2.2.0 for the design of the Terrestrial Habitat Clearing, Disturbance and Indirect Effects study.

5.5.3.3.4 PARAMETERS

The monitoring parameters are:

- Olive-sided flycatcher presence in each sample location;
- Habitat attributes of each sample location;
- Amounts of primary and secondary breeding habitat that are directly and indirectly affected by the Project; and,
- Total amounts of primary and secondary breeding habitat in Study Zone 4.

5.5.3.3.5 BENCHMARKS

Benchmarks are not applicable for the first study objective since it is documenting habitat associations.

Regarding the second and third objectives, the general EIS approach for bird species at risk was that a 10% loss of existing habitat area for the species was the benchmark that triggered management concern. Olive-sided flycatcher habitat effects monitoring will use this as the benchmark for habitat effects. Reductions to habitat effectiveness due to sensory disturbance will be factored into the habitat loss calculations.

5.5.3.3.6 STUDY AREA

Data collection will predominantly occur within Study Zone 4 (Map 3). Some validation samples may be collected outside of Study Zone 4. Periodic mapping of breeding habitat will be limited to Study Zone 4.

5.5.3.3.7 SAMPLE LOCATIONS

A sample location consists of a habitat patch that is large enough to support an olive-sided flycatcher nesting territory. These will generally be mixtures of different terrestrial habitat and surface water types.

Sample locations will be selected as follows:

1. To identify the sampling units and strata for random selection, classify Study Zone 4 into the major subtypes of primary, secondary and unsuitable habitat patches by applying the statistically derived habitat quality model to the terrestrial habitat map (which includes surface water types);
2. From each of the strata identified in step 1, randomly select four habitat patches (i.e., the sampling units) for sampling during the 2016 breeding season;
3. Repeat Steps 1 and 2 for the 2017 breeding season; and,
4. Repeat Steps 1 and 2 for the 2018 breeding season.

Step 1 is completed each sample year to account for habitat loss due to Project construction and for natural events that change terrestrial habitat composition (e.g., wildfires). Map 12 shows the habitat patches available for the random selections.

A power analysis completed during the winter of 2018/2019 will determine whether a larger sample size is needed for model validation.

5.5.3.3.8 SAMPLE FREQUENCY AND SCHEDULE

Sampling will occur during the 2016, 2017 and 2018 breeding seasons and along the reservoir in years 8, 12 and 20 of operation.

Each sample location will be sampled in one year only.

Each sample location will be visited three times during the breeding season. Each visit will be separated by at least 10 days.

5.5.3.3.9 FIELD AND LAB METHODS

If a random sample coincides with a sensory disturbance impact location, then data from the Sensory Disturbance study (Section 5.5.2) will be used for this location.

For the remaining samples, one transect will be located within each location. Transect placement will vary with the shape of the selected habitat patch such that the transect runs centrally through the patch parallel to its long side. The biologist should generally be able to detect birds up to 300 m on either side of the transect because the olive-sided flycatcher call is loud and distinctive.

A qualified biologist will walk slowly along each transect and listen for olive-sided flycatchers. If an olive-sided flycatcher is detected, the observer will go off transect and approach the location of the vocalizations. Binoculars will be used to spot the individual. Bird behaviours (e.g., singing, calling, feeding) will be recorded. After the flycatcher moves towards another location within its territory, the perch tree will be marked using GPS, and the individual will then be followed. The same technique will be used to find other perch trees. A maximum of three perch sites per day will be mapped.

Field surveys will occur between 4:30 a.m. and 10:30 a.m., but will be adjusted slightly (i.e., earlier or later) depending on time of local sunrise.

5.5.3.3.10 ANALYSIS

Habitat patch type is the treatment, the sample locations are the replicates and native versus human-affected is the primary covariate in the analysis. There is one subsample of each location because the field method is expected to census most if not all of the nesting territory. Analysis methods will be determined by the nature of the statistical habitat quality model and the structure of the datasets used for analysis. Some of the validation method possibilities include confusion matrices, Kappa statistics and receiver operating characteristic curves. Statistical model and inferential assumptions will be tested during the analyses.

For the Project-affected and available habitat mapping component of this study, the validated habitat quality model will be applied to the terrestrial habitat map periodically produced by the Terrestrial Habitat Clearing, Disturbance and Indirect Effects study (Section 2.0).

5.5.4 HABITAT ENHANCEMENT

5.5.4.1 INTRODUCTION

The Terrestrial Mitigation Implementation Plan includes the installation of perching structures in open, decommissioned borrow areas that retain water (sources of invertebrates for olive-sided flycatchers) to offset some of the losses in olive-sided flycatcher habitat. Perch poles may be used for singing and for foraging.

The distribution of perch poles in borrow areas that contain potential breeding habitat would be enhanced if olive-sided flycatcher locate and use these perches for foraging and territorial display. This mitigation measure is anticipated to provide temporary habitat. Suitable habitat will develop as a mature plant community re-establishes over the borrow area rehabilitation period.

The need for perch poles as a Project mitigation measure has diminished because forest fires in the summer of 2013 have naturally enhanced olive-sided flycatcher habitat by creating forest edge for nesting and dead standing trees for perching. On this basis, the perch pole program will be implemented on a smaller scale in decommissioned borrow areas. If this mitigation measure is proven to be beneficial to olive-sided flycatcher in select areas, and if a need for additional perching sites is identified by the overall olive-sided flycatcher monitoring program, then the perch pole program may be expanded to other areas within the Project footprint.

The goal of the habitat enhancement monitoring is to evaluate whether local olive-sided flycatcher habitat is improved with the use of perch poles.

5.5.4.2 OBJECTIVES

The objectives of the olive-sided flycatcher habitat enhancement monitoring study is to:

- Evaluate whether the installed perch poles become suitable habitat for olive-sided flycatcher foraging and territorial display.

5.5.4.3 STUDY DESIGN

5.5.4.3.1 OVERVIEW

There is one component to this study. The Habitat Enhancement study will monitor the use of perch poles identified in the Terrestrial Mitigation Implementation Plan. Data collection will focus on olive-sided flycatcher response to the potential habitat developed in the in borrow areas.

The use of perch poles to enhance olive-sided flycatcher habitat is a novel management prescription. No data are available to assess the value of this technique. Based on this information, only a small number of 'test' poles will initially be deployed and monitored within a borrow area that contains water. If successful, this concept could be expanded into operation, if reservoir expansion topples trees and reduces perch availability in riparian areas.

5.5.4.3.2 EXISTING DATA

Olive-sided flycatcher occurrence and habitat data are described in Section 5.5.2.3.2.

5.5.4.3.3 DESIGN

Since this technique is not established in the literature, this is a proof of concept intervention study. This study will determine if olive-sided flycatcher will use constructed perch poles and, if so, the specific environmental attributes of used versus unused poles.

Borrow areas that do not contain wetlands will less likely be used by olive-sided flycatcher, and will not receive perch poles. Each borrow area that receives perch poles will be sampled for olive-sided flycatcher use.

All perch poles installed to provide habitat will be sampled. The fieldwork will occur during the construction and operation phases as borrow areas are decommissioned and perch poles are installed.

Data for the Habitat Enhancement study will be gathered over three years, with each location being sampled each year. Thereafter, each location will be sampled once every three years. Each location will be visited three times during the nesting period in June to increase detection probability and distinguish frequent use from transient or atypical use. Thereafter, each location will be sampled once every three years until year 15 of operation. The distribution of the perches and surrounding habitat in the borrow area will be monitored according to the schedule established during the Terrestrial Rehabilitation Implementation and Success study (Section 3.0).

Suitable data from other studies will also be used where appropriate. For example, the olive-sided flycatcher habitat effects studies will provide reference data for this study because many of the olive-sided flycatcher sample locations will be situated near water or adjacent upland habitat.

5.5.4.3.4 PARAMETERS

The monitoring parameters are:

- Site occupancy, behaviour and use of perch poles by olive-sided flycatcher; and,
- Amounts, locations and environmental attributes of the constructed perch poles.

5.5.4.3.5 BENCHMARKS

There are no benchmarks for this study since it is evaluating a novel management prescription.

5.5.4.3.6 STUDY AREA

Data collection will occur in decommissioned borrow areas within Study Zone 2.

5.5.4.3.7 SAMPLE LOCATIONS

A sample location consists of a constructed perch pole.

All perch poles will be sampled in each year of sampling.

5.5.4.3.8 SAMPLING FREQUENCY AND SCHEDULE

The specific years when sampling occurs will be determined based on the actual year when perch poles are introduced into the borrow areas that are being decommissioned.

Each sample location will be sampled over the first three years after installation, and thereafter, each location will be sampled once every three years for a total of 15 years from pole installation.

Each sample location will be visited three times during the breeding bird season for olive-sided flycatcher. Although specific dates can change from year to year depending on weather, the approximate dates will be from June 7 to July 10. Each visit will be separated by at least 7 days.

5.5.4.3.9 FIELD AND LAB METHODS

Perching structures will be monitored to verify the efficacy of this of mitigation measure. A qualified biologist will visit decommissioned borrow areas with installed perch poles to determine if olive-sided flycatcher are using these structures. These borrow areas will be visited between 4:30 a.m. and 10:30 a.m. on three separate occasions during the primary nesting period. Visits will be well separated into early, mid and late June or early July to detect the differential arrival of birds on the breeding ground, and individuals that may move throughout the breeding territory seasonally. A 10-minute stationary point count will be conducted near the perch poles. If perch poles are separated by no more than 300 m, a strip transect method will be used to visit all perch poles in the borrow area. During each period (i.e., early, mid and late June/early July), sites with olive-sided flycatcher will be visited three times within a five-day period.

If an olive-sided flycatcher is detected, the biologist will determine whether or not a perch pole is being used and for what purpose. The bird will be approached as soon as it is heard or seen. Binoculars will be used to spot the bird. If the bird is not using an installed perch pole, the search for other individuals in the borrow area will continue. If an olive-sided flycatcher is observed using an installed perch pole, its behaviour (e.g., singing, calling, feeding) will be recorded for a period of no greater than 20 minutes. If the flycatcher moves towards an alternate perch pole, it will be followed and its behaviours recorded. A maximum of three perch pole movements will be pursued each day. If olive-sided flycatcher densities are sufficient, counter-singing and pursuits will also be mapped to separate individuals from adjacent territories.

The distribution of the perch poles will be measured and mapped during the Terrestrial Rehabilitation and Success study (Section 2.0).

5.5.4.3.10 ANALYSIS

Basic descriptive statistics will generally be the level of data analysis. Presence/absence analysis, frequency of nesting tunnel use and frequency of nesting success will be used to describe the success of the treatment. An index of nesting success over time will be developed to demonstrate the utility of nesting tunnels. Maps of the tunnel locations and mallard presence will be used to examine distribution.

5.5.5 REPORTING

5.5.5.1 ANNUAL REPORTS

A report will be produced during the winter after each year when field studies occur, and will be submitted to MCWS the following spring, as per Environment Act License 3107, Clause 20.

Reports will summarize the activities and general findings of the monitoring during the preceding year. Basic descriptive statistics will be the level of data analysis for these reports. Any major unanticipated events or recommendations for changes to study design or mitigation will be noted.

5.5.5.2 SYNTHESIS AND RECOMMENDATIONS

A synthesis report will be produced after the first five years of field studies, after construction completion and after the final planned year for field studies during operation. Synthesis reports will consolidate, analyze and evaluate all monitoring information gathered to date, including that produced by EIS and other monitoring studies. An integrated evaluation of the habitat, sensory disturbance and mortality pathways of effects on the species will be completed. Actual Project effects will be evaluated relative to the EIS predictions, and the cumulative effects assessment will be updated to reflect actual Project effects. These reports will also include recommendations for any needed modifications to subsequent study design or to mitigation. The operation synthesis report will make recommendations regarding the need for any further monitoring.

5.6 RUSTY BLACKBIRD

5.6.1 INTRODUCTION

5.6.1.1 BACKGROUND

Rusty blackbird is a species at risk that is afforded regulatory protection under SARA, listed as special concern under Schedule 1. Like most species at risk, they occur at low numbers and are sensitive to changes in habitat. Construction-related effects on rusty blackbird are expected to be limited to temporary disturbance and potential avoidance of preferred habitats (e.g., riparian zones along sluggish streams) in areas adjacent to construction sites.

Species at risk have regulatory protection and are often indicators for change in an ecosystem, as they are often either in low numbers and/or at the edge of their range. Potential operation-related effects on rusty blackbird include additional loss of some habitat associated with the filling of the reservoir, shoreline erosion and peatland disintegration as well as changes in abundance and distribution during operations.

During the breeding bird surveys for Keeyask EIS studies, detection of this species was relatively uncommon. Within Study Zone 3 (Map 3), average breeding density of rusty blackbirds was between 0.01-0.02 birds/ha (or 1-2 birds/km^2).

5.6.1.2 ASSESSMENT SUMMARY

Removal and degradation of some rusty blackbird breeding habitat is expected to occur following construction-related land clearing and increased access where rusty blackbird habitat occurs adjacent to roadways used during future operation of the Keeyask Generating Station.

Land clearing activities associated with the development of the reservoir, roads, construction camp, borrow areas and other infrastructure will result in the loss of a small amount of breeding habitat for rusty blackbirds where suitable habitat falls within or adjacent to infrastructure zones. Rusty blackbirds nest in trees and shrubs in the riparian areas of sedge marshes and forest wetlands. They can often be found foraging along the floodplains of rivers and streams, and in the herbaceous vegetation of bogs and beaver floods. Land clearing associated with the development of the Keeyask Generation Project may also have an adverse effect on rusty blackbirds by reducing nesting and foraging habitat that is available for the long-term.

As land is cleared in preparation for Project development (e.g., reservoir, dykes, south access road and trails), approximately 3% (547 ha) of the regional rusty blackbird breeding habitat will be lost or reduced in quality for the long-term. Suitable, alternate rusty blackbird breeding habitat (e.g., treed wet peatland, riparian habitats) is widespread throughout Study Zone 4 (Map 3).

Construction-related noise from heavy equipment will be short-term and temporary. Although construction noise may reduce acoustical quality of bird song communication, reproductive success of rusty blackbirds is not expected to be adversely effected.

Increased human access during the construction phase will increase the collision risk for rusty blackbirds along areas of the north and south access roads where wetland habitat occurs. This collision risk is considered small and unlikely to affect local populations.

The following mitigation measures will be implemented to minimize or avoid potential effects of Project construction on rusty blackbird:

- Land clearing activities will be undertaken outside of the sensitive breeding period (April 24-August 25) to the extent practicable to minimize disturbance to breeding birds; and,
- 100 m 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.

Suitable alternate habitat for rusty blackbird is widespread throughout the Keeyask Region.

Rusty Blackbird populations could be negatively affected by breeding habitat loss resulting from long-term shoreline erosion and peatland disintegration processes. Increased access associated with the operation of the access roads is not anticipated to have a measurable effect on local rusty blackbird populations.

5.6.1.3 COMPONENTS THAT WILL BE MONITORED

The availability of suitable breeding habitat (which includes nesting, shelter and foraging habitats used during the breeding season) is the driver expected to have the greatest influence on rusty blackbird distribution and abundance in the Keeyask Region. Other drivers potentially influencing rusty blackbird distribution and abundance, but to a much lesser degree include:

- Predation by other birds (e.g., gray jay, raptors) or mammals (e.g., red squirrel);
- Mortality as a result of collisions with vehicle traffic or Project structures;
- Mortality from extreme weather events;
- Malnutrition from arriving in the Keeyask Region after the spring insect hatch;
- Project-related hydrological or other changes that alter insect community composition; and,
- Sensory disturbance from equipment, blasting and other human activities that may cause individuals to avoid nesting within and adjacent to infrastructure and activity zones, or to reduce foraging time in preferred habitats within these zones.

Except for sensory disturbance, Project influences on all of the non-habitat drivers are expected to be very low to nil.

On this basis, and because the EIS predicted that residual Project effects will be small in magnitude and cumulative effects will be below the ecological benchmarks, monitoring studies for rusty blackbird will focus on verifying the Project effects predictions that have the greatest potential for altering the EIS conclusions if inaccurate. The associated concerns include:

- Determining how sensory disturbances influence the distribution of rusty blackbird;

- Quantifying how much breeding habitat is lost or altered due to the Project activities; and,
- Evaluating how Project-related changes to habitat influence the distribution and abundance of rusty blackbird.

The Sensory Disturbance study (Section 5.5.2) will evaluate how sensory disturbance alters habitat effectiveness and rusty blackbird distribution. The Habitat Effects study (Section 5.5.3) will evaluate habitat effects in terms of habitat availability and how changes to habitat availability affect rusty blackbird distribution and abundance.

Accidental mortality from sources such as collisions with vehicles and the communication tower is also included in this monitoring program even though is not a substantial concern as it can be monitored with minimal effort using information collected by other studies. Qualitative estimates for how Project-related accidental mortality affects rusty blackbird abundance will use information gathered by other studies and site reports (e.g., Bird Collisions with Lighted Towers study, see Section 5.9). A study design is not required for this component of rusty blackbird monitoring.

Compliance monitoring relating to pre-clearing nest searches is described in the Avian Management Plan, implemented under the Project's Generating Station and South Access Road Construction Environmental Protection Plans (EnvPPs).

Relevant rusty blackbird information obtained by all terrestrial and resource use monitoring will be periodically consolidated, analyzed and evaluated in a synthesis report to provide an integrated comparison of predicted and actual Project effects on rusty blackbird.

5.6.2 SENSORY DISTURBANCE

5.6.2.1 INTRODUCTION

The goal of this study is to determine if rusty blackbird distribution and relative abundance change in the vicinity of the Project due to sensory disturbance.

5.6.2.2 OBJECTIVES

The objectives of the rusty blackbird distribution and abundance monitoring study are to:

- Evaluate how Project-related changes to habitat influence the potential distribution and relative abundance of rusty blackbird in Study Zone 4;
- Evaluate how sensory disturbance from the access roads influences distribution and relative abundance; and,
- Qualitatively estimate how Project-related accidental mortality affects abundance.

5.6.2.3 STUDY DESIGN

5.6.2.3.1 OVERVIEW

In this study, relative abundance refers to the expected relative density of rusty blackbirds in each of the rusty blackbird breeding habitat types. These habitats are mapped by applying a habitat quality model to the mapped terrestrial habitat types and surface water types.

There are two components to monitoring how Project-related habitat changes may influence the distribution and relative abundance of rusty blackbirds in Study Zone 4. One is identifying breeding habitat areas that rusty blackbirds can no longer use, while the other is mapping Project-related changes to the quantity and quality of breeding habitat.

The potential distribution of rusty blackbird in Study Zone 4 will be temporarily or permanently reduced where Project clearing occurs. The terrestrial habitat clearing and disturbance mapping (Section 2.0) will identify reductions to potential distribution created by habitat removal resulting from Project clearing.

To identify effects on the potential distribution and relative abundance of rusty blackbird due to other Project-related sources of breeding habitat loss or alteration, the Habitat Effects study (Section 5.6.3) will identify changes to the quantity and quality of available habitat.

Sensory disturbance effects on rusty blackbird distribution and relative abundance will be monitored in proximity to Project features. Monitoring focuses on the features that create sensory disturbance throughout construction and/or operation. Other Project features and activities are too intermittent to be monitored effectively for a regionally rare species. The access roads represent the greatest anticipated source of extended sensory disturbance for rusty blackbird.

The north and south access roads are the footprints included in the sensory disturbance monitoring during construction and operation. Given the rarity and habitat preferences of rusty blackbird, too few potential sample locations are available to monitor effects from the Project area.

Qualitative estimates for how Project-related accidental mortality affects rusty blackbird abundance will use information gathered by other studies and site reports (e.g., Bird Collisions with Lighted Towers study, see Section 5.9). A study design is not required for this component of the distribution and abundance study.

5.6.2.3.2 EXISTING DATA

Rusty blackbird occurrence and habitat data were collected from 2001 to 2014 for environmental assessment and monitoring studies associated with the Keeyask Infrastructure Project (KIP), the Keeyask Generation Project, and the Keeyask Transmission Project. During this time, point-count surveys were primary method used to detect rusty blackbirds during the breeding season. Data were also collected from boat-based surveys, aerial surveys, remote audio recorders, and creek reconnaissance surveys. The number and location of point-count plots varied annually, with some plots being surveyed in multiple years. Point-counts were conducted at 197 stops in 2001, 226 stops in 2002, 336 stops in 2003, 58 stops in 2004, 135 stops in 2005, 118 stops in 2006, 126 stops in 2007, 71 stops in 2011, 99 stops in 2012, and 141 stops in 2013 (1,507 total). Rusty blackbirds were detected at approximately 4% of point-count stops, with some plots being surveyed in more than a single year. These data were collected as an element of bird community studies located a variety of habitat types (typically with several plots in a single stand) as well as for a focused rusty blackbird study.

Virtually all of the plots were in Study Zone 4, with the majority in Study Zone 3. For all studies, data were collected during the breeding season using point count surveys. Standard data collection protocols for point-count surveys were employed.

Many of the plots with rusty blackbird observations situated west of Stephens Lake were either burned in the 2005 and 2013 fires, cleared during KIP construction or will be cleared during Project construction.

5.6.2.3.3 DESIGN

The sensory disturbance monitoring is a dose-response study. The "dose' is the degree of sensory disturbance and the "response" is rusty blackbird avoidance or less frequent use of otherwise suitable habitat. Both the dose and response levels are expected to decrease with distance from Project feature.

Field studies and the expert information model identified three potential rusty blackbird breeding habitat locations adjacent to the north access road and three adjacent to the south access road. If this reflects the number of samples that will be available for monitoring then there are too few replicates for a statistical study design.

A pilot study during the 2015 breeding season will determine if there are a sufficient number of rusty blackbird breeding territories along the north and south access roads to support a dose-response disturbance study. If not, a less robust presence-absence based sensory disturbance design will be implemented. This presence-absence design will determine if rusty blackbird will use available breeding habitat within 300 m of the access roads. If there is a sensory disturbance effect, then this distance should capture it. The design consists of a census of all available breeding habitat locations along the access roads to determine whether or not rusty blackbirds are using these areas.

During the pilot study, qualified birders will visit potential nesting pair sites selected through a paired impact-reference design to determine whether sufficient nesting pairs appear to be present to implement the desired impact-gradient by time design. In the event this is the case, then the number of audio recorders required to implement the strong dose-response design that is feasible given the number of nesting pairs will be requisitioned and placed in the field starting in the 2016 breeding season. A power analysis using the 2016 field data will determine the number and locations of audio recorders to be employed during the subsequent breeding season. Since the pilot study design will estimate variances needed for a multi-year design from a single year study, there may be substantive design changes for the subsequent monitoring which can use multiple years of data for statistical analysis and inference. A power analysis using results to date will be conducted each winter following a sample year to determine the optimal number of audio recorders and their locations for the subsequent breeding season.

Since rusty blackbird habitat is a subset of olive-sided flycatcher habitat, the olive-sided flycatcher sensory disturbance study may employ additional audio recorders to provide some suitable data for evaluating sensory disturbance to rusty blackbird.

Reference sample locations will be used to confirm that rusty blackbird is using comparable breeding habitat elsewhere in Study Zone 4. The Habitat Effects study (Section 5.6.3) will provide these data.

5.6.2.3.4 PARAMETERS

The monitoring parameters are:

- Rusty blackbird presence within the 200 m of roads;
- Intensity, duration and frequency of Project-related noise levels (in decibels); and,
- Access road traffic counts.

5.6.2.3.5 BENCHMARKS

Benchmarks are not applicable for the first study objective since it is documenting habitat associations and the zone of sensory disturbance. Reductions to habitat effectiveness due to sensory disturbance will be factored into the habitat loss calculations, after which the habitat effects benchmarks (Section 5.6.3.3.5) will be applied.

5.6.2.3.6 STUDY AREA

Data collection will occur within Study Zone 4, predominantly within Study Zone 3. Study Zone 3 extends well beyond the anticipated zone of Project-related sensory disturbance. Study Zone 4 includes PR 280 and Butnau Road and likely some reference sample locations.

5.6.2.3.7 SAMPLE LOCATIONS

For the pilot study, the sampling frame for Project impacts consists of breeding pair nesting territories that extend into a 100 m buffer of the relevant Project footprint. The buffer provides for some current habitat avoidance due to existing sensory disturbance, as well as for subsequent habituation.

The Project impacts sampling frame is constructed as follows:

1. Select potential breeding habitat patches:
2. From the breeding habitat map, select primary habitat patches within 100 m of the north and south access roads and extending at least 200 m perpendicular to the road; and,
3. Create points every 300 m along the access roads to identify any breeding habitat patches that may not be identified by the expert information model. Drop any of these systematically located points that fall within 50 m of the sample location selected in Step 1.
4. Go to each predetermined location and determine if a rusty blackbird nesting pair is present.
5. Create a list of the locations with nesting pairs. These are the sampling units for the sampling frame.

Reference sample locations are a stratified, random sample of the unaffected breeding habitat patches. These data will be provided by the Habitat Effects study (Section 5.6.3).

Additional impact locations will also be situated along PR 280 and Butnau Road to test for long-term habituation to sensory disturbance, to provide a broader range of sensory disturbance levels for estimating the dose-response relationship and to increase total sample size. PR 280 and Butnau Road provide a strong contrast in levels of sensory disturbance due to the high difference in traffic volumes. Sample locations will be selected using the same selection methods as for the north and south access roads. Ideally, five sample locations will be established on PR 280 and on Butnau Road for the pilot study, increasing the total “treated” sample size by 10. Map 13 shows the habitat patches and roadside locations available for the pilot study surveys.

All sample locations will be sufficiently separated in space to be independent samples of pair nesting home ranges.

Results from the pilot study and later years may modify the study design for the subsequent breeding season. Each winter following a sample year, a power analysis using results to date will determine whether modifications to the study design are needed and, if so, the nature of those modifications.

5.6.2.3.8 SAMPLING FREQUENCY AND SCHEDULE

Provided there are enough breeding pairs to implement the desired sampling design, sampling during construction will occur annually for five years to physically control for year-to-year variability in sensory disturbance and behavioral responses, and for possible behavioral changes over longer periods of time. Some of these years may not be consecutive.

Sampling will likely occur annually in years two to five of operation, and then every third year until year 15. Results from the construction phase will determine the actual monitoring schedule for the first five years of operation. After year five of operation, all results to date will be used to determine the actual monitoring schedule for subsequent years.

After the final planned year of operation monitoring, an evaluation of results to date will determine if additional monitoring is desirable and, if so, during which years.

Sampling will take place three times during the breeding period (June-July), specifically in mid-June, late June and early July.

5.6.2.3.9 FIELD AND LAB METHODS

PILOT STUDY

A qualified biologist will go to pre-identified rusty blackbird habitat patches along the north and south access roads between 4:30 a.m. and 10:30 a.m. to determine the number of locations with breeding rusty blackbirds. Sample times will be adjusted slightly (i.e., earlier or later) depending on time of local sunrise. At each stop, the biologist will listen for rusty blackbirds for 10 minutes, recording the estimated direction and distance to each call during that time.

At each location where a rusty blackbird is detected, the biologist will move into the patch and roughly map the locations of rusty blackbird activity to determine if areas within 300 m of the road are being used.

See Section 5.6.3 for reference location field methods.

SUBSEQUENT STUDIES

In the event that the pilot study determines there are likely sufficient nesting pairs to implement the impact-gradient by time design, the nesting pair territories mapped in 2015 will be revisited to confirm that these sites have nesting pairs in 2016. Unoccupied territories will be replaced using the methods described in Section 5.6.2.3.7.

Two microphone array audio recorders will be placed centrally in the selected nesting territories at distances of 150 m and 300 m from the road within the rusty blackbird habitat. Point counts outside of the audio recording area will be conducted during the audio recording period. These point counts will confirm that the pair is still using the habitat patch and determine if their territory has shifted such that one or more audio recorders should be repositioned.

In the lab, the recorded data will be screened for rusty blackbird songs and calls using sound analysis software (e.g., Adobe Audition 2.0). An hourly and daily sample of the rusty blackbird recordings will be selected for further processing and analysis. The amplitude (i.e., decibels) statistics of each song is extracted from the microphone array recordings. Summary statistics and triangulation will be used to estimate the direction and distance to the bird given that the bird call was recorded from the fixed and known location of the audio recording unit. Multiple spatial positions of each blackbird within its territory will be mapped using GIS software.

Frog calls and other regionally rare bird species calls and songs detected in the audio recordings will also be included in the data extraction to provide data for other studies (e.g., frogs, yellow rail, common nighthawk, olive-sided flycatcher).

5.6.2.3.10 ANALYSIS

The sensory disturbance areas and the unaffected areas are the two treatments, sample locations are the replicates and breeding habitat type is the primary covariate in the analysis. The analysis methods and inferential approach will be determined by the final sampling design, sample size and the structure of the datasets used for analysis.

Possibilities include dose–response regressions and structural equations modeling.

The possibilities increase as additional years of data become available. Covariates for olive-sided flycatcher distribution and abundance will be included in the analysis to account for confounding factors and natural variation as far as possible. Statistical model and inferential assumptions will be tested during the analysis.

5.6.3 HABITAT EFFECTS

5.6.3.1 INTRODUCTION

The availability of suitable breeding habitat is expected to have the greatest influence on rusty blackbird distribution and abundance in the Keeyask Region (Section 5.6.2.1). Breeding habitat must provide suitable sites for nesting, food, roosting and shelter. While rusty blackbirds often roost with other blackbird species, their habitat requirements are more specialized.

Rusty blackbirds nest in young conifers and shrubs adjacent to areas that pool water. Their summer diet is predominantly wetland insects, supplemented by other insects, snails, crayfish, salamanders, and small fish.

According to the literature, rusty blackbirds most frequently nest close to forest openings with bogs, muskeg, swamps, and beaver ponds or near the wetlands adjacent to rivers, streams and lakes. They can often be found foraging along the floodplains of rivers and streams, and in the herbaceous vegetation of bogs and beaver floods. Rusty blackbirds tend to select naturally disturbed habitats that have reverted to early- to mid-successional stages due to fire or beaver activity.

The majority of rusty blackbirds observed during field studies in the Keeyask Region were using riparian habitat associated with inland lakes, creeks, the Nelson River shorelines at creek mouths and inlets, and wet peatlands located in inland areas.

To quantify and situate rusty blackbird habitat in Study Zone 4, the EIS classified the following terrestrial habitat and surface water types into breeding habitat:

- needleleaf tree or tall shrub on deep wet peatland ;
- black spruce and tamarack are the dominant tree species;
- wet or deep peatland associated with horizontal or riparian fens
- mixedwood and needleleaf on shallow peatland;
- needleleaf dominant with some bog birch;
- ground ice present in peatland; and,
- habitat associated with a collapse scar or peat plateau bog.

Using this classification, primary and secondary breeding habitat for rusty blackbird habitat is widespread throughout Study Zone 4. Most of the primary habitat within Study Zone 4 is along the creeks and rivers that flow into Gull Lake. Most of the riparian area associated with the Nelson River was considered sub-optimal habitat; areas that were included as primary habitat were associated with some of the creek mouths and inlets.

The goal of the habitat effects monitoring is to evaluate how the Project changes the distribution and abundance of rusty blackbird breeding habitat.

5.6.3.2 OBJECTIVES

The objectives of the rusty blackbird habitat effects monitoring study are to:

- Verify the habitat association assumptions that were used to predict Project effects on rusty blackbird habitat; and,
- Quantify how much primary and secondary breeding habitat are lost or altered due to the Project.

5.6.3.3 STUDY DESIGN

5.6.3.3.1 OVERVIEW

This study consists of two components: validating the breeding habitat quality model; and, then applying the validated model to the post-Project terrestrial habitat map (which includes surface water types). The latter component quantifies and situates primary and secondary breeding habitat.

Regarding the first component, the EIS used an expert information model to classify terrestrial habitat and surface water types into primary, secondary and unsuitable habitat for rusty blackbird. This expert information model was developed from field data collected in the Keeyask Region, relevant scientific literature and professional judgement. This model will not be replaced with a statistically derived multivariate habitat quality model during construction since there are too few replicates available for this. This habitat effects study will validate the expert information habitat quality model using data that collected in an appropriate range of habitat types.

Following this, the validated, and possibly refined, expert information habitat quality model will be applied to the post-Project terrestrial habitat map to quantify and situate primary and secondary breeding habitat. Permanent and temporary breeding habitat loss due to Project infrastructure and indirect Project effects on terrestrial habitat and surface water types that are inputs into the habitat quality model will be determined from the Terrestrial Habitat Clearing, Disturbance and Indirect Effects study (Section 2.1). This general approach will also determine alterations to the quantities and qualities of various breeding habitat types.

5.6.3.3.2 EXISTING DATA

As noted in Section 5.6.2.3.2, rusty blackbird occurrence and habitat data were collected at over 1,500 bird listening plots in Study Zone 4 during the 2001 to 2014 breeding seasons. Rusty blackbirds were detected at 4% of these plots, with some plots appearing in more than one year and, in some cases, multiple plots represented the same breeding territory.

Sampling was conducted in a variety of habitat types using several sampling designs. Common habitat types had the most plots, while less common habitat types had fewer plots. Some rarer habitat types (e.g., those with jack pine, tamarack, trembling aspen and white birch) had proportionally more plots to identify rare, uncommon or unique bird species and/or species assemblages.

5.6.3.3.3 DESIGN

This is a population and habitat patch level resource selection study. This study is not determining the specific environmental attributes that rusty blackbirds use (e.g., do they nest in conifers, eat aquatic insects and small fish) since this is already well established in the literature. Rather, it is testing which of the mapped terrestrial habitat and surface water patch types best incorporate these attributes based on demonstrated higher proportional use.

All other things being equal, rusty blackbirds are expected to be found in a higher proportion of their preferred habitat types compared with less preferred types, and to be absent or highly infrequent in unsuitable areas. A stratified, random sample of available habitat types will be classified into used versus unused based on species detections during the fieldwork. Stratification for random sampling involves classifying Study Zone 4 into the major subtypes (e.g., “wet or deep peatlands associated with horizontal or riparian fens, riparian areas along shorelines of inland lakes, creeks and wetlands, low vegetation on wet peatlands and adjacent forest edge, marsh and fen) of predicted primary, secondary and unsuitable habitat patches using the statistical habitat quality model. Including the major subtypes provides replication for the major factors potentially affecting habitat quality. A random sample will be obtained from each of the resulting strata.

Data will be gathered over three years, with each location being sampled in one year only. An annual random sample captures year-to-year variability. Each location will be visited three times during the breeding season to increase detection probability and distinguish frequent use from transient or atypical use. Suitable data from other studies will also be used where appropriate.

Assuming a sufficient number of sample locations are used by rusty blackbirds to validate and refine the habitat quality model, the refined model will be applied to the terrestrial habitat map, which will be periodically updated to reflect direct and indirect Project effects. See Section 2.2.0 for the design of the Terrestrial Habitat Clearing, Disturbance and Indirect Effects study.

5.6.3.3.4 PARAMETERS

The monitoring parameters are:

- Rusty blackbird presence in the sample location;
- Habitat attributes of the sample location;
- Amounts of primary and secondary breeding habitat that are directly and indirectly affected by the Project; and,
- Total amounts of primary and secondary breeding habitat in Study Zone 4.

5.6.3.3.5 BENCHMARKS

Benchmarks are not applicable for the first study objective since it is documenting habitat associations.

Regarding the second objective, the general EIS approach for bird species at risk was that a 10% loss of existing habitat area for the species was the benchmark that triggered management concern. Rusty blackbird habitat effects monitoring will use this as the benchmark for habitat effects. Reductions to habitat effectiveness due to sensory disturbance will be factored into the habitat loss calculations.

5.6.3.3.6 STUDY AREA

Data collection will predominantly occur within Study Zone 4. Some validation samples may be collected outside of Study Zone 4. Periodic mapping of breeding habitat will be limited to Study Zone 4.

5.6.3.3.7 SAMPLE LOCATIONS

A sample location consists of a habitat patch that is large enough to support a rusty blackbird nesting territory. These will generally be mixtures of different terrestrial habitat and surface water types.

Sample locations will be selected as follows:

1. To identify the sampling units and the strata for random selection, classify Study Zone 4 into the major subtypes of primary, secondary and unsuitable habitat patches by applying the expert information habitat quality model to the terrestrial habitat map (which includes surface water types);
2. From each of the strata identified in step 1, randomly select four habitat patches (i.e., sampling units) for sampling during construction year 2 breeding season;
3. Repeat Steps 1 and 2 for the year 3 breeding season; and,
4. Repeat Steps 1 and 2 for the year 4 breeding season.

Step 1 is completed each sample year to account for habitat loss due to Project construction and for natural events that change terrestrial habitat composition (e.g., wildfires). Map 13 shows the habitat patches available for the random selections.

A power analysis completed during the winter of year 3 and will determine whether a larger sample size is needed for model validation.

5.6.3.3.8 SAMPLING FREQUENCY AND SCHEDULE

Sampling will occur during the 2015, 2016 and 2017 breeding seasons.

Each sample location will be sampled in one year only.

Each sample location will be visited three times during the breeding season. Each visit will be separated by at least 10 days.

5.6.3.3.9 FIELD AND LAB METHODS

If a random sample coincides with a sensory disturbance impact location, then data from the Sensory Disturbance study (Section 5.6.2) will be used for this location.

For the remaining samples, a transect will be located within each sample location. Transect placement will vary with the shape of the selected habitat patch. The biologist should generally be able to detect birds up to 50 m on either side of the transect.

A qualified biologist will walk slowly along the transect between 4:30 AM and 10:30 AM and listen for rusty blackbirds. Sample times will be adjusted slightly (i.e., earlier or later) depending on time of local sunrise. If a rusty blackbird is detected, the observer will go off transect and approach the location of the vocalizations. Binoculars will be used to spot the individual. Bird behaviours (e.g., singing, calling, feeding) will be recorded. After the rusty blackbird moves towards another location within its territory, the perch will be marked using GPS, a photograph taken of the site, and the individual will then be followed. The same technique will be used to find other perch sites. A maximum of ten perch sites per day will be mapped before moving on to another territory.

5.6.3.3.10 ANALYSIS

The sample locations are the replicates, transects are the subsamples, habitat patch type is the treatment and native versus human-affected is the primary covariate in the analysis. Analysis methods will be determined by the nature of the statistical habitat quality model and the structure of the datasets used for analysis. Some of the validation method possibilities include confusion matrices, Kappa statistics and receiver operating characteristic curves. Statistical model and inferential assumptions will be tested during the analysis.

For the Project-affected and available habitat mapping component of this study, the validated habitat quality model will be applied to the terrestrial habitat map periodically produced by Terrestrial Habitat Clearing, Disturbance and Indirect Effects monitoring (Section 2.1).

5.6.4 REPORTING

5.6.4.1 ANNUAL REPORTS

A report will be produced during the winter after each year when field studies occur, and will be submitted to MCWS the following spring, as per Environment Act License 3107, Clause 20.

Reports will summarize the activities and general findings of the monitoring during the preceding year. Basic descriptive statistics will be the level of data analysis for these reports. Any major unanticipated events or recommendations for changes to study design or mitigation will be noted.

5.6.4.2 SYNTHESIS AND RECOMMENDATIONS

A synthesis report will be produced after the first five years of field studies, after construction completion and after the final planned year for field studies during operation. Synthesis reports will consolidate, analyze and evaluate all monitoring information gathered to date, including that produced by other monitoring studies. Actual Project effects will be evaluated relative to the EIS predictions, and the cumulative effects assessment will be updated to reflect actual Project effects. These reports will also include recommendations for any needed modifications to subsequent study design or to mitigation. The operation synthesis report will make recommendations regarding the need for any further monitoring.

5.7 COMMON NIGHTHAWK

5.7.1 INTRODUCTION

5.7.1.1 BACKGROUND

The common nighthawk is a medium-sized bird, with dark brown mottled plumage, a large flattened head, large eyes, a large mouth, and a small bill. It has long slender pointed wings, a slightly notched tail and a white patch on its primaries. They forage for flying insects at dusk and dawn, filling a niche similar to that of bats. The common nighthawk migrates from wintering grounds in South America and arrives on breeding ground in Canada in early May to mid-June. They are adapted to living in natural and human disturbed habitats, nesting on bare ground, sand or gravel substrates, and particularly favour recent burns. Female common nighthawks display a high degree of breeding site fidelity, with a high return to individual nest sites each spring. This species produces one clutch holding an average of two eggs per year. Eggs are often preyed upon by predators such as American crows, common ravens, gulls, and foxes. Nestlings remain in the nest from mid-June to late August and are fully developed after 6-7 weeks of growth. This species has been uncommonly observed in the Keeyask Region.

As a species at risk, the common nighthawk is afforded protection under the federal *Species at Risk Act* (SARA; listed as 'threatened') and the Manitoba *Endangered Species and Ecosystems Act* (MESEA; listed as 'threatened'). The common nighthawk is currently experiencing widespread declines throughout its range.

Common nighthawk monitoring is important because there is a potential for substantial Project effects and a moderate degree of uncertainty remains concerning the effects predictions. Species at risk can be indicators for change in an ecosystem, as they are often either low in numbers and/or at the edge of their range.

5.7.1.2 ASSESSMENT SUMMARY

The main drivers of change and stressors of common nighthawk in the Keeyask Region include fire, land clearing, insect food quality and abundance, water regime, sensory disturbances and climate change. Wildfire is a key driver in creating suitable breeding habitat for common nighthawk. Changes to any of these factors have potential to affect the local and regional common nighthawk populations, primarily through habitat change, or indirectly by affecting the fitness of individuals. Other drivers and stressors that could influence habitat quality or individuals to a lesser degree include extreme weather events, accidents, predation, disease and parasites. The availability of suitable breeding habitat is expected to have the greatest influence on common nighthawk distribution and abundance in the Keeyask Region.

The potential pathways for Project effects on common nighthawk are the same as those described for all birds in Section 5.0. However, no access effects are anticipated as common nighthawk is a listed species at risk and is not harvested.

Predicted Project effects on common nighthawk include the loss or alteration of habitat. This model identified 7,503 ha of primary breeding habitat in Study Zone 4. Of this total, 1,506 ha are located in Study Zone 3 and 428 ha are within the 150 m buffer of the Project Footprint. The model also identified 5,957 ha of secondary breeding habitat in Study Zone 4. Of this total, 1,789 ha are located in Study Zone 3 and 536 ha are within the 150 m buffer of the Project Footprint. Approximately 3,689 ha of breeding habitat will be temporarily created through reservoir clearing, resulting in a 15% net increase (2,764 ha) in common nighthawk breeding habitat within the Study Zone 4. Some of this cleared area will form primary and secondary habitat where mineral soils occur, with lower quality breeding habitat in peatland-dominated areas.

Positive 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 Study Zone 4) will be lost due to Project development. The loss, alteration and creation of common nighthawk habitat is expected to be adverse, moderate in magnitude, small in extent and long-term in effect on local common nighthawk populations. This local population change is not anticipated to have a measureable effect on the regional common nighthawk populations as other suitable open, sparsely vegetated habitats (e.g., burns) occur within the Study Zone 4.

While land clearing activities may create some breeding and foraging habitat for common nighthawks, sensory disturbance in those areas may render them unsuitable in the near term. Construction-related noise from heavy equipment, blasting and other human activities may cause common nighthawk to avoid using areas within or adjacent to the Project Footprint. In these areas, avoidance of breeding habitats will likely persist until disturbances have ceased. Birds displaced from breeding habitat will likely relocate to alternate available habitats not affected by construction disturbance, providing the disturbance occurs early enough in the breeding season that nesting can be re-initiated. Edges suitable for foraging may be created where Project clearing in treed areas creates openings and areas adjacent to water.

Changes to forest structure, hydrology or wetlands may also impact insect prey populations, thereby reducing habitat quality. Project-related clearings such as cutlines, borrow areas and access roads create more edge habitat, some of which may be used by common nighthawk for foraging.

The development of roads and the installation of a communications tower could create hazards for common nighthawk movements. Mortalities from vehicle collisions and bird tower strikes have the potential to affect the local population. Because common nighthawk are expected to forage above traffic-level height, construction and operational effects should be negligible. Tower collisions are also unlikely events as common nighthawk migration pathways are not present in the region and tower collisions are rare for agile fliers such as the common nighthawk.

Mitigation measures should offset some of the losses in common nighthawk habitat. In addition to the general mitigation measures described for all birds in Section 5.1.2, the following mitigation measures will be implemented to minimize or avoid potential effects on common nighthawk:

- Land clearing activities will be undertaken outside of the sensitive breeding season (April 24-August 25) to the extent practicable to minimize disturbance to breeding birds; and,
- Portions of the decommissioned borrow areas may be left with patches of bare ground (i.e., not rehabilitated) in order to provide suitable nesting habitat for common nighthawks.

Other drivers that will continue to influence common nighthawk breeding habitat include fires. The 2013 wildfire temporarily created primary and secondary common nighthawk habitat along the north access road and elsewhere in the region. This habitat type is likely to improve in the near term before becoming less suitable in the long-term. Future fires will continue to influence common nighthawk habitat.

Habitat is not considered to be a factor limiting common nighthawk populations within the Keeyask Region as primary and secondary breeding habitat are widespread and abundant.

5.7.1.3 COMPONENTS THAT WILL BE MONITORED

The availability of suitable breeding habitat (which includes nesting, shelter and foraging habitats used during the breeding season) is the driver expected to have the greatest influence on common nighthawk distribution and abundance in the Keeyask Region. Other drivers potentially influencing common nighthawk distribution and abundance, but to a much lesser degree, include:

- Predation by other birds (e.g., raptors) or mammals (e.g., red fox);
- Mortality as a result of collisions with vehicle traffic or Project structures;
- Mortality from extreme weather events;
- Project-related hydrological or other changes that alter insect community composition; and,
- Sensory disturbance from equipment, blasting and other human activities that may cause individuals to avoid nesting within and adjacent to infrastructure and activity zones, or to reduce foraging time in preferred habitats within these zones.

Sensory disturbance is expected to be of lesser concern for common nighthawk than for other species since common nighthawk is known to inhabit urban areas.

Monitoring studies for common nighthawk will focus on verifying Project effects predictions. The main concern that should be verified by monitoring is quantifying how much breeding habitat is lost or altered due to the Project activities.

The Habitat Enhancement study (Section 5.7.3) will verify the efficacy of the common nighthawk habitat enhancement measures described in the Terrestrial Mitigation Implementation Plan (i.e., allocating portions of decommissioned borrow sites for common nighthawk nesting by leaving areas unvegetated, with bare mineral substrate).

Accidental mortality from sources such as collisions with vehicles and the communication tower is included in this monitoring program even though is not a substantial concern as it can be monitored with minimal effort using information collected by other studies. Qualitative estimates for how Project-related accidental mortality affects common nighthawk abundance will use information gathered by other studies and site reports (e.g., Bird Collisions with Lighted Towers study, see Section 5.9). A study design is not required for this component of common nighthawk monitoring.

Compliance monitoring relating to pre-clearing nest searches is described in the Avian Management Plan, implemented under the Project's Generating Station and South Access Road Construction Environmental Protection Plans (EnvPPs).

Relevant common nighthawk information obtained by all terrestrial and resource use monitoring will be periodically consolidated, analyzed and evaluated in a synthesis report to provide an integrated comparison of predicted and actual Project effects on common nighthawk.

5.7.2 HABITAT EFFECTS

5.7.2.1 INTRODUCTION

While not expected to be limiting in the post-Project environment, the availability of suitable breeding habitat is expected to have the greatest influence on common nighthawk distribution and abundance in the Keeyask Region (Section 5.7.1.3). Breeding habitat must provide suitable sites for nesting, food, roosting and shelter.

Common nighthawks are known to inhabit both urban and rural areas. They forage for flying insects at dusk and dawn near marshes, rivers and lakeshores. Their primary natural breeding habitat is in clearings, on rock outcrops or in burned sites.

The majority of common nighthawks observed during field studies in the Keeyask Region were foraging in recent burns and in areas along the south access road route. Foraging activity was also detected in open habitats including at wetlands, inland lakes and creeks, and along the Nelson River.

To quantify and situate common nighthawk habitat in Study Zone 4, the EIS classified the following terrestrial habitat and surface water types into breeding habitat:

- Dry post-disturbance stages <20 years since burn with sparse vegetation cover for nesting (total shrub cover <20%, total tree cover <10%);
- Open, dry coniferous forest, forest clearings, forests with sparse ground cover on mineral soil:
- Early successional stage or shrub communities maintained by fire or clearing (cutlines) or flooding (fen/marsh/wet meadow);
- Areas where seedlings and advanced regeneration may be abundant;
- Areas where tree cover is less than 10%;
- Areas where shrub cover is less than 20% and, herb layer cover is greater than 20%; and,
- Coniferous forest (jack pine dominant; mature to old forest).

Using this classification, primary and secondary breeding habitat for common nighthawk is widespread in Study Zone 4. This model identified 10,188 ha of primary breeding habitat in Study Zone 4. Of this total, 1,506 ha are in Study Zone 3 and 428 ha are within the 150 m buffer of the Project Footprint (Study Zone 2). The model also identified 5,974 ha of secondary breeding habitat in Study Zone 4. Of this total, 1,789 ha are in Study Zone 3 and 536 ha are within the 150 m buffer of the Project Footprint (Study Zone 2).

The goal of the Habitat Effects study is to evaluate how the Project changes the distribution and abundance of common nighthawk breeding habitat.

5.7.2.2 OBJECTIVES

The objectives of this study are to:

- Verify the habitat association assumptions that were used to predict Project effects on common nighthawk breeding habitat; and,
- Quantify how much primary and secondary breeding habitat are lost or altered due to the Project.

5.7.2.3 STUDY DESIGN

5.7.2.3.1 OVERVIEW

This study consists of two components: validating the breeding habitat quality model, and then applying the validated model to the post-Project terrestrial habitat map (which includes surface water types). The latter component quantifies and situates primary and secondary breeding habitat.

Regarding the first component, the EIS used an expert information model to classify terrestrial habitat and surface water types into primary, secondary and unsuitable habitat for common nighthawk. This expert information model was developed from field data collected in the Keeyask Region, relevant scientific literature and professional judgement. This model will not be replaced with a statistically derived multivariate habitat quality model since there are too few replicates available for this due to the species' rarity and nesting site detectability. This habitat effects study will validate the expert information habitat quality model using data collected in an appropriate range of habitat types.

Following this, the validated, and possibly refined, expert information habitat quality model will be applied to the post-Project terrestrial habitat map to quantify and situate primary and secondary breeding habitat. Permanent and temporary breeding habitat loss due to Project infrastructure and indirect Project effects on terrestrial habitat and surface water types that are inputs into the habitat quality model will be determined from the Terrestrial Habitat Clearing, Disturbance and Indirect Effects study (Section 2.0). This general approach will also determine alterations to the quantities and qualities of various breeding habitat types.

5.7.2.3.2 EXISTING DATA

Common nighthawk occurrence and habitat data were collected from 2001 to 2014 for environmental assessment and monitoring studies associated with the Keeyask Infrastructure, Generation and Transmission Projects. Both point-count surveys and remote-recorder data were collected.

During this time, over 1,400 point-count plots were surveyed, with some plots being surveyed in multiple years. As breeding bird surveys are not designed to capture nocturnally active species such as common nighthawk, very few were detected during these surveys. Habitats where they were detected include mostly open areas with low vegetation.

In June of 2012 and 2013, site-specific investigations for nocturnally active species at risk (including common nighthawk) occurred in suitable habitats throughout Study Zone 4. Remote recording units were deployed in areas that had the highest potential of detecting common nighthawk (*e.g.*, wetlands, regenerating forest). Common nighthawk are most vocal and therefore detectable, in foraging habitat (*e.g.*, forest openings). Units were programmed to monitor morning, early evening and night-time bird activity.

Recording units were deployed in forty different locations during the breeding bird survey periods in 2012 and 2013. Common nighthawk were present at 29 out of 40 recording units, with the proportion of nighthawks being high because they were all located in preferred foraging habitat and common nighthawk home ranges are relatively large. Recorders where common nighthawks were observed were in open areas with young regeneration, low vegetation and tall shrubs.

Many of the sample locations with common nighthawk observations west of Stephens Lake were either burned in the 2005 and 2013 fires, cleared during KIP construction or will be cleared during Project construction.

5.7.2.3.3 DESIGN

This is a population and habitat patch level resource selection study. This study is not determining the specific environmental attributes that common nighthawks use (e.g., do they nest on the ground, or eat flying insects) since this is already well established in the literature. Rather, it is testing which of the mapped terrestrial habitat and surface water patch types best incorporate these attributes based on demonstrated higher proportional use.

All other things being equal, common nighthawks are expected to be found in a higher proportion of their preferred habitat types compared with less preferred types, and to be absent or highly infrequent in unsuitable areas. A stratified, random sample of available habitat types will be classified into used versus unused based on species detections during the fieldwork. Stratification for random sampling involves classifying Study Zone 4 into the major subtypes (e.g., within a burn, within a human clearing, close to active human disturbance) of predicted primary, secondary and unsuitable habitat patches using the expert information habitat quality model. Including the major subtypes provides replication for the major factors potentially affecting habitat quality. A random sample will be obtained from each of the resulting strata. Since existing borrow areas with open patches may provide a proxy for the efficacy of this mitigation measure, a random sample of borrow areas developed for the Kettle, Long Spruce and Limestone Generation Projects and PR 280 will also be included since most of these still have large barren patches.

Data will be gathered over three years, with each location being sampled in one year only. An annual random sample captures year-to-year variability. Each location will be visited three times during the breeding season to increase detection probability and distinguish frequent use from transient or atypical use. Suitable data from other studies will also be used where appropriate.

Assuming a sufficient number of sample locations are used by common nighthawks to validate and refine the expert information habitat quality model, the refined model will be applied to the terrestrial habitat map, which will be periodically updated to reflect direct and indirect Project effects. See Section 2.0 for the design of the terrestrial habitat mapping updates.

5.7.2.3.4 PARAMETERS

The monitoring parameters are:

- Common nighthawk presence in the sample location;
- Habitat attributes of the sample location;

- The amounts of primary and secondary breeding habitat that are directly and indirectly affected by the Project; and,
- The total amounts of available primary and secondary breeding habitat in Study Zone 4.

5.7.2.3.5 BENCHMARKS

Benchmarks are not applicable for the first study objective since it is documenting habitat associations.

For the second objective, the general EIS approach for bird species at risk was that a 10% loss of existing habitat area for the species was the benchmark that triggered management concern. Common nighthawk habitat effects monitoring will use this as the benchmark for habitat effects. Reductions to habitat effectiveness due to sensory disturbance will be factored into the habitat loss calculations.

5.7.2.3.6 STUDY AREA

Data collection will predominantly occur within Study Zone 4. Periodic mapping of breeding habitat will be limited to Study Zone 4.

