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9. EXISTING ENVIRONMENT

This chapter provides an overview of the existing physical, biological and human environments of the Project study areas. As the level of detail for the valued components corresponds to the anticipated level of interaction between the component and the Project, some valued components require a greater level of detail than others. Further detailed biophysical or human environment information required to enable an accurate effects assessment is contained in the relevant Key Lines of Inquiry or Subject of Note.

9.1 LOCATION

The Project area spans the Taiga Shield Ecozone and the Southern Arctic Ecozone (Ecological Stratification Working Group 1995). The boundary between the Taiga Shield and the Southern Arctic ecozones is defined by the northern extent of continuous forest. The current alignment is shown in Figure 9.1.1; the ecozones are shown in Figure 9.1.2.

Ecological regions have recently been redefined for the Taiga Shield, leading to a new array of ecozones (Ecosystem Classification Group 2008). The Canadian Ecosystem Classification system recognizes four levels of ecosystem divisions and subdivisions for the Taiga Shield Ecozone. The southern and central sections of the Project area occur below the treeline in the Taiga Shield Ecoregion (Level II), which corresponds to the Taiga Shield Ecozone within the Canadian Ecosystem Classification system. The section of the Project area within the Taiga Shield Ecoregion is further subdivided into the High and Low Subarctic, and the High and Mid Boreal Ecoprovinces (Level III; Ecosystem Classification Group 2008). The Level IV subdivisions, including landform, soils, and vegetation associations, are summarized in Table 9.1.1. The northern section of the transmission line ROW lies within the Southern Arctic Ecozone, and entirely within the Takijuq Lake Upland Ecoregion (Figure 9.1.2). This ecoregion is characterized by unvegetated rock outcrops that are common on the Canadian Shield. The region consists mainly of massive Archean rocks that form broad sloping uplands, plateaus, and lowlands (Ecological Stratification Working Group 1995). Numerous lakes are present in the lowlands. Vegetative cover is characterized by shrub tundra, consisting of dwarf birch, willow, northern Labrador tea, *Dryas* spp., *Vaccinium* spp., willow, Sphagnum moss, and sedge tussocks. Scattered stands of spruce occur along the southern boundary of the ecoregion.

TALTSON Hydroelectric Expansion Project	Developer's Assessment Report 2009	Taltson Hydroelectric Expansion Project Area Overview	Figure 9.1.1

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TALTSON Hydroelectric Expansion Project	Developer's Assessment Report 2009	Ecozones and Ecoregions	Figure 9.1.2

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Table 9.1.1 — Ecological Classification of the Taiga Shield Ecozone within the Project Area

Level I (Ecoclimatic Province)	Level II (Ecozone)	Level III (Ecoprovince)	Level IV (Ecoregion)	Characteristics
Taiga	Taiga Shield	High Subarctic	Mackay Upland	Complex of till plains and bedrock outcrops; elevations from <100 m to >500 m; local variations generally <100 m but terrain can be rugged; outwash plains and esker complexes are common. Widespread permafrost; Cryosols dominant order with Brunisols on coarse-textured material. Stunted black and white spruce woodlands.
			Whitefish Plain	
		Low Subarctic	Porter Upland	High-relief (hummocky to rolling) bedrock with scattered till (bouldery, coarse-textured) and lacustrine veneers on lower slopes; coarse-textured outwash deposits occur throughout. Drumlin fields are extensive in the southeast. Widespread permafrost; Brunisols on mineral and Organics/Cryosols in peatlands. Open, low-growing black spruce with lichen/shrub understorey; some jack pine stands.
		High Boreal	Rutledge Upland	Exposed bedrock plains and undulating to hilly bedrock uplands with thin bouldery till veneers; elevations of 100 m to >500 m; peat plateaus between bedrock exposures. Discontinuous permafrost; Brunisols on mineral and Organics/Cryosols in peatlands. Closed, young jack pine stands or closed black spruce with lichen/shrub understorey.
			Nonacho Upland	
		Mid Boreal	Slave Plain	Hummocky to rolling bedrock and till or lacustrine veneers/blankets in low areas; bedrock decreases in southern portions, which is dominated by lacustrine and fluvial plains. Discontinuous permafrost; Brunisols/Cryosols on mineral and Organics/Cryosols in peatlands; peatlands are extensive. Closed, mixedwood stands including aspen, white spruce, and jack pine.

9.2 AREAS OF SPECIAL SENSITIVITY

The Project does not encroach on any existing protected areas including territorial parks, national parks or International Biological Program sites. The proposed East Arm National Park, a proposed protected area, exists within the Project footprint, located at the east arm of Great Slave Lake. The protected areas nearest to the Project are described below, regardless of whether they would be affected by the Project.

Territorial parks are protected under the *Territorial Parks Act,* and Wood Buffalo National Park (WBNP) is protected under the *National Parks Act*. Other potentially protected areas include lands withdrawn as part of the negotiations between the federal government and the Akaitcho Dene First Nation (ADFN). Figure 9.2.1 shows existing protected areas, the proposed protected area, and the other potentially protected areas near the study area. In addition, this document includes a discussion of the International Biological Program (IBP) sites located near the study area.

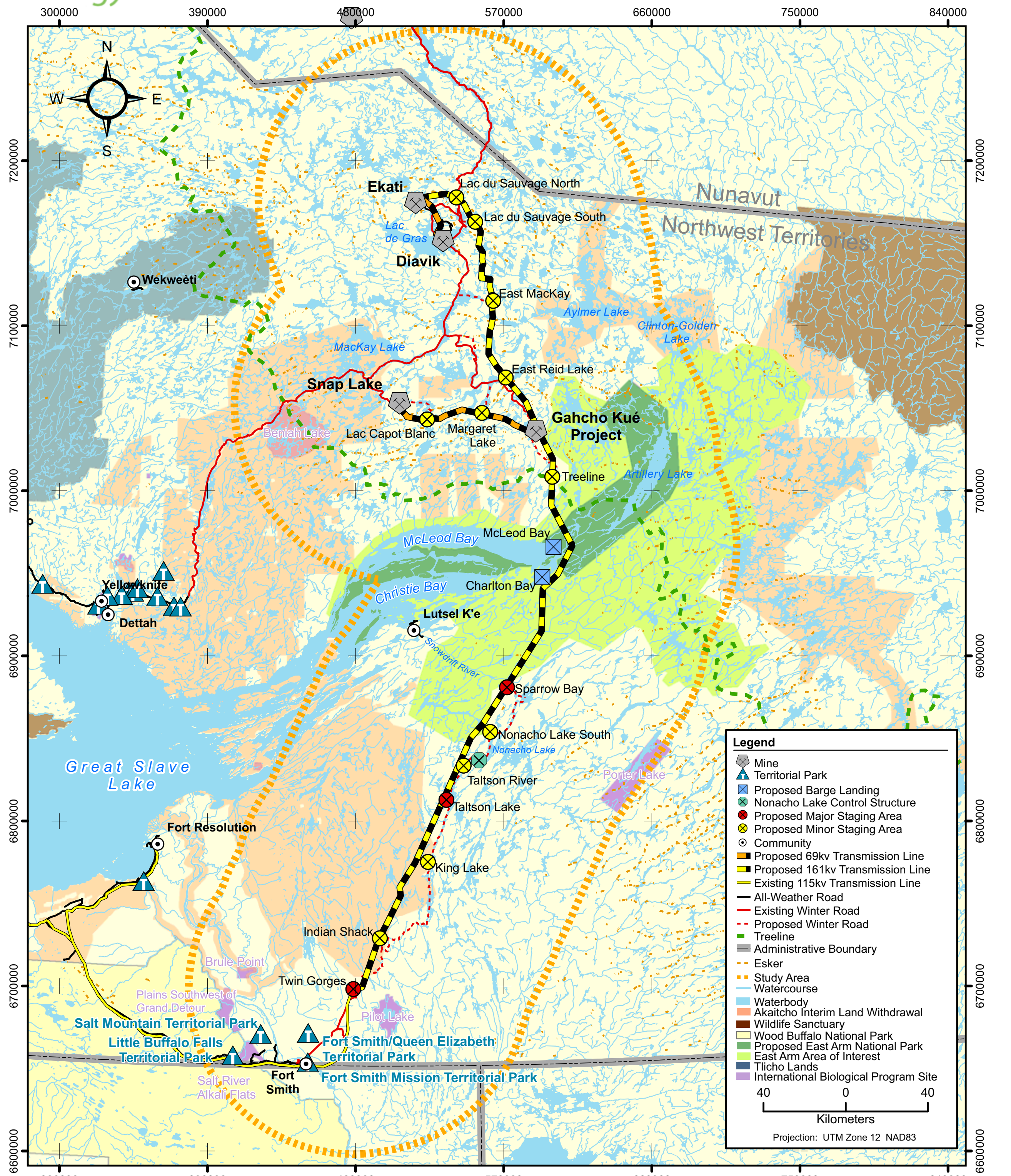
9.2.1 Protected Areas: Territorial Parks

9.2.1.1 QUEEN ELIZABETH TERRITORIAL PARK

Queen Elizabeth Territorial Park is located at the eastern end of Wood Buffalo National Park and is very close to Fort Smith. The park is important for its world-class white-water kayaking and rafting along the Slave River. The rapids are also known for the large numbers of white pelicans that spend their summers fishing off the rock outcrops in the middle of the river. The red-sided garter snake can also be found here, and is one of the few reptiles in the NWT. This reptile is at the northern limit of its range here (ITI 2008a).

9.2.1.2 LITTLE BUFFALO RIVER FALLS TERRITORIAL PARK

Little Buffalo River Falls Territorial Park is located along Highway 5, approximately 50 km northwest of Fort Smith. It is very close to the NWT entrance to WBNP, and is a popular camping area for visitors. The Little Buffalo River Falls is the main park attraction, but people also go to study the successional vegetation growth that resulted from a massive fire in 1981, which burned most of the land in and around the park (ITI 2008a).



TALTSON Hydroelectric Expansion Project	Developer's Assessment Report 2009	Protected Areas and Potentially Withdrawn Lands	Figure 9.2.1

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9.2.1.3 FORT SMITH MISSION TERRITORIAL PARK

Fort Smith Mission Territorial Park is a heritage park located in downtown Fort Smith, which consists of the remains of the old Oblate Catholic Mission that operated from 1876 to the early 1980s. The park provides an extensive self-guided tour of the mission sites, with sign boards describing various aspects of the history and activities of the mission, such as the bishop's residence, the cathedral, the Grotto, machine shop, and various other buildings (ITI 2008a).

9.2.1.4 SALT MOUNTAIN TERRITORIAL PARK

Salt Mountain Territorial Park is a wayside park situated along Highway 5 at km 234. It has not been developed for recreational purposes (Wayside Parks Regulations NWT Reg. 026-2003).

9.2.2 Protected Areas: National Parks

9.2.2.1 WOOD BUFFALO NATIONAL PARK

WBNP was established in 1922 to conserve the last remaining bison herds of northern Canada. The park is managed by Parks Canada (headquartered in Fort Smith) and currently covers an area of 44,807 km^2, straddling the border between the NWT and Alberta (Parks Canada 2008). The park is designated as a United Nations Educational, Scientific, and Cultural Organization (UNESCO) World Heritage Site and includes wetlands of international significance (indicated by a RAMSAR designation). Highway 5 passes through WBNP, linking Fort Smith to Hay River and the rest of the NWT.

9.2.3 Proposed Protected Areas

9.2.3.1 PROPOSED EAST ARM NATIONAL PARK

In October 2006, a Memorandum of Understanding (MOU) was signed between the Łutsel K'e Dene First Nation (LKDFN) and the Canada Parks Agency that formally launched a feasibility study for a proposed national park in the East Arm of Great Slave Lake (CBI, 2006; Parks Canada 2007a). The MOU "establishes a collaborative approach to assessing the proposed national park as part of a broader protection initiative for the [LKDFN] Dene's traditional territory" (Parks Canada 2007b). The area of interest and the proposed boundaries for the proposed national park are shown in Figure 9.2.1.

The National Parks System Plan guides completion of the national parks system (Parks Canada 1997). The system plan divides Canada into 39 distinct natural regions. The goal of the Parks Canada Agency is to have each natural region represented by at least one national park. The proposed national park at the East Arm of Great Slave Lake is representative of the North Western Boreal Uplands.

There are five steps in the creation of a national park (Parks Canada 1997):

- Step 1: Identify areas representative of a natural region.
- Step 2: Select a potential park area.
- Step 3: Assess the park's feasibility.
- Step 4: Negotiate new park agreements.
- Step 5: Formally protect the national park or park reserve under the *Canada National Parks Act.*

The proposed East Arm National Park is currently at the feasibility study stage (Parks Canada 2007b). When a potential park area has been selected, a new park proposal is prepared as the basis for a detailed feasibility assessment. The study is conducted with the direct involvement of the territorial government, and would involve consultation with local communities, Aboriginal peoples, non-government organisations, relevant industries, other government departments, and the interested public. Alternate land uses may also be considered (Parks Canada 1997).

In developing the potential boundaries of the proposed park, the following are considered (Parks Canada 1997):

- protect ecosystems and landscape features representative of the natural region,
- accommodate the habitat requirements of viable populations of native wildlife species,
- include an undisturbed area that is relatively unaffected by impacts originating from the surrounding landscape,
- maintain the integrity of natural communities and drainage basins,
- protect exceptional natural phenomena, and vulnerable, threatened, or endangered wildlife and vegetation,
- offer opportunities for public understanding and enjoyment,
- minimize possible disruption of the social and economic life of the surrounding region,
- include significant cultural heritage features or landscape, and
- exclude permanent communities.

Step 4 involves negotiations to determine final park boundaries and decisions about land acquisition. This step may also involve working with provincial or territorial governments, local and regional landowners, and comprehensive land claims by Aboriginal peoples. This step is completed when the Federal Environment Minister, with Cabinet approval, signs the negotiated park establishment agreement. At that time, Parks Canada becomes responsible for the operation of the national park, or national park reserve, under the authority of various provincial, territorial, or federal regulations (Parks Canada 1997).

Lands for the proposed national park in the East Arm of Great Slave Lake were initially given interim protection under the *Territorial Lands Act* in 1970. However, consultations on the proposed park were halted shortly thereafter at the request of the then NWT Indian Brotherhood and the LKDFN, due to their concerns about the possible effects of the park on their traditional use of the land (Parks Canada 2001). In 2001, the community of Łutsel K'e expressed a renewed interest in the national park proposal, at which time discussions between the LKDFN and Parks Canada recommenced (Parks Canada 2001). In 2005, the LKDFN identified their intent to seek protection of ‘Thaydene Nene’ (“the land of our ancestors”) based on several ecological and cultural criteria, and requested that Parks Canada reassess the boundaries of the proposed East Arm National Park to include more of this area, which is part of their traditional territory (Mondor 2006). At the same time, the LKDFN resolved that the park negotiations would fall under the auspices of the Akaitcho Process (see below). In response, Parks Canada identified an area of interest for a national park in the East Arm, which is consistent with Parks Canada’s objectives for establishing a park (Figure 9.2.1).

The locations within the proposed East Arm National Park that are important to the LKDFN and their perceptions of the world include a variety of spiritual, cultural, social, historical, and ecological values. One highly-valued spiritual location is the “Waters of Desnedhe Che”. Desnedhe Che is the Dene name for the Lockhart River, which flows into the East Arm of Great Slave Lake. The Waters of Desnedhe Che include the “Old Lady of the Falls” (also known as Parry Falls). Łutsel K’e Dene First Nation members make regular visits to the Lockhart River and the Falls to pay respects and to seek guidance from the Old Lady.

The proposed national park is remotely located, and there is no year-round or winter road access. Tourist and recreational activities within the boundary of the proposed park are summer-based, and mostly focus on the East Arm of Great Slave Lake. There are fly-in fishing lodges, such as Trophy Lodge, within the boundary of the proposed park, where tourists may also participate in wildlife viewing or photography. Elsewhere within the boundary for the proposed national park, Artillery Lake Adventures has a camp on the west side of Artillery Lake.

The study area for the proposed national park includes wilderness canoe routes, such as the Pike’s Portage/Lockhart River/Artillery Lake circuit, and Great Slave Lake. The East Arm is also a gateway to other wilderness rivers outside the study area.

It can take years to move through all the steps of establishing a national park (Parks Canada 1997). Referring to the national park creation process in general, Parks Canada indicates that “Many issues, including the need for local community and provincial or territorial government support, competing land-use pressures, consultation with and engagement of Aboriginal groups and the need to secure funds for the establishment and operation of new parks make the pace of advancement hard to anticipate and at times impossible for Parks Canada to control” (Parks Canada 1997, 2007b). Depending upon the length of time for the feasibility study, and the time to negotiate the remaining stages of the park planning process, the proposed East Arm National Park may not be created until the Project is well into its operations phase.

9.2.4 Potential Protected Areas

9.2.4.1 Akaitcho Process and Interim Land Withdrawal

The proposed Project transmission line right of way (ROW) would pass along the outer edge of land set aside for the Akaitcho Interim Land Withdrawal, as well as above and below the East Arm of Great Slave Lake. The ADFN includes the communities of the LKDFN, the Deninu Kue First Nation (Deninu Kue/Fort Resolution), and the Yellowknives Dene First Nation (N'Dilo and Detah) (AAIR n.d.). The ADFN has been working with the Government of the Northwest Territories (GNWT) and the Government of Canada to achieve a lands, resources, and governance agreement through a course of action known as the Akaitcho Process.

In October 2005, a protocol was signed whereby lands in the Akaitcho territory would be temporarily withdrawn for five years through Order-in-Council (Figure 9.2.1). The Order-in-Council was signed on November 1, 2007 by the Governor General. An Interim Land Withdrawal helps protect specific areas from new development while negotiations continue. All pre-existing third party interests (including the Project) would not be impacted by the land withdrawal, and all parties with leases, permits, claims, licences, or other dispositions prior to the Order-in-Council would have their interests protected. The total area of the Akaitcho Interim Land Withdrawal is about 62,000 km^2, making it the largest in Canada (AAIR n.d.). It encompasses land around the city of Yellowknife and a large portion of land above and below the middle of the East Arm of Great Slave Lake.

9.2.5 Other Ecologically Important Areas

9.2.5.1 International Biological Program

In the late 1960s, the IBP and the International Council of Scientific Unions, in conjunction with 58 other nations around the world, worked together to establish a detailed understanding of all the components of their homelands' ecological communities (Beckel 1975). Each ecological site presents an opportunity to understand the ecological functioning of an area. Many of these areas can include breeding grounds, endangered populations, migration routes, pristine lakes and rivers, rare geological formations, and unique plant associations. These sites are proposed reserve sites near the Project footprint, which are not protected through the federal government, yet their importance has been identified.

9.2.5.1.1 Beniah Lake

The Beniah Lake site, located about 80 km northeast of Yellowknife, was chosen because it is a representative sample of the spruce lichen habitat at the edge of the tundra (Beckel 1975). The Discovery Mine site, located 90 km north of Yellowknife, was chosen because it typifies the degree and extent of ecological modifications that accompany mining activities in the transition forest portion of the Canadian Shield (Beckel 1975).

9.2.5.1.2 Porter Lake

Porter Lake is located about 140 km east of Great Slave Lake and 140 km north of the Saskatchewan border. It is about 17 km from the south east arm of Nonacho Lake. The lake is about 415 km^2 and it is part of the undulating Kazan Upland of the Canadian Shield. Porter Lake was proposed as a reserve ecological site because it is a very important part of the winter range for barren-land caribou herds. It is also considered a typical example of the northwestern transition of the northern boreal forest. The boreal forest vegetation here consists of white and black spruce, larch, and scattered sedge swamps covering base-poor glacial drift over acidic Precambrian rocks. Occasional bedrock outcrops occur throughout, and long, well-defined eskers are common (Beckel 1975).

9.2.5.1.3 Pilot Lake

Pilot Lake is located about 20 km east of the Taltson River Airstrip near Twin Gorges dam. The proposed ecological site has a total area of approximately 175 km^2, while the lake itself is about 109 km^2. The site is important because the lake was formed from a meteor impact that occurred an estimated 445 million years ago. It is a 90 m deep, flat bottomed, nearly circular meteor crater lake in the Precambrian Shield. Rolling hills surround the lake shores, which are covered with open jackpine stands and thick lichens. Pilot Lake contains lake trout, northern pike, whitefish, and pickerel, which support a strong summer market for recreational fishing (Beckel 1975).

9.2.5.1.4 Salt River Alkali Flats

The Salt River Alkali Flats area is close to the Alberta-NWT border about 16 km west of the Slave River, and a large portion of it is protected within WBNP. This area consists of large amounts of salt deposits left in depressions by outwash from brine springs in the Brine Creek drainage system. The vegetation consists of rare plants with saline affinities. This area is an important winter range for bison and other ungulates, which use it for salt licks (Beckel 1975).

9.2.5.1.5 Brule Point

The Brule Point area is about 65 km northwest of Fort Smith, located on the western side of the Slave River north of Grand Detour. The IBP considers this an important ecosystem because it is a flat alluvial delta of a former arm of Great Slave Lake. The Slave River frequently inundates portions of the site, resulting in wet sedge meadows. This site also includes several abandoned stream meanders, some of which contain lakes and meadows (Beckel 1975).

9.2.5.1.6 Plains Southwest of Grand Detour

The Plains Southwest of the Grand Detour area is located east of the Little Buffalo River and southwest of Grand Detour on the Slave River. The ecosystem consists of grass-sedge meadows and prairie, with forest along the margins. It is recognized as an important summer range for bison and wolves (Beckel 1975).

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9.3 TALTSON BASIN HYDROLOGY

9.3.1 Taltson Basin Description

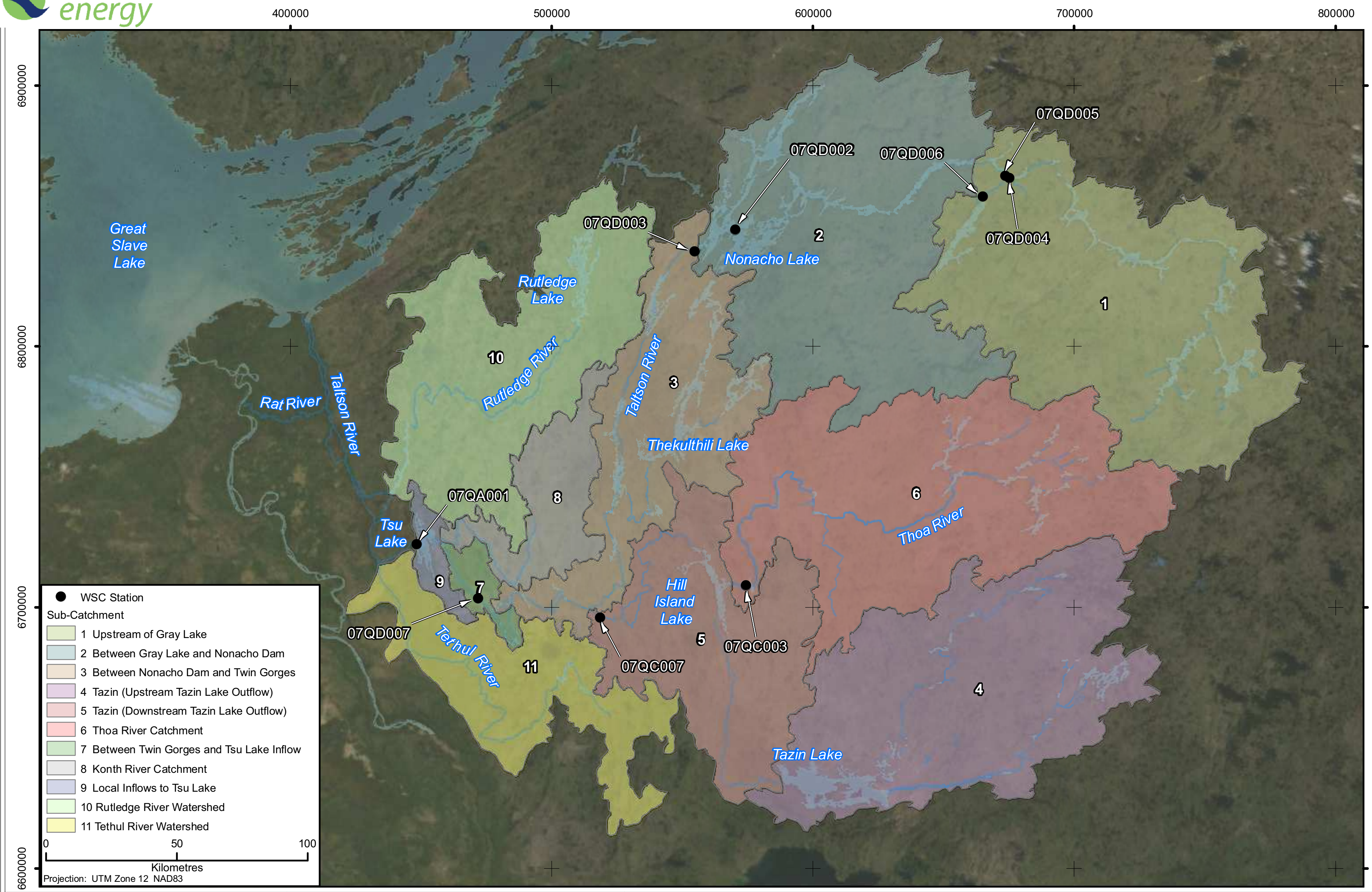
The Taltson River basin is a relatively large drainage area of approximately 60,000 km^2 located between Lake Athabaska and Great Slave Lake (Figure 9.3.1). The region is characterized as a subhumid, high boreal ecoclimate with typically cool summers and very cold winters. The basin comprises a relatively complex system of interconnected lakes, draining generally southwest from the higher elevation Canadian Shield area and then northwards along, and eventually into, the Slave River lowland zone. The river enters Great Slave Lake on its southern shore at the western end of the Simpson Island chain. Two main tributaries form the lower Taltson River on which the existing generation facility was developed – the mainstem Taltson River and the Tazin River.

The Taltson River basin is comprised of a number of main sub-watersheds (Table 9.3.1). The headwaters of the river rise near a series of lakes (e.g., Coventry and Dymond Lakes) in the north-east of the basin. The Taltson River then flows north to McArthur Lake and west from there to Gray Lake, an arm of Nonacho Lake. Hjamar Lake, the north-western arm of Nonacho Lake, receives flow from a series of minor tributaries.

Table 9.3.1 — Main Sub-watersheds of the Taltson River Basin above Tsu Lake

ID	Sub-watershed	Area (km^2)	Percent of Total
1	Catchment upstream of Gray Lake	11,486	23.5%
2	Catchment between Gray Lake and Nonacho Dam	10,922	22.3%
3	Catchment between Nonacho Dam and Twin Gorges Forebay	5,942	12.1%
4	Tazin River Catchment (upstream of Tazin Lake outflow)[1]	494	1.0%
5	Tazin River Catchment (downstream of Tazin Lake outflow, excluding Thoa River)	5,969	12.2%
6	Thoa River Catchment	10,941	22.3%
7	Local inflows between Twin Gorges and Tsu Lake inflow	527	1.1%
8	Konth River Catchment	2,180	4.5%
9	Local inflows to Tsu Lake	508	1.0%
	Total Catchment (upstream of Tsu Lake - Net)	**48,969**	**100.0%**

[1]Tazin River Catchment (upstream of Tazin Lake outflow) has an actual catchment area of 9,875 km^2; however, approximately 90 to 95% of the flow from Tazin Lake is diverted south to the Charlot River (95% assumed for this calculation). Therefore, an effective catchment area of 494 km^2 is being used.



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Taltson River Watershed and Main Sub-watersheds

Figure 9.3.1

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Nonacho Lake is the largest lake in the Taltson River basin and has one of the three Taltson Hydroelectricity Facility control structures within the basin. The other two control structures are at Tazin Lake and the Twin Gorges Facility. Outflow from Nonacho Lake occurs at two locations, the Nonacho Dam control structure and Tronka Chua Gap. Discharge from Nonacho Lake to the Taltson River passes at Nonacho Dam through the existing dam underflow gates as leakage through the dam, or over the dam spillway. Flow drops through a series of rapids before entering the Taltson River. Tronka Chua Gap is a natural saddle in the southwest corner of the lake. Flow that passes through Tronka Chua Gap rejoins the Taltson River at Lady Grey Lake after passing through a series of lakes including Tronka Chua Lake and Thekulthili Lake. Prior to the construction of the Nonacho control structure in 1968, it is likely that all outflow from Nonacho Lake entered directly into the mainstem of the Taltson River. Discharge over the Tronka Chua Gap was limited and at most intermittent.

The reach between Nonacho Lake and Twin Gorges Forebay is a complex series of slow-moving, low gradient river reaches divided by a series of lakes, rapids, and waterfalls. The major lakes within the upper section of this reach include Taltson, King, and Lady Grey. In many cases, the backwaters from one lake extend almost as far upstream as the rapids near the outflow of the next upstream lake, such that flow through the system is primarily controlled by lake storage and flow restrictions at rapids and lake outlets. The outflow from Lady Grey Lake is approximately 130 km downstream of Nonacho Lake.

Below Lady Grey Lake, the Taltson River regains more typical river characteristics and flows the remaining 110 km to the Twin Gorges Forebay. In this reach, the river passes through a number of smaller lakes, including Benna Thy Lake. The Tazin River, the largest tributary of the Taltson River, joins the mainstem of the Taltson within this reach. Flow out of Tazin Lake is controlled by a dam constructed to divert water into the Charlot River system to operate hydroelectric projects that currently contribute to the Saskatchewan power grid. The diversion effectively removes approximately 9,400 km^2 of area from the Taltson Basin, or about 17% of the total potential drainage area at Twin Gorges. Flow over the Tazin Lake dam into the Taltson River basin is intermittent. Therefore, except during higher than normal runoff periods, discharge into the Taltson River basin is limited to the portion of the watershed downstream of Tazin Lake, including the Thoa River.

Water leaves the Twin Gorges Forebay either through the hydropower generating plant, or over the SVS, located 7 km east of the power plant. Water passing through the generating plant flows over Elsie Falls and continues through the Taltson River. Flow over the SVS is diverted through Trudel Creek, which flows for approximately 30 km in a broad loop to the south before returning to join the Taltson River at Elsie Falls. Currently, a substantial portion of the outflow from Twin Gorges enters Trudel Creek via the SVS. However, prior to construction of the Twin Gorges Power Facility in 1965, flow to Trudel Creek from the Taltson River would have been much lower (Rescan 2006a).

Below Elsie Falls, the Taltson River flows an additional 33 km to Tsu Lake, passing over a number of rapids and through a narrow gorge immediately upstream of Tsu Lake (Nende Chute). Tsu Lake receives additional runoff from the Konth River that drains from the northeast. Downstream of Tsu Lake, the Taltson River flows a final 132 km to Great Slave Lake. The Rutledge and Tethul River sub-watersheds drain to the Taltson River, and the main river also passes through Deskenatlata Lake within this reach.

Additional description of the Taltson River Basin is provided in Section 6.1.

9.3.2 Summary of Historic Hydrometric Data

Water Survey of Canada (WSC) has historically operated a total of eight gauging stations within the Taltson River system (Table 9.3.2, Figure 9.3.1). Two of the eight stations are currently active; 07QD002 Nonacho Lake near Łutsel K'e (water level) and 07QD007 Taltson River below Hydro Dam (flow). In addition, only two of the eight historically operated stations have long-term (>25 years) records; 07QD002 Nonacho Lake near Łutsel K'e and 07QA001 Taltson River at Outlet of Tsu Lake (flow).

In June 2007, WSC was contracted by Dezé to re-install station 07QD004 Taltson River above Porter Lake Outflow, which had been deactivated in 1990, and to install a new station on the lowest reach of the Tazin River above the Taltson mainstem (07QC007 Tazin River near the Mouth). Although both of these stations are currently active, flow data were not available. However, data from these stations will be extremely valuable for ongoing monitoring throughout the life of the Project and will be incorporated into future Project studies related to the hydrologic environment.

Table 9.3.2 — Water Survey Canada Hydrometric Stations on the Taltson River System

Station ID	Station Name	Latitude Longitude	Period of Record	Watershed Area (km^2)	Comments
07QA001	Taltson River at Outlet of Tsu Lake	60°28′1″ N 111°30′46″ W	1952 to 1997	49,300[1]	No data available 1955 to 1961
07QC003	Thoa River near Inlet to Hill island Lake	60°30′18″ N 109°38′56″ W	1968 to 1995	8,830	On Thoa River upstream of Hill Island Lake and Tazin River
07QD002	Nonacho Lake near Łutsel K'e	61°43′50″ N 109°40′15″ W	1962 to present	n/a	Water level gauge only
07QD003	Taltson River near Outlet of Nonacho Lake	61°39′36″ N 109°58′7″ W	1975 to 1977	22,600	WSC considers records to be poor
07QD004	Taltson River above Porter Lake Outflow	61°52′32″ N 107°40′12″ W	1977 to 1990; 2007 to present	9,660	WSC considers records to be good
07QD005	Porter Lake Outflow above Taltson River	61°53′0″ N 107°41′50″ W	1971 to 1981	2,060	Intermittent measurements on tributary to Taltson River
7QD006	Porter Lake Outflow	61°48′57″ N 107°52′11″ W	1983 to 1990	2,060	Tributary to Taltson River
07QD007	Taltson River below Hydro Dam	60°28′1″ N 111°30′46″ W	1995 to present	56,500	Reliable data and current data collection

Station ID	Station Name	Latitude Longitude	Period of Record	Watershed Area (km^2)	Comments
07QC007	Tazin River near the Mouth	60°24′31″ N 110°39′52″ W	2007 to present	17,400[1]	Early phases of data development, data considered reasonable.

[1] Area not available from WSC, value estimated accounts for the diversion of 95% of the Tazin watershed upstream of Tazin Lake out of the watershed.

The longest flow data sets in the Taltson Basin include 07QA001 Taltson River at Outlet of Tsu Lake, 07QC003 Thoa River near Inlet to Hill Island Lake, 07QD004 Taltson River above Porter Lake Outflow, and 07QD007 Taltson River below Hydro Dam. The Tsu Lake gauge was replaced by WSC in 1994 with the currently operated gauge downstream of Elsie Falls (07DQ007). Both of the gauges were in operation from April 1995 to September 1997 to provide an overlap to allow comparison (Figure 9.3.2). As these records show good comparative consistency, the new gauge data has been used in conjunction with the Tsu Lake record, with a combined period of 45 years (1962 to 2007), to form a robust data set below the Twin Gorges facility. Due to its long record and location just downstream of the Project area, hydrometric data from the Taltson River below Twin Gorges provides the primary data set used to summarize the existing and past hydrologic regimes of the Taltson Basin. The available WSC records from the Taltson River above Porter Lake Outflow and the Thoa River near the Inlet to Hill Island Lake were also considered.

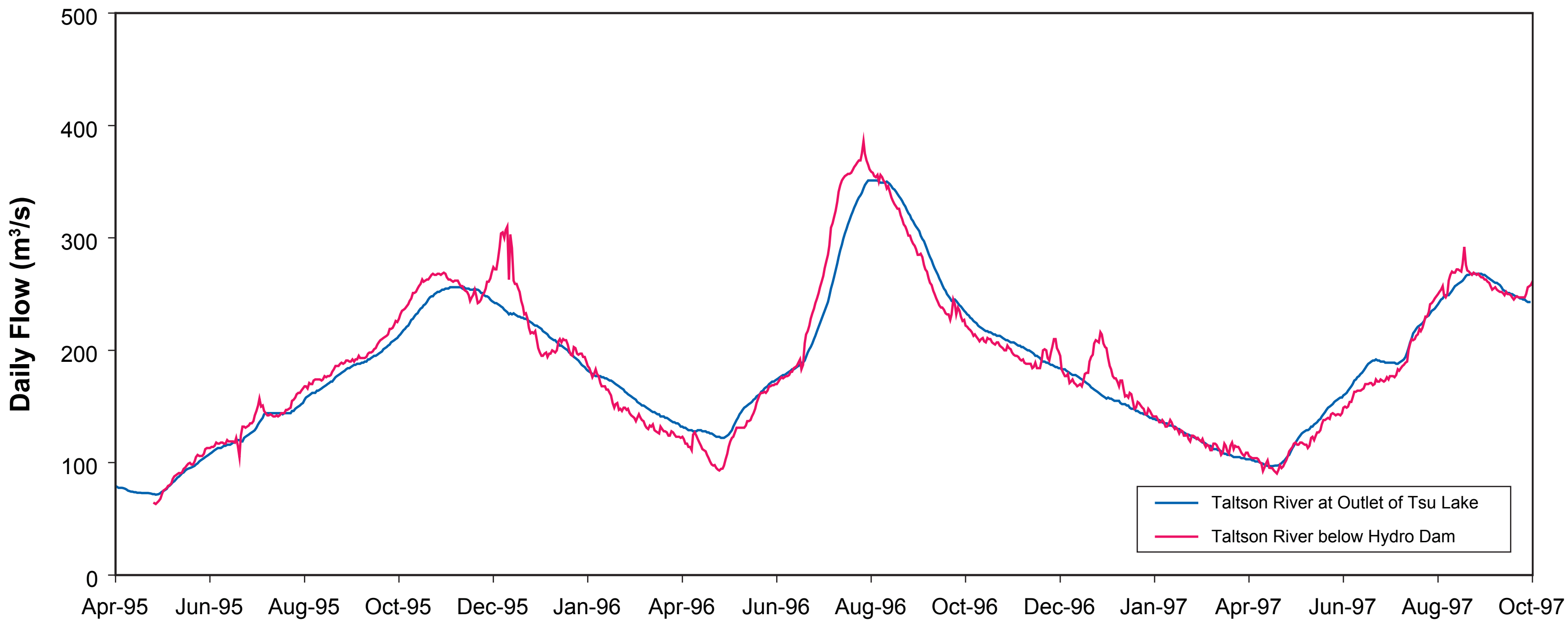
In the following sections, the hydrology of the Taltson Basin will be discussed in terms of annual runoff, monthly distribution of flow, and peak flows.

9.3.2.1 ANNUAL RUNOFF

Annual runoff is a measure of the total hydrological response of a watershed and can be presented as runoff depth, runoff volume or as an annual flow (average flow over the entire year). In this section, annual flow will be used to represent annual runoff.

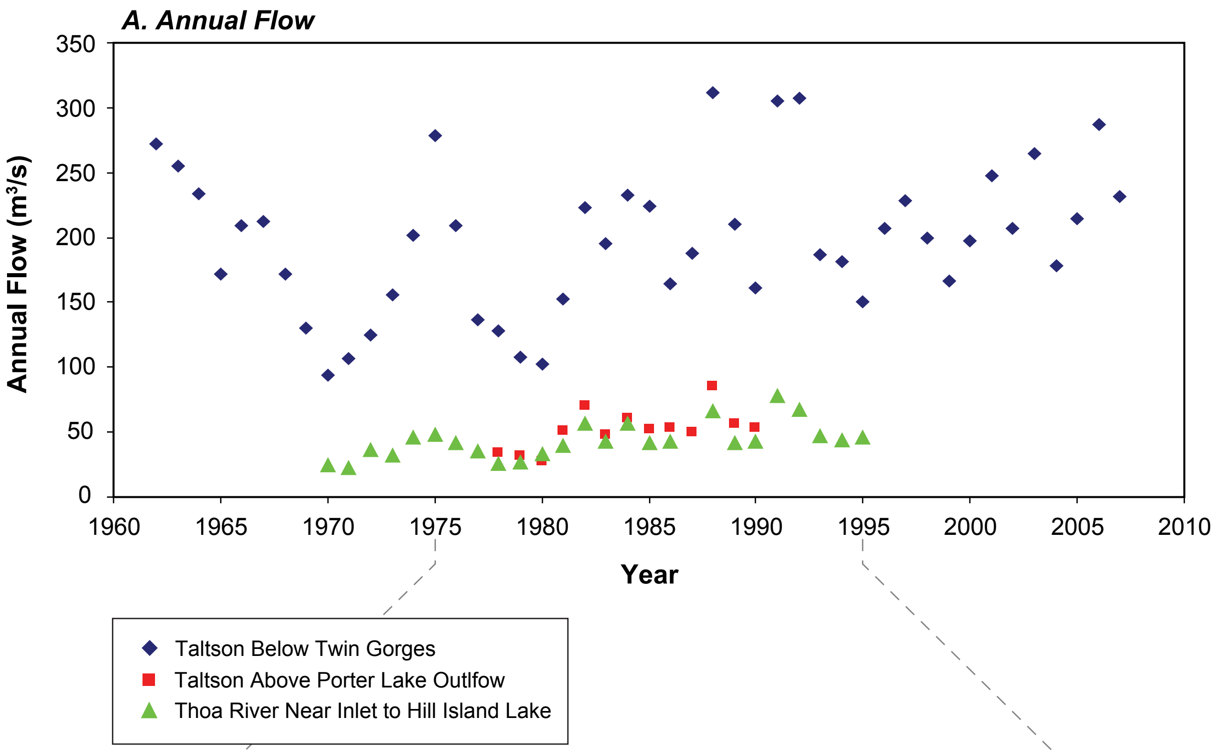
9.3.2.1.1 Mean Annual Flow

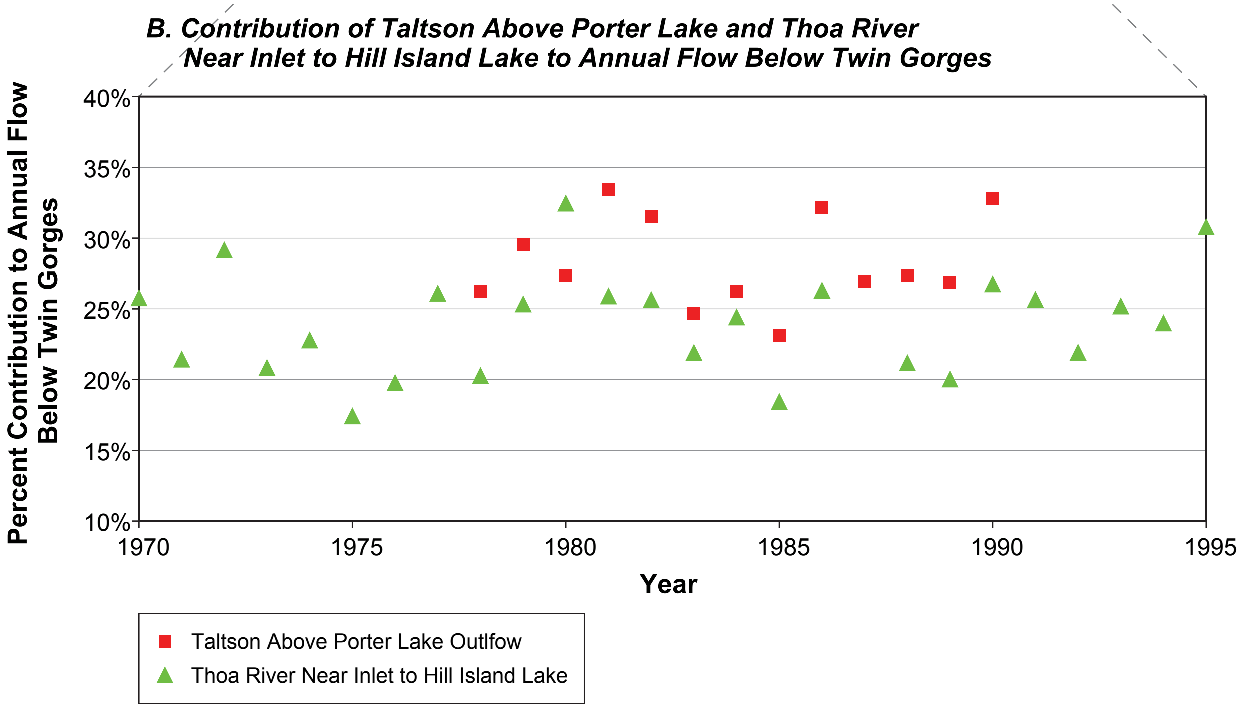
The annual flow in the Taltson Basin for the three main gauging sites over their respective record periods is shown in Figure 9.3.3a. The mean annual flow for the key gauging sites is 196, 52, and 43 m^3/s for the Taltson below Twin Gorges, Taltson above Porter Lake, and Thoa River respectively. Over the concurrent period of records, the Taltson River above Porter Lake accounted for 28% of the flow below Twin Gorges, on average, while the Thoa River contributed 24% on average (Figure 9.3.3b). The percent contribution of annual flow from the two upstream catchments to flow below Twin Gorges (based on the watershed area at the outlet of Tsu Lake) does vary from year to year and in some cases (e.g., 1980) the Thoa River contributes more to the mean flow below Twin Gorges than the Taltson River above Porter Lake does. However, generally the contribution of annual flow from the upstream catchments to annual flow below Twin Gorges is consistent with the contribution of the total watershed area below Twin Gorges by the two upstream gauged catchments. The Taltson River above Porter Lake catchment accounts for 20% of the Taltson River below Twin Gorges and the Thoa River near Hill Island Lake catchment accounts for 18%.



TALTSON Hydroelectric Expansion Project	Developer's Assessment Report 2009	Comparison of Concurrent Flow Data for WSC Stations at the Outlet of Tsu Lake (07QC003) and Downstream of Elsie Falls (07QD007) (503-005 / a21371m)	Figure 9.3.2

Dezé energy





TALTSON Hydroelectric Expansion Project	Developer's Assessment Report 2009	Annual Flow of the Taltson River Below Twin Gorges, Taltson River Above Porter Lake, and Thoa River Near Inlet to Hill Island Lake (503-005 / a21372m)	Figure 9.3.3

9.3.2.1.2 Return Period Annual Flow

Assuming a normal distribution, return period wet and dry estimates of annual flow for the Taltson River below Twin Gorges are summarized in Table 9.3.3. Due to their shorter periods of record, return period annual flows were not estimated for the Taltson River above Porter Lake nor the Thoa River near Hill Island Lake data sets.

Table 9.3.3 — Return Period Annual Flow for the Taltson River below Twin Gorges

Condition	Return Period (years)	Estimated Annual Flow (m^3/s)
Dry	100	70
Dry	50	80
Dry	25	100
Dry	10	130
Dry	5	150
Normal	2	200
Wet	5	250
Wet	10	270
Wet	25	300
Wet	50	310
Wet	100	330

The lowest annual flow on record occurred in 1970 (90 m^3/s), while the highest annual flow on record occurred in 1988 (312 m^3/s). These two years are estimated to be approximately a 1 in 30 year dry year and 1 in 55 year wet year, respectively.

9.3.2.2 Monthly Runoff Distribution

The average monthly flow distribution for a watershed (the per cent of the annual flow that occurs during each month) provides an indication of the seasonal variation in runoff from that watershed. In northern climates, the distribution of flow throughout the year in unregulated watersheds is strongly influenced by the annual temperature regime and specifically the occurrence of warming temperatures in the spring that drive the spring freshet. In regulated watersheds, the distribution of flow throughout the year can be substantially altered due to operations of water users.

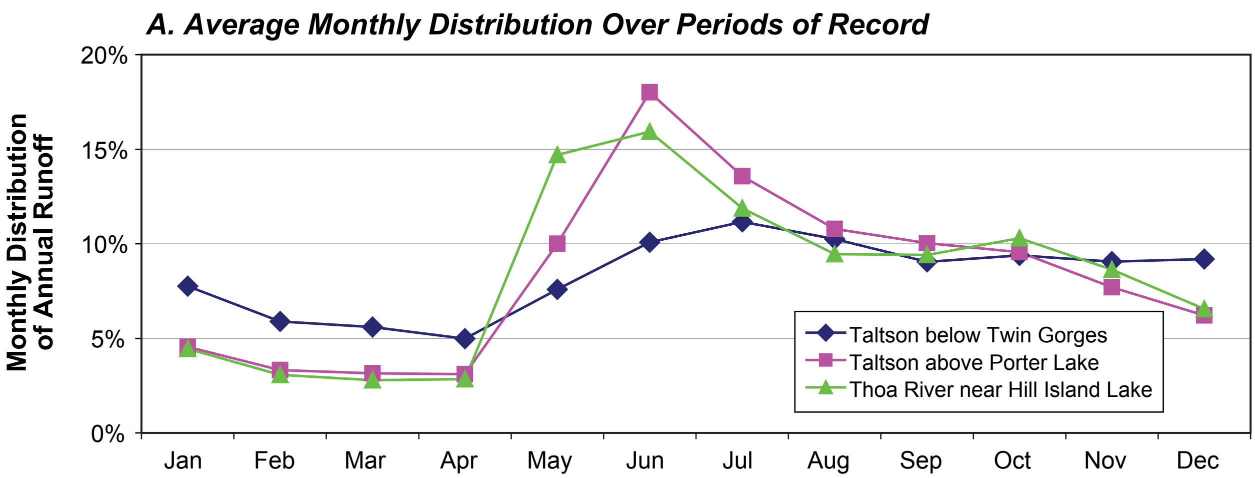
The Taltson River below Twin Gorges has been a regulated system since the construction of the original Twin Gorges facility and the Nonacho Dam in 1965 and 1968, respectively. On the other hand, the Taltson River above Porter Lake and the Thoa River near Hill Island Lake are both unregulated watersheds.

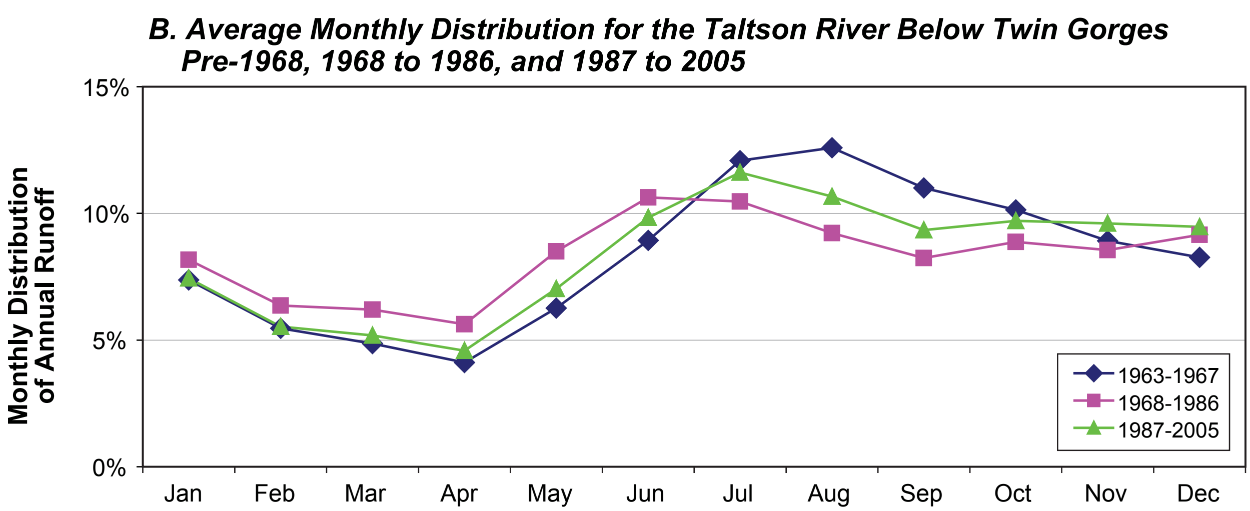
The average monthly distribution of runoff in the Taltson Basin for the three main gauging sites over their respective record periods is shown in Figure 9.3.4a. It must be noted that the averages for the three sites are based on varying lengths of records. Therefore, some caution should be used when comparing the results between sites as differences may be due to the period of record rather than actual average hydrologic regime. Nevertheless, the record period for each site was considered sufficiently long to allow for some comment on the average conditions within the Taltson River basin.

In the upper catchments of the Taltson River (Taltson above Porter Lake and Thoa River near Hill Island Lake), the freshet period generally persists from May to August. On average, summer and fall flows (August, September, and October) remain at a moderate level before steadily declining through the winter which normally extends through April. A similar distribution of annual runoff is observed in the Taltson below Twin Gorges. However, at this downstream location, the rising limb of the freshet extends for a longer period, resulting in peak monthly flows generally delayed by a month compared to the upstream catchments. In addition, in the Taltson below Twin Gorges, the distribution of flow is more consistent throughout the year, with freshet flows accounting for less of the annual runoff, and winter flows accounting for more in relation to the Taltson above Porter Lake and Thoa River near Hill Island Lake. This is consistent with the distance and substantial storage features (i.e., lakes and wetlands) between the upstream catchments and the Taltson River below Twin Gorges. For a watershed the size of the Taltson River basin (~50,000 km^2), there is a substantial lag time for runoff occurring in the upper reaches of the basin to arrive at downstream reaches, which would delay the occurrence of maximum flows at more downstream locations. Additionally, the numerous lakes within the Taltson River basin store a portion of any upstream runoff and release the stored water over a prolonged period. The two largest lakes within the Taltson system (Nonacho Lake and Hill Island Lake) are located between the upstream gauged catchments and Twin Gorges, which contributes to relatively consistent distribution of flow throughout the year in the Taltson below Twin Gorges.

The natural storage function of Nonacho Lake has been enhanced by the construction of the Nonacho Dam and associated control structures. From 1968 the Nonacho Dam has had the potential to operate such that more of the freshet can be stored in the lake than would naturally occur, which could be then be released over a greater period of time than would naturally occur. As a result of the existing power development and the historic modes of operation, it is useful to consider monthly distribution of flow in the Taltson below Twin Gorges over three time periods (Figure 9.3.4b):

- Pre-1968, when the existing dams at Twin Gorges and Nonacho Lake were completed, altering natural flows downstream of Nonacho Lake and in Trudel Creek,
- 1968 to 1986, when Taltson Twin Gorges was operating at capacity and providing power to the Pine Point Mine, and
- 1987 to present, after the closure of the Pine Point Mine, when power demands from Taltson Twin Gorges were significantly lessened.





TALTSON Hydroelectric Expansion Project	**Developer's Assessment Report 2009**	**Monthly Runoff Distribution of the Taltson River Below Twin Gorges, Taltson River Above Porter Lake, and Thoa River Near Inlet to Hill Island Lake** (503-005 / a21373m)	**Figure 9.3.4**

When comparing the average distribution between these three periods, it must be noted that the available record sets for the periods are of varying lengths. Therefore, some caution should be used when comparing the results between sites as differences may be due to the period of record rather than actual average hydrologic regime. The pre-1968 period in particular should be viewed with caution as the record is limited to five complete years.

In relation to the two later periods, the pre-1968 monthly distribution displayed a greater percentage of flow during the freshet and lower percentage of flows during the winter, similar to the unregulated distributions of the Taltson River above Porter Lake and the Thoa River near Hill Island. Of the three periods, the 1968 to 1986 period had on average the least percentage flow during the freshet and greatest percentage of flow during the winter. This is consistent with the operations of Nonacho Dam during this time, which limited outflow from the reservoir during the freshet and distributed it throughout the remainder of the year to augment lower summer, fall, and winter flows from the unregulated portions of the watershed.

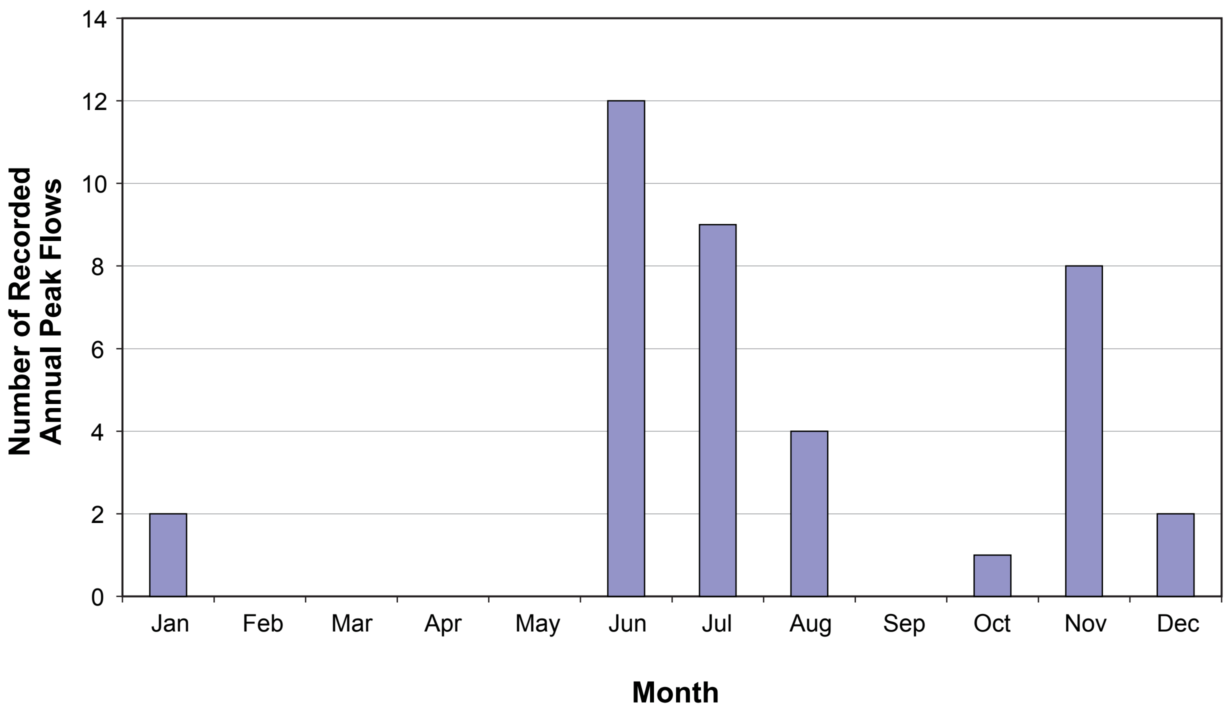
9.3.2.3 PEAK FLOWS

Peak annual flows in the Arctic are typically produced during the spring freshet period due to rapid melting of the snow pack. The magnitude of the peak freshet flows are controlled by the depth of the accumulated snow pack, conditions controlling the rate of the snow melt (i.e., temperature and sunlight), and storage deficits of the watershed storage elements (i.e., lake and wetland levels).

Late fall runoff events can occur as a result of fall rainfall events, which can also result in annual peak flows. However, these events are less frequent and generally have lower magnitude than freshet peak flow events.

For the Taltson River below Twin Gorges, the peak annual flow usually occurs in June or July, although annual peak flows have been recorded later in the summer and over the winter (Figure 9.3.5).

Over its record period, peak flows of the Taltson River below Twin Gorges have ranged from 151 m^3/s to 543 m^3/s in 1980 and 1988, respectively (Table 9.3.4). Return period estimates of the peak annual flow can be estimated by assuming the annual flows follow some form of extreme value probability distribution. Fitting the available date set to a *Log Pearson Type III* distribution provides return period flood estimates as summarized in Table 9.3.5.



TALTSON Hydroelectric Expansion Project	Developer's Assessment Report 2009	Timing of Annual Peak Flow Events in the Taltson River Below Twin Gorges (503-005 / a21374m)	Figure 9.3.5

Table 9.3.4 — Observed Annual Peak Flows for the Taltson River below Twin Gorges

Year	Annual Peak[1] (m^3/s)	Year	Annual Peak[1] (m^3/s)	Year	Annual Peak[1] (m^3/s)
1964	413	1978	187	1991	521
1965	362	1979	165	1992	514
1966	326	1980	151	1993	230
1967	340	1981	228	1994	329
1969	264	1982	409	1995	256
1970	156	1983	271	1996	351
1971	154	1984	340	2000	346
1972	204	1985	431	2001	446
1973	218	1986	221	2002	312
1974	311	1987	257	2003	530
1975	479	1988	543	2004	317
1976	368	1989	392	2006	487
1977	198	1990	215	2007	370

[1] Values listed in table are daily peak flows. From the available data instantaneous peak flows are on average 2% greater than daily peak flows.

Table 9.3.5 — Return Period Annual Peak Flows for the Taltson River below Twin Gorges

Return Period (years)	Annual Peak Flow (m^3/s)
2	320
5	420
10	470
20	510
50	550
100	580
200	600
500	620

9.3.3 Taltson Basin Flow Model

The WSC stations operating within the Taltson River Basin provide extremely valuable data for describing long-term hydrologic conditions at specific gauging locations. However, to facilitate an assessment of the Expansion Project on the hydrology of the Taltson River basin, it is desirable to understand the hydrologic conditions throughout the watershed and to be able to project changes in the hydrology under operations of the Expansion Project. To this end, the Dezé Energy Corporation initiated and supported the creation of the Taltson Basin Flow Model (Flow Model).

The Flow Model was initially developed in 2006. While ultimately it is anticipated that the model will become quite sophisticated and embody most of the operating strategy for the Project, the specific roles the model currently plays are:

- To provide an estimate of the current (i.e., baseline) hydrologic conditions throughout the main-stem of the Taltson River from Nonacho Lake to Great Slave Lake, including Trudel Creek, and
- To assess larger-scale changes in timing and characteristics of flow conditions, and lake and river levels throughout the basin sub-zones that would be influenced by the construction and operation of the Expansion Project.

Though utilizing the same baseline data set to construct basin hydrological inputs, the Flow Model is separate from the power generation model described in Section 6.1. The following sections outline the Flow Model set-up and describe the simulated baseline conditions for the Taltson River and Trudel Creek. Simulated conditions under the Expansion Project are described in Sections 13.3 and 14.3.

9.3.3.1 General Model Description and Methodology

A complete description of the model can be found in Appendix 9.3A.

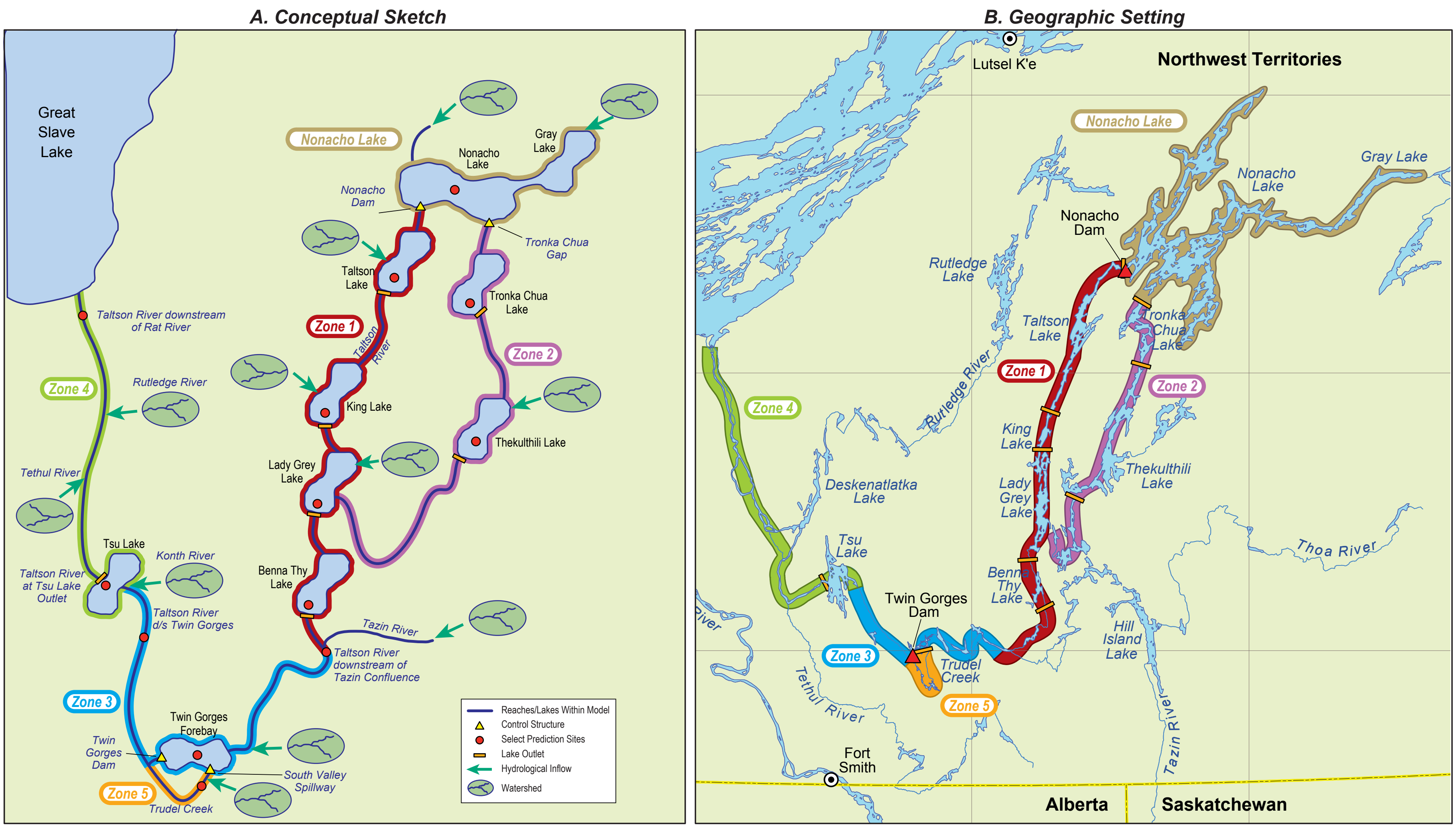
The Flow Model was created using HEC-ResSim software (version 3.0). This software was developed by the US Army Corps of Engineers (USACE) to assist planners and engineers in predicting the response of reservoir systems to changes in management. The software allows for the modelling of complex operations, including the simulation of hydropower generation and their effects on downstream flow conditions.

The model encompasses the Taltson River from Nonacho Lake to Great Slave Lake and includes representations of the major lake and river reaches within the study area. Sub-watersheds upstream of Nonacho Lake are considered only as hydrological inputs to the model. Similarly, major tributaries of the Taltson River including the Tazin, Konth, Tethul, and Rutledge Rivers are also represented only as hydrological inputs.

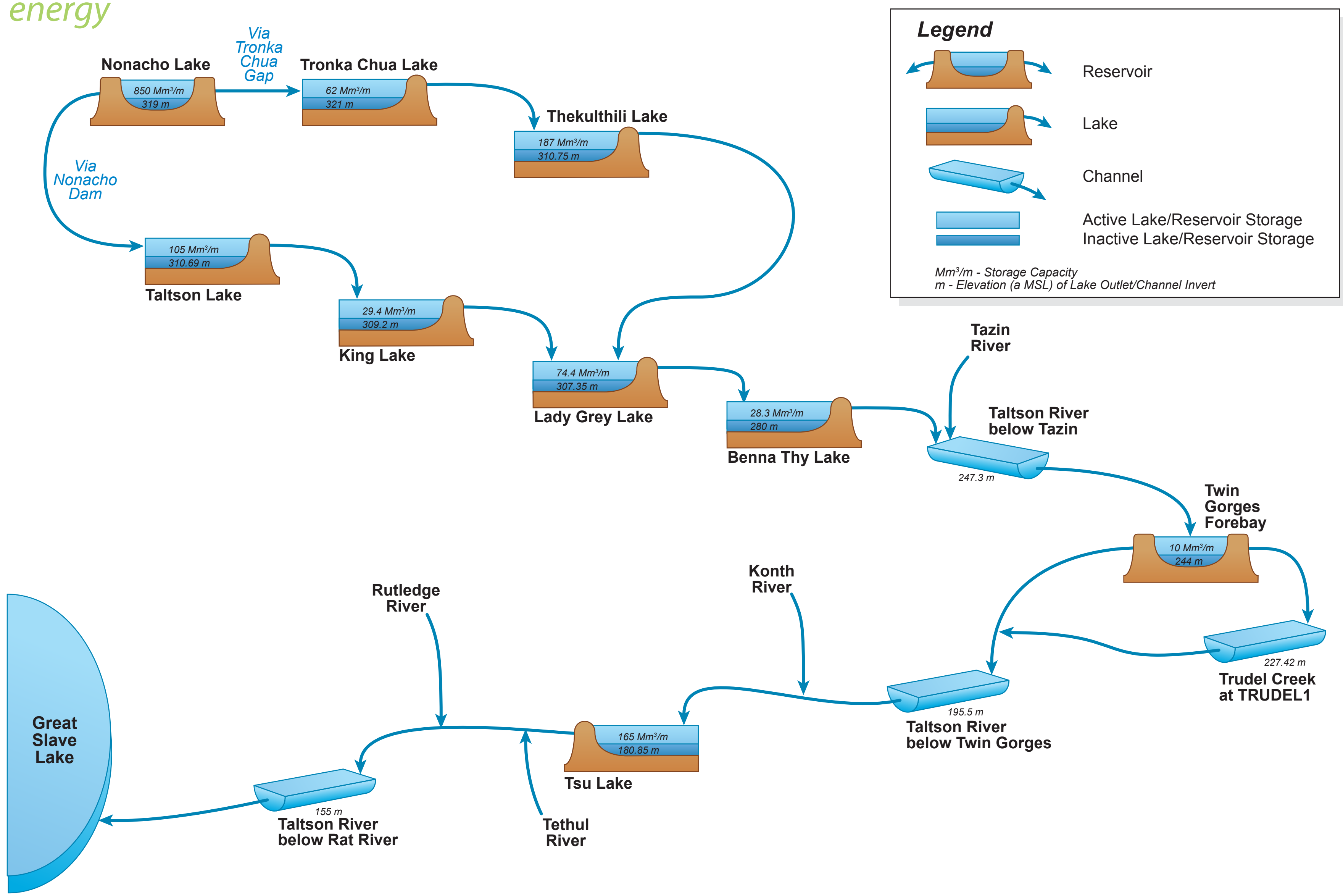
The following sections describe key features of the Flow Model including modelling zones, hydrological inflows, approach to flow routing, approach for estimating water levels, and the approach to modelling outflows from Nonacho Lake and the Twin Gorges Forebay.

9.3.3.1.1 Model Zones

To facilitate an environmental effects assessment, the Taltson River system has been divided into a number of zones within the model. The model representation of each zone is outlined in Table 9.3.6. In addition, schematics of the modelled system are illustrated in Figures 9.3.6 and 9.3.7. These figures indicate the location of key model components such as hydrological inflows, control structures and lake outlets.



TALTSON HYDROELECTRIC EXPANSION PROJECT	**Developer's Assessment Report** **2009**	**Planar Schematic and Geographic Setting of the Taltson Basin Flow Model**	**Figure** **9.3.6**



TALTSON
Hydroelectric Expansion Project

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2009

Taltson Basin Flow Model
Schematic - Longitudinal Profile

(503-005 / a22380w)

Figure 9.3.7

Table 9.3.6 — Approach to Modelling Assessment Zones

Zone	Modelling Approach	
Nonacho Lake Zone: Nonacho Lake	Hydrological Inflows	Hydrological Inflows modelled: Taltson River watershed upstream of Nonacho Lake
	Outflow from Nonacho Lake	Model represents flow over the spillway to the Taltson River, through underflow gates, seepage through the dam, and flow over the Tronka Chua Gap
	Lake Routing	Flow is routed through Nonacho Lake based on rating curves for each outlet and specified operations of the underflow gates
Zone 1: Nonacho Lake to Tazin River to confluence on Taltson River	Hydrological Inflows	Hydrological Inflows modelled: Local inflows to Taltson Lake, King Lake, Lady Grey Lake, and Benna Thy Lake
	Outflow from Nonacho Lake	Flow over the spillway, through underflow gates, and water seeping through the dam enters the upstream end of Zone 1
	Lake and River Routing	Linear reservoir routing is provided for: Taltson Lake, King Lake and Benna Thy Lake
Zone 2: Tronka Chua Gap to Lady Grey Lake	Hydrological Inflows	Hydrological Inflows modelled: Local inflows to Tronka Chua Lake and Thekulthili Lake
	Outflow from Nonacho Lake	Flow over the Tronka Chua Gap discharges into the upstream end of Zone 2
	Lake and River Routing	Linear reservoir routing is provided for: Tronka Chua Lake and Thekulthili Lake
Zone 3: Tazin River confluence to Tsu Lake outfall	Hydrological Inflows	Hydrological inflows modelled: Tazin River at confluence with Taltson River Konth River just upstream of Tsu Lake Local inflow to Twin Gorges Forebay and Tsu Lake
	Outflow from Twin Gorges Forebay	Model represents flow over the SVS and through power plant
	Lake and River Routing	Linear reservoir routing is provided for Tsu Lake Muskingum routing for river reaches between lakes
Zone 4: Tsu Lake outfall to Great Slave Lake	Hydrological Inflows	Hydrological inflows modelled: Tethul River and Rutledge River
	Lake and River Routing	Muskingum routing for river reaches between Tsu Lake and Great Slave Lake
Zone 5: Trudel Creek	Hydrological Inflows	Hydrological inflows modelled: Local inflow to Trudel Creek
	Outflow from Twin Gorges Forebay	Discharge over the SVS enters the upstream end of Zone 5
	River Routing	Flow through Trudel Creek is routed using the Muskingum method

9.3.3.1.2 Flow Routing

The Flow Model is primarily a routing model, simulating the movement of water through the Taltson River, which enters the system as specified inflow hydrographs. The hydraulics of the Taltson River are controlled primarily by the storage of water within a series of many lakes. Within the model, a number of the key large lakes within the river system are modelled as linear reservoirs (described by a modified Puls routing equation). Each lake is represented by a set of relationships between the lake level (masl), the active storage volume at that lake level (m^3), and the outflow rate from the lake at that lake level (m^3/s). Lake outlet rating curves were generated within HEC-RAS (a one-dimensional hydraulic model developed by the USACE) using representations of the cross-sectional geometry provided by Envirocon (1986). The rating curves were calibrated using manual flow measurements conducted in 2003, 2006, and 2007. Lake surface areas were determined using 1:250,000 NTS map data and calculating the areas using GIS software. Storage volume curves are developed assuming constant surface area with rising elevation.

For sections of the study area that are less influenced by lake storage, the model uses a Muskingum river routing approach. This approach was used for the Taltson River between the Tazin River confluence and Twin Gorges, between Twin Gorges and Tsu Lake, and downstream of Tsu Lake to Great Slave Lake. Muskingum routing was also used for Trudel Creek. Muskingum routing is a simple method of river routing and requires the specification of two parameters: K (hours) that represents the delay in the hydrograph within the river reach; and X (dimensionless) that represents the degree of attenuation within the reach (see Chow 1981 or standard hydraulics textbook for more details). The delay, K, in the hydrograph was estimated using field observations of cross-section velocities and calculated reach lengths. The degree of attenuation, X, was set as 0.5, which results in no attenuation of flows within the reach.

9.3.3.1.3 Estimating Water Levels

The Flow Model calculates the change in flow rates throughout the model study area. In order to predict water level changes at any location, a rating equation needs to be defined specific to that location.

For lakes, rating equations are provided for the outlet of each lake. Based on the simulated outflow, the resulting stage is assumed to represent the level of the entire lake surface area. The lake outlet rating equations were developed based on HEC-RAS models of the assumed geometry of each lake outlet calibrated using flow measurements conducted in 2003, 2006, and 2007.

For river sections, rating equations were either developed within a HEC-RAS developed for Trudel Creek (for Trudel Creek at TRUDEL1, see Section 14.3 — Trudel Creek Alteration to Water Quantity) or by fitting a power curve to flow measurements conducted in the field in 2003, 2006, and 2007 (for the Taltson River downstream of the Tazin River and downstream of Twin Gorges) (Rescan 2003, 2006b, and 2007).

A complete presentation of the rating equations used for modelling is found in Appendix 9.3A.

9.3.3.1.4 Modelling Reservoirs

Within the Flow Model, reservoirs are represented differently from natural lakes in that there are many options to simulate and control flow and levels within reservoirs. The Twin Gorges Forebay and Nonacho Lake are both represented as reservoirs within the model.

9.3.3.1.4.1 Twin Gorges Forebay

Flows can exit the Twin Gorges Forebay through the generating station and over the SVS to Trudel Creek. Flows through the proposed power plant were estimated based on water levels within the Forebay, physical parameters of the power plant (capacity, plant head, efficiency, etc.) and a power demand curve. Flows over the SVS were determined using a rating equation (obtained from the Dezé Energy Corporation Ltd.) developed assuming that flow over the spillway could be approximated by a weir equation (Appendix 9.3A).

The existing power plant was modelled with an 18 MW maximum capacity, and 74 m^3/s maximum flow-through. The plant head is 30.8 m, and plant efficiency is 80.5%.

Operation of the Forebay can be controlled to meet specified releases or water levels. Specific operations for the calibration and baseline scenarios modelled within the Flow Model are discussed in Section below. Specific operations for the expansion scenarios are discussed in Section 13.3 Taltson Basin Effects to Water Quantity.

9.3.3.1.4.2 Nonacho Lake

Within the Flow Model, outflow from Nonacho Lake is controlled by water level within the lake, rating equations for each of the reservoir outlets, and operational constraints set up for the controlled releases from the reservoir.

Currently there are four outlets in Nonacho Lake, which include the Nonacho Dam control structure and spillway, seepage through the dam, and uncontrolled flow over the natural topographic saddle at Tronka Chua Gap. Each outlet is represented by separate rating curves that relate the water level within the lake to flow rates at each of the outlets. Releases through the Nonacho Dam control structure are further controlled by operational specifications.

Operation of the Nonacho Lake control structure can be controlled to meet specified releases from, or water levels in, Nonacho Lake. Specific operations for the calibration and baseline scenarios modelled within the Flow Model are discussed in Section 9.3.3.3 below. Specific operations for the expansion scenarios are discussed in Section 13.3 Taltson Basin Effects to Water Quantity. Operational constraints for Nonacho Lake, used for all model scenarios, were based on the water licence, which stipulates a minimum water level for the reservoir of 321.71 masl and a minimum release from Nonacho Lake to Taltson River of 14 m^3/s.

9.3.3.1.5 Hydrological Inflows

The Flow Model is essentially a flow routing model in that it simulates the movement of water through the Taltson River system. The model does not predict runoff generated from precipitation. Therefore, all inflows to the model must be provided. Hydrological inflows for the model are provided for the Taltson Basin upstream of Nonacho Lake and all major lateral inflows from Nonacho Lake to Great Slave Lake (Figure 9.3.6). The lateral inflows include local watersheds entering the Taltson River between Nonacho Lake and Great Slave Lake as well as the Tazin, Tethul, and Rutledge Rivers.

Hydrological inflows are a key component of the model. Thus, it was desired to incorporate as much observed historical data as possible. Historic records from four WSC stations in the Taltson Basin were used to estimate the hydrological inflows to the Flow Model; 07QA001 Taltson River at Outlet of Tsu Lake, 07QC003 Thoa River near Inlet to Hill Island Lake, 07QD002 Nonacho Lake near Łutsel K'e, and 07QD004 Taltson River above Porter Lake Outflow. The longest period of concurrent measurements between the four historical data sets with minimal data gaps extended from 1978 to 1990. Therefore, the period of record was used to generate the hydrological inflows used for all of the operational scenarios simulated by the Basin Model. This includes a calibration scenario, two hypothetical historical scenarios (Pine Point era and current or baseline era), and two hypothetical future expansion scenarios (36 MW and 56 MW expansions of the existing Twin Gorges power facility).

The 13 calendar year period from 1978 through 1990 is considered a representative period of the longer flow data set for the Taltson River below Twin Gorges (Figure 9.3.8). The annual flow for the period from 1978 through 1990 is below the mean annual flow for the longer data set for the Taltson River below Twin Gorges (185 m^3/s compared to 198 m^3/s). However, it is considered to be a good representation of expected hydrological conditions in the basin as it contains the second and fourth lowest annual flows on record (1979 and 1980) as well as the highest annual flow (1988), based on calendar years.

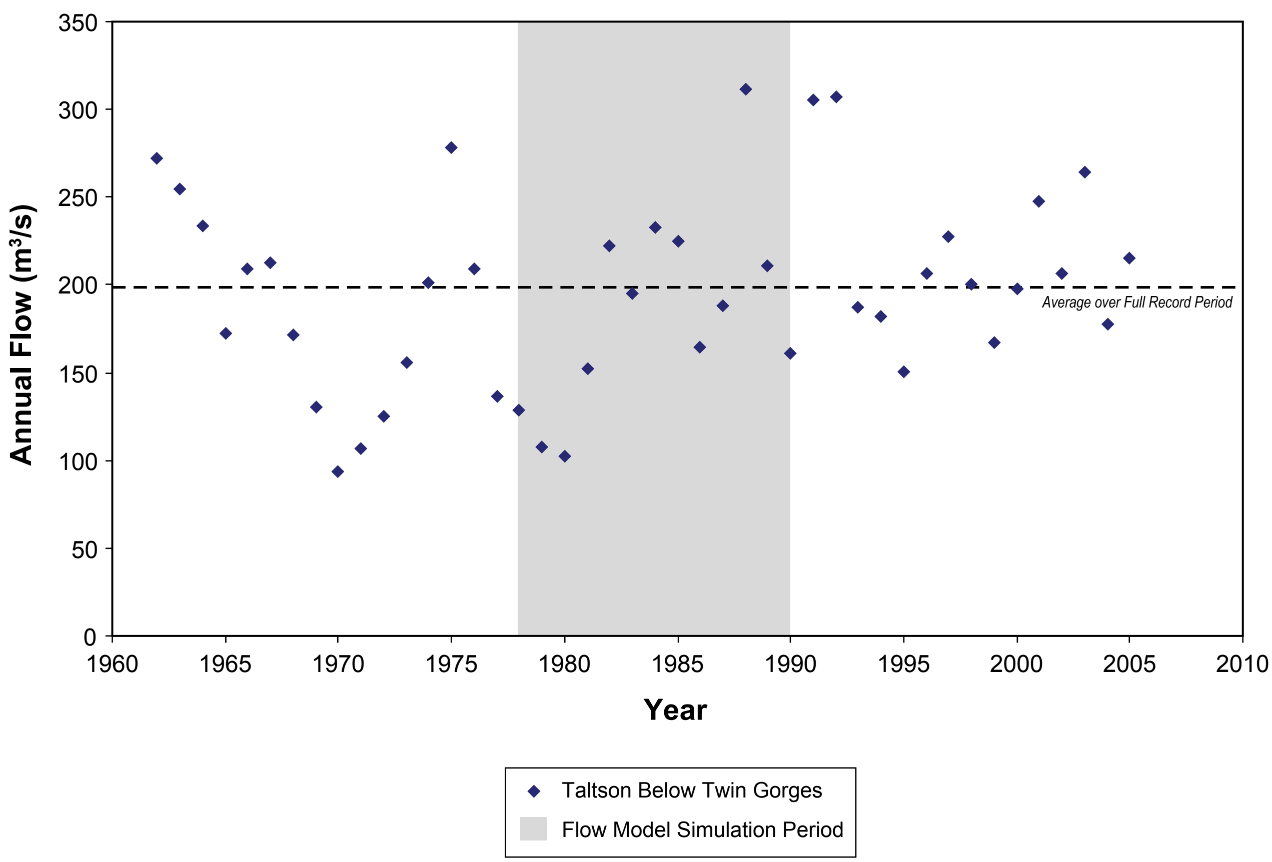
9.3.3.1.5.1 Inflow to Nonacho Lake

Inflows to Nonacho Lake were estimated by performing a back-routing exercise using the available WSC lake level data from the 07QD002 Nonacho Lake near Łutsel K'e station. Daily lake levels were used along with calculated outflow rates from the various Nonacho Lake outlets to estimate what the net inflow into the lake must have been to result in the observed water level.

9.3.3.1.5.2 Lateral Inflow from Ungauged Watersheds downstream of Nonacho Lake

Downstream of Nonacho Lake, inflow hydrographs were estimated for the Tazin, Tethul, and Rutledge Rivers as well as local watersheds between Nonacho Lake and Twin Gorges, and between Twin Gorges and Tsu Lake.

Hydrographs for the Tazin River and the local watersheds between Nonacho Lake and Tsu Lake were estimated using the available WSC data at the Taltson River at Outlet of Tsu Lake and Thoa River near Inlet to Hill Island Lake WSC stations along with simulated outflow from Nonacho Lake. The simulated outflow from Nonacho Lake and observed flows from the Thoa River were routed along the Taltson River within the Flow Model to Tsu Lake. The resulting hydrograph at Tsu Lake was then subtracted from the observed flow record at the outlet of Tsu Lake. This provided residual flows at Tsu Lake that were proportionally distributed to the ungauged portions of the watershed between Nonacho Lake and Tsu Lake based on watershed area.



TALTSON Hydroelectric Expansion Project	**Developer's Assessment Report** **2009**	**Period of Record Used to Develop Hydrological Inflows to the Flow Model Compared to the Long Term Data Set for the Taltson River Below Twin Gorges** (503-005 / a22357f)	**Figure 9.3.8**

To estimate inflow hydrographs for the Tethul and Rutledge Rivers, regression equations were developed using observed WSC data from the stations on the Taltson River above Porter Lake Outflow and the Thoa River near Inlet to Hill Island Lake. Hydrographs for the Tethul and Rutledge Rivers were then scaled based on area from the same WSC records and the regression equations.

For a complete discussion of the hydrological inflows used in the model, refer to Appendix 9.3A.

9.3.3.2 MODEL CALIBRATION

In order to assess the performance of the Flow Model, a calibration exercise was undertaken whereby the model was run for the period of January 1978 through December 1990 and compared to observed data for the same period. To model this period, operations at the Twin Gorges Forebay and the Nonacho Lake control structure were set to represent the actual operating conditions during this time.

Observed data for the flow through the power plant at Twin Gorges was not available for this period. Therefore, it was assumed that the power facility was run at full capacity (18 MW and 74 m^3/s) until the closure of the Pine Point Mine in 1986. Following the closure of the mine, it was assumed that power production decreased and varied throughout the year with 12 MW (50 m^3/s flow through) production during the winter and 8 MW production (30 m^3/s) during the summer.

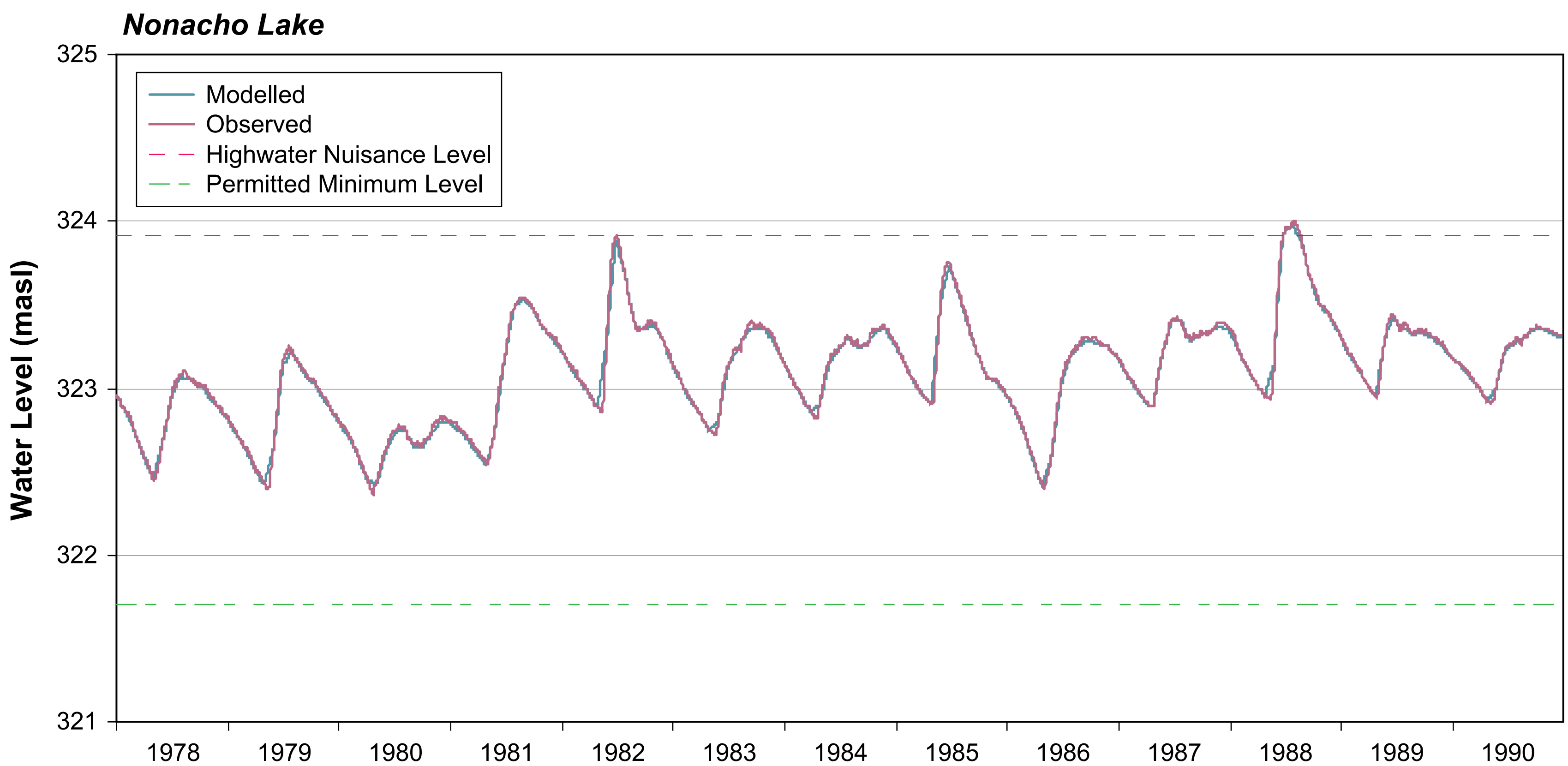
For Nonacho Lake, the record of gate openings at the Nonacho Lake control structure spanning the calibration period (Froelich 1996) was used to specify the capacity that the control structure was operated at.

The available data sets used for comparison are the 07QD002 Nonacho Lake near Łutsel K'e water level data (Figure 9.3.9) at the upstream boundary of the model domain and 07QA001 Taltson River at Outlet of Tsu Lake flow data (Figure 9.3.10) in the lower reaches of the model domain.