5.7.2.3.7 SAMPLE LOCATIONS

Common nighthawk nesting sites are very difficult to detect in the field. The nests are well hidden and the adults do not call on or near the nest. A nesting site is situated within the pair's foraging area, which can be as large as 30 ha or more. Foraging birds make calls and loud "booms", which can be readily detected with audio recorders.

Nest searches within predicted suitable versus unsuitable habitats would be too time consuming to be practicable for a habitat associations study. Since a nesting site is situated within the pair's foraging area, field detections of foraging birds will be used to indicate the general area containing the nest site, and to identify broad habitat associations for nesting habitat. Audio recorders will be placed in large relatively homogenous areas to classify nesting habitat areas into broad habitat types based on observed foraging activity.

Sample locations will be selected as follows:

1. To identify the sampling units:
    a. Classify Study Zone 4 into the major subtypes of nesting habitat, which includes recently burned, old vegetation with many areas of low vegetation and dry ground, mature to old jack pine forest, and low vegetation human disturbance areas. All other terrestrial areas are considered unsuitable habitat.
    b. In a GIS, merge the patches created by the major subtypes of suitable nesting habitat into larger consolidated patches. Classify each consolidated patch into a habitat mixture type (i.e., the predicted nesting habitat types). Remove all consolidated patches that are less than 100 ha in size;
    c. Also classify each nesting habitat and unsuitable habitat patch as either being within Study Zone 3 or outside of it. The resulting combinations of nesting habitat type and within Study Zone 3 form the predicted nesting habitat types.

2. From each of the strata identified in step 1, randomly select at least four habitat patches (i.e., sampling units) for sampling during the year 3 breeding season;
3. Repeat Steps 1 and 2 for the year 4 breeding season; and,
4. Repeat Steps 1 and 2 for the year 5 breeding season.

Step 1 is completed each sampling year to account for habitat loss due to Project construction and for natural events that change terrestrial habitat composition (e.g., wildfires). Map 14 shows the habitat patches available for the random selections.

It is recognized that this study design will not identify the stand level habitat types used for nesting, and may not include all of the nesting habitat types used by common nighthawk because some will be too small to meet the minimum size criterion.

A power analysis completed during the winter of 2018/2019 will determine whether a larger sample size is needed for model validation.

5.7.2.3.8 SAMPLING FREQUENCY AND SCHEDULE

Sampling will occur during the 2016, 2017 and 2018 breeding seasons.

Each sample location will be sampled in one year only.

Audio recorders will be stationary for at least two weeks during the breeding season (June 7 to July 10). Recorders may be moved to other sample locations to optimize the number of recorders and/or to increase the sample size. Determining the minimum stationary period and the number of audio samples per day will be elements of the power analyses.

5.7.2.3.9 FIELD AND LAB METHODS

Stationary audio recorders will be systematically located within each sample location. A recorder will be placed at the center point of 500 m by 500 m grid overlain on the sampling locations. The anticipated detection distance for a recorder is approximately 250 m. The recorders will be programmed to record for 10 minutes at 30 minute intervals between 10:00 p.m. and 4:30 a.m., but adjusted accordingly depending on sunset and sunrise local time.

In the lab, the recorded data will be screened for common nighthawk calls using sound analysis software (e.g., Adobe Audition 2.0). Samples of the common nighthawk recordings will be selected for further processing and analysis.

Frog calls and other regionally rare bird species calls and songs detected in the audio recordings will also be included in the data extraction to provide data for other studies (e.g., frogs, yellow rail, olive-side flycatcher, rusty blackbird).

5.7.2.3.10 ANALYSIS

Habitat patch type is the treatment, the sample locations are the replicates and within versus outside of Study Zone 3 is the primary covariate in the analysis. The listening areas for the audio recorder are the subsamples. Analysis methods will be determined by the nature of the statistical habitat quality model and the structure of the datasets used for analysis. Some of the validation method possibilities include confusion matrices, Kappa statistics and receiver operating characteristic curves. Statistical model and inferential assumptions will be tested during the analyses.

For the Project-affected and available habitat mapping component of this study, the validated habitat quality model will be applied to the terrestrial habitat map periodically produced by the Terrestrial Habitat Clearing, Disturbance and Indirect Effects monitoring (Section 2.1).

5.7.3 HABITAT ENHANCEMENT

5.7.3.1 INTRODUCTION

The Terrestrial Mitigation Implementation Plan includes delineating areas for common nighthawk habitat restoration following borrow area and quarry decommissioning. The location and layout of areas to be retained for common nighthawk habitat will be determined with consideration of other borrow area mitigation measures, including revegetation plans for these areas. Any areas identified for common nighthawk habitat restoration will be clearly identified in the overall revegetation strategy, as outlined in the Vegetation Rehabilitation Plan.

In the EIS, the KHLP made commitments to offset common nighthawk habitat loss by allocating portions of decommissioned borrow sites for common nighthawk nesting (i.e., leaving areas unvegetated, with bare mineral substrate). Due to the widespread creation of common nighthawk breeding habitat resulting from the 2013 wildfires, the value of this mitigation measure has likely lessened; however, a smaller scale program will still be implemented and monitoring through the TEMP will help to determine whether any additional areas should be added throughout the construction phase.

The goal of the habitat enhancement monitoring is to assess the efficacy of leaving areas unvegetated, with bare mineral substrate to provide nesting habitat.

5.7.3.2 OBJECTIVES

The objective of the common nighthawk habitat enhancement monitoring study is to:

- Evaluate whether leaving areas unvegetated, with bare mineral substrate become suitable nesting habitat for common nighthawk.

5.7.3.3 STUDY DESIGN

5.7.3.3.1 OVERVIEW

There is one component to this study. The Habitat Enhancement study will monitor the use of Project areas that are left unvegetated by common nighthawk, with bare mineral substrate as identified in the Terrestrial Mitigation Implementation Plan. Data collection will focus on the common nighthawk response to the potential nesting habitat developed in selected borrow areas.

Leaving areas unvegetated with bare mineral soil to enhance common nighthawk nesting habitat is a novel management prescription. There is a moderate level of uncertainty if managed leave areas can benefit the local common nighthawk population. Although no prescriptive management data are available elsewhere in North America, this species is highly adaptable, as it has nested in cultivated fields, corn and potato fields, orchards, parks and gardens in residential areas and railways. It has also used flat gravel covered roofs in urban areas for nesting. Within the breeding territory, nighthawks will nest on the ground, and it's natural nest sites are associated with, but not limited to forest clearings, rock outcrops, beaches and burned-over areas.

5.7.3.3.2 EXISTING DATA

Common nighthawk occurrence data are described in Section 5.7.2.3.2.

5.7.3.3.3 DESIGN

Since this technique is not established in the literature, this is a proof of concept intervention study. This study will determine if common nighthawk use the unvegetated sites with bare mineral substrate and, if so, the specific environmental attributes of used versus unused areas.

Each borrow area that receives a treatment of unvegetated sites with bare mineral substrate will be sampled for common nighthawk habitat. The fieldwork will occur during the construction and operation phases as borrow areas are decommissioned.

Data for Project-created habitat will be gathered over three years, with each location being sampled each year. Thereafter, each location will be sampled once every three years until such time that the bare patches overgrow naturally with vegetation, or, they are no longer being used by common nighthawks. Each location will be visited three times during the nesting season in mid-June to early July to increase detection probability and separate frequent use from transient or atypical use. The composition, size and distribution of the unvegetated sites with bare mineral substrate will be monitored according to the schedule established during the Terrestrial Rehabilitation and Success Study (Section 3.0).

Suitable data from other studies will also be used where appropriate. For example, common nighthawk habitat effects studies will provide reference data for this study because many of the sample locations will be situated near open habitat types.

See Section 2.0 for the design of the Terrestrial Habitat Clearing, Disturbance and Indirect Effects monitoring study.

5.7.3.3.4 PARAMETERS

The monitoring parameters are:

- Site occupancy, behaviour and use of unvegetated areas with bare mineral substrate by common nighthawk; and,
- The amounts, locations and habitat attributes of the bare mineral substrate in borrow areas.

5.7.3.3.5 BENCHMARKS

There are no benchmarks for this study since it is evaluating a novel management prescription.

5.7.3.3.6 STUDY AREA

Data collection will occur within borrow areas in Study Zone 2.

5.7.3.3.7 SAMPLE LOCATIONS

A sample location consists of a borrow area having prescribed unvegetated sites with bare mineral substrate. The individual openings with bare mineral substrate within a borrow area are the sample units.

All bare mineral substrate sites will be sampled in each year of study.

5.7.3.3.8 SAMPLING FREQUENCY AND SCHEDULE

The specific years when sampling occurs will be determined based on the actual year when unvegetated bare mineral substrates are prescribed in the borrow areas that are being decommissioned.

Each sample location will be sampled over three years, and thereafter, each location will be sampled once every three years until such time as the unvegetated bare mineral substrates overgrow with vegetation, or, it is no longer being used by common nighthawks.

Each sample location will be visited three times during the breeding period. Although specific dates can change from year to year depending on weather, the approximate dates will be from June 7 to July 10. Each visit will be separated by at least 10 days.

5.7.3.3.9 FIELD AND LAB METHODS

Protocols for pre-clearing nest site searches will be used to look for common nighthawk nests. Strip transects will be laid over the search area approximately 10 m apart. Qualified biologists will slowly walk along each transect during morning daylight hours searching the ground for nests. If a nest is found it will be georeferenced and a photograph will be taken of the site. This search technique will be repeated for each site visit.

The composition, size and distribution of the unvegetated bare mineral substrate will be measured and mapped during the Terrestrial Rehabilitation and Success study (Section 3.0).

5.7.3.3.10 ANALYSIS

Basic descriptive statistics will generally be the level of data analysis. Presence/absence analysis, frequency and abundance will be used to describe the local common nighthawk population at the sample locations. An index of abundance over time will be developed to demonstrate the utility of leaving bare mineral substrate in borrow areas. Maps of bare mineral substrate and common nighthawk presence will be used to examine distribution.

5.7.4 REPORTING

5.7.4.1 ANNUAL REPORTS

A report will be produced during the winter after each year when field studies occur, and will be submitted to MCWS the following spring, as per Environment Act License 3107, Clause 20.

Reports will summarize the activities and general findings of the monitoring during the preceding year. Basic descriptive statistics will be the level of data analysis for these reports. Any major unanticipated events or recommendations for changes to study design or mitigation will be noted.

5.7.4.2 SYNTHESIS AND RECOMMENDATIONS

A synthesis report will be produced after the first five years of field studies, after construction completion and after the final planned year for field studies during operation. Synthesis reports will consolidate, analyze and evaluate all monitoring information gathered to date, including that produced by other Keeyask terrestrial studies. These reports will also include recommendations for any needed modifications to subsequent study design or to mitigation. The operation synthesis report will make recommendations regarding the need for any further monitoring.

5.8 OTHER PRIORITY BIRDS

5.8.1 INTRODUCTION

5.8.1.1 BACKGROUND

Other priority birds included in the EIS were ruffed grouse (*Bonasa umbellus*), horned grebe (*Podiceps auritus*), yellow rail (*Coturnicops noveboracensis*), colonial waterbirds, species that occur at the edge of their range, and species that are listed under the Manitoba *Endangered Species and Ecosystems Act* (MESEA), *Species at Risk Act* (SARA), or by the Committee on the Status of Endangered Species in Canada (COSEWIC). Since the EIS, two other species have been added to the priority bird list, including barn swallow (*Hirundo rustica*) and bank swallow (*Riparia riparia*). Project monitoring for colonial waterbirds is covered separately in Section 5.3.

The ruffed grouse is a common upland game bird in Manitoba, and is found at the edge of its range in the Keeyask Region. Because of this, ruffed grouse may be sensitive to habitat changes and other population drivers, making it a priority species. Few ruffed grouse were observed during Keeyask field surveys. Between one and five birds were observed annually from 2001 to 2005. No ruffed grouse were observed in 2006, 2007, and 2013 studies.

The horned grebe has been listed as a species of special concern by COSEWIC and the yellow rail has been listed under Schedule 1 of SARA as a species of special concern. Both the horned grebe and yellow rail are reliant on wetland and aquatic habitat, which are being lost and altered in Canada. As a result of these species' reliance on aquatic habitat, it is a priority species for this study. No yellow rails were detected in Keeyask Generation Station EIS field studies, and only one horned grebe was observed.

The barn swallow and bank swallow are both been listed as threatened by COSEWIC. The bank swallow is reliant on aquatic habitat and steep banks, a habitat that is being lost and altered in Canada. The availability of nesting habitat is a major factor limiting the size and distribution of breeding populations. The barn swallow relies on human structure as habitat. This species is rare at Keeyask because it is located towards the northern fringe of its range. The magnitude and geographic extent of the decline are cause for conservation concern. As a result of these species' reliance on aquatic habitat, rare habitat, and concern for population declines, bank and barn swallows have been designated as a priority species for this study.

5.8.1.2 ASSESSMENT SUMMARY

The main drivers and stressors for ruffed grouse include land clearing, forest fires, vehicle traffic, creation of linear features, sensory disturbance, and extreme weather events. These drivers and stressors can affect ruffed grouse habitat or affect their abundance and distribution.

Clearing and site preparation in the Project Footprint is predicted to result in the loss of 70 ha (10%) of ruffed grouse breeding habitat (i.e., mixedwood forest with dense shrub understorey). Although ruffed grouse are somewhat tolerant of noise and visual disturbances, some effective habitat may also be lost as a result of sensory disturbance around construction sites. An additional 65 ha (8%) may be affected during operation from peatland disintegration, and changes in groundwater levels, resulting in vegetation changes. Ruffed grouse habitat is also anticipated to develop in some of the decommissioned borrow areas and may offset some lost habitat. The changes to ruffed grouse habitat are not expected to have an effect on local populations.

Land clearing and the construction of linear features may attract some ruffed grouse to these features in search of grit and forage. Attraction to linear features, such as roads, may result in increased mortality from vehicle collisions and increased hunting vulnerability. With mitigation, these developments are not anticipated to have a measurable effect on the regional population.

Mitigation will be used in an attempt to offset habitat loses caused by the Project. In addition to mitigation measures described for all birds in Section 5.0, specific ruffed grouse mitigation measures will include the prohibition of hunting by Project staff onsite (this includes along access trails).

Limiting factors for rare species at the fringe of their range, in part, likely involves habitat availability. The main drivers and stressors for other priority birds in the Keeyask Region that use shore zone habitat, such as the horned grebe and yellow rail, include sensory disturbance, changes to the water regime, and extreme weather events. Additionally, reservoir clearing activity could potentially result in the loss of breeding habitat for bank swallows, if earthen banks are disturbed and bank nests collapse. These drivers and stressors can affect bank swallow, barn swallow, horned grebe and yellow rail habitat or affect their abundance and distribution.

For species of priority birds that use aquatic habitat, Project construction is predicted to cause the loss of effective and physical habitat at Gull Rapids and in Gull Lake. The loss of gull and tern habitat is described in Section 5.3. During Project operation, peatland disintegration and inundation of shorelines will result in the loss of habitat for horned grebe, yellow rail, and other bird species that use shoreline habitat.

Other drivers that may influence priority birds include forest fires, climate change, predation, disease and parasites, accidents, and extreme weather events. Due to the wide variety of priority bird species, these drivers will have varied effects.

5.8.1.3 COMPONENTS THAT WILL BE MONITORED

The availability of suitable breeding habitat (which includes nesting, shelter and foraging habitats used during the breeding season) is the driver expected to have the greatest influence on yellow rail, horned grebe, barn swallow, bank swallow and ruffed grouse distribution and abundance in the Keeyask Region. Other drivers potentially influencing these species distribution and abundance, but to a much lesser degree include:

- Predation by other birds (e.g., gray jay, raptors) or mammals (e.g., red squirrel);
- Mortality as a result of collisions with vehicle traffic or Project structures;
- Mortality from harvest (i.e., ruffed grouse);
- Mortality from extreme weather events;
- Malnutrition from arriving in the Keeyask Region after the spring insect hatch;
- Project-related hydrological, or other changes that alter insect community composition; and,

- Sensory disturbance from equipment, blasting and other human activities that may cause individuals to avoid nesting within and adjacent to infrastructure and activity zones, or to reduce foraging time in preferred habitats within these zones.

Project influences on all of the non-habitat drivers are expected to be very low.

On this basis, and because the EIS predicted that residual Project effects will be negligible to small in magnitude and cumulative effects will be below the ecological benchmarks, monitoring studies for yellow rail, horned grebe, barn swallow, bank swallow and ruffed grouse will continue to focus on verifying the Project effects predictions that have the greatest potential for altering the EIS conclusions if inaccurate. The associated concerns include:

- Verifying if there is habitat for yellow rail and horned grebe, and barn swallow; and,
- Quantifying how much breeding habitat for ruffed grouse and bank swallow is lost or altered due to the Project.

The Yellow Rail study (Section 5.8.2) will determine if yellow rail are present in the study area.

The Horned Grebe study (Section 5.8.3) will determine if horned grebe are present in the study area.

The Ruffed Grouse study (Section 5.8.4) will evaluate habitat effects in terms of habitat availability, and how changes to habitat availability affect ruffed grouse distribution and abundance.

The Barn Swallow study (Section 5.8.5) will determine if barn swallow are present in the study area.

The Bank Swallow study (Section 5.8.6) will evaluate habitat effects in terms of habitat availability, and how changes to habitat availability affect bank swallow distribution and abundance.

Accidental mortality from sources such as collisions with vehicles and the communication tower is also included in this monitoring program even though is not a substantial concern as it can be monitored with minimal effort using information collected by other studies. Qualitative estimates for how Project-related harvest mortality affects ruffed grouse abundance will use information gathered by the Resource Use Monitoring Plan. A study design is not required for this component of priority bird species monitoring.

Compliance monitoring relating to pre-clearing nest searches is described in the Avian Management Plan, implemented under the Project's Generating Station and South Access Road Construction Environmental Protection Plans (EnvPPs).

Relevant yellow rail, horned grebe, barn swallow, bank swallow and ruffed grouse information obtained by all terrestrial and resource use monitoring will be periodically consolidated, analyzed and evaluated in a synthesis report to provide an integrated comparison of predicted and actual Project effects on these species.

5.8.2 YELLOW RAIL

5.8.2.1 INTRODUCTION

Although yellow rail were not detected over the course of pre-Project field studies (2001-2014), they do have a limited potential to breed within Study Zone 4 (Map 3) and be subjected to Project effects. Potential construction-related effects on yellow rail include short-term habitat avoidance due to construction-related noise and human activities. No Project-related effects are anticipated for yellow rail during the operation period.

The goals of the yellow rail monitoring program is to continue re-evaluating whether any suitable habitat exists in the Keeyask Region and to assess potential mortality. Accidental mortality is included in this monitoring study even though it is not a substantial concern because it can be monitored with minimal effort using information collected by other studies.

5.8.2.2 OBJECTIVES

The objectives of this study are:

- To determine yellow rail presence in Study Zone 4;
- If yellow rails are detected in sufficient numbers, design a long-term monitoring program suited to verifying the EIS predictions, and,
- Qualitatively estimate how Project-related accidental mortality affects yellow rail abundance.

5.8.2.3 STUDY DESIGN

5.8.2.3.1 OVERVIEW

There are three components to this study. Although yellow rails were not detected over the course of pre-Project field studies (2001–2014), they have a limited potential to breed within Study Zone 4 and be subjected to Project effects. The first component is to continue determining yellow rail presence or absence in Study Zone 4. The second component would design a study so that if individuals were detected, to expand sampling effort and consider developing a design that may be sufficient to verify elements of the EIS predictions. Finally, accidental mortality will be qualitatively monitored through the Bird Collisions with Lighted Towers study (Section 5.9).

5.8.2.3.2 EXISTING DATA

Other priority bird occurrence and habitat data were collected from 2001 to 2014 for environmental assessment and monitoring studies associated with the KIP, and the Keeyask Generation and Transmission Projects. During this time, breeding bird surveys were conducted at over 1,400 point-count plots, with some plots being surveyed in multiple years. Point-counts were conducted at 197 stops in 2001, 226 stops in 2002, 336 stops in 2003, 58 stops in 2004, 135 stops in 2005, 118 stops in 2006, and 126 stops in 2007. In 2012 and 2013, point-counts were conducted at 37 and 120 stops, respectively. Point counts were conducted at 71 stops in 2011 and 2012 and at 80 stops in 2013 for the KIP monitoring. Forty recording units were deployed in 2012 and 2013 to determine the presence of species at risk, particularly those that are nocturnally active, such as yellow rail. No yellow rails were detected.

Boat-based surveys were conducted in spring, summer, and fall 2001 to 2003, and in 2011. A total of 833 km was surveyed in 2001, 294 km in 2002, 220 km in 2003, and 156 km^2 in 2011. Helicopter surveys were conducted in 2001 to 2003, 2001, 2011, and 2013. A total of 2,110 km of shoreline was surveyed in 2001, 889 km in 2002, 2,523 km in 2003, 201 km in 2006, 1,708 km² in 2011, and 439 km in 2013. No yellow rails were detected.

Many of the breeding bird survey plots situated west of Stephens Lake were either burned in the 2005 and 2013 fires, cleared during KIP construction or will be cleared during Project construction.

5.8.2.3.3 DESIGN

Yellow rail, considered a 'secretive marsh bird', are difficult to detect visually and not often detected during early morning breeding-bird surveys. Since males tend to call primarily at night, the use of standardized night surveys with call broadcast methods is the preferred approach to detect this species. However, passive listening methods at night are also effective in detecting the presence of this species if done frequently. Yellow rails also tend to arrive earlier in the breeding period than other boreal forest birds. At Keeyask, early May to early June would likely be the most suitable detection period.

A statistical design is not required for this monitoring program. Suitable data from other studies will be used where appropriate. For example, bird studies will provide reference data for this study because all of the rusty blackbird and many of the olive-sided flycatcher sample locations will be situated near open water, bogs and fens. Stationary audio recorders employed in these studies will also be programmed to record sounds during the peak frog calling periods at night. Hand held and additional stationary audio recorders will be used at the remaining sample locations. Sites in the vicinity of the Project construction areas are the focus of these studies. Refer to Sections 5.5, 5.6, and 5.7 for the collection of potential yellow rail data.

5.8.2.3.4 PARAMETERS

The monitoring parameters are:

- Yellow rail presence in the sample location; and,
- Number of yellow rails affected by strikes with the communications tower (contingent upon birds being detected in the study area).

5.8.2.3.5 BENCHMARKS

Benchmarks are not applicable for this study since it is documenting whether or not the species is present and, if so, mortality. The target is that there be no Project-related mortality for this species.

5.8.2.3.6 STUDY AREA

Data collection from other studies that provide information on yellow rail will occur within Study Zone 4, and predominantly within Study Zone 3.

5.8.2.3.7 SAMPLE LOCATIONS

There are no sample locations specifically for yellow rail since other bird studies are providing the required data.

5.8.2.3.8 SAMPLE FREQUENCY AND SCHEDULE

There is no fieldwork for this study. Data from other studies will be reviewed annually during the construction and operation periods, as available.

5.8.2.3.9 FIELD AND LAB METHODS

There is no fieldwork for this study.

Automated recording units and hand-held recording units from other studies will be screened for yellow rail calls during peak calling times (dusk to dawn) in May and early June using sound analysis software (e.g., Adobe Audition 2.0).

5.8.2.3.10 ANALYSIS

The analysis methods and inferential approach will be determined by the final sampling design and the structure of the datasets used for analysis.

5.8.3 HORNED GREBE

5.8.3.1 INTRODUCTION

Horned grebe, identified as a priority bird, has been named a species of special concern by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). Only one horned grebe was detected over the course of pre-Project field studies (2001-2014), and as such, have a limited potential to breed within Study Zone 4 (Map 3) and be subjected to Project effects. The potential Project-related construction effects are a reduction in and degradation of nesting and foraging habitat.

No Project-related effects are anticipated for horned grebe during the operation period.

The goals of the horned grebe monitoring program is to continue re-evaluating whether any suitable habitat exists in the Keeyask area and to assess mortality. Accidental mortality is included in this monitoring study because even though it is not a substantial concern, it can be monitored with minimal effort using information collected by other studies.

5.8.3.2 OBJECTIVES

The objectives of this study are:

- To determine horned grebe presence in the study area;
- If horned grebe are detected in sufficient numbers, to design a long-term monitoring program suited to verifying the EIS predictions, and,
- To qualitatively estimate how Project-related accidental mortality affects abundance.

5.8.3.3 STUDY DESIGN

5.8.3.3.1 OVERVIEW

There are three components to this study. Although horned grebe were detected over the course of pre-Project field studies (2001–2014), only a single individual was detected at one location, and therefore this species has limited potential to breed within Study Zone 4 and to be subjected to Project effects. The first component is to continue evaluating horned grebe presence or absence in Study Zone 4. No field surveys are required for this study as aerial surveys for detecting horned grebes will occur in conjunction with Canada goose aerial surveys (Section 5.2.3). The second component would be developed if individuals were detected, and would include a study to expand sampling effort and consider developing a design that would be sufficient to verify elements of the EIS predictions. Finally, accidental mortality will be qualitatively monitored through the Bird Collisions with Lighted Towers study (Section 5.9). Road mortalities are not of concern for the horned grebe.

5.8.3.3.2 EXISTING DATA

Previous sampling efforts for horned grebe are the same as outlined for Canada goose (Section 5.2.2.2). Canada goose and mallard abundance and habitat data were collected from 2001 to 2014 for environmental assessment and monitoring studies associated with the KIP, and the Keeyask Generation and Transmission Projects. Helicopter and boat-based surveys were conducted along the Nelson River and in off-system areas during the spring, summer and fall. Only one horned grebe was observed during these pre-Project surveys.

5.8.3.3.3 DESIGN

A statistical design is not required for this monitoring program. Suitable data from other studies will be used where appropriate. For example, waterfowl monitoring studies will provide reference data for this study because of wetland habitat similarities between mallard, Canada goose and horned grebe. Other studies that include the use of stationary audio recorders will also record sounds for this species.

5.8.3.3.4 PARAMETERS

The monitoring parameters are:

- Horned grebe presence in the sample location; and,
- Number of horned grebe affected by strikes at the communications tower (contingent upon birds being detected in the study area).

5.8.3.3.5 BENCHMARKS

Benchmarks are not applicable for this study since it is documenting whether or not the species is present and, if so, mortality. The target is that there be no Project-related mortality for this species.

5.8.3.3.6 STUDY AREA

Data collection from other studies that provide information on horned grebe will occur within Study Zone 4, and predominantly within Study Zone 3.

5.8.3.3.7 SAMPLE LOCATIONS

There are no sample locations since other bird studies are providing the required data.

5.8.3.3.8 SAMPLE FREQUENCY AND SCHEDULE

There is no fieldwork for this study. Data from other studies will be reviewed annually during the construction and operation periods as available.

5.8.3.3.9 FIELD AND LAB METHODS

There is no fieldwork for this study.

Automated recording units and hand-held recording units from other studies will be screened for horned grebe calls recorded in May and June from other bird and frog studies using sound analysis software (e.g., Adobe Audition 2.0).

5.8.3.3.10 ANALYSIS

The analysis methods and inferential approach will be determined by the final sampling design and the structure of the datasets used for analysis.

5.8.4 RUFFED GROUSE

5.8.4.1 INTRODUCTION

Ruffed grouse, considered a species at the edge of their range, are a year-round resident with a limited distribution in Study Zone 4 (Map 3). For these reasons, ruffed grouse is a priority bird. Grouse have also been identified as important birds that are harvested by the KCNs. Anticipated Project construction-related effects are considered to be loss and alteration of some foraging or breeding habitat and possible increased mortality due to access road traffic and increased harvest pressure due to increased access.

As outlined in the EIS, potential Project effects during operation would be due to increased traffic and access anticipated through an area of primary ruffed grouse habitat along the north access road. However, at this time, no Project-related effects are anticipated during the operation period since wildfires in 2013 have temporarily removed much of that former habitat.

The goals of the ruffed grouse monitoring program are to continue re-evaluating whether any suitable habitat exists in the study area and to assess both accidental and harvest mortality. Accidental mortality is included in this monitoring study because even though it is not a substantial concern, it can be monitored with minimal effort using information collected by other studies.

5.8.4.2 OBJECTIVES

The objectives of this study are to:

- Evaluate whether ruffed grouse can be detected in sufficient numbers to verify the habitat quality model, and,

- Qualitatively estimate how Project-related harvest and accidental mortality affects abundance.

5.8.4.3 STUDY DESIGN

5.8.4.3.1 OVERVIEW

There are two components to this study. The first component is to evaluate whether the ruffed grouse habitat quality model can be verified in order to confirm Project effects on ruffed grouse habitat in Study Zone 4 in suitable habitat areas using remote audio-recording techniques to enhance existing datasets. The second component of this study uses information provided by other studies to qualitatively estimate accidental and harvest mortality. Accidental mortality is included in this monitoring study even though it is not a substantial concern because it can be monitored with minimal effort using information collected by other studies.

5.8.4.3.2 EXISTING DATA

Ruffed grouse occurrence and habitat data were collected from 2001 to 2014 as an element of environmental assessment and monitoring studies associated with the Keeyask Infrastructure, Generation and Transmission Projects. During this time, breeding bird surveys were conducted at over 1,400 point-count plots, with some plots being surveyed in multiple years. Point-counts were conducted at 197 stops in 2001, 226 stops in 2002, 336 stops in 2003, 58 stops in 2004, 135 stops in 2005, 118 stops in 2006, and 126 stops in 2007. In 2012 and 2013, point-counts were conducted at 37 and 120 stops, respectively. Point counts were conducted at 71 stops in 2011 and 2012 and at 80 stops in 2013 for the KIP monitoring. Forty recording units were deployed in 2012 and 2013 to determine the presence of species at risk.

Ruffed grouse drumming surveys were conducted at 24 stops in 2012.

5.8.4.3.3 DESIGN

There are two components to this study. Because ruffed grouse were rarely detected during Project field studies (2001–2014) despite a relatively high degree of sampling effort, and as suitable habitat appears to be limited in the study area, a scientifically credible statistical design to validate or verify the habitat suitability model is not feasible at this time. Therefore, the first component is to continue evaluating ruffed grouse presence or absence in Study Zone 4 in expected primary habitat areas. Ruffed grouse breeding displays occur in April and May, and therefore, the ability of other bird studies included in TEMP to detect ruffed grouse is limited. Road survey opportunities to detect individuals using drumming counts in spring along the north access road have been exhausted. As such, ruffed grouse detection studies will target the remaining primary habitat types that have not been affected by the 2013 fire.

To quantify and situate ruffed grouse habitat, the EIS classified the following terrestrial habitat and surface water types into ruffed grouse breeding habitat:

- Broadleaf forests with downed woody debris measuring 35–40 cm in diameter; and,
- Dense, tall shrub understory with stem densities of 18,000-20,000 stems/acre.

This classification, or expert information model, indicated that primary and secondary breeding habitat for ruffed grouse is limited within Study Zone 4. Clearing and site preparation in the Project footprint is predicted to result in the loss of 70 ha (10%) of ruffed grouse breeding habitat (i.e., mixedwood forest with dense shrub understorey). Although ruffed grouse are somewhat tolerant of noise and visual disturbances, some effective habitat may also be lost as a result of sensory disturbance around construction sites. An additional 65 ha (8%) may be affected during operation from peatland disintegration, and changes in groundwater levels, resulting in vegetation changes.

Primary ruffed grouse breeding habitats will be mapped in Study Zone 4, and locations selected as described in Section 5.8.4.3.7. Remote audio-recording units will be used to detect the presence of ruffed grouse. These units will be programmed to sample a minimum of 3 times for a 10-minute period, once per hour during the early morning, generally between 4:30 a.m. and 88:30 a.m. depending on local sunrise times. Recorders will be located strategically within a breeding habitat patch. Because ruffed grouse populations cycle over a 10-year period, the sample frequency and schedule will be adjusted to this cycle to maximize detections during low and high portions of the cycle. If enough individuals are detected over time, it will be feasible to verify elements of the habitat quality model.

Regarding the first component, the EIS used an expert information model to classify terrestrial habitat and surface water types into primary, secondary and unsuitable habitat for ruffed grouse. This expert information model was developed from field data collected in the Keeyask Region, relevant scientific literature and professional judgement.

Following this, the validated, and possibly refined habitat quality model will be applied to the post-Project terrestrial habitat map to quantify and situate primary and secondary breeding habitat. Permanent and temporary breeding habitat loss due to Project infrastructure and indirect Project effects on terrestrial habitat and surface water types that are inputs into the habitat quality model will be determined from Terrestrial Habitat Clearing, Disturbance and Indirect Effects monitoring (Section 2.1). This general approach will also determine alterations to the quantities and qualities of various breeding habitat types.

The second component of this study is accidental and harvest mortality. Monitoring will be limited to roads associated with the Project. The Site Environmental Lead will provide the wildlife biologist with reports about accidental wildlife-vehicle collisions for review. Resource harvest mortality by the Project construction workforce will be obtained from the Resource Use Monitoring Plan. Available data and reports from ATK monitoring plans will be used to corroborate the findings of this study.

5.8.4.3.4 PARAMETERS

The monitoring parameters are:

- Ruffed grouse presence in the sample location;
- Habitat attributes of locations that are sampled; and,
- Number of ruffed grouse harvested and killed accidentally.

5.8.4.3.5 BENCHMARKS

Benchmarks are not applicable for the first objective of this study since it is documenting whether or not the species is present in sufficient numbers to estimate a habitat quality model.

For the second objective, the target is that there be no Project-related mortality for this species.

5.8.4.3.6 STUDY AREA

Data collection will predominantly occur within Study Zone 4. Some validation samples may be collected outside of Study Zone 4. Periodic mapping of breeding habitat, if feasible, will be limited to Study Zone 4.

5.8.4.3.7 SAMPLE LOCATIONS

A sample location consists of a habitat patch that is large enough to support a ruffed grouse nesting territory. These will generally be mixtures of different terrestrial habitat and surface water types.

Sample locations will be selected as follows:

1. To identify the sampling units and strata for random selection, classify Study Zone 4 into the major subtypes of primary, secondary and unsuitable habitat patches by applying the expert information habitat quality model to the terrestrial habitat map (which includes surface water types);
2. From each of the strata identified in step 1, randomly select four habitat patches (i.e., the sampling units) for sampling during the year 3 breeding season;
3. Repeat Steps 1 and 2 for the year 6 breeding season; and,
4. Repeat Steps 1 and 2 for the year 9 breeding season.
5. Repeat Steps 1 and 2 for the year 12 breeding season.
6. Repeat Steps 1 and 2 for the year 15 breeding season.

Step 1 is completed each sample year to account for habitat loss due to Project construction and for natural events that change terrestrial habitat composition (e.g., wildfires). The number of years sampled will carry over two peaks of the ruffed grouse cycle.

A power analysis is not contemplated at this time since the number of observed individuals and habitat units are expected to be too low for statistical inference.

There are no sample locations for mortality monitoring since other studies are providing the required data.

5.8.4.3.8 SAMPLE FREQUENCY AND SCHEDULE

Sampling will begin in the 2016 breeding season during construction and continue every 3 years until 2022.

Each sample location will be sampled in one year only.

Each sample location will be sampled once during the breeding season. The recorders will be left out for at least 2 weeks in the primary breeding (i.e., drumming) season (April and May) before they are moved to other sites.

There is no fieldwork for the mortality portion of this study.

5.8.4.3.9 FIELD AND LAB METHODS

For the sample locations selected for the study, two microphone array audio recorders will be placed centrally in the potential habitat at distances of 400 m apart. These positions will provide complete audio coverage for a 200 m wide band extending 600 m through a potential ruffed grouse territory, which captures an area of approximately 12 ha (a typical ruffed grouse pair territory is about 4 ha).

In the lab, the recorded data will be screened for ruffed grouse drumming using sound analysis software (e.g., Adobe Audition 2.0). An hourly and daily sample of the ruffed grouse recordings will be selected for further processing and analysis. The amplitude (i.e., decibels) statistics of each song will be extracted from the microphone array recordings. Summary statistics and triangulation will be used to estimate the direction and distance to the bird given that the bird call was recorded from the fixed and known location of the audio recording unit. Multiple spatial positions of each grouse within its territory will be mapped using GIS software.

5.8.4.3.10 ANALYSIS

The sample locations are the replicates, the audio recording areas are the subsamples, habitat patch type is the treatment and native versus human-affected is the primary covariate in the analysis. Analysis methods will be determined by the nature of the habitat quality model and the structure of the datasets used for analysis. Some of the validation method possibilities include confusion matrices, Kappa statistics and receiver operating characteristic curves. Statistical model and inferential assumptions will be tested during the analysis.

For the Project-affected and available habitat mapping component of this study, if sufficient field data can be collected to validate and refine the habitat quality model, then the refined model will be applied to the terrestrial habitat map periodically produced by Terrestrial Habitat Clearing, Disturbance and Indirect Effects monitoring (Section 2.1).

5.8.5 BARN SWALLOW

5.8.5.1 INTRODUCTION

Barn swallow, identified as a priority bird, has been designated as threatened by COSEWIC. Only four barn swallows were detected over the course of pre-Project field studies (2001-2014), and as such, have a limited potential to breed within Study Zone 4 (Map 3) and be impacted by Project effects. The potential Project-related construction effects on barn swallows are sensory disturbances from people, machinery and equipment. As barn swallow rely on human infrastructure for nesting, habitat in the Study Zone 1 is expected to increase. No Project-related effects are anticipated for barn swallow during the operation period.

The goals of the barn swallow monitoring program is to evaluate whether any suitable habitat exists in the Keeyask area and to assess mortality. Accidental mortality is included in this monitoring study because even though it is not a substantial concern, it can be monitored with minimal effort using information collected by other studies.

5.8.5.2 OBJECTIVES

The objectives of this study are:

- To determine if barn swallows are present in Study Zone 4;

- If barn swallows are detected in sufficient numbers, design a long-term monitoring program suited to verifying Project effects and,
- Qualitatively estimate how Project-related accidental mortality affects barn swallow abundance.

5.8.5.3 STUDY DESIGN

5.8.5.3.1 OVERVIEW

There are three components to this study. Although barn swallows were detected over the course of pre-Project field studies (2001–2014), only four individuals were detected, and therefore this species has limited potential to breed within Study Zone 4 and be impacted by Project effects. The first component is to determine barn swallow presence or absence in Study Zone 4. The second component would design a study so that if individuals were detected, to expand sampling effort and consider developing a design that may be sufficient to verify potential Project effects. Finally, accidental mortality will be qualitatively monitored through the Bird Collisions with Lighted Towers study (Section5.9).

5.8.5.3.2 EXISTING DATA

Other priority bird occurrence and habitat data were collected from 2001 to 2014 for environmental assessment and monitoring studies associated with the KIP, and the Keeyask Generation and Transmission Projects. During this time, breeding bird surveys were conducted at over 1,400 point-count plots, with some plots being surveyed in multiple years. Point-counts were conducted at 197 stops in 2001, 226 stops in 2002, 336 stops in 2003, 58 stops in 2004, 135 stops in 2005, 118 stops in 2006, and 126 stops in 2007. In 2012 and 2013, point-counts were conducted at 37 and 120 stops, respectively. Point counts were conducted at 71 stops in 2011 and 2012 and at 80 stops in 2013 for the KIP monitoring. Forty recording units were deployed in 2012 and 2013 to determine the presence of species at risk. Only four barn swallows were detected over the course of pre-Project field studies (2001-2014).

Many of the breeding bird survey plots situated west of Stephens Lake were either burned in the 2005 and 2013 fires, cleared during KIP construction or will be cleared during Project construction.

5.8.5.3.3 DESIGN

Barn swallow are easy to detect visually and by vocalizations during early morning breeding-bird surveys. Nests are easy to detect as well since most nests are built inside or are attached to human infrastructure. Birds vocalize in the morning, and often throughout the day into the evening, and therefore, passive listening methods are effective in detecting the presence of this species if done frequently. At Keeyask, early June to early July would likely be the most suitable detection period.

A statistical design is not required for this monitoring program. Suitable data from other studies will be used where appropriate. For example, personnel travelling throughout the Keeyask camp area are highly likely to observe birds or nests if present in the construction areas. Second, bird studies will provide reference data for this study because all of the rusty blackbird and many of the olive-sided flycatcher sample locations will be situated near riparian habitats and marsh which are preferred feeding areas for barn swallow. Stationary audio recorders employed in these studies will be programmed to record sounds during morning hours. Hand held and additional stationary audio recorders will be used at the remaining sample locations. Sites in the vicinity of the Project construction areas are the focus of these studies. Refer to Sections 5.5, 5.6, and 5.7 for the collection of potential barn swallow data.

5.8.5.3.4 PARAMETERS

The monitoring parameters are:

- Barn swallow presence in the sample location; and,
- Number of barn swallows affected by strikes with the communications tower (contingent upon birds being detected in the study area).

5.8.5.3.5 BENCHMARKS

Benchmarks are not applicable for this study since it is documenting whether or not the species is present and, if so, mortality. The target is that there be no Project-related mortality for this species.

5.8.5.3.6 STUDY AREA

Data collection from other studies that provide information on barn swallow will occur within Study Zone 4, and predominantly within Study Zone 3.

5.8.5.3.7 SAMPLE LOCATIONS

There are no sample locations specifically for barn swallow since other bird studies are providing the required data.

5.8.5.3.8 SAMPLE FREQUENCY AND SCHEDULE

There is no fieldwork for this study. Data from other studies will be reviewed annually during the construction and operation periods, as available.

5.8.5.3.9 FIELD AND LAB METHODS

There is no fieldwork for this study.

Automated recording units and hand-held recording units from other studies will be screened for barn swallow calls during peak calling times (morning) in June using sound analysis software (e.g., Adobe Audition 2.0).

5.8.5.3.10 ANALYSIS

The analysis methods and inferential approach will be determined by the final sampling design and the structure of the datasets used for analysis.

5.8.6 BANK SWALLOW

5.8.6.1 INTRODUCTION

Bank swallow is a priority bird because it is designated as threatened by COSEWIC. The maximum number of bank swallows detected over the course of pre-Project field studies (2001-2014) in a single year was 65 individuals. These birds were distributed at three sites, and as such, have a limited potential to breed within Study Zone 4 (Map 3) and be subjected to Project effects. Anticipated Project construction-related effects are considered to be loss and alteration of some foraging or breeding habitat and possible increased mortality due to access road traffic. The potential Project-related construction effects also include sensory disturbances from people, machinery and equipment in borrow areas where colonies might become established. No Project-related effects are anticipated for bank swallows during the operation period.

The goals of the bank swallow monitoring program are to evaluate how much suitable habitat exists in the Keeyask area and to assess mortality. Accidental mortality is included in this monitoring study because even though it is not a substantial concern, it can be monitored with minimal effort using information collected by other studies.

5.8.6.2 OBJECTIVES

The objectives of this study are:

- Develop a habitat quality model for bank swallow;
- Evaluate whether bank swallow can be detected in sufficient numbers to verify the habitat quality model, and,
- Qualitatively estimate how Project-related accidental mortality affects bank swallow abundance.

5.8.6.3 STUDY DESIGN

5.8.6.3.1 OVERVIEW

There are two components to this study. Although bank swallows were detected over the course of pre-Project field studies (2001–2014), only a limited number of individuals were detected, and therefore this species has limited potential to breed within Study Zone 4 and to be subjected to Project effects. The first component is to evaluate whether a new expert information bank swallow habitat quality model can be developed and verified in order to confirm Project effects on bank swallow habitat in Study Zone 4 in suitable habitat areas using visual observations to enhance existing datasets. The second component, accidental mortality, is included in this monitoring study even though it is not a substantial concern because it can be monitored with minimal effort using information collected by other studies (Bird Collisions with Lighted Towers study, Section 5.9).

5.8.6.3.2 EXISTING DATA

Other priority bird occurrence and habitat data were collected from 2001 to 2014 for environmental assessment and monitoring studies associated with the KIP, and the Keeyask Generation and Transmission Projects. During this time, breeding bird surveys were conducted at over 1,400 point-count plots, with some plots being surveyed in multiple years. Point-counts were conducted at 197 stops in 2001, 226 stops in 2002, 336 stops in 2003, 58 stops in 2004, 135 stops in 2005, 118 stops in 2006, and 126 stops in 2007. In 2012 and 2013, point-counts were conducted at 37 and 120 stops, respectively. Point counts were conducted at 71 stops in 2011 and 2012 and at 80 stops in 2013 for the KIP monitoring. Forty recording units were deployed in 2012 and 2013 to determine the presence of species at risk.

Boat-based surveys were conducted in spring, summer, and fall 2001 to 2003, and in 2011. A total of 833 km was surveyed in 2001, 294 km in 2002, 220 km in 2003, and 156 km² in 2011. Helicopter surveys were conducted in 2001 to 2003, 2001, 2011, and 2013. A total of 2,110 km of shoreline was surveyed in 2001, 889 km in 2002, 2,523 km in 2003, 201 km in 2006, 1,708 km² in 2011, and 439 km in 2013.

Flocks of bank swallows were common along the Nelson River east of Kettle Rapids, and were observed foraging adjacent to steep riverbank cliffs in 2002, 2003 and 2011. Fourteen, 5 and 24 bank swallows were observed on Stephens Lake in 2001, 2002 and 2003 respectively. Forty birds were observed along the south shore of Stephens Lake, 2 at Clark Lake and 23 in Gull Lake in 2011.

Many of the breeding bird survey plots situated west of Stephens Lake were either burned in the 2005 and 2013 fires, cleared during KIP construction or will be cleared during Project construction.

5.8.6.3.3 DESIGN

There are two components to this study. Because bank swallows were rarely detected during Project field studies (2001–2014) despite a relatively high degree of sampling effort, and as suitable habitat appears to be limited and potentially ephemeral in the study area, a scientifically credible statistical design to verify a newly developed habitat model is not feasible at this time. Therefore, the first component is to continue evaluating bank swallow presence or absence in Study Zone 4 in expected primary habitat areas. Because bank swallow nesting occurs in June and July, the ability of other bird studies included in TEMP to detect bank swallow is increased.

Areas thought to provide primary bank swallow nesting habitat and that will be searched include:

- Cliffs or banks greater than 2 m tall with an incline of less than 7 degrees from vertical;
- Sandy substrate with no vegetation;
- Adjacent to foraging areas generally next to water; and,
- Actively worked sand and gravel borrow areas.

Clearing and site preparation in the Project footprint is predicted to result in some loss of bank swallow nesting habitat, the approximate quantity to be determined after an expert information GIS model is developed in early 2016. Second, bank swallows tend to tolerate human activity as they are known to nest in and frequent borrow areas that have suitable cliffs and soil; however, some effective habitat may also be lost as a result of sensory disturbance around heavy construction sites. Habitat is unlikely to be affected during operation because bank swallow rely on soil erosion to maintain steep nesting cliffs or banks.

Primary bank swallow nesting habitats will be mapped in Study Zone 4, and locations selected as described in Section 5.8.4.3.7. Binocular sweeps and visual observations will be used to detect the presence of a bank swallow colony. Sampling will occur in the morning during daylight hours, and end by 12:00 p.m. At Keeyask, mid-June and July is the most suitable detection period. Because bank swallow colonies are somewhat ephemeral and prone being created by erosion or possibly ice scour, the sample frequency and schedule will be adjusted to maximize detections. If enough colonies are detected over time, it will be feasible to verify elements of the habitat quality model.

Regarding the first component, the expert information model developed in early 2016 will classify terrestrial habitat and surface water types into primary and unsuitable habitat for bank swallow. This expert information model will be validate from field data collected in the Keeyask Region, relevant scientific literature and professional judgement.

Following this, the validated habitat quality model will be applied to the post-Project terrestrial habitat map to quantify and situate primary nesting habitat. Permanent and temporary nesting habitat loss due to Project infrastructure and indirect Project effects on terrestrial habitat and surface water types that are inputs into the habitat quality model will be determined from Terrestrial Habitat Clearing, Disturbance and Indirect Effects monitoring (Section 2.1). This general approach will also determine alterations to the quantities and qualities of various habitat types.

This study will also evaluate accidental mortality from sources such as collisions with vehicles and the radio communication tower. The radio communication tower is included in this study even though is not a substantial concern as it can be monitored with minimal effort using information collected by other studies. Qualitative estimates for how Project-related accidental mortality affects bank swallow abundance will use information gathered by other studies and site reports (e.g., Bird Collisions with Lighted Towers study; see Section 5.9). A study design is not required for this component of the priority bird species monitoring program.

A statistical design is not required for this monitoring program. Suitable data from other studies will be used where appropriate. For example, bird studies will provide some reference data for this study because all of the rusty blackbird and many of the olive-sided flycatcher sample locations will be situated near riparian habitats and marsh which are preferred feeding areas for bank swallow. Binocular sweeps will be used at the remaining sample locations. Sites in the vicinity of the Project construction areas are the focus of these studies.

5.8.6.3.4 PARAMETERS

The monitoring parameters are:

- Bank swallow presence in the sample location;
- Habitat attributes of locations that are sampled; and,
- Number of bank swallows affected by strikes with the communications tower (contingent upon birds being detected in the study area).

5.8.6.3.5 BENCHMARKS

Regarding the first and third objectives, benchmarks are not applicable for this study since it is documenting whether or not the species is present and, if so, mortality.

Regarding the second objective, the general EIS approach for bird species at risk was that a 10% loss of existing habitat area for the species was the benchmark that triggered management concern. Bank swallow habitat effects monitoring will use this as the benchmark for habitat effects.

5.8.6.3.6 STUDY AREA

Data collection will predominantly occur within Study Zone 4. Some validation samples may be collected outside of Study Zone 4. Periodic mapping of nesting habitat, if feasible, will be limited to Study Zone 4.

5.8.6.3.7 SAMPLE LOCATIONS

A census of all potential bank swallow habitat within Study Zone 4 will be completed since it is anticipated that the amount of bank swallow primary habitat within this area is limited.

There are no sample locations for mortality monitoring since other studies are providing the required data.

5.8.6.3.8 SAMPLE FREQUENCY AND SCHEDULE

Sampling will begin in the 2016 nesting season during construction and continue every 2 years until 2024. Each sample location will be sampled in one year only, and will be sampled three times during the breeding season.

There is no fieldwork for the mortality portion of this study.

5.8.6.3.9 FIELD AND LAB METHODS

A qualified biologist will visit potential nesting habitat to determine if bank swallows are present. Potential nesting habitats will be visited between 6:00 a.m. and 12:00 p.m. on three separate occasions during the primary nesting period. Visits will be well separated into mid June, early July and mid-July to detect the differential arrival of birds on the breeding ground, and individuals that may move throughout the breeding territory seasonally. A 20-minute stationary count will be conducted near potential nesting habitat. If nesting habitat extends greater than 100 m, a strip transect method will be used to explore the length of the potentially suitable habitat.

If a bank swallow is detected, the bird will be approached as soon as it is heard or seen. Binoculars will be used to spot the bird. The bird and nearby suitable nesting structure will be scanned for nest burrow entrances. If burrows are detected, the total number of nest burrow entrances will be counted. If a bank swallow is observed using a nest burrow entrance, its behaviour (e.g., calling, feeding, frequency of emergence to and from the burrow) will be recorded for a period of no greater than 20 minutes. If more than one bird is detected, the total number of birds at the colony will be estimated. The distribution of the nest burrow will be measured and mapped.

5.8.6.3.10 ANALYSIS

The censused areas will be subdivided into sampling units for the purposes of analysis. The sampling units are the replicates, habitat patch type is the treatment and native versus human-affected is the primary covariate in the analysis. Analysis methods will be determined by the nature of the habitat quality model and the structure of the datasets used for analysis. Some of the validation method possibilities include confusion matrices, Kappa statistics and receiver operating characteristic curves. Statistical model and inferential assumptions will be tested during the analysis.

For the Project-affected and available habitat mapping component of this study, if sufficient field data can be collected to validate and refine the habitat quality model, then the refined model will be applied to the terrestrial habitat map periodically produced by Terrestrial Habitat Clearing, Disturbance and Indirect Effects monitoring (Section 2.1).

5.8.7 REPORTING

5.8.7.1 ANNUAL REPORTS

A report will be produced during the winter after each year when field studies occur, and will be submitted to MCWS the following spring, as per Environment Act License 3107, Clause 20.

Reports will summarize the activities and general findings of the monitoring during the preceding year. Basic descriptive statistics will be the level of data analysis for these reports. Any major unanticipated events, such as if large numbers of ruffed grouse, or any yellow rail are detected, or recommendations for changes to study design or mitigation, will be noted.

5.8.7.2 SYNTHESIS AND RECOMMENDATIONS

A synthesis report will be produced after the first five years of field studies, after construction completion and after the final planned year for field studies during operation. Synthesis reports will consolidate, analyze and evaluate all monitoring information gathered to date, including that produced by EIS and other monitoring studies. An integrated evaluation of the habitat, and mortality pathways of effects on the species will be completed. Actual Project effects will be evaluated relative to the EIS predictions, and the cumulative effects assessment will be updated to reflect actual Project effects. These reports will also include recommendations for any needed modifications to subsequent study design or to mitigation. In this case, if yellow rail, or horned grebe are detected, a design would need to be developed further with a process to verify Project effects. The operation synthesis report will make recommendations regarding the need for any further monitoring.

5.9 BIRD COLLISIONS WITH LIGHTED TOWERS

5.9.1 INTRODUCTION

The Keeyask Hydropower Limited Partnership (KHLP) is erecting a permanent communication tower for the operation phase of the Project. The study is expected to continue for three years following installation of the communication tower. Data from the avian collision mortality study will be used to monitor environmental impacts on migratory birds in the area, allow the KHLP to apply adaptive mitigation measures if required.

5.9.1.1 ASSESSMENT SUMMARY

Some species of migratory birds are vulnerable to collisions with communication towers, particularly if these types of structures are located along migration pathways, flyways or heavily used local movement corridors. Concerns regarding bird collisions related to tower illumination stem from the recognition that birds can be attracted to lighting on tall towers. Once attracted to the lighting, birds may collide with the tower or become "trapped" in the illuminated area, hesitant to fly into the darkness and end up circling the area until collapsing from exhaustion.

5.9.1.2 COMPONENTS THAT WILL BE MONITORED

Monitoring studies of bird collisions with lighted towers will focus on bird fatalities associated with the communications tower. The main study components will be which bird species are colliding with the communications tower, and at what frequencies.

5.9.2 MORTALITY

5.9.2.1 INTRODUCTION

Birds may be attracted to the communications tower, possibly resulting in collision mortality. The mortality study will focus on monitoring bird fatalities at the communications tower, and will take effect when the permanent communications tower has been installed and is lighted.

5.9.2.2 OBJECTIVES

The objectives of bird collision monitoring are to:

- Document the number of bird fatalities associated with the lighted communications tower; and,
- Consider alternate mitigation measures (e.g., lighting options) should the lighted communications tower prove to be an attractant for birds.

5.9.2.3 STUDY DESIGN

5.9.2.3.1 OVERVIEW

Bird fatalities at the Project communications tower will be monitored through ground-based carcass searches. Information gathered will be compared to data obtained from relevant, published studies that assessed bird mortality at communication towers of comparable heights.