The simulated results compare very well to the observed data records. This was expected in both cases as both of the observed data sets were used to produce the input hydrographs for the model (see previous section). The quality of the fit between modelled and observed data indicates that the model is able to represent the large-scale operations of the Nonacho Lake to Twin Gorges system as well as the lag time of flows that leave Nonacho Lake to travel to Tsu Lake. This conclusion is especially strengthened by the quality of fit at the outlet of Tsu Lake, near the downstream boundary of the model domain, which is separated by substantial distances from the location of major model inputs (i.e., upstream of Nonacho Lake at that confluence with the Tazin River).

9.3.3.3 MODELLED HISTORIC AND BASELINE SCENARIOS

The primary purpose for the development of the Flow Model was to predict the alteration in flow and water levels throughout the Taltson Basin as a result of the Expansion Project. To facilitate this, the Flow Model was first used to simulate flows and levels at all sites of interest within the study area under a baseline scenario.



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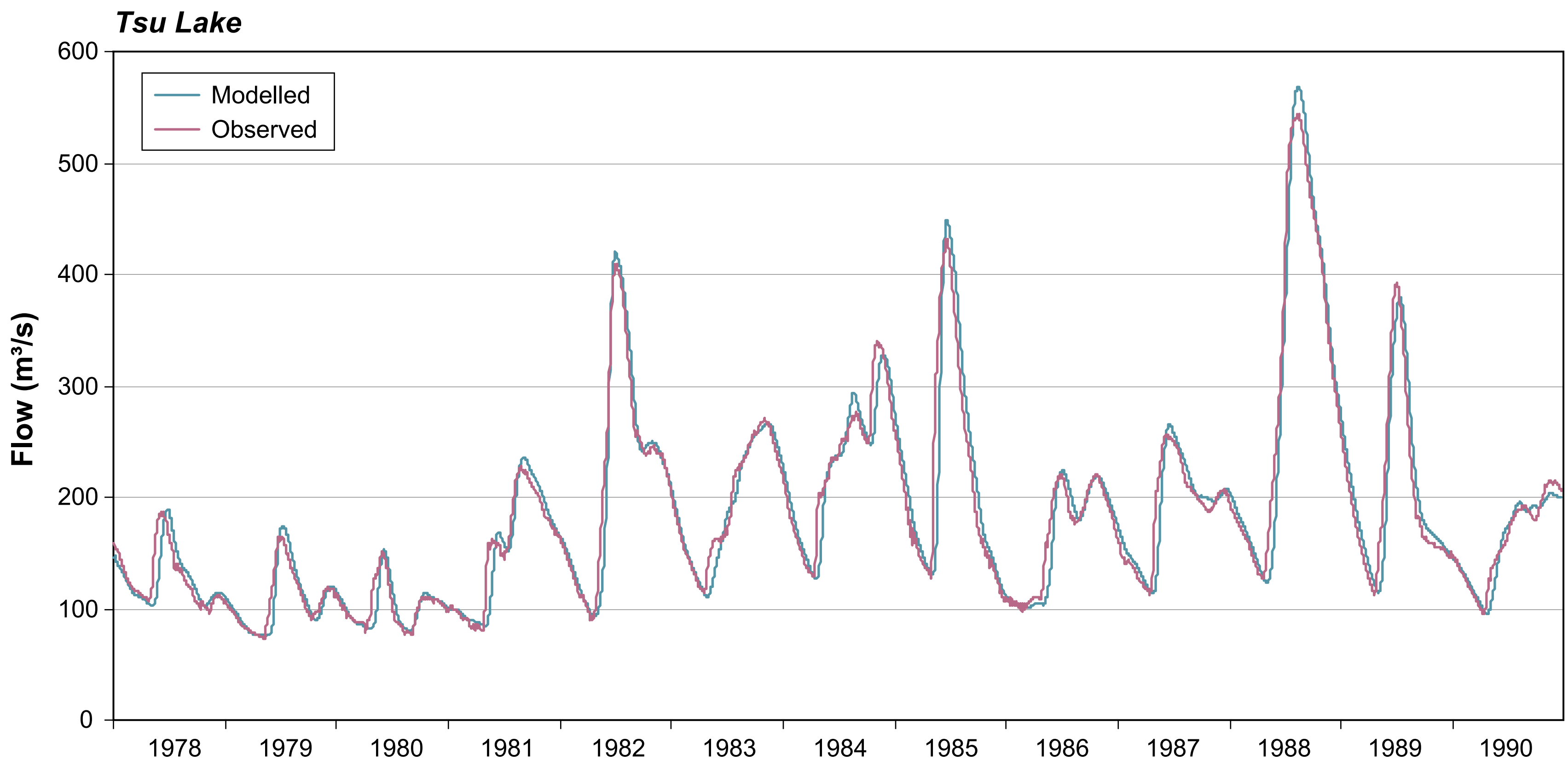
2009

Comparison of Modelled and Observed Water Levels in Nonacho Lake

(503-005 / a22358f)

Figure 9.3.9



TALTSON Hydroelectric Expansion Project	Developer's Assessment Report 2009	Comparison of Modelled and Observed Flow at the Outlet of Tsu Lake (503-005 / a22359f)	Figure 9.3.10

It was desired that the baseline scenario reflect current operations of the Nonacho Lake to Twin Gorges system, which have been relatively consistent since the closure of the Pine Point Mine in 1986. However, the hydrological inputs used to run the model are based on flow records from 1978 through 1990. This period spans two operational eras of the existing Twin Gorges facility. From 1978 to 1986 the existing facility was operated to supply power to the Pine Point Mine. From 1986 to 1990, the facility was operated at a reduced capacity following the closure of the mine and is representative of current operations of the facility. Although operations of the facility during the 1986 to 1990 period were consistent with current operations, the short length of this period (four years) was considered to be too short to form the baseline data set. Therefore, a hypothetical scenario was created using the full 13-ear period that hydrological inputs could be confidently estimated for (1978 through 1990) and assuming that the current operational scheme of the Twin Gorges facility was followed over this period (Table 9.3.7). Results from this hypothetical scenario, representing the current operations of the Twin Gorges facility, were used as the baseline scenario in the Expansion Project effects assessment.

Table 9.3.7 — Summary of Baseline and Historic Model Scenarios

Model Scenario	Period Of Record Used to Estimate Hydrologic Inflows	Operational Scheme Assumed Over the Simulation Period
Calibration	1978 through 1990	Pine Point operations from 1978 to 1986; Current operations from 1986 through 1990
Baseline (Current Era)	1978 through 1990	Current operations from 1978 through 1990
Pine Point Era	1978 through 1990	Pine Point operations from 1978 through 1990

Although not required for the assessment of incremental effects as a result of the Expansion Project, the hydrological regime within the Taltson Basin during operation of the Pine Point Mine was also of interest in relation to the variation in the hydrological regime of the Taltson Basin as a result of human activity over the past several decades. Therefore, in addition to the baseline scenario, which represents current hydrological conditions within the study area, a hypothetical scenario was also simulated to represent the hydrologic regime during the Pine Point era. The Pine Point era scenario was created by applying the same 13-year period of hydrological inputs as that used for the baseline scenario, but assumed that the operational scheme of the Twin Gorges facility during the Pine Point era was followed over this period.

The hydrological regime of the study area prior to the initial construction of the Twin Gorges Facility was not modelled within the Flow Model due to a relative lack of information. However, a separate assessment has been made on flow within Trudel Creek under pre-Project conditions (Rescan 2006a). Results from this assessment are provided for comparative purposes in Section 9.3.3.3.2.6 that presents simulated flows within Trudel Creek under the two historic scenarios within the Flow Model.

The following sections describe the model set-up for the baseline and Pine Point era model scenarios as well as results from the two scenarios for a few key sites of interest. Operations defined for, and results from, the calibration exercise discussed in Section 9.3.3.2 are also presented for comparative purposes.

9.3.3.3.1 Operations for Historic and Baseline Scenarios

To allow prediction of the flows and water levels within the model study area under the baseline and Pine Point era, the operations of the Twin Gorges Forebay and Nonacho Lake reservoir within the Flow Model were altered accordingly. However, all physical characteristics (i.e., storage volumes of lakes and reservoirs, rating curves for lake and reservoir outlets, etc.) of the model were held constant between the two scenarios.

The Flow Model was used to address "normal operations" of the Project only. Outage scenarios which could lead to ramping were not considered. A discussion of outage scenarios is provided in Chapter 6, Project Development (Section 6.6).

9.3.3.3.1.1 Operations of the Twin Gorges Forebay

Water exits the Twin Gorges Forebay either through the hydroelectric facility or over the SVS to Trudel Creek.

The Flow Model simulates flow through the hydroelectric facility based on physical parameters of the facility (i.e., generation capacity, plant efficiency, and head drop); a power demand curve; and water levels in the Forebay.

The power demand curve was altered between the two historic scenarios to represent power demand during operation of the Pine Point Mine and following the closure of the Pine Point Mine. For the Pine Point era scenario, the power demand curve was set to provide a constant power production of 18 MW and 74 m^3/s full generation flow. For the baseline scenario, representing the current era, the power demand curve was set to alternate between power production at 8 MW during the summer and 12 MW during the winter with flow-though of 30 m^3/s and 50 m^3/s, respectively (Table 9.3.8).

9.3.3.3.1.2 Operations at Nonacho Lake

Within the Flow Model, outflow from Nonacho Lake is controlled by water level within the lake, rating equations for each of the reservoir outlets, and operational constraints set up for the controlled releases from the reservoir via the Nonacho Dam control structure.

Currently the Nonacho Dam control structure consists of three identical underflow gates that allow flow to be discharged to the Taltson River. The maximum flow through the three gates is approximately 45 m^3/s to 60 m^3/s depending on water levels in the lake. The gates were constructed to provide some control of flows released to the Twin Gorges Forebay to maximize power production during the Pine Point era. After closure of the Pine Point Mine in 1986, there has been little control of flows through these gates. Typically the gates are opened for a period each year to mitigate rising levels within Nonacho Lake.

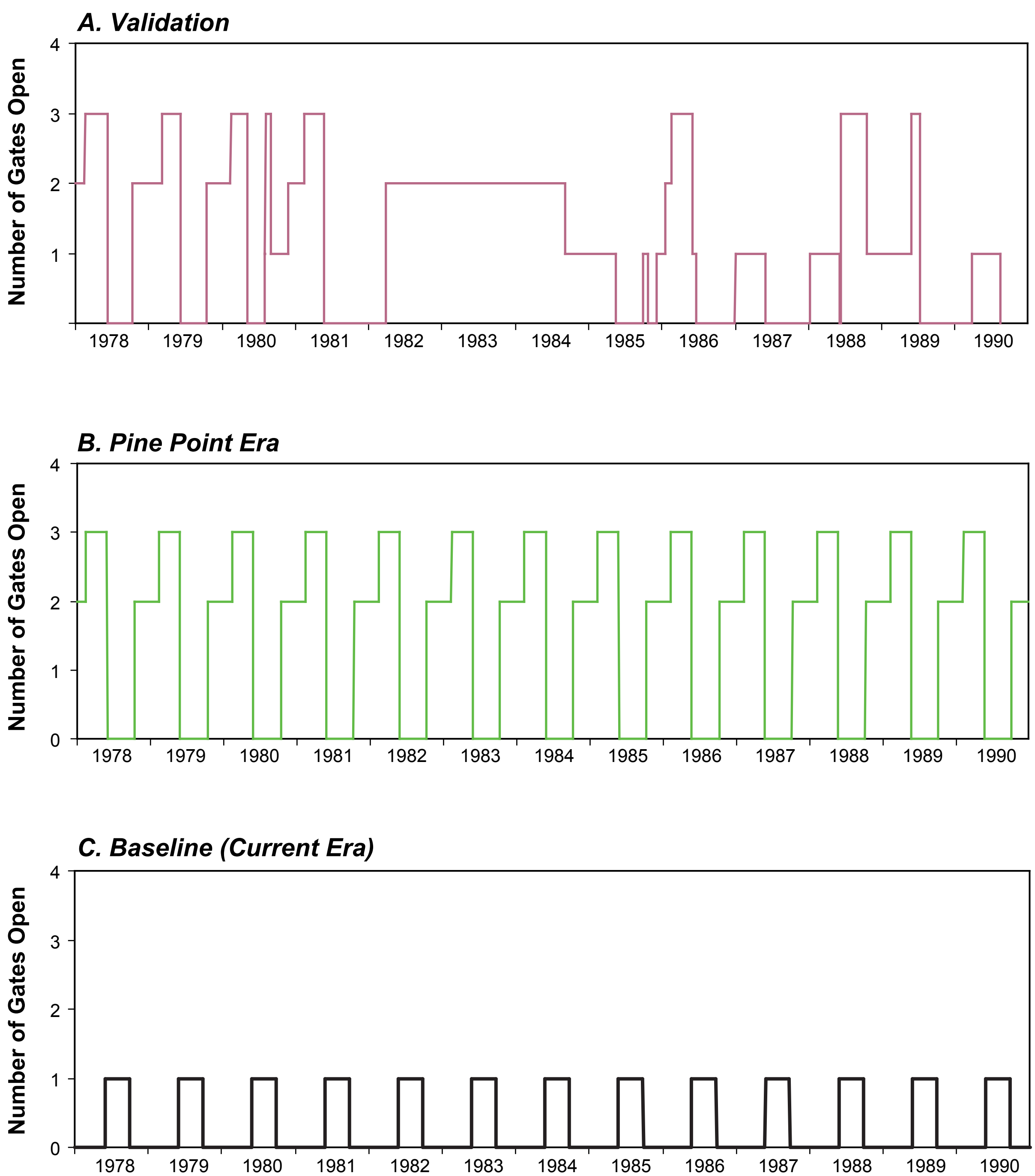
Table 9.3.8 — Power Demand Curve and Flow Through at the Twin Gorges Hydroelectric Facility for Historic Model Scenarios

Month	PINE POINT ERA SCENARIO		BASELINE (CURRENT ERA) SCENARIO	
	Target Power Production (MW)	Target Generation Flow (m^3/s)	Target Power Production (MW)	Target Generation Flow (m^3/s)
January	18	74	12	50
February	18	74	12	50
March	18	74	12	50
April	18	74	12	50
May	18	74	12	50
June	18	74	8	30
July	18	74	8	30
August	18	74	8	30
September	18	74	8	30
October	18	74	12	50
November	18	74	12	50
December	18	74	12	50

For the calibration exercise, a record of gate openings and closures during the period of 1978 through 1990 was available (Froelich 1996) and used within the Flow Model to control flow through the control structure. Although this data set includes recorded gate openings during a portion of both historic scenarios, it was deemed inappropriate to use part of the recorded gate openings in a synthetic record to represent either era for the entire 13-year simulation period. For example, for the Pine Point era scenario, it was deemed inappropriate to use the recorded gate openings from 1978 to 1986 and then to provide assumed gate openings from 1986 to 1990. Rather, an assumed 13-year record of gate openings was provided for each historic scenario that was based on the patterns observed from the Froelich data as well as from anecdotal information from the Dezé Energy Corporation. Although this introduces a known error in the "operational decisions" within the model for both historic scenarios, this error is applied consistently throughout the simulation period rather than for only a portion of each period. Thus, for the Pine Point era scenario, it was assumed that the gates were closed during the freshet period to store some of the freshet within Nonacho Lake and were opened through the winter to augment flow to Twin Gorges (Figure 9.3.11). For the current (or baseline) era, it was assumed that the gates remained closed for the majority of the year, but one gate was opened during the open-water season of June through September to alleviate issues related to high water levels in Nonacho Lake.

9.3.3.3.2 Model Results for Historic and Baseline Scenarios

In the following sections, Flow Model results for the historic Pine Point era scenario and the baseline (current era) scenario are provided at two locations within the model domain for water level, and six locations for flow. The model results from the baseline scenario, which represents current operations of the Twin Gorges facility, are used as the baseline condition for the effects assessment in Chapters 13 and 14.



TALTSON Hydroelectric Expansion Project	Developer's Assessment Report 2009	Gate Openings of the Nonacho Dam Control Structure used for Historic Model Scenarios Compared to the Available Record (503-005 / a22360f)	Figure 9.3.11

Water levels for the two historic scenarios are provided for Nonacho Lake and the Twin Gorges Forebay, as these are the two main features where water levels are directly influenced by operations of the existing Taltson hydroelectric facility.

Simulated flows for the two historic scenarios are provided for:

- outflow from Nonacho Lake to the Taltson River,
- outflow from Nonacho Lake at Tronka Chua Gap,
- the Taltson River below the confluence with the Tazin River,
- outflow from the Twin Gorges Forebay through the power plants,
- the Taltson River at the outlet of Tsu Lake, and
- Trudel Creek.

These six locations were chosen such that there is at least one set of flow predictions from each of the five model zones downstream of Nonacho Lake. In addition to flows simulated by the Flow Model, estimated monthly flows for pristine conditions (i.e., prior to the original construction of the Twin Gorges facility in 1965) are also presented for Trudel Creek.

Simulated flow and water levels for additional locations under the baseline scenario are also provided along with model results under the Expansion Project in Section 13.3 - Taltson Basin – Effects to Water Quantity and 14.3 - Trudel Creek – Effects to Water Quantity. Model results at all locations within the model domain are presented in Appendix 9.3A.

9.3.3.3.2.1 Nonacho Lake

Although Nonacho Lake has been operated as a reservoir over the past several decades in conjunction with the operations of the hydroelectric facility at Twin Gorges, water levels within Nonacho Lake were, and are, still strongly influenced by the natural runoff regime of the area. High water levels occur during the open water season and typically peak in June, July, or August (Figures 9.3.12 and 9.3.13). Annual minimum water levels occur in late winter just prior to rising air temperatures that signal the onset of freshet and typically occur in April. On average, water levels were lower during the Pine Point era compared to the baseline scenario, as water stored in the reservoir was released during otherwise low flow periods to maximize power production at Twin Gorges.

9.3.3.3.2.2 Zone 1 – Taltson River from the Nonacho Dam to the Tazin River

Releases from the Nonacho Dam to the Taltson River form the upstream boundary of Zone 1 and are the dominant source that controls the shape of the hydrograph throughout the zone.

Under the baseline (current era) conditions, the annual hydrograph of the releases from Nonacho Dam would have been typical of a natural lake outlet (Figure 9.3.14 and 9.3.15). Following the closure of the Pine Point Mine and the reduction in generation demand at Twin Gorges, the need to control the release of water from Nonacho Lake would have been reduced. The underflow gates at the control structure would only have been operated during the freshet and summer periods to mitigate against high water levels in the reservoir, which can become a nuisance to a fishing lodge located on Nonacho Lake.

Under the Pine Point era scenario, the annual hydrograph of the releases from Nonacho Dam would have reflected the greater use of Nonacho Lake as a reservoir to supply water to Twin Gorges throughout the year. Part of the freshet each year would have been stored within Nonacho Lake and released during the fall and winter. Consequently, the peak flow into Zone 1 from Nonacho Lake would have occurred on average in October or November rather than June, July, or August. The minimum annual flow would generally have occurred in late May or early June rather than April, just after the control structure was closed in anticipation of the natural freshet contributions to flow at Twin Gorges. With increasing distance below Nonacho Dam, the altered hydrograph would have been smoothed out by runoff from unregulated catchment areas contributing runoff to the Taltson River, as well as the attenuating effects of the numerous downstream lakes.

Under baseline conditions, flow over the Nonacho Dam spillway would have been constant throughout the 13-year simulation period. However, under the Pine Point era scenario, the greater release of water throughout the winter would have dropped water levels in the reservoir and resulted in zero flow occurring over the spillway during very dry periods (e.g., 1979, 1986).

9.3.3.3.2.3 *Zone 2 – Tronka Chua Gap to Lady Grey Lake*

Historically, there was likely little connectivity between Nonacho Dam and Zone 2. However, following the construction of the Nonacho Dam in 1968, which raised lake levels approximately 2 m, flow began passing regularly over the natural topographic saddle of the Tronka Chua Gap. Outflow from Nonacho Dam at Tronka Chua Gap forms the upstream boundary of Zone 2. Although the outflow at Tronka Chua Gap would have been much less than outflow from Nonacho Lake at the Nonacho Dam (~15% of total annual outflow under baseline condition and ~11% under Pine Point era conditions), it would still have been the main input to all of Zone 2.

Tronka Chua Gap is an uncontrolled spillway, and flow at the gap is directly related to levels within Nonacho Lake. The shape and timing of the annual hydrograph under both historic scenarios would have been typical of a natural lake outlet in the region, with peak flows generally occurring during the freshet period and minimum flows occurring during the late winter (Figures 9.3.16 and 9.3.17).

Under the baseline scenario, flow over Tronka Chua Gap into Zone 2 over the 13-year simulation period would have been constant. However, as a result of water levels being lower on average in Nonacho Lake under the Pine Point era scenario, and especially during lower runoff periods, there would have been times that Tronka Chua Gap would have become dewatered (1978, 1979, 1980, 1981, and 1986). Although under the Pine Point era, flow would have ceased for periods at the Tronka Chua Gap, local runoff to the lakes within Zone 2 would have provided some inflow to the zone.

9.3.3.3.2.4 *Zone 3 – Taltson River from Tazin River to Tsu Lake*

Zone 3 extends from the confluence of the Taltson and Tazin Rivers to Tsu Lake and includes the Twin Gorges Forebay. The Tazin River is the largest tributary of the Taltson River and contributes approximately 40% of the annual flow to Twin Gorges, while Nonacho Lake contributes approximately 51%, based on the Flow Model results. Thus, the annual hydrograph in Zone 3 (Figure 9.3.18 and 9.3.19), as well as the downstream zones (Zone 4 and 5), would have been strongly influenced by the unregulated flows from the Tazin River as well as the regulated outflow from Nonacho Lake .

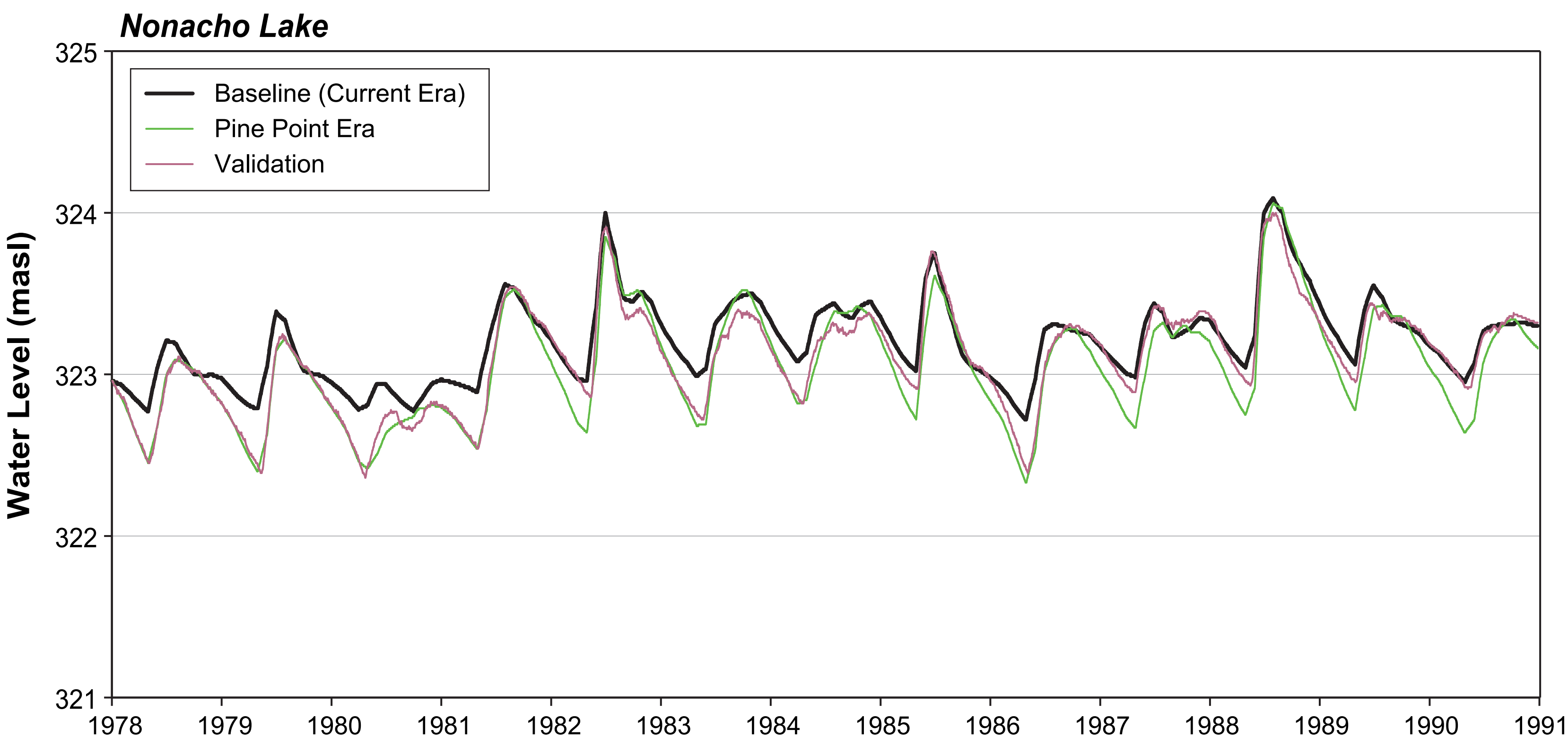
Any signature of the controlled releases at the Nonacho Lake control structure would have been substantially reduced below the Tazin River compared to immediately below the Nonacho Dam. This is due to the large unregulated contribution from the Tazin River, the numerous lakes the Taltson River flows through in Zones 1 and 2, and the return of flow over the Tronka Chua Gap to Zone 1 at Lady Grey Lake. This is most evident for the Pine Point era scenario where in Zone 3, the operations of Nonacho Lake would have resulted in a small shift in the timing of the peak flows and an overall dampening of the annual hydrograph, with peak annual flows being lower and minimum annual flows being higher, on average.

Flow entering the Twin Gorges Forebay continues downstream via either the power plant or the SVS. The flow through the power plants is controlled by the power generation of the plant, which differed between the two historic scenarios. Under baseline conditions, power would have been generated below the full capacity of the facility and fluctuates throughout the year. Power generation would have been higher during the winter (12 MW) than during the winter (8 MW). This is reflected in a fluctuation in the generation flow of the power plant of 50 m^3/s over the winter and 30 m^3/s during the summer (Figure 9.3.20 and 9.3.21). For the modelled Pine Point era, it was assumed that power would have been produced at the full 18 MW capacity throughout the year, which would have required a constant generation flow of 74 m^3/s. Under both hypothetical historic scenarios, the flow in the Taltson basin would have been large enough to satisfy the full power demand throughout the 13-year simulation period.

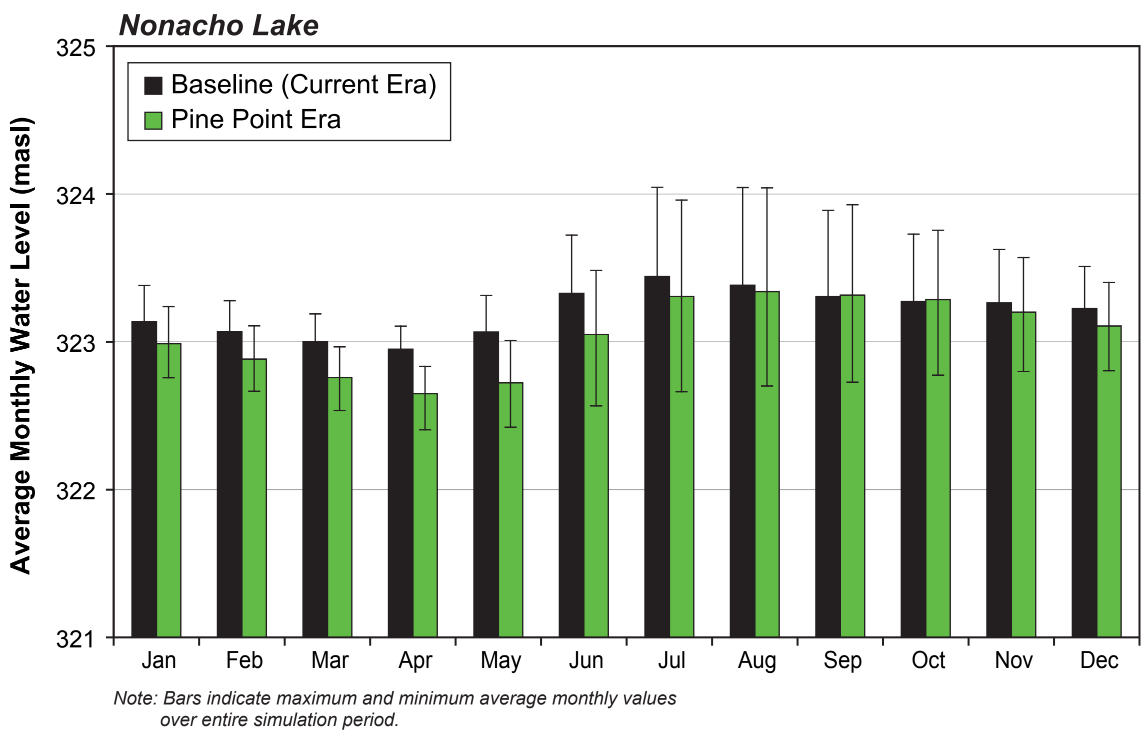
Water that is not used for power production spills over the SVS and into Trudel Creek. Flow Model results for Trudel Creek, which are representative of results at the SVS, are discussed as part of Zone 5.

Water levels within the Twin Gorges Forebay largely reflect inflows from upstream rather than operations of the power plant (Figure 9.3.22 and 9.3.23). The difference in simulated water level time-series between the baseline and Pine Point scenarios is driven primarily by the operations of Nonacho Lake rather than directly due to operations of the power plants. Only during extremely dry periods under the Pine Point era does the flow through the power plants have a noticeable effect. In 1979 and 1980, rapid draw-downs in the level of the Forebay would have occurred as a result of inflow dropping below power plant, due to the relatively small storage within the Forebay.

The split outflow from the Twin Gorges Forebay through the power plant and over the SVS recombine below Elsie Falls near the downstream end of Zone 3. At this location, the hydrograph would have been relatively similar to just below the confluence with the Tazin River.



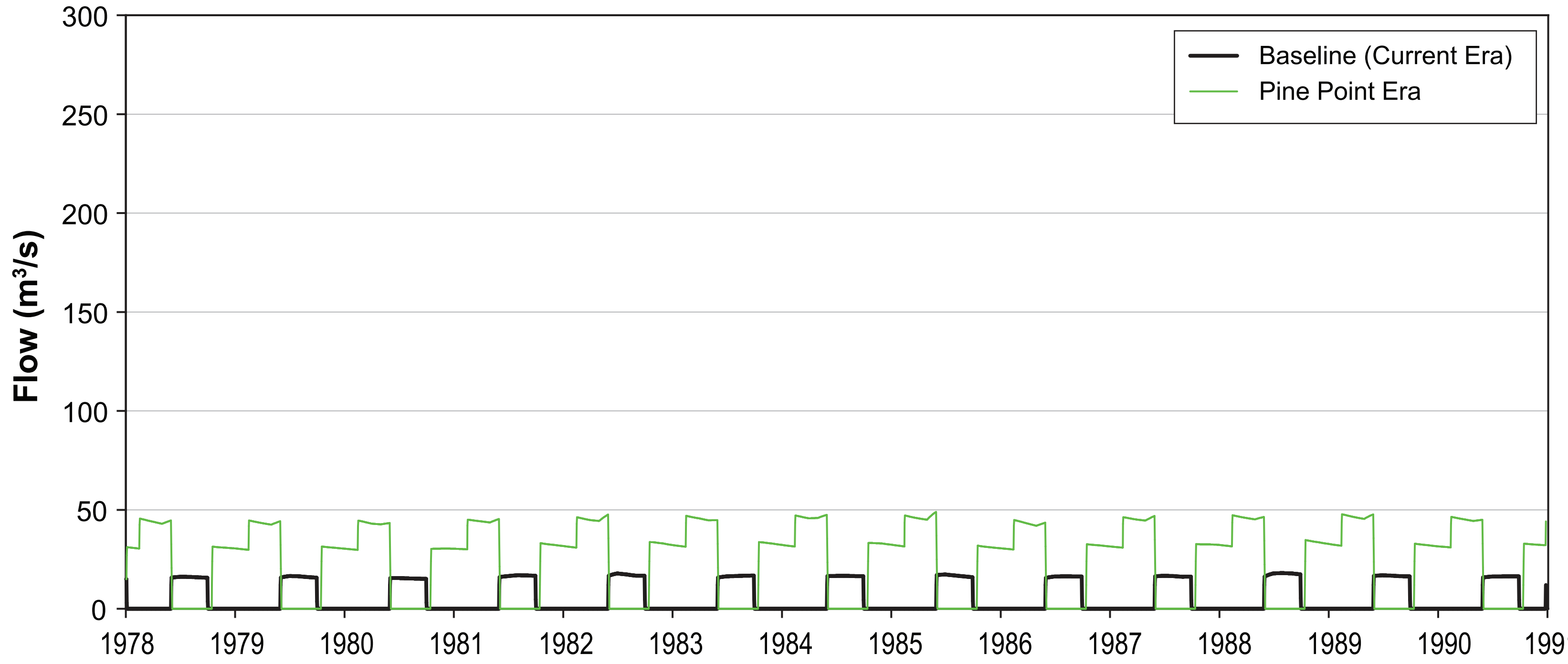
TALTSON Hydroelectric Expansion Project	Developer's Assessment Report 2009	Taltson Basin Flow Model Results: Nonacho Lake Historic Water Level Time Series (503-005 / a22361f)	Figure 9.3.12



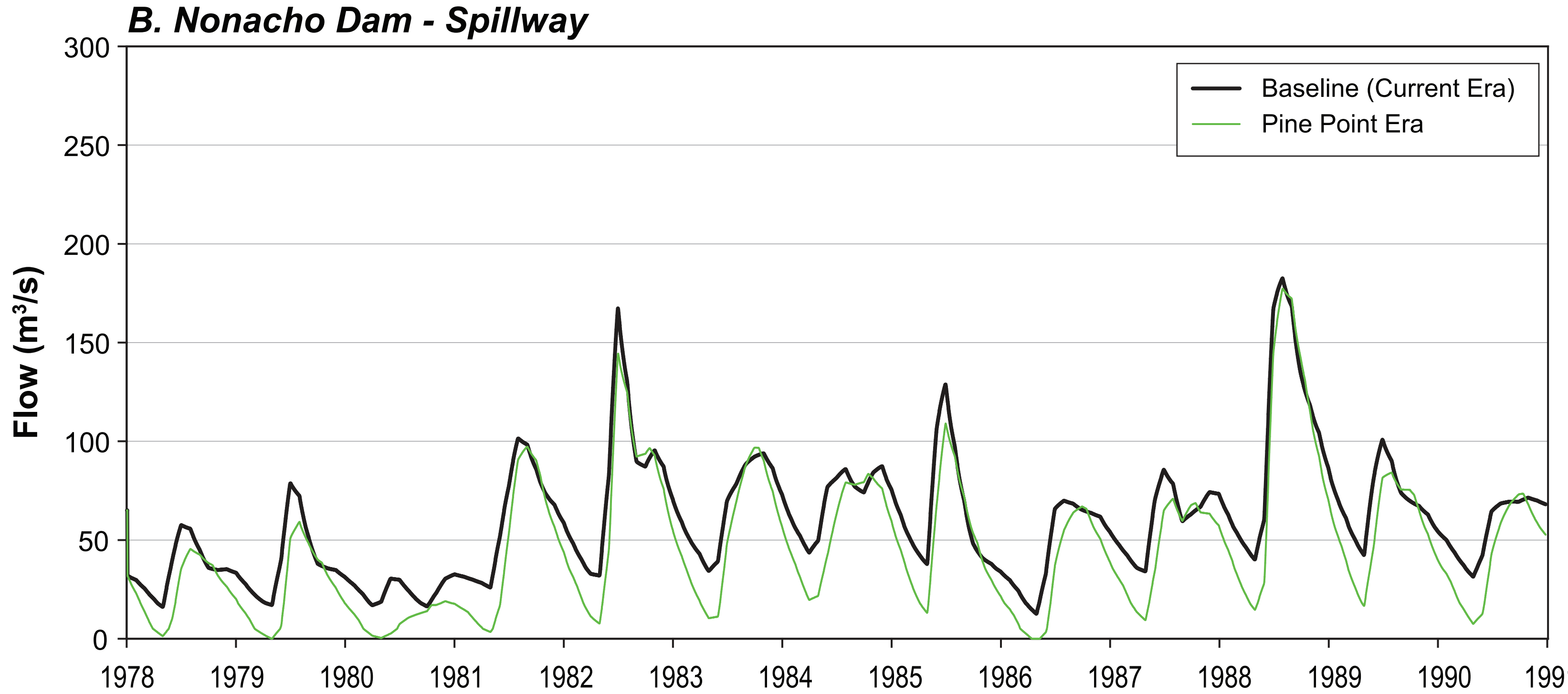
TALTSON Hydroelectric Expansion Project	Developer's Assessment Report 2009	Taltson Basin Flow Model Results: Nonacho Lake Historic Water Level Monthly Summary (503-005 / a22362f)	Figure 9.3.13

Dezé energy

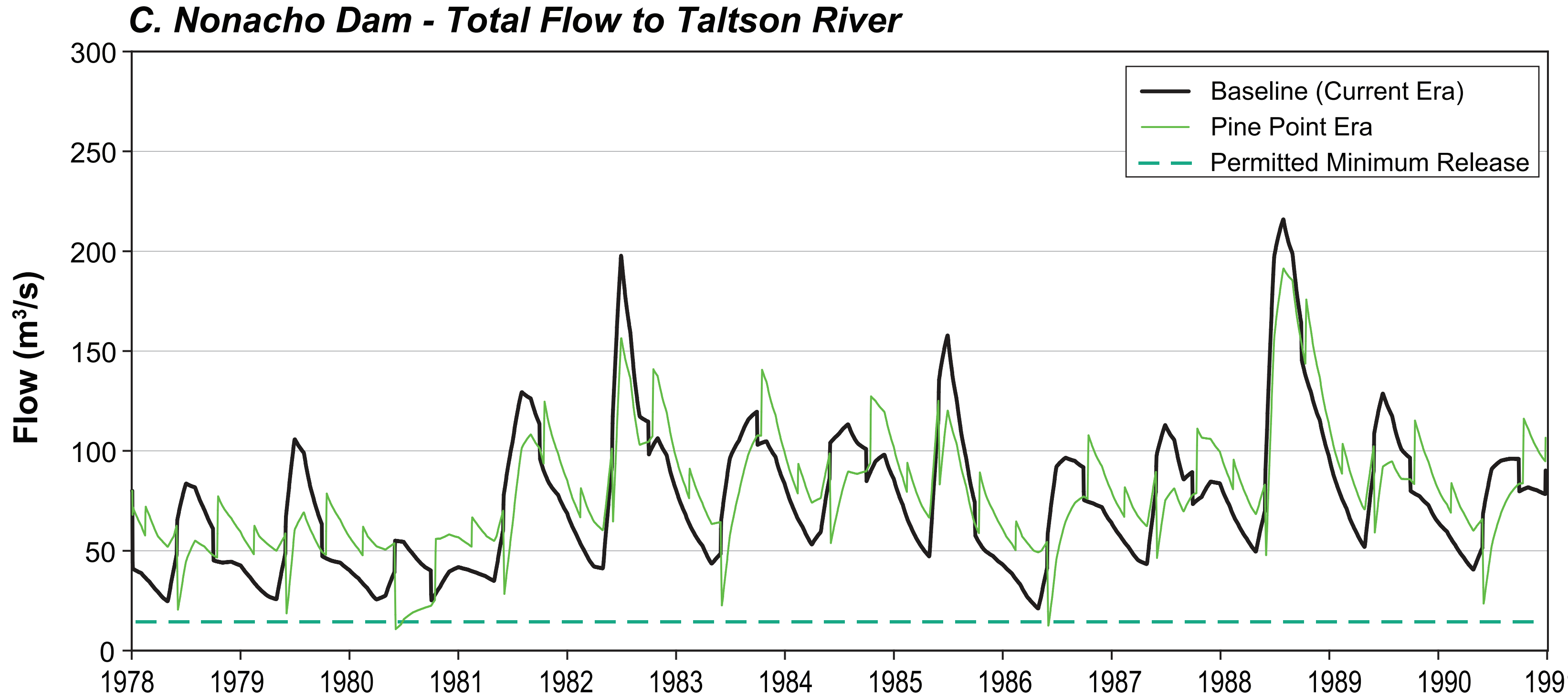
A. Nonacho Dam - Underflow Gates



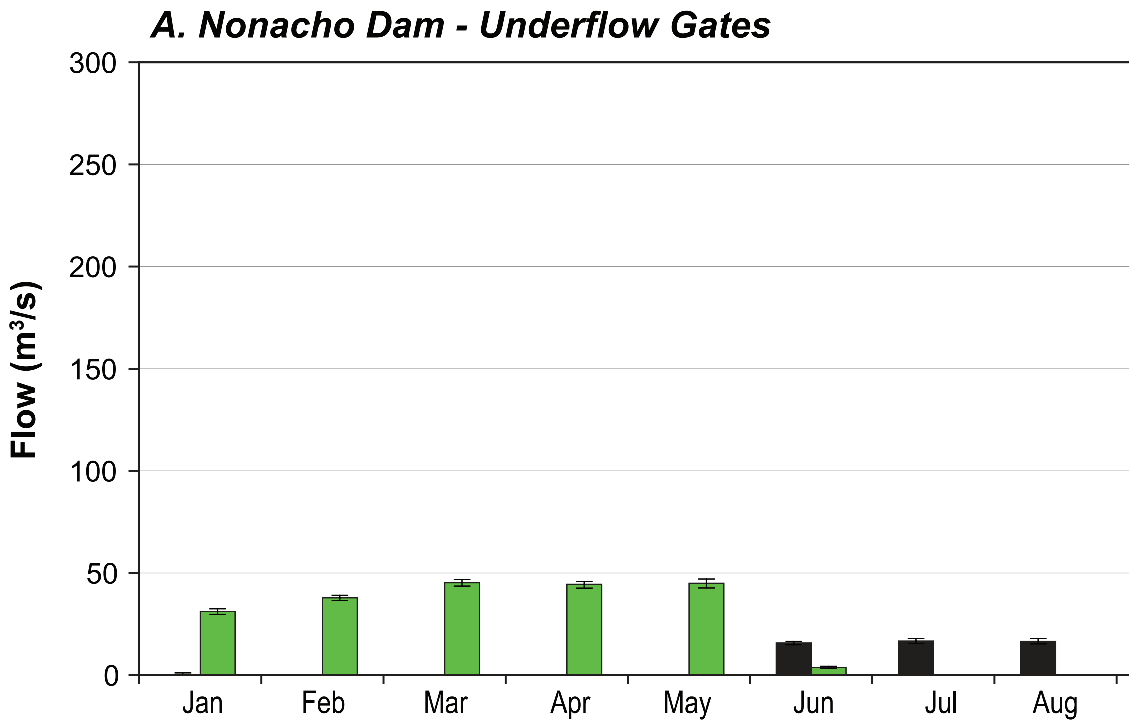
B. Nonacho Dam - Spillway

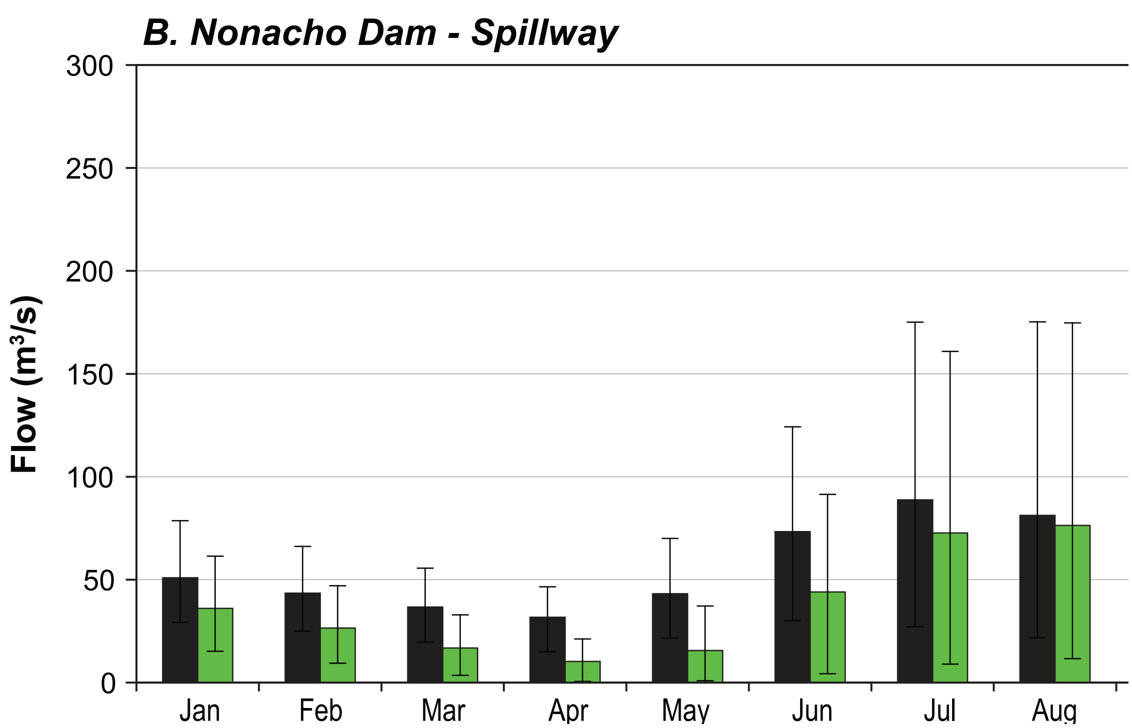


C. Nonacho Dam - Total Flow to Taltson River

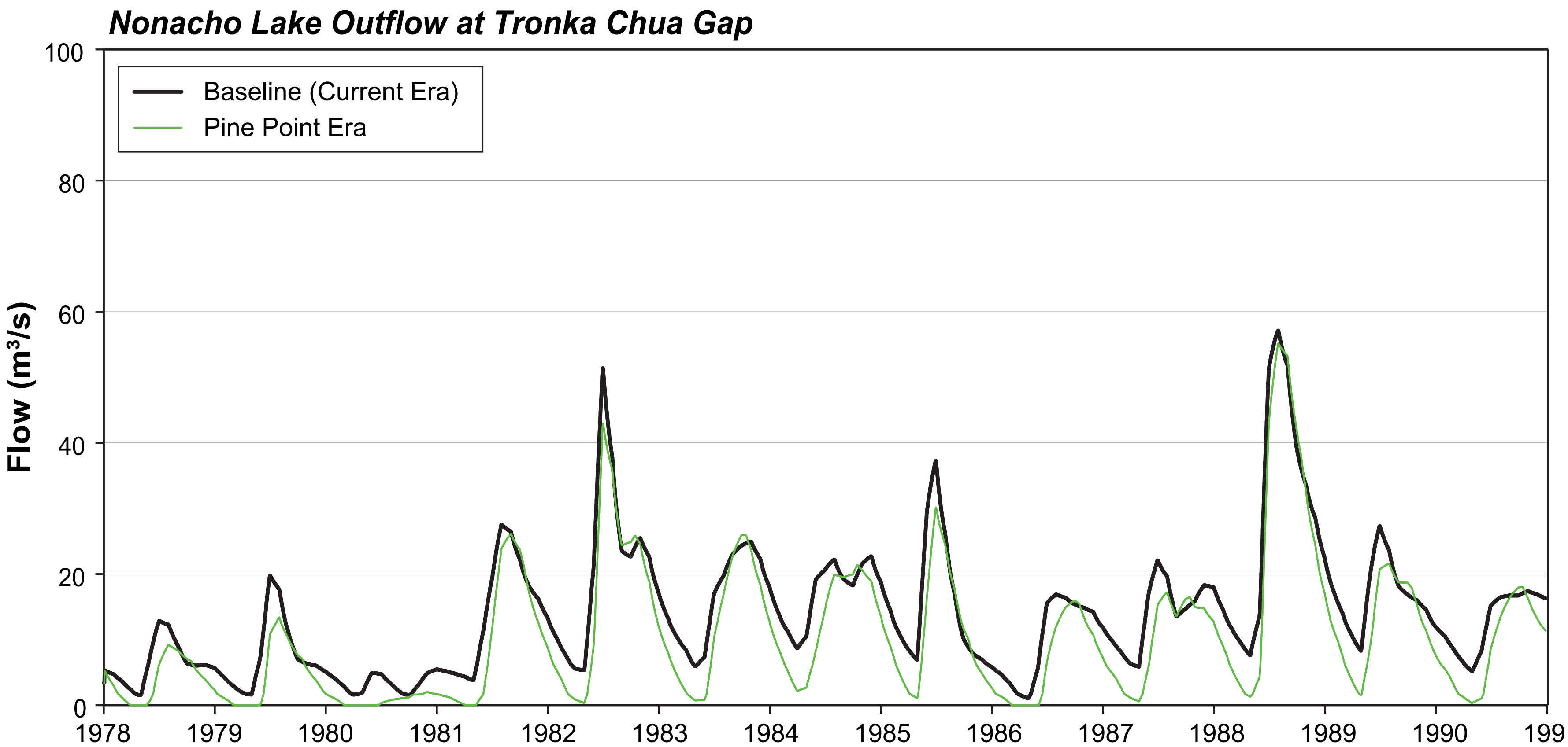


TALTSON Hydroelectric Expansion Project	Developer's Assessment Report 2009	Taltson Basin Flow Model Results - Zone 1: Nonacho Dam Historic Outflow to Taltson River Time Series (503-005 / a22363f)	Figure 9.3.14





TALTSON HYDROELECTRIC EXPANSION PROJECT	**Developer's Assessment Report 2009**	**Taltson Basin Flow Model Results, Zone 1: Nonacho Dam Historic Outflow to Taltson River Monthly Summary**	**Figure 9.3.15**

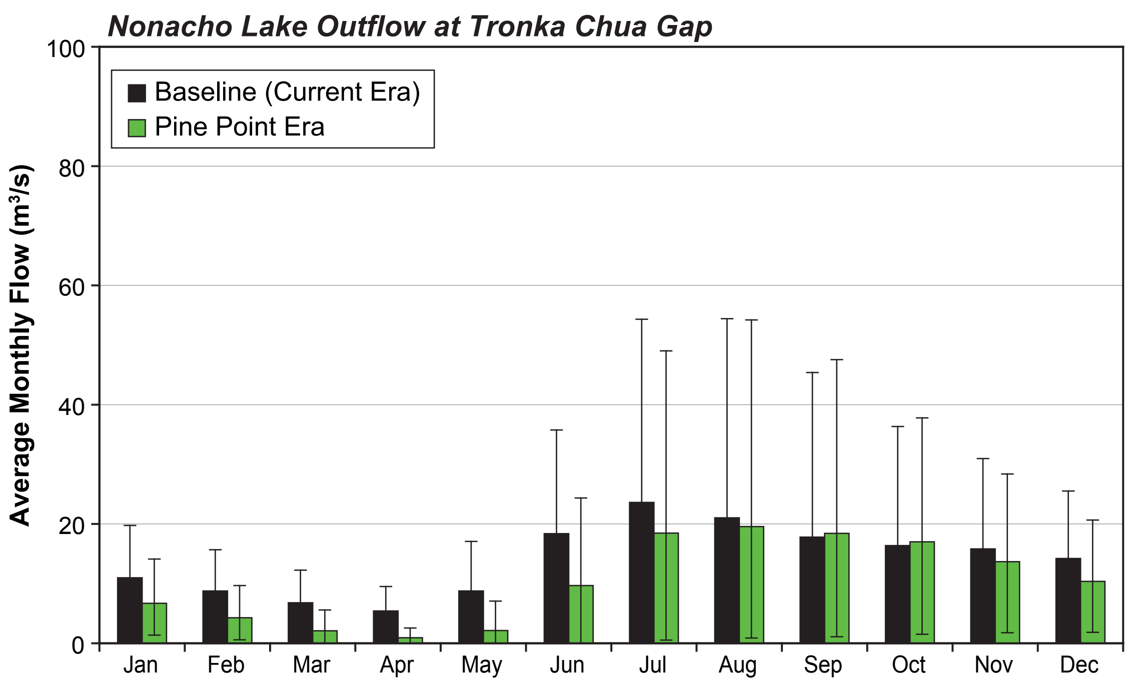


TALTSON
HYDROELECTRIC EXPANSION PROJECT

Developer's Assessment Report
2009

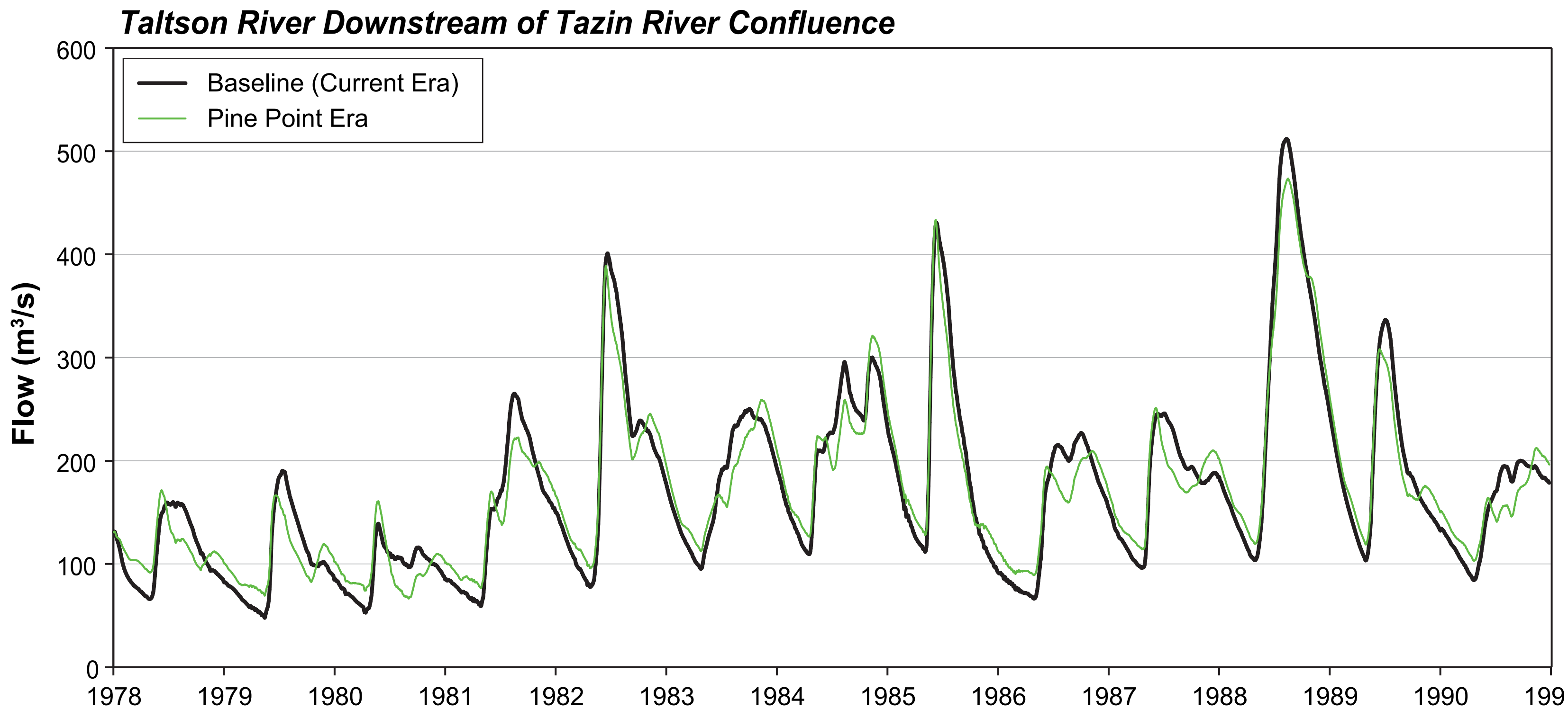
Taltson Basin Flow Model Results, Zone 2:
Lake Historic Outflow at Tronka Chua Gap Time Series

FIGURE
9.3.16

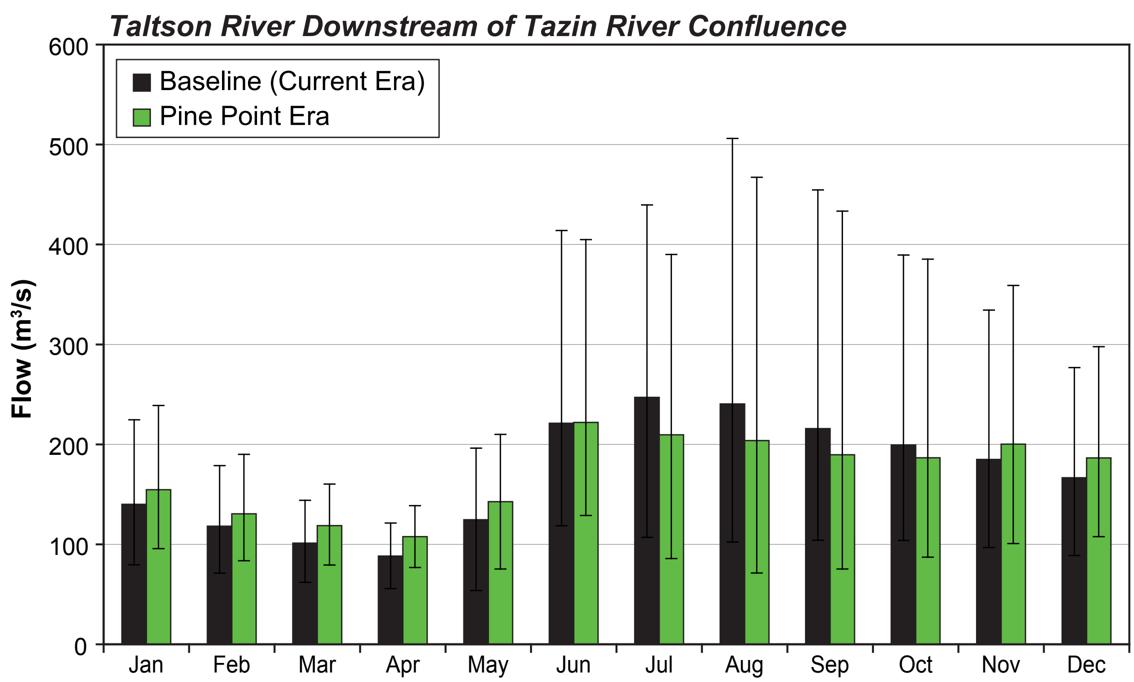


Note: Bars indicate maximum and minimum average monthly values over entire simulation period.

Dezé energy



TALTSON Hydroelectric Expansion Project	**Developer's Assessment Report 2009**	**Taltson Basin Flow Model Results - Zone 3: Taltson River downstream of Tazin River Historic Flow Time Series** (503-005 / a22375f)	**Figure 9.3.18**



Note: Bars indicate maximum and minimum average monthly values over entire simulation period.

TALTSON Hydroelectric Expansion Project	**Developer's Assessment Report 2009**	**Taltson Basin Flow Model Results - Zone 3: Taltson River downstream of Tazin River Historic Flow Monthly Summary** (503-005 / a22376f)	**Figure 9.3.19**

9.3.3.3.2.5 Zone 4 – Tsu Lake to Great Slave Lake

Zone 4 extends from Tsu Lake to the mouth of the Taltson River at Great Slave Lake. The hydrograph throughout this zone would have largely reflected the inflow from Zone 3 (Figure 9.3.24 and Figure 9.3.25). The hydrologic regime of this Zone is well described by the long-term historic data available from the WSC and presented above in Section 9.3.2. Differences between the two historic scenarios are consistent with those discussed for the Taltson River downstream of Tazin River in Zone 3.

9.3.3.3.2.6 Zone 5 – Trudel Creek

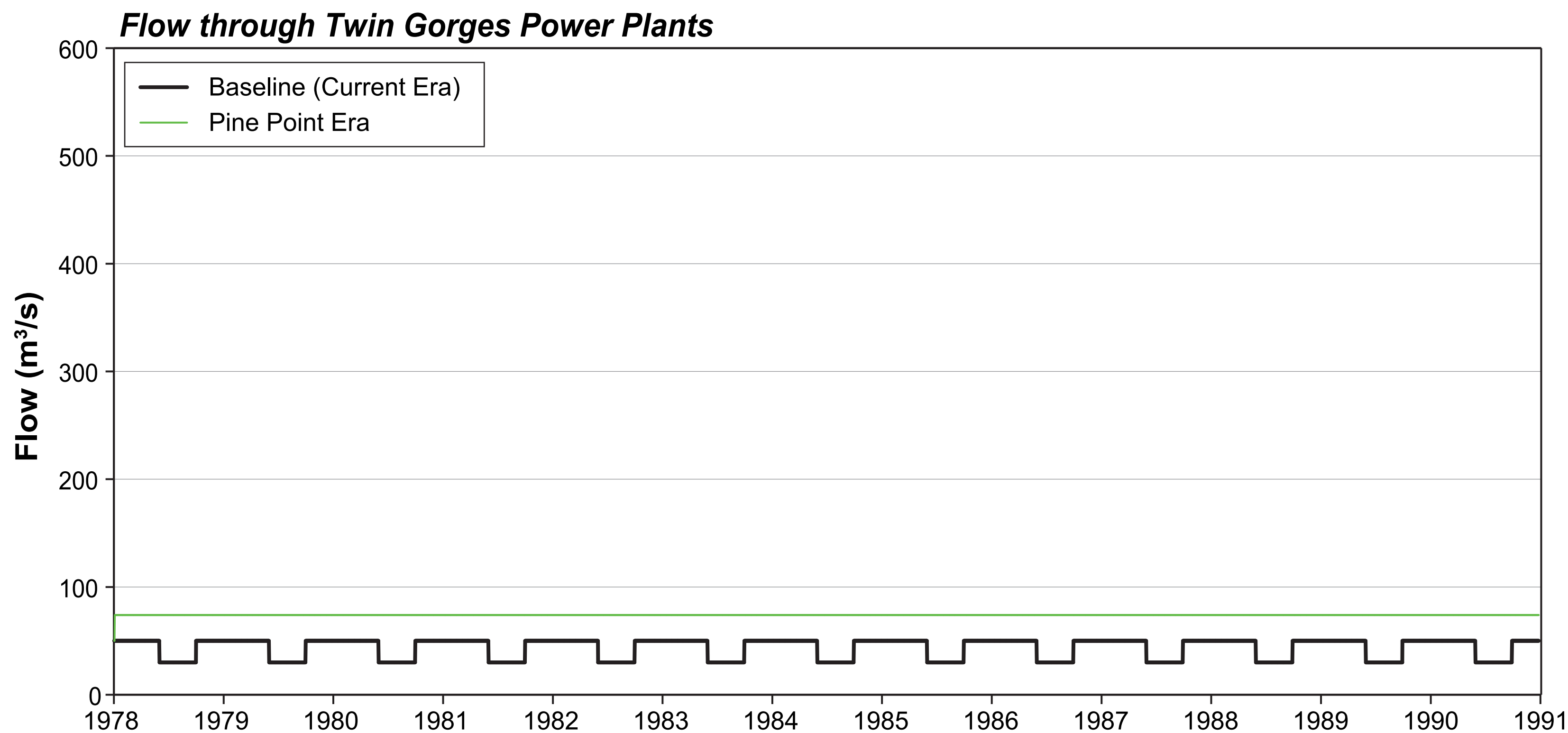
Inflow to the Twin Gorges Forebay not required for power production discharges over the SVS to Trudel Creek. The creek flows in a broad loop southwards and then northwards, passing through a series of three lakes before rejoining the Taltson River below Elsie Falls.

Trudel Creek has experienced the greatest effects from the various eras of operations of the Twin Gorges hydroelectric facility. Flow Model results for the baseline and Pine Point era scenarios are presented in Figures 9.3.26 and 9.3.27. Due to the relatively substantial effects the original construction of the Twin Gorges facility had on Trudel Creek, an assessment of what the “pristine” hydrological conditions were of the creek was also conducted (Rescan 2006). The results from this assessment are incorporated in Figure 9.3.27.

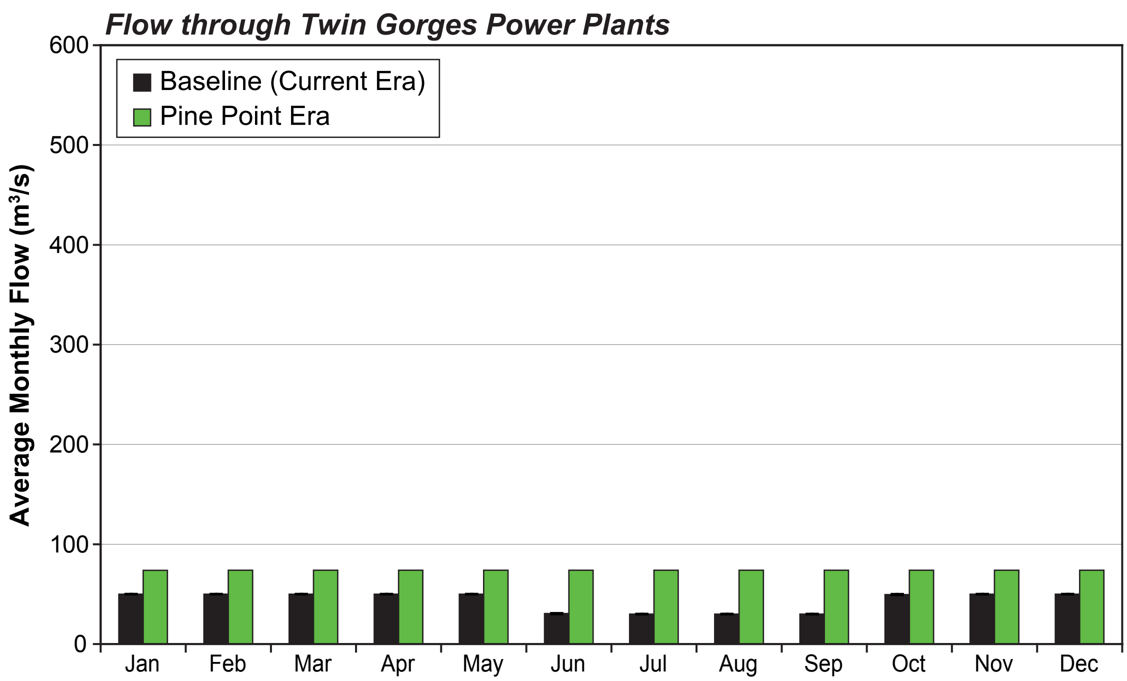
Prior to the construction of the dam and SVS at Twin Gorges in 1965, Trudel Creek was normally a small meandering stream interconnecting the three lakes in this reach. Connection between the Taltson River and the Trudel Creek was likely limited. However, from review of air photos, it appears that at times more water flowed through the Trudel Creek system than would have been generated solely by the small local watershed (Rescan 2006). This suggests that seasonal or potentially year-round connectivity existed between the Taltson River and the upper reaches of Trudel Creek. It was estimated that pre-development flows in Trudel Creek may have been approximately 0% to 12% of current flows. Since the construction of the original Twin Gorges facility, the majority of flow within Trudel Creek enters via the SVS. However, runoff from the surrounding watershed does still contribute a small portion to the total flow in Trudel Creek.

Since the use of Trudel Creek as the spillway route for the Twin Gorges facility, additional high flows have been routed into this watercourse. Based on model results, spill flows from the Twin Gorges Forebay into Trudel Creek during the Pine Point era were reduced compared to baseline (current era) conditions. Since the closure of the Pine Point Mine, power generation has decreased along with flow through the power plant, releases from Nonacho Lake have been less structured, and approximately 75% of the annual flow has spilled over the SVS into Trudel Creek. During the Pine Point era approximately 60% of the annual flow to the Forebay entered Trudel Creek.

Flow generally occurred at the SVS throughout the year; however, during very dry periods when water levels in the Forebay would have dropped, flow over the SVS to Trudel Creek would have stopped. This would likely have occurred in 1979 under the baseline condition and 1979 and 1980 under the Pine Point era. During these periods Trudel Creek would likely still receive runoff from local catchment areas.

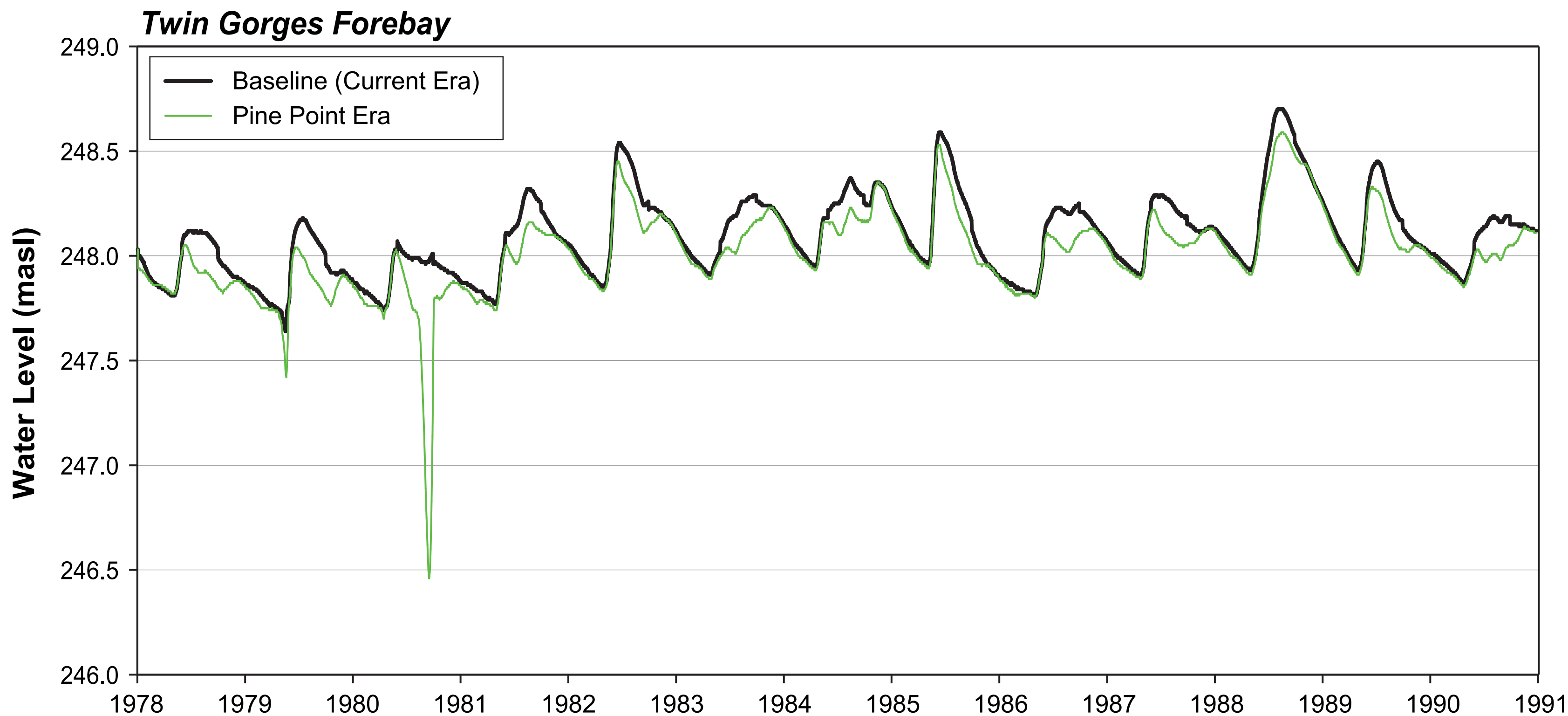


TALTSON Hydroelectric Expansion Project	Developer's Assessment Report 2009	Taltson Basin Flow Model Results - Zone 3: Historic Flow through Twin Gorges Power Plants Time Series (503-005 / a22367f)	Figure 9.3.20

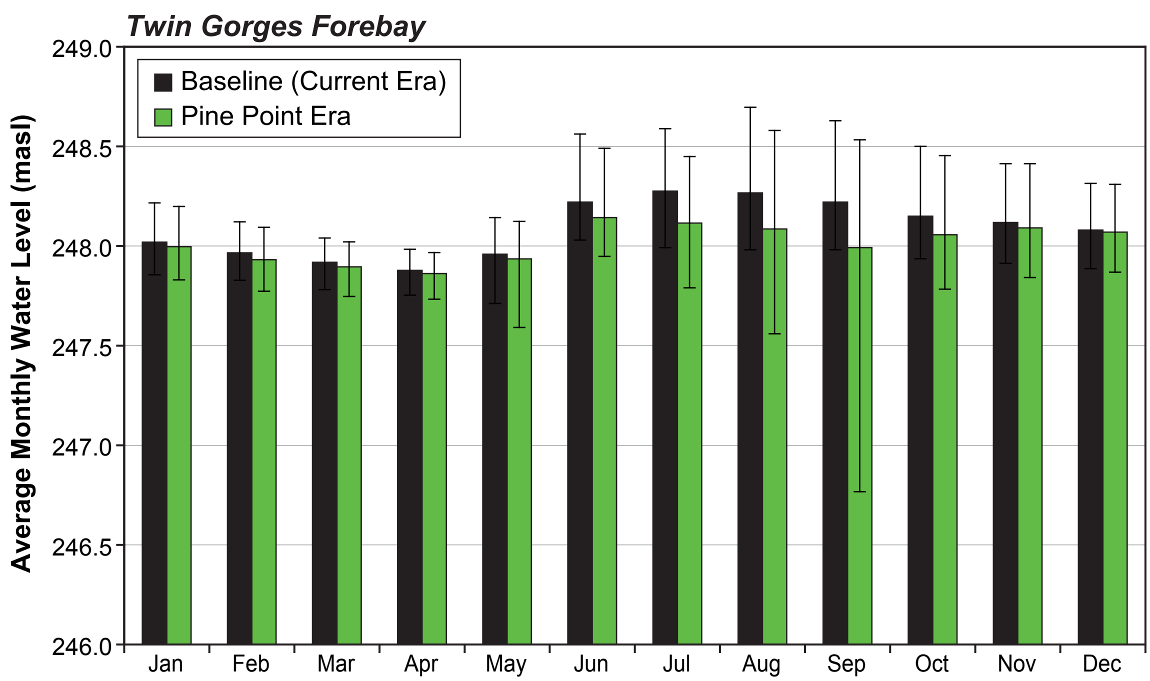


Note: Bars indicate maximum and minimum average monthly values over entire simulation period.

TALTSON Hydroelectric Expansion Project	Developer's Assessment Report 2009	Taltson Basin Flow Model Results - Zone 3: Historic Flow through Twin Gorges Power Plants Monthly Summary (503-005 / a22368f)	Figure 9.3.21

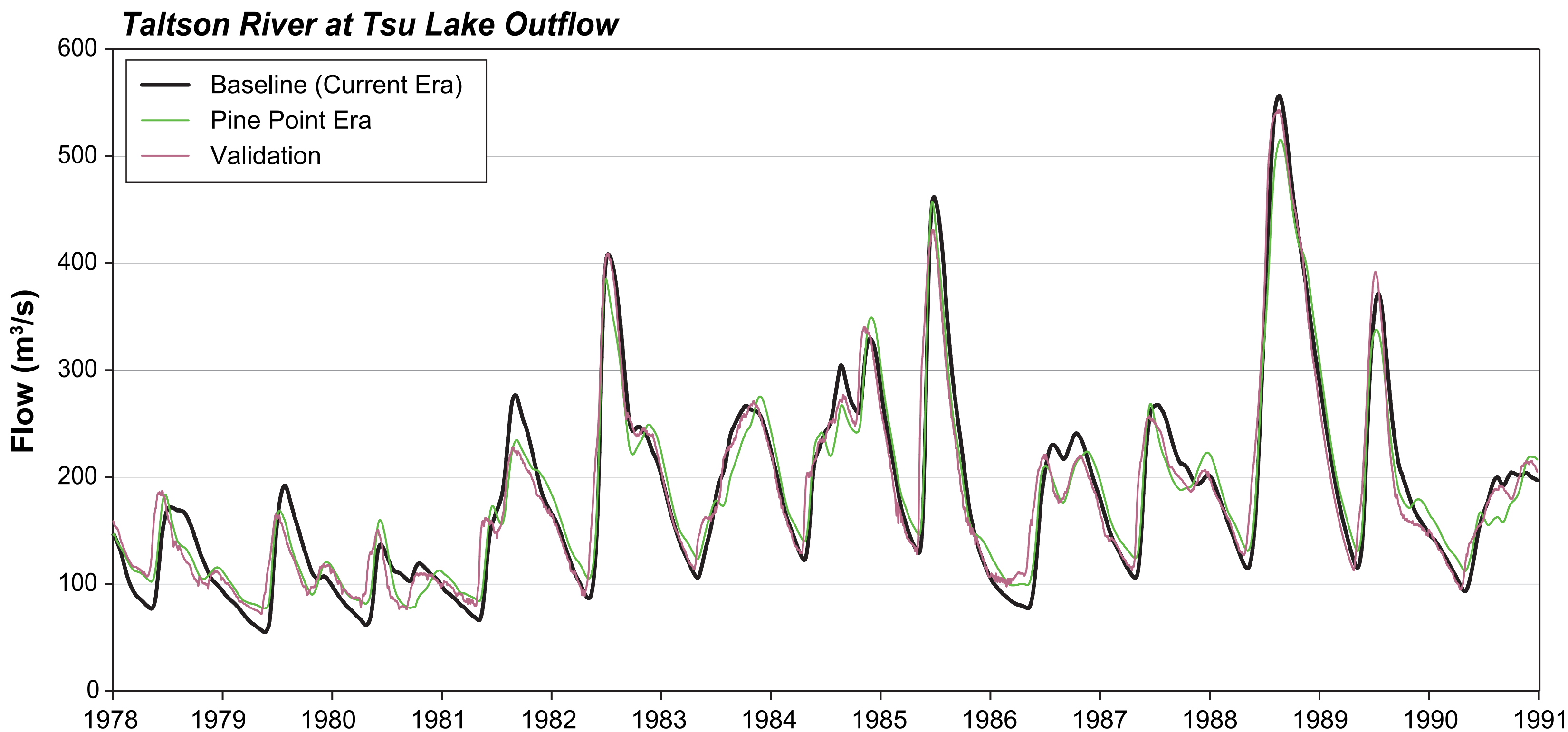


TALTSON Hydroelectric Expansion Project	Developer's Assessment Report 2009	Taltson Basin Flow Model Results - Zone 3: Twin Gorges Forebay Historic Water Level Time Series (503-005 / a22369f)	Figure 9.3.22

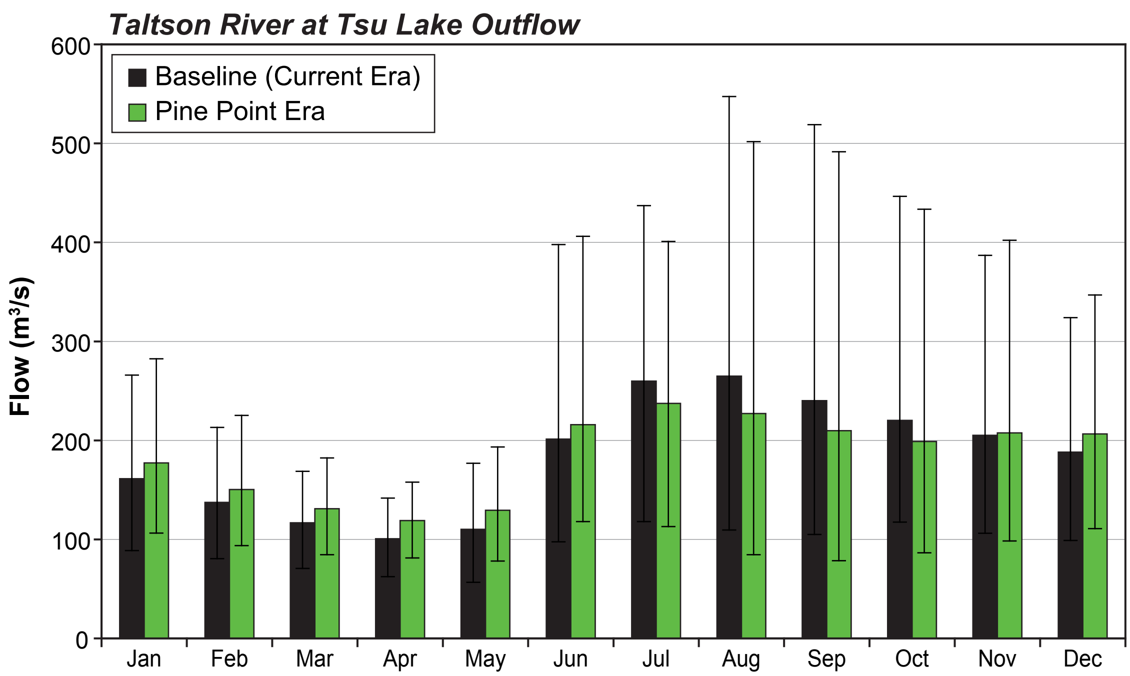


Note: Bars indicate maximum and minimum average monthly values over entire simulation period.

TALTSON Hydroelectric Expansion Project	Developer's Assessment Report 2009	Taltson Basin Flow Model Results - Zone 3: Twin Gorges Forebay Historic Water Level Monthly Summary (503-005 / a22370f)	Figure 9.3.23

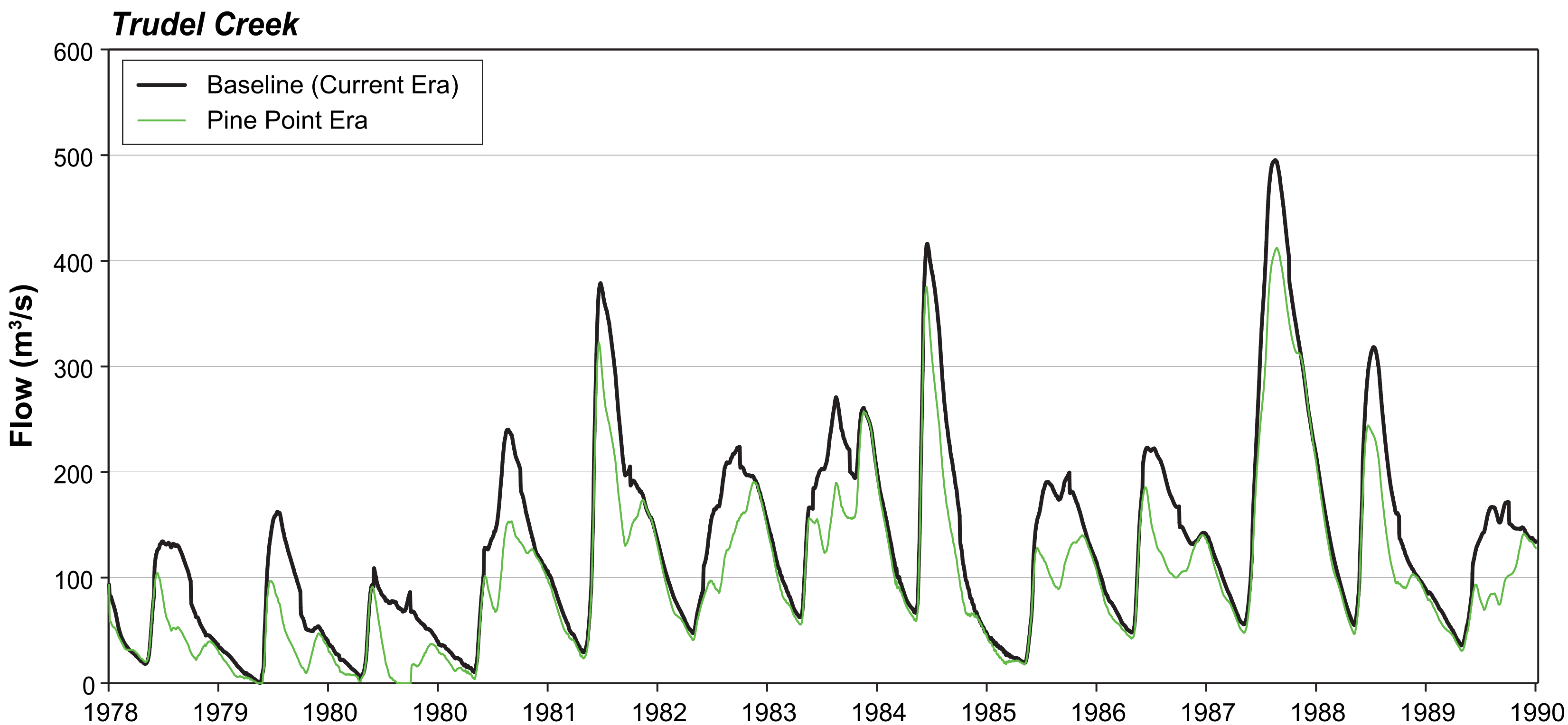


TALTSON Hydroelectric Expansion Project	**Developer's Assessment Report** **2009**	**Taltson Basin Flow Model Results - Zone 4: Taltson River at Outlet of Tsu Lake Historic Flow Time Series** (503-005 / a22371f)	**Figure** **9.3.24**

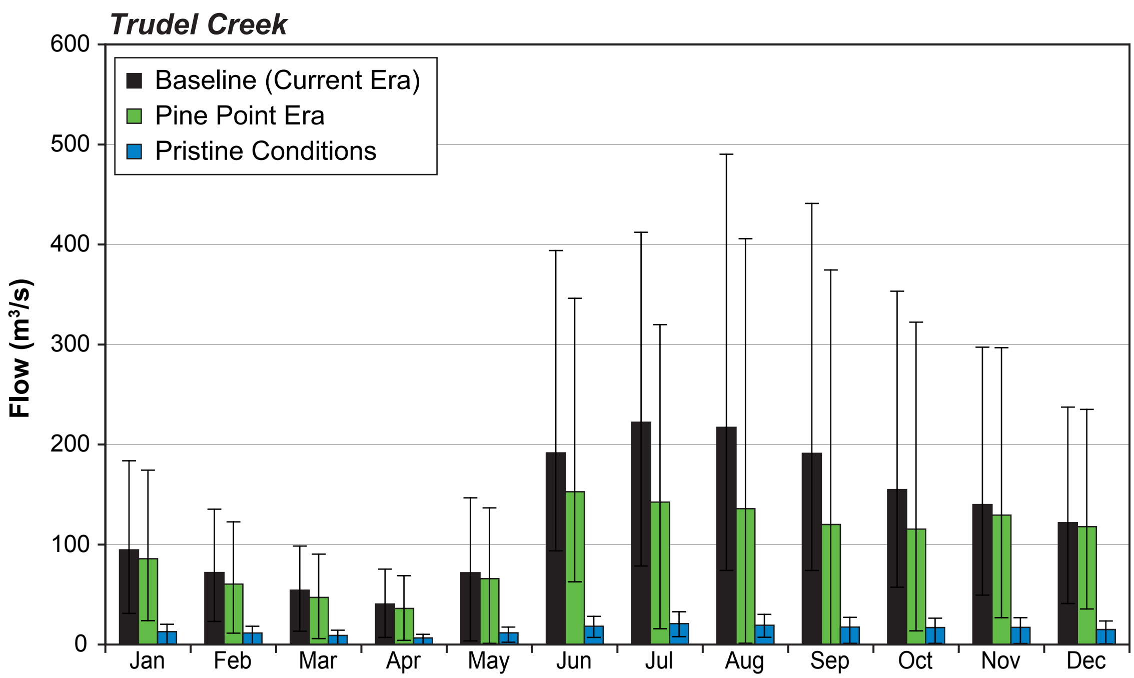


Note: Bars indicate maximum and minimum average monthly values over entire simulation period.

TALTSON Hydroelectric Expansion Project	Developer's Assessment Report 2009	Taltson Basin Flow Model Results - Zone 4: Taltson River at Outlet of Tsu Lake Historic Flow Monthly Summary (503-005 / a22372f)	Figure 9.3.25



TALTSON Hydroelectric Expansion Project	Developer's Assessment Report 2009	Taltson Basin Flow Model Results - Zone 5: Trudel Creek Historic Flow Time Series (503-005 / a22373f)	Figure 9.3.26



Note: Bars indicate maximum and minimum average monthly values over entire simulation period.

Due to the small storage volume of the Twin Gorges Forebay, changes in inflow to the Forebay would be experienced at the SVS and in Trudel Creek relatively quickly. Therefore, the trends in the hydrograph of Trudel Creek largely reflect that of Zone 3, discussed previously. The differences between the two historic scenarios are largely consistent with those discussed for the Taltson River downstream of Tazin River for Zone 3.

9.3.3.4 MODEL UNCERTAINTIES

The Flow Model was developed using the best available data in terms of the physical characteristics of the model domain, the assumed operations of the Nonacho Lake and Twin Gorges Forebay reservoirs, and the hydrological inputs used to run the model.

The Flow Model represents more than 350 km of the Taltson River, including river reaches and a substantial number of lakes. A considerable amount of field work was done to obtain field data for key locations that were believed to have the greatest control on the movement of water through the study area. However, a number of assumptions and estimations were required to create the physical representation of the Taltson River within the Flow Model, and the model cannot be expected to perfectly replicate the natural, complex system that it represents.

Data was available on the historic operations at Nonacho Lake, but due to the different eras of operations and the relatively limited time period that hydrological inputs could be estimated for, simplified operations at Nonacho Lake had to be assumed in order to simulate the historic scenarios. However, based on results from the hypothetical historic model scenarios compared to the calibration exercise (see following section), these assumptions did not have a substantial effect on modelled releases from Nonacho Lake. Detailed, reliable data on historic power production at Twin Gorges was limited; therefore, assumptions were made on the constant power production at the facility, which may introduce uncertainty specific to flows in Trudel Creek.