5.9.2.3.2 EXISTING DATA

There is extensive literature on how communication towers and other high manmade objects including buildings, transmission lines and wind turbines affect bird mortality in North America. There is no existing data for collisions with communication tower in the Keeyask Region. As a temporary construction-phase communication tower was not deemed to required by the Project (a small wooden pole structure is instead being used to mount communication devices), no pre-operation communication tower monitoring data is available.

5.9.2.3.3 DESIGN

Bird fatalities at the Project communications tower will be monitored through ground-based carcass searches. Information gathered will be compared to data obtained from relevant, published studies that assessed bird mortality at communication towers of comparable heights.

5.9.2.3.4 PARAMETERS

The parameter of concern is the number of bird fatalities associated with the Project communications tower.

5.9.2.3.5 BENCHMARKS

Benchmarks are not applicable for this study since it is documenting bird fatalities and then making mitigation recommendations, if needed, based on monitoring results.

5.9.2.3.6 STUDY AREA

Bird mortality monitoring will occur within Study Zone 2.

5.9.2.3.7 SAMPLE LOCATIONS

This monitoring will take place at the Keeyask Generating Station site where the communications tower will be located during the operation phase. Current plans indicate the communication tower will be mounted on a concrete service bay of the generating station.

5.9.2.3.8 SAMPLE FREQUENCY AND SCHEDULE

It is expected that bird fatality monitoring at the communication tower will take place for three years once the communications tower has been installed and is lighted. Monitoring will occur for four weeks during the spring migration season (April through May) and four weeks during the fall migration period (September-

October). Depending on the timing of tower installation, monitoring may not begin until the Project operation phase.

5.9.2.3.9 FIELD AND LAB METHODS

The methods to monitor bird collisions at the communication tower involve carcass searches and are adapted from methods proposed by the Canadian Wildlife Service for monitoring bird mortality at wind turbines:

- A few months prior to carcass searches, applications will be submitted for federal and/or provincial permits required to handle and collect dead birds or parts thereof;
- Carcass searches will be conducted every three days at the site, to minimize loss of carcasses due to scavenging, and to estimate more reliably the actual date/weather conditions when mortality took place. If scavenger efficiency trials (see below) reveal the persistence of carcasses for a week or more, then less frequent searches will occur;
- The accuracy of bird mortality estimates (extrapolated from carcass search results) can be affected by the removal of carcasses by scavengers (e.g., common raven). In order to account for carcasses lost to scavengers, scavenger efficiency trials are required during each season and each year of monitoring. Scavenger efficiency trials will be conducted early in the monitoring period. Results from scavenger trials will be used to determine the frequency of carcass searches (more or less often than the proposed frequency of every 3 days);
- Carcass searches will occur shortly after sunrise in order to minimize carcass loss from early morning scavengers;
- During each visit, the searcher(s) will focus searches on the concrete service bay and the surrounding ground within a 35m radius below the communication tower. The searcher(s) will walk a survey grid with adjacent survey lines close enough together to assure that complete coverage of the ground occurs;
- Since the tower will be located on concrete service bay, the lack of vegetation will enhance searcher efficiency. It is expected that with high searcher efficiency, trials to determine the number of carcasses that go undetected by the searcher(s) will not be required. However, if part of the search area is covered in vegetation, searcher efficiency trials may be deemed necessary;
- For every carcass found, date, time, state of decomposition and species will be recorded. Photographs and GPS coordinates would also be taken for reference; and,
- Weather conditions will be recorded for each night during search periods (spring, and fall search periods).

5.9.2.3.10 ANALYSIS

It will be necessary to interpret the results of the bird mortality monitoring activities immediately to evaluate whether negative effects are occurring, the magnitude of the effect and whether any adaptive management measures can be undertaken to lessen these effects. In the situation where bird mortality warrants adaptive measures, a report will be made to Manitoba Hydro as soon as possible.

5.9.2.4 REPORTING

Annual reports outlining the results of monitoring activities, any efforts/modifications that are made to reduce observed collision impacts and the success of these measures will be produced. A final report will be produced following the third year of bird collision monitoring which will consider, compile and analyze all years of monitoring conducted and based on the results, produce recommendations for any further monitoring or mitigation. Permitting reports will be made to Environment Canada as described in the conditions of the permit.

6.0 MAMMALS MONITORING

6.1 INTRODUCTION

Mammal populations are an integral part of the boreal ecosystem. Each mammal species has a key role in the community in which it lives. Carnivores (also called predators) like gray wolf prey on other species such as caribou, while groups like small mammals provide food for many birds and mammals. Some species like moose and American marten are harvested by resource users, contributing to local lifestyles and economies.

Construction-related monitoring will verify Project effects on mammals, with an emphasis on where substantial scientific uncertainty exists (see Keeyask Generation Station EIS, TE Volume 7, Section 7.4.10). Recommended monitoring and follow-up related primarily to mammal VECs (caribou, moose and beaver) and other priority mammals such as gray wolf, black bear, and other species listed the Manitoba *Endangered Species and Ecosystems Act* (MESEA), federal *Species at Risk Act* (SARA), or the Committee on the Status of Endangered Species in Canada (COSEWIC).

This section outlines the mammal monitoring programs that are typically intended to validate and test key predictions and effectiveness of mitigation measures in the EIS.

6.1.1 PROJECT EFFECTS PATHWAYS

Potential Project effects on mammals relate mainly to habitat loss or alteration, sensory disturbance, and access effects. Land clearing within the Project Footprint will affect habitat in the Study Zone 1 for several mammal species. Sensory disturbances due to construction activity (e.g., blasting, machinery, traffic on the access roads) will likely result in temporary avoidance of otherwise suitable habitat by some individuals, which is referred to as a loss of effective habitat.

In addition to sensory disturbance, Project-related disturbances could include accidental spills or leaks resulting in contaminated habitat, which would affect water quality and food sources (e.g., plants). Collisions with vehicles could increase mammal mortality along the access roads, and increased access to formerly remote areas could increase harvest pressure on trapped and hunted species.

6.1.2 MITIGATION

Mitigation measures have been identified for several Project-related effects on mammals:

- A Construction Access Management Plan will be implemented to reduce the effects of increased access;
- Except for existing resource-use trails and those required for operation, 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 chemical vegetation control will be utilized during construction clearing;

- To reduce the possibility of vehicle and wildlife collisions, speed limits will be implemented along the access roads;
- All vehicle collisions with wildlife will be reported to the Site Environmental Lead, who will report it to the local Natural Resources Officer (Manitoba Conservation and Water Stewardship) and regional Wildlife Manager (Manitoba Conservation and Water Stewardship). Road kill will be disposed of as soon as practicable;
- Staff working on-site will attend wildlife awareness training;
- No person on-site will feed or harass wildlife. Failure to comply could lead to dismissal from the Project;
- The hunting or harvesting of wildlife by Project staff will not be allowed on-site (this includes access trails). Signs prohibiting these activities will be posted as necessary;
- Solid waste containing food wastes will be collected on a regular basis to prevent wildlife attraction to work area(s);
- Waste will be disposed of at a facility approved under an operating permit;
- Animal (bear)-proof bins, building or electric fences will be used to contain food waste and other waste until it is disposed; and
- Wildlife that affects, or has the potential to affect, worker health and safety will be immediately reported to the Site Environmental Lead, who will then contact the local Natural Resources Officer (Manitoba Conservation and Water Stewardship) and Regional Wildlife Manager (Manitoba Conservation and Water Stewardship).

6.2 CARIBOU

6.2.1 INTRODUCTION

6.2.1.1 BACKGROUND

Caribou are medium-sized ungulates (hoofed mammals) that require large tracts of undisturbed landscapes to maintain populations. All caribou are of the species *Rangifer tarandus*; however, there is some debate regarding further classification of caribou subtypes. Currently, caribou are classified based on morphological characteristics, habitat use, behaviour, and genetics, among other factors. Notable behaviours include solitary versus *en masse* calving and seasonal migrations. The extent of seasonal movements varies by population, from long-distance migrations to short movements within a home range.

Three migratory caribou herds occasionally occupy the Keeyask Region in winter: barren-ground caribou (*Rangifer tarandus groenlandicus*) from the Qamanirjuaq herd; and two coastal caribou (*R. t. caribou*) herds, the Pen Islands and Cape Churchill herds, which are forest-tundra migratory woodland caribou ecotypes. Barren-ground caribou from the Qamanirjuaq herd migrate from Nunavut in autumn to overwinter in Manitoba's northern forests and then leave the Keeyask Region in spring to calve. On occasion, a small fraction of the Qamanirjuaq herd may reach the Keeyask Region. Coastal caribou from the Cape Churchill and Pen Islands herds migrate from northern Manitoba and northern Ontario into parts of the Keeyask Region in winter and leave the area in spring to calve. Larger groups of Pen Islands coastal caribou, numbering in the hundreds, have been observed in the Keeyask Region on occasion, but there are generally fewer than about 50 individuals in a typical winter.

A fourth group occupies the Keeyask Region in spring and summer (herein referred to as summer resident caribou), and is known to calve on the islands in Gull and Stephens lakes and on treed black spruce islands surrounded by expansive wetlands or treeless areas (peatland complexes), collectively referred to as calving and rearing habitat. Summer resident caribou likely move within and beyond the Keeyask Region, but the extent of their core range is unknown. These caribou remain in the Keeyask Region to calve, but it is unclear whether the same individuals calve in the area year after year. Summer residents are conservatively estimated to number 20 to 50 individuals.

Caribou monitoring is important because the species is important in the Keeyask Region, having ecological, cultural, and economic value. There is a potential for small to moderate adverse Project effects and a moderate degree of uncertainty concerning the effects predictions. There is a high degree of certainty and confidence in habitat availability, existing core areas, and regional intactness estimates.

6.2.1.2 ASSESSMENT SUMMARY

The main drivers of change and stressors of caribou in the Keeyask Region are habitat disturbance from fire and from human activities, and predation. Changes to either of these factors have the potential to affect the local and regional caribou populations, primarily through disturbance or loss of physical habitat. Other drivers and stressors that could influence habitat quality or individuals to a lesser degree include sensory disturbance, the number of alternate prey (moose and invasive species such as deer), extreme weather events, mortality due to harvest, and other mortality sources (disease or parasites and accidents).

Predicted Project effects on caribou include the loss or alteration of 6,686 ha (0.5%) of winter habitat, 201 ha (<0.1%) of calving and rearing habitat, and a 0.2% reduction in habitat intactness (or the degree to which habitat remains unaltered by fire and human disturbances) in the Keeyask Region. Long-term habitat losses are associated with reservoir impoundment, mineral bank erosion, peatland disintegration, and reservoir-related groundwater and edge effects. A small additional loss of calving islands (<0.1%) is anticipated after 30 years of operation.

In addition to the loss of physical habitat, a loss of effective habitat due to sensory disturbance is anticipated. Caribou may temporarily avoid or less frequently use otherwise suitable habitat near construction activity. A lesser effect may occur near Project infrastructure and roads during operational activity. Movement patterns in and through the Keeyask Region could also be affected.

The development of roads and trails could increase caribou mortality from predation and harvest. Improved access to the area could increase predators' hunting efficiency and increase the caribou harvest by resource users. Wildlife-vehicle collision on the access road could also result in caribou mortality. Project effects on caribou populations are expected to be adverse and small to moderate.

In addition to the general mitigation measures described for all mammals in Section 6.0, the following mitigation measures have been or will be implemented to minimize or avoid potential Project effects on caribou:

- The access roads were routed to avoid caribou calving complexes and reduce the loss of effective habitat;
- The excavated material placement areas were sited to avoid caribou calving complexes and reduce the loss of effective habitat;
- Contractors were briefed on protocols to be used to avoid caribou conflicts to prevent and minimize inadvertent vehicle harassment disturbance and to reduce the potential for caribou-vehicle collisions. Recommendations were implemented for reduced vehicle speeds, and to stop and wait for caribou groups to clear the roadway if encountered;
- Fire prevention measures will be employed in remote working environments to minimize the risk of habitat loss;
- Future caribou 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 the islands from clearing disturbances;
- Gates will be added to the north and south dykes, to be closed and locked from May 1 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;
- Blasting will be minimized to the extent practicable from May 1 to June 30, to reduce the effects on calving females and their young;
- If caribou are present, Manitoba Conservation and Water Stewardship will be consulted for advice prior to blasting;

- Shielded and downward-directed lighting will be placed on the outside of the generating station to reduce sensory disturbance;
- Much of the future reservoir area will be cleared prior to impoundment in 2019, which will reduce debris accumulation on shorelines. Floating debris will be collected from the reservoir under the Waterways Management Program to further reduce possible debris accumulation along shorelines;
- In the event that additional access trails are identified during construction, any cross-country access trails through forested areas will be designed to either be less than 200 m long or cleared in a manner such that sight lines are no greater than 200 m;
- Wildlife crossing signs will be placed along the access roads near caribou travel corridors and high-quality habitats to reduce the potential of wildlife-vehicle collisions, and to emphasize the need for safety for migrating caribou; and,
- A Keeyask Caribou Coordination Committee (KCCC) has been created, with representatives from each of the four KCNs communities and Manitoba Hydro. Information sharing (e.g. presentations at committee meetings and communications outside committee meetings) will occur between the KCCC and other interested stakeholders to coordinate caribou mitigation and monitoring activities. These stakeholders may include other Manitoba Hydro northern projects, as well as government authorities and other existing caribou committees and management boards.

Mitigation measures for caribou (e.g., access road signage) are referred to in the Project's Generating Station and South Access Road Construction Environmental Protection Plans (EnvPPs).

Other drivers that will continue to influence caribou habitat include fires. The 2013 wildfire removed some caribou winter habitat and calving habitat in the Keeyask Region. This burned habitat will not be suitable for caribou for several decades. Traditional knowledge has already indicated that caribou are avoiding the recently burned area. Future fires in the region will continue to influence caribou habitat availability.

6.2.1.3 COMPONENTS THAT WILL BE MONITORED

Monitoring studies for caribou will focus on verifying Project effects predictions related to winter abundance, summer resident caribou range and how caribou distribution and abundance are altered by Project-related sensory disturbance and habitat changes.

The Winter Abundance Estimates study (Section 6.2.2) will continue monitoring the number and distribution of caribou migrating through Study Zone 5 during the winter using aerial surveys. Abundance estimates, using information collected during the aerial surveys, will be produced periodically throughout the monitoring program. This study will provide a descriptive evaluation of winter distribution within Study Zone 5 given the level of effort required to provide robust statistical estimates. This study will also describe observed movement patterns in relation to the Project and river crossing areas.

The Summer Resident Range study (Section 6.2.3) will attempt to evaluate the distribution of the summer resident caribou in the early winter months, immediately following the calving and rearing season. This study will include aerial surveys, carried out in early winter before Pen Islands coastal caribou have moved into the Project area, as well as collection of genetic samples to better understand the herd association of the summer resident caribou.

The Sensory Disturbance study (Section 6.2.4) will evaluate how Project-related sensory disturbance alters habitat effectiveness for caribou calving and rearing habitat. This study uses ground tracking transects and trail cameras to collect information on caribou use of habitat in the Project area. Since it is anticipated that caribou will temporarily avoid or less frequently use otherwise suitable habitat near active construction areas, monitoring will be more focused on the latter half of the construction period; this is when sensory disturbance will start to decrease and caribou may begin to resume use of the Project area. As this is a major study evaluating effects on islands in lakes and in peatland complexes, it will provide the majority of the data for the habitat effects monitoring.

The Habitat Effects study (Section 6.2.5) includes several components that collectively address Project effects on caribou habitat availability. The habitat quality model used to predict the amounts of calving and rearing habitat affected by the Project will be further validated. Changes to regional habitat intactness due to wildfires and Project development will be periodically measured. Implementation of key habitat mitigation measures will be verified.

The Mortality study (Section 6.2.6) will examine various sources of caribou mortality such as Project-related mortality (e.g., wildlife-vehicle collisions, harvest by workers), predation and harvest during the winter migration.

Mortality monitoring results will be used to gauge the efficacy of mitigation measures such as signage along access roads, and to identify other mitigation or remedial actions that may be required. The efficacy of some of the other mitigation measures will be monitored by the caribou studies (e.g., the Sensory Disturbance study) or other wildlife monitoring programs.

Mitigation implementation monitoring is generally not included for caribou. Exceptions are the following: the timing and frequency of blasting will be reviewed as an element of the Sensory Disturbance study; future islands over 0.5 ha in the Keeyask reservoir will be checked during construction to ensure they are not cleared and remain available as potential caribou calving and rearing habitat, and debris mapping along future reservoir shorelines will be checked to evaluate whether they may impede caribou movements. A periodic review of shoreline debris mapping be will be evaluated with respect to potential effects on caribou.

Keeyask Generation Project caribou monitoring studies will be coordinated with Manitoba Conservation and Water Stewardship (MCWS) and other Manitoba Hydro monitoring initiatives.

Information from this caribou monitoring program will be provided as needed to the Keeyask Caribou Coordination Committee (KCCC) to support the Partnership's monitoring activities and collaborate, if requested, in the development of broader common research goals and perspectives with Manitoba Hydro, MCWS and local stakeholders.

Synthesis reports (Section 6.2.7.2) will provide an integrated evaluation of Project effects on caribou distribution and abundance, the availability of suitable habitat and habitat effectiveness using results from this monitoring program as well as relevant information from other monitoring programs.

6.2.2 WINTER ABUNDANCE ESTIMATES

6.2.2.1 INTRODUCTION

Three groupings of caribou are described for the Keeyask Region: 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 Qamanirjuaq herd migrate from Nunavut in autumn to overwinter in Manitoba's northern forests and then leave in spring to calve. On occasion, a small fraction of the herd may reach Study Zone 6 (Map 3). About 10,000 animals migrated this far south once in the last 10 years (in 2004). An estimated 264,000 animals were in the herd in 2014.

Coastal caribou from the Cape Churchill and Pen Islands herds migrate from northern Manitoba and northern Ontario into parts of Study Zone 6 in winter and typically leave the area in spring to calve. The number of Pen Islands coastal caribou in Study Zone 6 is highly variable from year to year, typically ranging from none to hundreds of animals. On occasion, larger numbers occur in the area. An estimate of about 7,500 animals was observed near the north access road on 31 January, 2013, after having crossed the Nelson River. The abundance of animals in the eastern half of Study Zone 5 (Map 3) was estimated at 13,985 ($\pm$ 18.1%, 95% CI) from February 5 to 8, 2014. This population was genetically confirmed as Pen Islands caribou.

Summer resident caribou likely move within and beyond Study Zone 6, but the extent of their core range is unknown. These caribou remain in Study Zone 6 to calve, but it is unclear whether the same individuals calve in the area year after year. From trail camera studies conducted from 2010 to 2013, the minimum number of summer residents ranged from 15 to 30 individuals in the Gull and Stephens lakes area.

Winter aerial surveys conducted in select township blocks from 2002 to 2006 indicated that the winter abundance and distribution of caribou in the Keeyask Region varies widely from year to year. Small groups of a dozen to a hundred migratory caribou are generally observed in a typical winter but larger groups numbering in the hundreds or thousands are occasionally observed. Caribou density in Study Zone 6 ranged from a minimum of 0.02 individuals/km^2 in 2005 to a maximum of 0.26 individuals/km^2 in 2004. Mean density over the five-year study period was 0.12 individuals/km^2, which is low compared to the large sizes of migratory herds.

Winter caribou distribution in Study Zone 5 has varied considerably. Caribou numbers and distribution patterns in Study Zone 5 are highly variable during winter. Long-term abundance is cyclic and likely driven by climate interacting with forage availability, predation, pathogens and other habitat drivers such as fire. Annual variations in abundance and distribution in winter are influenced by summer forage quality, winter temperature and snowfall patterns, forage availability, predator numbers and predator distribution. Additionally, the distribution of natural and anthropogenic disturbances affects habitat quality.

Because of this long-term cyclic and annual variability, it will be difficult to attribute changes in winter abundance and distribution to a particular cause, such as construction activity in a small portion of large caribou ranges. KCNs Members predict that caribou may not return to the Keeyask area, or if do they return, they will avoid the area due to cumulative effects of hydroelectric development in the region.

The goal of this study is to characterize the variability in caribou abundance in the winter and to evaluate how the Project may be affecting movement patterns.

6.2.2.2 OBJECTIVES

The objectives of this study are to:

- Estimate the variability in the number of caribou in Study Zone 5 (Map 3) during the winter; and,
- Evaluate whether there is any suggestion that winter habitat use, and/or river crossings in the context of highly variable winter distribution patterns, are affected by the Project.

6.2.2.3 STUDY DESIGN

6.2.2.3.1 OVERVIEW

Abundance surveys conducted in 2012 and 2013 will continue through construction and operation using the same methods as for the 2012/2013 surveys. The study design involves line transect distance sampling that provides 25% coverage of the study area in a three to four day period.

6.2.2.3.2 EXISTING DATA

Caribou distribution and abundance information was collected from 2002 to 2014 for environmental assessment and monitoring studies associated with the Keeyask Infrastructure and Generation Projects. Trail cameras were set up in the winter of 2011/12 to capture caribou movements in the lower Nelson River area. The placement of trail cameras was based on the use of 5 km by 10 km grid patterns to capture potential migratory movements into the Keeyask Region during this time. In total 126 trail cameras were set-up and maintained as part of this study.

Aerial surveys were conducted in the winters of 2002/03 to 2006/07, 2011/12, and 2012/13. All surveys were conducted using fixed-wing aircraft and often occurred over several days. Over the 2002/2003 to 2006/2007 survey period, surveys were flown over six different time periods and were based on the surveying of township blocks, as well as reconnaissance trajectories, to demonstrate the presence of any large caribou herds in the region. The surveying of township blocks was based on the alternate consideration of blocks with different habitat types, burn history and levels of linear feature development to assess for potential differences in the distribution of species present based on this information.

Three aerial surveys were conducted in 2011/2012 and were based on the surveying of pre-designed survey transects that were in the eastern portion of Study Zone 5 and were conducted based on the use of two fixed-wing aircraft to cover this area more efficiently and prevent double counting of individual animals. Based on large migratory movements of the Pen Islands caribou population into the Keeyask Region in February 2013, one additional survey was flown of this area and used those previously designed transects for the 2011/2012 aerial surveys. An additional helicopter survey was performed in the area immediately surrounding the Keeyask Region in January 2013 and served to provide supplemental information on the number of caribou migrating through the Keeyask worksite as well as identify caribou river and lake crossings. Incidental observations of caribou were also recorded during the 2009 and 2010 moose aerial surveys of the Split Lake Resource Management Area.

6.2.2.3.3 DESIGN

This is a regional (as opposed to a local) species abundance and distribution dynamics study. A trend by time design will be employed to estimate the winter abundance of caribou within the study area. Surveys will be conducted when migratory caribou move into the study area. The entire study area will be surveyed during each sampling period. Line transect distance sampling will be used to estimate caribou abundance during the survey period. Distance-sampling techniques usually provide the ability to correct for effects of cluster size and distance on detectability. Distance sampling is more cost and time efficient in larger study areas with sparsely distributed animal populations.

The number and locations of caribou and river crossings will be detected by aerial surveys, replicating the surveys conducted in the winters of 2011/12 and 2012/13. The use of high resolution, multi-spectral satellite imagery to document winter distribution patterns and river crossing areas will be tested for suitability.

Data sources such as terrestrial habitat maps, satellite imagery and weather records will be used to measure factors that may influence winter movement patterns (e.g., snow depth, location of the Project Footprint, human settlements).

Monitoring will occur during construction and periodically during operation (Section 6.2.2.3.8).

6.2.2.3.4 PARAMETERS

The monitoring parameters are:

- Number and locations of caribou;
- Number and locations of caribou river crossing areas; and,
- Landscape and human features that may influence movement patterns.

6.2.2.3.5 BENCHMARKS

Benchmarks are not applicable for this study since it is documenting and evaluating trends and patterns.

6.2.2.3.6 STUDY AREA

Past aerial surveys were conducted within the eastern portion of Study Zone 5 (Map 15), between Split Lake and the Long Spruce generating station. Since migratory caribou are not known to venture into the remaining portion of Study Zone 5, surveys will continue to occur in the eastern portion of Study Zone 5. If it appears these caribou are changing distributional patterns and venturing further west, then the study area will be extended westward.

6.2.2.3.7 SAMPLE LOCATIONS

Aerial surveys in the study area will occur along systematically located parallel lines spaced 2 km apart, which provides 25% coverage of the study area. Aerial survey lines will be the same as those flown in the winters of

2011/12 and 2012/13. Survey lines are oriented in a north-south direction. The boundary of Study Zone 5 provides the northern and southern limits of the lines. Map 15 shows the area included in the winter abundance surveys.

6.2.2.3.8 SAMPLING FREQUENCY AND SCHEDULE

Aerial surveys will occur every second year during the construction period and every two years during the first six years of operation. The need for and frequency of continued monitoring will be evaluated in Year 6 of operation based on results from all monitoring to date.

In each year that aerial surveys occur, two surveys will be conducted during the winter, typically between December and February. Actual timing may vary based on local reports that caribou are moving into the study area.

6.2.2.3.9 FIELD AND LAB METHODS

Standard aerial survey techniques and distance sampling methods will be followed. Surveys will be conducted from a fixed-wing aircraft during high visibility weather and complete snow coverage. Three observers (including KCNs Members) and a pilot will fly in a fixed-wing aircraft at a speed of 80-140 km/hr and approximately 80 m above ground level (range 70-100 m AGL), depending on topography and tree canopy density. The flight path will be guided by a hand-held Global Positioning System (GPS) unit (e.g, Garmin GPSMAP 60 CSx).

The unit of observation is a cluster of caribou, which is an individual or group of caribou that are less than 50 m apart. The front right observer is responsible for detecting caribou clusters near the transect line through the front window of the aircraft, while the rear observers are responsible for sighting caribou clusters on either side of the aircraft. The front right observer records cluster locations with a second GPS unit, as well as the estimated number of caribou in the cluster and the perpendicular distance from the aircraft to the centre of the cluster. Distances estimates are recorded in 50 m intervals out to a maximum distance of 500 m. Animal disturbance and safety is a high priority. To minimize disturbance, the aircraft will not circle wildlife.

When caribou are observed, data regarding the cluster will be recorded. Age will be determined where possible based on morphological characteristics, and the number of individuals will be counted or estimated if groups are large. Sex information will be recorded incidentally, only if possible without circling the group. Tracks and river crossing attempts will also be recorded.

Caribou detections made when not conducting the formal survey will be recorded as incidental observations. Other incidentally collected data may include gray wolf and wolverine tracks and observations.

High resolution, multi-spectral satellite imagery (e.g., RapidEye, Worldview 2) will be reviewed to determine if this type of data can be used to confirm there is only one mass movement through the study area, and if river crossing areas or animal groups occurring between the surveyed areas can be mapped.

6.2.2.3.10 ANALYSIS

There are no replicates within a given year. The line transects are the subsamples. Human and landscape features are the primary covariates.

Once there are at least six years of data, exploratory data analysis will evaluate the extent to which a statistically robust analysis of abundance and distribution, and the factors influencing these population parameters, can be undertaken. The appropriate analysis methods and inferential approach will be determined following the exploratory data analysis. Covariates will be included in the statistical analysis to account for confounding factors and natural variation as far as possible. Statistical model and inferential assumptions will be tested during the analyses.

6.2.3 SUMMER RESIDENT RANGE

6.2.3.1 INTRODUCTION

Summer resident caribou are caribou identified as occurring on islands in Gull and Stephens lakes during the summer months. These islands are thought to play an important role for calving and rearing activities due to their role in providing protection from predators during the sensitive calving and rearing period. Less is known about the distribution of summer residents in the winter months following the calving and rearing season.

The goal of this study is to attempt to evaluate the distribution of the summer resident caribou in the early winter months, immediately following the calving and rearing season. Having information on the early winter distribution of summer residents will provide a means of assessing potential changes in the distribution of this population based on Project development, outside of those effects anticipated to occur in calving and rearing areas, which will be studied using the methods outlined in Section 6.2.3.3.9.

6.2.3.2 OBJECTIVES

The objectives of this study are to:

- Evaluate the distribution of summer resident caribou through reconnaissance surveys; and,
- Evaluate the home range of summer resident caribou based on genetic sampling.

6.2.3.3 STUDY DESIGN

6.2.3.3.1 OVERVIEW

This study will attempt to identify and delineate the current range of summer resident caribou in the Keeyask Region. This will be done through combining aerial survey efforts with the collection of genetic information from summer resident caribou. Aerial survey efforts will allow the distribution of caribou to be assessed at the time of the survey by following caribou tracks to their furthest point from Gull and Stephens Lakes. Fecal samples from tracked animals will be collected for genetic analysis when the aerial survey is ongoing. Fecal samples will also be collected as during the summer months from islands where summer resident caribou are present. Genetic testing will subsequently be used to verify the identity of those caribou located during the aerial surveys, and to map their home range.

6.2.3.3.2 EXISTING DATA

Existing information indicates where the summer resident animals are expected to occur in the Keeyask Region during the summer months, notably islands in Gull and Stephens lakes and peatland complexes. Results from recent radio collaring of the Pen Islands and Cape Churchill caribou herds, undertaken by Manitoba Hydro, Manitoba Conservation and Water Stewardship, and the York Factory, Fox Lake and Split Lake Resource Management Boards, have been used to inform on caribou movement patterns in the region.

Fecal samples were collected as part of genetic studies in the summer of 2014 to compare the genetics of summer resident caribou with other caribou herds in the region. These samples may provide an initial dataset for use in identifying summer resident caribou relative to sampled caribou in the winter months and be used to supplement later sampling efforts of summer residents.

6.2.3.3.3 DESIGN

To assess the identity of caribou identified as potential summer residents during the early-winter aerial surveys, it will first be necessary to acquire genetic samples of actual summer residents. Non-invasive sampling methods will collect caribou fecal pellets from islands in Gull and Stephens lakes during the summer/fall calving and rearing season. These reference samples will be compared with fecal samples collected during the early-winter months through genetic analysis.

The early winter surveys will be conducted when a suitable layer of snow is present to aid in the identification of animals and for following the tracks until caribou are observed. It is important that these aerial surveys be conducted as soon after the summer/fall calving and rearing season as possible to increase the likelihood that observed caribou are indeed summer residents that were using islands in Gull and Stephens lakes and peatland complexes in the preceding months. Surveys will not be conducted if Pen Islands caribou have already moved into the study area, as it would not be possible to differentiate between the summer resident and Pen Islands caribou.

The winter distribution of the summer resident caribou will be identified through following track sets in the snow and identifying the distance summer resident caribou have travelled relative to Gull and Stephens Lakes to provide a preliminary range map. Effort will be placed on limiting the amount of disturbance caused to observed caribou by restricting the number of flyovers that occur. Location information on where track sets and caribou were identified will be used to inform on the distribution of summer resident caribou in the region.

The distribution of caribou observed from aerial surveys will be compared to the known distribution of summer resident caribou based on where they are known to be located in the summer months. To this extent, the parameter of interest will be how far from known calving/rearing areas were summer resident caribou successfully located. This distribution may also be assessed based on distance to other features of interest such as the town of Gillam as well as the Keeyask construction site. In conducting winter aerial surveys, information on the group size of observed caribou as well as available age class information will be recorded. Sex information will be recorded incidentally, only if possible without circling the group.

6.2.3.3.4 PARAMETERS

The monitoring parameters are:

- Location of caribou;
- Number of caribou;
- Habitat attributes of the locations; and,
- Identity sex (if possible) and age of individual caribou.

6.2.3.3.5 BENCHMARKS

Benchmarks are not applicable for this study objective since it is documenting the nature of the evaluation areas. Overall range use will be factored into the habitat loss calculations.

6.2.3.3.6 STUDY AREA

The collection of fecal pellets in the summer/fall season will occur based on the locations of islands in Gull and Stephens lakes that are accessible by boat and where caribou have been previously identified. Aerial surveys conducted in the early winter, and the corresponding collection of fecal pellets at this time, will occur along systematic transects within the general survey area shown on Map 16. Some deviations from this survey area, potentially extending further into Study Zone 5, are expected in order to follow caribou track locations and locate caribou, to fully indicate the extent they have travelled from Gull and Stephens lakes.

6.2.3.3.7 SAMPLING FREQUENCY AND SCHEDULE

Up to two aerial surveys will be conducted in the winter, typically between October and December. Actual timing may vary based on the earliest snowfall that completely cover and remain on the ground.

Aerial surveys will occur in at least three years during the construction period, when suitable snow cover exists.

6.2.3.3.8 SAMPLE LOCATIONS

Track locations throughout the Keeyask Region will be used to inform on the distribution of summer resident caribou. For the collection of winter samples, cratering locations will be identified during the aerial survey and used to aid in the collection of pellets.

For the summer collection of fecal pellet samples, the islands included in the Sensory Disturbance studies (Map 17, Map 18) will be searched for fresh fecal pellets for use in genetic analysis.

6.2.3.3.9 FIELD AND LAB METHODS

The collection of caribou fecal pellets will occur based on the sampling of islands in Gull and Stephens lakes where summer resident caribou have been identified in past field studies. The collection of fecal pellets is expected to occur twice during the summer and fall, with approximately three days set aside during each sample period for the collection of fecal pellets by boat. An effort will be placed on collecting the freshest samples possible, as well as collecting samples from different islands to avoid double-sampling of individuals. Collected samples will be placed in sterile sampling bags, frozen and then be shipped to Trent University for genetic analysis.

Aerial surveys will be conducted shortly after the earliest snowfall events in the Keeyask Region and will incorporate the use of a helicopter flying fixed transects until caribou or caribou tracks are observed. Surveys will be flown with three observers who will identify the presence of fresh caribou tracks and follow them until caribou are found.

The collection of caribou fecal pellets will occur based on cratering locations identified while following the caribou tracks. Pellet sample size will be 1.5 times the estimated individual caribou in order to provide a good potential of sampling all individuals. When the animals are located they will be counted and aged by observation. Sex is recorded as possible without circling the group. Other species of interest including predators (e.g., wolf, wolverine) will be recorded.

Fecal pellet samples will be analyzed for available genetic information at Trent University with only the high quality samples submitted for comparison of the genetic relationship of summer collected samples with those collected during the early winter survey. Laboratory analysis of collected fecal pellets for genetic information will occur following those protocols identified by Trent University in their analysis of fecal pellets elsewhere in Manitoba. Data will include the identification of individuals, lineage and sex of the animal.

6.2.3.3.10 ANALYSIS

The distribution of summer resident caribou during the early-winter will be evaluated based on the distance of identified caribou tracks from Gull and Stephens lakes if individuals are confirmed to be summer residents by genetic analysis. This will serve to indicate the extent of possible movements away from the Gull and Stephens lakes by summer resident caribou in the early winter months.

Trent University will perform the genetic analysis of fecal pellets, and will determine which genetically defined population each animal belongs to using the program Structure. Structure will associate samples collected during the summer/fall calving and rearing season and during the early winter aerial survey as belonging to part of the same or separate genetically defined populations.

6.2.4 SENSORY DISTURBANCE

6.2.4.1 INTRODUCTION

The goal of this study is to determine if caribou distribution and relative abundance change in the vicinity of the Project due to sensory disturbance. Islands in lakes and virtual islands in peatland complexes are the two major types of calving and rearing habitat. They require different study designs due to their very different ecological contexts.

A robust study design is possible for sensory disturbance to calving and rearing on islands in lakes since Stephens Lake includes a large number of well-distributed islands. In comparison, the best possible design for calving and rearing in peatland complexes is weaker, as there are too few complexes within 4 km of the access roads and the generating station site to implement a dose gradient-response study.

6.2.4.2 OBJECTIVES

The objectives of this study are to:

- Evaluate how Project-related sensory disturbance during construction affects caribou calving and rearing on islands in lakes relative to distance from the disturbance;
- Evaluate how Project-related sensory disturbance during construction affects caribou calving and rearing in peatland complexes relative to distance from the disturbance;
- Evaluate the efficacy of minimizing blasting to the extent practicable from May 1 to June 30 in terms of reducing Project effects on calving females;
- Determine the extent to which caribou increase their use of calving and rearing habitat during operation; and,
- Estimate the loss of effective habitat during construction and operation.

6.2.4.3 STUDY DESIGN

The format of this section differs from the rest of the TEMP since the same general question is being addressed using different study designs for the two major types of caribou calving and rearing habitat. Existing data is presented first since the integrated nature of past caribou studies provides data relevant for both components of sensory disturbance monitoring. This is followed by the two study components: Calving and Rearing on Islands in Lakes, and Calving and Rearing in Peatland Complexes.

6.2.4.3.1 EXISTING DATA

Caribou occurrence and habitat data were collected from 2001 to 2014 for environmental assessment and monitoring studies associated with the Keeyask Infrastructure, Generation, and Transmission Projects. Reconnaissance surveys were conducted on islands in 2003 and 2005, and sign surveys and trail camera surveys were conducted on calving islands in Gull and Stephens lakes from 2010 to 2014 and near the north access road from 2010 to 2013. Sign surveys were conducted in summer and winter 2001 to 2004, mainly in Study Zones 1, 2, and 3.

Many of the sample locations in caribou calving habitat were burned in the 2013 fires or will be cleared during Project construction.

6.2.4.3.2 CALVING AND REARING ON ISLANDS IN LAKES

OVERVIEW

Construction activities in the generating station and borrow areas represent the greatest anticipated source of sensory disturbance for calving and rearing on islands in Stephens Lake and the Gull reach of the Nelson River (i.e., islands in lakes). This disturbance continues throughout construction.

An impact-gradient by time statistical design is possible for sensory disturbance to calving and rearing on islands in lakes. There are more than 150 islands at least 0.5 ha in size within Stephens Lake and the Keeyask upstream hydraulic zone of influence. These islands are replicated at a wide range of distances from the Project Footprint. More than half of the islands are beyond the maximum anticipated zone of Project sensory disturbance, providing a strong reference sample. The islands themselves range widely in size, providing the additional option of evaluating the influence of island size on island use. The only design limitation is that the largest island size classes are not replicated at the greatest distances from the Project except in locations where they may be influenced by sensory disturbance from Gillam. Since all but one of the Stephens Lake islands escaped the 2013 wildfires, pre-Project baseline data is available as these islands were sampled prior to construction.

This study will evaluate caribou use of islands during the calving and rearing season, as well as factors influencing island use. Monitoring will occur throughout construction and periodically during operation. Operation phase monitoring will determine if habitat effectiveness increases after construction completion.

DESIGN

This is a dose gradient-response study. The "dose" is the degree of sensory disturbance and the "response" is the degree to which caribou less frequently use otherwise suitable island habitat. Both the dose and response levels are expected to decrease with distance from Project feature, all other things being equal. The shape of the dose and/or response function relative to distance from the Project may be non-linear.

An impact-gradient by time design will be employed to estimate the spatial extent and degree of sensory disturbance on the distribution and activity of individuals near the action construction areas. A stratified, random sample of islands in lakes will be selected and monitored for caribou use, and for stand level habitat associations, during the calving and rearing season. Islands within the anticipated zone of sensory disturbance from PR 280 and Gillam will be included to provide samples for other disturbance sources and for combined disturbance from the Project and other sources. Islands that are not affected by the Project or other sources of sensory disturbance are the reference locations.

Islands will be surveyed for caribou use during two periods: the calving and early calf rearing period; and, the mid to late calf rearing period.

Caribou use of islands will be detected using tracking transects and camera trapping. For tracking transects, calf sign will be evidence for calving and rearing use. Since the field visits are separated by about six weeks, calf and adult sign density during each sample period will provide a qualitative indication of the duration and degree of island use, which contributes to evaluating the dose-response relationship. Sign density will not provide an indication of site level habitat use because caribou constantly move around an island, which means travel and use sign cannot be reliably separated.

Trail cameras will be employed to supplement tracking transect data. With tracking signs it is uncertain whether it was, say, one individual that left five signs or five individuals passing through the island each left one sign. Trail cameras provide age and sex of the photographed animals with a high degree of accuracy, which is occasionally not possible with tracks in summer. Additionally, individual animals can usually be identified from the photographs, allowing the tabulation of the minimum number of individuals that are present in the sampling unit as well as the number of times each individual intersected the camera detection area. These data provide a second measure for the duration and degree of island use.

Tracking transects and trail cameras also provide data for other wildlife species. Of particular interest are the presence of predators and moose within the sampling units.

Stationary audio recorders will measure the degree of auditory disturbance (i.e., the "dose") at a subset of the surveyed islands, which will be selected to provide representation for major distance classes and non-Project sources of disturbance. The frequency and duration of the recordings will be set so as to sample the typical level of disturbance as well as the periodic extreme levels from blasting audio recorders mounted on tripods will be placed at strategic locations relative to sample locations and Project features to quantify the degree and duration of selected audio disturbances. At the Project features test sites, audio recorders will be calibrated with standardized noise levels. Distance to the Project features and environmental parameters that affect noise (e.g., wind direction, vegetation cover) will be measured at each location. These characteristics will allow for the development of sound magnitude and duration curves. Audio recorders will also confirm that the reference islands are not subject to auditory disturbance.

Manitoba Hydro will provide a report documenting the location, timing and nature (e.g., multiple short blasts, charge size, presence of blasting blankets) of blasting events. The actual blasting record provides data to measure an element of the dose, and determines the proportion of these disturbances being captured by the audio recorders.

Terrestrial habitat maps will be used to measure factors that may influence island use during the calving and rearing season (e.g., habitat composition, distance to mainland). Since cows may avoid islands if the lake ice is present when they are ready to give birth, trail cameras placed on islands will record the timing of ice breakup.

Monitoring will occur every year during construction to account for natural year-to-year variability, possible habituation over time (calving already occurs on islands with summer cottages on them) and to increase between year sample size. Monitoring will continue periodically during operation to determine if caribou calving and rearing activity increases on islands affected during construction, and to test for possible habituation over longer periods of time.

In general, the same islands will be used during both Project phases. During operation, eroded small islands and islands lost to reservoir flooding will be dropped while islands created by the reservoir will be added. Some of the islands in Stephens Lake may be dropped during operation if a power analysis of results to date indicates that a smaller sample size is expected to achieve adequate statistical precision.

PARAMETERS

The monitoring parameters are:

- Caribou sign density;
- Distance from the closest active Project construction area;
- Distance from non-Project sources of sensory disturbance;
- Intensity (in decibels), duration, timing and frequency of noise;
- Location, timing and nature of blasting events;
- Stand level habitat composition of the island;
- Island size; and,
- Timing of ice breakup.

BENCHMARKS

Benchmarks are not applicable for this study objective since it is documenting the nature of the zone of sensory disturbance. Reductions to habitat effectiveness due to sensory disturbance will be factored into the habitat loss calculations, after which the habitat effects benchmarks (Section 6.2.5.3.5) will be applied.

STUDY AREA

Data collection will occur within Stephens Lake and the upstream Project hydraulic zone of influence.

SAMPLE LOCATIONS

Islands in lakes are the target elements of the survey population. Although the water surrounding an island is the essential attribute that makes the island calving and rearing habitat by providing predator protection, the surrounding water is not part of the target element. The lake is not used as habitat except for a narrow margin bounding the island that may be used for drinking, to cool down or for wind to drive away bugs.

A sampling unit consists of a habitat patch that is large enough to support a cow and her calf (cows only have one calf) for at least a portion of the calving season. The pair will move from a small island to another island when forage availability is low, if the animals are disturbed or if they need to escape from predators. It is thought that cows may select calving islands larger than some minimum size to provide time for the calves to grow stronger to improve flight response speed and endurance when exposed to depredation.

EIS study results indicate that 0.5 ha is the minimum island size for an island to be used during a portion of the calving and rearing period. Islands larger than approximately 150 ha are expected to provide habitat for more than one cow and her calf.

Sample locations for the construction phase will be selected as follows:

1. To identify the sampling units for the sampling frame:
    - Select all islands larger than 0.5 ha within the study area;
    - Subdivide islands larger than approximately 300 ha into sampling units that are each approximately 150 ha in size.
2. Drop potential sampling units that have less than 5% tree cover.
3. Classify each of the sampling units remaining after step 2 into size classes, distance classes and habitat mixture types.
4. From each of the remaining combinations of size class, distance class and habitat mixture type, randomly select five sampling units as the sample locations.
    - Note that, to anticipate changes to habitat due to island erosion or groundwater that may have occurred since the terrestrial habitat mapping was completed, more than five sampling units will be selected. In the field, if it is found that tree cover is less than 5% then the sampling unit will be dropped and the biologist will move to the next island in the list. This will continue until five units are obtained.

Map 16 and Map 18 show the islands selected using this approach. All of these locations will be sampled during each year of construction. A power analysis completed during the winter after the second year of sampling will determine whether a larger sample size is needed for subsequent sampling.

During the first year after the reservoir reaches full supply level, the sampling frame will be adjusted to account for island loss and gain. Islands will be dropped if they are lost to reservoir flooding or if they have declined well below the minimum size due to erosion. The sampling frame will also be adjusted by adding islands created by reservoir flooding. All of these new islands will be sampled.

SAMPLING FREQUENCY AND SCHEDULE

Sampling will occur during years 2, 4, 5, and 6 of construction. Sampling will likely occur every second year of operation until year 14, however the results from the construction phase will determine the actual monitoring schedule during operation. After three years of operation phase sampling, results from all monitoring to date will be used to review the schedule for monitoring to year 15 of operation; results will be used to determine if additional monitoring is recommended and, if so, during which years.

Islands will be visited three times annually, with the timing coinciding with the end of the calving and early calf rearing period (July) and the end of the early to the late calf rearing period (September). The first visit in early to mid-April sets the thread and confirms that cows have not yet arrived. The second visit in July records sign during the calving and early calf rearing period while the third visit in September records sign during the mid to late calf rearing period.

FIELD AND LAB METHODS

Tracking transects will be positioned in a criss-cross configuration to maximize the probability of caribou detection. Mammal sign surveys will occur along these predesigned survey transects. Sign surveys will collect information from mammal species leaving signs, including tracks, trails, droppings, beds, browse sign (presence only), sounds and visual observations. To facilitate the recording of mammal activity, on the first site visit, biodegradable hip chain thread is placed along the transect, and it becomes the centreline. The hip-chain thread is strung approximately 0.75 m above the ground, and it is stretched and anchored on trees and shrubs about every 20 m along the entire transect. Sign data is collected and recorded up to 1 m to either side of the survey transect. During the second and third visits, breaks in the thread are used to indicate recent mammal activity. Only sign specific to the thread break location is assessed and recorded. Where sign is not located at a thread break site, it will be marked as an unknown. During the second visit, thread breaks are repaired to facilitate greater detection of recent mammal activity during the third visit. During the third site visit, thread will be removed or the thread will be broken into small pieces to facilitate degrading. The locations of all observed sign are recorded through use of Global Positioning System (GPS) units where information on the date and location of the survey transect is recorded also. All recorded sign information is copied to a digital database once sampling activities are complete.

A camera will be placed in each of the selected islands. Reconyx™ PM35C31 or similar trail cameras will be situated in locations that appear to have the highest probability of detecting caribou activity based on heavy use game trails, large openings and the habitat mosaic. The field biologist will choose candidate locations from habitat maps and/or digital orthorectified imagery prior to going to the island. A field reconnaissance of these locations will determine the best camera location. Once the location is selected, the trail camera will be attached to the nearest sturdy tree. The area immediately in front of the trail camera area will be cleared of any low vegetation obstructions which may interfere with the motion detection capabilities of the trail camera. Cameras will be set to take a rapid-fire series of five photographs. During the first visit, the cameras will be tested using 'walk mode' to ensure their proper functioning. Trail cameras will be maintained during the second visit, including battery and memory card exchange, and the camera will be removed during the third visit.

Hand-held or stationary remote audio recording units will be placed at test sites. At the Project features test sites, audio recorders will be calibrated with standardized noise levels. Distance to the Project features and environmental parameters that affect noise (e.g., wind direction, vegetation cover) will be measured at each location.

In the lab, trail camera photographs will be reviewed by a technician and observed caribou attributes will be entered in a spreadsheet which includes the identification of species present, species age and sex based on primary and secondary sexual characteristics and the number of individuals present within each photograph. Recorded attributes will include the species, number of individuals, sex, and age class of photographed animals. Sex and age are determined based on the presence of male or female sex organs and the presence and shape of antlers or vulva patch. All photographs will be reviewed in duplicate by a second technician or biologist to ensure the accuracy of recorded information.

Trail cameras will also be used to photograph other wildlife species of interest. Of particular interest is the presence of predators (e.g., wolf, bear, wolverine) and moose within the sampling units. Data recorded for other wildlife species will be analogous to that recorded for caribou.

In the lab, the audio recording data will be screened for noise disturbances using sound analysis software (e.g., Adobe Audition 2.0). The amplitude (i.e., decibels) statistics and frequency of each noise is extracted from the microphone recordings. Data will be entered into an a spreadsheet from each recorder location and recording.

ANALYSIS

Sensory disturbance versus unaffected are the two treatments, the sample locations are the replicates, tracking transect or camera are the subsamples while frequency, intensity and duration of sensory disturbance as a function of distance from the source is the dose gradient. Human disturbance type (e.g., Project only, Project and Gillam), habitat mixture type, island size, distance from next nearest land area and timing of ice breakup are the primary covariates in the analysis. Intensity of auditory disturbance as a function of distance will be interpolated from sound recordings, fitting the appropriate non-linear model to the data. Dose duration and frequency will be estimated from audio recorders and blasting records.

The analysis methods and inferential approach will be determined by the shape of the temporal dose-response curves and the structure of the datasets used for analysis. Possible methods include dose–response regressions, logistic regression, ANOVA and structural equations modeling. The possibilities increase as additional years of data become available, keeping in mind that repeated sampling is a form of pseudoreplication. Covariates will be included in the statistical analysis to account for confounding factors and for natural variation as far as possible. Statistical model and inferential assumptions will be tested during the analyses.

In addition to the dose gradient-response question, the analysis will evaluate how island size, island habitat composition, distance to nearest land areas and timing of ice breakup influence habitat use. Results will feed into the habitat quality model validation completed by the Habitat Effects study (Section 6.2.5).

Distance to mainland may influence island use in opposing ways. The cow-calf pair may move from small islands to a nearby mainland area to feed. However, the greater the open water area between the island and other land areas, the greater the degree of predator protection, particularly for wolves.

Ice break-up timing on lakes may be an important factor in the selection and use of island habitat and the development of solitary calving behaviours as opposed to calving en masse in regions outside Study Zone 6, or alternatively, using peatland complexes for calving and calf-rearing.

6.2.4.3.3 CALVING AND REARING IN PEATLAND COMPLEXES

OVERVIEW

Construction activities in the generating station, access road and borrow areas represent the greatest anticipated source of sensory disturbance for calving and rearing in peatland complexes. This disturbance continues throughout construction. Access road sensory disturbance to some of these complexes continues through operation.

Caribou use of calving and rearing complexes within 2 km of the access roads and 4 km of the generating station will be evaluated. This study area represents the maximum anticipated distance of Project-related sensory disturbance. Overall use in this study area could be very low or nonexistent for many years simply because these complexes are embedded in a matrix of recent burns (from fires occurring in 2001 and 2013). To provide some control for the confounding of burn with Project effects, peatland complexes elsewhere in the 2013 burns that are unaffected by human activity will be included as reference locations.

Compared with the islands in lakes study, a weaker impact-trend by time statistical design is feasible. There are only eight peatland complexes experiencing Project disturbance alone, and most of these are situated a similar distance from the access roads. Additionally, the burns resulting from the 2013 wildfires confound the use of pre-Project data from these complexes as the before data in a study design.

This study will monitor caribou use of peatland complexes during the spring to fall period, as well as factors influencing complex use. Monitoring will occur throughout construction and periodically during operation. Operation phase monitoring will determine if habitat effectiveness increases after construction completion, and if there is any residual avoidance of roads or other Project components.

DESIGN

This is a qualitative dose-response study. In this study, the dose is the presence or absence of sensory disturbance while the response is the presence or absence of caribou calving and rearing. Depending on the density of caribou use in proximity to the Project Footprint, there may turn out to be some limited ability to infer degree of response through activity levels, but this is not expected from the outset.

An impact-trend by time design will be employed to estimate the occurrence of a sensory disturbance response in proximity to the access roads and generating station. All caribou calving and rearing peatland complexes within 4 km of the access roads and 6 km of the generating station, and experiencing disturbance from these features only, will be sampled. The focus of the analysis will be on complexes within 2 km of the access roads and 4 km of the generating station since this is the maximum anticipated distance of sensory disturbance. More distant complexes are included in the treatment sampling frame in an attempt to confirm the maximum distance, but success depends on the proportion of complexes in the 2013 burn that are used by caribou.

Peatland complexes located elsewhere within the 2013 burns but not subject to sensory disturbance will be paired with each of the treatment complexes to provide reference locations.

An additional 10 complexes within the 2013 burns and not subject to human activity will be sampled to provide additional data to estimate naturally variability of complex use.

Peatland complexes will be surveyed for caribou use during two periods: the calving and early calf rearing period; and, the mid to late calf rearing period.

Caribou use of complexes, and the islands within them, will be detected using tracking transects and camera trapping. See Field and Lab Methods for the rationale for these methods.

In addition to peatland complex sampling, 5 km long tracking transects will be established perpendicular to the access roads to serve several purposes - to detect whether caribou are moving through the area but not making use of the area during the summer; to estimate summer moose density since this is a potential attractant for wolves that could opportunistically prey on caribou; and, to estimate summer bear activity in the area.

Stationary audio recorders will measure the degree of auditory disturbance (i.e., the “dose”) at a subset of the surveyed complexes. The recorder locations will be selected to provide representation for major distance classes and non-Project sources of disturbance. The frequency and duration of the recordings will be set so as to sample the typical level of disturbance as well as the periodic extreme levels from blasting. Audio recorders mounted on tripods will be placed at strategic locations relative to sample locations and Project features to quantify the degree and duration of selected audio disturbances. At the Project features test sites, audio recorders will be calibrated with standardized noise levels. Distance to the Project features and environmental parameters that affect noise (e.g., wind direction, vegetation cover) will be measured at each location. These characteristics will allow for the development of sound magnitude and duration curves. In addition to the audio-recorders, trail cameras will be set up near the recorders alongside access roads to provide information on the types of vehicles and traffic.

Manitoba Hydro will provide a report documenting the location, timing and nature (e.g., multiple short blasts, charge size, presence of blasting blankets) of blasting events. The actual blasting record provides data to measure an element of the dose and determines if the audio recorders are capturing all of these disturbances.

Terrestrial habitat maps will be used to measure factors that may influence island use during the calving and rearing season (e.g., habitat composition, surrounding burn intensity and severity).

Monitoring will occur every year during construction to account for natural year-to-year variability, possible habituation over time (calving already occurs on islands close to PR 280) and to increase between year sample size. Monitoring will continue periodically during operation to determine if caribou calving and rearing activity increases once the access roads are the only remaining substantive source of Project-related sensory disturbance, and to test for possible habituation over longer periods of time.

The same complexes will be used during construction and operation provided they are not substantively altered by a subsequent unanticipated human disturbance or another wildfire.

PARAMETERS

The monitoring parameters are:

- Caribou sign density;
- Distance to the closest relevant footprint;
- Distances to other sources of sensory disturbance;
- Stand level habitat composition of the complex and the islands within them;
- Island and complex sizes;
- Location, timing and nature of blasting events; and,
- Intensity (in decibels), duration and frequency of noise.

BENCHMARKS

Benchmarks are not applicable for this study objective since it is documenting the nature of the zone of sensory disturbance. Reductions to habitat effectiveness due to sensory disturbance will be factored into the habitat loss calculations, after which the habitat effects benchmarks (Section 6.2.5.3.5) will be applied.

STUDY AREA

Treatment complexes are within 6 km of the Project Footprint. Most, if not all, reference complexes will be within Study Zone 5.

SAMPLE LOCATIONS

A sampling unit consists of a habitat patch that is large enough to support a cow and her calf for at least a portion of the calving season. In contrast with the islands in lakes study, it is not appropriate to use individual islands in peatland complexes as the target elements of the survey population. In peatland complexes, cows and calves use some of the non-island areas as foraging habitat.

A cow-calf pair may move from a small complex to another complex when forage availability is low, if the animals are disturbed or it has to escape predators. EIS study results suggest that that 30 ha is the minimum complex size for use during a portion of the calving and rearing period. Suitable peatland complexes larger than approximately 400 ha are expected to provide habitat for more than one cow and her calf.

Peatland complex sample locations will be selected as follows:

1. To identify the sampling units for the treatment sampling frame:
    - Select all caribou calving and rearing peatland complexes that are within 4 km of the access roads and 6 km of the generating station and are experiencing disturbance from these features only;
    - Drop complexes that are within the planned Project Footprint;

- Subdivide complexes larger than 800 ha into sampling units that are each approximately 400 ha in size.

2. For each treated complex, select a paired reference sample location based on similarity with the most influential drivers for calving and rearing habitat selection. This will be the complex that meets all of these criteria:
    - Is closest to the selected treatment complex but at least 6 km from the Project Footprint; and,
    - Is a similar size; and,
    - Encompasses a similar habitat mixture; and,
    - Is embedded in a similar landscape matrix (within or outside of 2013 burns); and,
    - Is not subject to sensory disturbance.
3. For the additional natural variability reference locations, randomly select 10 complexes not already included in the sample and that are not subject to sensory disturbance:
    - Five are from within the 2013 burns; and,
    - Five are outside of the 2013 burns.

For camera trapping, one camera will be placed into the following locations:

1. Place a camera in every complex smaller than 40 ha to evaluate whether the complex provides habitat for the entire calving and rearing period;
2. For the remaining sample locations, randomly select two of the sample locations related to each distance from the Project class (i.e., 0-2 km; 2-4 km; 4-6 km).

Sample locations for the perpendicular to road transects will be selected as follows:

1. Subdivide a 5 km buffer of the access roads into 1 km by 5 km blocks; and,
2. Randomly select 3 blocks from each major age class type along the north access road. Repeat this process for the south access road.

Map 19 shows the peatland complex units selected using this approach. Map 20 shows the 5 km long tracking transects that will be established perpendicular to the access roads. All of the selected unit will be sampled during each year of construction. A power analysis completed during the winter after the second year of sampling will determine whether a larger sample size is needed for subsequent sampling.

SAMPLING FREQUENCY AND SCHEDULE

Sampling will occur during years 2, 4, 5, and 6 of construction. Sampling will likely occur every second year of operation until year 14, however the results from the construction phase will determine the actual monitoring schedule during operation. After three years of operation phase sampling, results from all monitoring to date will be used to review the schedule for monitoring to year 15 of operation; results will be used to determine if additional monitoring is recommended and, if so, during which years.

Peatland complexes will be surveyed three times annually, in early to mid-April, in July and in September. See Section 6.2.4.3.2 for the rationale.

The perpendicular to road tracking transects will be surveyed three times annually, specifically during the caribou pre-calving period (early May) to determine if caribou are exploring the area for calving sites, in early July to determine if caribou are using non-calving habitat during the mid calf rearing season and during the late calf rearing season (late August).

FIELD AND LAB METHODS

Tracking transects in peatland complexes will be positioned in a configuration that maximizes the probability of caribou detection while considering that the sampling units will vary in size and shape, and generally be mixtures of different terrestrial habitat types. A criss-cross transect shape will detect presence and activity in a sampling unit. Tracking transect methods are described in Section 6.2..4.3.2.

For the perpendicular to road tracking transects, the 5 km buffer of the road is subdivided into 1 km blocks along the road length. Paired transects are located at the 333 m and 667 m positions with the 1 km base of the sample block that touches the road. In the field, the biologist will start where the first paired transect intersects the road, walk 5 km away from and perpendicular to the road, make a right angle turn at the end of the first transect and walk 333 m (parallel to the road), make a right angle turn and walk along the second paired transect back towards the road (which will be approximately 5 km, depending on the alignment of the road). The paired transect route will be provided as a GPS route to field staff, and will be followed to the extent possible given surface water and safety conditions along the route.

Trail camera methods are described in Section 6.2.4.3.2. Trail cameras will also be used to trap other wildlife species of interest. Of particular interest is the presence of predators and moose within the sampling units. Analogous data similar to caribou will be recorded for other wildlife species as possible.

Trail cameras will be placed in proximity to the access roads to record the type of vehicle traffic.

Hand-held or stationary remote audio recording units will be placed at test sites. Audio-recorder methods are described in Section 6.2.4.3.2.

In the lab, trail camera that photograph wildlife will be reviewed by a technician as described in Section 6.2.4.3.2. Audio-recording data will be processed as described in Section 6.2.4.3.2.

Traffic trail camera photographs will be reviewed by a technician. Vehicle attributes will be entered in a spreadsheet. Recorded attributes will include the type of vehicle, size of vehicle, and number of vehicles.

ANALYSIS

Sensory disturbance versus unaffected are the two treatments, the sample locations are the replicates, tracking transect or camera are the subsamples while frequency, intensity and duration of sensory disturbance as a function of distance from the source is the dose gradient. Habitat mixture type, complex size, total island size, surrounding landscape composition and surrounding burn intensity and severity are the primary covariates in the analysis. Intensity of auditory disturbance as a function of distance will be interpolated from sound recordings, fitting the appropriate non-linear model to the data. Dose duration and frequency will be estimated from audio recorders and blasting records.

The analysis methods and inferential approach will be determined by the shape of the temporal dose-response curves and the structure of the datasets used for analysis. Possible methods include dose–response regressions, logistic regression, ANOVA and structural equations modeling. The possibilities increase as additional years of data become available, keeping in mind that repeated sampling is a form of pseudoreplication. Covariates will be included in the statistical analysis to account for confounding factors and natural variation as far as possible. Statistical model and inferential assumptions will be tested during the analyses.

In addition to the dose-response question, the analysis will evaluate how peat island and complex size, habitat composition and distance to human or relevant landscape features influence habitat use.

6.2.5 HABITAT EFFECTS

6.2.5.1 INTRODUCTION

The availability and intactness of caribou habitat are expected to have the greatest influence on caribou abundance and distribution in the Keeyask Region. Calving and rearing habitat must provide refuge from predators and sufficient forage for females. The main requirement for winter habitat is the availability of lichens, an important winter food source for caribou.

Caribou select habitat for a variety of reasons, particularly food availability, predator avoidance, and levels of human and fire disturbance. Human-caused or natural alteration and fragmentation may attract moose, which in turn attract gray wolves, increasing the predation risk for caribou. Caribou select habitat at multiple spatial scales, and based on its level disturbance.

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. Areas with abundant arboreal and terrestrial lichens and relatively shallow snow are preferred. As these lichens are found in older successional stages of forest, mature forests constitute important caribou habitat.

Green forage such as horsetails, graminoids, and forbs are commonly consumed by caribou in spring. Summer and autumn forage consists of horsetails, graminoids, forbs, sedges, deciduous shrubs, and fungi.

Caribou are sensitive to human and fire disturbance. Caribou avoid areas where sensory disturbances are high. Caribou also avoid burned habitat because these areas attract moose and predators, and because winter foods such as lichens may be limited.

In the Keeyask Region, summer habitat applies only to summer resident caribou, as the other caribou groups do not occupy the region at this time. Summer habitat is situated in peatlands and black spruce-dominated stands. When calving, female caribou tend to select areas that decrease the risk of predation, such as relatively undisturbed islands in lakes or raised treed areas in expansive treeless wetlands (peatland complexes).

The majority of caribou activity observed during field studies in the Keeyask Region was during summer; caribou were generally scarce in winter. There was high seasonal variation in caribou density, as several caribou populations migrate through the Keeyask Region in the winter.

To quantify and situate caribou winter habitat, the EIS classified terrestrial habitat as follows:

- Black spruce, jack pine or tamarack-dominated peatlands.

To quantify and situate caribou summer habitat, the EIS classified terrestrial habitat and surface water as follows:

- Primary calving and rearing habitat was islands greater than 10 ha in size in lakes or peatland complexes greater than 2,000 ha; and,
- Secondary calving and rearing habitat was islands between 0.5 and 10 ha in size in lakes or peatland complexes between 30 and 200 ha.

A total of 850,307 ha of winter habitat was identified in Study Zone 6, of which 112,496 ha was in Study Zone 4. Some calving and rearing habitat may be created in the reservoir following impoundment as new islands are formed.

Using this classification, primary and secondary calving and rearing habitat for caribou is abundant in Study Zone 4. This model identified 204,240 ha of primary and secondary calving and rearing habitat in Study Zone 6, 14,254 ha of which is in Study Zone 4.

To quantify habitat intactness for caribou, the EIS used two approaches that were based on Environment Canada's model for measuring critical habitat for the boreal population of woodland caribou in Canada. The Environment Canada model identifies critical habitat within a specific caribou range as being any area that has not been affected by forest fires in the past 40 years or occurring within 500 of anthropogenic disturbance. The initial model used in the EIS indicated potential levels of caribou habitat as any area within Study Zone 5 exclusive of most bodies of water in this area, including the Stephens Lake reservoir. The second modelling approach was based more closely on the Environment Canada model where any area inside Study Zones 5 or 6, including lakes and bodies of water, was treated as potential caribou habitat. The calculation of caribou habitat using these two modelling approaches was similarly treated with habitat quantities compared to those documented by Environment Canada as sufficient for supporting a self-sustaining caribou range.

The goal of this study is to evaluate how Project-related changes to the locations and amounts of summer calving habitat as well as habitat intactness could potentially change caribou distribution and abundance within Study Zone 4.

6.2.5.2 OBJECTIVES

The objectives of this study are to:

- Verify the habitat association assumptions that were used to predict Project effects on caribou habitat;
- Quantify how much primary and secondary summer calving habitat is lost or altered due to the Project; and,
- Evaluate how Project-related changes to habitat influence the potential distribution and relative abundance of caribou within Study Zone 5.

6.2.5.3 STUDY DESIGN

6.2.5.3.1 OVERVIEW

There are four components to this study:

- Validate and refine the existing calving and rearing habitat quality model for summer resident caribou;
- Apply the refined model to the post-Project terrestrial habitat map (which includes surface water types) to quantify and situate primary and secondary calving habitat;
- Update the caribou habitat intactness map to reflect Project-related effects and natural disturbance and succession dynamics (i.e., shifting regional habitat mosaic created by new wildfires and by vegetation becoming old enough to provide caribou habitat); and,
- Confirm compliance for key mitigation measures.

The winter habitat quality model will not be validated because it is similar to the caribou regional intactness models produced in the EIS. The intactness models will be included in the integrated evaluation of the habitat.

For the first component, the EIS used an expert information model to classify terrestrial habitat and surface water types into primary, secondary and unsuitable habitat for calving and rearing. This expert information model was developed from field data collected in the Keeyask Region, relevant scientific literature and professional judgement. This model will be replaced with a statistically derived multivariate habitat quality model in 2016.

The Habitat Effects study will validate and refine the statistically derived habitat quality model using data collected by other studies. Additional data collection is not planned for two reasons. A considerable amount of data and effort will have been incorporated into the statistically derived habitat quality model. The Sensory Disturbance study will evaluate key elements of habitat associations (e.g., importance of island size or matrix composition) and will provide a considerable amount of data for model validation. The need for additional data will be evaluated after the validation is completed.

Following habitat quality model refinement, the model will be applied to the post-Project terrestrial habitat map to quantify and situate primary and secondary calving and rearing habitat. Permanent and temporary habitat loss due to Project infrastructure and indirect Project effects on terrestrial habitat and surface water types that are inputs into the habitat quality model will be determined from the Terrestrial Habitat Clearing, Disturbance and Indirect Effects monitoring (Section 2.1). This general approach will also determine alterations to the quantities and qualities of various habitat types, as well as evaluating the accumulation of woody debris at shorelines.

For distribution and abundance effects, the potential distribution of summer resident cows and calves will be temporarily or permanently reduced where Project clearing occurs. The terrestrial habitat clearing and disturbance mapping (Section 2.0) will identify reductions to potential distribution created by habitat removal due to Project clearing. Changes to the locations, quantity and quality of available habitat will be used to determine changes to the potential distribution and relative abundance of summer resident caribou.

Changes to caribou habitat intactness in the Keeyask Region, the third study component, will be periodically measured. Project footprints, along with appropriate disturbance buffers, will be reclassified as non-habitat due to disturbance. The boundaries of recent wildfires will remove current habitat. Regenerating burns will be reclassified as intact habitat when they reach 40 years of age.

The two methods used to identify the disturbance and management benchmark are as follows. The guidelines established by Environment Canada in the 2012 Recovery Strategy for the Boreal Population of Woodland Caribou in Canada. Additionally, results from EIS studies suggest that fire and human disturbance are not equivalent for regional caribou, and that regional caribou populations may be viable with higher levels of overall disturbance because human disturbance is low. Monitoring of linear feature density to evaluate the potential for increased hunter and predator access to caribou populations.

As part of the Keeyask Generating Station and South Access Road Environmental Protection Plans (EnvPPs), future caribou 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 the islands from clearing disturbances. To confirm compliance for key mitigation measures, all potential future caribou calving and rearing islands in the reservoir will considered a terrestrial sensitive site and be evaluated as part of the Ecosystem Diversity Priority Habitats study (Section 2.3.2).

6.2.5.3.2 EXISTING DATA

Reconnaissance surveys were conducted on islands in Gull and Stephens lakes in 2003 and 2005, and sign surveys and trail camera surveys were conducted on calving islands in Gull and Stephens lakes from 2010 to 2014 and near the north access road from 2010 to 2013. Sign surveys were conducted in summer and winter 2001 to 2004, mainly in Study Zones 1, 2, and 3. Sign surveys were conducted in a variety of habitat types using variously-shaped transects. Common habitat types were surveyed the most, while fewer transects were surveyed in less common habitat types (e.g., jack pine-dominated and broadleaf mixedwood). Less common habitat types were originally targeted for over-sampling due to their potential significance as mammal habitat. Subsequent, more detailed analysis of vegetation and land cover resulted in the re-classification of habitat types in the Keeyask Region. As such, some habitats originally classified as rare were in fact common. Lake perimeters and riparian shorelines were also surveyed.

6.2.5.3.3 DESIGN

This is a population and habitat patch level resource selection study. This study is not determining the specific environmental attributes that caribou use (e.g., do they use trees for cover or eat reindeer lichen) since this is already well established in the literature. Rather, the study is testing which of the mapped habitat patch types (i.e., mixtures of terrestrial habitat and surface water types) best incorporate these attributes based on demonstrated higher proportional use. All other things being equal, cows and calves are expected to be found in a higher proportion of their preferred habitat types compared with less preferred types, and to be absent or highly infrequent in unsuitable areas.

Aerial survey, tracking transect, camera trapping and terrestrial habitat mapping data gathered by other studies will be used to complete the validation and refinement.

The refined habitat quality model will be applied to the terrestrial habitat map, which will be periodically updated to reflect direct and indirect Project effects (Section 2.0).

Results from this study will contribute to understanding caribou distribution in Study Zone 5, which is of particular interest given the large areas burned during the 2013 wildfires.

6.2.5.3.4 PARAMETERS

The monitoring parameters are:

- Caribou presence in the sample location;
- Habitat attributes of sample locations;
- The amounts of primary and secondary calving habitat that are directly and indirectly affected by the Project;
- Flagging of potential calving islands in the future Keeyask reservoir prior to flooding; and,
- Vegetation regrowth in and blocking of decommissioned trails (Section 2.2.2).

6.2.5.3.5 BENCHMARKS

Benchmarks are not applicable for the first study objective since it is documenting habitat associations.

For the remaining objectives, the EIS considered that a 10% cumulative loss of historical habitat area for the species was the benchmark that triggered management concern. Caribou habitat effects monitoring will use these same benchmarks. Reductions to habitat effectiveness due to sensory disturbance will be factored into the habitat loss calculations.

6.2.5.3.6 STUDY AREA

Study Zone 5 (Map 3) is the study area.

6.2.5.3.7 SAMPLE LOCATIONS

Samples for the habitat quality model validation are provided by other studies, primarily the Sensory Disturbance study (Section 6.2.4).

Sample locations for compliance monitoring are provided by other studies, primarily in the Long-Term Effects on Habitat study (Section 2.1.3).

6.2.5.3.8 SAMPLING FREQUENCY AND SCHEDULE

Samples for the habitat quality model validation are provided by other studies, primarily the Sensory Disturbance study (Section 6.2.4).

The frequency and schedule for sampling will be determined from an evaluation of gaps in the cumulative data collected to the end of construction.

Compliance monitoring frequency and schedule for vegetation presence on caribou calving islands and vegetation regrowth on trails is described in the Long-Term Effects on Habitat study (Section 2.1.3).

6.2.5.3.9 FIELD AND LAB METHODS

There is no fieldwork for the habitat quality model validation.

Manitoba Hydro will provide construction activity progress reports as needed to plan field studies, and to qualify the level and distribution of construction disturbances. Similarly, blasting summary reports will be provided annually by Manitoba Hydro, including details on blasting times, locations and methods.

Ecosystem Diversity (Section 4.0) reports will be reviewed to verify compliance with expected future caribou calving island conditions.

6.2.5.3.10 ANALYSIS

Habitat patch type is the treatment, the sample locations are the replicates and native versus human-affected is the primary covariate in the analysis. The tracking transects and camera viewing areas are no subsamples. Analysis methods will be determined by the nature of the statistical habitat quality model and the structure of the datasets used for analysis. Some of the validation method possibilities include confusion matrices, Kappa statistics and receiver operating characteristic curves. Statistical model and inferential assumptions will be tested during the analyses.

For the Project-affected and available habitat mapping component of this study, the validated habitat quality model will be applied to the terrestrial habitat map periodically produced by Terrestrial Habitat Clearing, Disturbance and Indirect Effects monitoring (Section 2.1). An element of this mapping will be updates to the fire and human disturbance mapping. Vegetation regrowth in and blocking of decommissioned trails analyses are described in the Terrestrial Disturbance study.

Analysis methods for compliance monitoring will include basic descriptive statistics.

6.2.6 MORTALITY

6.2.6.1 INTRODUCTION

The main drivers of change and stressors of caribou in the Keeyask Region are habitat disturbance from fire and from human activities, and predation. Gray wolf plays an important role in adult caribou predation during winter. Gray wolf and black bear are important predators of calves. Other predators of caribou calves can include lynx and wolverine. Changes to any of these predator populations have the potential to substantively affect local and regional caribou populations. Because caribou mortality is cumulative, other stressors that potentially influence caribou populations include the number of alternate prey (moose and invasive species such as deer), harvest mortality, and other less important mortality sources (i.e., extreme weather events, disease or parasites, and accidental vehicle collisions and drownings.

The goal of the Mortality study is to examine the mortality implications of Project-related changes to predator populations, harvest and accidental mortality on caribou populations during Keeyask construction and operation. Accidental mortality is included in this monitoring study even though it is not a substantial concern because it can be monitored with minimal effort using information collected by other studies.

6.2.6.2 OBJECTIVES

The objectives of this study are to:

- Qualitatively evaluate caribou predation in Study Zone 6;
- Qualitatively evaluate caribou harvest mortality in Study Zone 6;
- Qualitatively estimate how Project-related accidental mortality (wildlife-vehicle collisions, potential drowning) affects caribou abundance; and,
- Evaluate the effectiveness of mitigation measures such as signage along access roads, and identify other mitigation or remedial actions that may be required to prevent mortality.

6.2.6.3 STUDY DESIGN

6.2.6.3.1 OVERVIEW

There are two components to this study. These include evaluating reports of substantive direct and indirect caribou mortality potentially associated with the Keeyask Project and lesser potential effects that includes accidental wildlife mortality. The Site Environmental Lead will provide the wildlife biologist with reports about road signage and accidental wildlife-vehicle collisions within the Project site for review. Any information provided on caribou mortality from traffic collisions along PR 280 by the public will also be included.

6.2.6.3.2 EXISTING DATA

Data describing caribou mortality are included the Keeyask Project EIS, as well as the Keeyask Infrastructure Project (KIP) Environmental Assessment Report and the KCNs' Project Assessment Reports.

6.2.6.3.3 DESIGN

A statistical design is not required for this monitoring program because Project effects monitoring relies on data from other studies.

Predator abundance and distribution data collected during the Caribou Sensory Disturbance study (Section 6.2.4) and Moose Habitat Effects study (Section 6.3.3.) will be used as covariates in the analyses of potential Project effects associated with caribou mortality.

Suitable mortality data collected incidentally from other studies will be used where appropriate, including the caribou Winter Abundance Estimates study (Section 6.2.2), Summer Resident Range study (Section 6.2.3) and Sensory Disturbance study (Section 6.2.4), and the moose Population Estimates study (Section 6.3.2).

River crossing attempts and accidental mortalities will be evaluated during the caribou Winter Abundance Estimates study (Section 6.2.2). Manitoba Hydro will provide water and ice condition data to the wildlife biologist if accidental caribou drowning mortality occurs. Available results of the KCNs' Aboriginal Traditional Knowledge (ATK) monitoring programs will also be reviewed and used in conjunction with the findings of this study.

Effects of increased access that may result in increased harvest pressure will be assessed by examining resource harvest by the Project construction workforce documented through the Resource Use Monitoring Plan, available results from the KCNs ATK monitoring reports, and Manitoba Conservation and Water Stewardship known rights-based and illegal harvest data, which are also reviewed as part of the Resource Use Monitoring Plan.

Caribou-vehicle collision data from Manitoba Public Insurance Corporation statistics and Manitoba Conservation and Water Stewardship wildlife reports will be compiled and evaluated.

Mortality monitoring results will be used to assess the effectiveness of mitigation measures such as signage along access roads, and to identify other mitigation or remedial actions that may be required if caribou mortalities occur in Study Zone 1.

6.2.6.3.4 PARAMETERS

The monitoring parameters are:

- Number of caribou harvested;
- Number of caribou depredated;
- Number of vehicle-wildlife collisions accidents, if any;
- Number of caribou drownings, if any; and,
- Habitat, landscape and human attributes of the location.

6.2.6.3.5 BENCHMARKS

There are no benchmarks for this study. Observed Project-related mortality effects will be considered in combination with habitat effects in the integrated analysis completed for the synthesis report (Section 6.2.7.2).

6.2.6.3.6 STUDY AREA

Study Zone 6 is the study area. Data collection from other studies that provide mortality information on caribou will occur predominantly within Study Zones 4 and 5.

6.2.6.3.7 SAMPLE LOCATIONS

There are no sample locations since other terrestrial monitoring studies are providing the required data.

6.2.6.3.8 SAMPLE FREQUENCY AND SCHEDULE

This element is not applicable as the study relies on incidental data from annual reports.

6.2.6.3.9 FIELD AND LAB METHODS

There is no planned fieldwork, but in the event that Project-related caribou mortality is reported, it may be investigated in the field. Any reports of caribou accidental drownings will be investigated. Data collected will include the location, number of animals involved, timing, and associated ice conditions.

In the lab, radio-collaring data from other studies in the Keeyask Region will be used to confirm caribou movements and predator kills in Study Zone 4, if available.

6.2.6.3.10 ANALYSIS

The analysis methods and inferential approach will be determined by the structure of the datasets used for analysis. Basic descriptive statistics will be the level of data analysis for these reports. Predator abundance and distribution data will be used as covariates in the analyses of potential Project effects on caribou mortality. Here, statistical model and inferential assumptions will be tested during the analysis.

6.2.7 REPORTING

6.2.7.1 ANNUAL REPORTS

A report will be produced during the winter after each year when field studies occur, and will be submitted to MCWS the following spring, as per Environment Act License 3107, Clause 20.

Reports will summarize the activities and general findings of the monitoring during the preceding year. Basic descriptive statistics will be the level of data analysis for these reports. Any major unanticipated events or recommendations for changes to study design or mitigation will be noted.

The wildlife biologist will review and contribute information to the trail rehabilitation reporting produced for the Terrestrial Habitat and Ecosystems monitoring studies (Section 2.0). Unanticipated effects and the success of trail rehabilitation relative to predator and human access concerns will be reported.

The wildlife biologist will review and contribute information to the caribou calving island sensitive sites report produced for the Ecosystem Diversity monitoring studies (Section 4.0). Unanticipated effects and the success of leaving trees on future potential caribou calving islands in the reservoir will be reported.

The wildlife biologist will review any Pen Islands and Cape Churchill coastal caribou mortality data available from MCWS.

A periodic synthesis report (Section 6.2.7.2) will integrate monitoring information obtained over multiple years.

6.2.7.2 SYNTHESIS AND RECOMMENDATIONS

A synthesis report will be produced after the first five years of field studies, after construction completion and after the final planned year for field studies during operation. Synthesis reports will consolidate, analyze and evaluate all monitoring information gathered to date, including that produced by EIS and other monitoring studies. An integrated evaluation of the habitat, sensory disturbance and mortality pathways of effects on the species will be completed. Actual Project effects will be evaluated relative to the EIS predictions, and the cumulative effects assessment will be updated to reflect actual Project effects. This update will include an evaluation of the modified Environment Canada intactness model developed for the EIS. These reports will also include recommendations for any needed modifications to subsequent study design or to mitigation. The operation synthesis report will make recommendations regarding the need for any further monitoring.

A Keeyask Caribou Coordination Committee has been formed by the Keeyask Hydropower Limited Partnership (KHLP). This committee will communicate results from Project caribou monitoring activities to other interested stakeholders, including other northern hydroelectric developments, government authorities and existing caribou committees and management boards. Project caribou monitoring results will be shared with this committee on an annual basis.

6.3 MOOSE

6.3.1 INTRODUCTION

6.3.1.1 BACKGROUND

The moose is a large ungulate (hoofed mammal) that inhabits the boreal forest. Moose occupy a variety of riparian and upland habitats, including recent burns, deciduous and coniferous forests, and riparian zones. Moose select habitat with an abundance of food and cover, including shoreline areas for summer feeding. This species is common in the Keeyask Region.

Moose are important to resource users, especially the Keeyask Cree Nations (KCNs), and are harvested by residents and non-residents of the Keeyask Region. While significant declines in some Manitoba moose populations have been observed, moose are generally widespread and abundant and are not listed under federal or provincial species at risk legislation.

Moose monitoring is important because, while there is a high degree of certainty for predicted Project effects on moose, the KCNs expressed concern about effects of the Project on moose habitat and populations. A Moose Harvest Sustainability Plan has been created by the Cree Nation Partners (CNP; consisting of Tataskweyak Cree Nation and War Lake First Nation), and changes in moose abundance, harvest, and habitat will be documented within the Split Lake Resource Management Area (RMA).

6.3.1.2 ASSESSMENT SUMMARY

The main drivers of change and stressors of moose in the Keeyask Region include habitat disturbances such as fire and linear features, plus predation and harvest. Changes to any of these factors have the potential to affect local and regional moose populations primarily through habitat loss or alteration and through access effects that result in increased mortality due to predation or harvest. Other drivers and stressors that could influence moose to a lesser degree include sensory disturbance, mortality due to collisions with vehicles, weather events such as deep snow, disease and malnutrition, and accidents (e.g., falls or combat injuries during the rut). Invasive species such as deer that may contribute to alternate prey and disease are not found in the Keeyask Region. Habitat availability and mortality due to predation and harvest are expected to have the greatest influence on moose distribution and abundance in the Keeyask Region.

Predicted Project effects on moose include the loss or alteration of 1.73% of primary habitat and 0.79% of secondary habitat, for a total of 12,116 ha, or just under 1% of moose habitat in the Keeyask Region as land is cleared (e.g., reservoir, dykes, south access road and trails). Long-term habitat loss or alteration is also associated with flooding, shoreline erosion, peatland disintegration, and reservoir-related groundwater and edge effects.

Edges suitable for foraging and mineral licks may be created where Project clearing in treed areas and roads create openings. While land clearing activities may create some foraging habitat for moose, sensory disturbance in those areas may render them unsuitable in the near term. Although moose are usually not as sensitive to disturbances as other species, sensory disturbance could result in a loss of effective habitat and temporary abandonment of calving and rearing habitat near the access roads and generating station. As moose habitat covers a large portion of the Keeyask Region and alternate habitat is widely available, a small adverse effect on moose is expected.

The creation of roads, trails, and transmission lines could result in increased moose mortality. If moose travel on linear features or are attracted to habitat adjacent to these features, they could be more susceptible to predation by wolves. An increase in linear feature density across the landscape could result in an influx of predators in the Study Zone 4 which, combined with changes in cover, could result in an increase in predator success. Harvest of moose by resource users could increase during construction due to improved access to Study Zone 4, and the provision of harvesting opportunities to replace the loss of traditional resource areas because of the Project (this will disperse existing harvest pressure in Study Zone 4). Moose mortality in the Split Lake Resource Management Area will be an on-going cumulative effect.

Collisions with vehicles on the access roads could also result in increased moose mortality. While vehicles may occasionally collide with moose, such events are uncommon and will likely have a minimal effect on the regional moose population. Manitoba Public Insurance statistics indicate that less than 2% of wildlife-vehicle collisions in the Thompson area are with moose. Two moose vehicle collisions were reported recently for the Keeyask Infrastructure Project (KIP) along the north access road.

In addition to the general mitigation measures described for all mammals in Section 6.0, the following mitigation measures will be implemented to minimize or avoid potential Project effects on moose:

- Rehabilitation of roadside ditches with native plants with low quality food values for moose where practicable, to minimize the attraction of moose to the road and the risk of wildlife-vehicle collisions and harvest opportunities;
- Much of the future reservoir area will be cleared prior to impoundment in 2019, which will reduce debris accumulation on shorelines. Floating debris will be collected from the reservoir to further reduce possible debris accumulation on shorelines; and,
- The hunting or harvesting of wildlife by Project staff will not be allowed on-site (this includes access trails). Signs prohibiting these activities will be posted as necessary.

Mitigation measures for moose (e.g., access road signage) are referred to in the Project EnvPPs.

Wildfires are another driver that will continue to influence moose habitat. The 2013 wildfires temporarily removed some moose habitat. However, high-quality habitat is created as burns regenerate up to about 30 years. Future fires will continue to affect moose habitat.

6.3.1.3 COMPONENTS THAT WILL BE MONITORED

Monitoring studies for moose will focus on verifying Project effects predictions related to regional population estimates, how moose distribution and abundance are altered by habitat changes, and increased mortality through changes to hunter access, vehicle collisions and predator populations.

The Population Estimates study (Section 6.3.2) will continue monitoring the number and distribution of moose occurring in Study Zone 5 during the winter, using aerial surveys. Areas extending outside of Study Zone 5 and into the Split Lake RMA will not be surveyed as part of TEMP; however, broader regional data are needed from the Split Lake RMA to evaluate cumulative effects. Where feasible, these data will come from the implementation of the CNP Moose Harvest Sustainability Plan. Population estimates will be produced periodically throughout monitoring and provide information on the health of the population with bull cow ratios and recruitment rates. Winter distribution will also be assessed based on proximity to Project infrastructure.

The Habitat Effects study (Section 6.3.3) includes several components that will address Project effects on moose habitat availability. The habitat quality model used to predict the amounts of moose habitat affected by the Project will be further validated. Changes to regional habitat intactness due to wildfires and Project development will also be periodically measured. Further changes in habitat will be associated with changes in winter moose distribution as indicated through the Regional Population Estimates study, as described above, and the caribou Habitat Effects study (Section 6.2.5). Although Project-related sensory disturbance is not considered a major concern, data collected as part of the caribou Sensory Disturbance study (Section 6.2.4) will be used to confirm if sensory disturbance alters habitat effectiveness for calving and rearing habitat used by moose.

The Mortality study (Section 6.3.4) will examine various sources of moose mortality such as predation and Project-related mortality (e.g., wildlife-vehicle collisions, harvest by workers). Changes in wolf and black bear abundance and distribution will also be monitored qualitatively based on observations during caribou Sensory Disturbance study (Section 6.2.4) and the moose Population Estimates study (Section 6.3.2). Changes in harvesting pressure based on increased access will be assessed through license and harvest data collected from the Resource Use Monitoring Plan where possible. Increases in moose-vehicle collisions will be recorded by Manitoba Hydro.

Mortality monitoring results will be used to gauge the effectiveness of mitigation measures such as signage along access roads and prohibiting firearms in camp during Project construction. Alternate mitigation or remedial actions will be developed as required.

Mitigation implementation monitoring is generally not included for moose. An exception is that a periodic review of shoreline debris mapping be will be evaluated with respect to potential effects on moose. The efficacy of other mitigation measures will be assessed through other wildlife monitoring studies specific to moose as well as for other species.

The Project moose monitoring studies will be coordinated with MCWS and other Manitoba Hydro monitoring initiatives.

The synthesis report (Section 6.3.4.5) will provide an integrated evaluation of Project effects on moose distribution and abundance, the availability of suitable habitat and mortality, using results from this monitoring program as well as relevant information from other monitoring programs. The implementation and results of the CNP Moose Harvest Sustainability Plan for example, are needed to understand the level of harvest effort, and the abundance and distribution of the moose population within the Split Lake RMA.

6.3.2 POPULATION ESTIMATES

6.3.2.1 INTRODUCTION

Moose are widely distributed and common in the Keeyask Region. Changes in density are associated with habitat distribution of recent burns, shrublands, forest, waterbodies and watercourses. Winter aerial surveys conducted in select township blocks from 2002 to 2006 indicated that the winter abundance of moose in the Keeyask Region varied from year to year. Moose density in the Keeyask Region Study Zone 5 (Map 3) ranged from 0.02 individuals/km² in 2002 to 0.06 individuals/km² in 2004 during 2002–2006 aerial surveys of township blocks. Mean density was 0.04 individuals/km². Moose density in Study Zone 4 ranged from 0.02 individuals/km² in 2002 to 0.27 individuals/km² in 2004. None of the blocks surveyed in 2006 were in Study Zone 4. Mean density was 0.13 individuals/km².

A moose reconnaissance survey conducted in March 2009 in the SLRMA demonstrated a wide and clustered distribution of moose. A modified Gasaway-style aerial survey for moose was conducted in January 2010, covering the entire Split Lake RMA, and included Study Zones 4 and 5. The abundance of moose in the Split Lake RMA was estimated at 2,600 (± 21.4%, 95% CI). The sex ratio of bulls to cows was 118:100. The calf:cow ratio was 36:100. The abundance of moose was estimated at 950 individuals in the Keeyask Region.

The goal of this study is to evaluate how the Project may be affecting patterns and trends in moose distribution and abundance.

6.3.2.2 OBJECTIVES

The objectives of this study are to:

- Quantify the trends in the number of moose in the Keeyask Region; and,
- In the context of variable winter distribution patterns, evaluate whether there is any suggestion that winter habitat use is affected by the Project.

6.3.2.3 STUDY DESIGN

6.3.2.3.1 OVERVIEW

Aerial surveys for moose in the Keeyask Region (Map 21) will be conducted in winter when moose are easiest to observe. The study design is a modified Gasaway-style survey that involves fixed-wing aircraft line transect sampling to detect moose tracks in the study area. The moose population in the study area will be stratified primarily using track density observations. The allocation of the sampling effort among the strata is determined by the stratum's mean density and variance. For each strata, random samples will be flown by helicopter in survey blocks measuring 3.0 by 5.5 km. A total count of moose is conducted for each block. The size of the moose population will be estimated from the survey block moose count data.

This monitoring will document the distribution, abundance and population characteristics (including age and sex) of moose in the Keeyask Region during construction in order to compare with pre-Project information on moose activity in the same area. The status of the moose population will be assessed using abundance measures, sex ratio and recruitment of calves. The distribution, abundance and recruitment of calves near Project construction, and during operations will be compared to that in Study Zone 5.

6.3.2.3.2 EXISTING DATA

For EIS studies, aerial surveys for ungulates (moose and caribou) were conducted in the winters of 2002/03 to 2006/07, 2011/12, and 2012/13. Ungulate counts included observations of individuals or signs of their presence (e.g., tracks). Reconnaissance trajectories were flown to locate ungulate populations, particularly caribou. Township flight blocks were then selected by incorporating common habitat types, burns, and linear feature replicates, and the density of ungulates was determined in the surveyed areas. For reconnaissance surveys, a total of 902 km was flown in 2002/03, 1,732 km in 2003/04, 1,579 km in 2004/05, and 485 km in 2005/06. Eight township blocks were surveyed over the winter of 2002/03, 27 in 2003/04, 21 in 2004/05, 20 in 2005/06, and 19 in 2006/07. Reconnaissance and township block surveys were typically conducted several times per winter, and township blocks were often surveyed more than once. Over the five-year period, a total area of 3,641 km^2 was surveyed in township blocks.

A moose reconnaissance survey was conducted in March 2009 in the SLRMA and demonstrated a wide and clustered distribution of moose. A modified Gasaway-style aerial survey for moose was conducted in January 2010 that covered the SLRMA, and included Study Zones 4 and 5.

Aerial surveys for caribou were conducted in the eastern portion of Study Zone 5 in the winter of 2011/12 and were repeated in the winter of 2012/13. Moose were common and were observed throughout the region during these surveys.

6.3.2.3.3 DESIGN

The survey will follow a stratified random sampling design similar to a Gasaway-style survey but modified using modern technology (i.e., GIS, GPS). The first step in this type of survey is stratification, which consists of flying survey lines over the entire study area, searching for moose tracks, to allow each sample unit to be classified as having a high, medium or low density of moose. The second step is sampling, which consists of searching randomly selected sample units with a helicopter, and counting all the moose inside the sample unit's boundary. The allocation of the sampling effort among the strata is determined by the stratum's mean density and variance. Allocation of helicopter time is optimized using a program called MOOSEPOP.

Stratification is based on moose tracks observed from a fixed-wing aircraft. Flight lines are oriented north-south, 1.5 minutes of longitude apart (which is approximately 1.5 km), and are arranged so that two lines are flown through each sample units. For safety reasons, some sample units around Thompson and the Thompson airport may be dropped.

In addition to counting moose tracks, caribou track density information and the abundance and location of gray wolf observations are also collected.

Moose are counted in sample units by using a helicopter. Flight lines are north-south, approximately 500 m apart, to provide 100% coverage and a total count of moose.

Stratification flights are only conducted if there is not a significant snowfall the previous day and if visibility is good. Sampling flights are conducted on all days which have adequate visibility for detecting moose.

To minimize the time between stratification flights and sample unit counts that may allow moose to move out of the sample units, the total survey area is divided into three sections, each of which is surveyed as if it were a separate survey. Boundaries are chosen to reduce the length of the north-south lines that would be flown by the stratification aircraft.

6.3.2.3.4 PARAMETERS

The monitoring parameters are:

- Number and locations of moose,
- Sex and age of moose;
- Number and locations of wolves, and,
- Landscape and human features that may influence distribution patterns.

6.3.2.3.5 BENCHMARKS

Benchmarks are not applicable for this study is it is documenting trends and patterns. Observed Project-related effects will be considered in combination with habitat effects in the integrated analysis completed for the synthesis report (Section 6.3.4.5).

6.3.2.3.6 STUDY AREA

Study Zone 5 is the study area (Map 3).

6.3.2.3.7 SAMPLE LOCATIONS

To conduct the survey, it is necessary to define regular sampling unit boundaries which are approximately the same, and aligned with a grid of three minute cells (three minutes of latitude by three minutes of longitude), which is the framework of sample units for the survey. The width varies slightly with latitude, so the area of the cells ranges from approximately 17.5 km^2 in the southern portions of the study area to approximately 17.0 km^2 in the north. The sampling grid extends slightly outside of Study Zones 4 and 5 since the grid cells are rectangular and the study zone boundaries were delineated using other criteria. Map 21 shows the grids that will be used for the two stage selection during aerial surveys.

6.3.2.3.8 SAMPLING FREQUENCY AND SCHEDULE

An aerial survey will be conducted every three years during construction to monitor changes in abundance, distribution and population characteristics of moose in Study Zone 5.

Aerial surveys for moose will occur approximately every three years during operation and will continue for up to 15 years of operation. At which point, the need for and frequency of continued monitoring will be evaluated based on results from all monitoring to date.

Aerial surveys for moose under this plan will be coordinated with any moose aerial surveys being done within the Split Lake RMA to support the CNP Moose Harvest Sustainability Plan.

6.3.2.3.9 FIELD AND LAB METHODS

Standard aerial survey techniques will be followed. Surveys will be conducted from a fixed-wing aircraft during primary daylight hours (10:00 am to 2:30 pm) where possible, with high visibility weather and complete snow coverage to count moose tracks. Stratification flights are only conducted if there is not a significant snowfall the previous day. Incidental observations of moose, caribou tracks and gray wolf are also recorded. Fixed-wing aircraft observations include one pilot, a crew chief seated beside the pilot, and two observers in the back seats (including KCNs Members). Airspeed is approximately 160 km/hr and elevation is approximately 100 m above ground. Both airspeed and elevation tends to vary with factors such as wind direction and terrain. Whenever moose tracks are observed, the crew chief is notified. Incidental observations of predators (e.g., gray wolf and wolverine) will also be recorded. The location is marked as a waypoint in a GPS, and the crew chief notes the waypoint number on a data sheet, along with the associated data. At the end of each line flown, observers are given frequent opportunities to rest their eyes and attention.

Searching the randomly selected sample units will be conducted with a helicopter, counting all the moose inside the sample unit's boundary. The flight crew is arranged the same as in the fixed-wing aircraft. Flight lines are north-south, approximately 500 m apart, so that observers on each side scan a strip 250 m wide. Altitude is approximately 50 m agl, and airspeed varies from 100 kph to 140 kph. When moose are sighted, the crew chief is notified, and the animal is classified as bull, cow, calf, or unknown. The location is collected using a GPS unit.

In the lab and each evening, data are taken from the GPS and the hard copy data sheets, and transmitted as Garmin files and Excel spreadsheets to the survey's data manager. During sampling, route files for the next day's flying in the helicopter are prepared by the data manager and transmitted to the survey crew for loading into the helicopter's GPS for the next day's sampling. The allocation of the sampling effort among the strata is determined by the stratum's mean density and variance. Allocation of the helicopter time is optimized using the software program MOOSEPOP (Version 2.0; R.A. DeLong and D.J. Reed, Alaska Department of Fish and Game, Fairbanks, Alaska, USA).

6.3.2.3.10 ANALYSIS

The grid cells are the subsamples within a given year. Human and landscape features, predators, and habitat are the primary covariates.

Once there are at least three years of data, exploratory data analysis will evaluate the extent to which a statistically robust analysis of abundance and distribution, and the factors influencing these population parameters, can be undertaken. The appropriate analysis methods and inferential approach will be determined following the exploratory data analysis. Covariates will be included in the statistical analysis to account for confounding factors and natural variation as far as possible. Statistical model and inferential assumptions will be tested during the analyses.

6.3.3 HABITAT EFFECTS

6.3.3.1 INTRODUCTION

Habitat availability has an important influence on moose distribution and abundance in the Keeyask Region. Moose select habitat based on food availability and cover. Moose are browsers, feeding on a variety of trees and shrubs in winter and on herbaceous plants, leaves, and new growth in summer. Calving and rearing habitat must provide a cow with food, shelter, seclusion, and a means to escape predators, such as nearby water. Similar to caribou, islands in Gull and Stephens lakes and islands of black spruce surrounded by expansive wetlands or treeless areas (peatland complexes) are often used by moose for calving and calf-rearing. Peninsulas and shorelines of lakes and rivers are also used.

According to the literature, moose are found in lowland and upland mature forest stands, shrubs, and aquatic areas. Forest fires provide excellent moose browse. Burned areas are commonly used; deciduous stands are preferred but conifer stands are also occupied. Moose density peaks between 11 and 30 years after a fire. The edges of burned stands allow moose to browse on new growth near protective cover from the nearby canopy.

Moose were widely distributed and often found near water during field studies in the Keeyask Region. Moose signs were very abundant and very widespread on Gull Lake shorelines and on islands in lakes. Signs of moose activity were found in all habitats in Study Zone 4 (Map 3).

To quantify and situate moose habitat, the EIS classified the following terrestrial habitat types as moose habitat:

- Forest stands dominated by broadleaf trees, jack pine, and tall shrubs were primary habitat; and,
- Forest stands dominated by black spruce and low vegetation were secondary habitat.

The presence of recent burns and stand age were used further to modify moose habitat into primary and secondary terrestrial habitat types.

Using the primary and secondary habitat classification system, moose habitat is widespread in Study Zone 5. This model identified 256,111 ha of primary habitat in Study Zone 5. Of this total, 35,095 ha are in Study Zone 4 and 4,437 ha are in Study Zone 2. The model also identified 972.394 ha of secondary habitat in Study Zone 5. Of this total, 128,647 ha are in Study Zone 4 and 7,678 ha are in Study Zone 2.

The goal of the moose habitat effects monitoring is to evaluate how the Project changes the distribution and abundance of moose habitat.

6.3.3.2 OBJECTIVES

The objectives of this study are to:

- Verify the habitat association assumptions that were used to predict Project effects on moose habitat;
- Quantify how much primary and secondary habitat is lost or altered due to the Project; and
- Evaluate how Project-related changes to habitat influence the potential distribution and relative abundance of moose within Study Zone 5.

6.3.3.3 STUDY DESIGN

6.3.3.3.1 OVERVIEW

There are four components to this study:

- Validate and refine the existing moose habitat quality model;
- Apply the refined model to the post-Project terrestrial habitat map (which includes surface water types) to quantify and situate primary and secondary habitat;
- Update moose habitat intactness to reflect Project-related effects and natural disturbance and succession dynamics (i.e., shifting regional habitat mosaic created by new wildfires and by vegetation becoming young enough to provide primary moose habitat); and,
- Confirm compliance for key mitigation measures.

For the first component, the EIS used an expert information model to classify terrestrial habitat and surface water types into primary, secondary and unsuitable habitat for moose. This expert information model was developed from field data collected in the Keeyask Region, relevant scientific literature and professional judgement. This model will be replaced with a statistically derived multivariate habitat quality model in 2016.

The Habitat Effects study will validate and refine the statistically derived habitat quality model using data collected by other TEMP studies, including: the Terrestrial Habitat Clearing, Disturbance and Indirect Effects study (Section 2.0);); the Intactness study (Section 5.0);); the caribou Winter Abundance Estimates study (Section 6.2.2), Summer Resident Range study (Section 6.2.3), and Sensory Disturbance study (Section 6.2.4);); and the moose Population Estimates study (Section 6.3.2).).

Data from the Population Estimates study will be used to validate hierarchical resource selection at the regional and landscape levels. Moose data collected by the caribou Sensory Disturbance study (Section 6.2.4) will be used to validate stand level resource selection component of the habitat quality model. This study will also provide data to evaluate the extent to which sensory disturbance may reduce habitat effectiveness in the vicinity of the Project.

Additional data collection for model validation is not planned for two reasons. A considerable amount of data and effort will have been incorporated into the statistically derived habitat quality model, and other monitoring studies will provide a considerable amount of additional use and habitat data. The need for additional data will be evaluated after the validation is completed.

Following habitat quality model refinement, the model will be applied to the post-Project terrestrial habitat map to quantify and situate primary and secondary habitat. Permanent and temporary habitat loss due to Project infrastructure and indirect Project effects on terrestrial habitat and surface water types that are inputs into the habitat quality model will be determined from the Terrestrial Habitat Clearing, Disturbance and Indirect Effects monitoring (Section 2.1). This general approach will also determine alterations to the quantities and qualities of various primary and secondary habitat types, as well as evaluating the accumulation of woody debris at shorelines. Any relevant data on submergent vegetation that is collected under the Aquatic Effects Monitoring Plan (AEMP) will be used in evaluating moose habitat quality.

For distribution and abundance effects, the potential distribution of moose will be temporarily or permanently reduced where Project clearing occurs. The Habitat Loss and Disturbance study (Section 2.0) will identify reductions to potential distribution created by habitat removal due to Project clearing. Changes to the locations, quantity and quality of available habitat will be used to determine changes to the potential distribution and relative abundance of moose.

Changes to moose habitat intactness in the Keeyask Region, the third study component, will be periodically measured. The boundaries of recent wildfires will add to current habitat. Provided they are not suitable or unsuitable habitat for other reasons, regenerating burns will be reclassified as primary habitat when they reach 10 years of age, and secondary habitat when they reach 36 years of age. Conversely, Project footprints, along with appropriate disturbance buffers, will be reclassified as non-habitat due to disturbance.

To confirm compliance for key mitigation measures, information related to hunting, as gathered through the Resource Use Monitoring Plan, will be reviewed. Data from the Rehabilitation Implementation and Success study (Section 3.2) will be reviewed to assess if the rehabilitation of roadside ditches with low quality food values for moose was successful. A study design is not required for this component.

6.3.3.3.2 EXISTING DATA

The identification of moose habitat associations has occurred based on sampling information collected from 2001 to 2014 for environmental assessment and monitoring studies associated with the Keeyask Infrastructure and Generation Projects.

Sign surveys were conducted in summer and winter 2001 to 2004, mainly in Study Zones 1, 2, and 3. Survey transects were established in a number of different areas including within defined 'coarse habitat types', on lake perimeters (2002 and 2003 only), riparian shorelines and the proposed north and south access road routes. Transects were revisited periodically throughout the field season and incorporated the use of hip-chain thread to detect recent species activity in the consideration of caribou and other large mammal species. Based on different areas sampled as part of each transect design, the frequency of mammal activity relative to each sampling area was calculated and used as a means of identifying those areas of relative high use, including potentially important habitat areas. For transects designed based on coarse habitat types, common habitat types were surveyed the most, while fewer transects were surveyed in less common habitat types (e.g., jack pine-dominated and broadleaf mixedwood). Less common habitat types were originally targeted for over-sampling due to their potential significance as mammal habitat. Subsequent, more detailed analysis of vegetation and land cover resulted in the re-classification of habitat types in the Keeyask Region. As such, some habitats originally classified as rare were in fact common.

As part of conducted mammal sign surveys, reconnaissance surveys were conducted on islands on Gull and Stephens lakes in 2003 and islands on Stephens Lake in 2005. These surveys occurred to examine the potential for caribou calving activity in these areas but where used to provide supplemental information on moose calving and rearing habitat. To this extent, additional mammal sign and trail camera surveys were conducted on islands in Gull and Stephens lakes from 2010 to 2014. The use of trail cameras provided a supplemental means of detecting species activity and were placed on every island where transects were present. The sampling of islands from 2011 to 2014 varied from those sampled in 2010 as the 2011 to 2014 sampling of islands occurred based on the removal of the smallest islands and adding in some larger islands located closer to the mainland. From the 2010 to 2014 survey period, 69 islands were sampled in total with a minimum of one trail camera present on each one for each study year. In 2014, many small islands were subsequently added back into the survey. Based on the 2013 fires in the Keeyask Region, some islands were not sampled in this year over the 2nd and 3rd visits and where some trail camera information was not recovered due to their destruction in the fire.

Surveys of peatland complexes, potentially used for calving and rearing by caribou, occurred 2009 – 2014 with these sampling results also used to inform on moose habitat use patterns. In 2009, sampling of peatland complexes, identified as caribou 'habitat' areas occurred through conducting timed searches to detect recent caribou calving activity. Alternately, sampling of 'non-habitat' areas occurred based on mammal sign surveys conducted along pre-designed transects in areas comprised of alternate habitat types. In 2010, transects of peatland complexes were limited to 11 complexes and the placement of 30 trail cameras on complexes occurring in proximity to proposed construction activities associated with the Keeyask Project. For, 2011-2014, mammal sign surveys occurred on 33 complexes based on their proximity to past or future disturbance features. This included the consideration of reference transects (not affected by past or planned future development), EA transects (within 5 km of Keeyask project components) and road reference transects (within 5 km of PR 280). For the Project effects transects, 48 trail cameras were also present to provide a supplemental means of detecting species on these complexes. Based on the 2013 fires in the Keeyask Region, some complexes were not sampled in this year over the 2nd and 3rd visits and some trail camera information was not recovered due to their destruction in the fire.

Mammal sign surveys were conducted off the north access road from 2010 to 2014. From 2011 – 2014, this included 11 paired transects with eight transects set up on the north side and three transects set up on the south side of the access road. Based on the 2013 fires in the Keeyask Region, some transects were not sampled in this year over the 2nd and 3rd visits.

Population data are described in the Population Estimates study (Section 6.2.3.2).

6.3.3.3.3 DESIGN

This is a population and habitat patch level resource selection study. This study is not determining the specific environmental attributes that moose use (e.g., do they use trees for cover or browse willows) since this is already well established in the literature. Rather, the study is testing which of the mapped habitat patch types (i.e., mixtures of terrestrial habitat and surface water types) best incorporate these attributes based on demonstrated higher proportional use. All other things being equal, moose are expected to be found in a higher proportion of their preferred habitat types compared with less preferred types, and to be absent or highly infrequent in unsuitable areas.

Suitable data collected incidentally from other studies will be used where appropriate, including Terrestrial Habitat Clearing, Disturbance and Indirect Effects (Section 2.0), Intactness (Section 5.0), caribou Winter Abundance Estimates study (Section 6.2.2), Summer Resident Range study (Section 6.2.3) and Sensory Disturbance study (Section 6.2.4), and moose Population Estimates (Section 6.3.2). These data will be used to complete the validation and refinement.

The refined habitat quality model will be applied to the terrestrial habitat map, which will be periodically updated to reflect direct and indirect Project effects (Section 2.3).

Results from this study will contribute to understanding trends in moose distribution within the study area.

6.3.3.3.4 PARAMETERS

The monitoring parameters are:

- Moose presence in the sample location;
- Habitat attributes of sample locations;
- Amounts of primary and secondary habitat that are directly and indirectly affected by the Project; and,
- Total amounts of primary and secondary habitat in Study Zone 5; and
- Food values relative to moose for vegetation in roadside ditches.