A key uncertainty in the model arises from the limited period that hydrological inputs could be confidently estimated for. There is a high confidence in the estimates generated for the 13-year simulation period used in the Flow Model. However, the fact that this 13-year period spans two historic operational scenarios introduces greater uncertainty for simulating the baseline (current era) scenario than if the 13-year period spanned only the baseline (current era) scenario.

An additional uncertainty in the use of a record period two decades in the past is that, based on the 40-year historic record of flows below Twin Gorges, there appears to be a trend increasing runoff in the Taltson basin (see Section 16.1 – Project Effects on the Environment). Therefore, the hydrological inflows used for the baseline scenario represent, in general, a drier period compared to the current hydrological regime (i.e., the last decade).

This is of additional relevance to the expansion scenarios as, based on current projections, the climate will become increasingly wet. Although climate change scenarios for the Taltson area were included in the DAR (Chapter 16 – Project Responses to the Environment), the projections in climate parameters were not considered for the Flow Model scenarios as the degree of uncertainty in the climate projections, combined with the additional uncertainty of what implications this would have on simulated river flow, would have had such great uncertainty that it was not considered to be a meaningful exercise.

The continued monitoring of flow below Twin Gorges, as well as at the new WSC station at the mouth of the Tazin River and the reactivated WSC station on the Taltson River above Porter Lake, will provide valuable data sets for future refinements of the Flow Model.

Although there are a number of uncertainties in the model, it is considered to be a robust representation of the Taltson River between Nonacho Lake and Great Slave Lake and appropriate for use as an environmental assessment tool, which is supported by the good comparison of simulated to observed results from the calibration exercise.

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9. EXISTING ENVIRONMENT

9.4 PHYSICAL ENVIRONMENT

9.4.1 Bedrock, Subsurface, and Soil Characteristics

A survey of dominant surficial materials along the proposed transmission line Right of Way (ROW) between Twin Gorges and Snap Lake was completed as part of an earlier geotechnical evaluation (Geo-Engineering 2003). Preliminary soil and terrain baseline field surveys were also completed within an earlier transmission line alignment. That alignment followed the north shore of McLeod Bay from the Lockhart River to Snap Lake (Rescan 2004). However, the transmission line alignment past the Lockhart River has since been re-routed to travel directly north to Gahcho Kué. South of the Lockhart River crossing, near Fort Reliance, the Project follows the same transmission line ROW as initially proposed. The current alignment has been expanded to include the Gahcho Kué project, the Ekati Diamond Mine, and the Diavik Diamond Mine (Figure 9.4.1). Additional geotechnical evaluations were completed for three routing options for the expanded Project ROW (Teshmont 2008). These evaluations included reconnaissance of the proposed routes to confirm the terrain types and validate the applicable tower foundations that could be applied in design and preliminary costing analyses. The following additional assessments have confirmed the terrain features and physical environment of the proposed Project area:

- Northwest Territories Power Commission Transmission Lines to Diamond Mines – Input to Foundation Designs/Geotechnical Information (Geo-Engineering, 2005).
- Northwest Territories Power Commission Transmission Lines to Diamond Mines – Preliminary Terrain/Geotechnical Information (Geo-Engineering 2005).
- Taltson Hydroelectric Expansion Project – Project Description in Support of the MVLWB Land and Water Application (Dezé, Cambria Gordon, & Solstice Consulting Services 2007).

9.4.1.1 BEDROCK

Bedrock foundations are the dominant feature of the Project landscape and comprise as much as 82% of the proposed Project route as shown in Table 9.4.1 (Teshmont 2008). Bedrock outcrops are characterized as having granite gneiss rock modified by glacial action (i.e., grooved and etched), with heavily-weathered surfaces and lichen cover (Teshmont 2008). The bedrock is massive, of high strength, and occurs at elevations of over 300 m above the surrounding terrain. At lake shorelines, the rock has been shattered through frost action into large boulders up to 2 m in diameter. Sandy/gravelly glacial till, with significant proportions of cobbles and boulders, is the dominant surficial material and is expressed as a veneer or blanket over the bedrock. The amount of exposed bedrock along the proposed ROW also is extensive (Geo-Engineering 2005) and is less susceptible to wind and water erosion.

Table 9.4.1 — Summary of Terrain Foundation Types Within the Project Area

Route	Total Route Length	Rock Foundations		Soil Foundations		Permafrost		Fragmented Rock	
Twin Gorges to Diavik Mine Terminal	560 km	461 km	82.3%	4 km	0.7 %	46 km	8.2 %	49 km	8.8 %
Snap Lake to Gahcho Kué	93 km	31 km	33.2%	0 km	0 %	12.9 km	13.8 %	49 km	52.5 %

Source: Teshmont 2008

9.4.1.2 SURFICIAL MATERIALS AND LANDFORMS

The majority of the Project area lies on the Canadian Shield, which has a generally undulating topography broken by valleys (Geological Survey of Canada 2003). This area consists of glaciated bedrock outcrops and thin soils overlying bedrock that lack a well-defined topsoil horizon. These soils, where present, have formed on discontinuous, thin, unconsolidated veneers and blankets of hummocky to rolling morainal, glaciofluvial, and organic deposits. Discontinuous permafrost is present in the area.

Twelve terrain types were identified within the initial Project area (Teshmont 2008), although the information is also relevant to other sections of the current Project area. Surficial materials characterizing the terrain types observed are summarized in Table 9.4.2. Most of the Project area occurs on an upland plateau defined by bedrock with typical relief values of 100 m or less. Elevations range from 250 m above sea level (masl) at Twin Gorges, to 185 masl at the Lockhart River crossing and 440 masl at the Snap Lake Mine.

Table 9.4.2 — Terrain and Surficial Materials in the Project Area

Terrain Type	Subsurface Conditions
Organic Bog/Veneer and Lake Basin	Peat and organic-rich silt and clay
Alluvial Floodplain	Sand, minor silt, and/or gravel
Alluvial Terrace	Sand, minor silt, and/or gravel
Glaciolacustrine Beach	Sand and gravel
Glaciolacustrine Plain	Silt and sand, minor gravel and/or clay
Glaciofluvial Plain/Terrace	Sand and gravel; generally frozen in northern sections
Esker/Kame Complex	Sand and gravel
Ground/Drumlinoid Moraine	Silt-sand-gravel till, with cobbles and boulders
Moraine Veneer	Shallow till, over bedrock
Bedrock	Bedrock, sporadic shallow till veneer
Bedrock, Minor Moraine	Bedrock, discontinuous shallow till veneer
Bedrock, Minor Organics, and Lake Deposits	Bedrock, discontinuous shallow organic/lacustrine veneer

Source: Geo-Engineering, 2003 #544

Eskers, ridges, and other outwash deposits were identified as locally common, prominent features of the landscape. They can vary in size from a few hundred metres to hundreds of kilometres long, several hundred metres wide, and tens of metres high. These landforms are usually composed of gravels and cobbles, but may have high percentages of sands (Trenhaile 1998). Eskers that contain fine particle sizes have steep slopes (>20%) and low vegetative cover, which makes them potentially vulnerable to wind and water erosion.

Alluvial, lacustrine, and organic materials are common, but generally of limited extent. Large, very poorly drained organic deposits accumulate in depressions in the exposed bedrock. Discontinuous permafrost is associated with the organic deposits and can be described as having moderate to low ice content and sparse ice wedges.

9.4.1.3 ROUTE-SPECIFIC TERRAIN

A preliminary terrain baseline study in the Twin Gorges to Fort Reliance section of the Project area was completed between July, 2003, and March, 2004 (Rescan 2004). The following describes the landscape from the Twin Gorges facility north to the Lockhart River (Figure 9.4.1).

The terrain north of Twin Gorges consists of glacial material overlying undulating bedrock, although there are some level areas. Steep bedrock outcrops occur near the Taltson River, while hummocky terrain, dominated by steep and hummocky landforms, becomes more common north of Champagne Lakes. The area near Robinson Lake has low relief with few instances of exposed bedrock. Topography is more variable around Walker Lake, but is predominantly low relief in the form of gently undulating landforms. Slope values in this area do not exceed 50%, even where steep bedrock outcrops occur. Near Walker Lake, the topography pattern changes to a long, uniform, steep slope (>50%). The area between Walker Lake and Knox Lake is dominated by gently undulating, bedrock-dominated topography comprising glacial drift and weathered bedrock.

TALTSON Hydroelectric Expansion Project	**Developer's Assessment Report 2009**	**Surficial Terrain Areas**	**Figure 9.4.1**

N:\Active\GIS\2008\07-1328-0013 Taltson\Mapping\MXD\DAR_Figures/YK_134 Surficial Terrain Areas

Near Siltaza Lake, the topography is dominated by a large glacial outwash channel, characterized by glaciofluvial plains and a prominent esker. Beyond this glacial outwash channel, the terrain returns to a bedrock-defined landscape, with gently to moderately sloped topography.

The topography and geomorphology of the Snowdrift River Valley is unique when compared to the rest of the proposed route (Rescan 2004). A series of large esker complexes, including both crest and slope, were observed on northern and southern banks of the Snowdrift River. The Snowdrift River is characterized by a wide, relatively shallow channel containing numerous sandbars and islands.

The landscape immediately north of the Snowdrift River Valley has a relatively high proportion of exposed bedrock. Slopes vary from 27% to 50% and are undulating to hummocky. Farther north, but south of the Lockhart River, the transmission line ROW is dominated by low relief, undulating topography, and contains little exposed bedrock. Organic plains and depressions are limited in this area. Approaching the Lockhart River the landscape changes, becoming dominated by hummocky terrain with as much as 70% exposed bedrock. Several river gorges transect the route along this segment.

To the north of Fort Reliance is a broad, open plain where thick organic accumulations occur and drainage is poor. The Lockhart River crossing is defined by bedrock and materials are generally glaciofluvial in origin. Sediments are generally stable within this area (Rescan 2004). In the general region of the Lockhart River, the topography is higher in relief and contains a greater variance in slope gradients and exposed bedrock. The surface materials are slightly more variable, containing ground moraines and widespread colluvium (Geo-Engineering 2005).

North of the Lockhart River, the topography continues as undulating to hummocky terrain with varying degrees of exposed bedrock (Geo-Engineering 2003, 2005; Rescan 2004). Bedrock and till materials still dominate the landscape, but eskers are more common. Surface materials in this area may be slightly more variable, containing more colluvium and ground moraine materials (Geo-Engineering 2005). All active diamond mines (i.e., Ekati, Diavik, and Snap Lake) as well as the Gahcho Kué project are above the treeline, where surficial materials consist mainly of low-relief undulating bedrock with extensive esker systems and boulder fields.

9.4.1.4 SOILS

Much of the High Boreal Ecoprovince is exposed bedrock or bedrock-controlled shallow drift with soils of the Nonacho Lake 2 soils association. In general, these soils consist of sandy loam to loamy sand glacial till deposited as a veneer less than 1 m deep. The glacial till parent materials were derived mainly from granitic rocks. Common soil types are lithic phases of Eluviated Dystric Brunisols, with peaty phase Rego Gleysols in well-vegetated bedrock fractures (Bradley, Rowe, Tarnocai, & Ironside, 1982).

Soils associated with eskers, outwash plains, and major river terraces are commonly non-calcareous sands and gravels created through ice-contact, glaciofluvial or recent fluvial origin, referred to as the Snowdrift River 1 soil association. In the well-drained, vegetated sites, Eluviated or Orthic Dystric Brunisols typically occur, with

Orthic Regosols on eroded sites (Bradley et al. 1982). Gleyed Dystric Brunisols or peaty phase Rego Gleysols can also occur on esker toe slopes or adjacent depressions. These imperfectly drained mineral soils generally mark the transition to organic soils composing the Taltson River Association in the Project area (Table 9.4.3). Taltson River soils are found in the wetland areas and are typically Fibric and Mesic Cryosols developed from deep fibric Sphagnum peat as well as both mesic forest and fen peat (Bradley et al. 1982).

The High Subarctic Ecoprovince boundary roughly parallels the change from woodland to tundra. This change is accompanied by several characteristic terrain features including eroded polygonal peat plateaus, collapsed “peat cliffs” marking thaw extensions of lake bays, and strongly sorted stone nets in lake shallows. The thickness of the till mantle may range from several centimetres to several metres over the underlying bedrock (Bradley et al. 1982).

All the till soil associations in the High Subarctic are sandy loam to loamy sand in texture. Soils are mainly Brunisols with Eluviated Dystric Brunisols, which are often cryoturbated (soil horizons are disturbed, mixed, or broken through ice freeze-thaw activity within the profile) where bedrock is close to the surface, and occur on well-drained sites. Orthic Dystric and Gleyed Dystric Brunisols are found in the downslope positions. Shallow peats on lower slopes overlie Gleyed Turbic Cryosols with some segregation of ice crystals, veins, and lenses. In general, the ice content is low, and patterned ground, where it occurs, is in the form of non-sorted circles (Bradley et al. 1982).

Table 9.4.3 provides a summary of the Project area’s soil types.

Table 9.4.3 — Summary of Soil Types Within the Project Area

Soils Association	Associated Soil Types	General Soil Characteristics	Soil Patterns
Nonacho Lake 2	Lithic phase Eluviated Dystric Brunisols	Coarse-textured sands, loamy sands and sandy loams Generally rapidly to well-drained (dry) soils Developed on glaciofluvial parent materials Eluviated Dystric Brunisols are acidic soils with a developed Ae horizon (mineral horizon near the surface, formed through the eluviation of clay or iron)	Occur with exposed bedrock or on bedrock-controlled shallow drift Thin veneer (<1 m) of sandy loam to loamy sand over glacial till Lithic phase: lithic (bedrock) contact generally within 1 m of surface

Soils Association	Associated Soil Types	General Soil Characteristics	Soil Patterns
	Peaty phase Rego Gleysols	Soils exhibiting gleying (an indication of prolonged, intermittent, or continuous saturation with water during soil development) Generally imperfectly to poorly drained (wet) Developed with a wide range of texture classes on a variety of parent materials including glaciofluvial, glaciolactustrine, and glacial till deposits Rego Gleysols lack a well defined B horizon	Occur in local topographic lows and well-vegetated bedrock fractures Peaty phase: peat layer at soil surface is typically 15-40 cm thick
Snowdrift River 1	Eluviated or Orthic Dystric Brunisols	Coarse-textured sands, loamy sands, and sandy loams Generally rapidly to well-drained (dry) soils Developed on glaciofluvial parent materials Eluviated Dystric Brunisols are acidic soils with a developed Ae horizon Orthic Dystric Brunisols are acidic soils which lack a developed Ae horizon	Occur in the well-drained, vegetated areas of eskers, outwash plains, and major river terraces
	Orthic Regosols	Developed with a wide range of texture classes on a variety of parent materials including alluvium (sediment deposited by flowing water), and colluvium (unconsolidated materials moved by gravity as on unstable slopes) Generally rapidly to imperfectly drained soils Have insufficient horizon development as in the other soil groups	Occur in eroded areas typical of eskers, outwash plains, and major river terraces
	Gleyed Dystric Brunisols	Coarse-textured sands, loamy sands, and sandy loams Generally well to imperfectly drained soils Developed on glaciofluvial parent materials Gleyed Dystric Brunisols are acidic soils exhibiting gleying	Occur in esker toe slopes or adjacent depressions (local topographic lows)

Soils Association	Associated Soil Types	General Soil Characteristics	Soil Patterns
	Peaty phase Rego Gleysols	Soils exhibiting gleying (an indication of prolonged, intermittent, or continuous saturation with water during soil development) Generally imperfectly to poorly drained (wet) Developed with a wide range of texture classes on a variety of parent materials including glaciofluvial, glaciolactustrine, and glacial till deposits Rego Gleysols lack a well defined B horizon	Occur in esker toe slopes or adjacent depressions (local topographic lows) often marking the transition to organic (deep peat soils) Peat layer at soil surface is typically 15-40 cm thick
Taltson River Association	Fibric and Mesic Cryosols	Parent materials typically consist of *Sphagnum spp* peat Generally poorly to very poorly drained Cryosolic soils can be mineral or organic soils and have a permafrost layer (perennially frozen material) within 1 m of the surface in some part of the soil profile Fibric Cryosols exhibit the least amount of decomposition of the peat material; Mesic Cryosols exhibit some degree of decomposition of peat materials	Occur in wetland areas
Coldblow Lake, Lynx Lake, Wolverine Lake	Cryoturbic phase Eluviated Dystric Brunisols	Coarse-textured sands, loamy sands, and sandy loams Generally rapidly to well-drained (dry) soils Developed on glacial till parent materials Eluviated Dystric Brunisols are acidic soils with a developed Ae horizon	Occur on a variety of till landforms from generally level ground moraine plains to undulating and steeper ice-moulded features The thickness of the till mantle may range from several centimetres to several metres over bedrock Cryoturbic phase: admixing of organic layer materials within the mineral profile resulting from cryoturbation
	Orthic Dystric and Gleyed Dystric Brunisols	Coarse-textured sands, loamy sands, and sandy loams Generally well to imperfectly drained soils Developed on glacial till parent materials Gleyed Dystric Brunisols are acidic soils exhibiting gleying Orthic Dystric Brunisols are acidic soils that lack a developed Ae horizon	Occur on a variety of till landforms generally in the downslope positions The thickness of the till mantle may range from several centimetres to several metres over bedrock Cryoturbic phase: admixing of organic layer materials within the mineral profile resulting from cryoturbation

Soils Association	Associated Soil Types	General Soil Characteristics	Soil Patterns
	Gleyed Turbic Cryosols	Cryosolic soils can be mineral or organic soils and have a permafrost layer (perennially frozen material) within 1 m of the surface in some part of the soil profile Till parent material Generally poorly to very poorly drained Turbic Cryosols have a Bm horizon and horizons are strongly disrupted by cryoturbation; evidence of gleying is generally not strong but occurs just above the permafrost	Occur on a variety of till landforms generally in the downslope positions Shallow peat surface occurs above mineral horizons The thickness of the till mantle may range from several centimetres to several metres over bedrock

9.4.2 Areas of Potential Instability

9.4.2.1 Geological Stability and Seismicity

The proposed Project area is not subject to measurable seismic events and is considered a seismically stable region (Adams & Halchuk 2004), with the following three exceptions:

- failures in heavily weathered bedrock near Knox Lake (i.e., rock falls and rock slides) (Rescan 2004);
- a large tectonic fault near Siltaza Lake (Rescan 2004); and
- a major shear zone near Great Slave Lake (Geological Survey of Canada 1991; Peirce, Corsden & Glenn, 2001).

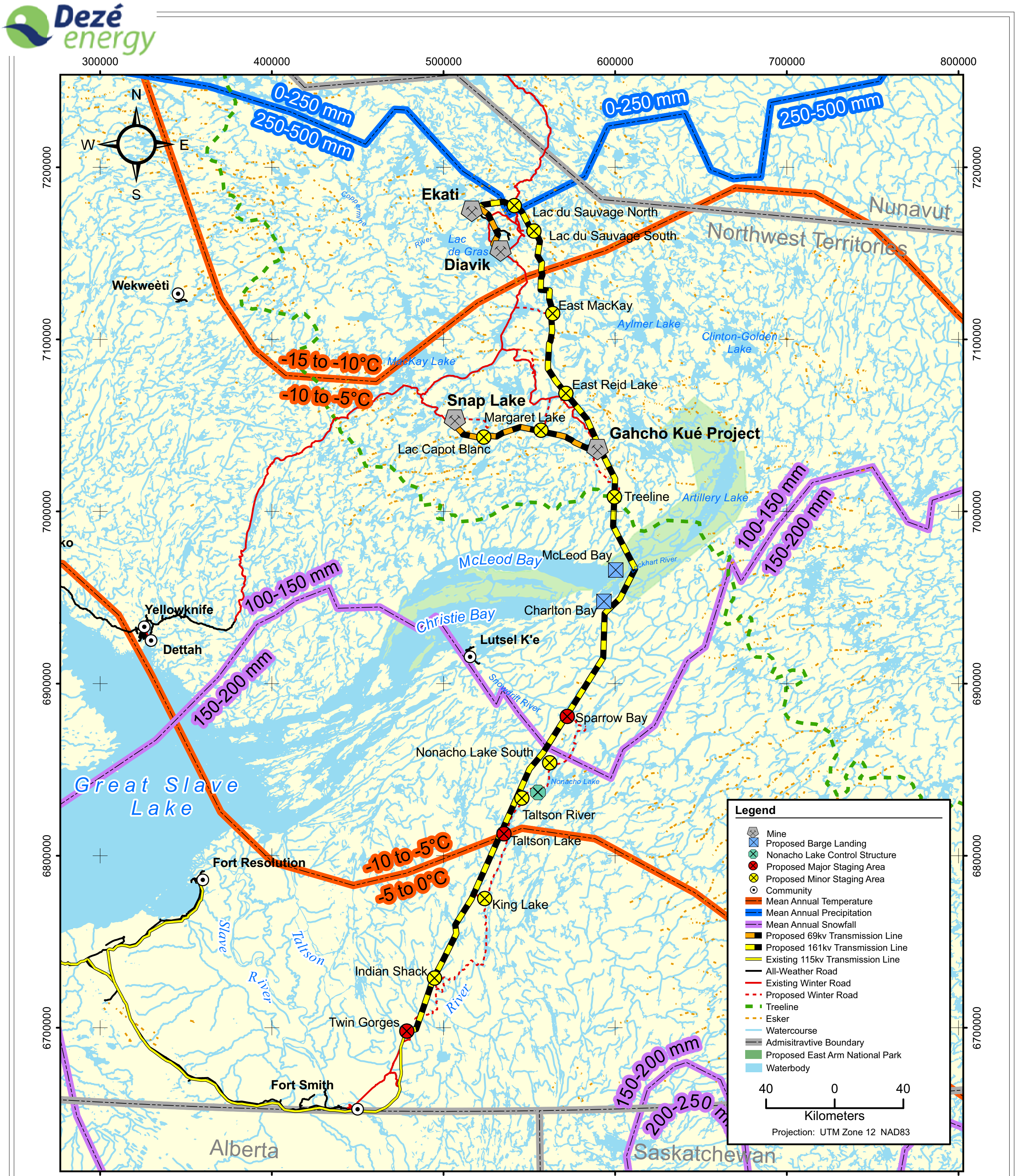
In addition, eskers with potentially steep slopes and permafrost, both discontinuous and continuous, occur throughout the route (Geo-Engineering 2003, 2005; Rescan 2004).

9.4.2.2 Permafrost

Permafrost is defined as soils that have a frozen or “cryic” layer throughout the year, which form in saturated soils that freeze to depths well below the ground surface. Below the ground surface and above the upper boundary of the permafrost layer is the active layer. In the Canadian Subarctic, the active layer may be up to 1.5 m or more in thickness (French & Slaymaker 1993). Within the Project area extending from the Taiga Shield Ecozone to the Southern Arctic Ecozone, the thickness of the active layer depends on a number of factors including:

- ambient air temperatures (Figure 9.4.2),
- slope angle and orientation,
- vegetation cover,
- duration of snow cover;
- depth and density of ice wedges,
- soil and rock type, and
- ground moisture conditions.

The stresses produced from these combined factors can affect the amount of activity in the active layer. In northern Canada, stresses may result in movement rates of the order of 0.5 to 10.0 centimetres per year (cm/y). Active layer failures are common, but are difficult to predict (French & Slaymaker 1993). In the Taiga Shield Ecozone, failures often follow destruction of vegetation. Maintaining the geotechnical stability of the terrain when dealing with cryosolic (permafrost) soils requires consideration of the capacity of these soils to store and preserve organic carbon.



TALTSON Hydroelectric Expansion Project | Developer's Assessment Report 2009 | Mean Annual Temperature, Precipitation, and Snowfall | Figure 9.4.2

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Discontinuous permafrost is present in the southern portions of the Project area (i.e., Taiga Shield Ecozone), while continuous permafrost characterizes the northern portion of the Project area (i.e., Southern Arctic Ecozone; Geo-Engineering 2003, Figure 9.4.2). The preliminary geotechnical evaluation suggested that permafrost would be relatively thin, sporadically distributed, and linked primarily to organic materials in the southern region (Geo-Engineering 2003). Permafrost is expected to get progressively thicker (as much as 200 m or greater) towards the boundary separating discontinuous permafrost from continuous permafrost (Geo-Engineering 2003). The section of the proposed route between Lockhart River and Ekati lies primarily in the continuous permafrost zone. Therefore, conclusions regarding permafrost depths reaching greater than 200 m (Geo-Engineering 2003) can be extrapolated to this section of the proposed Project route with the exception of the area between Lockhart River and Gahcho Kué, which appears to lie near the northern extent of the discontinuous permafrost zone. In the Project area's northern portion, as much as 80% to 90% of the surface may be occupied by permafrost (Geo-Engineering 2003). Some organic deposits were identified between the south end of the proposed route and Snap Lake, but there was insufficient information to map permafrost in these areas (Rescan 2004). No spatial estimates of ice content were completed during preliminary baseline studies.

Permafrost is generally associated with organic deposits; however, cryosolic soils do occur on mineral material, especially in the northerly portions of the Project area. When organic cryosolic soils melt, carbon is released as either carbon dioxide or methane, which contributes to greenhouse gas emissions. Permafrost is vulnerable to melting following vegetation clearing because the surface insulating layer is lost, and melting in the summer months deepens the unfrozen layer. In addition, organic deposits have complex hydrological, chemical, and biotic conditions. Disturbed organic soils are susceptible to desiccation, which is difficult to reverse. The loss of permafrost and associated ice wedges creates a softer surface layer, which can reduce soil geotechnical stability in relation to road construction (Strahler & Strahler 1992; Trochim & Lipovsky 2007) and structural pilings for transmission line towers.

9.4.2.3 Acid Rock Drainage

Acid Base Accounting (ABA) testing was completed on ten granite gneiss samples from the Twin Gorges and Nonacho sites collected between July 6 and 10, 2008 (Appendix 6A). Two surface samples each from the Twin Gorges site, South Valley Spillway, and the Nonacho Lake Control Structure were collected, as well as four sub-surface samples from the Twin Gorges site (ranging from 9.3 m to 36.7 m depth). Modified ABA tests were performed according to Canmet NMB-1 standard on each sample to assess the potential for acid generation. Testing was performed by SGS Mineral Services, Burnaby, British Columbia.

The ABA testing indicated that the granite gneiss samples were alkaline (pH ≥8.5) and were not currently acid-generating. Total sulphide-sulphur ($S[S_{2-}]$) is uniformly low indicating a low concentration of acid-generating minerals. The high Sobek NPR values (i.e., high neutralization potential and low acid-production potential) indicate there is sufficient long-term neutralizing potential in the form of silicate buffering. As such, these samples can be classified as non-acid generating (Appendix 6A).

9.4.3 Climate

The Northwest Territories' climate is generally dry and cold, with long winters and mild summers. Dry conditions are caused by the persistence of high pressure systems originating in northern Siberia, and the Arctic and Greenland ice-caps. The area is also in the rain shadow created by the western Cordillera. In the Project area, the period from November to May is typically relatively dry compared to wetter conditions in the late summer to early fall, caused by storm systems bringing moist air into the region from the south and southwest (Government of Canada 1990). Lake-effect precipitation may also play a role in fall precipitation because of the Project's proximity to many large water bodies, including Great Slave Lake. This effect occurs when cooler air passes over warmer water, picking up moisture and heat and subsequently releasing precipitation along the downwind shore.

Parameters used to describe the Project area's climate include air temperature and precipitation, both of which would have a direct influence on the Project's operation. Air temperatures control evaporation, dictate annual rain-to-snow ratios, and cause snowmelt as well as ice freeze-up and break-up. Precipitation represents water inputs to the basin, a portion of which translates into runoff.

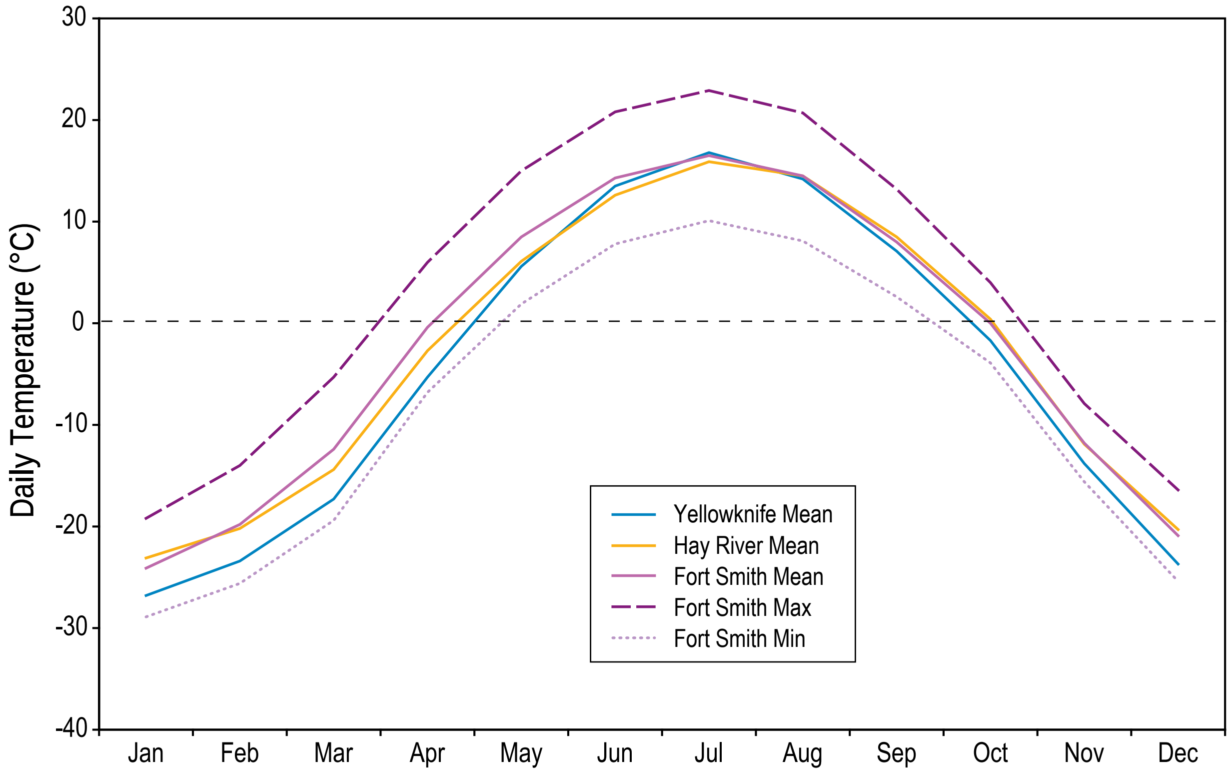
9.4.3.1 Data Sources

Three meteorological stations, one in Yellowknife (62.45°N, 114.43°W), one in Fort Smith (60.02°N, 111.95°W), and one in Hay River (60.83°N, 115.77°W) were used to characterize the area's existing climate. Data from these stations were obtained from Environment Canada for the climate normal period spanning 1971 to 2000. Fort Smith, having a long period of record and being nearest to the Project, is considered to be the most representative for the Project area. Finally, specific to the Project area, short-term monitoring was conducted at Nonacho Lake in 2003.

Air Temperature

Based on the three meteorological stations near the Project area, mean annual air temperature ranges from -4.6 °C at Yellowknife to -2.3 °C at Fort Smith. Figure 9.4.3 compares the average monthly daily mean temperatures between the three stations, which are shown to be very similar. Because they are at higher latitude, temperatures are colder at Yellowknife compared to the other two stations, except for the summer period from June to August, when all three stations are almost equal. Also shown for the Fort Smith station are the daily maximum and daily minimum temperatures, averaged for each month. Figure 9.4.3 shows that the range of daily temperatures at Fort Smith is much greater than the range of mean temperatures across the three stations.

At Fort Smith, mean temperature is above freezing levels (0 °C) during half of the year (i.e., April to October), and maximum temperatures exceed freezing levels for about an extra month of the year. This temperature parameter is important in controlling northern hydrology processes such as snowmelt; the snowpack begins to ripen as soon as surface air temperatures exceed the freezing point, and the snowpack may begin to melt soon thereafter. The greatest average monthly maximum temperature occurs during the month of July, and is 22.9 °C. Average monthly minimum temperature reaches as low as -28.9 °C during the month of January.



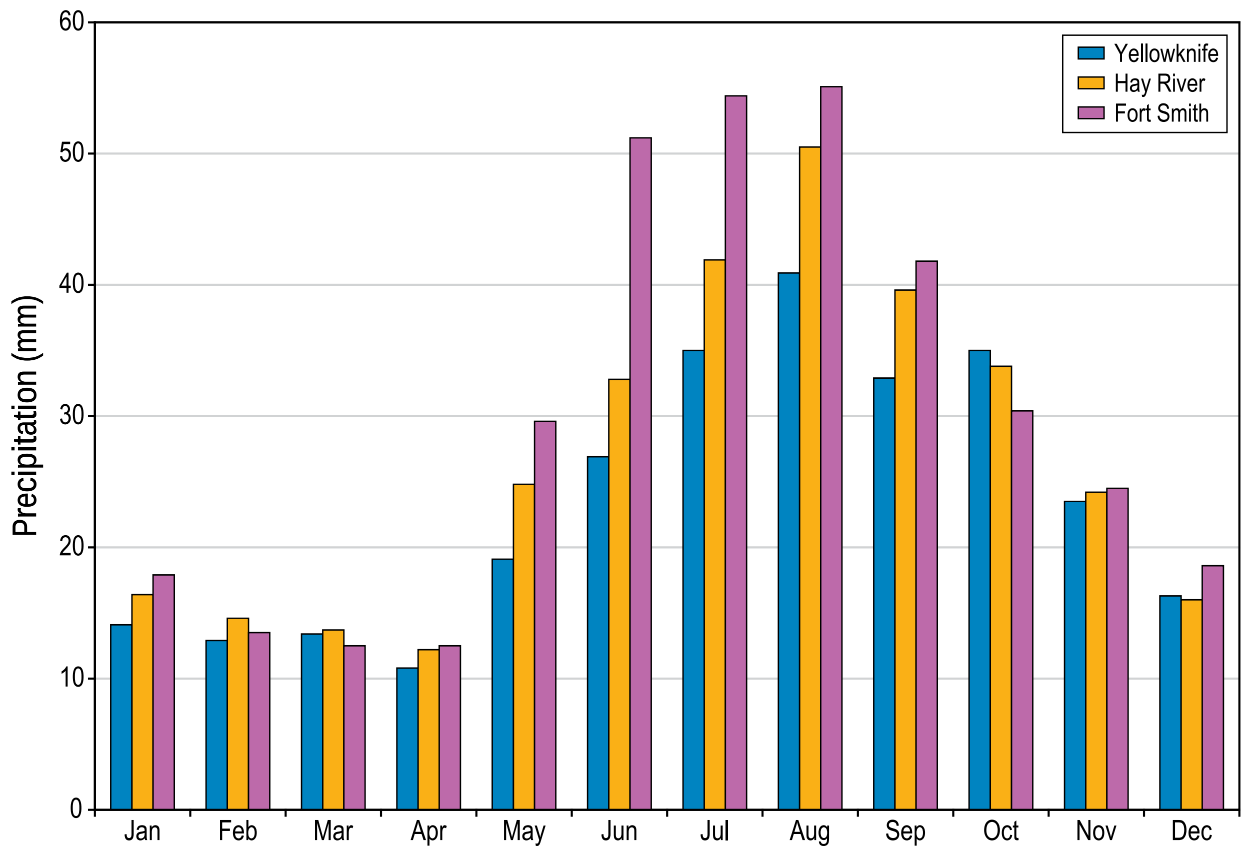
TALTSON Hydroelectric Expansion Project	**Developer's Assessment Report 2009**	**Average Monthly Temperature at Three Stations near the Project Area: 1971 to 2000**	**Figure 9.4.3**

Precipitation

The average annual precipitation among the three meteorological stations ranges from 280.7 mm to 362.0 mm. Figure 9.4.4 compares their average monthly precipitation. The distribution is similar at all stations, with higher totals during the warmer months of June to October. During this period there is a marked precipitation gradient with greater summer precipitation at lower latitude stations. For example, Yellowknife, on average, experiences 170.7 mm of precipitation from June to October, while Hay River experiences 198.6 mm during this period. Fort Smith experiences the greatest average precipitation during this period, at 232.9 mm.

Weighing annual precipitation more strongly toward the Fort Smith station (because it is closest to the Project area) compared to the other two stations, average annual precipitation is estimated to be 350 mm for the Project area. Monthly precipitation distribution and type is presented in further detail in Table 9.4.4. During the months spanning June to October, 64% of the annual precipitation occurs. Rainfall comprises 68% of annual precipitation. On average, mean snow depth reaches a maximum of 50.0 cm, and typically occurs in February.

A considerable portion of precipitation inputs are lost to evaporation. In winter, a portion of the snowpack is sublimated, which is enhanced during windy periods. In summer, evaporation occurs because of the many lakes and wetlands surrounding the Project area. The average annual lake evaporation in the area is estimated to range between 300 mm and 400 mm (Government of Canada 1990).



60
50
40
30
20
10
0
Precipitation (mm)
Yellowknife
Hay River
Fort Smith
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

Table 9.4.4 — Average Monthly Precipitation at Fort Smith: 1971 to 2000

Month	Rainfall (mm)	Snowfall (cm)	Total Precipitation (mm)	Mean Snow Depth (cm)
Jan	0.0	24.5	17.9	40.0
Feb	0.1	19.3	13.5	50.0
Mar	0.3	16.0	12.5	46.0
Apr	4.6	9.2	12.5	20.0
May	26.3	3.4	29.6	0.0
Jun	51.2	0.0	51.2	0.0
Jul	54.4	0.0	54.4	0.0
Aug	54.9	0.2	55.1	0.0
Sep	41.1	1.0	41.8	0.0
Oct	12.5	20.5	30.4	2.0
Nov	1.4	31.9	24.5	15.0
Dec	0.1	25.1	18.6	30.0
Total	**246.9**	**151.2**	**362.0**	**203.0**

Site-Specific Data

Because of the predominance of open water bodies in the Project area, short-term monitoring of several parameters, including evaporation and wind speed, was conducted at Nonacho Lake for 55 days in 2003 (Rescan 2004). Results are shown in Table 9.4.5. The total open water evaporation (using the Penman Combination Model) for 55 days of monitoring was 125 mm. The average wind speed 2.3 m above the water surface was relatively constant at 4.5 m/s. The maximum instantaneous wind gust for the monitoring season was 14.3 m/s (51 km/hr) recorded on August 2, 2003.

The average air temperatures gradually decreased near the end of the monitoring season. Air temperatures were near freezing when the station was dismantled on September 22, 2003. The total rainfall recorded during the monitoring period was 61.2 mm. The highest daily rainfall was 18.8 mm on August 23. Mean daily net and short-wave radiation gradually decreased toward the end of the monitoring season as the hours of sunlight decreased. The relative humidity values were nearly constant, around 74%.

Table 9.4.5 — Nonacho Lake Meteorological Station Summary: 2003

Month	Avg Wind Speed[1]	Maximum Instantaneous Wind Gust (m/s)	Penman Open Water Evaporation (mm)	Average Air Temp (°C)	Total Rain (mm)	Mean Daily Net Radia-tion (W/m^2)	Mean Daily Incoming Short Wave Radiation (kW/m^2)	Mean Monthly Relative Humidity[2]
Jul[3]	4.5	12.8	8.7	20.1	0.3	127.6	0.21	60.5
Aug	4.2	14.3	83.4	14.6	51.3	86.2	0.16	73.2
Sep[4]	4	14	32.5	10	9.6	36.9	0.11	74.1
Total	**-**	**-**	**124.6**	**-**	**61.2**	**9**	**-**	**-**

[1] Measured at 2.3 m above water (m/s)

[2] Measured at 2.05 m above water (%)

[3] Data began July 30th

[4] Data ended September 22nd

9.4.4 Air Quality

The only existing anthropogenic air emissions within the remote Project area are the emissions associated with mines (e.g., Ekati, Diavik, Snap Lake) around the Project area and the existing facility, which provides hydroelectricity to the towns of Fort Smith and Hay River. Emissions are primarily from vehicle, aircraft, and equipment exhaust, and include air contaminants such as CO_2, SO_2, NO_x, CO, PM_{10}, and $PM_{2.5}$. In addition, traffic along unpaved roads results in emissions of fugitive dust and particulate matter (PM). Overall, the existing facility's current air contaminant and greenhouse gas (GHG) emissions can be considered low or negligible. Natural sources of background air emissions include those resulting from tundra wildfires.

Data for emissions from the existing facility are not available. When site-specific background concentrations are unknown or uncertain, conservative (high) estimates of background concentrations from available data sources can be used. Table 9.4.6 shows typical background air contaminant concentrations assumed for the Project area. The concentrations represent the medium to upper range of observed concentrations in the Northwest Territories and Nunavut (GNWT 2006).

Table 9.4.6 — Assumed Background Air Contaminant Concentrations

Air Contaminant	Assumed Background Concentration ($\mu g/m^3$)
Sulphur Dioxide (SO_2)	7
Nitrogen Dioxide (NO_2)	10
Carbon Monoxide (CO)	100
$PM_{2.5}$	5
Total Suspended Particulates (TSP)	7.5
Ozone (O_3)	60
Total Dustfall (g/m^2/year)	**0.8**

9.4.5 Noise

Noise is defined as unwanted sound and is characterized by the pressure of sound waves. Humans have non-linear sound perception; for instance, the sound level is perceived as doubled when there is a ten-fold increase in sound pressure. The decibel (dB) is a logarithmic measure of noise level that incorporates this non-linearity. It is defined as the logarithm of the ratio of the root mean square (rms) sound pressure with respect to the standard rms sound pressure. The standard rms sound pressure is the hearing threshold below which the human ear cannot detect sound; it is usually 20 μPa. For humans, a change in sound level is only perceived if the change is greater than 3 dB.

Human sound detection is dependent on frequency, and therefore sound pressure is weighted by its frequency. Most common is the "A" weighting, which represents human hearing, given in units of "dBA." Examples of typical noise levels (dBA) are shown in Table 9.4.7.

Table 9.4.7 — Typical Noise Level Examples

Example	Noise Level (dBA)
Rustling leaves	20
Living room and humming of refrigerator	40
Normal conversation	60
Business office	65
Average city traffic	80 to 85
Jack hammer	100
Jet take-off at 100 m distance	130
Motorcycles and small firearms	up to 140

The human pain threshold is 130 dBA (Brüel & Kjær 2001).

In the Project area, there are natural background noise sources such as wind, rain, storms, waterways, and wildlife. The primary anthropogenic noise source at the Project site is the existing hydroelectric facility. Baseline data for noise from the existing facilities' Project area are not available but background noise levels in undisturbed areas typically range from 30 to 40 dBA (BKL, 2004). This range can vary as environmental noise is typically not steady and continuous but varies over time. Because of the Project's remote location, there are no communities or residences near the site. However, there are concerns regarding the effects of the facility, traffic, and construction noise on wildlife.

A study of a proposed hydroelectric power plant in B.C. (Ashlu), which is similar to the existing Twin Gorges power facility, predicted a "worst case" power plant noise level during operations of 22 dBA at a distance of 2.7 km (BKL 2004). It is assumed that these "worst case" noise levels would be similar for the Project. Additional noise caused by activities associated with the existing facility such as helicopters, fixedwing aircraft, and vehicles generate short-term elevated sound levels in the Project area.

9.4.6 Water Quality

Surface water in the Taltson Basin is an intrinsic component of the biological and physical environment. It acts as an indicator of environmental health because it is linked to other key ecosystem components such as fish and fish habitat, aquatic resources (benthos, zooplankton, phytoplankton, and periphyton), soil, vegetation, and wildlife. Below is a summary of the available water quality data within the Project area. More detailed summaries of water quality data from the Taltson River and Trudel Creek are provided in Sections 13.4 and 14.4 Trudel Creek Water Quality and Taltson Water Quality respectively.

9.4.6.1 TALTSON RIVER (EXCLUDING TRUDEL CREEK)

Baseline water quality studies focused on the primary water bodies that the Expansion Project would affect, specifically Nonacho Lake, within and immediately downstream of the Twin Gorges Forebay, and Trudel Creek. Data for Nonacho Lake and the area near the Twin Gorges Forebay are summarized in this section, while data for Trudel Creek are presented in the following section.

A range of water quality parameters was measured in Nonacho Lake and near the Twin Gorges Forebay to establish the existing water quality. Water from the study area was sampled and analyzed for physical parameters, dissolved anions, nutrients, total and dissolved metals, and total organic carbon.

Water samples were collected from three pairs of shallow and deep stations in Nonacho Lake in 2003 and 2004. In 2003, twelve water samples were analyzed for all water quality parameters described in Section 13.4. In 2004, 24 samples were analyzed for alkalinity and nutrients. Temperature and dissolved oxygen depth profiles were also surveyed for stratification at three sites in Nonacho Lake in 2008.

Nonacho Lake surface waters were clear (low turbidity), soft, slightly alkaline, and had very low concentrations of nutrients and total metals. Turbidity ranged from 0.3 to 0.9 nephelometric turbidity units (NTU) and total suspended solids (TSS) ranged from <1 mg/L to 5.3 mg/L. The lake is oligotrophic, with most nutrients near detection limits, and has a low buffering capacity. Total metal concentrations were similar among sites, and all of the measured water variables had concentrations well below the CCME guidelines for the protection of aquatic life. Temperature profiling showed that Nonacho Lake (which is 30 m deep) water temperature averaged 15 ºC to 16ºC at depths to 11 m. At 15 m, a mild thermocline was noted. Dissolved oxygen content was near 100% saturation, well-oxygenated and varied between sites, but did not change with respect to depth.

Water samples were collected at three pairs of shallow and deep stations in the Twin Gorges Forebay area in August, 2004. Four samples were collected in shallow waters and two in deep waters (13 m to 17 m). The samples were analyzed for physical variables, dissolved anions, nutrients, and organic carbon.

Twin Gorges Forebay water was clear, soft, slightly alkaline, and had very low concentrations of nutrients. The Forebay is oligotrophic with a low buffering capacity, and has similar ranges of measured parameters to Nonacho Lake. Total metal concentrations in the Twin Gorges Forebay were not assessed.

Water samples were also collected in May 2007 at three locations immediately downstream from the existing facility. The sites were selected to assess the effect of water turbulence and sediment disturbance at the existing facility, at the confluence with Trudel Creek, and the attenuation of effects farther downstream. The samples were analyzed for turbidity and TSS.

The water at Elsie Falls was clear, and contained lower TSS than the Twin Gorges Forebay water. At the confluence with Trudel Creek, turbidity and TSS increased slightly, indicating some influx of these parameters from Trudel Creek.

9.4.6.2 TRUDEL CREEK

In Trudel Creek, baseline water quality data is available for Trudel Creek, Unnamed Lake, Trudel Lake, and Gertrude Lake. Water samples were collected in August 2008 at 10 sites in Trudel Creek, Unnamed Lake, Trudel Lake, and Gertrude Lake. Water quality samples were also collected in August 2007 at three sites in Trudel Creek. The samples were analyzed for physical and organic parameters, dissolved anions, nutrients, and total metals.

Each water body showed similar water quality: soft, relatively clear, and slightly alkaline with a low buffering capacity, dissolved anions, and nutrient content. Total metal concentrations were below the Canadian Council of Ministers of the Environment (CCME) guidelines except one water sample in Trudel Lake, which had chromium and copper concentrations slightly above CCME guidelines. Total mercury concentrations were either below or marginally above detection levels.

In 2007, samples were collected at nine locations in Trudel Creek. These samples were analyzed for turbidity and TSS. Overall, the water was relatively clear with a turbidity ranging from <3.0 NTU to 12.5 NTU and TSS ranging from 2.73 mg/L to 4.66 mg/L. Water turbidity was slightly higher at lake inlets compared to lake outlets.

Temperature and dissolved oxygen depth profiles were collected between July 2007 and June 2008 from Trudel Lake, upstream from Unnamed Lake, and Gertrude Lake. Trudel Creek and lake waters were warm (17 ºC to 18 ºC) and well oxygenated (9.6 mg to 13.8 mg O_2/L) during the summer months. No thermal stratification was observed.

In addition to collecting temperature and dissolved oxygen depth profiles, three Tidbit temperature data loggers were installed in the Trudel system in August, 2007 set to collect data every 2 hours, 24 hours/day, 365 days/year.

After one year, data loggers indicated that peak water temperatures occurred between June and August and ranged from 18 °C to 20 °C. Water temperatures steadily dropped between September and November to zero or sub-zero degrees.

Bank erosion and sedimentation were assessed at three sites in Trudel Creek. The erosion assessment was conducted in July 2008, corresponding to the peak flow month through Trudel Creek.

The three monitoring sites included a site just downstream of the South Valley Spillway (SVS), one at the outlet of Gertrude Lake, and another along the reach between the Gertrude Lake outflow and the confluence with the Taltson River.

The monitoring site downstream of the SVS has a wide, shallow floodplain, is a depositional area during low flow periods, and is a potential site of erosion during high flows or high water levels. The floodplain consisted of 68% sand and 32% fines, which provide some stream bank cohesion. Overall, this site was rated as having a medium potential to erode.

The monitoring site at the outflow from Gertrude Lake was composed of a sediment deposit bar and sand bank. The bank comprised sand and cobblestone, which provide natural armouring against erosion. Overall, this site was rated as having a low potential to erode.

The monitoring site along Trudel Creek, midway between the Gertrude Lake outflow and the confluence with the Taltson River, contains self-armouring regions composed of cobblestones that reduce water velocity, causing backflows and sedimentation zones. The potential for erosion from high water flows in this area is low. However, mudslide regions were noted where heavy rainfall had reduced bank stability. Thus, this site was rated as having a high potential to erode.

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9.5.1.1 FISH

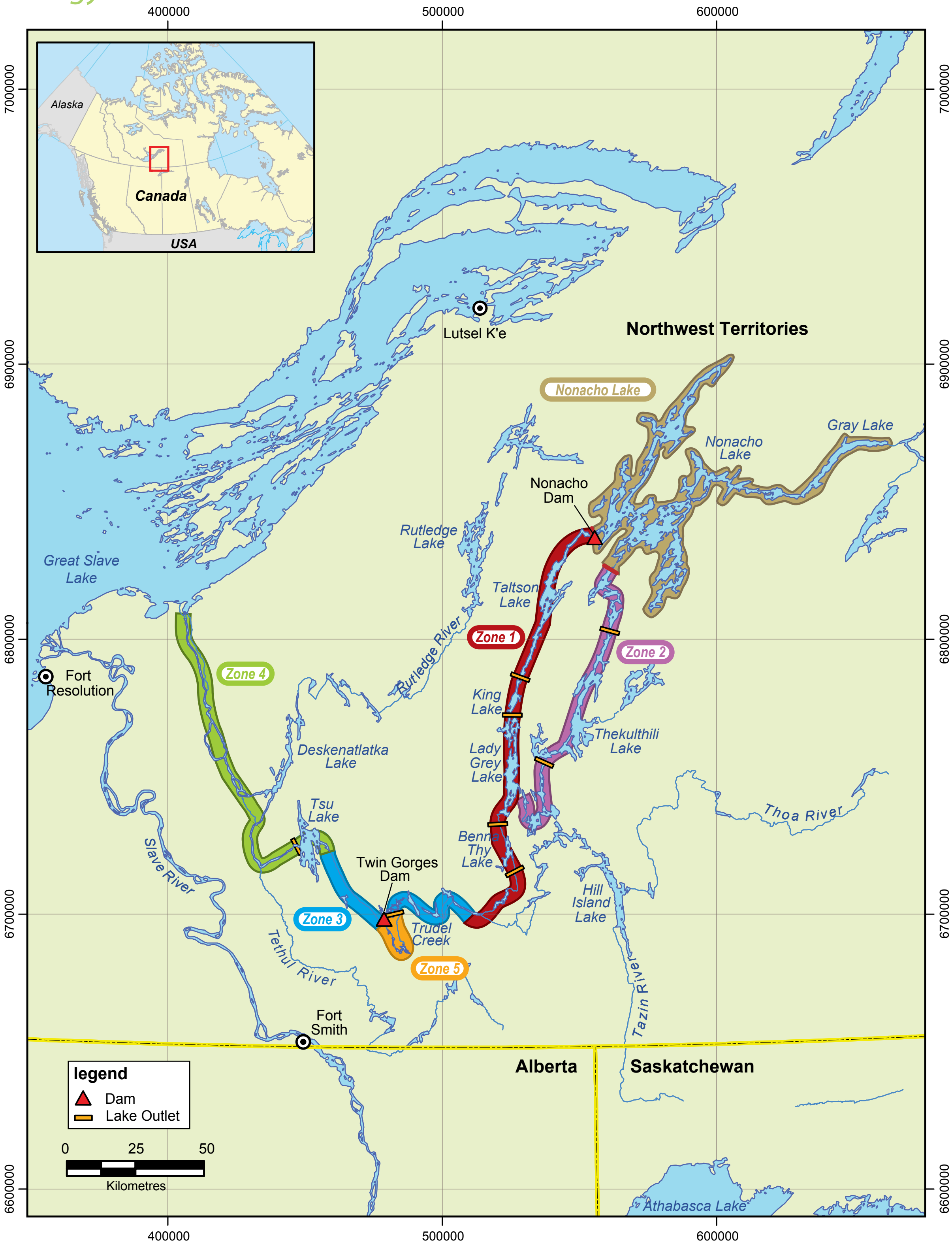
Many fish species serve an important role in the ecological, economic, and cultural aspects of the NWT. Fish species are captured in recreational fisheries, support local economies and cultures, and some species act as indicators of aquatic environmental health. Fish and fish habitat are protected under federal legislation, such as the Fisheries Act.

The Fisheries Act defines fish habitat as "spawning grounds and nursery, rearing, food supply and migration areas on which fish depend directly or indirectly to carry out their life processes." The Fisheries Act also prevents the "harmful alteration, disruption, or destruction" (HADD) of fish habitat through physical, chemical, or biological means (DFO 1985), and the 'Policy for the Management of Fish Habitat' (DFO 1991), which outlines Fisheries and Oceans Canada's (DFO) policy statement of "no net loss of productive capacity" of fish habitat.

The Expansion Project would span a wide range of fish habitat including lakes, rivers, streams, and wetlands. Fish-bearing water bodies are located along the proposed transmission line and winter road. Power generation would involve Nonacho Lake, the upper and lower Taltson River, and associated lakes from Nonacho Lake to Great Slave Lake, and Trudel Creek.

The section of the Taltson River potentially affected by the Project includes Nonacho Lake and the Taltson River downstream from Nonacho Lake to Great Slave Lake. This area has been divided into Nonacho Lake and five zones for the purpose of the Project (Figure 9.5.1). Zones 1 to 4 are discussed with respect to the Taltson River Watershed and Zone 5 is discussed with respect to Trudel Creek within the Taltson River Watershed.

The majority of the lakes and rivers in the Project area eventually drain into Great Slave Lake, with the exception of the section of transmission line north of MacKay Lake, which is in the Coppermine River watershed. There are 17 fish species present within the Taltson River. Table 9.5.1 summarizes the key fish species found within Great Slave Lake, Taltson River, Trudel Creek, and in water bodies along the proposed transmission line and winter haul road.



TALTSON Hydroelectric Expansion Project	**Developer's Assessment Report 2009**	**Geographic Setting of the Taltson Basin Flow Model** (503-004 / a22589w)	**Figure 9.5.1**

Table 9.5.1 — Key Fish Species Known to be Present in the Project Area

Common Name	Scientific Name	LOCATION				Notes
		Great Slave Lake	Taltson River	Trudel Creek	Tundra Water-courses	
Arctic grayling	*Thymallus arcticus*	X	X		X	Mid-sized sport fish, lakes and streams
Arctic lamprey	*Lampetra japonica*	X				Present in Great Slave Lake
Brook stickleback	*Culaea inconstans*	X				In tributaries to Great Slave Lake
Burbot	*Lota lota*	X	X	X	X	Large predator, lakes and streams
Chum salmon	*Oncorhynchus keta*	X				Spawns in tributaries to Great Slave Lake
Deepwater sculpin	*Myoxocephalus quadricornus*	X				Present only in Great Slave Lake, lake resident only
Emerald shiner	*Notropis atherinoides*	X				In tributaries to Great Slave Lake
Flathead chub	*Platygobio gracilis*	X				Present in Great Slave Lake
Goldeneye	*Hiodon alosoides*	X				Present in Great Slave Lake
Inconnu	*Stenodus leucichthys*	X	X			In tributaries to Great Slave Lake
Lake chub	*Couesius plumbeus*	X	X		X	Small forage fish, lake resident
Lake cisco	*Coregonus aretedii*	X	X	X	X	Large forage fish
Lake trout	*Salvelinus namaycush*	X	X		X	Large predator, lake resident
Lake whitefish	*Coregonus clupeaformis*	X	X	X	X	Large forage fish, lake resident
Least cisco	*Coregonus sardinella*	X				Present in Great Slave Lake
Longnose dace	*Rhinichthys cataractae*	X				In tributaries to Great Slave Lake
Longnose sucker	*Catostomus catostomus*	X	X	X	X	Large forage fish, lake and stream resident
Ninespine stickleback	*Pungitis pungitis*	X	X	X	X	Common, small-bodied forage fish
Northern pike	*Esox lucius*	X	X	X	X	Large predator, lakes, streams and wetlands

Common Name	Scientific Name	LOCATION				Notes
		Great Slave Lake	Taltson River	Trudel Creek	Tundra Water-courses	
Round whitefish	*Prosopium cylindraceum*	X	X		X	Mid-sized forage fish, lake resident
Shortjaw cisco[1]	*Coregonus zenithicus*	X				Present in Great Slave Lake
Slimy sculpin	*Cottus cognatus*	X	X	X	X	Small, widely distributed lake and stream bottom-dweller
Spoonhead sculpin	*Cottus ricei*	X				Great Slave Lake, stream and lake resident
Spottail shiner	*Notropis hudsonius*	X	X			In tributaries to Great Slave Lake
Trout-perch	*Percopsis omiscomaycus*	X	X			In tributaries to Great Slave Lake
Walleye	*Stizostedion vitreum*	X	X	X		In tributaries to Great Slave Lake
White sucker	*Catostomus commersoni*	X	X	X		Large forage fish, lake resident, larger rivers
Yellow perch	*Perca fluvescens*	X	X			In tributaries to Great Slave Lake

Source: Sawatzky et al. (2007)
[1] Putative

9.5.1.1.1 Fish Habitat and Communities in the Taltson River (Excluding Trudel Creek)

Nonacho Lake is a deepwater basin within the Project area. The lake shoreline provides a combination of steep rocky habitat, shallow bench shorelines, and flooded bays. Seven fish species were captured: lake trout, lake whitefish, lake cisco, northern pike, lake chub, longnose sucker, and burbot. Lake trout were the most abundant species in Nonacho Lake, followed by lake whitefish.

Zone 1 provides both riverine habitat with slow to moderate velocities, as well as shallow and deeper water lake habitat. A total of four fish species were captured: lake whitefish, lake trout, lake cisco, and northern pike. Lake whitefish were the most abundant species in Zone 1.

Zone 2 provides very similar habitat to Zone 1 and has connectivity to Nonacho Lake and Zone 1; therefore, it is assumed that Zone 2 supports a similar diversity and abundance of species.

Zone 3 includes areas of the Taltson River above the Twin Gorges Forebay, in the Forebay, and below Twin Gorges. Different fish communities have been found in each of these three areas. Lake whitefish were the most abundant species above and within the Forebay. Fish community above the Forebay was composed of lake whitefish, lake cisco, white sucker, lake trout, northern pike, longnose sucker, and trout perch. The fish community within the Forebay was composed of lake whitefish, northern pike, lake cisco, lake trout, longnose sucker, and white sucker. Below the gorges, lake cisco was the most abundant species. The fish community below the gorges comprised lake cisco, longnose sucker, walleye, lake whitefish, white sucker, lake trout, and burbot.

Many species found within the Taltson River section of the Project area are known to be present in Zone 4 below Tsu Lake. A total of six species have been captured in Zone 4: lake whitefish, lake trout, northern pike, longnose sucker, walleye, and white sucker. Lake whitefish were the most abundant species in Zone 4.

Three habitat types have been identified as primary habitat within the Taltson basin. These include shallow rocky or non-vegetated areas, deep lacustrine habitat, and shallow habitat with emergent and submergent vegetation. Littoral habitat studies were conducted within two representative lakes in the Taltson Basin, Lady Grey and Nonacho. In Lady Grey Lake the emergent vegetation communities were fairly consistent and primarily composed of water sedge, beaked sedge, swamp horsetail, common great bulrush, creeping spikerush, and small yellow pond lily. The submergent vegetation community was fairly consistent throughout Lady Grey Lake and primarily comprised bladderworts and pondweed. In Nonacho Lake, the emergent vegetation communities were consistent and were primarily composed of water sedge, beaked sedge, common cattail, and swamp horsetail. The submergent vegetation community was consistent throughout Nonacho Lake and was primarily composed of pondweed.

Because of proposed construction activities at the Nonacho Lake dam and Twin Gorges power facility, habitat features at these locations were assessed in greater detail than the rest of the larger study area. At the Nonacho control structure and adjacent areas, the conditions of the existing habitat were assessed using habitat units. The area was divided into nine distinct habitat areas, which were described as one of the following:

- Shoreline lacustrine habitat: typical habitat type comprised a shallow bedrock bench along the lake shoreline with sparse submergent and emergent vegetation. Off-shore substrates were composed of bedrock and boulders. Small woody debris was present throughout the habitat type.
- Pool lacustrine habitat: typical habitat type comprised steeply-sloped boulder shoreline with sparse submergent and emergent vegetation. Large woody debris and boulders were present throughout the habitat type.
- Cascade pool morphology: typical habitat type comprised bedrock and boulder substrates along the river shoreline and channel. High to moderate water velocities were present within the habitat type. Submergent and emergent vegetation was not present.
- Riffle pool morphology: typical habitat type comprised bedrock and boulder substrates along the river shoreline and channel. Channel depths ranged between 0.5 m to 3 m and water velocities were moderate. Submergent and emergent vegetation was not present.

The habitat around the proposed North Gorge intake canal location in the Twin Gorges Forebay was very similar to the surrounding areas. A fairly steep terrestrial shoreline supports small shrubs and trees, and the aquatic habitat was characterized as a rocky shoreline. Because of past flooding of the Forebay, the shoreline was littered with large and small woody debris and standing dead trees. Sparse aquatic vegetation was observed near the intake location.

The tailrace at the downstream end of the proposed North Gorge canal would enter the Taltson River approximately 400 m downstream from the confluence of Trudel Creek and Elsie Falls in the Taltson River. The shoreline habitat in this area was dominated by steep bedrock banks, intermixed with patches of emergent vegetation. The substrate along the shoreline was generally bedrock and boulders with a layer of fine sediment on top. Sparse terrestrial vegetation or woody debris was present along the shore.

9.5.1.1.2 <u>Fish Habitat and Communities in Trudel Creek</u>

Seven fish species have been identified in Trudel Creek: lake whitefish, white sucker, walleye, longnose sucker, northern pike, slimy sculpin, and ninespine stickleback. Lake whitefish was the most abundant species followed by white sucker, northern pike, slimy sculpin, walleye, longnose sucker, and ninespine stickleback in Zone 5.

Littoral habitat studies were conducted within riverine and lacustrine habitats of Trudel Creek. In Trudel Creek, the emergent vegetation communities were consistent and primarily composed of beaked sedge, common mare’s tail, and horsetails. The submergent vegetation community was also consistent throughout Trudel Creek and was primarily composed of pondweed.

9.5.1.1.3 Transmission Line and Winter Road

The proposed transmission line would pass through a transitional zone between dense coniferous forest and open, barren-land tundra. The proposed transmission line would pass through the east arm of Great Slave Lake, the Taltson River Watershed, and the tundra near Snap Lake and Ekati mines. The Ekati Mine lies at the northern end of the transmission line. The transmission line would avoid structure placements in lakes, rivers, and riparian zones, not only to reduce the effect of the Project on the aquatic environment, but to ensure the stability of the towers and lines.

The new transmission line would span a wide range of fish habitat including lakes, rivers, streams, and wetlands. Crossings range from dry channels or marshes to large rivers. All flowing water bodies affected by the Project would be considered fish-bearing, unless otherwise known.

The transmission line would cross several notable fish-bearing rivers and lakes including: Lac de Gras, Lockhart River, McKay Lake, Snowdrift River, Nonacho Lake, and Taltson River.

The winter road would be built for construction access and materials distribution along the southern and northern sectors of the transmission line. The northern section would involve short lake surface spur roads off the existing mine road access.

The number of watercourses and water bodies that the winter road, transmission line, and access trail would cross are outlined in Table 9.5.2.

Table 9.5.2 — Watercourse and Water Body Crossings

Feature	Region	Watercourse Crossings	Water Body Crossings
Winter Road	boreal	46	89
	tundra	11	55
Temporary Access Trail	boreal	5	7
	tundra	1	0
Transmission Line	boreal	111	193
	tundra	133	239

9.5.2 Taltson and Trudel Wetlands

Wetlands are defined as land that is saturated with water long enough to promote wetland or aquatic processes as indicated by poorly drained soils, hydrophytic vegetation, and various kinds of biological activity that are adapted to a wet environment. Wetlands perform a variety of functions that contribute to the maintenance of biodiversity and healthy ecosystems. A wetlands baseline study was conducted in the Project area in August 2008 and consisted of three components: mapping wetlands, identifying wetland properties and wetland classification, and modelling ecological assembly. Presented below is a summary of the available data for wetlands along the Taltson River and Trudel Creek within the Project area. See Section 9.3 for a full description of the Project area's hydrological setting. A more detailed discussion of the current wetlands in the Project area is presented in sections 13.7, 14.6, and Appendix 13.7A.

9.5.2.1 TALTSON RIVER (EXCLUDING TRUDEL CREEK)

As part of the wetlands baseline study, wetlands in Nonacho Lake and hydrological Zone 1 of the Taltson River, which extends from Nonacho Lake to the confluence with the Tazin River, were mapped. At each site, vegetation, soil, and hydrodynamic characteristics were recorded and used to classify sites into wetland classes following the Canadian System of Wetland Classification.

Fourteen wetland ecosystems were surveyed in Zone 1. The dominant ecosystem class was riparian marsh, comprising four distinct communities. One fen ecosystem was surveyed in Zone 1. The most common (50% of survey sites) wetland community in Zone 1 was the Sedge-Willow riparian marsh. Two other riparian marsh communities (Sedge-Horsetail and Sedge-Rush) accounted for 35% of wetlands surveyed in this zone. The Sedge-Rush community was observed as a floating vegetation mat on the river bank. The remaining wetland communities in Zone 1 included a Sedge-dominated riparian marsh and a Sedge-Birch fen.

Fifteen wetlands were surveyed in the Nonacho Lake zone. In this zone, wetlands occur in roughly equal proportions of bogs, fens, and riparian marsh communities. The most common wetland community in this zone was the Sedge-Leatherleaf fen, which accounted for 33% of wetlands surveyed. This fen community was observed in the Nonacho Lake zone as either a floating vegetation mat or on the shore of Nonacho Lake. The next most abundant communities in the Nonacho Lake zone were the Sedge riparian marsh (27%) and the Sedge bog (27%). The Sedge bog communities were only observed in the Nonacho Lake zone as floating vegetation mats. The remaining 13% of surveyed wetland communities in the Nonacho Lake zone were Sedge-Horsetail and Sedge-Willow riparian marshes.

No wetlands were mapped or surveyed in hydrological Zone 2 (Tronka Chua Gap to Lady Grey Lake), Zone 3 (Taltson River between the Tazin River and Tsu Lake), and Zone 4 (Tsu Lake to Great Slave Lake), preventing a detailed assessment.

9.5.2.2 TRUDEL CREEK

Eighteen wetland ecosystems were surveyed in the Trudel Creek zone. The dominant ecosystem class was riparian marsh, which comprised five distinct communities. The most common wetland community in Trudel Creek was the Sedge-Horsetail riparian marsh; it was observed at seven sites (39%). The next most abundant community in Trudel Creek was the Sedge-Horsetail-Calamagrostis riparian marsh. This community represented 28% of the wetlands surveyed in Trudel Creek and was only observed in this zone of the baseline study area. Three remaining communities accounted for approximately 10% each: Sedge riparian marsh, Sedge-Rush riparian marsh, and Sedge-Willow riparian marsh. These three communities were also observed in other baseline study area zones. The Sedge-Rush community was observed on the river bank and lake shores in the Trudel Creek zone.

9.5.3 Birds and Bird Habitat

9.5.3.1 Introduction

The following section summarizes the existing information on the bird community within the region of the Taltson Hydroelectric Expansion Project (the Project). This bird community consists of passerines (i.e., songbirds), waterfowl (i.e., loons, ducks and geese), and raptors (i.e., eagles, hawks, falcons and owls). The information was collected from baseline studies, published and unpublished scientific literature, discussions with wildlife experts, and Traditional Knowledge (TK).

Birds are an important component of the ecosystem, and have provided food and materials, such as feathers, which were used to make blankets and pillows for the Aboriginal people of the NWT (Łutsel K'e Dene Elders et al. 2002). The following sections will describe the bird species present near the Project, their habitat use, distribution, population characteristics, issues affecting the populations, and use by humans. For the purposes of this summary, and due to their diversity, the bird species present have been divided into three categories: passerines, waterfowl and raptors.

9.5.3.2 Passerines

Passerines are a taxonomic group (order Passeriformes), also known as perching birds or songbirds. The group constitutes more than half of all bird species on earth. Passerines in the Taiga Shield and Southern Arctic ecozones include warblers, sparrows, and finches, among others. Passerines are commonly included in baseline and monitoring programs because they represent an abundant and diverse group of species that is relatively easy to observe and monitor with relatively small home ranges (compared to other bird species) and specific habitat requirements.

Table 9.5.3 includes a list of passerine species that are expected to occur within the boundaries of the Project area. The list was compiled through a comparison of the geographic extents of the Project including the transmission line, barge landing sites, and Twin Gorges to Nonacho Lake winter road, with the estimated bird ranges (C. Machtans, personal communication, 9 July 2008). The list also contains two federal species at risk (COSEWIC 2008), the olive-sided flycatcher and the rusty blackbird. These species are addressed in further detail in Section 9.5.7. Baseline surveys of passerines were not conducted for the Project.

Table 9.5.3 — Passerine Species Expected to Occur Within the Project Footprint

Common Name	Scientific Name	Boreal (B) or Tundra (T) Breeders
Olive-sided Flycatcher[1]	*Contopus cooperi*	B
Yellow-bellied Flycatcher	*Empidonax flaviventris*	B
Alder Flycatcher	*Empidonax alnorum*	B
Least Flycatcher	*Empidonax minimus*	B
Eastern Phoebe	*Sayornis phoebe*	B
Eastern Kingbird	*Tyrannus tyrannus*	B
Northern Shrike	*Lanius excubitor*	B
Blue-headed Vireo	*Vireo solitarius*	B
Red-eyed Vireo	*Vireo olivaceus*	B
Gray Jay	*Perisoreus canadensis*	B
Black-billed Magpie	*Pica hudsonia*	B
American Crow	*Corvus brachyrhynchos*	B
Common Raven	*Corvus corax*	B/T
Horned Lark	*Eremophila alpestris*	B/T
Tree Swallow	*Tachycineta bicolor*	B
Bank Swallow	*Riparia riparia*	B
Cliff Swallow	*Petrochelidon pyrrhonota*	B
Barn Swallow	*Hirundo rustica*	B
Black-capped Chickadee	*Poecile atricapillus*	B
Boreal Chickadee	*Poecile hudsonica*	B
Red-breasted Nuthatch	*Sitta canadensis*	B
Ruby-crowned Kinglet	*Regulus calendula*	B
Gray-cheeked Thrush	*Catharus minimus*	B
Swainson's Thrush	*Catharus ustulatus*	B
Hermit Thrush	*Catharus guttatus*	B
American Pipit	*Anthus rubescens*	T
American Robin	*Turdus migratorius*	B/T
European Starling	*Sturnus vulgaris*	B
Bohemian Waxwing	*Bombycilla garrulus*	B
Cedar Waxwing	*Bombycilla cedrorum*	B
Tennessee Warbler	*Vermivora peregrina*	B
Orange-crowned Warbler	*Vermivora celata*	B

Common Name	Scientific Name	Boreal (B) or Tundra (T) Breeders
Yellow Warbler	*Dendroica petechia*	B
Magnolia Warbler	*Dendroica magnolia*	B
Cape May Warbler	*Dendroica tigrina*	B
Yellow-rumped Warbler	*Dendroica coronata*	B
Palm Warbler	*Dendroica palmarum*	B
Ovenbird	*Seiurus aurocapilla*	B
Blackpoll Warbler	*Dendroica striata*	B
Black-and-white Warbler	*Mniotilta varia*	B
Northern Waterthrush	*Seiurus noveboracensis*	B
Wilson's Warbler	*Wilsonia pusilla*	B
Western Tanager	*Piranga ludoviciana*	B
American Tree Sparrow	*Spizella arborea*	B/T
Chipping Sparrow	*Spizella passerina*	B
Clay-coloured Sparrow	*Spizella pallida*	B
Savannah Sparrow	*Passerculus sandwichensis*	B/T
Le Conte's Sparrow	*Ammodramus leconteii*	B
Fox Sparrow	*Passerella iliaca*	B
Song Sparrow	*Melospiza melodia*	B
Lincoln's Sparrow	*Melospiza lincolnii*	B
Swamp Sparrow	*Melospiza georgiana*	B
White-throated Sparrow	*Zonotrichia albicollis*	B
Harris' Sparrow	*Zonotrichia querula*	B/T
White-crowned Sparrow	*Zonotrichia leucophrys*	B/T
Dark-eyed Junco	*Junco hyemalis*	B
Lapland Longspur	*Calcarius lapponicus*	T
Smith's Longspur	*Calcarius pictus*	T
Snow Bunting	*Plectrophenax nivalis*	T
Red-winged Blackbird	*Agelaius phoeniceus*	B
Rusty Blackbird[2]	*Euphagus carolinus*	B
Common Grackle	*Quiscalus quiscula*	B
Pine Grosbeak	*Pinicola enucleator*	B
Red Crossbill	*Loxia curvirostra*	B
White-winged Crossbill	*Loxia leucoptera*	B

Common Name	Scientific Name	Boreal (B) or Tundra (T) Breeders
Common Redpoll	*Carduelis flammea*	B/T
Hoary Redpoll	*Carduelis hornemanni*	T
Pine Siskin	*Carduelis pinus*	B

[1] Olive-sided flycatcher listed as a Threatened species by COSEWIC (see Section 9.5.7).
[2] Rusty blackbird listed as a Species of Concern by COSEWIC (see Section 9.5.7).

9.5.3.2.1 Habitat Use and Distribution

The spring migration of birds to the NWT from the southern wintering grounds occurs in May. The breeding season for passerines typically starts during the first week of June and continues for about three weeks. The fall migration begins in mid-August for some species and continues through to mid-September. While most passerine species are only present in the Taiga Shield and Southern Arctic ecozones during the summer breeding season, some will also winter in the Taiga Shield forest. These include the gray jay, common raven, hoary redpoll, common redpoll, white-winged crossbill, and boreal chickadee (BNA 2008).

Passerines occupy a variety of habitats, both above and below treeline, throughout the length of the Project Right of Way (ROW). Coniferous forests, mixed forests, riparian shorelines, wetlands, eskers, and open tundra contain an array of passerine species. The majority of these species may be found south of treeline in the Taiga Shield. This region is host to flycatchers, vireos, swallows, thrush, warblers and sparrows (Table 9.5.3). North of the treeline in the Southern Arctic ecozone, the passerine community consists predominantly of sparrows. Several of the species within the study area are found in both boreal and tundra environments including the horned lark, American robin, American tree sparrow, white-crowned sparrow, Harris' sparrow, savannah sparrow and common redpoll (Table 9.5.3).

Detailed information on passerine tundra-breeding species is available from the Ekati Diamond Mine (Ekati) and Snap Lake Diamond Mine (Snap Lake). At Ekati, 14 passerine species have been observed (not including vagrants, which were only observed on a single occasion). Included in these 14 species were 3 species normally associated with boreal environments, including the yellow warbler, blackpoll warbler, and Lincoln's sparrow, which were observed within small patches of spruce or dense willow (BHPB 2007). Lapland longspurs were the most common bird species observed in heath tundra and sedge wetlands. Savannah sparrows, Harris' sparrows, and American tree sparrows were also abundant (BHPB 2007).

Just north of the treeline at Snap Lake between 1999 and 2000, 18 passerine species were observed. While most were tundra breeders, some species commonly considered to be boreal species were present in the small, isolated patches of forest and dense willow common in the region. These included the yellow warbler, yellow-rumped warbler, blackpoll warbler, rusty blackbird, and grey-cheeked thrush (De Beers 2002). Species diversity was significantly higher in riparian shrub than in heath tundra and sedge wetland habitats, while species richness did not differ between habitats (De Beers 2002).

Above the treeline, Lapland longspur, horned lark, American tree sparrow, savannah sparrow, and Harris' sparrow nest on or near ground, often among the thick vegetation at the base of willows and hummocks (Naugler 1993; Beason 1995; Norment & Shackelton 2008; Wheelwright & Rising 2008). Snow buntings will nest in cavities or under rock (Lyon & Montgomerie 1995). In the Project footprint's forested regions, passerine species employ a variety of nesting habitats including upland shrub, riparian shrub, cliff faces, and tree branches and cavities. Boreal cavity nesters include northern waterthrush, tree swallow, red breasted nuthatch, European starling, boreal chickadee and black-capped chickadee (BNA 2008).

9.5.3.2.2 Population Characteristics

Within the Southern Arctic ecozone, north of the treeline, densities of passerines north of treeline were obtained from monitoring conducted at Ekati since 1997 (BHPB, 2007). This data provides an estimate of passerine density at 214 birds per square kilometre (birds/km^2), excluding water (i.e., lakes, ponds, rivers). Seventeen passerine species have been observed during this monitoring, the most common of which have been the Lapland longspur, savannah sparrow, American tree sparrow, and Harris' sparrow. Three species (the myrtle warbler, orange-crowned warbler, and eastern kingbird) have only been observed on one occasion.

The Canadian Breeding Bird Census Database (BBC) provides a relatively simple means of estimating boreal bird populations, as it contains breeding pair density information from 640 sites spread across 76 of Canada's 194 ecoregions (Blancher 2003). Of these sites, 138 were sampled in the boreal forest. While the BBC provides comparative data, it should be noted that not all habitats have been covered well by the BBC in Canada and data collection peaked between 1965 and 1982, so most of the data are two to four decades old (Blancher 2003). Passerine densities within Canada are estimated at 460 birds per km^2 (Blancher 2003, Table 9.5.4). Baseline studies of passerines in the Taiga Shield have been conducted by Fortune Minerals Ltd., at the NICO Project, near Hislop Lake and approximately 50 km north of the community of Wha Ti. Passerine densities in this area are approximately 440 birds per km^2 (Fortune Minerals Ltd., unpublished data).

Table 9.5.4 — Estimated Number of Passerines Breeding in Canadian Boreal Forests: by Family

Family	Species	Density (birds/km^2)
Parulidae (Wood warblers)	27	191.86
Emberizidae (Sparrows and Allies)	26	130.47
Turdidae (Thrushes)	11	51.80
Tyrranidae (Flycatcher)	16	24.94
Vireonidae (Vireos)	6	16.88
Regulidae (Kinglets)	2	16.12
Fringillidae (Finches)	10	5.76
Corvidae (Jays, Crows and Allies)	7	5.76

Family	Species	Density (birds/km^2)
Paridae (Chickadees and Allies)	4	4.80
Icteridae (Blackbirds and Allies)	11	3.84
Hirundinidae (Swallows)	7	3.65
Troglodytidae (Wrens)	4	3.26
Cardinalidae	2	1.50
Total Boreal Canada Passerines	133	460.64

Source: Blancher (2003)

Nation-wide changes in the abundance of some passerine species have been observed. The American robin, savannah sparrow, and yellow-rumped warbler have all experienced population increases (Eiserer 1980; Hendricks & Pidgeon 1990; Wilz & Giampa 1978), while the blackpoll warbler, rusty blackbird, and American tree sparrow have experienced unexplained declines (Hunt & Eliason 1999; Avery 1995; Badzinski 2003). Within the Mackenzie Valley, specifically near Fort Simpson and Norman Wells, there is indication of a subtle change in upland bird communities between 1975 and 2004 (Cooper et al. 2004). Over this time, the number of species has changed little, but the species composition appears to have changed. Densities were lower for 55% of the species analyzed, but largely unchanged for 34% of the species. There were no obvious reasons for this change, but factors such as changes to survey methods, changes in breeding distribution, climate and environmental changes were cited as possible reasons (Cooper et al. 2004.)

9.5.3.2.3 Issues Affecting Abundance and Distribution

Given the relative remoteness and natural integrity of the Taiga Shield and Southern Arctic ecozones, there are currently few local anthropogenic disturbances affecting the environment, and subsequently the passerines, in these regions. The Traditional Knowledge study program (LKDFN et al. 1999) identified several concerns that Traditional Knowledge holders have expressed in the past about potential impacts on birds, due to mining activities. These concerns include:

- loss of habitat;
- dust or spills that the birds might ingest; and
- dust or spills that might coat birds' feathers and then kill them (by poison or by affecting their insulation capabilities).

No concerns regarding the current status of passerine abundance and distribution were identified that were specific to the Taiga Shield and Southern Arctic ecozones.

In other regions, the effects of habitat loss and fragmentation are of concern, and have been intensively studied. Some studies have found little to no effects of habitat fragmentation on birds (McGarigal & McComb 1995), while others have documented impacts to bird density and populations for specific species (Jalkotzy et al. 1997). According to Fahrig (1997), the total amount of remaining habitat is more important for survival than the configuration of the remaining habitat. Similarly, a study conducted in Oregon by McGarigal and McComb (1995) found that direct habitat loss had more influence on breeding bird abundance than fragmentation.

9.5.3.2.4 Human Use

According to the reviewed sources of information containing TK and traditional land-use, upland birds, including passerines, are an important resource for Aboriginal people. In *Habitats and Wildlife of Gahcho Kué and Katth'I Nene* (LKDFN et al. 1999), TK holders from Łutsel K'e identified eleven upland bird species, including boreal chickadee and Lapland longspur, which are known to use habitat existing in the RSA.

The reviewed sources suggest that many of the birds that inhabit the area are migratory and can be found in the area only during certain times of the year, depending on the weather.

> *"I used to hear all kinds of birds. I saw longspurs and snowbirds. The snowbirds go there all year"* (LA in Łutsel K'e Dene Elders et al. 2002).

> *"We should also look at the vegetation – berries. We don't want it spoiled. We eat it – and the little birds eat it too"* (AM in Łutsel K'e Dene Elders et al. 2001).

9.5.3.3 WATERFOWL

The tundra of the Southern Arctic ecozone and forests of the Taiga Shield provide both breeding and staging habitat for a variety of dabbling ducks, diving ducks, sea ducks, geese, loons, and a single species of swan, totalling some 22 waterfowl and four loon species (Table 9.5.5). This was determined through a comparison of the geographic extents of the Project including the transmission line, barge landing sites, and Twin Gorges to Nonacho Lake winter road, with the estimated bird ranges (C. Machtans, personal communication, 9 July 2008), and from observations made during baseline studies. These species occupy a wide variety of habitats, but all share a requirement for aquatic habitat. The breeding distribution of several species including the yellow-billed loon, tundra swan, and greater white-fronted goose are exclusive to the tundra region (Table 9.5.5). Some species, such as the red-throated loon, the Pacific loon, Canada goose, northern pintail and red-breasted merganser, breed in both the boreal and tundra environments. All migrate south for the winter.

Table 9.5.5 — Waterfowl and Loon Bird Species Within the Project Footprint

Common Name	Scientific Name	Boreal (B) or Tundra (T) Breeders
Red-throated Loon	*Gavia stellata*	B/T
Pacific Loon	*Gavia pacifica*	B/T
Common Loon	*Gavia immer*	B
Yellow-billed Loon	*Gavia adamsii*	T
Greater White-fronted Goose	*Anser albifrons*	T
Tundra Swan	*Cygnus columbianus*	T
Canada Goose	*Branta canadensis*	B/T
American Wigeon	*Anas americana*	B
Mallard	*Anas platyrhynchos*	B
Blue-winged Teal	*Anas discors*	B
Northern Shoveler	*Anas clypeata*	B
Northern Pintail	*Anas acuta*	B/T
Green-winged Teal	*Anas crecca*	B
Canvasback	*Aythya valisineria*	B
Redhead	*Aythya americana*	B
Ring-necked Duck	*Aythya collaris*	B
Greater Scaup	*Aythya marila*	B
Lesser Scaup	*Aythya affinis*	B
Surf Scoter	*Melanitta perspicillata*	B
White-winged Scoter	*Melanitta fusca*	B
Long-tailed Duck	*Clangula hyemalis*	T
Bufflehead	*Bucephala albeola*	B
Common Goldeneye	*Bucephala clangula*	B
Common Merganser	*Mergus merganser*	B
Red-breasted Merganser	*Mergus serrator*	B/T
Ruddy Duck	*Oxyura jamaicensis*	B

9.5.3.3.1 Habitat Use and Distribution

All waterfowl in the Taiga Shield and Southern Arctic ecozones exhibit annual migration to northern breeding grounds which offer wetland and nesting habitat, fewer predators, and foraging opportunities (Sargeant & Raveling 1992). The spring migration of water birds to the NWT begins in early May, and in some years, at the end of April (Łutsel K'e Dene Elders et al. 2002). Most waterfowl arrive at breeding grounds in the central Canadian Arctic primarily by the Central and Mississippi

Flyways of North America. Staging by waterfowl refers to a gathering of birds at a particular site for an extended period of time (i.e., days to weeks) before continuing migration. Staging areas provide seasonally suitable habitat requisites, such as early open water and associated foraging areas. Staging waterfowl may remain at a site for several days or a continual turnover of birds may occur at the same wetlands site. These sites often have a traditional seasonal use and are considered important habitats used by migrating waterfowl species (Gurd 2007a, 2007b).

Waterfowl distribution is driven primarily by access to wetlands (Hansen & McKnight 1964; Murdy 1966; Smith 1971; Stroudt 1971). Early in the spring, migrants use ice-free areas, especially those near rivers, moving to wetlands and lakes as the season progresses. Aside from providing food, wetland attributes such as size, shape, and emergent vegetation structure and composition are important for waterfowl nesting territories and safety from predators (Gurd 2007a, 2007b). Different species of waterfowl will use different types of water bodies, or different habitats within that water body, depending on the characteristics of the water body. For example, mergansers will nest and raise their young on a lake that supports fish, while ducks eat aquatic insects, emergent plant seeds, benthic organisms, and submergent plants; and tundra swans eat submergent plant tubers and roots (Cox 1990; Korschgren & Dahlgren 1992). Dabbling ducks typically occupy shoreline (littoral) habitat while both diving ducks and sea ducks use open-water habitat. Both shallow and deepwater lakes in the region provide breeding habitat for loons, provided fish are present.

At the local scale, nest site selection is driven by factors including species-specific preference of water body size, upland cover density, and habitat structure influencing predation (Metcalfe 1984; Whittingham & Evans 2004). Dabbling ducks such as mallard, teals and shovelers, among others, seek nutrient-rich waters for forage and brood rearing, typically nesting in adjacent upland sites. Diving ducks and sea ducks such as scaup, canvasback, long-tailed ducks, white-winged scoter, common goldeneye, and red-breasted mergansers typically breed on larger, moderately productive, or low productive lakes. Above the treeline, tundra wetlands are shallower in depth than most lakes, and generally open earlier in the spring. These wetlands also usually contain considerable emergent vegetation, which may contribute to the higher number of water birds observed in these areas. Similarly, shallow bays, melt water ponds, and shoreline leads in the Diavik Diamond Mine (Diavik) study area, were identified as important areas for staging waterfowl (DDMI 2006) as they provide habitat requisites such as open water.

Within Great Slave Lake, several areas have been recognized as critical waterfowl habitat, including three federally significant Important Bird Areas (IBA). Bird Studies Canada (2008) recognizes Great Slave Lake's South Shore (i.e., from the Slave River Delta to Taltson Bay), North Arm, and West Shore as Canadian IBAs. With respect to the Project, recognizing and understanding migration movements between the Peace Athabasca Delta (PAD) and the three Great Slave Lake IBAs is critical to mitigating Project impacts. The PAD is the largest boreal delta and one of the largest freshwater deltas in the world. Comprising some 3,800 km^2, the PAD provides critical habitat to breeding and staging waterfowl, and is among North America's most important waterfowl areas (Environment Canada 2008). Staging areas within the PAD host waterfowl continuing to and returning from breeding areas in Canada's Artic and sub-Arctic. Spring waterfowl numbers within the PAD may reach as high as 400,000 birds, while fall counts may include more than one million birds migrating through the area (Environment Canada 2005). A portion of the Central and Mississippi flyways of North America pass through the Project ROW, especially during spring migration.

Nesting habitat for waterfowl below the treeline includes a variety of habitats, such as islands, shoreline edge, riparian areas, upland sites, and even wood or rock cavities. The timing of waterfowl nesting is dictated by the availability of food for young (Lack 1947, 1954; Immelmann 1971). For most waterfowl and loons, the breeding season represents the most vulnerable, or sensitive period, for these species (Sargeant & Raveling 1992).

9.5.3.3.2 Population Characteristics

Waterfowl densities are generally low on the tundra. Baseline water bird surveys completed at Diavik calculated a density of 0.58 birds per kilometre of shoreline (Penner & Associates 1998), while baseline surveys of lakes surrounding Snap Lake during June recorded an average density of 2.2 and 2.4 individuals per kilometre of shoreline (N=18 lakes) in 1999 and 2000, respectively (De Beers 2002).