6.3.3.3.5 BENCHMARKS

Benchmarks are not applicable for the first study objective since it is documenting habitat associations.

For the second study objective, the EIS considered a 10% cumulative of historical habitat area to be the effects level that triggered management concern. This same benchmark will be used for habitat effects monitoring.

For the remaining study objectives, observed Project-related effects and mitigation efficacy will be considered in combination with habitat effects in the integrated analysis completed for the synthesis report (Section 6.3.4.5).

6.3.3.3.6 STUDY AREA

Study Zone 5 (Map 3) is the study area.

6.3.3.3.7 SAMPLE LOCATIONS

Samples for the habitat quality model validation are provided by other TEMP studies, including: the Terrestrial Habitat Clearing, Disturbance and Indirect Effects study (Section 2.0); the Intactness study (Section 5.0); the caribou Winter Abundance Estimates study (Section 6.2.2), Summer Resident Range study (Section 6.2.3) and Sensory Disturbance study (Section 6.2.4);); and the moose Population Estimates study (Section 6.3.2).)

6.3.3.3.8 SAMPLING FREQUENCY AND SCHEDULE

Samples for the habitat quality model validation are provided by other TEMP studies, including: the Terrestrial Habitat Clearing, Disturbance and Indirect Effects study (Section 2.0); the Intactness study (Section 5.0), the caribou Winter Abundance Estimates study (Section 6.2.2), Summer Resident Range study (Section 6.2.3) and Sensory Disturbance study (Section 6.2.4);); and the moose Population Estimates study (Section 6.3.2).).The frequency and schedule for sampling will be determined from an evaluation of gaps in the cumulative data collected to the end of construction.

6.3.3.3.9 FIELD AND LAB METHODS

There is no fieldwork or lab methods for the habitat quality model validation.

6.3.3.3.10 ANALYSIS

Habitat patch type is the treatment, the sample locations are the replicates and native versus human-affected is the primary covariate in the analysis. Analysis methods will be determined by the nature of the statistical habitat quality model and the structure of the datasets used for analysis. Some of the validation method possibilities include confusion matrices, Kappa statistics and receiver operating characteristic curves. Statistical model and inferential assumptions will be tested during the analyses.

For the Project-affected and available habitat mapping component of this study, the validated habitat quality model will be applied to the terrestrial habitat map periodically produced by the Terrestrial Habitat Clearing, Disturbance and Indirect Effects study (Section 2.1).

Analyses for compliance monitoring will include basic descriptive statistics.

6.3.4 MORTALITY

6.3.4.1 INTRODUCTION

The main drivers of change and stressors of moose in the Keeyask region are habitat disturbance from fire, human activities, predation and harvest. Gray wolf plays an important role in adult moose predation during winter. Gray wolf and black bear are important predators of calves. Changes to these predator populations have the potential to substantively affect the local and regional moose population. Because moose mortality is cumulative, other stressors that potentially influence moose populations include harvest mortality, the number of alternate prey (caribou and invasive species such as deer), and other less important mortality sources (i.e., extreme weather events, disease or parasites, and accidental vehicle collisions).

The goal of the Mortality study is to examine the mortality implications of predator populations, harvest and accidental mortality on the moose population during Project construction and operation. Accidental mortality is included in this monitoring study even though it is not a substantial concern because it can be monitored with minimal effort using information collected by other studies (i.e., TEMP caribou ground tracking, TEMP caribou and moose aerial surveys, and the RUMP).

6.3.4.2 OBJECTIVES

The objectives of this study are to:

- Qualitatively evaluate moose predation in Study Zone 5;
- Qualitatively evaluate moose harvest mortality in Study Zone 5;
- Qualitatively estimate how Project-related accidental mortality (wildlife-vehicle collisions) affects moose abundance;

- Evaluate the effectiveness of mitigation measures such as signage along access roads, and identify other mitigation or remedial actions that may be required to prevent mortality; and,
- Address uncertainties with respect to the redistribution of harvest effort affecting the moose population in the Split Lake Resource RMA.

6.3.4.3 STUDY DESIGN

6.3.4.3.1 OVERVIEW

There are two components to this study. These include evaluating reports of substantive direct and indirect moose mortality potentially associated with the Project and lesser potential effects that includes accidental wildlife mortality. The Site Environmental Lead will provide the wildlife biologist with reports about road signage and accidental wildlife-vehicle collisions within the Project site for review. Any information provided on moose mortality from traffic collisions along PR 280 by the public will also be included.

6.3.4.3.2 EXISTING DATA

Data describing moose mortality are included the Project EIS, the KIP Environmental Assessment Report, the CNP Moose Harvest Sustainability Plan, and the KCNs' Assessment Reports.

6.3.4.3.3 DESIGN

A statistical design is not required for this monitoring program because Project effects monitoring relies on data from other studies.

Changes in wolf and black bear abundance and distribution data from the caribou Sensory Disturbance study (Section 6.2.4), the caribou Summer Resident Range study (Section 6.2.3) and the moose Population Estimates study (Section 6.3.2) will be used as covariates in the analyses of potential Project effects associated with moose mortality.

Available results of the KCNs' Aboriginal Traditional Knowledge (ATK) monitoring programs will also be reviewed and used in conjunction with the findings of this study.

Effects of increased access that may result in increased harvest pressure will be assessed by examining resource harvest by the Project construction workforce documented through the Resource Use Monitoring Plan, available results from KCNs ATK monitoring reports and Manitoba Conservation and Water Stewardship license and harvest data.

Broader area records from the CNP's Moose Harvest Sustainability Plan, developed for the SLRMA, will be evaluated including the use of moose management units, harvest strategies, and the models used to project future populations and harvest.

Moose-vehicle collision data from Manitoba Public Insurance Corporation statistics and Manitoba Conservation and Water Stewardship wildlife reports will be compiled and evaluated.

Any moose kill sites (e.g. kills by predators) that are encountered during TEMPTEMP wildlife monitoring (e.g., caribou and moose aerial surveys, caribou ground tracking transects) will be documented for this monitoring study.

Mortality monitoring results will be used to qualitatively gauge the effectiveness of mitigation measures such as signage along access roads, and to identify other mitigation or remedial actions that may be required if moose mortalities occur in Study Zone 1.

6.3.4.3.4 PARAMETERS

The monitoring parameters are:

- Number of moose harvested;
- Number of moose depredated;
- Number of vehicle-wildlife collisions accidents, if any; and,
- Habitat, landscape and human attributes of the location.

6.3.4.3.5 BENCHMARKS

There are no benchmarks for this study. Observed Project-related mortality effects will be considered in combination with habitat effects in the integrated analysis completed for the synthesis report (Section 6.3.4.5).

6.3.4.3.6 STUDY AREA

Study Zone 5 is the study area. Data collection from other studies that provide mortality information on moose will occur predominantly within Study Zones 4 and 5.

6.3.4.3.7 SAMPLE LOCATIONS

There are no sample locations since other terrestrial monitoring studies are providing the required data.

6.3.4.3.8 SAMPLE FREQUENCY AND SCHEDULE

This element is not applicable as the study relies on structured data from the CNP Moose Harvest Sustainability Plan monitoring reports as available, and incidental data from annual reports.

6.3.4.3.9 FIELD AND LAB METHODS

There is no fieldwork or lab work methods for the Mortality study as this study relies on data collected from other reports.

6.3.4.3.10 ANALYSIS

The analysis methods and inferential approach will be determined by the structure of the datasets used for analysis. Basic descriptive statistics will be the level of data analysis for these reports. Predator abundance and distribution data will be used as covariates in the analyses of potential Project effects on caribou mortality. Here, statistical model and inferential assumptions will be tested during the analysis.

6.3.4.4 ANNUAL REPORTS

A report will be produced during the winter after each year when field studies occur, and will be submitted to MCWS the following spring, as per Environment Act License 3107, Clause 20.

This report will summarize the activities and general findings of the monitoring during the preceding year. Basic descriptive statistics will be the level of data analysis for this report and include harvest statistics from the Project area and moose-vehicle collision data. Any major unanticipated events or recommendations for changes to study design or mitigation will be noted.

6.3.4.5 SYNTHESIS AND RECOMMENDATIONS

A synthesis report will be produced the year after construction is completed and after the final planned year for field studies during operation. Synthesis reports will consolidate, analyze and evaluate all monitoring information gathered to date, including that produced by EIS and other monitoring studies. An integrated evaluation of the habitat, sensory disturbance and mortality pathways of effects on the species will be completed. Actual Project effects will be evaluated relative to the EIS predictions, and the cumulative effects assessment will be updated to reflect actual Project effects. These reports will also include recommendations for any needed modifications to subsequent study design or to mitigation. The operation synthesis report will make recommendations regarding the need for any further monitoring.

Comprehensive reports on collisions will be prepared after year 3 and the final year of construction monitoring. This report will consider, compile, and analyze all years of monitoring conducted during that period, and based on those results, make recommendations concerning the need for any additional mitigation or monitoring.

The wildlife biologist will analyze all data collected and report every five years on the long-term moose population trends during operations. After year 15, recommendations for any further monitoring or mitigation will be produced.

6.4 BEAVER AND MUSKRAT

6.4.1 INTRODUCTION

6.4.1.1 BACKGROUND

Beaver and muskrat are medium-sized aquatic furbearers that inhabit waterbodies in forested areas. Beaver and muskrat are common in the Keeyask Region. By building dams, and through their feeding activities, beaver alter aquatic ecosystems, increase the diversity of species and habitat on a landscape, and create habitat for other species that use wetlands. Muskrats in the Keeyask area tunnel upward from below the water surface into the soil to make dens. Push-ups, smaller versions of the dens, are also created by muskrat during the period when ice is on the water. On the Nelson River, beaver and muskrat habitat is not commonly found along the main channel due to strong currents. However, the creeks, tributaries and ponds inland from the Nelson River provide habitat for both beaver and muskrat.

Beaver and muskrat are important furbearer species in the Keeyask Region, having cultural, economic, and ecological value. Due to their abundance and resilience to disturbance, beaver removal programs and subsidies are currently in place to manage beavers that cause property damage throughout Manitoba.

Beaver monitoring is important because there is potential for Project effects. There is a high degree of certainty in the assessment of Project effects on beaver, with some habitat loss and Project-related mortality expected. Similar Project effects on muskrat are anticipated, and muskrat mortality as a result of Project activities (i.e., trapping prior to reservoir clearing) will be recorded.

6.4.1.2 ASSESSMENT SUMMARY

The main drivers of change and stressors of beaver in the Keeyask Region include food availability and physiographic and hydrologic factors. Changes to any of these factors have the potential to affect the local and regional beaver populations, primarily through habitat change. Other drivers and stressors that could influence habitat quality or individuals to a lesser degree include mortality due to harvest and predation, accidents, and parasites and disease. Drivers and stressors are similar for muskrat. The availability of suitable habitat is expected to have the greatest influence on beaver distribution and abundance in the Keeyask Region, and will likely also have an effect on muskrat.

Predicted Project effects on beaver include habitat loss or alteration, sensory disturbance, and increased mortality. The loss or alteration of approximately 5% of the beaver habitat in Study Zone 4 is anticipated as a result of reservoir creation. Flooding will result in a permanent loss of beaver habitat as creeks, tributaries, and small ponds and lakes are flooded. Long-term habitat losses are associated with reservoir impoundment, erosion, and peatland disintegration. Fluctuations in water levels in the reservoir area will make any potential habitat unsuitable. However, the formation of immobile floating peatlands in the reservoir could attract beaver to these habitats, and temporarily increase the abundance of beaver in the reservoir. Once these peatlands break down, beaver will most likely abandon the reservoir.

Sensory disturbance from construction activities such as blasting and traffic can negatively affect beavers' use of habitat. Disturbance due to noise from construction activities could result in a small loss of effective habitat via habitat avoidance or temporary abandonment.

Several sources of potential beaver mortality were identified. As reservoir impoundment will flood beaver lodges and muskrat dens, beaver and muskrat will be humanely trapped out of affected areas (i.e., killed) by local trappers to prevent the prolonged exposure and displacement deaths of these animals, resulting in increased mortality in Study Zone 3. Trapping and predation efficiency could increase as a result of improved access via the access roads and trails. Wildlife-vehicle collisions at stream crossings along the access road could result in a marginal increase in beaver mortality. Additionally, beaver often come in conflict with humans, particularly in construction areas where they plug culverts and create impoundments next to roads. These plugs typically need to be removed. This, in addition to wildlife control measures such as removal or destruction of beaver, could result in increased beaver mortality. Project-related effects on the beaver population are expected to be adverse and small.

In addition to the general mitigation measures described for all mammals in Section 6.0, the following mitigation measures will be implemented to minimize or avoid potential effects on beaver:

- A 100 m buffer will be left at creeks, streams, ponds, and lakes to the extent practicable to maintain existing beaver habitat;
- The contractor will notify the Site Environmental Lead if beaver dams must be removed;
- 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; and,
- Beaver and muskrat 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.

Fire will continue to affect beaver habitat. The 2013 wildfire temporarily removed some beaver habitat. However, affected beaver habitat can be replaced over time as burned areas regenerate.

6.4.1.3 COMPONENTS THAT WILL BE MONITORED

For beaver, habitat change and predators are the drivers expected to have the greatest impact on abundance and distribution. Other drivers that may affect beaver abundance and distribution to a lesser degree include:

- Sensory disturbance from construction equipment, blasting and other human activities that may cause individuals to avoid constructing lodges or burrow within and adjacent to infrastructure and activity zones, or to reduce foraging time in preferred habitats within these zones;
- Malnutrition and reduced reproduction due to low quality food; and
- Disease and parasites.

Project influences on all of the non-habitat drivers are expected to be very low.

While some habitat loss and Project-related mortality are expected, there is a high degree of certainty that Project effects on beaver will be small. Predicted post-Project cumulative effects on beaver are low, and beaver are resilient to disturbance. Beaver are able to move in response to disturbance and to create shelter and rearing habitat where there is a suitable food source. For these reasons, beaver monitoring will consist of two studies. The Habitat Effects study (Section 6.4.2) will confirm the actual amount of beaver habitat loss while the Mortality study (Section 6.4.3) will monitor Project-related beaver and muskrat mortality.

Relevant beaver information obtained by all terrestrial and resource use monitoring will be periodically consolidated, analyzed and evaluated in a synthesis report to provide an integrated comparison of predicted and actual Project effects on this species.

6.4.2 HABITAT EFFECTS

6.4.2.1 INTRODUCTION

This Habitat Effects study focuses on beaver. Beaver habitat in creeks, tributaries and inland ponds adjacent to the Nelson River will be lost to Project clearing and flooding. However, beavers may create "bank burrows" and lodges in the immobile floating peatlands in the reservoir (*e.g.,* as has been observed in Wuskwatim Lake). Reservoir formation is expected to produce only a temporary increase in the abundance of beaver since much of the floating peatland area is expected to disappear over time due to ongoing peatland disintegration.

The quality of habitat in creeks near the reservoir, which will be important for maintaining the local beaver population, could also be affected by water level fluctuations. Change in beaver habitat quality in and near the reservoir, mainly due to water level fluctuations and floating peatland formation, is the driver expected to have the greatest influence on beaver distribution and abundance in the Keeyask Region.

The focus of this study will be on beaver use of the reservoir and nearby areas during operation. An existing beaver habitat quality model will be used to periodically quantify and situate beaver habitat in Study Zone 4.

6.4.2.2 OBJECTIVES

The objectives of this study are to:

- Quantify how much beaver habitat is lost or altered due to the Project; and,
- Characterize beaver use of reservoir habitats during operation.

6.4.2.3 STUDY DESIGN

6.4.2.3.1 OVERVIEW

There are two components to this study. The first component determines beaver use of reservoir habitats, and then uses these results to refine the existing habitat quality model. The second component applies the refined habitat quality model to the post-Project terrestrial habitat map (which includes surface water types) to quantify and situate primary and secondary beaver habitat.

For the first component, the EIS used an expert information model to classify terrestrial habitat and surface water types into primary, secondary and unsuitable habitat for beaver. This expert information model was developed from field data collected in the Keeyask Region, relevant scientific literature and professional judgement. This model will be replaced with a statistically derived multivariate habitat quality model in 2016.

This study will refine the reservoir component of the statistically derived habitat quality model using data collected by this study. Validation of the rest of the habitat quality model is not planned because a considerable amount of data and effort will have already been incorporated into the statistically derived habitat quality model and there is high confidence that Project effects on beaver will be small.

Following model refinement, the habitat quality model will be periodically applied to the post-Project terrestrial habitat map to quantify and situate primary and secondary habitat. Permanent and temporary habitat loss due to Project infrastructure and indirect Project effects on the terrestrial habitat and surface water types that are inputs into the habitat quality model will be determined from the Terrestrial Habitat Clearing, Disturbance and Indirect Effects study (Section 2.1).

6.4.2.3.2 EXISTING DATA

EIS studies collected beaver occurrence and habitat data along 3,327 km of shoreline in 2001, 2003, and 2006. A total of 228 km was surveyed in 2011. Lakes, ponds, creeks, and rivers were surveyed for the presence of beaver lodges and muskrat push-ups.

6.4.2.3.3 DESIGN

Beaver use of habitats in the reservoir, as well as waterbodies within one kilometer of the reservoir, will be censused through aerial surveys in five non-consecutive years during operation. In the event that very few beaver are observed after the first three of the sample years, a one-time aerial survey will be conducted in Study Zone 4 (Map 3) during the third sample year to determine if the study results are being confounded by a severe regional beaver population decline.

Potential beaver habitat in the study area consists of water shallower than two meters or floating peatlands. All potential beaver habitat within the reservoir and in waterbodies (i.e., lakes, ponds, creeks, and rivers) within one kilometer of the reservoir will be censused. Beaver lodges, burrows in mineral banks and floating peatlands, and food caches will be recorded as evidence of beaver use. Environmental attributes of each used location will be recorded for the habitat association analysis.

6.4.2.3.4 PARAMETERS

Parameters of concern include:

- Beaver presence in the sample location; and,
- Habitat attributes of the sample location.

6.4.2.3.5 BENCHMARKS

Benchmarks are not applicable for this study since it is determining habitat associations.

6.4.2.3.6 STUDY AREA

The study area for the fieldwork will be the reservoir area as well as waterbodies within one kilometer of the reservoir. Periodic mapping of primary and secondary habitat will be carried out for Study Zone 4.

6.4.2.3.7 SAMPLE LOCATIONS

In general, a sample location is a 100 m shoreline segment and a 100 m buffer of the shoreline segment. For small floating peatlands, the sample location is the entire peatland as well as a 100 m buffer of it. Map 22 shows the areas that will be surveyed by this study.

6.4.2.3.8 SAMPLE FREQUENCY AND SCHEDULE

Sampling will occur in years 1, 4, 7, 10 and 15 of operation. Each sample location will be surveyed once each year in early October, which is when winter food caches are most visible.

6.4.2.3.9 FIELD AND LAB METHODS

All sample locations in the study area will be censused. Helicopter-based aerial surveys will be used to locate and record beaver lodges, bank burrows, floating peatland burrows and food caches. Follow-up boat-based surveys may be needed to confirm the presence of burrows in floating peatlands.

Two biologists will fly along all shorelines, including those formed by floating peatlands. Wherever a beaver shelter or food cache is observed, relevant attributes that can be estimated from the air will be recorded, such as the type and size of the beaver shelter and presence/absence of a food cache size. Boat-based surveys will be used to collect site measurements such as lodge volume, food cache size and composition, bank slope and water depth. Additional relevant environmental attributes (e.g., distance to nearest food source) will be determined from the detailed terrestrial habitat map produced by the Terrestrial Habitat Clearing, Disturbance and Indirect Effects study (Section 2.1).

6.4.2.3.10 ANALYSIS

The sample locations are the replicates, habitat patch type is the treatment and native versus human-affected is the primary covariate in the analysis. There are no subsamples since the entire sample unit is surveyed.

Analysis methods will be determined by the actual structure of the field data. Some of the habitat association method possibilities included ANOVA, logistic regression and generalized linear models. Some of the validation method possibilities include confusion matrices, Kappa statistics and receiver operating characteristic curves. Statistical model and inferential assumptions will be tested during the analysis.

For the Project-affected and available habitat mapping component of this study, the validated and refined habitat quality model will be applied to the terrestrial habitat map that is periodically produced by the Terrestrial Habitat Clearing, Disturbance and Indirect Effects study (Section 2.1).

6.4.3 MORTALITY

6.4.3.1 INTRODUCTION

Keeyask reservoir impoundment will flood beaver lodges and muskrat burrows and dens. The KHLP committed to engaging local trappers to humanely trap out (*i.e.*, kill) beaver and muskrat in affected areas prior to this event to prevent the prolonged exposure and displacement deaths of these animals. Other mitigation measures include the deployment of beaver baffles at culverts, control structures and bridges that are blocked due to beaver dam construction if beaver create human safety hazards.

The Terrestrial Mitigation Implementation Plan includes directives and guidelines for trapping out beaver from the impoundment area and for avoiding the removal of dams and beavers where possible with the use of beaver baffles. The goals of the beaver and muskrat mortality monitoring study are to: assess the efficacy of trapping out beaver and muskrat from affected areas; and, to evaluate the response of beaver where beaver baffles are needed to manage water flow near roads.

6.4.3.2 OBJECTIVES

The objectives of the beaver and muskrat monitoring program for Project construction are to:

- Quantify and evaluate the removal of individual beaver and muskrat trapped prior to reservoir clearing and impoundment; and,
- Evaluate the response of beaver to any installed beaver baffles.

6.4.3.3 STUDY DESIGN

6.4.3.3.1 OVERVIEW

Registered trappers, ideally holders of the affected traplines, will search for and trap animals in Study Zone 1. Trappers will set traps for beaver and muskrat at appropriate locations. Traps will be checked and re-set regularly during the trapping season to ensure that all beaver and muskrat are trapped out completely. Trapping will follow humane trapping standards, as set in the Provincial guidelines. The disposition of beaver and muskrat meat and fur will follow all regulations and standards established by the Provincial authority.

There are two components to this study. The beaver and muskrat removal study will monitor the number of beaver and muskrat trapped by the trapline holders in the future reservoir area prior to impoundment. Compliance monitoring data collection will focus on where beaver and muskrat are located in Study Zone 1, and the abundance of these animals over time as the animals are removed immediately prior to impoundment. Reporting and feedback will be used to adjust the trapping protocols if needed to meet the reservoir clearing and impoundment schedules.

The second component to this study is mitigation efficacy monitoring that will examine the response of beaver at locations where beaver baffles are used. This management measure is commonly used in North America, where beaver become problematic when they dam or plug culverts and other water control structures. There is a high level of certainty that the installation of beaver baffles will minimize the further removal of beaver in Study Zone 1 if the baffles are deployed correctly.

6.4.3.3.2 EXISTING DATA

Beaver occurrence and habitat data are described in Section 6.4.2.3.2. An aerial survey was conducted in fall 2011 to quantify beaver lodges within the Project Footprint. About 23 active beaver lodges were identified in Study Zone 1.

Muskrat pushup data were collected in spring 2001, 2003 and 2006. Muskrat were common and widely distributed in Study Zone 4 during this period. Muskrat are often found in the same habitat as beaver at the edge of emergent vegetation zones. Creeks, streams, ponds, wetlands, and small lakes tend to be suitable habitats for muskrat. Muskrat abundance is rare in large lakes and along the Nelson River because habitat is not suitable.

6.4.3.3.3 DESIGN

Through helicopter surveys in Study Zone 1, this study will to supply additional data to the local trapper(s) by identifying beaver lodges in fall and muskrat pushups in spring. Because it will take a few years to trap out beaver and muskrat from the reservoir, the trapping program and monitoring will begin a minimum of three years prior to impoundment. Lodge and push-up data will be gathered over three years, with each location being sampled each year. Each location will be visited one time during the most appropriate season (i.e., in early October and in April/May, depending on freeze-up in fall and ice-off in spring) to increase detection probability. Beaver colony surveys are described further in the Habitat Effects study (Section 6.4.2.3.9).

Beaver and muskrat trapped by this program will be a source of liver, kidney and muscle tissue for the Mercury in Aquatic Furbearers study (Section 7.4).)

The beaver baffles component of this study will confirm if beaver baffles are needed, used, installed correctly and working, and if not, the specific environmental attributes of why it is not working so that the technique can be corrected.

Each culvert or water flow control structure that receives a beaver baffle will be sampled for effectiveness. If the device is working correctly, the site study ends. Monitoring would continue for beaver colonies that continue to block water flow; additional solutions would be offered in these circumstances. The fieldwork will occur during the construction and operation phases as these devises are installed.

6.4.3.3.4 PARAMETERS

The monitoring parameters are:

- the number of beaver and muskrat removed from Study Zone 1; and,
- the number and locations of installed beaver baffles; and,
- the number of beaver affected by beaver baffles.

6.4.3.3.5 BENCHMARKS

Benchmarks are not applicable to this study.

6.4.3.3.6 STUDY AREA

Study Zone 1 is the study area since this includes all of the areas where trapping and beaver baffle installation will occur.

6.4.3.3.7 SAMPLE LOCATIONS

All of the future reservoir area and any of the beaver baffle installations will be surveyed.

6.4.3.3.8 SAMPLE FREQUENCY AND SCHEDULE

This study will begin three years prior to reservoir impoundment, and it will occur on a yearly basis until the reservoir is impounded. Muskrat locations will be sampled in spring, and beaver lodges in the fall. Sample locations will be visited once per survey season.

For beaver baffles, the specific years when sampling occurs will be determined based on the year when the baffles are deployed. Each location will be surveyed the year in which the baffle is installed to evaluate the installation, and then in years 2, 3 and 4 following baffle installation to determine baffle efficacy.

6.4.3.3.9 FIELD AND LAB METHODS

Beaver and muskrat monitoring will include an annual helicopter survey to locate lodges and push-ups in the future reservoir area. Helicopter flights will be flown at approximately 30 m above ground level, with two observers. The location of beaver lodges and muskrat push-ups will be recorded using GPS units. Active versus inactive beaver lodges will be identified with the presence/absence of food caches and fresh mud on the lodge. Beaver lodge and muskrat push-up data will be provided to Manitoba Hydro each year prior to the implementation of trapping activities.

A qualified biologist will monitor trapping success in the field. During the trapping season, the biologist will record the number of animals trapped and collect tissue samples for the Mercury in Aquatic Furbearers study (Section 7.4).

In the lab, trapping standards, locations and success will be reviewed on a yearly basis. The location and number of individuals trapped will be recorded by trapper, or collected by assistants, and reported to the wildlife biologist. Other animal species that are trapped inadvertently during this program will be recorded and reported. The disposition of the meat and fur will also be reported.

Protocols for measuring the success of any installed beaver baffles will include site inspections and discussions with Manitoba Hydro engineers. If a beaver baffle is used, it will be georeferenced and photographs will be taken of the site. Potential concerns with the effectiveness of the system will be recorded on site.

6.4.3.3.10 ANALYSIS

Basic descriptive statistics will generally be the level of data analysis. Presence/absence analysis, frequency and abundance will be used to describe the local beaver and muskrat populations at the sample locations.

6.4.4 REPORTING

6.4.4.1 ANNUAL REPORTS

A report will be produced during the winter after each year when field studies occur, and will be submitted to MCWS the following spring, as per Environment Act License 3107, Clause 20.

Reports will summarize the activities and general findings of the monitoring during the preceding year. Basic descriptive statistics will be the level of data analysis for these reports. Any major unanticipated events or recommendations for changes to study design or mitigation will be noted.

Communication reports between the trapper and Manitoba Hydro will be required to gauge the success of the work, especially concerning the locations of active lodges and pushups that still require trapping efforts to remove animals. Any major unanticipated events or recommendations for changes to study design or mitigation will be noted where trapping effort should be increased.

6.4.4.2 SYNTHESIS AND RECOMMENDATIONS

A synthesis report will be produced after the first five years of field studies, after construction completion and after the final planned year for field studies during operation. Synthesis reports will consolidate, analyze and evaluate all monitoring information gathered to date, including that produced by other Keeyask terrestrial studies. These reports will also include recommendations for any needed modifications to subsequent study design or to mitigation. The operation synthesis report in year 15 of operation will make recommendations regarding the need for any further monitoring. The longevity of floating peatlands following reservoir impoundment will be a consideration in this evaluation.

6.5 RARE OR REGIONALLY RARE SPECIES

6.5.1 INTRODUCTION

6.5.1.1 BACKGROUND

Rare and regionally rare species include the wolverine (*Gulo gulo)* and the little brown myotis (bat; *Myotis lucifugus*). Wolverine and little brown myotis in the Keeyask Region are important as they may be present in very low numbers and may act as indicators of change to the environment. Wolverine is also important to local trappers for fur.

The wolverine is a medium-sized carnivore and the largest member of the weasel family. It is distributed throughout the boreal regions of North America, alpine tundra of the western mountains, and the arctic tundra. Wolverine occur at low densities within these habitats as they have extensive home ranges, and relatively low reproductive rates. It is estimated that approximately 15,000 to 19,000 are found in Canada, and about 1,200 to 1,600 occur in Manitoba. Due to its relatively low reproductive rate and requirement of vast amounts of habitat, the wolverine is listed as a species of Special Concern by the Committee on the Status of Endangered Species in Canada (COSEWIC). Few wolverine or signs were observed during Keeyask EIS field studies.

The little brown myotis is distributed throughout North America. These small (average 7.4 g), insectivorous bats generally forage over water at night, and roost in caves, trees, or buildings during the day. During winter, the little brown myotis use caves and mines, which provide cool, humid conditions to overwinter. Bats may travel hundreds of kilometers in the fall to reach these hibernacula. The little brown myotis is listed as endangered on Schedule 1 of the *Species at Risk Act* (SARA) and endangered on the Manitoba Endangered Species and Ecosystems Act (MESEA), due to large population declines resulting from the spread of white-nose syndrome. One other potential bat species that may range into the Keeyask Region is the hoary bat (*Lasiurus borealis*).

6.5.1.2 ASSESSMENT SUMMARY

The main drivers of change and stressors for the wolverine are sensory disturbance, land clearing, linear features, forest fires, trapping, and climate. These drivers and stressors have the potential to influence wolverine habitat, and can affect wolverine abundance and distribution. Other stressors that may impact wolverine habitat and populations, but to a lesser degree, include disease, predators, and accidents.

Habitat loss, habitat alienation and habitat fragmentation are often cited as a critical limiting factor for wolverine populations, especially where it affects a wolverine prey base of moose and caribou. The development of roads and trails at Keeyask will result in some reduced intactness. If wolverine are present in the region, there may be some effective habitat loss as a result of sensory disturbance caused by construction activities. Due to the relatively low density of wolverines in the province, this will likely affect very few individuals. Land clearing and forest fires may alter habitat for the wolverine. Depending on the types of habitat altered by these drivers, there may be a positive or negative impact on wolverine habitat. The creation of linear features could increase access by fur-trappers in the region, which may increase the harvest of wolverines. Linear features, such as roads make a barrier for wolverine movements. However, due to the large home ranges of wolverines, this would likely affect very few individuals. Disturbance of denning areas can affect individual wolverine.

The main drivers of change and stressors of the little brown myotis in the Keeyask Region are construction of buildings, land clearing, forest fires, beaver activity, climate and disease. These drivers and stressors have the potential to influence little brown myotis habitat or their abundance or distribution. Others drivers and stressors that may influence little brown myotis habitat or populations, to a lesser degree, include sensory disturbance, linear features, accidents, predators, parasites and climate. The availability of suitable habitat (maternity roosts, daily roosts and hibernacula), and the availability of insect prey, is expected to have the greatest influence on the abundance and distribution of the little brown myotis in the Keeyask Region.

The loss of beaver activity in the Project Footprint due to changes in the water regime and filling of the reservoir may decrease the amount of little brown myotis foraging habitat. Alternatively, the expansion of the reservoir may increase the amount of foraging habitat available. Land clearing may also increase the amount of foraging habitat available, but may also reduce the amount of roosting habitat. It is unlikely that hibernacula are present in the region as the nearest known hibernacula are present in the northern Interlake region of Manitoba, and as such, the loss of hibernacula is not anticipated. The construction of buildings may offer bats with an increased number of roosting sites.

Mitigation will be used in an attempt to offset habitat loses caused by the Project. Mitigation measures are described for all mammals in Section 6.0. No specific mitigation measures were identified for wolverine and little brown myotis.

Clearing and site preparation in the Project Footprint is predicted to result in the loss and alteration of wolverine habitat, although the extent of the change was not predicted in the EIS. Intactness was assessed for the Project EIS and it is described in Section 5.0.

6.5.1.3 COMPONENTS THAT WILL BE MONITORED

For wolverine, habitat fragmentation and overharvesting are the drivers expected to have the greatest impact on abundance and distribution. Due to their requirements for large tracts of habitat, wolverine are sensitive to habitat loss and fragmentation. Their large home ranges and relatively low reproductive rates also make them sensitive to overharvest by fur trappers. Other drivers that may affect wolverine abundance and distribution to a lesser degree include:

- Sensory disturbance from construction equipment, blasting and other human activities that may cause individuals to avoid denning within and adjacent to infrastructure and activity zones, or to reduce foraging time in preferred habitats within these zones;
- Malnutrition and reduced reproduction due to low prey abundance;
- Mortality due to vehicle collisions; and,
- Disease and parasites.

Project influences on all of the non-habitat drivers are expected to be very low.

For little brown myotis, the availability of over-winter hibernacula in the Keeyask Region is the driver expected to have the greatest impact on abundance and distribution. Hibernacula, such as caves and mines provide critical habitat needed for the over-winter survival of little brown myotis. Bats will travel hundreds of kilometers each fall from the summering grounds to reach these sites. If suitable hibernacula are not available in the region, or within a suitable distance, little brown myotis would not expected in the region. Other drivers that may affect little brown myotis abundance and distribution include:

- Amount of beaver habitat (wetlands) and forest openings for insect foraging;
- Sensory disturbance from construction activities;
- Availability of maternity roosts and shelter in buildings and natural habitat (snags and hollows in the trees; tree species including white birch, balsam fir, jack pine, and black spruce provide optimal roosting locations shielded from weather); and,
- Disease (e.g., whitenose syndrome which is the single largest stressor of bat populations that use caves).

Project influences on all of the non-habitat drivers are expected to be very low. Potential short-term habitat avoidance due to construction-related noise is unlikely as little brown myotis commonly occur in urban environments.

On this basis, and because the EIS predicted that residual Project effects will be from negligible to small in magnitude, monitoring studies for wolverine and little brown myotis will continue to focus on verifying the Project effects predictions that have the greatest potential for altering the EIS conclusions if inaccurate. The associated concerns include:

- Quantifying intactness and mortality for wolverine; and,
- Verifying if a little brown myotis population occurs in the study area.

The Wolverine study (Section 6.5.2) will evaluate intactness and wolverine mortality in the study area. Accidental mortality from sources such as collisions with vehicles is also included in this study even though is not a substantial concern as it can be monitored with minimal effort using information collected by other studies. Qualitative estimates for how Project-related harvest mortality affects wolverine abundance will use information gathered by the Resource Use Monitoring Plan.

The little brown myotis study (Section 6.5.3) will determine if little brown myotis are present in the study area.

Relevant wolverine and little brown myotis information obtained by all terrestrial and resource use monitoring will be periodically consolidated, analyzed and evaluated in a synthesis report to provide an integrated comparison of predicted and actual Project effects on these species.

6.5.2 WOLVERINE

6.5.2.1 INTRODUCTION

Limited wolverine signs were detected over the course of pre-Project field studies (2001-2014), and they have a limited potential to breed within Study Zone 6 (Map 3) and be subjected to Project effects. Potential construction-related effects on wolverine include short-term habitat avoidance due to construction-related noise and human activities. Intactness was relatively high in the Keeyask Region in 2010. This reflected the fact that most of the regional land area is undeveloped and existing development is concentrated along PR 280 and the Nelson River. Decreased intactness in the Keeyask Region is expected during operations, and overharvesting from increased access has the potential to affect the wolverine population.

The goal of the wolverine monitoring program is to verify that habitat intactness for wolverine in the Keeyask Region is not reduced substantially, and to assess potential mortality implications of increased access-related harvest and accidental mortality during construction and operation. Accidental mortality is included in this study even though it is not a substantial concern because it can be monitored with minimal effort using information collected by other studies.

6.5.2.2 OBJECTIVES

The objectives of this study are to:

- Evaluate Project-related changes to linear density and core area for wolverine; and,
- Qualitatively estimate how Project-related accidental mortality and trapping of wolverine affects abundance.

6.5.2.3 STUDY DESIGN

6.5.2.3.1 OVERVIEW

There are two components to this study. Wolverine require very large home range sizes, and therefore it is unlikely that more than a few individuals are present in Study Zone 6 (Map 3). Wolverine were also rarely detected over the course of pre-Project field studies (2001–2014). Because of this, they have a very limited potential to breed within Study Zone 4 (Map 3) and be subjected to Project effects. The first component is to verify habitat intactness, which is being studied in the Intactness study (Section 5.0). The second component examines trapping mortality and accidental mortality. No field studies are required.

6.5.2.3.2 EXISTING DATA

Wolverine occurrence and habitat data were collected from 2001 to 2014 for environmental assessment and monitoring studies associated with the Keeyask Infrastructure and Generation Projects. Mammal sign surveys were conducted in Study Zone 4 from 2001 to 2004. Transects were established in rare and common habitat mosaics, along riparian shorelines, and around lake perimeters. One hundred and four transects totalling 30,350 m in length were surveyed in summer 2001, 195 transects totalling 109,715 m in length were surveyed in summer 2002, and 210 transects totalling 115,030 m in length were surveyed in summer 2003. Transects were generally visited three times per summer, and total coverage over the survey period was 977,240 m². A sub-sample of transects was surveyed in winter 2001/02 and 2002/03. Fifty-five transects totalling 26,850 m in length were surveyed in 2001/02 and 72 transects totalling 35,380 m in length were surveyed in 2002/03. The total area surveyed was 193,265 m².

Additional sign surveys were conducted along the north and south access roads. In 2001, transects totalling 68,455 m in length were surveyed along the access roads. In 2002, 62,495 m of transect was surveyed and 20,020 m was surveyed in 2003. In 2004, 5,790 m of transect was surveyed along the south access road, and 1,290 m were surveyed at potential stream crossings at both roads. Total transect coverage was 316,115 m².

Wolverine data were collected incidentally during surveys for caribou and moose. One hundred and twenty-six trail cameras were installed in a large grid covering the lower Nelson River in the winter of 2012/13. Islands in Gull and Stephens lakes were surveyed in summer from 2010 to 2014. Peatland complexes were surveyed from 2010 to 2014. Eleven complexes were surveyed in 2010, and 30 trail cameras were deployed. From 2011 to 2014, 33 complexes were surveyed and 48 trail cameras were set up.

Aerial surveys were conducted for moose and caribou during which observations of wolverine or their signs were recorded. Aerial surveys in the winters of 2002/03 to 2006/07 included reconnaissance surveys and township blocks. For reconnaissance surveys, a total of 90 km were flown in 2002/03, 1,732 km in 2003/04, 1,579 km in 2004/05, and 485 km in 2005/06. Eight township blocks were surveyed over the winter of 2002/03, 27 in 2003/04, 21 in 2004/05, 20 in 2005/06, and 19 in 2006/07. Reconnaissance and township block surveys were typically conducted several times in a winter, and township blocks were often surveyed more than once. Over the five-year period, a total area of 3,641 km² was surveyed in township blocks. An aerial survey for moose was conducted in the winters of 2008/09 and 2009/10, covering the entire Split Lake Resource Management Area. Aerial surveys for caribou were conducted in the eastern portion of Study Zone 5 in the winter of 2011/12 and were repeated in the winter of 2012/13.

Field studies were conducted for caribou and moose in the summers of 2010 to 2013 for the Keeyask Infrastructure Project (KIP) monitoring, during which incidental observations of wolverine were recorded. A total of 246 sign survey transects were established in peatland complexes and on habitat islands to monitor caribou activity in calving and rearing habitat. Transects ranged from 100 m to 26 km in length and were visited three times each summer. Forty-eight trail cameras were set up at game trails on sign survey transects. Throughout all of these field sampling efforts, wolverine and their signs were sparse in the Keeyask Region.

6.5.2.3.3 DESIGN

A statistical design is not required for this monitoring program because the Project effects monitoring relies on data from other terrestrial monitoring studies. Suitable data from other studies will be used where appropriate, including the Intactness study (Section 5.0), the caribou Winter Abundance Estimates study (Section 6.2.2), the Summer Resident Range study (Section 6.2.3) and Sensory Disturbance study (Section 6.2.4), and the moose Population Estimates (Section 6.3.2).

Changes in harvesting pressure based on increased access will be assessed through license and harvest data collected from the Resource Use Monitoring Plan, where possible. Any wolverine collisions due to Project traffic will be recorded by Manitoba Hydro.

6.5.2.3.4 PARAMETERS

The monitoring parameters are:

- Project-related changes to linear feature density, by broad feature type;
- Project-related changes to the number, size and locations of core areas; and,

- Wolverine harvest and accidental mortality.

6.5.2.3.5 BENCHMARKS

Benchmarks are not applicable since it is documenting habitat associations.

6.5.2.3.6 STUDY AREA

Data collection from other studies that provide information on wolverine will occur within Study Zone 6, and predominantly within Study Zone 3.

6.5.2.3.7 SAMPLE LOCATIONS

There are no sample locations since other terrestrial monitoring studies are providing the required data.

6.5.2.3.8 SAMPLE FREQUENCY AND SCHEDULE

There is no fieldwork for this study. Data from other studies will be reviewed annually during the construction and operation periods as available.

6.5.2.3.9 FIELD AND LAB METHODS

Wolverine data will be collected opportunistically during caribou and moose calving and rearing habitat use surveys using track counts observations, trail camera photos, winter aerial surveys (see Sections 6.2.2 and 6.3.2), by reviewing wolverine trapping records, and from studies in the Resource Use Monitoring Plan, where possible.

There is no fieldwork for this study. Suitable data from other studies will be used where appropriate, including the Intactness study (Section 5.0), the caribou Winter Abundance Estimates study (Section 6.2.2), Summer Resident Range study (Section 6.2.3) and Sensory Disturbance study (Section 6.2.4), and the moose Population Estimates study (Section 6.3.2).

Presence/absence records from other studies listed above, accidental mortality records from Manitoba Hydro, spatial locations, and Manitoba Conservation and Water Stewardship trapping records that are reported in the Resource Use Monitoring Plan, will be compiled and mapped where feasible.

6.5.2.3.10 ANALYSIS

The analysis methods and inferential approach will be determined by structure of the datasets used for analysis. Basic descriptive statistics will generally be the level of data analysis. Presence/absence analysis, frequency and abundance will be used to describe the local wolverine population.

6.5.3 LITTLE BROWN MYOTIS

6.5.3.1 INTRODUCTION

Little brown myotis is a migrant species with a limited distribution in Study Zone 4 (Map 3). Only one bat was detected over the course of EIS field studies (in 2001) when this study was discontinued. Little brown myotis have limited potential to breed within Study Zone 4 and therefore are unlikely to be subjected to any Project effects. However, due to their recent listing as endangered under SARA and MESEA, a limited monitoring program has been developed to verify whether a population is present in the Keeyask area.

Potential construction-related effects may include foraging and roosting habitat loss due to clearing, and short-term habitat avoidance due to construction-related noise, although this is unlikely as little brown bats commonly occur in urban environments. Operational effects may include habitat alteration (i.e., change in foraging habitat in the reservoir, and alteration of roosting habitat with the construction of buildings). The wildfires in 2013 may have destroyed some of the potential maternity roosting and daily roosting sites present in that former habitat, although the creation of snags by the fire likely also created additional roosting sites.

The goal of the little brown myotis monitoring program is to evaluate whether a population and habitat exists in the Keeyask area and if so is it affected by the Project.

6.5.3.2 OBJECTIVES

The objectives of this study are:

- To determine if little brown myotis is present in Study Zone 4; and,
- If little brown myotis are detected in sufficient numbers, design a long-term monitoring program suited to verifying the EIS predictions.

6.5.3.3 STUDY DESIGN

6.5.3.3.1 OVERVIEW

There are two components to this study. Although one bat was detected over the course of EIS field studies in 2001, they have a limited potential to breed within Study Zone 4 and be subjected to any Project effects. The first component is to continue determining little brown myotis presence or absence in Study Zone 4. Sampling will occur in the study area using specialized equipment that is capable of detecting bats. The second component would design a study so that if individuals were detected, to expand sampling effort and consider developing a design that may be sufficient to verify elements of the EIS predictions.

6.5.3.3.2 EXISTING DATA

There is little existing occurrence and habitat data for little brown myotis, which appear to be sparse in Study Zone 4. None were identified during 2001 field surveys; however, one bat (species unknown) was detected incidentally in summer 2001 at a Keeyask field camp on Gull Lake. Based on size, it was likely a little brown myotis. Anecdotal reports of bat observations, possibly little brown myotis, near Gillam and in Study Zone 4 have been made, but not confirmed.

6.5.3.3.3 DESIGN

As Project construction and operations can affect habitat used by little brown myotis, potential species abundance will be monitored within Study Zone 3 (Map 3) using systematic searches and sample counts. If little brown myotis are detected in sufficient numbers, a revised design will be developed to address potential Project effects.

To situate the detection of potential bats in the Keeyask area, it is expected that they would arrive in early to mid-June after emerging from north Interlake hibernacula in May. Weather, temperature and insect emergence must coincide with their arrival.

Bats feed only at night, and often feed above forest canopy openings, along trails, and beside creeks, streams lakes and over marsh. The use of ultrasonic detectors is a passive system that allows the user to detect and sample echolocation calls at night for the presence of bats. It also allows the user to determine which species of bat is making the sound.

6.5.3.3.4 PARAMETERS

The monitoring parameter is:

- Little brown myotis presence in the sample location.

6.5.3.3.5 BENCHMARKS

Benchmarks are not applicable for this study since it is documenting species presence.

6.5.3.3.6 STUDY AREA

Study Zone 3 is the study area.

6.5.3.3.7 SAMPLE LOCATIONS

A sample location consists of a habitat patch that is large enough to support bat foraging. These will generally be mixtures of different terrestrial habitat and surface water types. Sample locations will be selected systematically along roads and trails will provide easy access and coverage of Study Zone 3 (Map 3). Sample locations will be 300 m apart, which will provide a 50 m listening radius with the sampling equipment being used. Additional sample locations will be placed where creeks cross a road or trail, or where two more trails converge that provide a suitable opening for foraging.

Monitoring for bats will also occur near the Keeyask generating station site and associated infrastructure (which could provide maternity roost and other roosting habitats), roads and other decommissioned access trails.

6.5.3.3.8 SAMPLE FREQUENCY AND SCHEDULE

Sampling will occur beginning in the 2015 breeding season and continue every second year until 2019. Program data needs will be evaluated in 2019.

Each sample location will be sampled three times per sampling year when bats are expected to inhabit the study area. Each visit will be separated by at least 20 days from mid-June to August.

6.5.3.3.9 FIELD AND LAB METHODS

Pedestrian surveys and point counts will be conducted at night, beginning at sunset and continuing until one-half hour before sunrise. Surveys will only be conducted on nights without rain and when the wind does not exceed 10 kph. Sampling at each survey point will last for 5 minutes. If a bat is detected while walking a transect between sample points, the bat will be recorded at this stop location.

Bat surveys will be conducted using hand-held Pettersson Elektronik - D240X bat detector. If a bat is detected, the signal will be recorded using a digital recorder and the recording will brought back to the lab for analysis. If a bat is detected, the GPS coordinate, date, time, habitat and weather conditions will be taken at the site.

In the lab, the recorded data will be analyzed using sound analysis software (e.g., Sonobat™), which has the capability of discriminating between bat species.

6.5.3.3.10 ANALYSIS

The analysis methods and inferential approach will be determined by the final sampling design and the structure of the datasets used for analysis.

6.5.4 REPORTING

6.5.4.1 ANNUAL REPORTS

A report will be produced during the winter after each year when field studies occur, and will be submitted to MCWS the following spring, as per Environment Act License 3107, Clause 20.

Reports will summarize the activities and general findings of the monitoring during the preceding year. Basic descriptive statistics will be the level of data analysis for these reports. Any major unanticipated events such as if large numbers of little brown myotis are detected or recommendations for changes to study design or mitigation will be noted.

6.5.4.2 SYNTHESIS AND RECOMMENDATIONS

A synthesis report will be produced after the first 5 years of field studies, after construction completion and after the final planned year for field studies during operation. Synthesis reports will consolidate, analyze and evaluate all monitoring information gathered to date, including that produced by EIS and other monitoring studies. An integrated evaluation of the habitat, and mortality pathways of effects on the species will be completed. Actual Project effects will be evaluated relative to the EIS predictions, and the cumulative effects assessment will be updated to reflect actual Project effects. These reports will also include recommendations for any needed modifications to subsequent study design or to mitigation. In this case, if little brown myotis are detected, a design would need to be developed further with a process to verify Project effects. The operation synthesis report will make recommendations regarding the need for any further monitoring.

6.6 GRAY WOLF, BLACK BEAR, AND OTHER WILDLIFE

6.6.1 INTRODUCTION

6.6.1.1 BACKGROUND

Gray wolf (*Canis lupis*) and American black bear (*Ursus americanus*) are large carnivores found throughout the Keeyask Region that generally require large areas of contiguous habitat. Both species require dens for the birthing and rearing of young, and in the case of bears, for hibernation. Dens, which are considered important life requisites of these species, may be disturbed by Project clearing and construction. The presence and location of gray wolf and black bear dens in the construction zone will be documented in order for appropriate protective action to be taken during construction.

Gray wolf and black bear are widespread and abundant in northern Manitoba. Gray wolf and black bear monitoring is important because of their position in the food web, as they prey mainly on ungulates (moose and caribou). No substantial, direct Project-related effects are anticipated on large carnivores, but indirect effects on ungulates are of concern. As animals are often attracted to human infrastructure such as the camps and work areas that will be associated with the Project, encounters with and displacement or mortality of species such as large carnivores and foxes will require monitoring.

6.6.1.2 ASSESSMENT SUMMARY

The main driver of change or stressor of gray wolves in the Keeyask Region is prey availability. Other drivers and stressors that could influence habitat quality or large carnivores to a lesser degree include habitat loss; sensory disturbance and habitat avoidance; den disturbance/abandonment; mortality due to harvest, conflicts with humans, or wildlife-vehicle collisions; accidents; and disease and parasites. Habitat loss and alteration affecting prey species (moose and to a lesser extent caribou) will likely have the greatest, although indirect, effect on gray wolf and black bear.

Predicted Project effects on gray wolf and black bear include habitat loss and alteration due to clearing (e.g., reservoir, dykes, south access road and trails). Rather than specific habitat types, large carnivores generally require large areas of undisturbed habitat. Habitat loss affecting prey and other food sources is expected to have a small, indirect effect on large carnivores.

Project-related disturbances may also affect large carnivores. Individual reactions to sensory disturbance due to construction activity near dens range from tolerance to den abandonment. Large carnivores could avoid roads, likely to minimize contact with humans; however, gray wolf and black bear are often attracted to human activity, particularly when a food source such as garbage is available. As these animals may pose a danger to workers in the area, they may have to be removed, relocated, or destroyed. Project effects could also include those related to improved access in the Keeyask Region. Vulnerability to hunting by workers and other resource users could increase due to improved access via the access road and trails. Changes in distribution and abundance are expected to be small, and the effects on moose as a food source will likely be small. The overall effect of the Project on gray wolf and black bear is expected to be adverse and small.

In addition to the general mitigation measures described for all mammals in Section 6.0, the following mitigation measures will be implemented to minimize or avoid potential Project effects on large carnivores:

- Roadside ditches will be rehabilitated with native plants that are of low quality food value for black bear, where practicable, to minimize attraction and the risk of collisions and harvest;
- The hunting or harvesting of wildlife by Project staff will not be allowed on-site (this includes along access trails). Signs prohibiting these activities will be posted as necessary; and
- Where practicable, 100 m buffers will be established around active gray wolf and black bear dens within the Construction Phase Project Footprint to minimize the disturbance of animals during sensitive periods.

Other drivers that will continue to influence gray wolf and black bear habitat include fires. The 2013 wildfire temporarily removed some large carnivore habitat. However, high-quality moose habitat is created as burned areas regenerate, which may indirectly benefit gray wolf in particular. Future fires will continue to affect large carnivores and their habitat.

6.6.1.3 COMPONENTS THAT WILL BE MONITORED

The availability of prey and other food abundance are the drivers expected to have the greatest influence on gray wolf and black bear. Other drivers and stressors potentially influencing large carnivore distribution and abundance, but to a much lesser degree include:

- Habitat loss;
- Sensory disturbance with habitat avoidance, and den disturbance/abandonment;
- Malnutrition and reduced reproduction due to low prey abundance;
- Mortality due to harvest, conflicts with humans, or wildlife-vehicle collisions;
- Accidents; and,
- Disease and parasites.

Other wildlife such as red fox may be affected by conflicts with humans if they are attracted to camp and work sites. These human-wildlife encounters will be monitored.

Project effects on all of the non-habitat drivers are expected to be low. In addition to Project-related effects on gray wolf and black bear, these two predators can affect other wildlife populations including caribou (Section 6.2) and moose (Section 6.3). Predator association information is needed to support the approach to these studies.

On this basis, and because the EIS also predicted that residual Project effects will be from small in magnitude, monitoring studies for gray wolf and black bear will continue to focus on verifying the Project effects predictions that have the greatest potential for altering the EIS conclusions if inaccurate. The associated concerns include:

- Quantifying gray wolf and black bear abundance to support other studies; and

- Quantifying potential mortality for gray wolf and black bear.

The caribou Sensory Disturbance study (Section 6.2.4) and moose Habitat Effects study (Section 6.3.3) will evaluate the change in distribution and abundance of gray wolf and black bear relative to caribou and moose studies in Sections 6.2 and 6.3, respectively. Additional gray wolf distribution and abundance data will be collected during the moose Population study (Section 6.3.2).

The Den Surveys study (Section 6.6.2) will determine if black bear or gray wolf dens are present in the study area.

The Human-Wildlife Interaction study (Section 6.6.3) will evaluate how gray wolf, black bear or other wildlife are interacting with humans.

Relevant gray wolf and black bear information obtained by all terrestrial and resource use monitoring will be periodically consolidated, analyzed and evaluated in a synthesis report to provide an integrated comparison of predicted and actual Project effects on these species.

6.6.2 DEN SURVEYS

6.6.2.1 INTRODUCTION

In spring, gray wolf and black bear are dependent on dens for giving birth to young. Black bear require dens in fall and winter for hibernation. If Project clearing activities coincide with these sensitive periods, Project effects may potentially include the disturbance of black bear and wolf dens.

The Project's Generating Station and South Access Road Construction Environmental Protection Plans (EnvPPs) include a directive for avoiding or minimizing the effects to black bear and gray wolf dens. The goals of the den survey compliance monitoring study are to: assess whether black bear or wolf dens occur in Study Zone 2 (Map 3); evaluate the response of animals to disturbances; and, to verify that accidental mortality during Project construction is not substantively affecting wildlife populations in the Keeyask Region. Accidental mortality is included in this monitoring study even though it is not a substantial concern because it can be monitored with minimal effort using information collected by other studies.

6.6.2.2 OBJECTIVES

The objectives of the den survey monitoring program for Project construction are to:

- Locate, if any, black bear and gray wolf dens; and,
- Evaluate the response of black bear and gray wolf to den disturbances.

6.6.2.3 STUDY DESIGN

6.6.2.3.1 OVERVIEW

A systematic ground search will be used to detect gray wolf and black bear dens in Study Zone 2. Prior to clearing of Project footprint areas, including the road right-of-ways, camp sites, borrow areas, and the reservoir, areas will be searched. The construction schedule will dictate the need for pre-clearing searches, as they are contingent on the timing of planned clearing. Only high quality habitats with a higher potential for black bear and gray wolf dens will be searched. Searches for black bear dens will occur in late fall and gray wolf den searches will occur in spring.

If an active den is found, mitigation measures will be applied. Mitigation measures include the prescription of a 100 m buffer as per Provincial guidelines. Den activity will be confirmed visually. Protocols for measuring the success of the active den buffer will include monitoring den activity with trail cameras mounted near each den site. The behaviour of the animal in the den will be evaluated in response to potential disturbances, and the effectiveness of the mitigation measure will be evaluated.

6.6.2.3.2 EXISTING DATA

Den searches were conducted prior to clearing for the Keeyask Infrastructure and Generation Projects.

6.6.2.3.3 DESIGN

Shapefiles of the areas selected for clearing will be provided by Manitoba Hydro. Using a Geographic Information System (GIS), habitat data will be extracted from the proposed clearing areas and divided into sections based on the potential to support black bear and gray wolf dens. For this exercise, a simple predictive model is developed by using soil and overstory data to categorize potential den habitat. Habitat with a high potential for black bear and gray wolf dens area areas of dry mineral soils with dense overstory cover, and riparian shorelines. Habitat with moderate potential for dens is thin peatland with some overstory cover. Habitat with low potential is defined by deep peatlands, and wet areas lacking overstory cover, water, and existing disturbed areas located within 300 m of active construction. High-resolution satellite imagery is used to validate selected habitat categories.

High quality black bear denning habitat that will be cleared in the upcoming winter will be searched by qualified ground crews in late fall of that same year. Where areas are to be cleared in April, similar techniques will be applied to searching for gray wolf dens prior to clearing. A pre-clearing aerial helicopter reconnaissance survey may also be conducted prior to ground searching, to validate potential den habitat quality and to look for wolf tracks.

Surveyors will be trained to identity structures that may appear to be dens or denning areas around hill sides, woody debris, root masses, and other sites that could be easily dug out or are close to food and water sources.

The pre-clearing den search is a compliance study. If active dens are found, the study becomes a mitigation efficacy study. This study will confirm if den buffers are effective, and if they are not, the study will use qualitative construction disturbance attributes to evaluate why they did not work, so the approach can be improved. Active den site locations will be provided to Manitoba Hydro in a timely manner for any remedial action to be taken, as may be appropriate for each circumstance.

Each active den site will be confirmed using trail cameras to determine the effectiveness of the mitigation. If the buffer distance is working correctly, the black bear or gray wolf in the den will continue to use the site. If the site is abandoned prematurely, consideration will be given to finding additional solutions that would be offered in these circumstances.

6.6.2.3.4 PARAMETERS

The monitoring parameters are:

- Number and locations of black bear and gray wolf dens;
- Environmental attributes of the den site; and,
- Number of active dens black bear and gray wolf dens disturbed.

6.6.2.3.5 BENCHMARKS

- Benchmarks are not applicable for the compliance monitoring study;
- Black bear waking up from hibernation prematurely (i.e., prior to spring); and,
- Gray wolf moving pups to an alternate den site.

6.6.2.3.6 STUDY AREA

Study Zone 1 is the study area since this includes all of the areas where direct clearing effects are predicted to occur.

6.6.2.3.7 SAMPLE LOCATIONS

Project infrastructure areas and the future reservoir clearing areas (Map 3) will be surveyed for black bear and gray wolf dens, with a focus on potentially high quality denning habitat where the needs are dictated by the Project clearing schedule.

A sample location is where an active black bear or gray wolf den is found.

6.6.2.3.8 SAMPLE FREQUENCY AND SCHEDULE

The frequency of pre-clearing den searches will be dictated by the Project clearing schedule.

For monitoring active black bear dens, trail cameras will remain on site from the date of discovery until the bear emerges from the den. Gray wolf dens will be monitored with trail cameras from the date of discovery until the den is no longer occupied.

6.6.2.3.9 FIELD AND LAB METHODS

Qualified personnel will intensively search sites for black bear and gray wolf dens. Only high-quality potential denning habitat will be surveyed. Individuals will walk parallel to each other approximately 10 m apart, searching for den cues including digging, hole sizes, tracks, scrapes, hills, hummocks, woody debris, root masses and other cues such as distance to water. Distances between searchers may vary depending on ground conditions, vegetation density, visibility, and the number of personnel available for searches.

An extension camera may be used to confirm whether the den is active if an animal is not visually detected by the biologist. In this case, the den site will be approached by three personnel: a camera boom operator, a camera operator, and a bear guard. The camera and safety equipment will be held at the ready. The den will be observed for a short period of time, listening for movement or any sounds that may indicate any animal is present within the den. If an animal is observed at this time, camera deployment will not take place, and the site will be treated as active. If no sounds or movements are detected, the infrared (IR) lights on the camera will be turned on and the camera boom operator will extend the boom slowly, positioning it into the den. The camera operator will record the event. If an animal is observed, the camera boom will be extracted from the den and the personnel will quickly and quietly leave the area.

All active dens will be flagged and their locations geo-referenced. Protocols for measuring the success of the active den buffer will include the installation of two trail cameras at each den site. Trail cameras will be set up at the den site approximately 20 metres from the den. Location and activity data will be recorded. Trail cameras will be maintained periodically and removed from the site after the animal emerges from the den.

Other animal species den sites will be recorded incidentally as practicable.

6.6.2.3.10 ANALYSIS

Basic descriptive statistics will generally be the level of data analysis. Maps of active black bear and gray wolf dens will be used to examine distribution.

6.6.3 HUMAN-WILDLIFE INTERACTION

6.6.3.1 INTRODUCTION

Animals are often attracted to human infrastructure such as camps and work areas that are associated with the Project. Displacement and/or mortality of animals could result if species such as gray wolf, black bear, or foxes conflict with humans. Human-wildlife encounter monitoring is important for human safety and for minimizing disruption to local wildlife populations. Mitigation measures for mammals are described in Section 6.1.2.

The goals of the Human-Wildlife Interaction monitoring program is to verify that potential mortality implications of wildlife control measures and accidental mortality during construction and operation are not substantively affecting wildlife populations in the Keeyask Region. Accidental mortality is included in this monitoring study even though it is not a substantial concern because it can be monitored with minimal effort using information collected by other studies.

6.6.3.2 OBJECTIVES

The objectives of this study are to:

- Qualitatively evaluate human-wildlife encounters in Study Zone 4; and,
- Qualitatively estimate how Project-related accidental mortality affects gray wolf, black bear and fox abundance.

6.6.3.3 STUDY DESIGN

6.6.3.3.1 OVERVIEW

There are two components to this study. These include human-wildlife interactions and accidental wildlife mortality. The Site Environmental Lead will provide the wildlife biologist with reports about human-wildlife interactions and accidental wildlife-vehicle collisions for review.

6.6.3.3.2 EXISTING DATA

Reports describing black bear, gray wolf, fox and other human-wildlife encounters and vehicle-wildlife collisions are available from the Keeyask Infrastructure Project.

6.6.3.3.3 DESIGN

A statistical design is not required for this monitoring program.

6.6.3.3.4 PARAMETERS

The monitoring parameter is:

- Number of black bear and gray wolves removed from Study Zone 1.

6.6.3.3.5 BENCHMARKS

Benchmarks are not applicable for this compliance monitoring study.

6.6.3.3.6 STUDY AREA

Data incidentally collected anywhere within Study Zone 4 will be used to monitor Project effects.

6.6.3.3.7 SAMPLE LOCATIONS

There are no sample locations since other terrestrial monitoring studies are providing the required data.

6.6.3.3.8 SAMPLING FREQUENCY AND SCHEDULE

This element is not applicable as the study relies on incidental data from annual reports.

6.6.3.3.9 FIELD AND LAB METHODS

This element is not applicable as the study relies on incidental data from reports.

The wildlife biologist will review data reports produced by Manitoba Hydro containing data on human-wildlife interactions and vehicle-wildlife collisions in the Study Zone 1.

6.6.3.3.10 ANALYSIS

This element is not applicable as the study relies on incidental data.

6.6.4 REPORTING

6.6.4.1 ANNUAL REPORTS

A report will be produced during the winter after each year when field studies occur, and will be submitted to MCWS the following spring, as per Environment Act License 3107, Clause 20.

Reports will summarize the activities and general findings of the monitoring during the preceding year. Basic descriptive statistics will be the level of data analysis for these reports. Any major unanticipated events or recommendations for changes to study design or mitigation will be noted.

Communication reports between Manitoba Hydro, MCWS, and the wildlife biologist will be required to monitor any human-wildlife interaction, especially concerning the removal or destruction of wildlife. Any major unanticipated events or recommendations for changes to monitoring or mitigation will be noted where human-wildlife encounter efforts should be changed.

6.6.4.2 SYNTHESIS AND RECOMMENDATIONS

A synthesis report will be produced after the first five years of field studies, after construction completion and after the final planned year for field studies during operation. Synthesis reports will consolidate, analyze and evaluate all monitoring information gathered to date, including that produced by other Keeyask terrestrial studies. These reports will also include recommendations for any needed modifications to subsequent study design or to mitigation. The operation synthesis report in year 15 of operation will make recommendations regarding the need for any further monitoring.

7.0 MERCURY IN PLANTS AND WILDLIFE

7.1 INTRODUCTION

Mercury (Hg) is a naturally occurring metal that exists in elemental, inorganic and organic forms in the environment. Inorganic mercury does not bioaccumulate. Methyl-mercury, which is the most common organic form of mercury, is soluble, mobile and can easily enter the aquatic food chain and bioaccumulate. Microorganisms indigenous to soils, fresh water and salt water are able to transform mercury from one form to another, including the methylation of inorganic mercury into organic methyl-mercury.

Mercury is naturally introduced into the environment through the weathering of minerals in rocks and soils and through volcanic activity. Human activities, such as mining and fossil fuel burning, have increased the amounts of mercury in the environment. Research has shown that mercury levels almost always increase in water after flooding, through the increased methylation of mercury from flooded vegetation and soils. Increased levels of methyl-mercury in flooded reservoirs have been found to bioaccumulate in fish species.

The KCNs have expressed deep concerns over the effects of mercury in their traditional foods, and as such the monitoring for mercury concentrations in terrestrial ecosystems will focus on the plant and wildlife species of concern to the KCNs. This monitoring was also previously identified under the Socio-Economic Monitoring Plan (SEMP) to confirm that mercury concentrations remain acceptable for domestic consumption. Given expected exposure pathways, as well as the importance of plants, waterfowl, aquatic furbearers, caribou and moose to the KCNs, mercury monitoring will also address these species. A Mercury and Human Health Risk Management Plan (MHHRMP) has been developed by the KHLP, which is intended to identify, assess, respond to, communicate and monitor risks to human health estimated to result from increased methylmercury (mercury) in the environment as a result of the operation of the Project.

7.2 MERCURY IN TERRESTRIAL PLANTS

7.2.1 INTRODUCTION

The KCNs Members are concerned about mercury levels in traditionally used terrestrial plants species. Mercury levels in these plants species will be monitored via tissue collected as a component of the TEMP, including voluntary submission of plant samples by KCNs Members. Post-Project mercury levels in selected terrestrial plant species will be compared with those in plants that were collected prior to reservoir impoundment. The four species groups selected by members of the Keeyask Mercury and Human Health Technical Working Group are Labrador tea (*Rhododendron groenlandicum*), northern Labrador tea (*Rhododendron tomentosum*), blueberries (*Vaccinium* spp.) and Seneca root (*Acorus americanus*).

7.2.2 OBJECTIVES

The objectives of this study are to:

- Evaluate pre-impoundment mercury levels in selected terrestrial plant species; and,
- Evaluate if there are changes in mercury levels in the selected terrestrial plant species during Project operation.

7.2.3 STUDY DESIGN

7.2.3.1 OVERVIEW

Mercury concentrations in Labrador tea leaves, northern Labrador tea leaves, blueberry fruits and Seneca roots that are collected before reservoir impoundment will be compared with samples of the same species collected during the operation phase. One set of samples for each of these species will be collected from locations near the future reservoir shoreline that will not be flooded. A second set of samples will be collected outside of the areas where plant tissue levels of mercury could potentially be affected by the future reservoir or other human features (e.g., dust from road traffic). Long-term atmospheric deposition of mercury is expected to be uniform throughout the study area.

7.2.3.2 EXISTING DATA

Between 2011 and 2013, tissue samples were obtained through a volunteer collection program by the KCNs Members, and from opportunistic collections by Project botanists conducting other terrestrial fieldwork in relevant areas. During this period, 29 plant tissue samples were collected, including 16 blueberry and 13 northern Labrador tea samples. All of the blueberry concentrations were below the detection limit of 0.010 ppm, while the mean northern Labrador tea leaf concentration was 0.014 ppm.

7.2.3.3 DESIGN

During Project construction, samples for each plant species will be collected at locations that will not be flooded and are within 50 m of the future reservoir shoreline. A second set of samples for each species will be collected at reference locations that are least 1 km away from the Nelson River or other human features that might influence mercury tissue levels (e.g., road dust). The volunteer collection program for the KCNs Members that began in 2011 will continue, with suitable voluntary samples adding to the sample size.

During operation, samples for each species will be collected within 50 m of the Keeyask reservoir and in the vicinity of the construction phase reference locations. To the extent feasible, the same locations and plants will be resampled during construction and operation. However, it may be the case that some replacements are needed where locations are subsequently disturbed or insufficient plant tissue is available for repeated sampling. The volunteer collection program for KCNs Members will continue, with suitable voluntary samples adding to the sample size.

7.2.3.4 PARAMETERS OF CONCERN

Parameters of concern are:

- Mercury concentrations in Labrador tea leaves, northern Labrador tea leaves, blueberries and Seneca root; and,
- Environmental attributes of the locations where plant tissue samples are collected.

7.2.3.5 BENCHMARKS

Plant mercury concentrations from this study are inputs provided to the toxicologist undertaking the Project's Human Health Risk Assessment (HHRA). Methods for analysis are found in the HHRA and EIS Supplemental Filings to Health Canada. Reporting procedures are found in the Project's Socio-Economic Monitoring Plan (SEMP).

7.2.3.6 STUDY AREA

Study Zone 4 is the study area.

7.2.3.7 SAMPLE LOCATIONS

A sample location consists of a patch of habitat for Labrador tea, northern Labrador tea, blueberry and/or Seneca root. Sample locations for each of the target species will be selected as follows:

1. Classify terrestrial habitat in Study Zone 4 into primary, secondary and unsuitable habitat patches for the target species..
2. Classify the primary habitat patches identified in Step 1 into the following areas: reservoir area (i.e., Reservoir Effects Collection Area), area influenced by other human features (samples not collected here), and area uninfluenced by the reservoir or other human features (i.e., Reference Sample Collection Area). The sampling frame consists of all primary habitat patches that are either in the reservoir area or are uninfluenced by the reservoir or other human features.
3. From each of the strata identified in Step 2, randomly select three sampling units for sampling during that year..
4. Repeat Steps 1 to 3 for each year that data collection occurs.

Map 23 shows the areas for both the Project-affected and reference collections.

For Seneca root, it may be difficult to obtain a sufficient sample size for statistical inference since this species was not discovered during the EIS terrestrial habitat field studies. As KCNs Members have reported collecting this species, they will be consulted to identify additional potential locations for collecting tissue samples.

7.2.3.8 SAMPLE FREQUENCY AND SCHEDULE

Plant tissue samples will be collected during years 2, 3 and 5 of construction and in years 1, 4 and 10 of operation.

Labrador tea leaves, northern Labrador tea leaves and Seneca root will be gathered in late August. Blueberries will be gathered when ripe.

7.2.3.9 FIELD AND LAB METHODS

Mercury can be easily lost from plant tissue if the sample is not correctly collected and stored. Mercury can also be unintentionally added to a plant tissue sample by contaminating it by contact with other items containing mercury. Because it is more difficult to obtain reliable results from plant tissue than animal tissue, it is important that the field collection protocol is followed carefully.

At each sample location, approximately 1/5th cup of blueberries or 1/3rd cup of Labrador tea leaves or Seneca root will be removed from the plants using a clean pair of disposable gloves. Samples will be placed in a new re-sealable plastic bag pre-labelled with the species, date of collection and a unique reference number.

The plant parts to be submitted, and the time they should be collected, are as follows:

- Labrador tea and northern Labrador tea:
    - Gather older leaves in late August.
    - Older leaves are the leaves that are furthest from the tip of the branch.
- Blueberries:
    - Gather berries when they are ripe.
    - For the voluntary collections, also collect leaves from the same plant, in order to identify which blueberry species the sample came from. Leaves are placed in a separate sample collection bag with the same unique sample reference number (see below) as the berries so the species can be identified.
- Seneca root:
    - Gather older roots in late August.
    - For the voluntary collections, also collect stems with leaves from the same plant, in order to determine which species the roots came from. Leaves on stems are placed in a separate sample collection bag with the same unique sample reference number as the roots so the species can be identified.

Samples will be placed in a cool temporary storage container while in the field. Once back from the field, samples will generally be stored frozen until they are shipped. Samples can be stored cold in a cooler if they will be shipped to Winnipeg in a cooler within a day or two.

The following steps will be taken to prevent cross contamination and to prevent mercury from escaping out of the plant tissue. A clean pair of disposable gloves will be used for each sample collection to avoid cross contamination. Any knives or other tools used to cut stems or dig up roots will be cleaned with water (preferably distilled water) between sample collections. Sampling equipment should not come into contact with the ground at any time after being washed. The gathered leaves, berries or roots will be placed directly from the plant into the collection bag, and not come into contact with the outside of the collection bag or any other surfaces. The labelled collection bag will be placed inside a second resealable plastic bag so the sample is double-bagged.

Information recorded for each tissue collection will include the plant species, date of collection, GPS coordinates for the sample location, growing conditions (e.g., soil type, soil moisture regime, soil drainage regime), approximate age of plant, condition of plant and tissue type (e.g., leaf, root, berry). Photos of the plant (prior to sampling) and sample location will be taken.

As a method of assuring quality of the laboratory and field methods, approximately one in every ten samples should include a duplicate collection, if possible. A duplicate is created by collecting a second sample from the same plant. If there is not enough tissue left on the same plant, then the same type of tissue from a nearby plant in similar condition can be used. Duplicate samples are assigned a unique reference number and packaged separately.

When a KCNs Member is willing to contribute some of the plants that he/she will be gathering to be submitted for analysis, it is recommended that they contact the designated Member(s) of their respective First Nation who is acting as a community coordinator for this program. The designated Member will explain how the samples need to be gathered and will provide a collection kit to the person who will be gathering plants in the field.

Before the sample is collected by a KCNs Member, a culturally appropriate community practice (e.g. tobacco offering, prayer, etc.) may be carried out by the community member. In the event that a non-community member is asked to collect the plant tissue, the person will carry out the appropriate practice identified by the community for their RMA.

The terrestrial ecologist will periodically submit plant tissue samples to an accredited laboratory for total mercury analysis. A chain-of-custody record will be completed. The lab will measure total mercury concentrations in the submitted plant tissues and supply the results of their analysis in a formal report.

The lab will be asked to return any sample material left over from the lab analysis, and this material will be forwarded to a KCNs Member to return to the land.

7.2.3.10 ANALYSIS

The level of analysis will generally be descriptive statistics, with comparisons of differences in mean concentrations using techniques such as ANOVA. Analysis methods will be determined by the actual structure of the field data. Statistical model and inferential assumptions will be tested during the analysis.

7.3 MERCURY IN WATERFOWL

7.3.1 INTRODUCTION

The primary pathway of concern for mercury exposure is through the aquatic food web. Flooding will increase mercury levels in the Keeyask reservoir. Potential effects on wildlife are linked to increases in fish mercury concentrations in the future Keeyask reservoir and Stephens Lake, and have important implications to domestic resource use. Mercury levels in some species of wildlife will increase over pre-Project conditions and peak approximately seven years after the reservoir is impounded. Mercury levels are expected to begin declining after that point and reach pre-Project levels (or will be considered stable at a new background level) approximately 20 to 30 years post-impoundment.

Mercury levels in herbivorous waterfowl species such as Canada goose are not expected to change due to the minute quantities of mercury taken up by plants. Small increases in mercury concentrations will likely occur in mallards, which forage on plants and lower trophic level invertebrates (*e.g.,* aquatic insects). Mercury levels in waterfowl typically consumed by local communities are expected to be low and unlikely to pose a risk to human health through consumption. This will be confirmed through the collection of waterfowl tissue samples voluntarily provided by local resource users.

7.3.2 OBJECTIVES

The objectives of this study are to:

- Establish pre-impoundment mercury levels in the consumable tissues and organs of Canada geese and mallard (or other duck species consumed locally), if an adequate number of suitable samples are provided during the construction phase; and,
- Determine if there are changes in mercury levels in these same species during operation, if an adequate number of suitable samples are provided.

7.3.3 STUDY DESIGN

7.3.3.1 OVERVIEW

Sample collection will occur based on the voluntary submission of samples from different waterfowl species harvested in the Keeyask Region, with focal species to include Canada goose and mallard. Because waterfowl move frequently among geographic regions and occupy and feed in numerous waterbodies during migration, and as spring waterfowl harvesting by the KCNs is preferred, it will not be possible to identify and compare samples from locations near the future reservoir to those outside the influence of the future reservoir, or before and after impoundment. Fall samples will be reported separately from samples collected in the spring. Mercury concentrations in waterfowl will be provided to the KHLP to assess human health risks.

7.3.3.2 EXISTING DATA

No data from the Keeyask Region is currently available.

7.3.3.3 DESIGN

Samples of Canada goose and mallard muscle, liver and kidney tissue will be collected and analyzed for mercury concentrations during both the construction and operation phases of the Project. Samples will be acquired from animals harvested by KCNs Members, and will be frozen and transported to an accredited laboratory for mercury analysis. Results will be related to the species of the bird, the season, and the location where it was harvested. Sex and age of the species will be added incidentally.

7.3.3.4 PARAMETERS

The monitoring parameters are:

- Mercury concentrations in muscle and organ tissues of Canada goose and mallard (or other duck species consumed; in μg/g).

7.3.3.5 BENCHMARKS

Mercury concentrations for Canada goose and mallard are inputs provided to the toxicologist undertaking the Project's Human Health Risk Assessment (HHRA). Methods for analysis are found in the HHRA and EIS Supplemental Filings to Health Canada. Reporting procedures are found in the Project's Socio-Economic Monitoring Plan (SEMP).

7.3.3.6 STUDY AREA

Study Zone 6 is the study area.

7.3.3.7 SAMPLE LOCATIONS

For Canada goose and mallard, sample locations will be variable based on locations where local harvesters are able to successfully harvest the species for which they are providing a sample.

7.3.3.8 SAMPLING FREQUENCY AND SCHEDULE

The program will begin in year 3 of the construction period. Voluntary samples of waterfowl tissue provided will be tested for mercury on an annual basis, until the end of construction.

Beginning in year 1 of operation, a request for voluntary submission of waterfowl samples will occur every year for the first 10 years of operation. The need for continued sampling will be reassessed after the results from this period are analyzed.

7.3.3.9 FIELD AND LAB METHODS

A wildlife biologist will facilitate quality control for the methods and collection of any data related to the tissue samples. This will be achieved through collaboration with a designated KCNs Member who is acting as a community coordinator for this program. The wildlife biologist will work with the designated KCNs Member, describing the collection methods and providing necessary collection materials for those harvesters interested in providing samples. The wildlife biologist will be responsible for submitting the samples for analysis and for providing reports summarizing mercury results to the KHLP.

When a KCNs Member is willing to contribute some of waterfowl tissue and organs that he/she will be gathering to be submitted for analysis, it is recommended that they contact the designated member(s) of their respective First Nation who is acting as a community coordinator for this program. The designated member will explain how the samples need to be gathered and will provide a collection kit to the person.

A sample of muscle and liver tissue, each approximately the size of two adult fingers, will be removed from the breast muscle and liver, respectively, and be placed in a re-sealable plastic bag. Alternately, for the muscle tissue only, one leg of the bird can be placed in a bag. One kidney of the bird will also be removed if possible, and placed in the bag. The bag will be labelled with the harvester's name, the date the samples were collected, the waterfowl species, sex, age (juvenile or adult) and the location where it was harvested. Samples will be submitted to the designated KCNs Member who will store them in a freezer. Local KCNs harvesters will be provided with collection materials such as freezer bags, tags and maps, and a sampling protocol.

The wildlife biologist will submit waterfowl tissue samples annually to an accredited laboratory for total mercury analysis. A chain-of-custody record will be completed. The lab will measure total mercury concentrations in the submitted tissues and supply the results of their analysis in a formal report. The test code description for mercury in tissue will follow EPA 200.3 methods using adapted procedures for the spectrochemical determination of total recoverable elements in biological tissues. The standard metal scan will use Inductively Coupled Plasma Atomic Emission Spectroscopy for the examination of biological tissues. The lower detection limits will be reported in mg/kg wet weight (wwt).

7.3.3.10 ANALYSIS

The level of analysis will generally be descriptive statistics and comparisons of differences in mean concentrations using techniques such as ANOVA, medians and trend analysis. Analysis methods will be determined by the actual structure of the field data.

7.4 MERCURY IN AQUATIC FURBEARERS

7.4.1 INTRODUCTION

The primary pathway of concern for mercury exposure is through the aquatic food web. Flooding will increase mercury levels in the Keeyask reservoir, which could affect aquatic furbearers (including mink, river otter, beaver and muskrat) in the Keeyask Region. Potential effects include increased mercury concentrations in fish and in the fish-eating aquatic furbearers (mink, river otter) that consume them. Effects on aquatic furbearers are linked to domestic resource use. Mercury levels in mink and river otter are expected to increase over pre-Project conditions and peak approximately seven years after the reservoir is impounded. Mercury levels are then expected to decline and reach pre-Project levels (or be considered stable at a new background level) approximately 20 to 30 years post-impoundment.

Mercury levels in beaver, a herbivore, are not expected to change due to the minute quantities of mercury taken up by plants. Small increases in mercury concentrations will likely occur in muskrat, which forage on plants and lower trophic level invertebrates such as molluscs.

7.4.2 OBJECTIVES

The objective of this study is to:

- Determine if there are changes in mercury levels in beaver, muskrat, mink and otter during operation.

7.4.3 STUDY DESIGN

7.4.3.1 OVERVIEW

Mercury concentrations in beaver, muskrat, mink and otter that were collected before reservoir impoundment will be compared with post-Project samples of the same species. One set of samples for each of these species was collected from locations near the future reservoir shoreline, and from waterbodies and watercourses connected to it. A second set of samples was collected far enough away to be outside of the future reservoir influence. A third set of samples for each of these species will be collected post impoundment from waterbodies and watercourses connected to the Keeyask reservoir and Stephens Lake.

7.4.3.2 EXISTING DATA

Samples of muscle and liver tissue of beaver, muskrat, mink and river otter were collected from the Split Lake Resource Management Area (SLRMA) Traplines 1, 3, 15, 60, 61, 62, and 65, from York Landing Trapline 13, and from Fox Lake Resource Management Area (FLRMA) Traplines 3, 4, and 5 by volunteer collection and under a scientific collection permit issued by Manitoba Conservation and Water Stewardship. Samples were collected from 2003 to 2008. Based on their locations, these traplines were treated as being "on-system" (where animals primarily consume materials from the Nelson River) or "off-system" (where animals primarily consume materials from waterbodies other than the Nelson River).

7.4.3.3 DESIGN

Pre-project data are available for beaver, muskrat, mink and otter. During construction, as beaver and muskrat will be trapped out of the Project Footprint (see Section 6.4.3), tissue samples will be collected and analyzed for mercury to provide additional pre-Project data for these two aquatic furbearer species.

During operation, samples for each of the previously sampled aquatic furbearer species will be collected within approximately 5 km of the Keeyask reservoir and Stephens Lake.

Manitoba Conservation and Water Stewardship and local trappers will be consulted to determine the sustainable harvest level of beaver, muskrat, mink and otter in the Keeyask reservoir and Stephens Lake areas. Sustainable harvest limitations will influence annual sample size for each species.

There are two component sampling techniques to this study. The first component is a voluntary sample submission program, where local trappers and resource users will be encouraged to submit samples for beaver, muskrat, mink and otter. Second, additional trapping of these species will be conducted under a scientific collection permit to secure an adequate sample size.

7.4.3.4 PARAMETERS

The monitoring parameters are:

- Mercury concentrations in muscle, liver and kidney tissue of beaver, muskrat, mink and river otter (in μg/g).

7.4.3.5 BENCHMARKS

Increases in mercury levels are expected to increase as a result of Project reservoir impoundment. One objective of monitoring is to identify when mercury levels peak (expected by year seven) and then subsequently decrease. Similarly, mercury levels in the Keeyask reservoir are expected to reach pre-impoundment levels (or will be considered stable at a new background level) 20-30 years following Project impoundment. Increases in mercury levels will be measured based on these timelines to assess if projected levels for different species are within those levels indicated in the EIS.

Toxicity reference values (TRV) for mercury incorporate a chronic lowest-observed adverse effects level threshold for adverse effects to reproduction, growth, and/or survival. As there are limited studies available for these values in river otter, the TRV was determined for mink and then scaled by body weight for river otter. In addition, the lowest observed adverse effect level (LOAEL) and no observed adverse effect level (NOAEL) are as follows:

- Mink TRV = 0.07 mg/kg/day, NOAEL = 0.015 mg/kg/day LOAEL = 0.025 mg/kg/day; and,
- River otter = TRV (0.08 mg/kg/day).

Mercury concentrations for aquatic furbearers are inputs provided to the toxicologist undertaking the Project's Human Health Risk Assessment (HHRA). Methods for analysis are found in the HHRA and EIS Supplemental Filings to Health Canada. Reporting procedures are found in the Project's Socio-Economic Monitoring Plan (SEMP).

7.4.3.6 STUDY AREA

Study Zone 6 is the maximum extent of the study area.

7.4.3.7 SAMPLE LOCATIONS

During the construction phase, sample locations for beaver and muskrat will be limited to riparian zones occurring in the future reservoir area where trapping efforts are targeted to remove animals prior to reservoir impoundment.

During the operation phase, aquatic furbearer samples will be submitted voluntarily by trappers from sites on their registered trap-lines within 5 km of the Keeyask reservoir and Stephens Lake. Collections that may be needed to supplement the voluntary submission of samples will occur in those waterbodies and watercourses directly connected to the Keeyask reservoir and to Stephens Lake.

7.4.3.8 SAMPLING FREQUENCY AND SCHEDULE

For aquatic furbearers, sampling will occur in conjunction with the beaver and muskrat trapping program that is set to occur prior to reservoir impoundment and is expected to occur yearly for several years while reservoir clearing is occurring.

Beginning in year 1 of operation, the collection of aquatic furbearer samples will occur annually for about 7 years of operation or until peak mercury levels are reached, and depending on the results, every three years thereafter up to year 30, until pre-impoundment mercury levels, or new stable levels, are reached. The sampling frequency will be reviewed during year 15 of operation.

7.4.3.9 FIELD AND LAB METHODS

A wildlife biologist will facilitate quality control for the methods and collection of any data related to the tissue samples. This will be achieved through collaboration with a designated KCNs Member(s) who is acting as a community coordinator for this program, who will describe the collection methods and provide the necessary collection materials for those harvesters interested in providing samples. The wildlife biologist will be responsible for submitting the samples for analysis and for providing reports summarizing mercury results to the KHLP.

When a KCNs Member is willing to contribute aquatic furbearer tissue and organ samples that he/she will be gathering to be submitted for analysis, it is recommended that they contact the designated Member(s) of their respective First Nation who is acting as a community coordinator for this program. The designated Member will explain how the samples need to be gathered and will provide a collection kit and sampling protocol to the person.

A sample of muscle and liver tissue, each approximately the size of two adult fingers, will be removed from the leg and liver of either beaver, muskrat, mink or otter, and placed in a re-sealable plastic bag. One kidney of the animal will also be removed if possible, and placed in the bag. The bag will be labelled with the harvester's name, the date the samples were collected, the aquatic furbearer species, sex, age (juvenile or adult) and the location where it was harvested. Samples will be submitted to the designated KCNs Member, who will store them in a freezer. Harvesters will be provided with collection materials such as freezer bags, tags, and maps to indicate sample location(s).

If voluntary sample submissions size is insufficient to monitor changes in mercury levels, additional trapping under a scientific collection permit will be required for sample collection. In this case, a wildlife biologist and local trapper will trap beaver, muskrat, mink and otter directly.

The wildlife biologist will submit beaver, muskrat, mink and otter tissue samples annually to an accredited laboratory for total mercury analysis. A chain-of-custody record will be completed. The lab will measure total mercury concentrations in the submitted tissues and supply the results of their analysis in a formal report. The test code description for mercury in tissue will follow EPA 200.3 methods using adapted procedures for the spectrochemical determination of total recoverable elements in biological tissues. The standard metal scan will use Inductively Coupled Plasma Atomic Emission Spectroscopy for the examination of biological tissues. The lower detection limits are reported in mg/kg wet weight (wwt).

7.4.3.10 ANALYSIS

The level of analysis will generally be descriptive statistics and comparisons of differences in mean concentrations using techniques such as ANOVA, medians and trend analysis. Analysis methods will be determined by the actual structure of the field data.

7.5 MERCURY IN CARIBOU AND MOOSE

7.5.1 INTRODUCTION

KCNs Members are concerned about mercury levels in caribou and moose. Mercury levels in moose and caribou typically consumed by local communities are expected to be low and unlikely to pose a risk to human health through consumption. This will be confirmed through the collection of moose and caribou tissue samples voluntarily provided by local resource users.

7.5.2 OBJECTIVES

The objectives of this study are to:

- Establish pre-impoundment mercury levels in the consumable tissues and organs of moose and caribou, if an adequate number of suitable voluntary samples are provided during the construction phase; and,
- Determine if there are changes in mercury levels in these species during operation, if an adequate number of suitable voluntary samples are provided.

7.5.3 STUDY DESIGN

7.5.3.1 OVERVIEW

Sample collection will occur based on the voluntary submission of samples from moose and caribou harvested in the Keeyask Region. Because moose move over moderately large areas, it will not be possible to identify and compare samples from locations near the future reservoir to those outside the influence of the future reservoir. Similarly, because most caribou move over very large geographic areas and spend limited time at Keeyask, it will not be possible to compare samples from locations near the future reservoir to those removed from the reservoir. Mercury concentrations in moose and caribou will be provided to the KHLP to assess human health risks under the Project's Human Health Risk Assessment (HHRA).

7.5.3.2 EXISTING DATA

Some samples of caribou and moose muscle, liver, and kidney tissue were voluntarily submitted by KCNs resource users over a two-year period. Samples from a caribou harvested in 2010 and one harvested in 2011 were submitted and analyzed, as were samples from one moose harvested in 2011.

7.5.3.3 DESIGN

Samples of caribou and moose muscle, liver and kidney tissue will be collected and analyzed for mercury concentrations during both the construction and operation phases of the Project. In addition, as requested by the KCNs, other heavy metal content (e.g. cadmium) will be measured for these two species. Samples will be acquired from animals harvested by KCNs Members, and will be frozen and transported to an accredited laboratory for mercury analysis. Results will be related to the species, sex and age of the animal, and the location where it was harvested, where possible.

7.5.3.4 PARAMETERS

The monitoring parameters are:

- Mercury concentrations in muscle and organ tissues of moose and caribou (in μg/g).

7.5.3.5 BENCHMARKS

Mercury for caribou and moose are inputs provided to the toxicologist undertaking the Project's Human Health Risk Assessment (HHRA). Methods for analysis are found in the HHRA and EIS Supplemental Filings to Health Canada. Reporting procedures are found in the Project's Socio-Economic Monitoring Plan (SEMP).

7.5.3.6 STUDY AREA

Study Zone 6 is the study area.

7.5.3.7 SAMPLE LOCATIONS

For moose and caribou, sample locations will be variable based on locations where local harvesters are able to successfully harvest the species for which they are providing a sample.

7.5.3.8 SAMPLING FREQUENCY AND SCHEDULE

The program will begin in year 3 during the construction period. Voluntary samples of moose and caribou tissues provided will be tested for mercury on an annual basis until the end of construction.

Beginning in year 1 of operation, a request for voluntary submissions of moose and caribou samples will occur every year for the first 10 years of operation. The need for continued sampling will be reassessed after the results are analyzed.

7.5.3.9 FIELD AND LAB METHODS

A wildlife biologist will facilitate quality control for the methods and collection of any data related to the tissue samples. This will be achieved through collaboration with a designated KCNs Member(s) who is acting as a community coordinator for this program. The wildlife biologist will work with the designated KCNs Member, describing the collection methods and providing necessary collection materials for those harvesters interested in providing samples. The wildlife biologist will be responsible for submitting the samples for analysis and for providing reports summarizing mercury results to the KHLP.

When a KCNs Member is willing to contribute some of moose or caribou tissue and organs that he/she will be harvesting to be submitted for analysis, it is recommended that they contact the designated Member of their respective First Nation. The designated Member will explain how the samples need to be gathered and will provide a collection kit and sampling protocol to the harvester.

A sample of muscle and liver tissue, each approximately the size of two adult fingers, will be removed from the leg and liver and placed in a re-sealable plastic bag. One kidney of the animal will also be removed if possible, and placed in the bag. The bag will be labelled with the harvester's name, the date the samples were collected, the animal species, sex, age (juvenile or adult) and the location where it was harvested. Samples will be submitted to the designated KCNs Member, who will store them in a freezer. Harvesters will be provided with collection materials such as freezer bags, tags, and maps to identify sample locations.

The wildlife biologist will submit moose and caribou tissue samples annually to an accredited laboratory for total mercury analysis. A chain-of-custody record will be completed. The lab will measure total mercury concentrations in the submitted tissues and supply the results of their analysis in a formal report. The test code description for mercury in tissue will follow EPA 200.3 methods, using adapted procedures for the spectrochemical determination of total recoverable elements in biological tissues. The standard metal scan will use Inductively Coupled Plasma Atomic Emission Spectroscopy for the examination of biological tissues. In addition, as requested by the KCNs, other heavy metal content (e.g. cadmium) will be measured and reported for these two species. The lower detection limits are reported in mg/kg wet weight (wwt).

7.5.3.10 ANALYSIS

The level of analysis will generally be descriptive statistics and comparisons of differences in mean concentrations using techniques such as ANOVA, medians and trend analysis. Analysis methods will be determined by the actual structure of the field data.

7.6 REPORTING

7.6.1 ANNUAL REPORTS

A report will be produced during the winter after each year when field studies occur, and will be submitted to MCWS the following spring, as per Environment Act License 3107, Clause 20.

Reports will summarize the activities and general findings of the monitoring during the preceding year. Basic descriptive statistics will be the level of data analysis for these reports. Any major unanticipated events or recommendations for changes to study design or mitigation will be noted.

7.6.2 SYNTHESIS AND RECOMMENDATIONS

A synthesis report will be produced after the first five years of field studies, after construction completion and after the final planned year for field studies during operation. Synthesis reports will consolidate, analyze and evaluate all monitoring information gathered to date, including that produced by other Keeyask terrestrial studies. These reports will also include recommendations for any needed modifications to subsequent study design or to mitigation. The operation synthesis report will make recommendations regarding the need for any further monitoring.

8.0 CREATED WETLANDS

8.1 OFF-SYSTEM MARSH CREATION

8.1.1 INTRODUCTION

Off-system marsh was identified as the only particularly important wetland type in the Keeyask Region, primarily due to its rarity and its role as high quality habitat for some wildlife species. Given its importance, a no net area loss approach is being implemented for this wetland type.

The location and details of the planned off-system marsh creation are described in the Terrestrial Mitigation Implementation Plan (TMIP).

The goal of this study is to verify that 12 ha of off-system marsh are successfully created.

8.1.2 OBJECTIVES

The objectives of this study are to:

- Verify the implementation of off-system marsh creation measures; and,
- Confirm the creation of 12 ha of marsh, with attributes similar to comparable off-system marshes.

8.1.3 STUDY DESIGN

8.1.3.1 OVERVIEW

There are two components to this study. The first verifies that wetland creation is being implemented in accordance with the TMIP, while the second verifies that 12 ha of marsh having attributes similar to native off-system marsh are created. During the construction phase, the primary monitoring focus will be on the implementation of the wetland installations since several years are required before it can be determined whether vegetation and soil targets are on the desired development pathway. As sufficient time passes for soils and vegetation to develop beyond the establishment stage, the monitoring focus will gradually shift to evaluating whether or not whether soils and vegetation attributes have already met the prescribed habitat targets or, if not, they appear to be on a pathway towards achieving to achieving them.

Surveys will be conducted within the wetland creation area identified in the TMIP.

8.1.3.2 EXISTING DATA

Reference data for the attributes of native off-system marsh is provided by EIS ground surveys and mapping. Shore zone transects were sampled at 127locations in 13 off-system lakes or ponds in 2005 and 2006. Shore zone wetland mapping included 1,362 km of shoreline mapped by photo-interpretation, which includes 98 km mapped by low altitude helicopter surveys and 51 km of boat surveys.

8.1.3.3 DESIGN

The wetland creation site identified in the TMIP will be surveyed to confirm implementation of the wetland prescriptions and to evaluate rehabilitation success of the wetland. Systematically located transects positioned perpendicular to the shoreline will generally be used to document the implementation and the effectiveness of rehabilitation efforts. Implementation surveys will confirm that rehabilitation prescription elements, such as material placement, planting density and species mix are in place. Off-system marsh creation surveys will focus on properties related to soil development, survival of planted seedlings, natural plant regeneration, species composition and other critical precursors to regenerating the target marsh type.

8.1.3.4 PARAMETERS

The monitoring parameters are:

- Percentage of area treated according to the prescriptions set out in the TMIP;
- Site conditions and other factors that influence the restoration of native marsh types;
- Vegetation, soil and site conditions within the created marsh location; and,
- Area, location and composition of off-system marsh that are successfully created.

8.1.3.5 BENCHMARKS

The targets are that the wetland prescriptions are implemented as described in the TMIP, and that wetland creation efforts will continue until 12 ha of off-system marsh is successfully created.

8.1.3.6 STUDY AREA

The study area is the wetland creation site identified in the TMIP.

8.1.3.7 SAMPLE LOCATIONS

Surveys will occur in the wetland creation site identified in the TMIP. Map 24 shows the general location where the marsh wetland will be created.

8.1.3.8 SAMPLING FREQUENCY AND SCHEDULE

Sampling to monitor implementation of the off-system marsh creation will be conducted once each year during the years wetland creation occurs, and once during each of the following two summers. Sampling will generally occur in mid- to late summer, but this may vary depending on the timing and nature of construction and mitigation activities that year.

Sampling to verify the efficacy of off-system marsh creation efforts will be conducted once in each of the first, third and fifth years after completion of mitigation measures. The frequency of subsequent sampling will be determined based on conditions observed in the year five survey.

8.1.3.9 FIELD AND LAB METHODS

In general, transects will be systematically located within the wetland creation site. The specific transect layout will depend on the shape of the site and the nature of the final wetland creation prescription.

Off-system marsh creation success will be evaluated using relevant attributes (e.g., vegetation cover, species composition, substrate development), geo-referenced photographs, marked-up maps and notes. Recorded information will include attributes such as plant species, plant vigour, whether the seedling is planted or naturally regenerated, and soil conditions. Occurrences of invasive plants will be reported to Manitoba Hydro so they can be eradicated.

Manitoba Hydro will provide detailed construction schedules for the wetland creation to support field survey planning.

8.2 WILDLIFE USE OF CREATED WETLANDS

8.2.1 INTRODUCTION

Off-system marsh was identified as the only particularly important wetland type in the Keeyask Region, primarily due to its rarity and its role as high quality habitat for some wildlife species. Habitat requirements for some of the key wildlife species (e.g., waterfowl, moose and muskrat) were considered in the design of wetland concepts because of their importance to the KCNs.

The planned off-system marsh creation concept is described in the TMIP.

The goal of this study is to verify that the 12 ha of created off-system marsh provides high quality wildlife habitat.

8.3 OBJECTIVES

The objectives of this study are to:

- Verify the use of the created wetland by a variety of wildlife species; and,
- Evaluate whether the 12 ha of created marsh has a wildlife community similar to that found in comparable off-system marshes.

8.4 STUDY DESIGN

8.4.1 OVERVIEW

There are two components to this study. The first verifies that the created wetlands are being used by a variety of amphibian, bird and mammal species, while the second verifies that created marsh habitat supports a wildlife community that is similar to native off-system marsh areas. There will be no monitoring of the created wetland for wildlife during the construction phase of the Project, because sufficient time is needed for the habitat to develop following creation of the wetland. Sampling of the created wetland for wildlife use will occur following standard protocols for surveying wildlife (e.g., amphibians, birds, mammals) that are typical of marsh ecosystems. Information will be gathered on species richness in the wetland.

Surveys will be conducted in the wetland creation area identified in the TMIP.

8.4.2 EXISTING DATA

Reference data for wildlife use of native off-system marsh is provided by ground surveys, aerial surveys and mapping of key amphibian, bird and mammal species that are documented in the EIS. Shore zone transects were sampled during amphibian and waterfowl surveys of off-system lakes or ponds, as described in Sections 4.0 and 5.0 respectively. Twelve off-system ponds, lakes and riverine marshes were ground-surveyed for muskrat, in addition to aerial surveys conducted in the spring of 2001, 2003 and 2006. As part of the terrestrial habitat and ecosystems studies for the EIS, shore zone wetland mapping included 1,362 km of shoreline mapped by photo-interpretation, which includes 98 km mapped by low altitude helicopter surveys and 51 km of boat surveys.

8.5 DESIGN

The wetland creation sites identified in the TMIP will be surveyed to evaluate wildlife abundance and distribution, with a focus on amphibians, waterfowl, wetland birds, muskrat and moose. As avian species at risk may use the wetland, they will be identified incidentally when studying the focal species. Points located around the perimeter of the wetland will be used to describe the amphibian and the wetland bird communities, using measures of abundance, distribution and richness. Waterfowl species and abundance will be sampled during aerial surveys in the spring and fall. Systematically located transects positioned perpendicular to the shoreline will generally be used to document the presence of mammals. Comparisons will be made to three other high quality off-system marshes with a focus on properties related to species composition.

Monitoring efforts will be coordinated with other TEMP studies, including Wetland Function (Section 2.5)Canada Goose and Mallard studies (Section 5.2), and surveys for olive-sided flycatcher and rusty blackbird (Sections 5.5 and 5.6).

8.5.1 PARAMETERS

The monitoring parameters are:

- Wildlife species, abundance and richness at the created wetland over time; and
- Areas, locations and composition of comparable off-system marsh wildlife communities.

8.5.2 BENCHMARKS

The first study objective does not have a benchmark.

For the second study objective, the benchmark is that the wildlife community that develops in the 12 ha wetland is similar to other off-system marshes in the Keeyask Region.

8.5.3 STUDY AREA

Studies will occur within Study Zone 4 (Map 3).

8.5.4 SAMPLE SITE LOCATIONS

Surveys will occur in the wetland creation site identified in the TMIP and three comparison marshes within Study Zone 4 (Map 3). Map 24 shows the general location where wetlands will be created.

8.5.5 SAMPLE FREQUENCY AND SCHEDULE

Wildlife monitoring at the constructed marsh will be coordinated with other TEMP wildlife monitoring occurring in the region. Monitoring will begin in year 5 after the wetland is constructed, and then every third year until year 14. The frequency of subsequent sampling will be determined based on conditions observed in the year 14 survey.

Sampling will be conducted in late May (for amphibians and migrant waterfowl), mid-June (for breeding birds), early August (for waterfowl broods, muskrats, and moose) and September (for migrant waterfowl).

8.5.6 FIELD AND LAB METHODS

In general, listening points and transects will be systematically located within the wetland creation site. The specific transect layout will depend on the shape and nature of the site and the nature of the wetland, as determined by the final wetland creation design.

Off-system marsh creation success will be recorded using relevant attributes (e.g., wildlife species composition and abundance of amphibians, birds and mammals). Amphibian methods will follow those prescribed in Section 4.2.3.9. In addition to these methods, the availability of amphibian habitat (e.g., presence of aquatic plants, grasses), and water quality information (water temperature, pH, TDS and turbidity) will be recorded and photographs of the wetland will be taken. In mid-June, wetland peripheries will be visually inspected for signs of amphibians (i.e., swimming adults, juveniles or egg masses).

Canada goose and mallard surveys in spring and fall, including habitat enhancement surveys for mallard nesting tunnels, will follow those methods and the schedule described in Section 5.2.2. Helicopter surveys will be used to collect species abundance and distribution data. All other wildlife observed (e.g., muskrat, beaver, moose) during surveys will be recorded and habitat use will be noted.

Automated or hand-held recorders will be used for detecting bird species occurrence and abundance; recordings will be processed in the lab. An alternate method may be used if the wetland shape is narrow. A qualified biologist, utilizing predetermined waypoint information for each survey site, will identify and record birds and other wildlife (e.g., amphibians) by sound and/or sight within and outside of a 50-m radius at each point-count stop. Other variables collected will include distance to all birds (e.g., rusty blackbird, olive-sided flycatcher). All birds heard or observed during a ten-minute listening period will be recorded.

Muskrat will be monitored with ground-based reconnaissance tracking surveys, where the layout and general principles of the survey design follow the shoreline. A field crew will search the created wetland for signs of muskrat presence, including but not limited to scat, tracks, and vegetation clippings. All signs of muskrat will be recorded. Signs of moose and other wildlife species associated with wetlands (e.g., mink, beaver) will be recorded incidentally.

8.6 REPORTING

8.6.1 ANNUAL REPORTS

A report will be produced during the winter after each year when field studies occur, and will be submitted to MCWS the following spring, as per Environment Act License 3107, Clause 20.

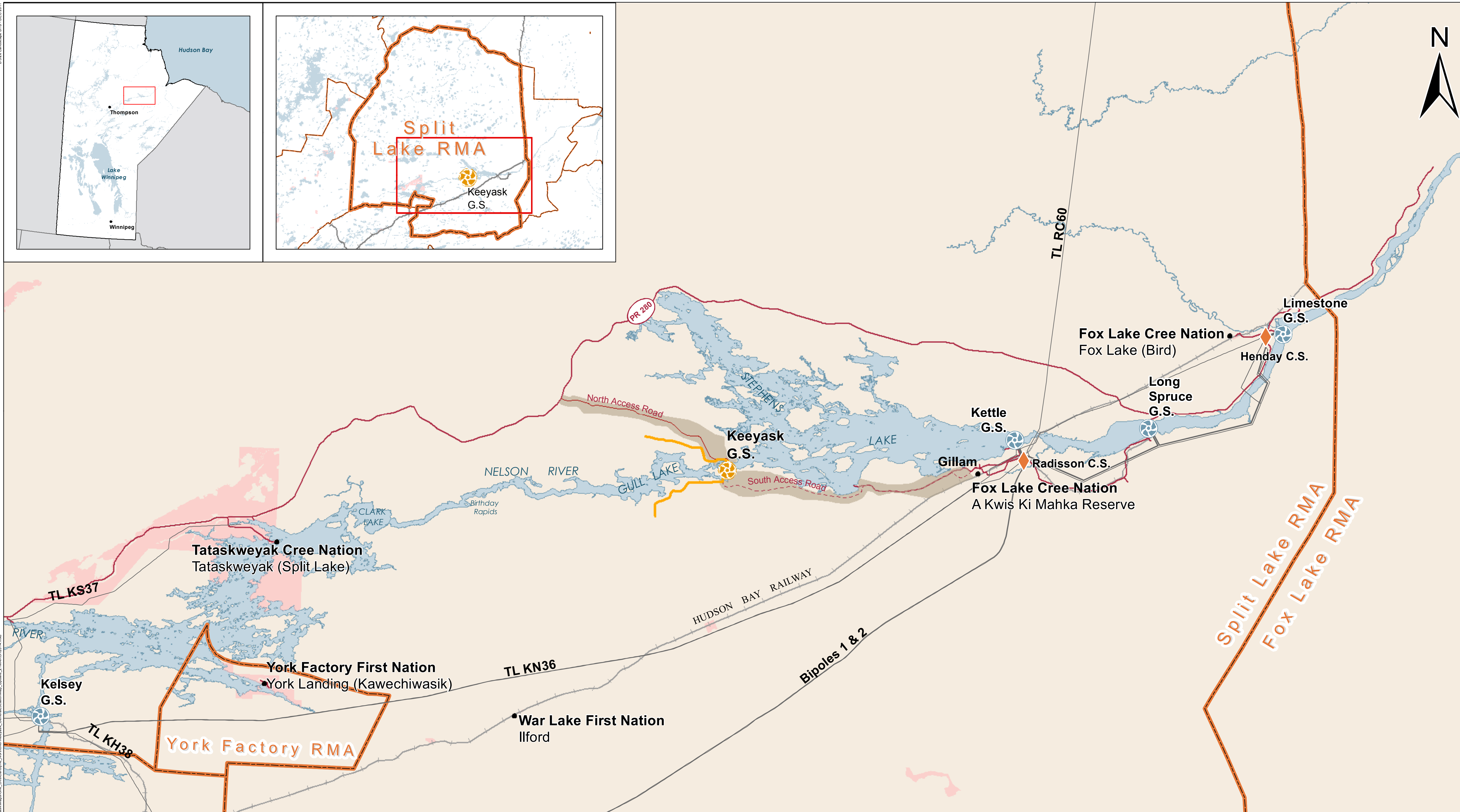
Reports will summarize the activities and general findings of the monitoring during the preceding year. Basic descriptive statistics will be the level of data analysis for these reports. Any major unanticipated events or recommendations for changes to study design or mitigation will be noted.

A report summarizing activities and general findings of all wildlife studies conducted at the created wetlands will be produced annually during the years that wildlife monitoring occurs. The report produced following the last year of operation-related monitoring will consider, compile and analyze all years of monitoring conducted during the operation period. Recommendations for any further monitoring will be determined at this time.