Tundra waterfowl densities not linked to lakes or a particular habitat were collected at the Jericho Diamond Mine, approximately 140 km north of the northernmost extents of the Project. Over two years of studies (including aerial surveys each June and August), a maximum waterfowl density of 0.008/ha was estimated (Golder 2008). The annual waterfowl density estimates collected by the U.S. Fish and Wildlife Service do not include any areas within the barren-grounds (see USFWS 2008, Fournier and Hines 2005). Waterfowl densities for the Taiga Shield were estimated to be 0.035 birds per ha in 2008 within an area that includes the boreal sections of the Project (USFWS 2008).

Relative abundances of waterfowl during the spring harvest period offer the Denesoline an indication of relative health for migratory birds for that season (Łutsel K'e Dene Elders et al. 2002). TK reports have indicated that large numbers of waterfowl have historically passed through the study area en route to northern breeding grounds. Recent accounts suggest both water bird diversity and abundance in the RSA have declined. Observations of water birds numbers specifically note a marked decline in both black scoter and white-winged scoter populations (Parlee et al. 2005). Species identified as experiencing declines include long-tailed duck, lesser scaup, surf scoter, white-winged scoter, and northern pintail (USFWS 2008)

9.5.3.3.3 Baseline Studies

9.5.3.3.3.1 Methods

Project-specific baseline surveys for waterfowl included a helicopter survey for waterfowl between Twin Gorges and Snap Lake, conducted in late August 2003, to document species occurrence and relative abundance. This aerial survey covered a previously-considered direct transmission line alignment between Twin Gorges and Snap Lake, for a total distance of 468 km. The transmission line alignment was roughly similar to the current Project description for the section between Twin Gorges and the Lockhart River. The survey was flown at a speed of 100 to 140 km/h, and an altitude of 30 to 50 m above ground level (agl). Two parallel transects were flown, for a total survey width of 800 m centered on the transmission line ROW (see Rescan 2004 for further details).

Further aerial waterfowl surveys were completed in June 2008 to document species occurrence and densities of both individuals and Indicated Breeding Pairs along the transmission line within the Taiga Shield ecozone. An Indicated Breeding Pairs survey is defined as a breeding population survey and not a true breeding pair survey. Indicated Breeding Pairs estimates are derived not only from observed pairs, but also from single males and birds in small groups (i.e., <5 individuals; Ducks Unlimited Canada 2003). Two surveys were conducted to capture early and late arriving waterfowl. The surveys took place on June 3rd and 18th. Protocol established by Ducks Unlimited Canada (2003) was followed. All water bodies within 1.0 km from the transmission line ROW, and between 5 ha and 300 ha in size were considered for the surveys. Of these, approximately 25% were randomly selected to be surveyed. A Bell 206B helicopter with one observer on each side flew the shoreline of each selected water body. Flight altitude varied between 15 and 50 m above ground level while speed varied from a hover while identifying birds to 100 km/h while surveying open straight shorelines. Complete coverage of each surveyed water body was assumed. Information obtained included species, number, gender and social status (e.g., lone male, pair, groups), for all waterfowl, and species and number for other waterbirds observed during the surveys.

Aerial encounter transects, which are useful for presence/not detected information, were also flown in Zones 1 (Taltson River), 5 (Trudel Creek), and Nonacho Lake. An experienced ornithologist made verbal observations of waterfowl (species and number of individuals) through binoculars while the assistant recorded the observations. Surveys were conducted in a Bell 206B helicopter.

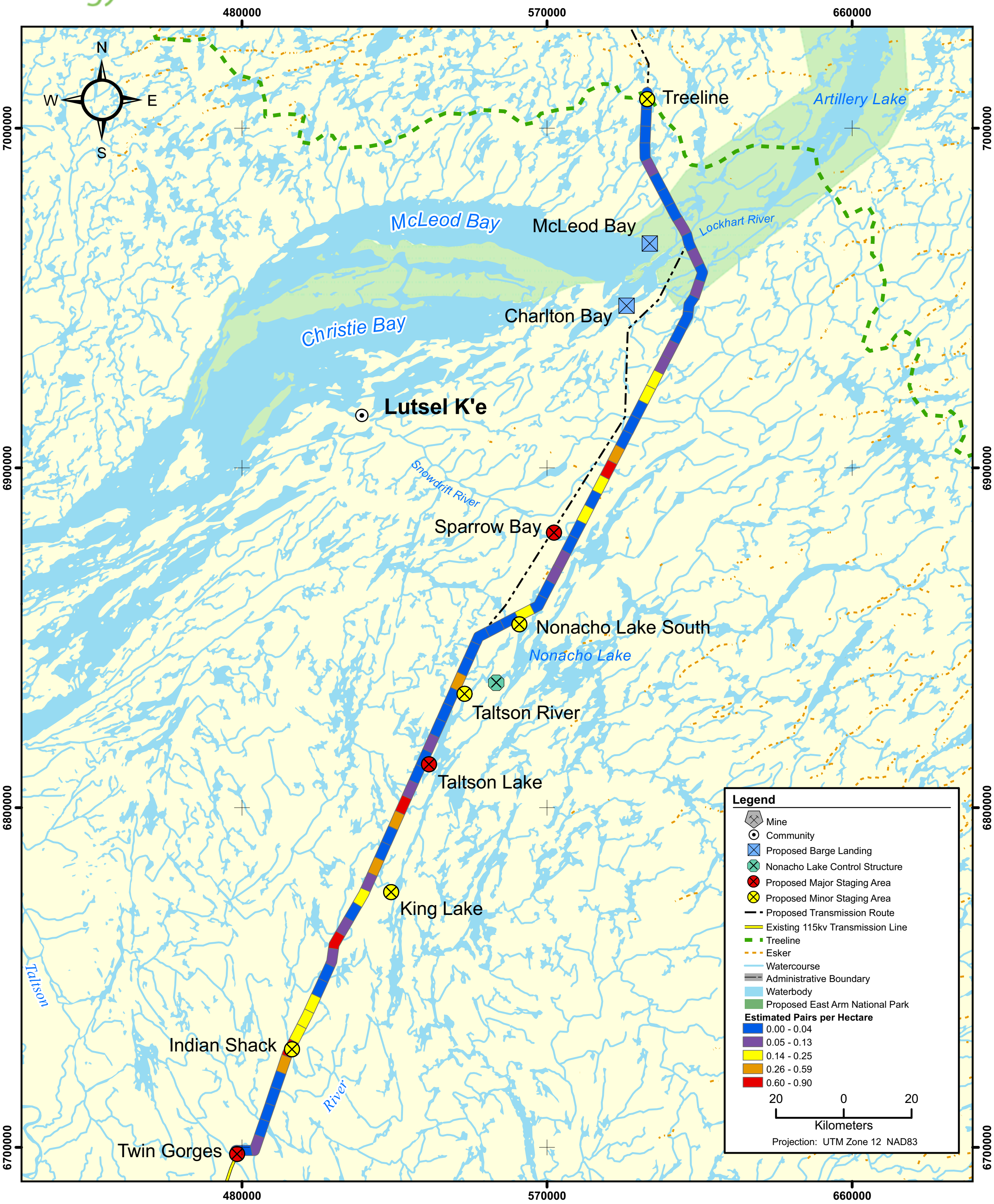
Fall aerial surveys for wildlife were conducted north of the treeline between September and November, 2006. Incidental observations of waterfowl were made during these surveys, but observations were limited to one flock of approximately 200 greater white-fronted geese near Gahcho Kué, and a flock of four common mergansers near MacKay Lake. As so few waterfowl were observed, this data was not considered further, and no further waterfowl surveys were conducted in the tundra regions.

9.5.3.3.3.2 *Results*

During the 2003 survey, over 1,300 waterfowl were observed in 468 groups. Overall, densities were low relative to other boreal regions. The largest groups and number of groups were observed in the Nonacho Lake area, but waterfowl were observed along the entire length of the 468 km survey. Scaup, scoters, teal, and mergansers were the most commonly observed waterfowl. Canada geese were the only geese species observed (Rescan 2004).

During the June 2008 aerial encounter surveys, a single waterfowl transect 30 minutes in duration was flown in Zone 1 (Taltson River), two transects were flown for a total of 162 survey minutes in Nonacho Lake, and two waterfowl transects were flown for 64 survey minutes in Zone 5 (Trudel Creek). Incidental observations of waterfowl were also made during yellow rail surveys. In total, 13 species of waterfowl, geese and cranes were observed in Zone 1, and 325 individual birds. These included the lesser scaup, northern pintail, surf scoter and whooping cranes, all of which are considered sensitive or at risk species in the NWT (Working Group on General Status of NWT Species 2006). In Nonacho Lake, 17 species of waterfowl, geese and cranes were observed. These included lesser scaup, northern pintail, surf scoter and white-winged scoters, all of which are classified as sensitive species (Working Group on General Status of NWT Species 2006). In Zone 5, 15 species of waterfowl, geese, and cranes were observed, including whooping cranes, a species at risk (SARA 2008). A total of 231 individual waterfowl including swans and cranes were observed during the survey. With an estimated surface area of 8.4 km^2 for Trudel Creek and the three lakes within Zone 5, the density of waterfowl observed was 16.47/km^2 (0.165/ha) when groups of five or more birds are excluded. These larger groups may have represented birds that were still migrating through the area. This is comparable to long-term average densities of breeding waterfowl surveyed by the U.S. Fish and Wildlife Service and the Canadian Wildlife Service in the boreal habitat of the Project area, which ranged from 5 to 15 birds/km^2 (Fournier & Hines 2005).

In 2008, 125 water bodies, totalling 3,011 ha in area, were surveyed during aerial waterfowl surveys below the treeline (Figure 9.5.2). However, the survey route did not follow exactly the currently proposed alignment due to subsequent changes in the transmission line alignment (illustrated in Figure 9.5.2). As the changes to the alignment were 20 km or less, confined to specific areas, and within the same ecozone and ecoregions, the results are considered to be relevant to the currently proposed alignment. Survey results along the 400 km section of transmission corridor recorded overall waterfowl densities of 0.0334 birds/ha within the surveyed area. These results are similar to the 0.035 birds/ha for the Taiga Shield in 2008 reported by the USFWS (2008). Over the entire survey, Indicated Breeding Pair densities for the RSA were 0.0168 pairs/ha for waterfowl. To identify areas of higher breeding waterfowl densities, the observations were divided into 5 km segments along the survey route. Most of the segments had a relatively low density, falling within the 0.00 to 0.04 pairs/ha category (Figure 9.5.2). Some scattered areas of relatively high density (from 0.60 to 0.90 pairs/ha) were identified, such as near the King Lake and Taltson Lake staging areas. Densities remained low for sections north of the Snowdrift River.



TALTSON **Hydroelectric Expansion Project**	**Developer's Assessment Report** **2009**	**Waterfowl Breeding Pair Density** **June 2008**	**Figure** **9.5.2**

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9.5.3.3.4 Issues Affecting Abundance and Distribution

No issues specific to the Taiga Shield or Southern Arctic ecozones which may affect waterfowl abundance and distribution were identified. Habitat loss in wintering areas, particularly due to agriculture, is considered the largest single threat to these species, and conservation efforts are aimed at wetland conservation (Ducks Unlimited 2008).

9.5.3.3.5 Human Use

TK holders from the LKDFN identified 35 bird species that are known to inhabit the RSA, 18 of which are edible (LKDFN et al. 1999). Geese, ducks, and loons are important for traditional use. According to TK, geese and ducks are a favourite food source for communities, and the feathers are used for making blankets and pillows (LKDFN et al. 2001). Harvest includes a variety of duck and goose species including Canada goose, northern pintail, white-winged scoter, long tailed duck, scaup, mallard, and tundra swan (Łutsel K'e Dene Elders et al. 2005; Parlee et al. 2005).

According to Łutsel K'e Elders, waterfowl harvest occurs primarily during spring migration (Parlee et al. 2005). Primary waterfowl harvesting areas for Łutsel K'e residents include the Snowdrift River, Łutsel K'e Bay, Stark Lake, and other areas along the shoreline of Great Slave Lake (LKDFN et al. 2001). During the spring, ice-free areas on Great Slave Lake provide foraging opportunity for congregating waterfowl. People travel to these waterfowl staging areas in the spring to harvest the migrating birds (Łutsel K'e Dene Elders et al. 2002).

9.5.3.4 RAPTORS

Raptors are birds of prey and include falcons, eagles, hawks, and owls. Impacts to raptor populations can be reflected throughout the ecosystem because they are at the top of the food chain and occupy a top trophic level in the ecosystem (Kennedy 1980). Raptors are considered to be valuable indicators of environmental change (Furness & Greenwood 1993), because they show high fidelity to nesting areas, and are sensitive to disturbance during the nesting period (Newton 1979). As such, raptors are commonly used as indicators of ecosystem health in baseline and monitoring programs. Declines in North American raptor populations have been attributed to contaminants (e.g., DDT), human activities, and developments (Craighead & Mindell 1981). However, the low nest densities of most raptors afford poor candidacy for Project-specific monitoring (e.g., BHPB 2007). Very little information is available for raptor populations in the NWT, and there is little current monitoring (Kirk 2003). Table 9.5.6 includes a list of raptors that may encounter the Project footprint and indicates the environment, boreal or tundra, commonly used for breeding by each. The list was compiled through a comparison of the geographic extents of the Project including the transmission line, barge landing sites, and Twin Gorges to Nonacho Lake winter road, with the estimated bird ranges (C. Machtans, personal communication, 9 July 2008.). Raptors which may encounter the Project footprint include two federal species at risk, the short-eared owl and the peregrine falcon (COSEWIC 2008). These species are addressed in further detail in Section 9.5.7.

Table 9.5.6 — Raptor Species within the Project Footprint

Common Name	Scientific Name	Boreal (B) or Tundra (T) Breeders
Osprey	*Pandion haliaetus*	B
Golden Eagle	*Aquila chrysaetos*	B/T
Bald Eagle	*Haliaeetus leucocephalus*	B/T
Northern Harrier	*Circus cyaneus*	B/T
Sharp-shinned Hawk	*Accipiter striatus*	B
Northern Goshawk	*Accipiter gentilis*	B
Red-tailed Hawk	*Buteo jamaicensis*	B
Rough-legged Hawk	*Buteo lagopus*	T
American Kestrel	*Falco sparverius*	B
Merlin	*Falco columbarius*	B
Gyrfalcon	*Falco rusticolus*	T
Peregrine Falcon[1]	*Falco peregrinus*	B/T
Great Horned Owl	*Bubo virginianus*	B
Northern Hawk Owl	*Surnia ulula*	B
Great Gray Owl	*Strix nebulosa*	B
Long-eared Owl	*Asio otus*	B
Short-eared Owl[2]	*Asio flammeus*	B/T
Boreal Owl	*Aegolius funereus*	B

[1] Peregrine falcon listed as a species of Special Concern under COSEWIC (see Section 9.5.7).

[2] Short-eared owl listed as a species of Special Concern under COSEWIC and under Schedule 3 of SARA (see Section 9.5.7).

9.5.3.4.1 Habitat Use and Distribution

Raptors are distributed throughout the Taiga Shield and Southern Arctic ecozones, but the species community and richness varies between tundra and boreal environments. Raptor species which may occur in the vicinity of the Project consist primarily of boreal specialists, with some tundra or open-habitat specialists (the peregrine falcon, gyrfalcon and rough-legged hawk), and several birds overlapping both habitat types. Raptors hunt in a variety of habitat types in relation to areas frequented by their prey, but have stringent requirements for nesting sites (Wightman & Fuller 2005).

All raptors in the Taiga Shield and Southern Arctic ecozones exhibit at least partial migration with relation to snowfall and prey availability (Macwhirter and Bildsten 1996; Booms & Fuller 2003; Wiggins et al. 2006; Wightman & Fuller 2006). Owl species remain in the boreal forest year round. If migrations occur, they are regional in nature and follow prey resources from areas of low to high abundance. Main prey items are small mammals (Bull & Duncan 1993; Duncan & Duncan 1988; Haywood & Haywood 1993; Houston et al. 1998; Marks et al. 1994). Short-eared owls are an exception as they nest on the tundra as well as in the boreal forest. Tundra nesting short-eared owls will migrate south beyond the treeline for the winter (Wiggins et al. 2006). Gyrfalcons nest exclusively on the tundra. Migration patterns vary; some remain north of the treeline year round while others will migrate south into the boreal forest. Similar to other raptor species, regional movements depend on the availability of their primary prey, which is ptarmigan (ENR 2008). All other raptor species, with the exception of the goshawk, migrate out of the northern boreal forest for the winter (ENR 2008). Some goshawks remain in the northern boreal forest year-round. Regional movements depend on the availability of their primary prey, which is snowshoe hare (ENR 2008).

Raptors typically select the most remote and rugged terrain available for nesting, such as tree tops or cliff faces. Raptors often exhibit low nest densities, especially in habitats were prey may be limiting (Ontiveros et al. 2005). The continental gyrfalcon population breeds exclusively in the North American Arctic, especially on the north coast and Arctic islands. The peregrine falcon has adapted to many North American habitats and breeds throughout the continent. Both subspecies of falcons are tolerant of human disturbance and have historically nested near human development including mine sites (BHPB 2004; DDMI 2006). It is normal for some falcon nests to be active most years, while others are only used in unusually good years. Consistent with raptor studies in the Arctic, cliffs are the main feature of raptor habitat in the Project RSA north of treeline. The American kestrel is a secondary cavity nester (Smallwood & Bird 2002). Northern harriers are obligate ground nesters (Macwhirter and Bildstein 1996). Owls are commonly tree nesters, with the exception of the ground-nesting snowy owl and short-eared owl, which nest exclusively in tundra habitats (Wiggins et al. 2006). Short-eared owls typically nest in marsh habitat or open tundra (National Geographic 1983, Wiggins et al. 2006).

The most sensitive stage of the raptor breeding cycle is just prior to egg-laying, when the female spends many hours sitting on or near her empty nest. Disturbance at this stage, even limited human disturbance, may cause desertion of the nest (Fyfe & Olendorff 1976).

9.5.3.4.2 Population Characteristics

Tundra-nesting raptors face various pressures related to inclement weather conditions (Court et al. 1988, Poole & Bromley 1988, Olsen & Olsen 1989, Bradley et al. 1997), prey population abundance (Steenhof et al. 1999), and forest fires (Carriere et al. 2003), which can have noticeable effects on raptor productivity. In addition, the proximity of other occupied nests can also influence peregrine falcon (and likely other raptor species) nest occupancy and success (Wightman & Fuller 2006).

Within the Northern Sector of the Project area, studies done for three existing mine sites (Ekati, Diavik and Snap Lake) offer long-term data on raptor populations in the study area. However, no equivalent data exists for raptor populations within the southern boreal portion of the Project.

Raptor studies at the mines have identified eight raptor species at Snap Lake (De Beers 2002) and nine raptor species at Diavik (Penner & Associates Ltd. 1998). Of these, only the peregrine falcon and gyrfalcon are commonly monitored, as they are relatively abundant and return to the same cliff nest each year. Peregrine falcons were the most commonly observed raptor. Observations of other species consisted primarily of bald eagle, gyrfalcon, and northern harrier (Penner & Associates Ltd. 1998, De Beers 2002, De Beers 2007, BHPB 2007).

Between 1995 and 2006, Ekati reported 85 occupied peregrine falcon nests and 28 occupied gyrfalcon nests. Since 1995, 29% to 90% of all nests were occupied by peregrine falcons, and 5% to 69% were occupied by gyrfalcons (BHPB 2007). The remaining nests observed at Ekati during this period were occupied by rough-legged hawks and a lone golden eagle. During baseline studies (1999 to 2004), occupancy rates at Snap Lake by species were 47% peregrines, 25% gyrfalcons, 3% ravens, and 25% unoccupied (N=68) (De Beers 2007). Long-term monitoring from other areas in the Canadian arctic indicates that peregrine falcon densities are at or near maximum occupancy of nest sites (Carriere et al. 2003).

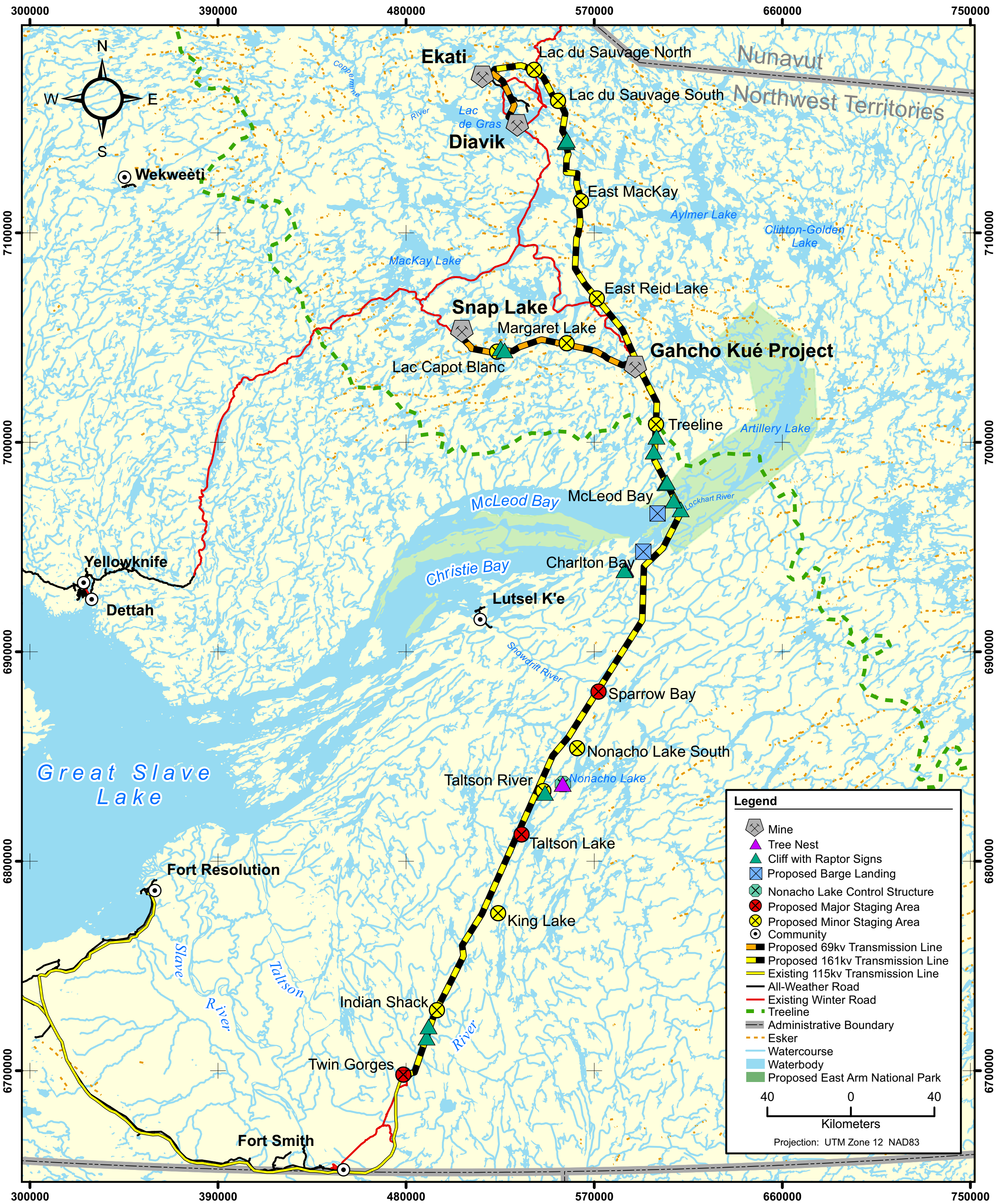
As with nest initiation, falcon productivity may vary strongly between years and range widely in annual success. A large proportion of the productivity to a raptor population typically originates from relatively few individuals at specific nest sites (Johnstone 1997). Within the Ekati study area between 1998 and 2006, the number of falcon chicks observed ranged from 16 in 1998 and 2000, to none in 2005 (BHPB 2007). Peregrine falcon productivity ranged from two to 12 chicks between 1998 and 2006 (BHPB 2007), and from none to ten chicks for gyrfalcons. Peregrines are the more common of the two species. Within the Snap Lake study area between 1999 and 2006, annual peregrine falcon production ranged from two chicks to 13 chicks (De Beers 2007), while annual gyrfalcon production ranged from none to six chicks in 2003.

Between the 1960s and the early 1980s, raptors that relied upon migratory birds for most of their diet (peregrines, merlins, sharp-shinned hawks) experienced population declines all over North America, including the NWT, due to DDT, a pesticide used throughout North, South and Central America. DDT persists in the body's fat cells and becomes more concentrated as it moves up the food chain (ENR 2008). Since the mid-1970s, the peregrine population in Canada has increased dramatically. In the NWT population levels and production of peregrines are at healthy levels (ENR 2008). Further details on peregrine falcons may be found in Section 9.5.7 - Vulnerable Species.

9.5.3.4.3 Baseline Studies

9.5.3.4.3.1 Methods

In August 2006 and August 2008, surveys for raptor nests within 1.5 km of the transmission line route were completed along the entire transmission line as currently proposed (approximately 693 km, Figure 9.5.3). Consistent with raptor studies in the north (i.e., Matthews 1989), surveys were focused on areas that were deemed to have the most suitable nest sites, such as prominent rock outcrops, cliff faces, and ledges. All such features were investigated by a single observer in a Bell 206 helicopter. In some cases, several passes by helicopter were necessary to investigate the entire cliff face. The presence of raptor adults, chicks, fledglings, eggs, nest sites, and evidence of use (i.e., scrapes and perches, stick nests, jewel lichen, and whitewash) were recorded at each site. Observers also searched for raptors flying in the vicinity of the cliff.



TALTSON HYDROELECTRIC EXPANSION PROJECT	**Developer's Assessment Report 2009**	**Raptor Nest Observations: 2006 and 2008**	**Figure 9.5.3**

9.5.3.4.4 Results

Fifty cliffs within approximately 1.5 km of the transmission line route were investigated. Of these, 15 had signs of historic nesting such as whitewash or stick nests (Figure 9.5.3). Historic nests were found to be largely concentrated in specific areas, such as within the proposed East Arm National Park, southeast of Snap Lake, and near the Indian Shack staging area (Figure 9.5.3). One tree nest was also observed, near the Nonacho Lake Control Structure. Raptors were not observed at any of the nest sites found, although the timing of the survey (August) was not optimal to detect activity.

The Northwest Territories Department of Environment and Natural Resources (ENR) maintains a database of all known raptor nests in the Northwest Territories. As the nearest nest to the Project identified by this source was approximately 13 km from the proposed transmission line ROW, this information was not considered further.

9.5.3.4.5 Issues Affecting Abundance and Distribution

The Project would be constructed through largely undisturbed areas, where there are few issues regarding raptor abundance and distribution. The vulnerability of raptor populations to anthropogenic disturbance is exacerbated by low raptor breeding densities and low reproductive rate. Specific to the vicinity of the Project, concerns have been raised regarding the effect of mining to raptors. Falcon monitoring at Ekati and Diavik indicated that raptor productivity may have increased with distance from mine (DDMI 2008). However, determining the effects of human disturbance and activity on raptor populations in the tundra environment can be difficult due to confounding factors of low densities, effects of extreme weather events, and fluctuations in prey populations, and the mechanisms leading to this change in productivity were not clear (DDMI 2008).

9.5.3.4.6 Human Use

Raptors have played a substantial role in the culture and spirituality of the Denesoline (LKDFN et al. 2001). Of note, the eagle is of significant importance and is featured on the Łutsel K'e Dene First Nations band crest.

9.5.4 Caribou

9.5.4.1 INTRODUCTION

Barren-ground caribou (caribou) have a significant social, cultural, and economic value for the people and communities living in the Canadian Arctic. Aboriginal people have a strong connection with caribou, and rely on the animals for food, clothing and cultural wellness. Caribou also influence the landscape through their movements and foraging, and provide food resources for predators and scavengers such as wolves, grizzly bears, wolverines, and foxes. As a result, caribou receive considerable attention and are a key component of environmental assessments in the Northwest Territories. The Bathurst, Ahiak, and Beverly herds are listed as "Sensitive" under the *General Status Ranks of Wild Species in the NWT Report* (Working Group on General Status of NWT Species 2006) due to significant herd declines over the past 10 years. The Bathurst, Ahiak, and Beverly herds are not listed federally under the Committee on the Status of Endangered Wildlife in Canada

(COSEWIC 2007). The following chapter summarizes the importance of caribou, the existing information regarding caribou and possible interactions with the Project, and known effects to caribou from similar developments.

9.5.4.2 IMPORTANCE OF CARIBOU

9.5.4.2.1 Human Use of Caribou

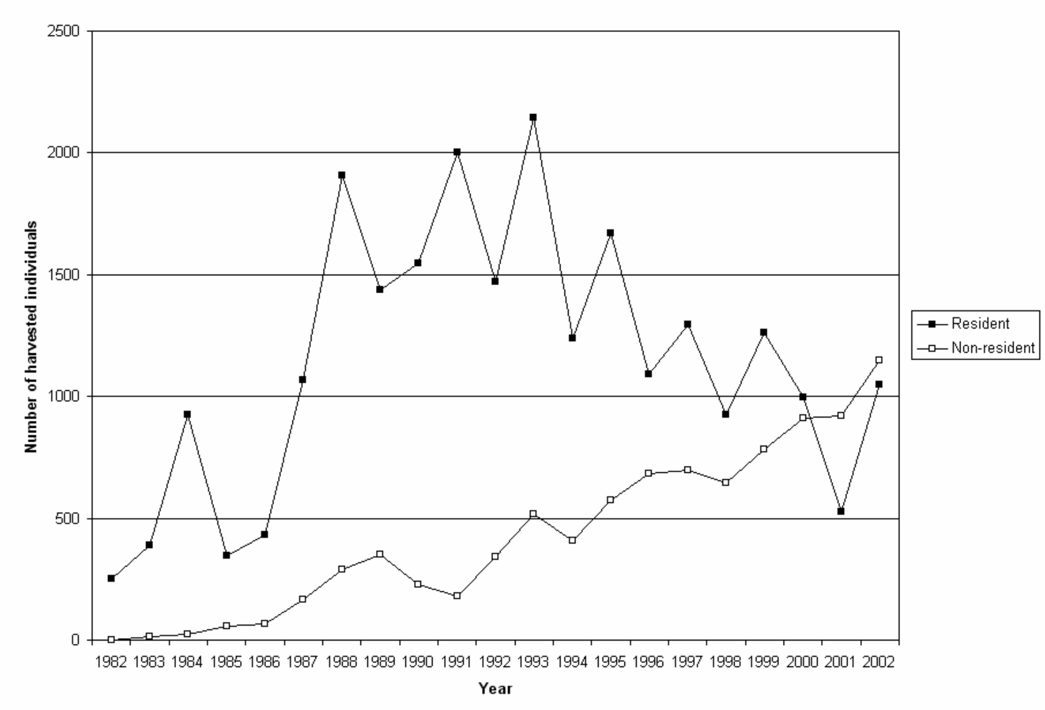
Based on the reviewed Traditional Knowledge (TK) and Traditional Land Use (TLU) information, caribou have been, and still are, the most important traditional food resource for aboriginal people of the NWT. Case et al. (1996) estimated that between 14,500 and 18,500 Bathurst caribou were harvested annually from 1982 to 1995.

There are few restrictions on caribou hunting by Aboriginal people for their own use; however, there are limits on the number of caribou from each herd that can be harvested for commercial sale and by sport and resident hunters (ENR 2008). Non-aboriginal harvest of caribou is regulated by the ENR. Resident hunters are allowed to harvest up to two caribou, males only, each year. The resident harvest occurs in two peaks: one in the fall when the caribou are near the treeline (August 15 to November 15); and one in winter (November 16 to April 30). Non-resident hunters can harvest a maximum of two caribou per year (August 15 to November 30 in North Slave region), and must obtain the services of a licensed outfitter. These outfitted hunts provide business and employment opportunities to local residents and generate approximately $3 million in revenue per year into the territorial economy (ENR 2008).

Commercial hunting of caribou is carried out in the Fort Smith Region of the NWT (i.e., North and South Slave region, excluding Yellowknife). Dragon (2002) reports that between 1989 and 2001 a minimum of 1,312 animals have been harvested for commercial sale.

The numbers of Bathurst caribou harvested by resident hunters has fluctuated annually from 1982 to 2002, and was on average 1,141 ± 120 (1 Standard Error [SE]) animals (Figure 9.5.4). The number of caribou harvested by non-residents has generally been lower (mean of 429 ± 74), but has been increasing over time (Figure 9.5.4).

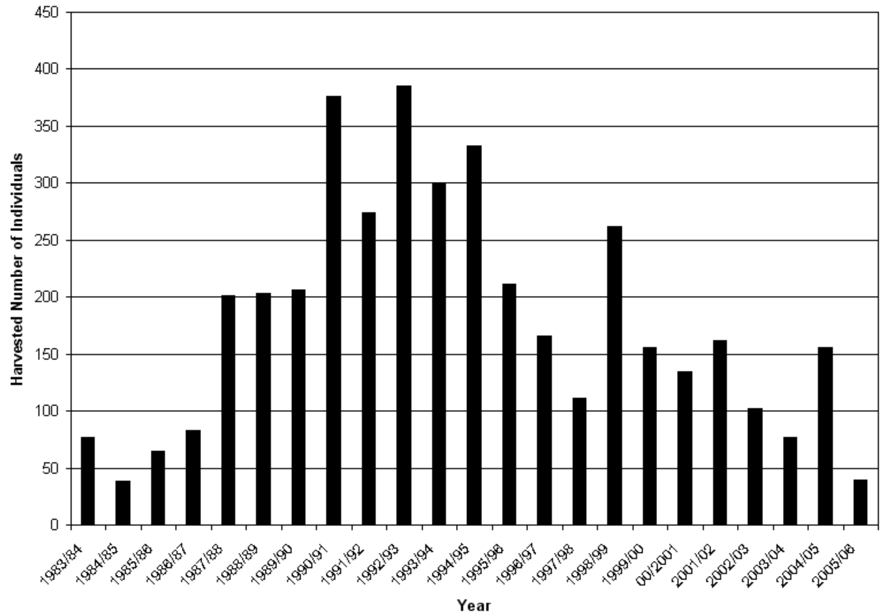
Figure 9.5.4 — Numbers of Bathurst Caribou Harvested Annually by Resident and Non-Resident Hunters in the Northwest Territories



As caribou tags are not herd-specific, residents of the NWT may also harvest caribou from the Beverly and Quamanirjuaq herds. Hunters from NWT, Nunavut, Manitoba, and Saskatchewan harvest about 18,500 caribou annually from these two herds for subsistence use. In the NWT, the non-aboriginal resident and non-resident harvest of these herds is extremely small as the Beverly herd is usually only accessible from Łutsel K'e and seldom travels close to NWT communities (ENR 2008). The Ahiak herd is seasonally hunted by people from Gjoa Haven, Umingmaktok, Cambridge Bay, and Łutsel K'e in some winters (ENR 2008). No estimates on the number of animals harvested were available.

Resident hunter harvest of barren-ground caribou in the Fort Smith Region has fluctuated annually from 1983 to 2006, but has averaged 179 animals per year (Figure 9.5.5). The harvested caribou would most likely be from the Ahiak and Bathurst caribou herds, since the annual ranges of these herds encompass parts of the North and South Slave regions.

Figure 9.5.5 — Estimated Barren-ground Caribou Harvest Levels by Residents of the Fort Smith Region: 1983/84 to 2005/06



9.5.4.2.2 Socio-Economics Related to Caribou

Available literature was reviewed to develop an approach for understanding the cultural values and ways of life associated with the region surrounding the Project. TK studies and reports primarily from the Łutsel K'e Dene First Nation (LKDFN), as well as from the GNWT and internet searches were available to enable a discussion of the cultural values, meanings, ways of life, and significance associated with the Aboriginal cultural landscape.

Caribou have an important social, cultural, and economic value to residents of the NWT. The herds are hunted by Aboriginal and non-aboriginal people from almost all communities. The minimum annual harvest is 11,000 caribou with a minimum economic value of $17 million dollars (includes meat replacement and outfitting) (ENR 2006). A recent socio-economic study found that the annual net value of the Beverly and Qamanirjuaq caribou harvest is more than $20 million (Soublière 2007). The NWT share of the Beverly and Qamanirjuaq caribou harvest accounts for less than $1 million of the annual revenue from harvested caribou. However, the economic value of harvested caribou is more than just food-replacement value. Wild meat can be nutritionally superior to store-bought meat, and hunting provides exercise, contributes to a healthy lifestyle, and has other cultural benefits as well (Soublière 2007).

Aboriginal peoples are dependent upon the land for their survival and prosperity. For generations, they have harvested resources for their own use, and continue to do so today. In the 21st century, the economies of many communities are made up of a mixture of the wage economy, the traditional/resource harvesting economy, and government transfer payments. Typically, in many of these smaller communities, traditional harvesting continues to play an important role in the economy as well as in the social and physical well-being of the community (Parlee 1998, Fast & Berkes 1999).

Caribou, duck, moose, muskrat, goose, and fish are some of the species consumed on a regular basis, and all community residents in Łutsel K'e consume some traditional food from the land (Parlee & Marlowe 2001). Participation in these harvesting activities not only provides food and resources, but also directly reduces economic stress on many Aboriginal households. On average, value attained from wild meat and fish harvested from the land has been related to $10,000 per household (Usher 1989). Involvement in harvesting activities also provides the intangible benefit in contributing to their identity and reaffirming their connection with the land.

In Łutsel K'e, over half of the adults and one-third of the youth surveyed consume six or more meals of caribou in a week. It was noted that caribou have been harvested less in the past few years due to the fact that the herds are farther from the community and it takes longer to reach them. Families and harvesters without access to snowmobiles and sufficient gasoline have difficulty reaching and harvesting from the herds (Łutsel K'e Dene Elders & Land-Users et al. 2005). Other reasons for the lack of participation in harvesting caribou include the prohibitive costs and lack of proper equipment, the need to travel farther distances from the community to reach the caribou herds, the lack of monetary resources, limited profits, and the lack of people possessing necessary traditional skills to share with others in the community.

9.5.4.2.3 Traditional Knowledge and Resource Use

The TK and TLU study program was individually tailored for each of the potentially affected Aboriginal communities. The specific methods used to collect TK and TLU from the relevant Aboriginal communities is detailed in Section 9.6.8 - Human Environment, Traditional Knowledge. In general, methods included reviews of available sources of information on TK and TLU, interviews through community researchers, field trips, mapping sessions, and working group meetings.

Aboriginal groups have had a historically important and respectful relationship with caribou, and continue to do so today. Respect for caribou is important for aboriginal people because caribou provide food, clothing, shelter, tools, and building materials. Caribou is consumed by most of the population in communities within the Project footprint (see Section 9.6.5 - Traditional Land Use).

Aspects of respect include only taking what is needed, using all parts of the harvested animals, and discarding any unused parts in respectful ways (Łutsel K'e Dene Elders & Land-Users et al. 2002). Respectful treatment of caribou while hunting them is also important. Hunters may not hit, poke, whip, or chase caribou too far. It is believed that chasing caribou with skidoos would make caribou ill and contribute to a population decline (Łutsel K'e Dene Elders & Land-Users et al. 2002). Respect is also shown by having and sharing knowledge of the caribou. Aboriginal people believe that a lack of knowledge, and, therefore, respect for caribou, would result in the caribou migrating farther from communities and would have reduced survival (caribou population decline), increasing hardship for the community (Łutsel K'e Dene Elders & Land-Users et al. 2002; Dogrib Treaty 11 Council 2001).

Traditional Knowledge is collected through harvesting activities, verified through discussions with other harvesters and elders, and shared through oral narratives (Dogrib Treaty 11 Council 2001). Based on the reviewed TK and TLU information, caribou is the most important resource harvested by Aboriginal groups surrounding the Project. As a result, they have accumulated a wealth of information about these animals (Łutsel K'e Dene Elders & Land-Users et al. 2003, 2005; Dogrib Treaty 11 Council 2001).

According to the reviewed TK and TLU, caribou consume primarily lichen (e.g., white, black, yellow, gray reindeer lichen, northern reindeer lichen, Iceland moss, hair lichen, leaf lichen-green kidney), as well as grass, sedge, cranberry leaf, willow leaf, cloudberry leaf, blueberry leaf, birch leaf, crowberry, and mushrooms (LKDFN et al. 1999, Dogrib Treaty 11 Council 2001). The reviewed sources also suggest that soil may be consumed (LKDFN et al. 1999). Hunters selectively harvest fat, healthy animals (Łutsel K'e Dene Elders & Land-Users et al. 2003, Łutsel K'e Dene Elders & Land-Users et al. 2002); therefore, it is important for aboriginal people that the caribou have access to abundant, high-quality food resources. Caribou fat is one of the most highly valued parts of the caribou, largely because of its taste, nutritional value and versatility. Caribou fat can be used as lard, for preserving berries, in pounded meat (pemmican), and for making candles (Łutsel K'e Dene Elders & Land-Users et al. 2002).

Most hunters hunt for caribou in areas where they are known to congregate (Łutsel K'e Dene Elders & Land-Users et al. 2003). Therefore, if these locations change, hunters may have less success in harvesting animals. Showing proper respect for caribou is also believed to ensure the health of aboriginal people and their ways (Łutsel K'e Dene Elders & Land-Users et al. 2002). Aboriginal people attribute changes in caribou migration routes to the level of respect that has been shown to animals in certain areas, as well as intensive industrial or tourism activity along traditional migration routes (Łutsel K'e Dene Elders & Land-Users et al. 2002).

Caribou have been migrating through the Project area for thousands of years. According to the reviewed TK and TLU, caribou migrate through the barren-land region twice a year, once in the fall and once in the spring, and during these migrations the caribou pass through the Project area (LKDFN et al. 1999). Migration routes vary annually, although aboriginal people note there are some migration routes that caribou always use (Łutsel K'e Dene Elders & Land-Users et al. 2002). In 2002 and 2003, the caribou migrated through Artillery Lake in what the LKDFN refer to as the "normal" way, although some hunters noted that the caribou were more spread out than usual (Łutsel K'e Dene Elders & Land-Users et al. 2005). In 2004 and 2005, the herd was considered to be farther away from Łutsel K'e. The identified TK and TLU information suggests that some LKDFN hunters were concerned that there were "less animals than there used to be in that area" (eastern side of Artillery Lake) and that the caribou were late and were "crossing at different locations than they used to, migrating more towards the north shore of Artillery Lake and not through the traditional crossings." (Łutsel K'e Dene Elders & Land-Users et al. 2005). Two explanations were proposed for why the caribou were migrating farther away from Łutsel K'e. One explanation suggests that forest fires have burned caribou habitat.

Another explanation is that mining and other development activity is stressing the caribou.

According to the reviewed TK and TLU information, several people in the Deninu Kué First Nation (DKFN) community are concerned that they have to travel farther than they did in the past to harvest caribou and believe the species population is decreasing (DKFN 2007). Aboriginals in the Fort Smith region of the NWT believe that caribou population has declined in recent years (Łutsel K'e Dene Elders & Land-Users et al. 2002). This perceived decline in the caribou population causes anxiety in aboriginal communities because of the high dependence of these communities on caribou for their individual and cultural well-being.

Aboriginal respect for caribou results from a spiritual connection and deep understanding of the land, water, and wildlife. Therefore, the abundance, distribution (migration), and condition of caribou are primary concerns for aboriginal communities (Łutsel K'e Dene Elders & Land-Users et al. 2002).

9.5.4.3 EXISTING INFORMATION

A literature review of all available information on caribou from effects monitoring and research programs was completed. Monitoring reports from existing diamond mines (i.e., Diavik Diamond Mine, Ekati Diamond Mine, and the Snap Lake Mine), scientific publications, and government manuscripts and file reports, current knowledge and relevant information regarding caribou research and the results of related monitoring activities for potentially affected caribou herds were included in the summary.

9.5.4.3.1 Review of Satellite-Collared Caribou Data

Satellite collar data from the Bathurst, Ahiak and Beverly herds were assessed from 1995 to 2007 (data courtesy of ENR 2007). The objectives of this desktop study were to estimate the natural range of variation in the following:

- annual and seasonal occurrence, abundance, distribution, group size and group composition of caribou in the study area;
- habitat associations, caribou movement patterns, and important movement corridors in the study area; and
- annual and seasonal likelihood of the Bathurst, Ahiak, and Beverly herds interacting with the Project.

Satellite-collar data (provided by the GNWT Department of Environment and Natural Resources [ENR]) suggests that the annual home range of the following three caribou herds may overlap the Project footprint: Bathurst herd (Figure 9.5.6); Ahiak (formerly the Queen Maud Gulf) herd; and Beverly herd (Figure 9.5.7).