8.6.2 SYNTHESIS AND RECOMMENDATIONS

A synthesis report will be produced after construction completion at year 15 of operation. Synthesis reports will consolidate, map, analyze and evaluate all monitoring information gathered to date studies. Overall use of the constructed wetland was predicted in the Keeyask EIS to benefit wildlife. These reports will also include recommendations for any needed modifications to subsequent study design. The year 15 report will also evaluate whether additional wildlife monitoring is needed for the created wetland and, if so, recommend a schedule.

9.0 MAPS



KEEYASK
Hydropower Limited Partnership

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

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

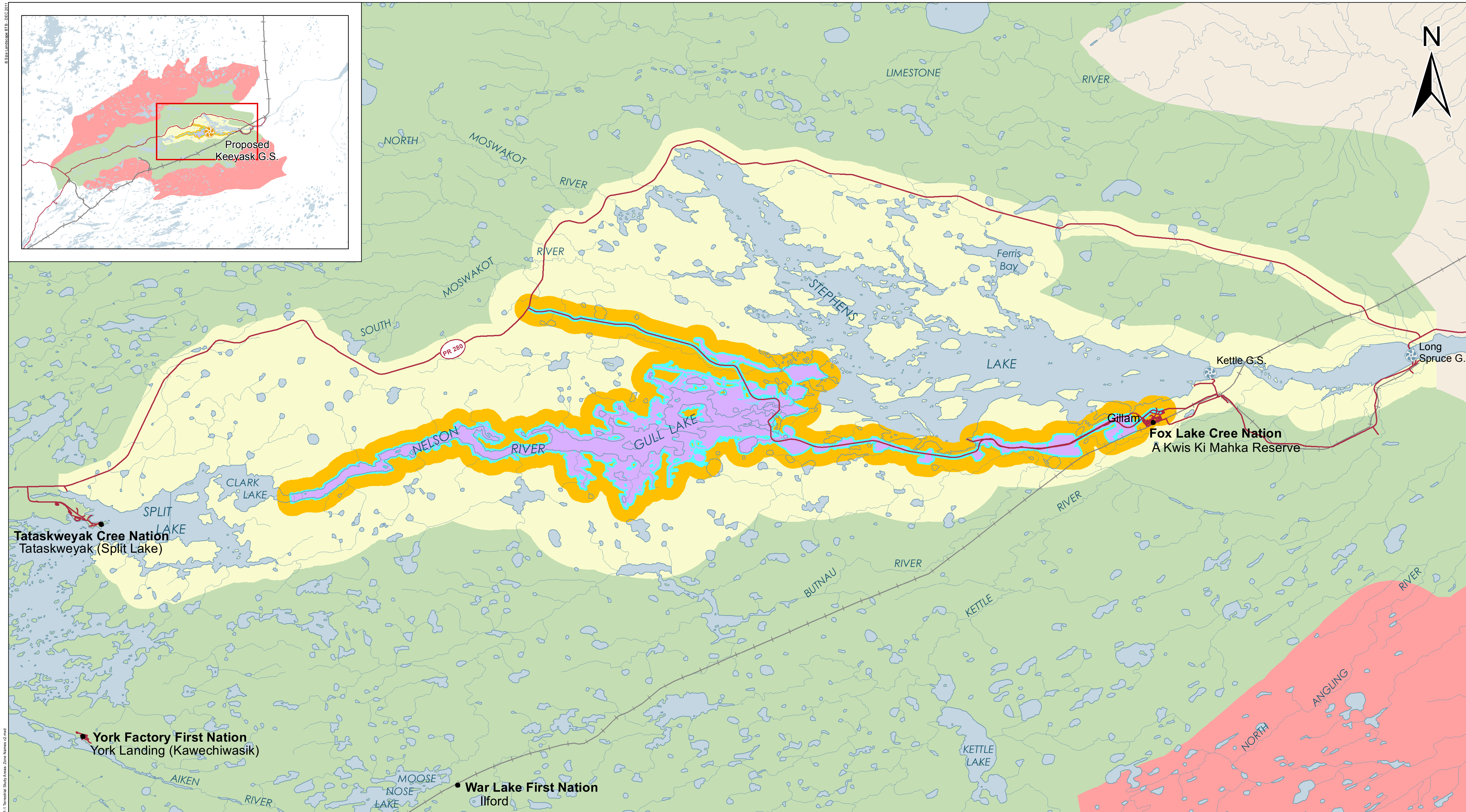
COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	03-AUG-11	21-MAR-14
0 5 10 Kilometres / 0 4 8 Miles	VERSION NO: 2.0	QA/QC: JCL/RDB

Legend

- Generating Station (Existing)
- Keeyask Generating Station
- Converter Station
- Keeyask Principal Structures
- Highway
- Access Road
- South Access Road
- Rail
- Transmission Line
- Proposed Road Corridor
- First Nation Reserve
- Resource Management Area

General Project Location

Map 2



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

0 2 4 Kilometres
0 2.5 5 Miles

VERSION NO:	QA/QC:
1.0	JWE/RDB/MWZ

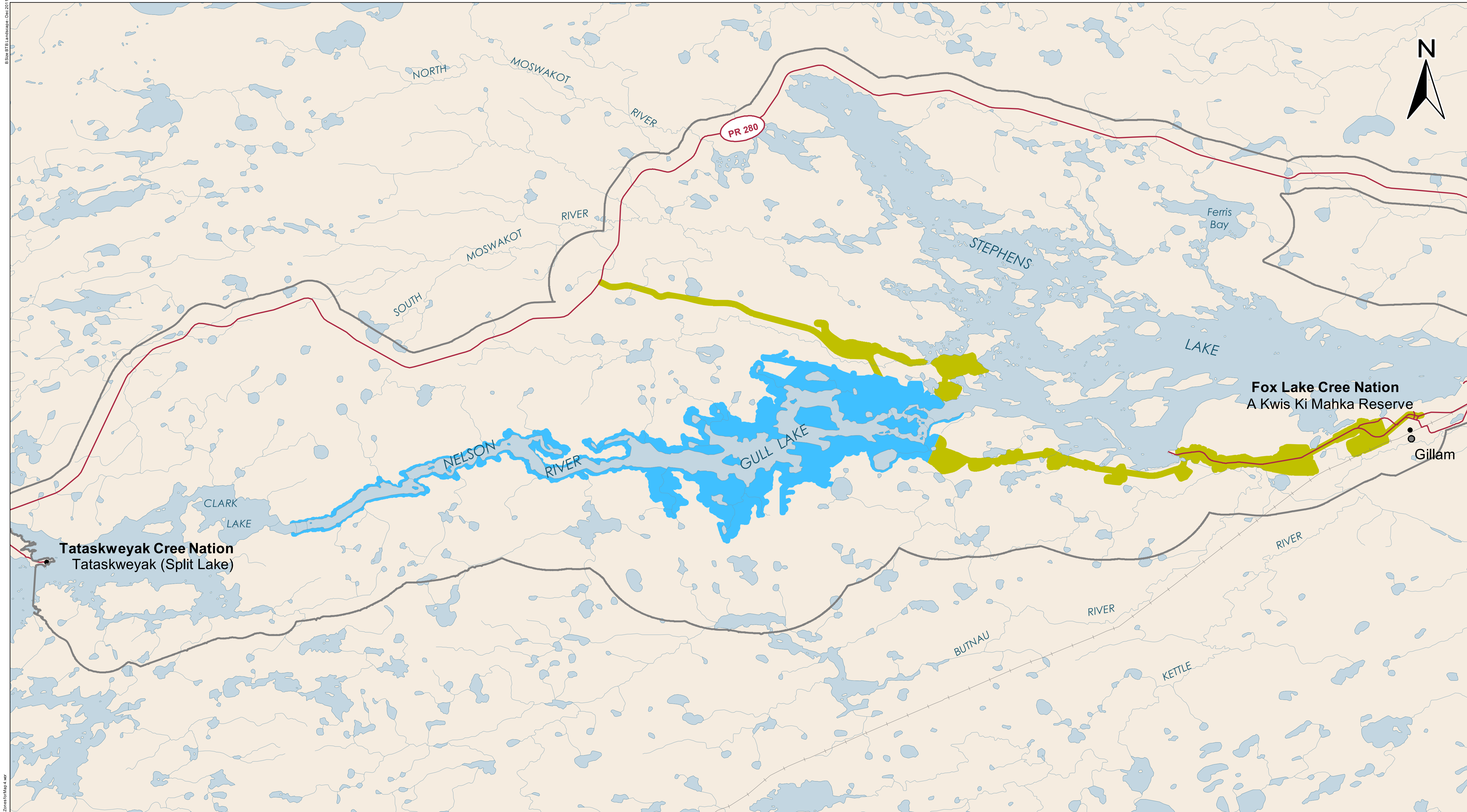
Legend

Geographic Zones

- Study Zone 1 (Planned Project Footprint)
- Study Zone 2
- Study Zone 3
- Study Zone 4
- Study Zone 5 (Keeyask Region)
- Study Zone 6

Note: Each zone includes all of the smaller zones within its perimeter

Geographic Zones Used for Terrestrial Study Areas



Keeyask Hydropower Limited Partnership

DATA SOURCE:
Zone of influence - ECOSTEM Ltd.; Study zones - Manitoba Hydro; Water - NTS; Roads and rail - Manitoba Conservation

CREATED BY:
ECOSTEM Ltd.

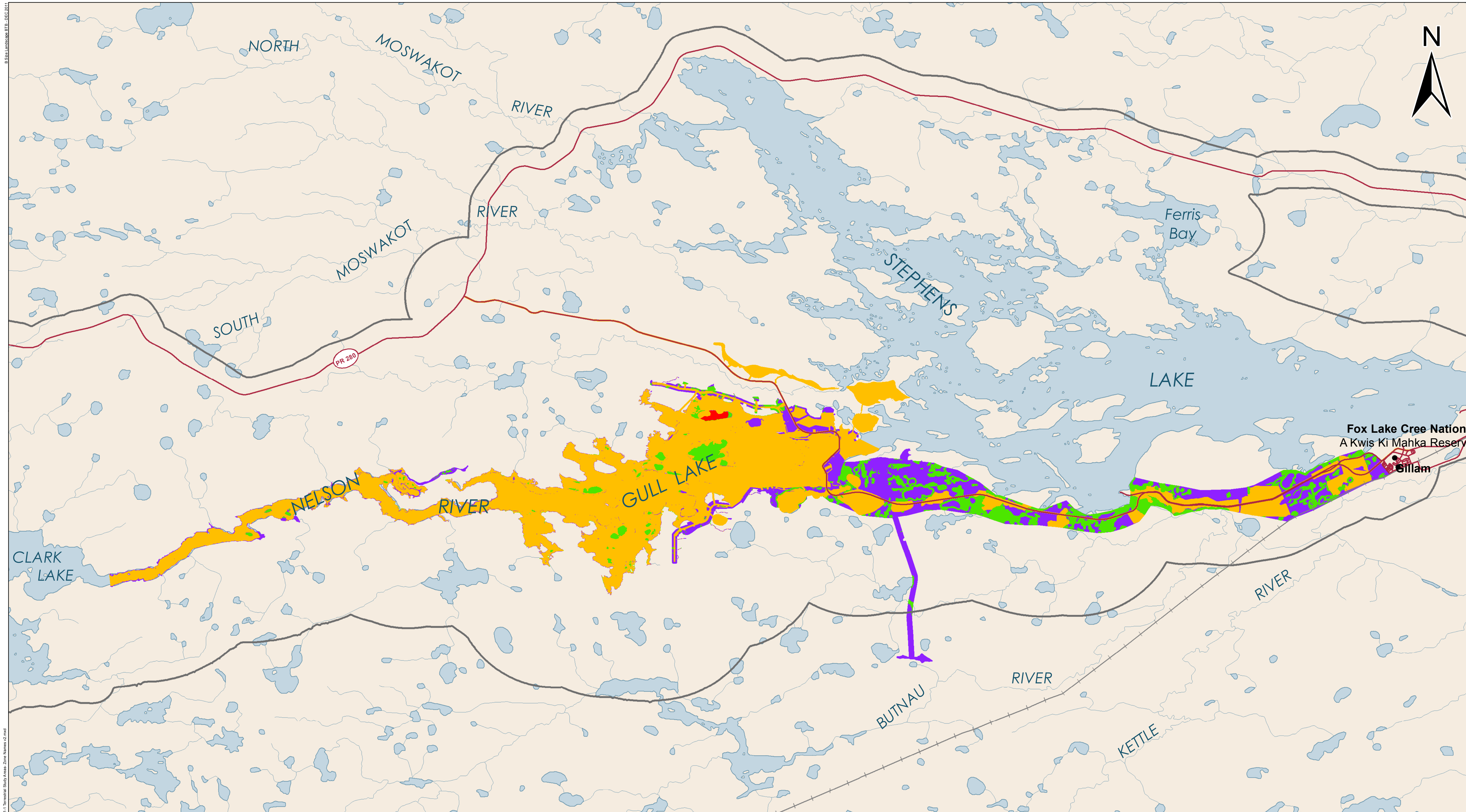
COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	23-APR-15	14-DEC-15
0 – 3 – 6 Kilometres; 0 – 1.5 – 3 Miles	VERSION NO: 1.0	QA/QC: RPB/RDB

Legend

Project Zone of Influence

- Hydraulic
- Non-hydraulic
- Study Zone 4

Terrestrial Habitat Project Zones of Influence



Hydropower Limited Partnership

DATA SOURCE:
Sensitive Sites - ECOSTEM Ltd.; Project Areas and Study Zones - Manitoba Hydro; Water - NTS; Roads and rail - Manitoba Conservation.

CREATED BY:
ECOSTEM Ltd.

COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	23-APR-15	15-DEC-15
0 1.5 3 Kilometres / 0 1.5 3 Miles	VERSION NO: 1.0	QA/QC: JWE/RDB

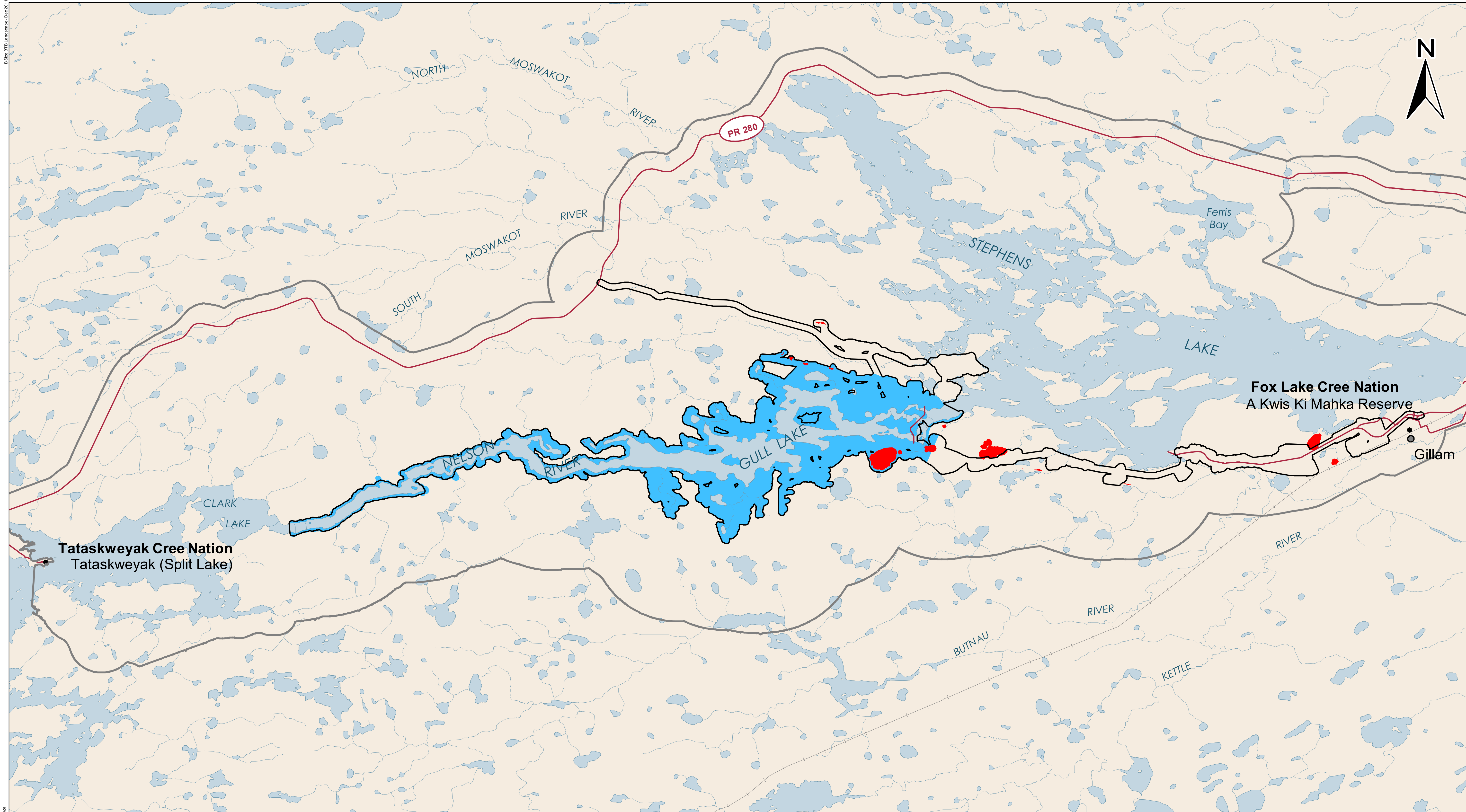
Legend

Sensitive Sites for Monitoring
- N-6
- Priority Habitat or Sensitive Site

Project Areas
- Planned Construction Footprint
- Possibly Disturbed Area

- Study Zone 4

Ecosystem Diversity - Sensitive Sites to Monitor



Hydropower Limited Partnership

DATA SOURCE:
Zone of influence - ECOSTEM Ltd.; Study zones - Manitoba Hydro; Water - NTS; Roads and rail - Manitoba Conservation

CREATED BY:
ECOSTEM Ltd.

COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	23-APR-15	23-APR-15

0 3 6 Kilometres
0 1.5 3 Miles

VERSION NO:	QA/QC:
1.0	RPB/RDB

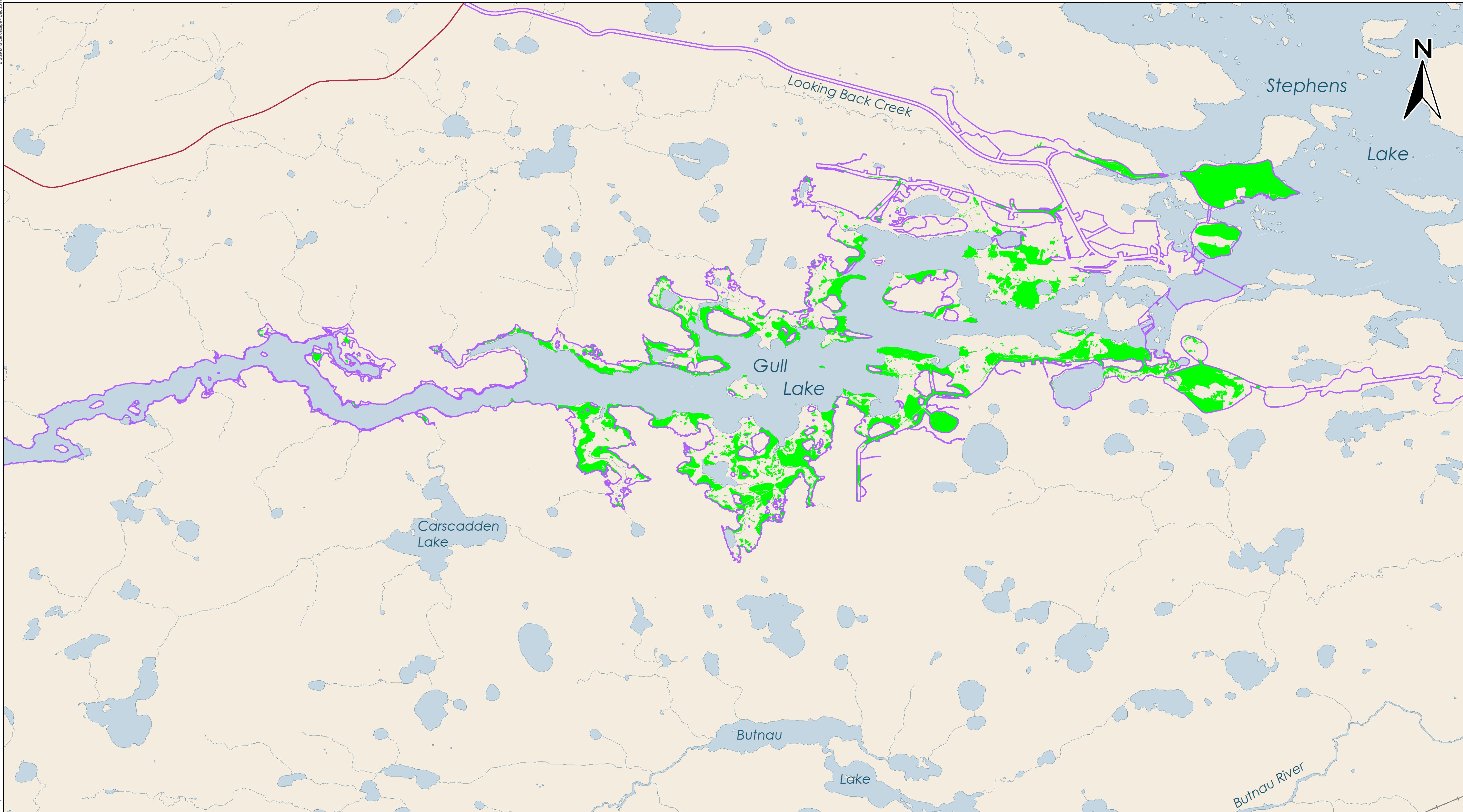
Legend

Sensitive Site Monitoring
Off-System Marsh Habitat

Project Zone of Influence
Hydraulic

Study Zones
Study Zone 2
Study Zone 4

Off-system Marsh Sites to Monitor



KEEYASK

DATA SOURCE:
Plant locations and Nelson River shoreline - ECOSTEM Ltd.; Footprints - Manitoba Hydro; Water and rail - NTS; Roads - Manitoba Conservation.

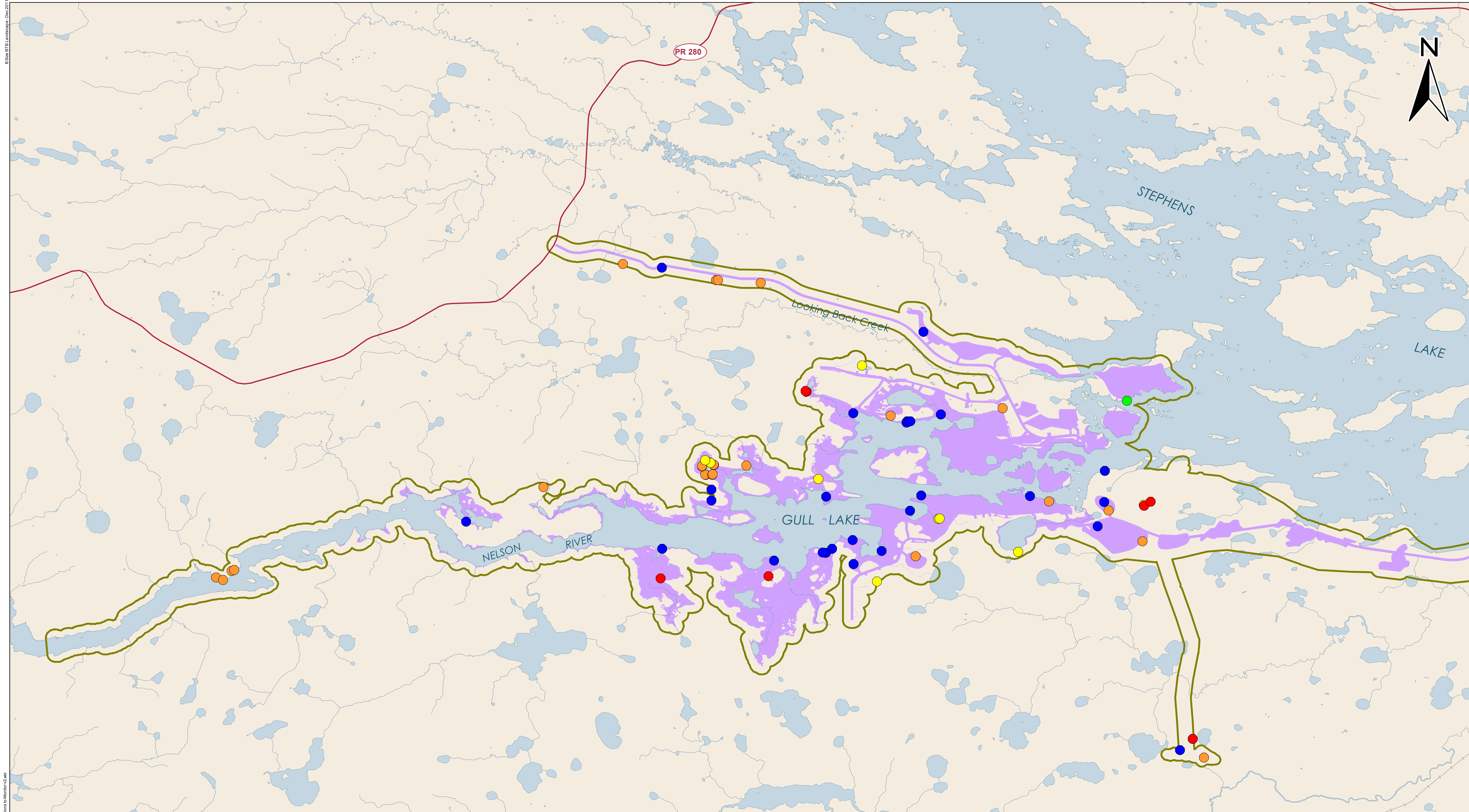
CREATED BY:
ECOSTEM Ltd.

COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	02-JUL-15	02-JUL-15
	VERSION NO:	**QA/QC:**
	1.0	JWE/YYY/ZZZ

Legend
Potential Areas to Search for Provincially Very Rare or Rare Plants
Habitat Patch

Planned Construction Footprint

Priority Plant Pre-clearing Survey Areas



Hydropower Limited Partnership

DATA SOURCE:
Monitoring locations and Nelson River shoreline - ECOSTEM Ltd.; Footprint and area - Manitoba Hydro; Roads and rail - Manitoba Conservation; Water - NTS.

CREATED BY:
ECOSTEM Ltd.

COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	24-APR-15	28-APR-15
0 2 4 Kilometres / 0 1 2 Miles	**VERSION NO:** 1.0	**QA/QC:** RPB/RDB

Legend

Priority Plant Locations to Monitor

- Provincially and Regionally Rare (7)
- Regionally Rare (28)
- Provincially Rare (14)
- Regionally Rare and Range Limit (2)
- Range Limit (26)

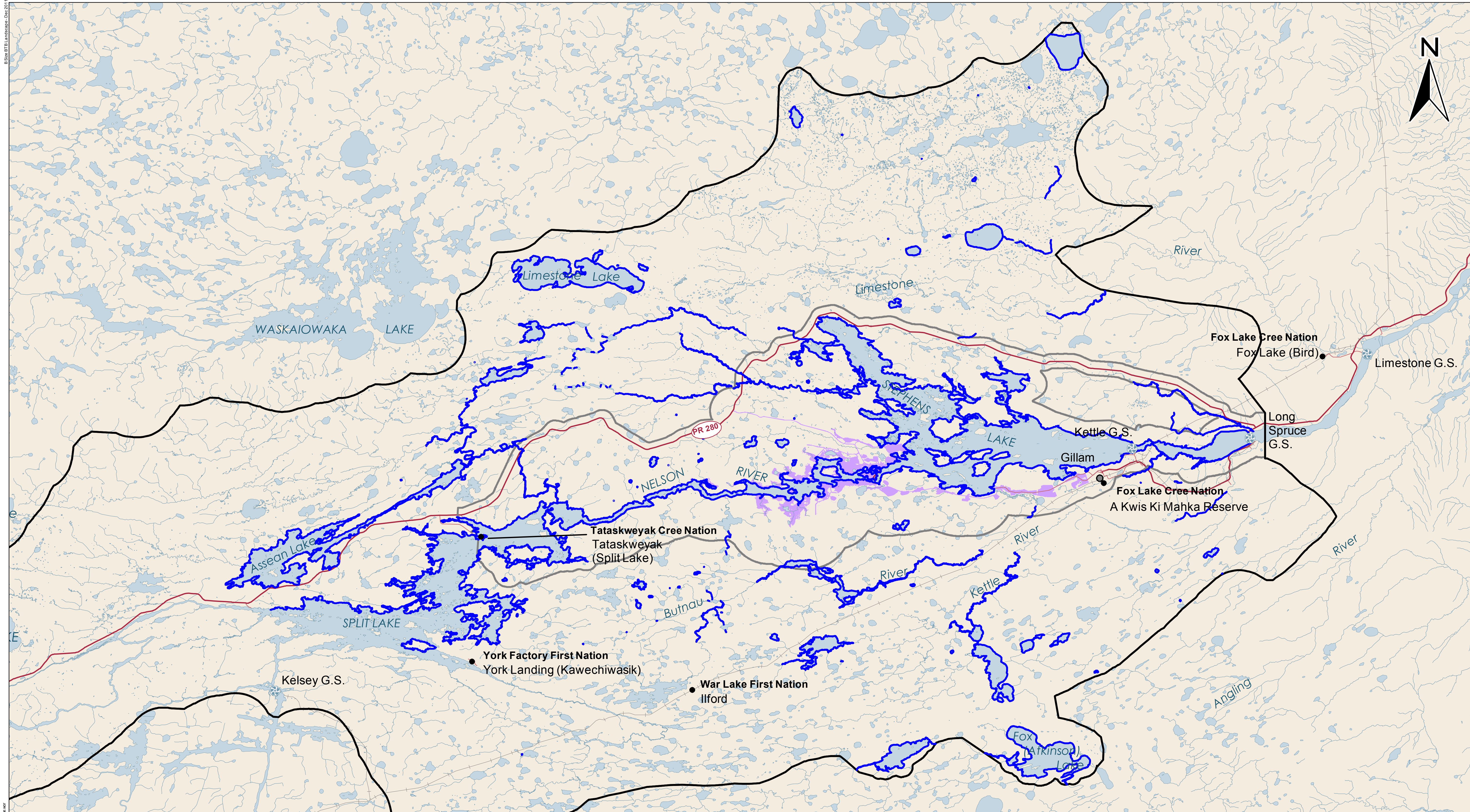
Areas Within and Near the Possible Outer Limits of Construction

Project Areas

Planned Construction Footprint

Note: A location may have more than one priority plant species.

Priority Plant Locations to Monitor



KEEYASK
Hydropower Limited Partnership

DATA SOURCE:
Sample locations - ECOSTEM Ltd.; Footprints and study areas- Manitoba Hydro; Roads - Manitoba Conservation; Water and rail - NTS.

CREATED BY:
ECOSTEM Ltd.

COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	23-APR-15	23-APR-15
	VERSION NO:	QA/QC:
	1.0	RPB/RDB

Legend

Mallard and Canada Goose Sample Locations

Shoreline Survey Area

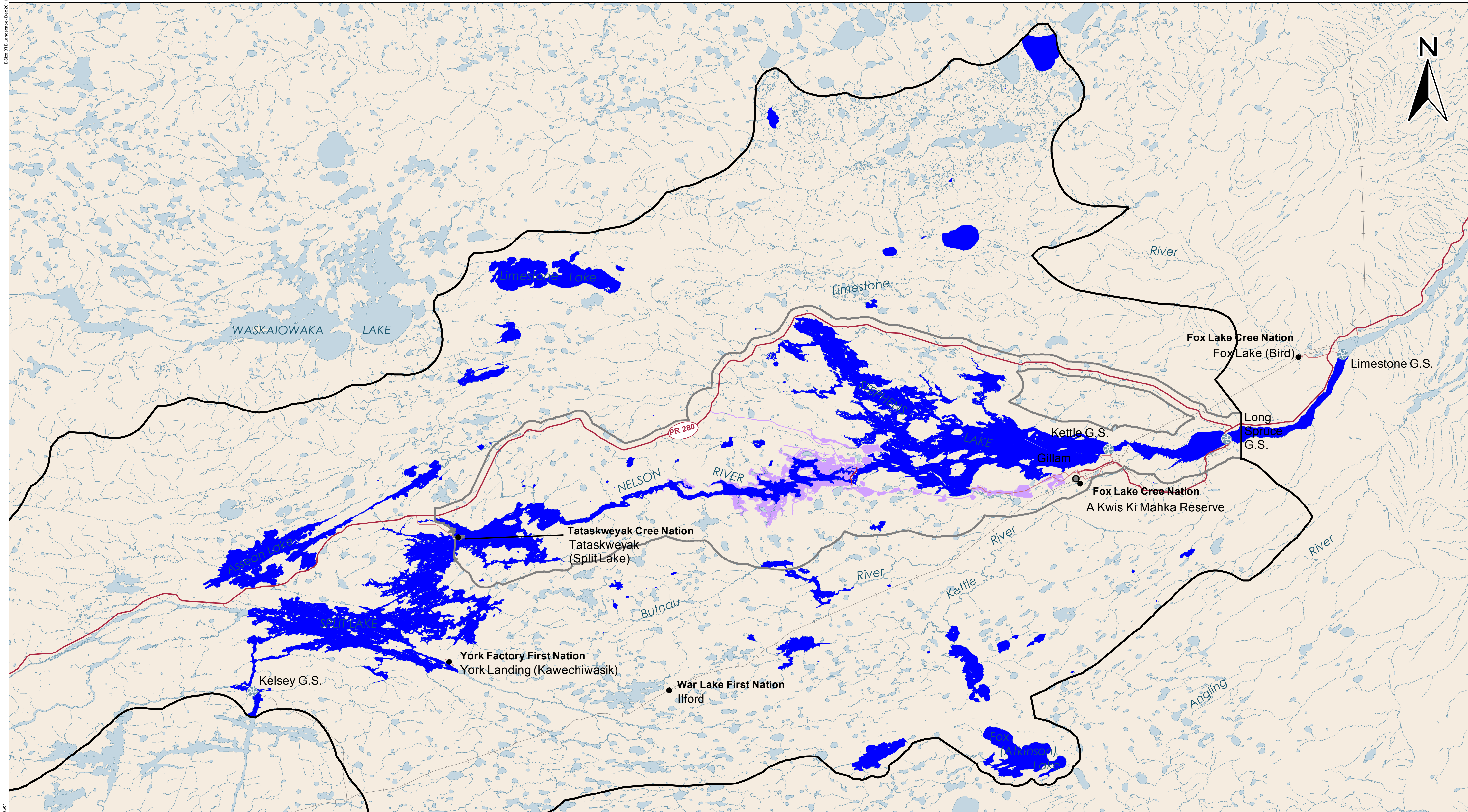
Planned Construction Footprint

Study Areas

Study Zone 4

Study Zone 5

Waterfowl Sample Locations



Hydropower Limited Partnership

KEEYASK

DATA SOURCE:
Sample locations - ECOSTEM Ltd.; Footprints and study areas- Manitoba Hydro; Roads - Manitoba Conservation; Water and rail - NTS.

CREATED BY:
ECOSTEM Ltd.

COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	24-APR-15	15-DEC-15
	VERSION NO: 1.0	QA/QC: RPB/RDB

Legend

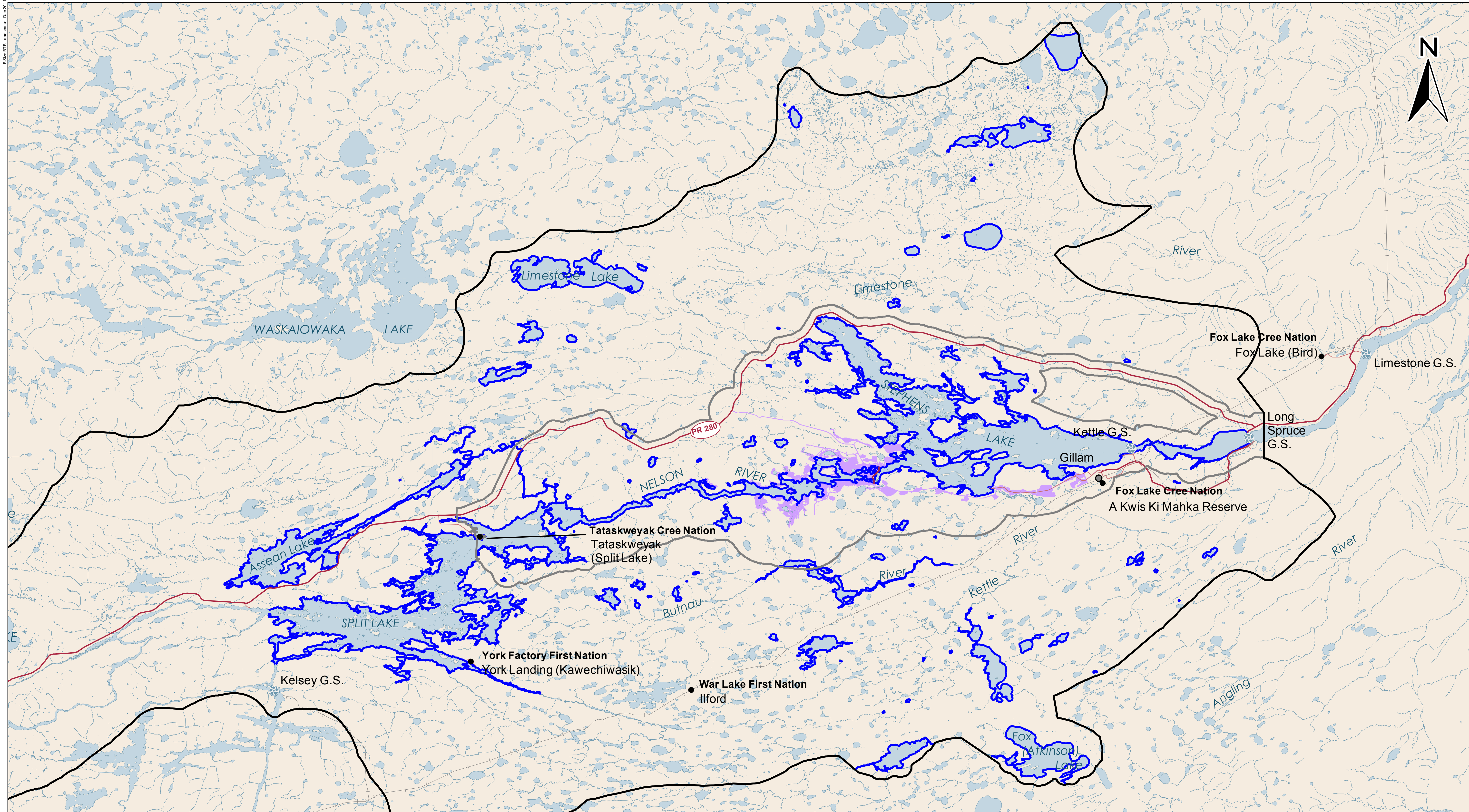
Colonial Waterbird Survey Locations

- Waterbodies Included in the Survey Area
- Planned Construction Footprint

Study Areas

- Study Zone 4
- Study Zone 5

Colonial Waterbird Survey Areas



DATA SOURCE:
Sample locations - ECOSTEM Ltd.; Footprints and study areas- Manitoba Hydro; Roads - Manitoba Conservation; Water and rail - NTS.

CREATED BY:
ECOSTEM Ltd.

COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	24-APR-15	28-APR-15
	VERSION NO:	QA/QC:
	1.0	RPB/RDB

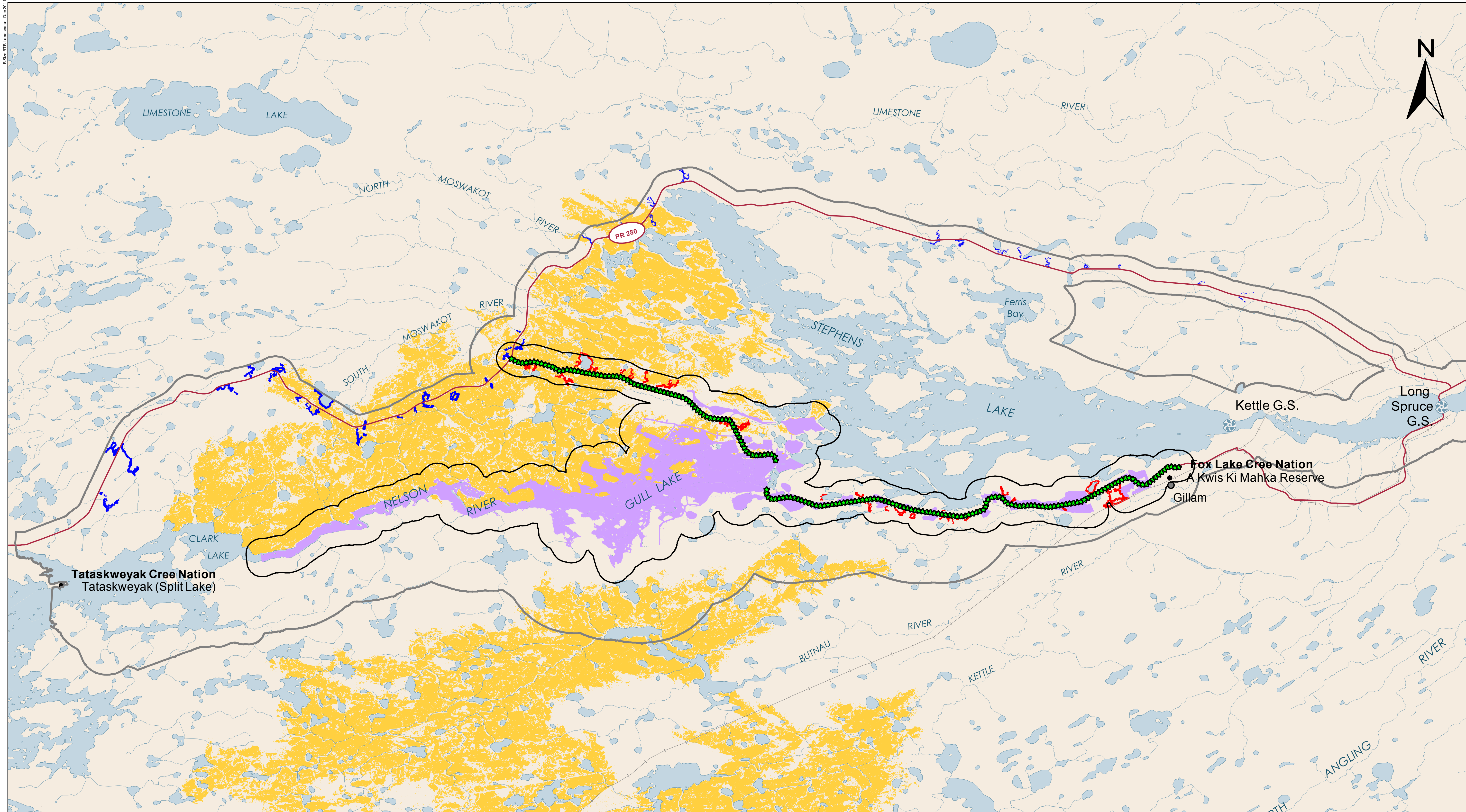
Legend

Bald Eagle Survey Locations
- Shoreline Survey Area
- Planned Construction Footprint

Study Areas
- Study Zone 4
- Study Zone 5

Bald Eagle Survey Areas

KEEYASK Hydropower Limited Partnership



Keeyask Hydropower Limited Partnership

DATA SOURCE:
Sample locations and burn - ECOSTEM Ltd.; Study zones and footprints - Manitoba Hydro; Water - NTS; Roads and rail - Manitoba Conservation

CREATED BY:
ECOSTEM Ltd.

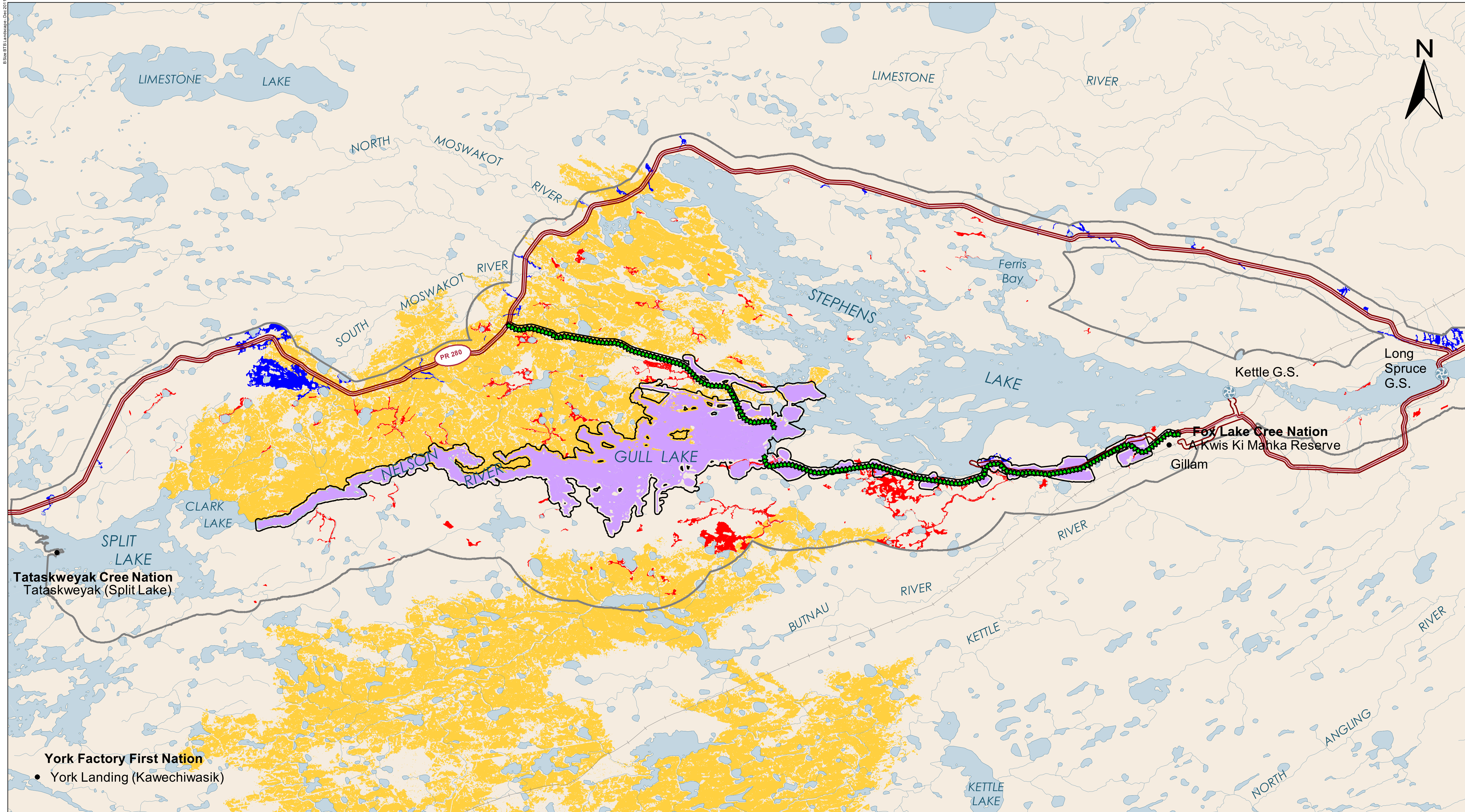
COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	22-APR-15	15-DEC-15
0 3 6 Kilometres / 0 1.5 3 Miles	VERSION NO: 1.0	QA/QC: RPB/RDB

Legend

Sample Location Areas by Type

- Traffic Disturbed Comparison Area
- Project Effects Area
- Backup Locations to Detect Nesting Pairs
- Planned Construction Footprint
- Burned in 2013
- Study Zone 3
- Study Zone 4

Olive-Sided Flycatcher Survey Areas



KEEYASK
Hydropower Limited Partnership

DATA SOURCE:
Sample locations, highway buffer and burn - ECOSTEM Ltd.; Study zones - Manitoba Hydro; Water - NTS; Roads and rail - Manitoba Conservation.

CREATED BY:
ECOSTEM Ltd.

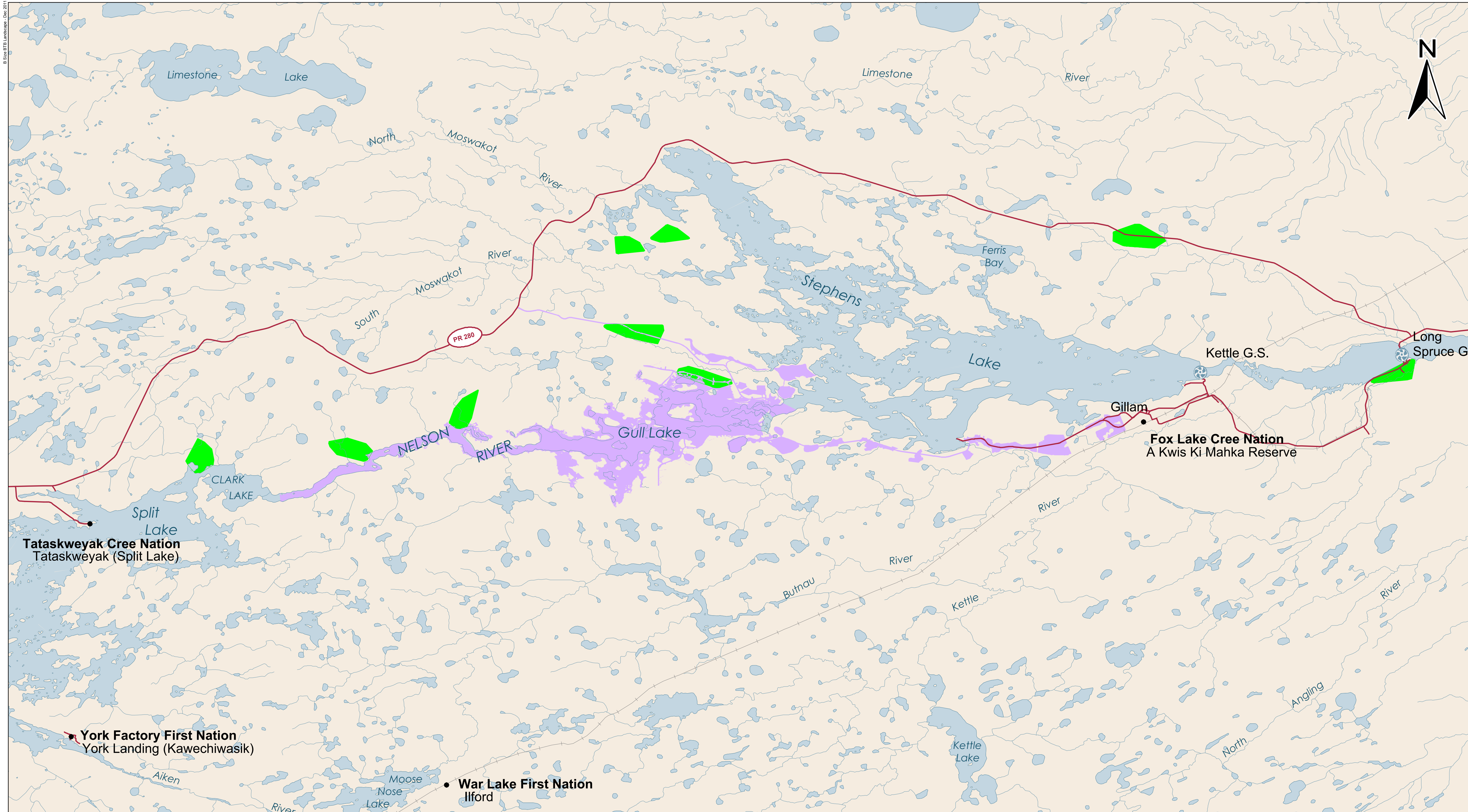
COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	22-APR-15	15-DEC-15
0 4 8 Kilometres / 0 2 4 Miles	VERSION NO: 1.0	QA/QC: RPB/RDB

Legend

Sample Location Areas by Type

- Traffic Disturbed Comparison Area
- Project Effects Area
- Backup Locations to Detect Nesting Pairs
- Burned in 2013
- 100 m Highway Buffer
- Planned Construction Footprint
- Study Zone 2
- Study Zone 4

Rusty Blackbird Survey Areas



KEEYASK
Hydropower Limited Partnership

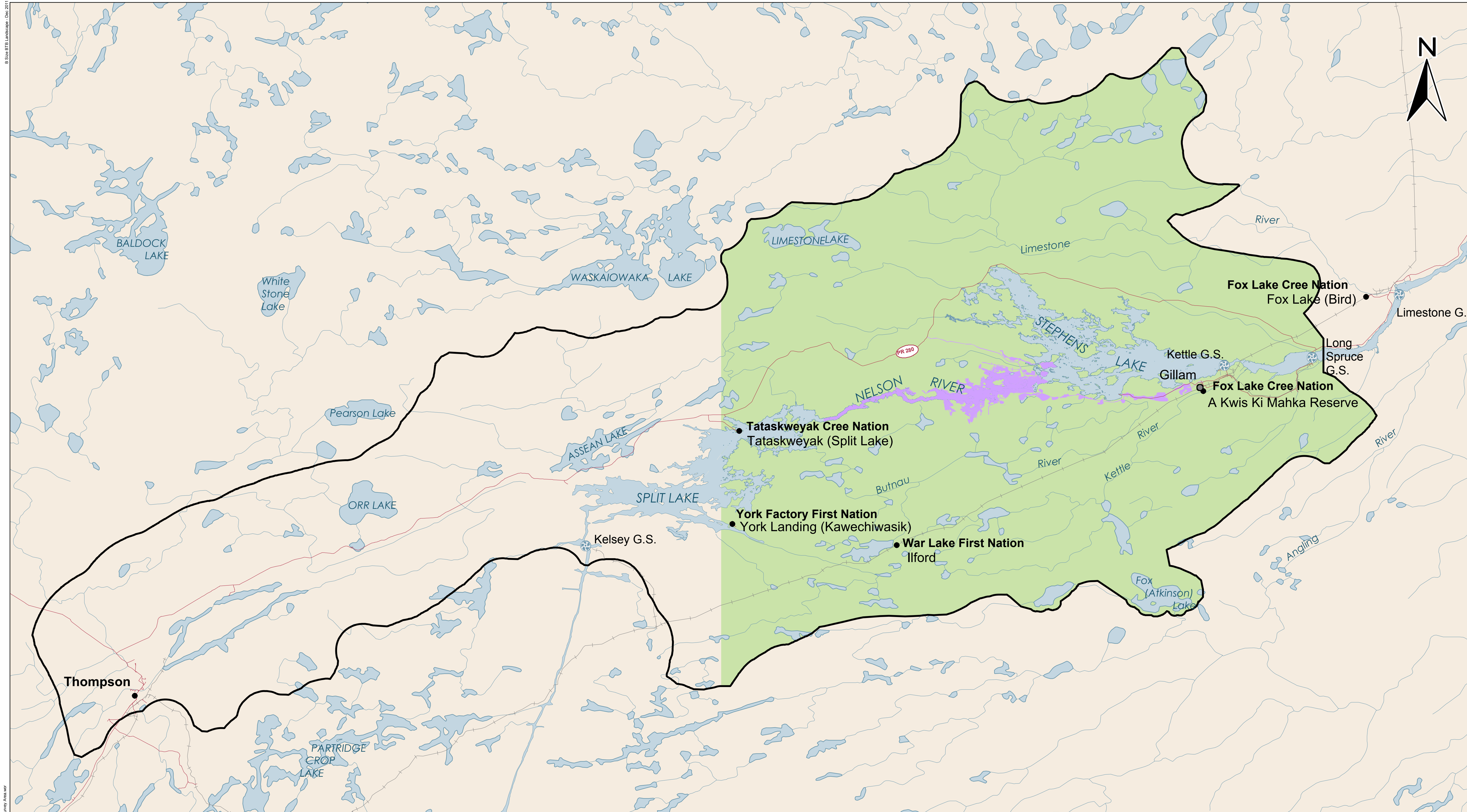
DATA SOURCE:
Survey areas - ECOSTEM Ltd.; Footprint - Manitoba Hydro; Water - NTS; Roads and rail - Manitoba Conservation.

CREATED BY:
ECOSTEM Ltd.

COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	02-JUL-15	15-DEC-15
0 4 8 Kilometres / 0 2 4 Miles	VERSION NO: 1.0	QA/QC: RPB/RDB

Legend
Common Nighthawk Survey Areas
Potential Survey Area
Planned Construction Footprint

Common Nighthawk Survey Areas



DATA SOURCE:
Survey area and Nelson River shoreline - ECOSTEM Ltd.; Study areas - Manitoba Hydro; Roads - Manitoba Conservation; Water and rail - NTS.

CREATED BY:
ECOSTEM Ltd.

COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	24-APR-15	27-APR-15
0 10 20 Kilometres / 0 5 10 Miles	VERSION NO: 1.0	QA/QC: RPB/RDB

Legend

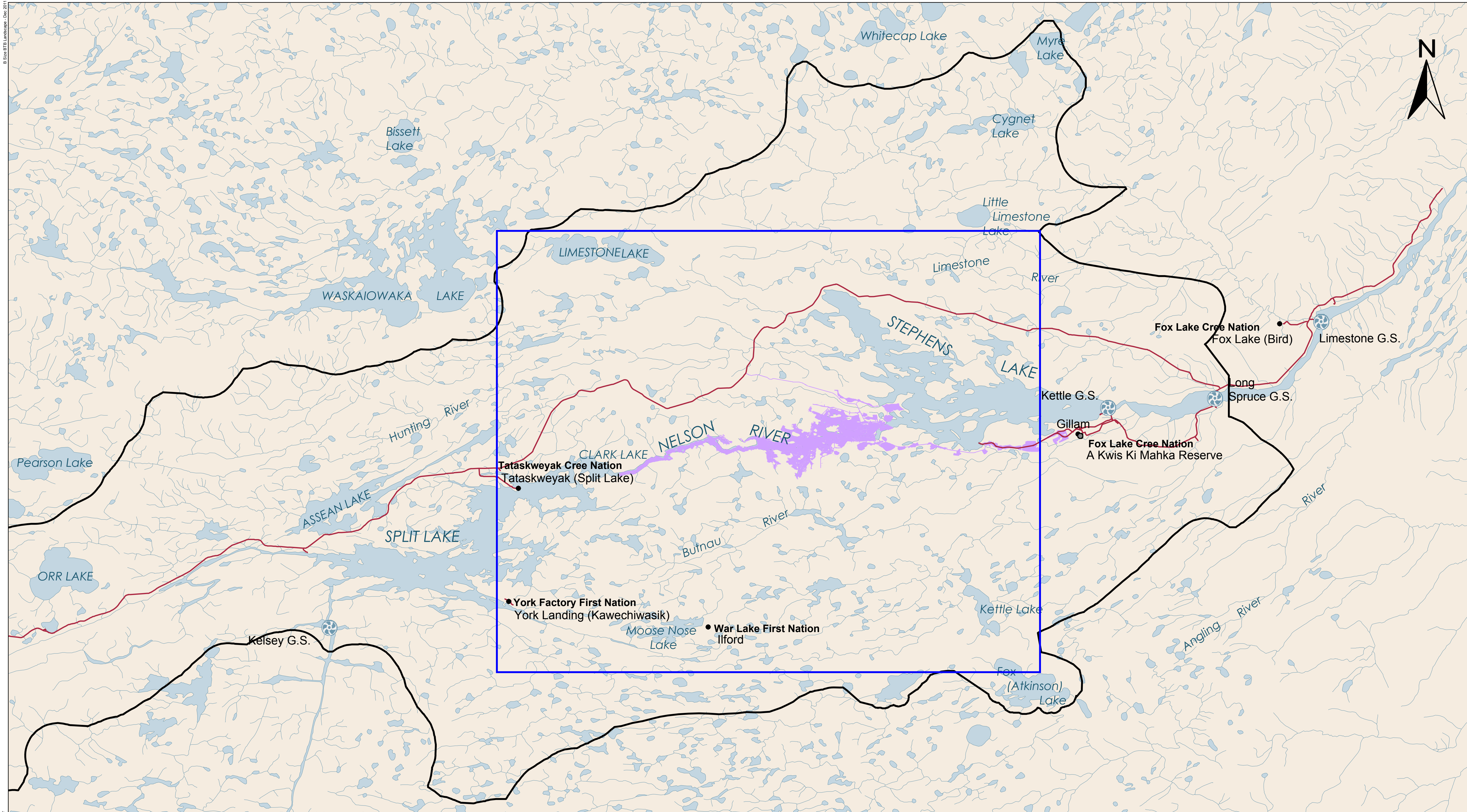
Caribou Winter Abundance Survey Area

Planned Construction Footprint

Study Areas

Study Zone 5

Caribou Winter Abundance Survey Area



DATA SOURCE:
Survey Area - ECOSTEM Ltd.; Footprints - Manitoba Hydro; Water - NTS; Roads and rail - Manitoba Conservation.

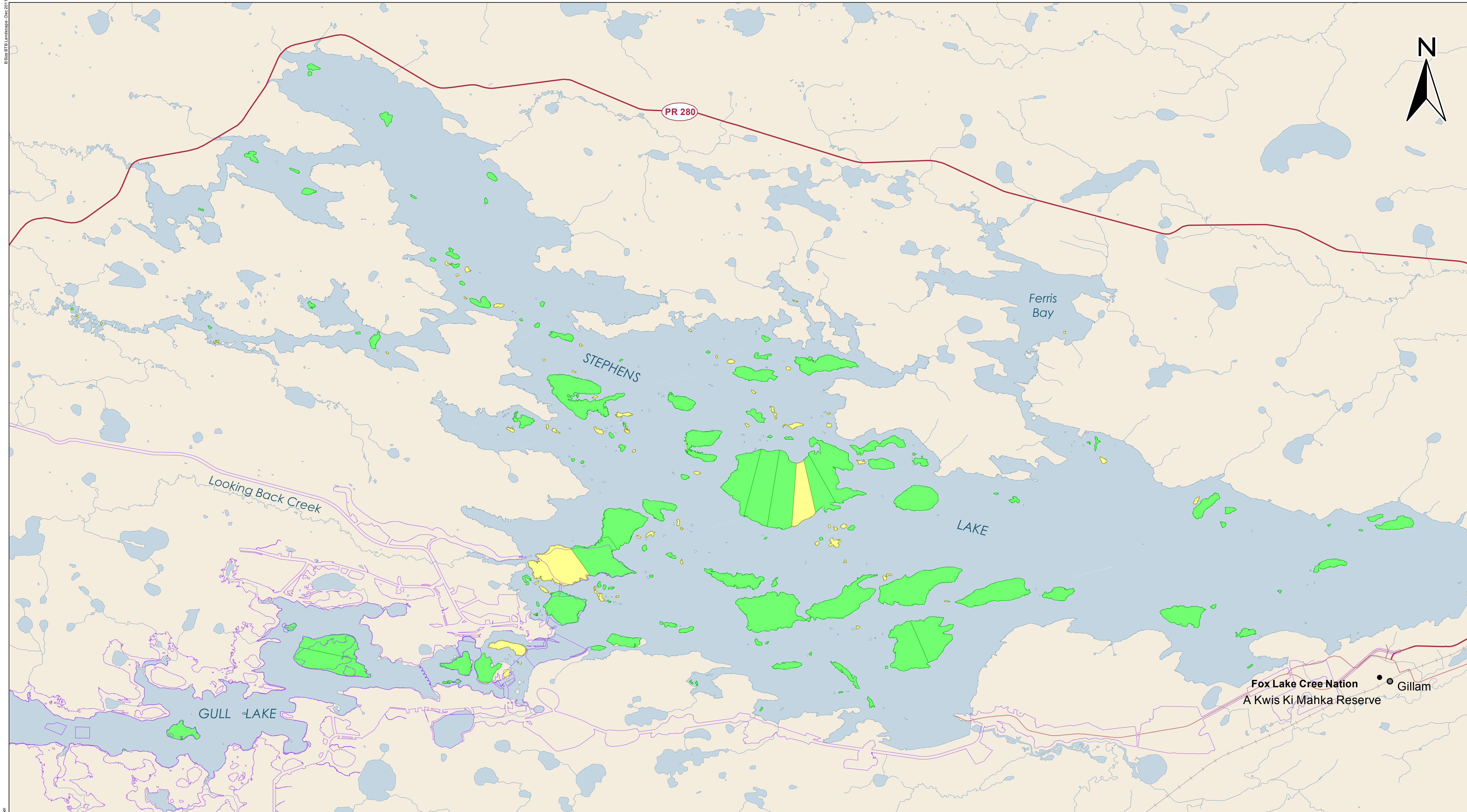
CREATED BY:
ECOSTEM Ltd.

COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	15-DEC-15	15-DEC-15
0 1 2 Kilometres / 0 0.5 1 Miles	VERSION NO: 1.0	QA/QC: JWE/RDB

Legend

- Summer Resident Caribou Winter Range Survey Area
- Study Zone 5
- Planned Construction Footprint

Summer Resident Caribou Winter Range Survey Area



KEEYASK
Hydropower Limited Partnership

DATA SOURCE:
Sampling units and Nelson River shoreline - ECOSTEM Ltd.; Footprints - Manitoba Hydro; Roads and rail - Manitoba Conservation; Water - NTS.

CREATED BY:
ECOSTEM Ltd.

COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	21-APR-15	27-APR-15
0 2 4 Kilometres / 0 1 2 Miles	VERSION NO: 1.0	QA/QC: RPB/RDB

Legend

Island in Lake Sampling Units

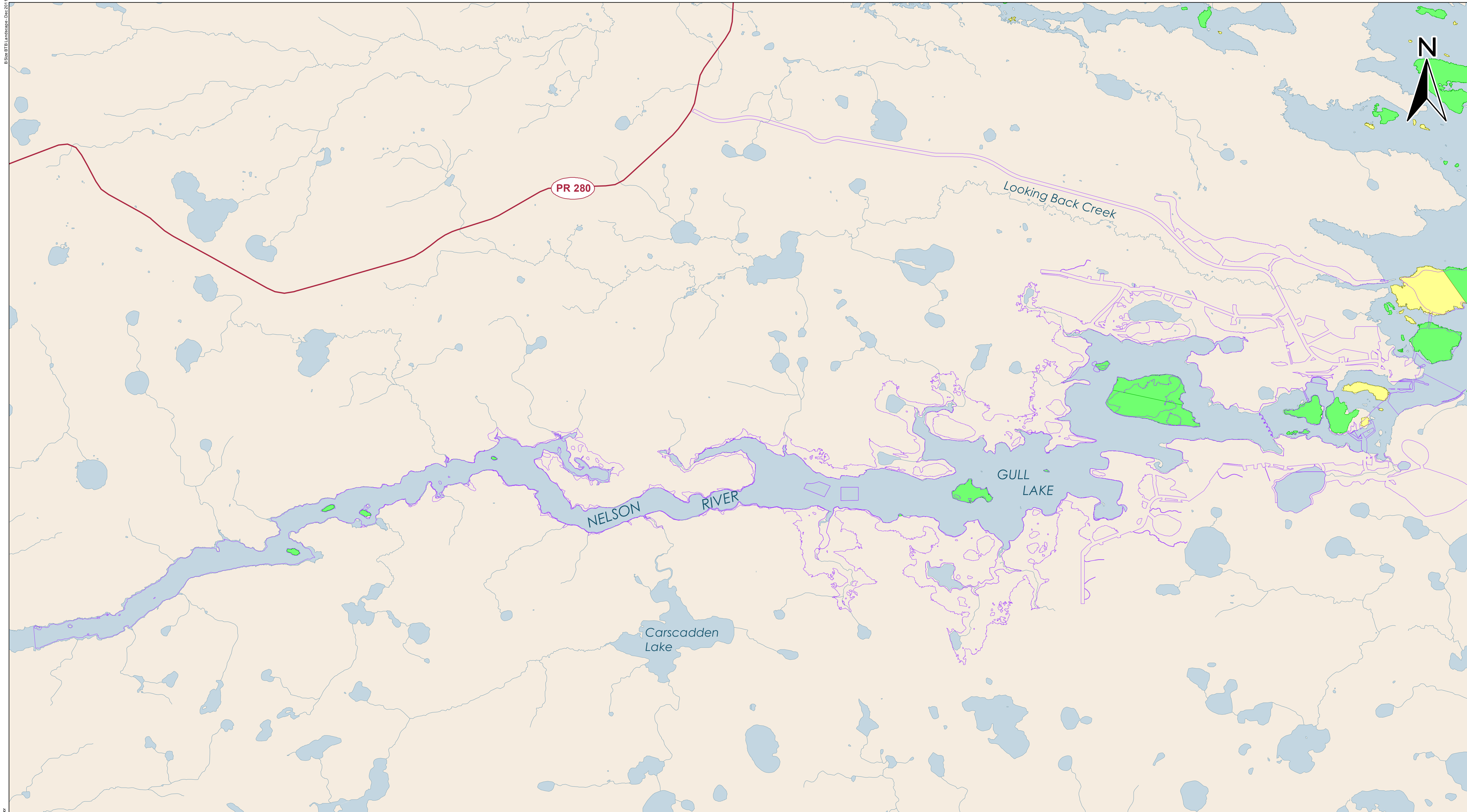
Sample Location

Other Potential Calving Island in the Study Area

Planned Construction Footprint

Note: Islands larger than approximately 300 ha were subdivided into sampling units that are each approximately 150 ha in size. A sample location will be replaced with an alternate location if conditions found in the field are different than expected (e.g, unanticipated disturbance).

Caribou Calving Islands in Lakes - Sample Locations



DATA SOURCE:
Sampling units and Nelson River shoreline - ECOSTEM Ltd.; Footprints - Manitoba Hydro; Roads and rail - Manitoba Conservation; Water - NTS.

CREATED BY:
ECOSTEM Ltd.

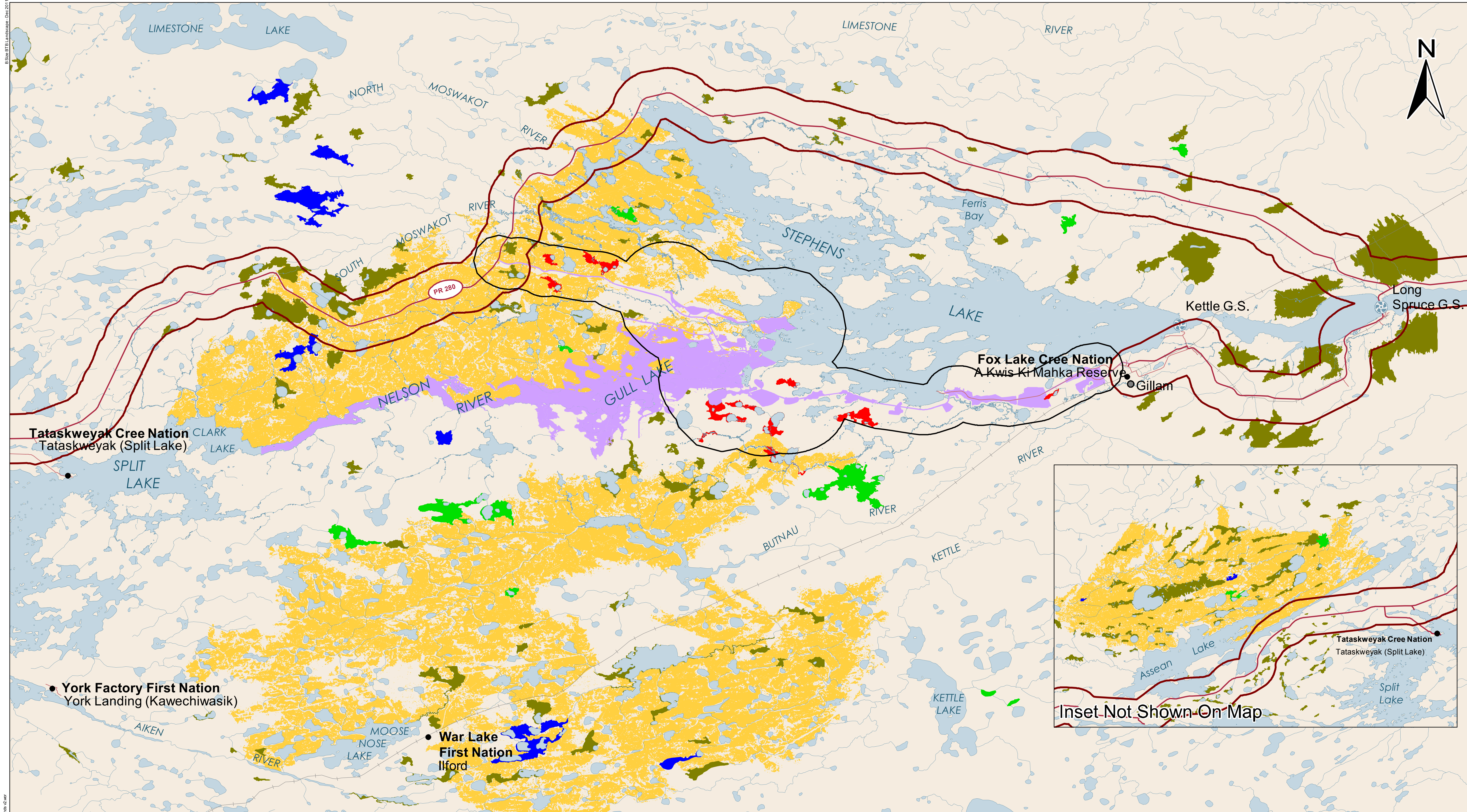
COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	21-APR-15	27-APR-15
0 1 2 Kilometres / 0 0.5 1 Miles	VERSION NO: 1.0	QA/QC: RPB/RDB

Legend
Island in Lake Sampling Units
- Sample Location
- Other Potential Calving Island in the Study Area
- Planned Construction Footprint

Note: Islands larger than approximately 300 ha were subdivided into sampling units that are each approximately 150 ha in size. A sample location will be replaced with an alternate location if conditions found in the field are different than expected (e.g, unanticipated disturbance).

Keeyask Hydropower Limited Partnership

Caribou Calving Islands in Lakes - Sample Locations



Hydropower Limited Partnership

DATA SOURCE:
Sample locations, burn and Nelson River shoreline - ECOSTEM Ltd.; Footprints - Manitoba Hydro Water - NTS; Roads and rail - Manitoba Conservation.

CREATED BY:
ECOSTEM Ltd.

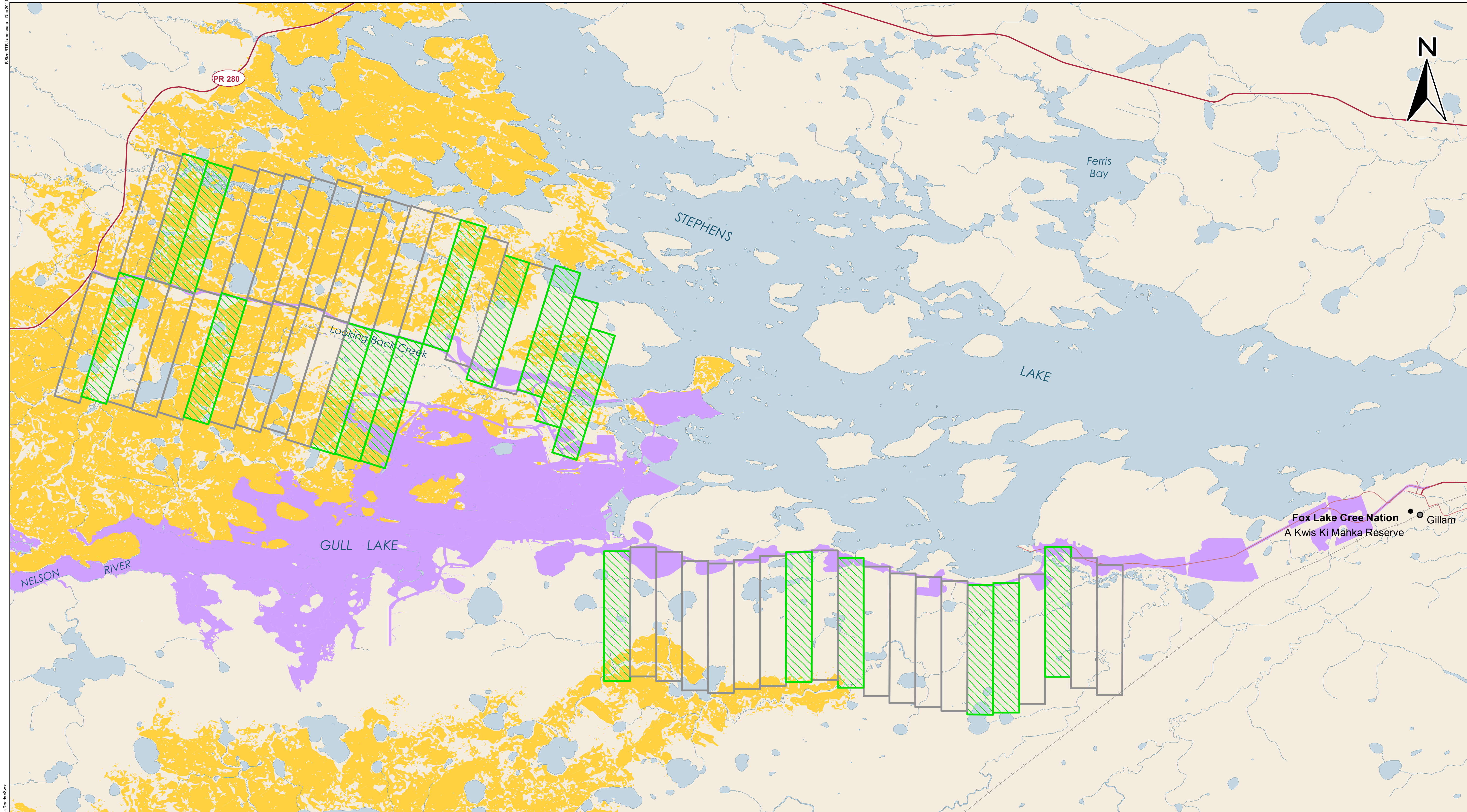
COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	21-APR-15	15-DEC-15
0 4 8 Kilometres / 0 2 4 Miles	VERSION NO: 1.0	QA/QC: RPB/RDB

Legend

Calving Complexes to Sample by Treatment
- Project
- Reference
- Random
- Other Calving Complexes in the Study Area
- Burned in 2013

Sensory Disturbance Zones
- Project Zone of Influence
- Major Roads
- Planned Construction Footprint

Caribou Calving Peatland Complex - Sampling Locations



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DATA SOURCE:
Tracking blocks, burn and Nelson River shoreline - ECOSTEM Ltd.; Footprints - Manitoba Hydro; Roads and rail - Manitoba Conservation; Water - NTS.

CREATED BY:
ECOSTEM Ltd.

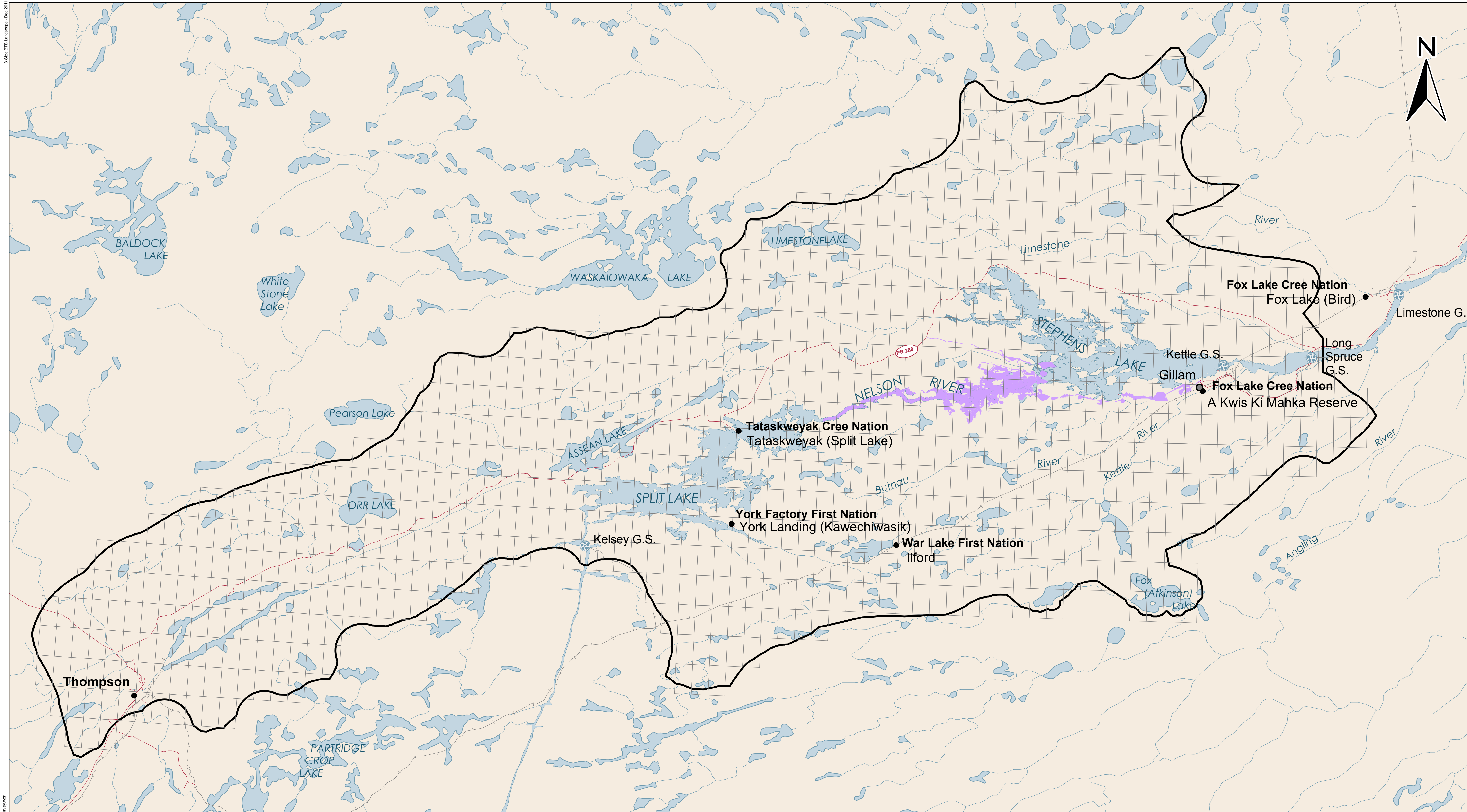
COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	21-APR-15	15-DEC-15
0 2 4 Kilometres / 0 1 2 Miles	VERSION NO: 1.0	QA/QC: RPB/RDB

Legend

Tracking Blocks in Sampling Frame

- Sample Location
- Block Not Sampled
- Planned Construction Footprint
- Burned in 2013

Access Road Mammal Tracking Blocks



DATA SOURCE:
Survey cells and Nelson River shoreline - ECOSTEM Ltd.; Study areas - Manitoba Hydro; Roads - Manitoba Conservation; Water and rail - NTS.

CREATED BY:
ECOSTEM Ltd.

COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	24-APR-15	27-APR-15

0 10 20 Kilometres
0 5 10 Miles

VERSION NO:	QA/QC:
1.0	RPB/RDB

Legend

Moose Population Survey Area
Grid Cell for Gasaway-style Survey

Project Area
Planned Construction Footprint

Study Areas
Study Zone 5

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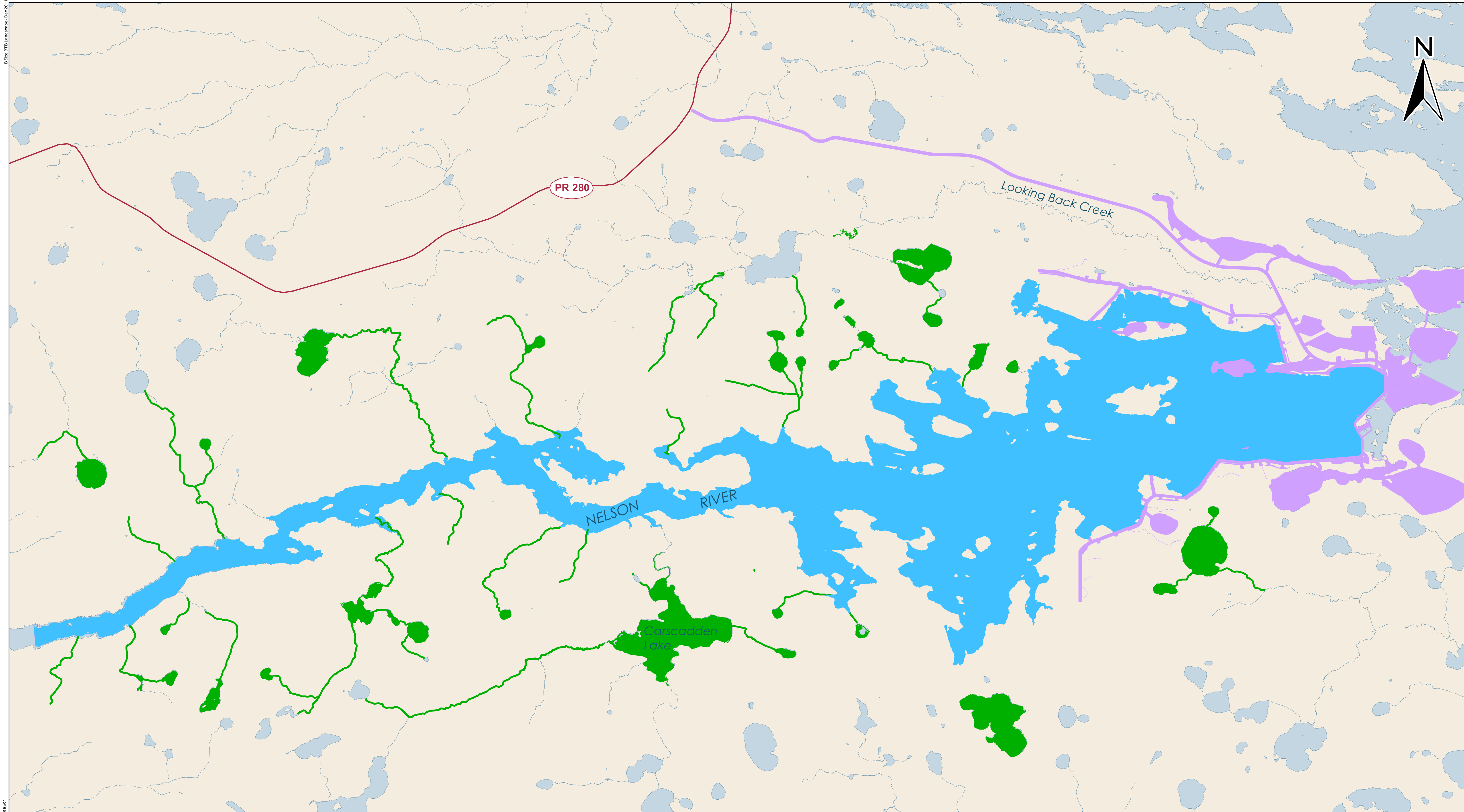
Moose Population Survey Grid Cells



KEEYASK
Hydropower Limited Partnership

DATA SOURCE:
Survey area and Nelson River shoreline - ECOSTEM Ltd.; Footprints - Manitoba Hydro; Roads and rail - Manitoba Conservation; Water - NTS.

CREATED BY:
ECOSTEM Ltd.

COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	24-APR-15	28-APR-15
0 1 2 Kilometres / 0 0.5 1 Miles	VERSION NO: 1.0	QA/QC: RPB/RDB

Legend

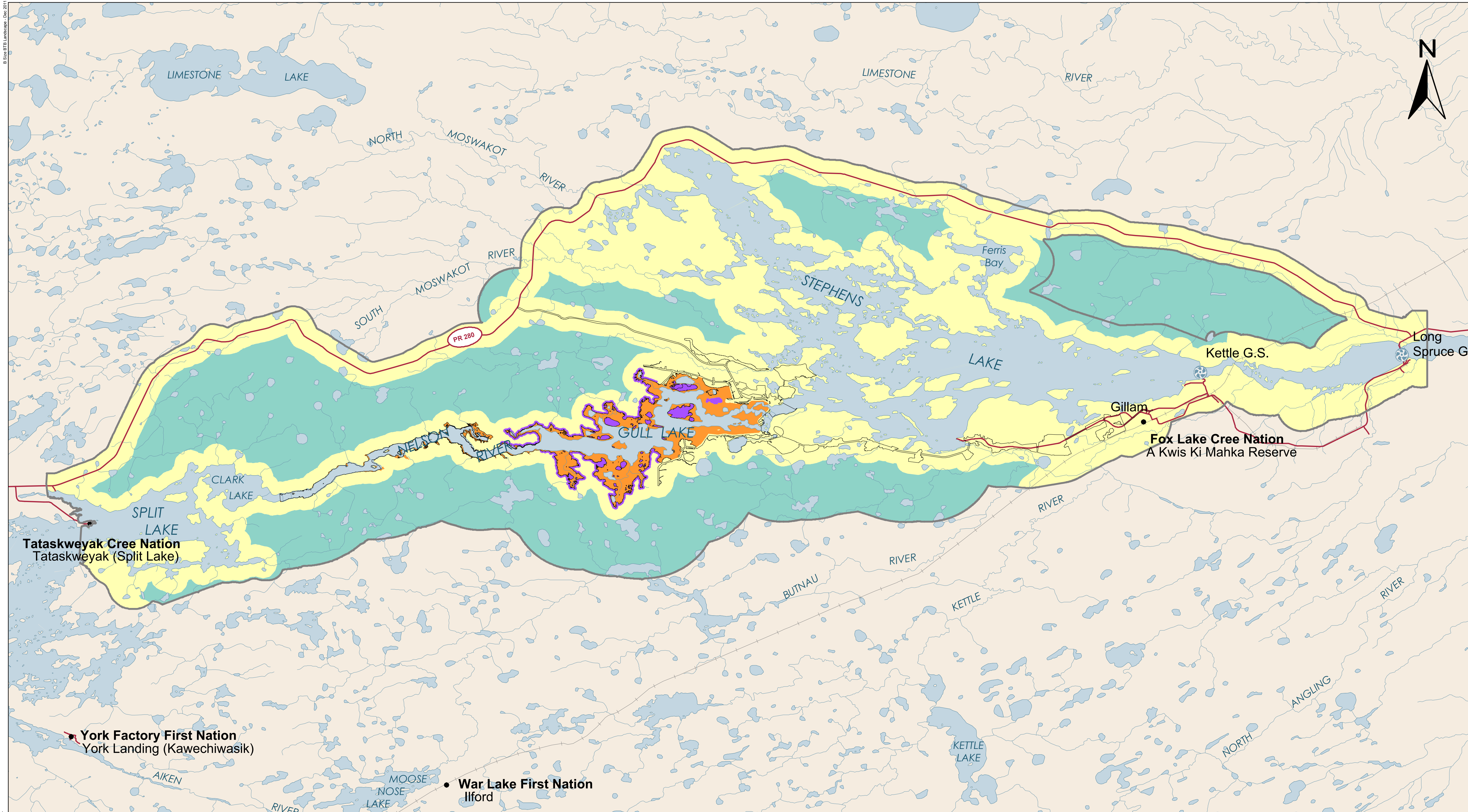
Beaver Survey Areas

- Predicted Reservoir Area at Year 30
- Reference Waterbody

Project Footprints

- Planned Construction Footprint

Beaver Survey Areas



DATA SOURCE:
Sampling areas - ECOSTEM Ltd.; Study areas - Manitoba Hydro; Water - NTS; Roads and rail - Manitoba Conservation.

CREATED BY:		
ECOSTEM Ltd.		
COORDINATE SYSTEM: UTM NAD 1983 Z15N	DATE CREATED: 24-APR-15	REVISION DATE: 15-DEC-15
0 4 8 Kilometres / 0 2 4 Miles	VERSION NO: 1.0	QA/QC: JWE/RDB

Keeyask Hydropower Limited Partnership

Legend

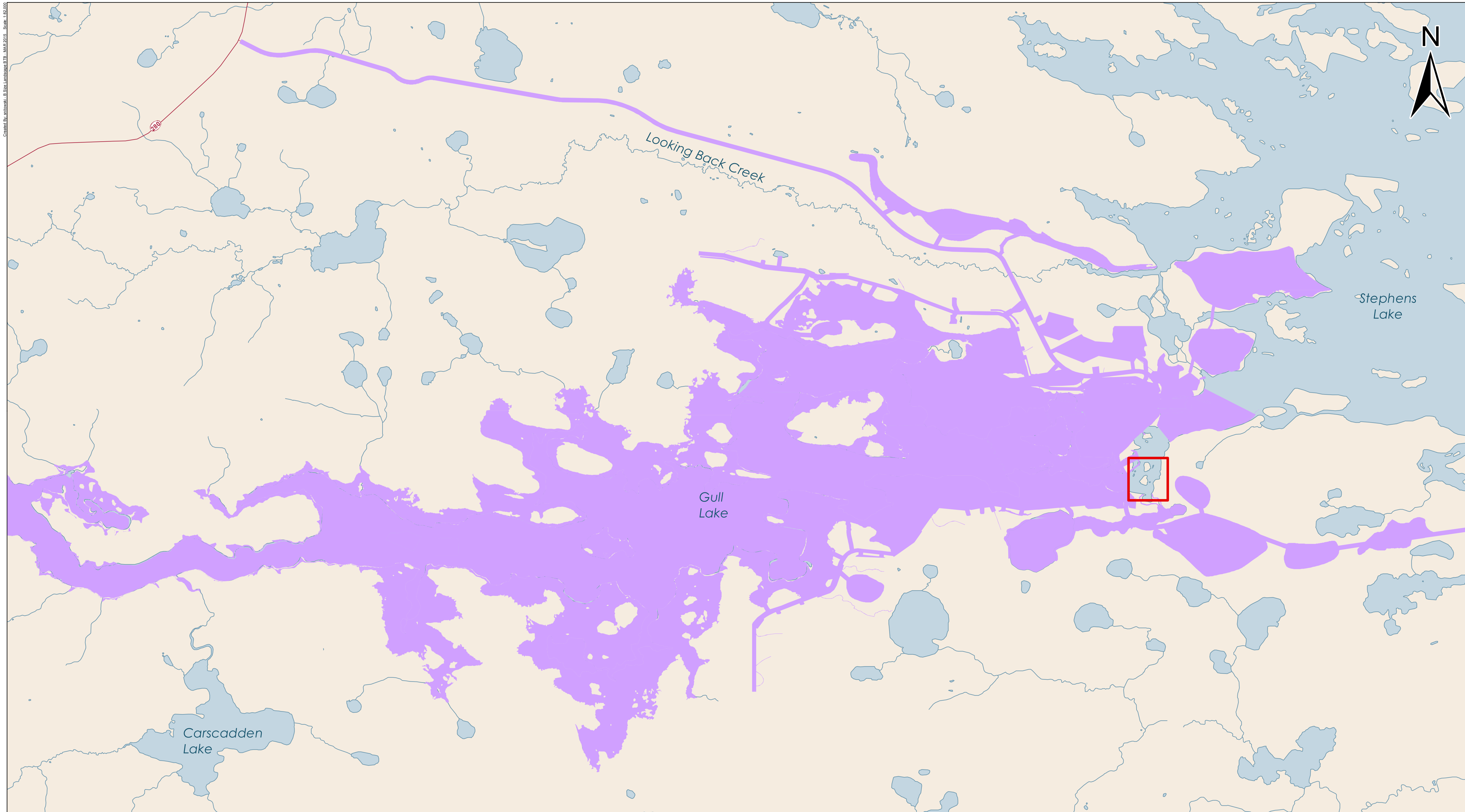
Mercury in Plant Sample Zones

- No Collections (Other Human Influences)
- No Collections (Reservoir Area)
- Reference Sample Collection Area
- Reservoir Effects Collection Area

- Planned Project Footprint
- Study Zone 4

Note: The boundaries of the zones will be adjusted to reflect actual reservoir flooding and existing human footprints at the start of operation.

Mercury in Plants Sampling Areas



KEEYASK
Hydropower Limited Partnership

DATA SOURCE:
Created Wetlands - ECOSTEM Ltd.; Footprints - Manitoba Hydro; Water - NTS; Roads - Manitoba Conservation.

CREATED BY:
ECOSTEM Ltd.

COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
NAD 1983 UTM Zone 15N	24-APR-15	15-DEC-15
0 0.9 1.8 Kilometres / 0 0.75 1.5 Miles	VERSION NO: 1.0	QA/QC: JWE/RDB

Legend

Created Wetlands

Wetland Development General Location

Planned Construction Footprint

General Location of Created Wetlands

10.0 ACRONYMS AND GLOSSARY

10.1 ACRONYMS, ABBREVIATIONS AND UNITS

Acronym / Abbreviation	
ATK	Aboriginal Traditional Knowledge
CNP	Cree Nation Partners
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
E	East
e.g.	example
EIS	Environmental impact statement
EL&P	Manitoba Hydro Environmental Licensing and Protection Department
EnvPP	Environmental protection plan
et al.	and others
etc.	and so forth
FRI	Forest Resource Inventory
FSL	Full supply level
GIS	Geographical Information System
GPS	Global positioning system
GS	Generating Station
i.e.	in other words
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)
MESEA	Manitoba *Endangered Species and Ecosystems Act*
PEMP	Physical Effects Monitoring Program
RMA	Resource Management Area
SARA	Species at Risk Act
SLRMA	Split Lake Resource Management Area
TEMP	Terrestrial Environment Monitoring Plan
TE SV	Terrestrial Environment Supporting Volume
VEC	Valued Environmental Component
W	West
Unit	
hectare	ha
Hour	h
kilometer	km
kilometer per hour	kph
meter	m
megawatt	MW

square kilometer	km^2

10.2 GLOSSARY

Aboriginal traditional knowledge (ATK): Aboriginal traditional knowledge is knowledge that is held by, and unique to, Aboriginal peoples. It is living knowledge that is cumulative, 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).

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*).

Amphibians: Cold-blooded animal of the Class Amphibia that typically lives on land but breeds in water (*e.g.*, frogs, toads, salamanders).

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.

Attribute: A readily definable and inherent characteristic of a plant, animal, or habitat.

Biomass: Total mass of living matter, within a given unit of area or volume.

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').

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.

Browse: Refers to animals eating the tender current growth (and occasionally older growth) or bark of woody plants as a food source; can also be the generic term for the food source, especially as it refers to ungulates.

Buffer: An area surrounding a defined geographic area, usually created by locating a line a fixed distance around the area of interest.

Cache: A hiding place for concealing and preserving provisions.

Caribou calving and rearing (habitat) complex: a habitat mosaic that includes a cluster of islands in 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 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.

Cause-effect linkage: The relationship between an event (the cause) and a second event (the effect) or subsequent event (an indirect effect), where the second event or subsequent event is a consequence of the first.

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.

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).

Confidence interval: An estimated range of values which is likely to include an unknown population parameter, the estimated range being calculated from a given set of sample data.

Confidence level (or level of confidence): A statement of how often you could expect to find similar results if the survey were to be repeated, or the degree of certainty of obtaining the same results. It often informs about how often the findings will fall outside the margin of error.

Construction: Includes activities anticipated to occur during Project development.

Core area: A natural area that meets a minimum size criterion after applying an edge buffer on human features. Two minimum sizes (200 ha, 1,000 ha) after applying a 500 m buffer on human features were used in the intactness effects assessment.

Cumulative effect: The effect on the environment, which results when the effects of a project combine with those of the past, existing, and future projects and; the incremental effects of an action on the environment when the effects are combined with those from other past, existing and future actions.

Diurnal: Active in the daytime.

Dyke: An earth embankment constructed to contain the water in the reservoir and limit the extent of flooding.

Ecosystem diversity: The number of different ecosystem types and the distribution of area amongst them, at various ecosystem levels.

Ecosystem function: The outcomes of ecosystem patterns and processes viewed in terms of ecosystem services or benefits. Examples include producing oxygen to breathe, habitat for animals, purifying water and storing carbon.

Ecosystem: A dynamic complex of plant, animal and microorganism communities and their non-living components of the environment interacting as a functional unit (Canadian Environmental Assessment Agency).

Edge effect: The effect of an abrupt transition between two different adjoining ecological communities on the numbers and kinds of organisms 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. The impact-effect terminology is a statement of a cause-effect relationship (see **Cause-effect linkage**). 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: An estimate of the percentage of habitat 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.

Element: The unit about which information is collected and that provides the basis of analysis. In habitat research, a homogenous patch of vegetation and soils is an example of an element, as is a polygon of fixed size and shape. In wildlife research, examples of elements are individual animals, entire populations or habitat units.

Environmental assessment: 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 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.

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.

Fire regime: The frequency, size, intensity, severity, patchiness, seasonality and type (*e.g.,* ground versus canopy) of fires in the Fire Regime Area.

Flooding: The rising of a body of water so that it overflows its natural or artificial boundaries and covers adjoining land that is not usually underwater.

Fragmentation: 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. *OR* 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.

Generating station: A complex of structures used in the production of electricity, including a powerhouse, spillway, dam(s), transition structures and dykes.

Groundwater: The portion of sub-surface water that is below the water table, in the zone of saturation.

Habitat attribute: A readily definable and inherent characteristic of a habitat patch.

Habitat effect: Regarding terrestrial habitat, any change in a habitat attribute that results from the Project.

Habitat loss: Conversion of terrestrial habitat into human features or aquatic areas.

Habitat recovery: Regarding terrestrial habitat in a temporarily affected area, the return to the habitat type that was there prior to the Project or to a similar habitat type through natural regeneration processes or rehabilitation measures.

Habitat: The place where a plant or animal lives; often related to a function such as breeding, spawning, feeding, etc.

Hydroelectric: Electricity produced by converting the energy of falling water into electrical energy (*i.e.*, at a hydro generating station).

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.*

Impact: Essentially, a statement of what the Project is in terms of the ecosystem component of interest while a project effect is a direct or indirect consequence of that impact (*i.e.*, a statement of the 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). Note that while *Canadian Environmental Assessment Act* requires the proponent to assess project effects, Manitoba legislation uses the terms impact and effect interchangeably. See also Effect.

Impoundment: The containment of a body of water by a dam, dyke, powerhouse, spillway or other artificial barrier.

Infrastructure: Permanent or temporary structures or features required for the construction of the principal structures, including access roads, construction camps, construction power, batch plant and cofferdams.

Invasive plant: A plant species that is growing outside of its country or region of origin and is out-competing or even replacing native organisms.

Keeyask Cree Nations: As a convenience to readers, all four communities are referred to in this document as the Keeyask Cree Nations (KCNs).

Key topic: A topic selected to focus the terrestrial effects assessment. Includes valued environmental components and key supporting topics.

Lacustrine: Of or having to do with lakes, and also used in reference to soils deposited as sediments in a lake.

Landscape: The ecological landscape as consisting of a mosaic of natural communities; associations of plants and animals and their related processes and interactions.

Local study area: The spatial area within which potential Project effects on individual organisms, or individual elements in the case of ecosystem attributes, may occur. Effects on the populations to which the individual organisms belong to, or the broader entity in the case of ecosystem attributes, were assessed using a larger regional study area; the spatial area in which local effects are assessed (*i.e.*, within close proximity to the action where direct effects are anticipated.

Magnitude: A measure of the size of an effect. *Alternatively,* a measure of how adverse or beneficial an effect may be.

Marsh: A class in the Canadian Wetland Classification System which includes non-peat wetlands having at least 25% emergent vegetation cover in the water fluctuation zone.

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."

Model: A description or analogy used to help visualize something that cannot be directly observed. Model types range from a simple set of linkage statements or a conceptual diagram to complex mathematical and/or computer model.

Mollusc: Animals in the phylum Mollusca, including snails (gastropods), clams and mussels (bivalves) and squids and octopuses (cephalopods).

Monitoring: Measurement or collection of data to evaluate 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; a 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.

Nocturnal: Active at night.

Off-system: Water body or waterway outside of the Nelson River hydraulic zone of influence.

On-system: Waterbody or waterway inside the Nelson River hydraulic zone of influence.

Organic: The compounds formed by living organisms.

Parameter: A value, usually unknown (and which therefore has to be estimated), used to represent a certain population characteristic.

Parameter: Characteristics or factor; aspect; element; a variable given a specific value.

Peatland: A type of wetland where organic material has accumulated at the surface.

Population: 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.

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: see **Priority species**.

Priority plant: A native plant species that is rare, plays a highly disproportionate role in ecosystem function, is highly sensitive to Project features or is highly valued by people.

Priority species: A species or group of species that is particularly important for ecological/social reasons.

Project feature: Any Project physical impact or activity that changes the environment. Synonymous with "action" in the *Canadian Environmental Assessment Act*.

Project Footprint: The maximum potential spatial extent of clearing, flooding and physical disturbances due to construction and operation of the Project, including areas unlikely to be used.

Push-up: A dome-shaped resting and feeding station built by muskrats by pushing vegetation and mud above holes in ice.

Raptor: Any of the group known as "birds of prey", including eagles, hawks, owls, vultures and falcons.

Reference site/area: A site or an area that is expected to be unaffected by the Project. Used for comparison with sites/areas affected by the Project.

Regional study area: The regional comparison area used for a particular key topic. Alternatively, the spatial area within which cumulative effects are assessed (*i.e.* extending a distance from the Project Footprint in which both direct and indirect effects are anticipated to occur).

Relative abundance: The number of individuals of one species compared to the number of individuals of another species. The number of individuals at one location or time compared to the number of individuals at another location or time. Generally reported as an index of abundance.

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: 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 selection study: characteristics measured on resource units such that its value for a unit is proportional to the probability of that unit being use. A species will select resources that are best able to satisfy its life requirements, and that high quality resources will be selected more than lo w quality ones. The availability of various resources is not generally uniform in nature, and use may change as availability changes. Therefore, used resources should be compared to available (or unused) resources in order to reach valid conclusions concerning resource selection. When resources are used disproportionately to their availability, use is said to be selective. Resource selection occurs in a hierarchical fashion from the geographic range of a species, to individual home range within a geographic range, to use of general features (habitats) within the home range, to the selection of particular elements (food items) within the general features (or feeding site). The criteria for selection may be different at each level.

Riparian: Along the banks of rivers and streams.

Sample location: The geographic location of a sampling unit selected for inclusion in the data collection.

Sample size: The number of elements in the obtained sample.

Sampling bias: The selected elements are not "typical" or "representative" of the larger populations that they have been chosen from. Alternatively, how far the statistic lies from the parameter value it is estimating.

Sampling error: This is the degree of error to be expected for a given sample design or the difference between the sample mean and the population mean.

Sampling frame: This is the actual list of sampling units from which the sample, or some stage of the sample, is selected. It is simply a list of the study population.

Sampling unit: The element or set of elements considered for selection in some stage of sampling (same as the elements, in a simple single-stage sample).

Sensory disturbance: To upset the natural and especially ecological balance or relations of[2] due to auditory, olfactory or visual stimuli.

Shoreline wetland: A wetland where surface water level fluctuations, water flows and ice scouring are the dominant driving factors.

Staging: The tendency of migratory organisms to stop temporarily (**stage**) at a site during migration; **staging areas** are stop-over sites where, for example, migratory birds will rest, forage, and/or moult along the course of a migration route.

Statistic: A quantity that is calculated from a sample of data. It is used to give information about unknown values in the corresponding population.

Statistical inference: The process of reasoning by which information about a population is extracted from sample data.

Study area: The geographic limits within which effects on a VEC (valued environmental component) or supporting topic is assessed.

Study design: A set of rules or procedures that specify how a sample is to be selected. Provides information on the target and final sample sizes, strata definitions and the sample selection methodology. This can either be probability or non-probability.

Substrate: 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 Project assessment topic of concern that is of lesser interest than a VEC.

Survey population: This is an operational definition of the target population; that is the portion of the target population that will be included in the study.

Target population: The entire collection of elements that is the focus of concern. A population can be of any size and while the elements need not be uniform, the elements must share at least one measurable feature

Terrestrial habitat: Terrestrial habitats include forests and grasslands (among others). They are typically defined by factors such as plant structure (trees and grasses), leaf types (*e.g.* broadleaf and needleleaf), plant spacing (forest, woodland, savannah) and climate.

Terrestrial plant: Any plant adapted to grow on the land or areas with water that is typically shallower than 2 m.

Terrestrial: Belonging to, or inhabiting the land or ground.

Transect: A line located between points and then used to investigate changes in attributes along that line.

Trophic level: one of the hierarchical strata of a food web characterized by organisms that are the same number of steps removed from the primary producers.

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.

Upland: A land ecosystem where water saturation at or near the soil surface is not sufficiently prolonged to promote the development of wetland soils and vegetation.

Valued environmental component: Any part of the environment that is considered important by the proponent, public, scientists and government involved in the assessment process. Importance may be determined on the basis of cultural values or scientific concern.

Waterbody: An area with permanent surface water

Wetland: A land ecosystem where periodic or prolonged water saturation at or near the soil surface is the dominant driving factor shaping soil attributes and vegetation composition and distribution. **Peatland**s are a type of wetland.

Zone of Influence: The spatial areas outside of the Project Footprint where direct and indirect effects occur. The location and size of the zone of influence varies for each ecosystem component of interest.

11.0 LITERATURE CITED

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