Annual and seasonal ranges were calculated for satellite-collared caribou in the Bathurst, Ahiak, and Beverly herds using data from 1995 to 2007. Annual and seasonal ranges for the Bathurst herd were calculated based on satellite-collar data from January 1, 1996 through October 31, 2007. The temporal extent of satellite-collar data for the Beverly herd is from January 1, 1995 through October 31, 2007, whereas the Ahiak herd range is based on data from January 1, 2001 to October 31,

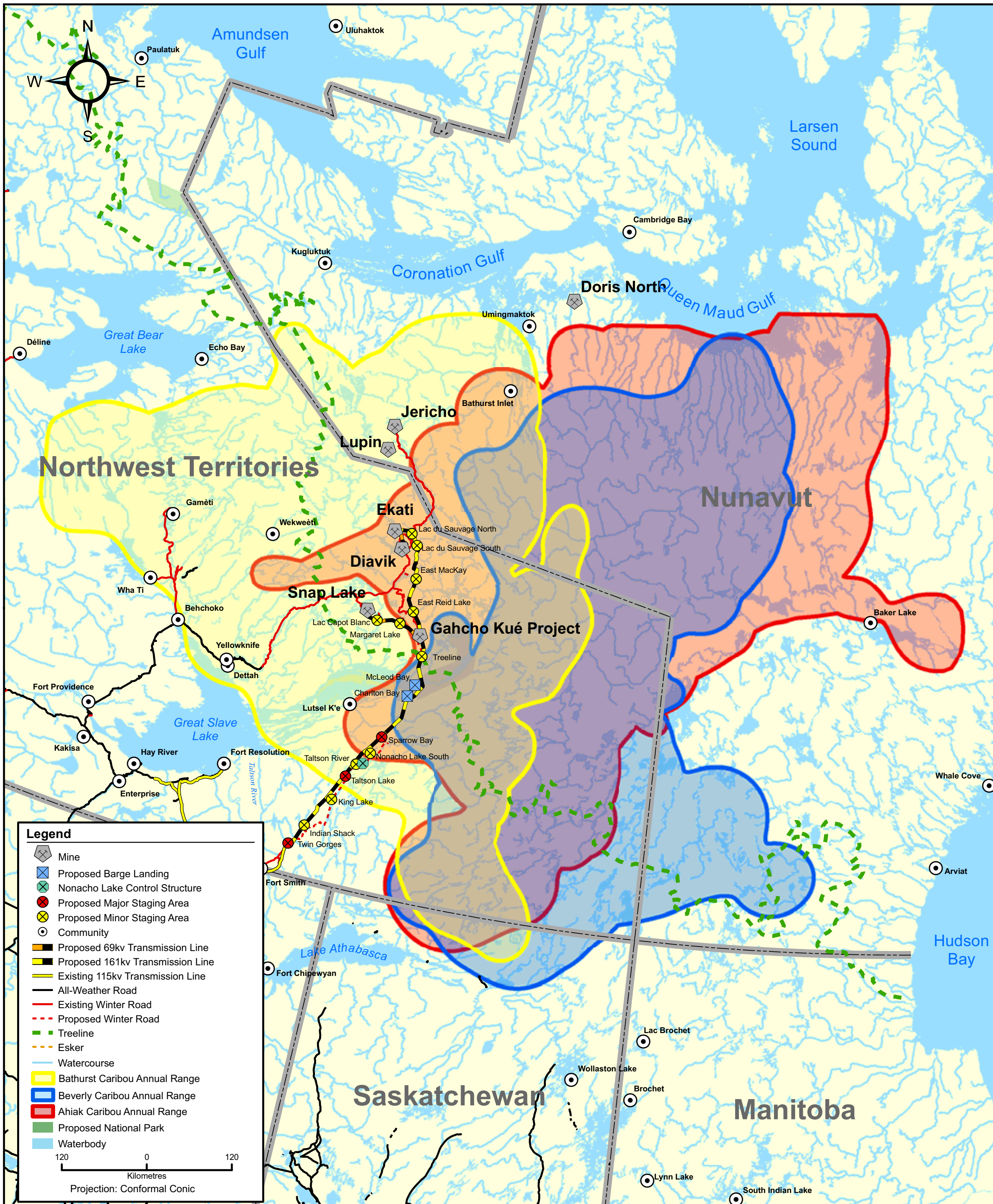
2007. Caribou distribution for each herd was classified into the following six periods (or biological seasons) based on inspection of annual movements of satellite-collared caribou (ENR 2008):

- northern migration – May 1 to 31,
- calving – June 1 to 15,
- post-calving aggregation – June 16 to July 1,
- summer dispersal – July 2 to August 31,
- rut and fall migration – September 1 to October 31, and
- winter dispersal – November 1 to April 30.

Locations of satellite-collared caribou were analyzed using a Geographic Information System (GIS) platform to investigate historical caribou use of the proposed transmission line ROW.

TALTSON Hydroelectric Expansion Project	Developer's Assessment Report 2009	Bathurst Caribou Seasonal Ranges	Figure 9.5.6

Dezé energy



TALTSON Hydroelectric Expansion Project	Developer's Assessment Report 2009	Ahiak, Bathurst and Beverly Caribou Herd Annual Ranges	Figure 9.5.7

9.5.4.3.2 Barren-Ground Caribou Seasonal Ranges

Caribou are distributed over the forest and the tundra of the mainland within the NWT and Nunavut (ENR 2008). Caribou migrate from their southern over-wintering grounds in the boreal forest to their northern calving grounds in the tundra. Pregnant cows lead the northern migration in late winter/early spring, followed by juveniles and bulls (Miller 1992). After calving, cows and calves begin to migrate back to the winter range. By summer, the cows meet up with the bulls that have continued to drift north (ENR 2008). In August and September, the caribou move across the tundra towards the treeline. The rut occurs in October and may last for two to three weeks. The distribution of caribou constantly changes during the winter as they search for places where the food is abundant and snow is the shallowest (ENR 2008). When spring arrives, the caribou once again begin their migration to their northern calving grounds again.

Variation in caribou movement and distribution occurs within and among years. Caribou population numbers naturally fluctuate, and caribou expand their range when populations increase and limit their distribution when populations decrease (Banfield & Jakimchuk 1980; Bergerud et al. 1984; Heard & Calef 1986). Although the precise timing and location of caribou movements between winter ranges and calving grounds are unpredictable, general corridors and the broad timing of movements are known. Caribou movements are generally classed into six periods (biological seasons) based on satellite-collar data (Figure 9.5.6; ENR 2008); each period is described below.

9.5.4.3.2.1 Northern Migration

The timing and route of caribou movements during the northern spring migration to the calving grounds tend to be more predictable than other migrations (Case et al. 1996; Gunn et al. 2002; BHPB 2004). The northern migration consists mainly of cows and yearlings, and cows nearest parturition (i.e., births) form the lead group (Pruitt 1960; Curatolo 1975). Bulls typically lag behind on the wintering grounds.

9.5.4.3.2.2 Calving

Most cows arrive on the calving grounds in the last week of May or early June. Bulls, some yearlings, and non-pregnant females tend to lag behind during the northern migration and generally do not migrate as far as the calving grounds (Case et al. 1996). Severe weather conditions and deep snow may delay animals and affect distribution on the calving grounds (Sutherland & Gunn 1996). Most caribou herds show some flexibility in the use of calving grounds, as well as variations in use of the same general area from year to year (Banfield & Jakimchuk 1980). For example, Bathurst caribou calving ground apparently switched from the east to the west of Bathurst Inlet during the 1980s (Sutherland & Gunn 1996).

Calving grounds are often located in high, rocky areas where there is little shelter from wind and driving snow. These conditions are favourable as they provide patches of bare ground that allow the cows to feed. Most wolves remain within or near the treeline to den and are a reduced threat to cows and newborns during the calving season. As well, these high, rocky areas of the calving grounds are difficult for wolves to access. However, the calving grounds are occupied by grizzly bears, which prey on newborn calves.

Although the breeding dates of caribou are highly synchronized (Gunn 1984a), cows that are in poor physical condition may have prolonged gestation (Bergerud 1975). In years with poor weather conditions or reduced forage productivity, calving may peak later than normal (Gunn 1984a). The majority of calving takes place in the first two weeks of June. Within this period, there is a five-day interval when most calves are born (Fleck & Gunn 1982). The timing of calving is also determined by the timing of the rut; however, factors that influence the rut are not well understood (Gunn 1984b). Poor range conditions and human disturbance that lead to increased energy expenditure by caribou in late summer could also result in poor body condition, delayed rutting, and potentially affect the following year's spring calving.

9.5.4.3.2.3 *Post-Calving Aggregation*

The post-calving period is characterized by an increase in movement and an aggregation of individuals into larger groups (Pruitt 1960; Curatolo 1975). Initially, these groups include cows and calves, who are then gradually joined by non-calving cows, yearlings, and adult bulls. The aggregation of caribou into large mixed groups is likely caused by insect harassment (Case et al. 1996) or may be related to forage requirements.

9.5.4.3.2.4 *Summer Dispersal*

The movement of the post-calving aggregations slows around the end of July, at which time animals begin to disperse (Curatolo 1975). Caribou form small groups with the bulls typically segregating into separate bands (Pruitt 1960). Timing of dispersal may be related to a decline in insect harassment, which allows caribou a chance to feed and rest. Caribou spend the summer primarily on the tundra portion of their range (Case et al. 1996), although some animals move towards the treeline (Banfield & Jakimchuk 1980). During this period, lactating cows and calves have high nutrient demands, and caribou attempt to restore energy reserves prior to winter (Gunn et al. 1983).

9.5.4.3.2.5 *Rut and Fall Migration*

Unlike the spring migration, movements in the fall are not easily predicted. Timing and location is highly variable and may occur from early September to late October. Some caribou may move towards the treeline in July or August (Banfield & Jakimchuk 1980). The location of caribou in late summer largely influences the fall migration routes, but the variation of summer distribution among years is not fully understood (Gunn 1984b). In addition, the rut usually coincides with the fall migration. Fall freezes and the lack of snow and ice on lakes may influence fall movements, which may also influence the location of the caribou during and after the rut (Gunn 1984b). At this time, caribou are generally found in large mixed groups near the treeline (Curatolo 1975; Case et al. 1996). Because of the variability in timing of the fall migration, the rut may take place before, during, or after the main migration (Banfield & Jakimchuk 1980). The rut typically peaks in late October (Gunn 1984b). Sparring may begin by the end of September, with sporadic rutting activity occurring through early November. Following the rut, the cows and bulls would segregate and disperse over the wintering grounds.

9.5.4.3.2.6 Winter Dispersal

Caribou generally disperse throughout their winter range from November through March. By April, animals will begin to gather into small groups for the migration north (Pruitt 1960). Caribou distribution over the winter range is highly variable and depends largely on snow depth and hardness (Curatolo 1975; Banfield & Jakimchuk 1980). Winter distribution is difficult to predict. The most frequently used winter ranges are near the treeline, although some animals will overwinter on the tundra (Banfield & Jakimchuk 1980). After the rut, the bulls generally move deeper into the forest than cows and yearlings (Case et al. 1996) and the sexes typically remain segregated (ENR 2008).

9.5.4.3.3 Barren-Ground Herds within the Project Extent

For the purposes of the Project, the locations of satellite-collared cows from the Bathurst (1996 to 2007), Beverly (1995 to 2007), and Ahiak herds (2001 to 2007) were used to define the annual and seasonal ranges for each herd (data courtesy of ENR). Figures 9.5.6 and 9.5.7 outline the seasonal ranges of the Bathurst, Beverly, and Ahiak herds according to known locations of satellite-collared cows (ENR 2007).

9.5.4.3.3.1 Bathurst Herd

Satellite-collar data indicate that Bathurst population caribou seasonal ranges overlap with the Project, with the exception of post-calving, has the greatest likelihood of interacting with the Project, primarily during the winter dispersal, rut and fall migration, northern migration, calving and summer dispersal periods (Figure 9.5.6). The Project footprint does not overlap with the historic Bathurst calving grounds (Sutherland & Gunn 1996). The Bathurst herd spends most of the winter mostly in forested areas below the treeline (ENR 2008). The estimated annual home range for the Bathurst herd (1996 to 2007) is 380,276 km^2. A total of 12,577 satellite locations for 89 collared cows were collected from January 1996 through October 2007 for the Bathurst herd. Observations were spread amongst the winter dispersal, northern migration, summer dispersal, and rut/fall migration periods (Table 9.5.7). Review of the satellite-collar data from the Bathurst caribou herd indicates that Bathurst caribou cross under the proposed transmission line ROW during northern migration, summer dispersal, fall migration, and winter dispersal (Table 9.5.7). During the northern migration, 26 collared caribou made a total of 56 crossings of the proposed transmission line ROW. During the post-calving and summer dispersal, 57 collared caribou made a total of 228 crossings, while 41 collared caribou crossed a total of 162 times during the rut and fall migration. During the winter dispersal period, 33 collared caribou made a total of 158 crossings of the proposed transmission line ROW.

Table 9.5.7 — Collared Caribou Intersections with the Proposed Transmission Line Route: by Season from 1996 to 2007

Herd	Season	Total Number of Collared Caribou	Total Number of Satellite Point Locations	Number of Collared Caribou Crossing the Proposed Transmission Line	Total Number of Crossings of the Proposed Transmission Line
Bathurst	Northern migration and calving	76	1800	26	56
	Post-calving and summer dispersal	74	4729	57	228
	Rut and fall migration	79	1677	41	162
	Winter dispersal	85	4371	33	158
Beverly	Northern migration and calving	8	95	0	0
	Post-calving and summer dispersal	8	178	0	0
	Rut and fall migration	7	126	0	0
	Winter dispersal	7	205	0	0
Ahiak	Northern migration and calving	16	308	2	4
	Post-calving and summer dispersal	16	1167	0	0
	Rut and fall migration	14	341	0	0
	Winter dispersal	16	888	5	12

9.5.4.3.3.2 Beverly Herd

The Beverly herd range overlaps with the Bathurst and Ahiak herds. Similar to the Bathurst herd, the Beverly herd also spends the winter largely in forested areas below the treeline (ENR 2008). Data suggest that the Beverly herd remains inland year-round as they travel between their calving grounds, located northwest of Baker Lake, to their winter range located in north central Canada (ENR 2008). Traditionally, the Beverly herd calving grounds are near Beverly Lake and the Thelon River system. More recently, their calving grounds have shifted towards Gary, Sand, and Deep Rose lakes in Nunavut (ENR 2008). Seasonal home ranges estimated from satellite-collar data for the Beverly Herd suggest that there is a low likelihood of interacting with the Project. However, these results are based on a maximum of one collared cow per year from January 1995 to May 2006, five to six collared animals from June 2006 to December 2006, and two cows during the late winter northern migration of 2007 (no collar data for calving and post-calving was available for 2007). Nonetheless, no collared caribou were observed crossing the proposed transmission line ROW (Table 9.5.7).

9.5.4.3.3.3 *Ahiak Herd*

Satellite-collar data suggest that the Ahiak caribou herd's range is from the Queen Maud Gulf to south of the Thelon Game Sanctuary, and as far west as Great Slave Lake (Figure 9.5.7). While satellite-collar data (from 2001 to 2007) indicates that the Ahiak caribou form a discrete herd during the calving and rutting seasons, their range has been known to overlap with other caribou herds. In the past, the calving grounds overlapped with the traditional calving grounds of the Bathurst herd (ENR 2008); however, the current calving grounds of the two herds are separate (ENR 2008). Post-calving and summer distributions are largely within the Queen Maud Gulf Migratory Bird Sanctuary. The winter range of the Ahiak herd extends farther southeast, and wintering may occur on the tundra (Gunn et al. 2000; ENR 2008). The Ahiak herd's southern wintering ranges may overlap with the ranges of the Beverly and Bathurst herds, while their northern winter ranges overlap with the Dolphin and Union herd's mainland winter ranges (ENR 2008). Of the 16 collared caribou from the Ahiak herd, two individuals crossed the proposed transmission line ROW four times during northern migration, and five individuals crossed 12 times during winter dispersal (Table 9.5.7).

9.5.4.3.4 Caribou Habitat Use

A wide range of forage plants is used by caribou, and food habits vary seasonally (Banfield & Jakimchuk 1980). In spring and summer, caribou tend to select new plant growth and flowers as these foods are rich in minerals and protein (Thompson & McCourt 1981). On the calving grounds, willow (*Salix* spp.), dwarf birch (*Betula glandulosa*), green alder (*Alnus crispa*), and cotton grass (*Eriophorum* spp.) are consumed as new growth emerges (Fleck & Gunn 1982). Cows select calving grounds based on the potential for high levels of green plant biomass during the peak lactation period when energetic demands are highest. The quality (i.e., energetic content) of forage within the Bathurst calving range may be lower compared to other herds (e.g., Porcupine Herd) (Griffith et al. 2002). Following calving, caribou will move to areas where new vascular plants are more abundant. Willow, forbs, grasses, and sedges become important forage species in summer (Case et al. 1996; Demarais & Krebs 2000). By late summer, the leaves of deciduous shrubs, such as willows, dwarf birch, and bearberry (*Arctostaphylos* spp.) form much of the diet. In the fall, grasses, sedges, birch, and willow leaves remain important because of the protein content (Skoog 1986). Mushrooms may also be consumed at this time of year (Kelsall 1968; Skoog 1986).

Caribou are not typically browsers and most of their early winter diet consists of lichens (*Cladonia* and *Cladina* are preferred), as well as the green parts of sedges and horsetails because of their high digestibility and high protein levels (Case et al. 1996; Thomas & Hervieux 1986). The consumption of grasses and sedges diminishes over winter, as these plants become less digestible (Kelsall 1968). In late winter, arboreal lichens are used extensively, although alder, birch, and willow may be consumed when other food resources are scarce. Snow characteristics, such as hardness and depth, can influence forage availability and the selection of winter habitat (Case et al. 1996). Snow cover, rather than food availability, appears to limit the capacity of winter ranges to support caribou. In spring, lichen uplands are the first areas to become snow-free, and shrubby lichens (e.g., *Cladonia* spp.) become important until new vascular plant growth emerges. Unique habitat features sought out by caribou include mineral licks of frost boils or mud boils, which are primarily mounds of silt and clay (Pruitt 1960).

Although the fine details of diet are important, wide-ranging species such as caribou may select habitats on a regional scale rather than a more local scale (Johnson et al. 2005). Resource selection models suggest that caribou chose habitats dominated by lichen veneer, heath tundra, and rock vegetation types. Observational studies also found that Bathurst caribou preferentially selected lichen heath habitat, and their calving and post-calving diet is dominated by lichens (Griffith et al. 2002).

Apparent habitat preference and behaviour of caribou are affected by large-scale environmental factors and seasonal changes. For example, the depth and hardness of snow affects food accessibility for caribou (Stuart-Smith et al. 1997), as do extreme weather events such as late spring snowfall or late snowmelt (Skogland 1984; Adamczewski et al. 1987; Cameron et al. 1993). As well, studies of caribou have shown that the historical cumulative effect of overgrazing on calving, summer, or winter ranges can result in periodic range shifts and large population fluctuations (Messier et al. 1988; Ferguson & Messier 2000).

Monitoring studies on the existing Ekati, Diavik, and Snap Lake mines indicate that caribou prefer heath tundra, heath tundra/boulder-bedrock, and riparian shrub habitats over other habitat types during both the northern and post-calving migration periods (BHPB 2004; DeBeers 2008; Golder 2008a). During the northern migration, frozen lakes appear to be less preferred (Golder 2008a). However, the hard-packed, windswept snow of frozen lakes and eskers may provide caribou a relatively easy surface for travel (Golder 2004, 2008a; Gunn 1984b; Williams 1990). In the winter, caribou utilize lichen-rich habitats with shallow snow (Arseneault et al. 1997). Foraging activity is concentrated in black spruce forests, while open areas, such as meadows and frozen lakes, are used for ruminating and bedding. Frozen, snow-covered lakes also provide escape terrain, and allow for easier detection of, and escape from, predators than deep snow found in forest-covered areas (Pruitt 1960; Kelsall 1968; Gunn 1984b). Aerial survey observations indicate that when lakes were not frozen, feeding and resting behaviours were more common in riparian shrub and sedge wetland habitats (De Beers 2008; Golder 2008a). Large lakes appear to influence caribou distribution during the summer period as animals tend to move around large, open bodies of water (De Beers 2008; Golder 2008a).

In addition to vegetation type, it is clear that the influence of major developments is also important in habitat use (Johnson et al. 2005). Caribou demonstrated a strong response to disturbance during the post-calving period and showed an avoidance of major developments. In Resource Selection Functions (RSF), these developments were shown to reduce high quality-habitat and increased the amount of low-quality habitat in recently produced RSFs (Johnson et al. 2005). Nonetheless, caribou are known to use artificial habitats created by mine structures (e.g., roads, processed kimberlite containment [PKC] facilities, waste rock piles). These structures may provide a means of avoiding insect harassment, as caribou are often observed bedding or resting on these structures (Gunn et al. 1998; BHPB 2004, 2007). During a 2008 winter caribou survey of the Snare Hydro Transmission Line (approximately 140 km of transmission line surveyed from Yellowknife to Snare Hydro), feeding craters were observed directly under the transmission line at two different locations (Golder 2008b). There is incomplete information on the effects of metal intake on caribou, but an analysis of fecal pellets from the inactive Colomac Mine and active Ekati Diamond Mine areas found elevated levels of ash content, indicating uptake of inorganic minerals (MacDonald & Gunn 2004). Caribou may be increasing their metal uptake through foraging on lichens in areas of increased dust deposition and re-vegetation on PKC areas, and possibly through direct consumption of soils.

9.5.4.3.5 Behaviour

Activity budgets of caribou are influenced by both environmental and anthropogenic (i.e., man-made) variables. Insect harassment is known to reduce foraging and influence body condition for caribou (Gunn et al. 2001; Weladji et al. 2003). Recent analyses of point observations of behaviour confirmed that the likelihood of feeding or resting declined as insect abundance increased (De Beers 2008; Golder 2008a).

Behavioural monitoring of the Bathurst caribou on their calving grounds indicated the active feeding cycle was about 98 minutes, while the resting cycle was 78 minutes (Griffith et al. 2002). There was concern that caribou experiencing disturbance from mining activities would reduce their amount of time feeding, which may lead to physiological effects, and ultimately influence survival and recruitment (Gunn et al. 2001). Therefore, behaviour monitoring is a component of most mine monitoring programs.

Modelling simulations, based on activity budgets based data from the Porcupine caribou herd in Alaska found that exposure to development may cause a 13% decline in fall body fat, and a 7% decline in herd growth rates (Gunn et al. 2001). This model has not yet been confirmed with activity budget data from existing diamond mines in the NWT. Only the Ekati Diamond Mine has substantial activity budget data. From 1998 through 2003, female caribou with calves spent about 10 to 13% less time feeding within 5 km of the mine than groups greater than 5 km from the mine, but the results were not statistically significant (BHPB 2004). The largest amount of variation in behaviour was explained by year effects. Further data on activity budgets at mine sites is required to assess potential behavioural changes due to mine-related disturbance, and cumulative effects of insect harassment combined with mine disturbance. Behavioural monitoring over a longer period indicated that resting or feeding behaviours were most common, even near airstrips or roads (Gunn et al. 1998; BHPB 2007).

Likewise, statistical models indicate that point observations of caribou behaviour are largely driven by habitat type or insect activity, rather than distance to the mine (BHPB 2004; De Beers 2008; Golder 2008a). In the cases where distance to the mine was related to behaviour, feeding or resting was more common closer to the mine. In some cases, feeding or resting behaviour declined during the construction phase of mine development, when noise and disturbance is predicted to be at a maximum (Golder 2005, 2008a). Nursery groups (i.e., groups with calves) appear to be slightly more sensitive to behavioural changes than adults alone (BHPB 2004; Golder 2008a; De Beers 2008).

Ground-based studies of behavioural responses to stressors at the Ekati Diamond Mine found that nursery groups (i.e., groups with calves) were also more likely to respond to stressors (BHPB 2007). Blasting was the most likely type of stressor to induce a response for all caribou groups, as opposed to vehicle or human stressors. The level of response, ranging from low (looking up) to high (running away) decreased as distance from the stressor increased (BHPB 2007).

9.5.4.3.6 Abundance

There are a number of natural, large-scale environmental factors that can influence the habitat use, behaviour, energetics, survival, and reproduction of the caribou population. Food abundance and quality on summer and winter ranges are important elements in caribou population dynamics (Reimers 1983; Skogland 1990; Post & Klein 1999). Snow conditions, such as depth and hardness, also affect the movement rate and food accessibility for caribou (Stuart-Smith et al. 1997). Extreme weather events, such as late spring snowfall or late snowmelt, can influence access to food and result in lower calf weights or delayed parturition, which influences survival of young (Skogland 1984; Adamczewski et al. 1987; Cameron et al. 1993). High insect abundance can also decrease forage intake, milk production, calf growth, and calf survival (Helle & Tarvainen 1984; Russell et al. 1993). Factors that influence adult female food intake between summer and winter also determine pregnancy rate and parturition rate. There also is a complex interaction between habitat and caribou foraging and movement patterns that is not well understood for caribou herds. For example, studies of caribou have shown that the historical cumulative effect of overgrazing on calving, summer, or winter ranges can result in periodic range shifts and large population fluctuations (Messier et al. 1988; Ferguson & Messier 2000).

Both traditional and scientific knowledge indicate that the number of animals in barren-ground caribou herds cycle at relatively regular intervals (e.g., 30 to 60 years [Kendrick et al. 2005, ENR 2008]; 70 to 90 years [Ferguson & Messier 2000]). Although these natural fluctuations in herd size appear to be linked to changes in climatic patterns and winter range quality (Ferguson & Messier 2000; Weladji & Holand 2003), the exact mechanisms responsible for generating these population cycles are unknown. Five of eight Arctic caribou herds (i.e., Porcupine, Cape Bathurst, Bluenose East, Bluenose West, and Bathurst) have declined during the past 10 years (Working Group on General Status of NWT Species 2006). All herds of caribou present in the NWT have declined over the past five to ten years (Working Group on General Status of NWT Species 2006). As a result, all herds of barren-ground caribou in the NWT, with the exception of the Peary caribou herd, are ranked as ‘sensitive’ in the NWT. The status of the Ahiak, Beverly, and Qamanirjuak herds since the mid-1990s is unknown, but given the synchronicity in population cycles of caribou, population decreases in these herds is suspected.

The Bathurst caribou herd is currently the largest of the four major barren-ground caribou herds found on the mainland of the NWT. The herd typically ranges over an area extending from Bathurst Inlet to the northern boreal forest (Gunn et al. 2002). The estimated annual range (based on 95% kernel density of data from 1996 to 2007 [Figure 9.5.6]) is 380,276 km^2. Winter distribution extends from the south side of Great Bear Lake to as far south as northern Saskatchewan. Although cows typically return to the same general area to calve, the specific locations used for calving changes from year to year (ENR 2008). The number of individuals in the Bathurst herd has declined almost 75% from a reported maximum population size of 472,000 in the late 1980s, to 128,000 in 2006 (GNWT 2006; Boulanger & Gunn 2007; Nishi et al. 2008). Gunn et al. (2005) reported an annual rate of decline of about 5% from 1996 to 2006. The 2006 population estimate suggested that the number of females in the herd declined from approximately 203,000 to 55,600 breeding females between 1986 and 2006 (ENR 2008). Herd size was approximately 472,000 caribou in 1986 and 128,000 caribou in 2006 (ENR 2008). Reduced fecundity and adult survival have been cited as contributing factors to the recent decline in herd size.

Using modelling techniques and data collected from 1996 to 2003, Boulanger and Gunn (2007) estimated the following annual survival rates of caribou from the Bathurst herd: female adult = 0.842, female yearlings (age 1) = 0.842; and female calves (young-of-the-year) = 0.259. Male adult survival was estimated to be 0.730. Estimates of survival rates for male yearlings and calves were not presented in Boulanger and Gunn (2007). Fecundity, defined as the average number of calves produced for each sex and a function of adult survival, was 0.45. Modelling results also showed that survival rates of adult females were relatively constant from 1986 to 2006, but that fecundity and calf survival declined during this period. For the population to exhibit a positive growth rate, it is necessary that calf and adult survival, as well as fecundity, must increase from current estimates (Boulanger & Gunn 2007).

The last population survey of the Beverly herd was completed in 1994, which estimated the number of caribou at 276,000 (ENR 2008). In 1984 the herd size was about 264,000 animals (ENR 2008). Results obtained in 1994 are consistent with 1984, indicating that the population of the Beverly herd has remained stable since that time.

During the most recent survey of the Ahiak herd in 1996, the herd was estimated at 200,000 individuals. This was the third largest caribou herd in Nunavut and the NWT at that time (ENR 2008).

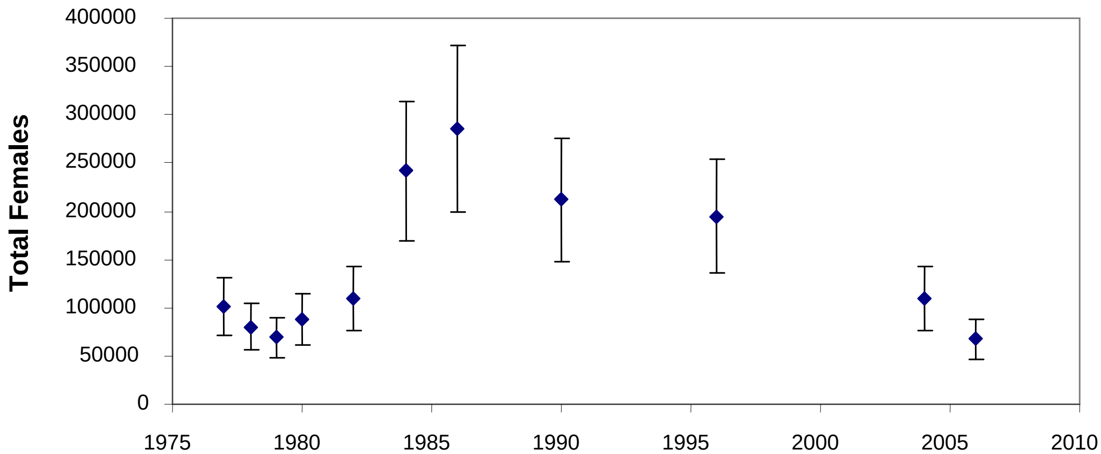
The links between demographic variables (e.g., adult and calf survival), environmental factors (e.g., food quality and quantity, insects, hunting, and development), and population growth are not well understood. Although direct losses of habitat (e.g., total mining footprint) are relatively small, and likely have marginal influences on the carrying capacity of the landscape (Johnson et al. 2005), industrial development has the potential to disrupt movements and reduce availability of high-quality habitat. For example, Johnson et al. (2005) showed that Bathurst caribou avoided areas of industrial development, particularly during post-calving movement, suggesting that caribou can adjust their behaviour to accommodate some disturbance (e.g., Colman et al. 2001). However, if avoidance behaviour is a product of a disturbance response, then there may be implications of sensory disturbance at the population level, such as reduced recruitment. If animals are exposed to multiple disturbance events, then there may be energetic costs (e.g., Tyler 1991). A single encounter with disturbance (e.g., loud noise) is unlikely to cause adverse energy consumption by an animal; however, the effect of exposure to disturbance should be proportional to the number of times an animal encounters disturbance events (Bradshaw et al. 1998).

Natural forces such as insect levels and climate may also have an important role in population dynamics, and their interacting effects with habitat requirements may confound any perceived relationships with human activity (Tews et al. 2007). For example, Tlicho caribou harvest data from 1916 to 1998 revealed that hunters reported harvesting some underweight caribou, approximately 33 out of the 1,026 cases (about 3% of the harvest) (Dogrib Treaty 11 Council 2001). Of these 33 cases there were 7 instances where all caribou harvested were considered to be underweight (the winters of 1917, 1918, and 1937; the falls of 1921, 1931 and 1956; and the spring of 1957). The reviewed TK and TLU suggested that poor body condition was due to shorter foraging times and harassment by predators and parasites (Łutsel K'e Dene Elders and Land-Users et al. 2005).

Other possible causes of recent reductions in herd size include sport and subsistence hunting (Boulanger & Gunn 2007). Case et al. (1996) estimated that between 14,500 and 18,500 Bathurst caribou were harvested annually from 1982 to 1995. Based on estimated population size from the Dogrib Harvest Study, Boulanger and Gunn (2007) estimated that on average, 6.7% of bulls (range = 3.0 to 9.2%) and 4.1% of cows (range = 1.4 to 7.0%) were harvested annually from 1988 to 1993. However, demographic models suggest that reduced levels of hunting generated only a slight increase in adult survival (3%), which was not enough to produce positive population growth (Boulanger & Gunn 2007).

In addition to the environmental and anthropogenic external factors mentioned above, density dependence may be an important factor in the population dynamics of caribou (Tews et al. 2006). Density dependence occurs when the growth rate of a population decreases as its density increases. In some cases, growth rates decrease because of declining forage resources, which result in reduced survival and/or reproduction. This mechanism can lead to cyclical trends in abundance beginning when foraging levels surpass a critical level for maintenance of population size, resulting in either gradual reductions in population growth or abrupt population declines. Temporal data on population size in Case et al. (1996) combined with more recent information from Boulanger and Gunn (2007), clearly show cyclical trends in Bathurst caribou abundance between 1976 and 2006 (Figure 9.5.8). Thus, density dependence is one possible mechanism that may underlie recent declines (beginning in the 1990s) in population size (Figure 9.5.8).

Figure 9.5.8 — Temporal Trend in Number of Female Caribou from the Bathurst Herd: 1976 to 2006



Notes:

* Estimates of total females on the calving ground are used in combination with herd composition to estimate total population.
* Values from Case et al. (1996) and Boulanger and Gunn (2007).
* Error bars = standard deviation.

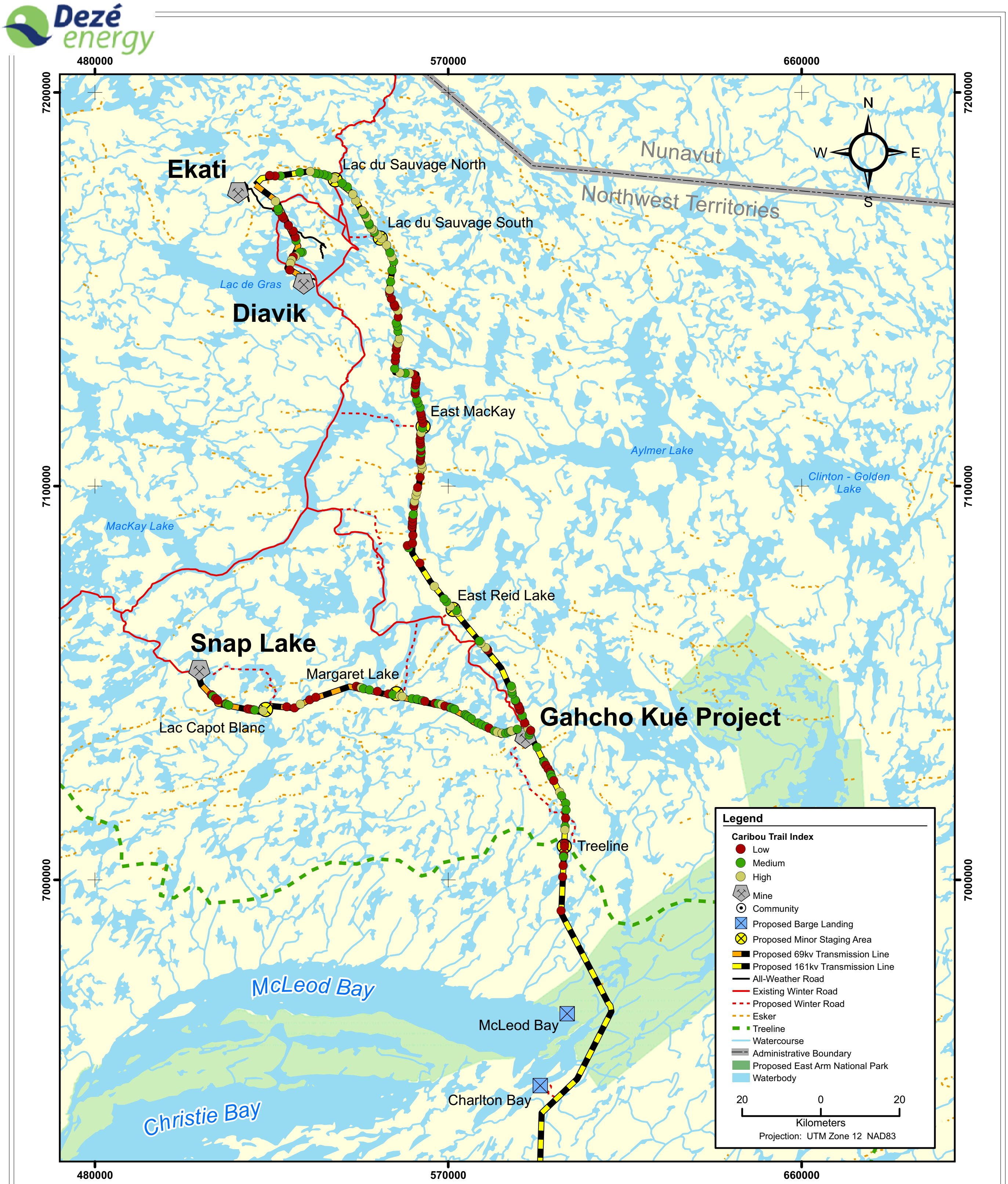
9.5.4.3.7 Distribution

Central Canadian caribou show a general pattern of seasonal movement between calving grounds near the arctic coast, followed by post-calving and rutting movements within the barren-grounds, followed by a movement into the northern boreal forest during winter. Most of the central Canadian barren-grounds appear to be used seasonally by at least one herd. The lower limits of the distribution of these herds appears to be limited to the southern extents of the Taiga Shield ecozone, with avoidance of recently burnt forest. Major geographic boundaries also exist, including Great Bear Lake and Great Slave Lake.

Overall, there is a high level of spatial and annual variation in the distribution of caribou (BHPB 2007, De Beers 2008, Golder 2008a). The Bathurst herd winters south of Great Slave Lake and may overlap with the Ahiak and Beverly herds. Although the annual calving ground is the most predictable part of the annual home range, over decadal periods the annual calving grounds may shift across the landscape (Gunn et al. 2002). Shifts in the calving range to the north or west may likely result in reduced green forage and could be detrimental to the nutrition of the herd (Griffith et al. 2002). The calving ranges of the Bathurst and Ahiak herds are geographically separate, but are adjacent to each other (Gunn & D'Hont 2002).

Historic movements and migrations of caribou have been identified based on trails that scar the landscape (Figure 9.5.9). Typically historic trails are located along the edges of large lakes and rivers or other geographic barriers where funnelling of caribou movements may occur, which leads to higher local densities. Most open-water crossings occur during the summer dispersal, post-calving movement, and fall migration. Caribou will cross open water, but they tend to follow shorelines and concentrate at specific crossing areas (Williams & Gunn 1982). The characteristics of preferred water crossings vary; however, most water crossings are narrow and the surrounding terrain funnelled caribou toward a particular crossing site where lakes narrowed. Caribou will swim across lakes and rivers up to 9 km in width and with surface water velocities that range from slow to rapid (Williams & Gunn 1982). Historic caribou trails were frequently observed along the entire length of the proposed Project's transmission line ROW north of the treeline. Particularly high densities were observed east of Lac de Gras and MacKay Lake, and between the east ends of these two lakes (Figure 9.5.9). The index for historic trails was also high near the Gahcho Kué Project. Although it is not possible to determine the number of caribou using these trails or the frequency of their use, the presence of trail scarring suggests that large numbers of caribou moved through these areas in the past. The frequency and density of caribou trails decreases as the transmission line ROW enters the boreal forest.

Based on monitoring programs at the existing diamond mines, overall there is high annual variation in the occurrence of nursery groups at the mine sites, and general correspondence in the years of high and low calf occurrence (De Beers 2008; Golder 2008a). For example, in 2005, the Ekati and Diavik mines reported relatively low proportions of nursery groups at 7% and 6% respectively (BHPB 2007; Golder 2008a). In contrast, the proportion of groups with calves in the Snap Lake Mine study area (3,000 km^2) in 2004 and 2005 was 37% and 34% respectively (De Beers 2007). The proposed transmission line ROW is not located near the calving grounds for the Bathurst, Beverly or Ahiak caribou herds (ENR 2008; Gunn and D'Hont, 2002; Gunn et al. 2002).



TALTSON **Hydroelectric Expansion Project**	**Developer's Assessment Report 2009**	**Caribou Trail Observations in the Bathurst Caribou Post-Calving Range, September 2006**	**Figure 9.5.9**

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9.5.4.4 BASELINE STUDIES

Wildlife studies for the Project have been conducted since 2003 to gain an understanding of the caribou herds, particularly in regards to their seasonal distribution. Information was gathered using both field and desktop studies. Aerial surveys were designed to provide estimates of the natural variation in wildlife presence, abundance, distribution, and movement around the location of the proposed transmission line. In addition to the field survey data, satellite-collar data from the Bathurst, Ahiak (or Queen Maud Gulf), and Beverly herds from 1995 to 2007 were analyzed. Satellite-collar data was obtained from the Government of Nunavut and the Government of the Northwest Territories (GNWT). Lastly, baseline and collared animal survey data was supplemented with ecological information from regional wildlife studies, published and unpublished scientific literature, discussions with wildlife experts, and Traditional Knowledge (TK).

The following summarizes the baseline caribou data collected for the proposed Taltson Hydroelectric Expansion Project:

- information on caribou herds with ranges that include the area of the proposed Project (including population trends for abundance, distribution and demographic rates such as calf survival and adult mortality, range use patterns and condition, and known natural and human-caused population pressures);
- a description of life stages (including calving, post-calving, overwintering, and migration) and habitat requirements during these life stages including when each herd may interact with the proposed Project;
- attributes of the seasonal habitats that relate to how caribou use them (e.g., insect relief, travel routes, forage);
- migratory routes, patterns and timing in relation to the Project activities;
- traditional caribou harvesting activities in relation to the proposed Project location;
- traditional values in the context of respect for caribou and how people should behave toward caribou;
- any known issues currently affecting caribou in the proposed Project area; and
- identification of important areas associated with the Project components, such as water crossings and calving grounds, where caribou may congregate.

9.5.4.4.1 Methods

Baseline aerial surveys for caribou along preliminary alignment routes between the Project and Snap Lake occurred from July 2003 to March 2004 (Rescan 2004). The preliminary transmission line alignment was similar to the current alignment between Twin Gorges and the Lockhart River crossing, but then veered west along the northern shoreline of McLeod Bay on Great Slave Lake, then north to Snap Lake. The transmission line route has been altered since these initial surveys to enable the Project to supply electricity to the proposed Gahcho Kué Project and the existing Ekati and Diavik mines. However, the information collected from areas south of the Lockhart River crossing near Great Slave Lake still remains relevant to the current Project description.

Rather than following the transmission line alignment directly, the survey used intersecting transects. The early October 2003 survey used a series of 40 km transects aligned perpendicular to the transmission line right of way (ROW), which was later altered to a zigzag pattern to minimize ferry time between transects. The resulting 12 transects ranged from 50 to 62 km in length. Surveys began in October 2003 and were conducted approximately every three weeks until late March 2004, for a total of nine surveys. Cessna 185, Cessna 337, and Bell 206B (mid-November and mid-February flights only) aircraft were used for these surveys. Survey altitude ranged from 100 to 125 m above ground level (agl), and airspeed ranged from 130 to 160 km/h. The altitude was lowered to 30 to 50 m elevation at 70 to 100 kph for the Bell 206B helicopter flights, to collect track information (e.g., caribou, wolves). All observations of caribou and caribou tracks were recorded.

Aerial surveys for caribou were again conducted in mid-February and mid-March, 2006, with the objective of documenting late winter caribou distribution, habitat association, behaviour, composition and group size (Golder 2006). These two surveys followed the alignment of the transmission line route as closely as possible. As caribou of the Bathurst herd are predominantly found below the treeline during the winter (Gunn et al. 2002), only sections of the transmission line ROW that are south of the treeline (i.e., from Twin Gorges to approximately 10 km south of the Gahcho Kué Project) were surveyed.

Surveys were conducted by helicopter, flying at approximately 120 m agl, at speeds of 80 to 120 km/h. The speed was varied to obtain the best possible observations, and to account for daylight and fuel limitations (i.e., slower speed over closed forests or areas of heavy wildlife activity, increased speed over unforested areas or areas with little wildlife activity). The location and nature of all ungulates, carnivores, and their sign were recorded. When an observation was made, a location coordinate was recorded using a handheld Global Positioning System (GPS) and the species, dominant behaviour, dominant land cover type and group size were noted, where possible. Habitat types were classified as bedrock, open pine forest, closed pine forest, open spruce forest, open mixed wood forest, lake (ice) and heath tundra. More specific classifications of habitat type were not possible due to snow cover. Field crews were in continuous communication to avoid recording the same observation twice. In addition, caribou snow track abundance was continuously recorded during the entire survey to determine areas that caribou had been present and their relative level of activity prior to the survey. Every two minutes, the two field crew members in the rear of the helicopter made instantaneous observations of caribou snow track abundance, according to the qualitative measures of “none” (no caribou sign), “low” (some individual caribou tracks), “medium” (caribou trails present), or “high” (continuous tracks or a network of trails). A location coordinate was also collected for each track observation, and relative abundance was recorded. Although survey methods and timing were selected to collect information regarding caribou, observations of other wildlife and wildlife sign were recorded. This included muskox, moose, wolf, wolverine, marten, fisher, river otter lynx, and fox (tracks of Arctic and red fox were not distinguished).

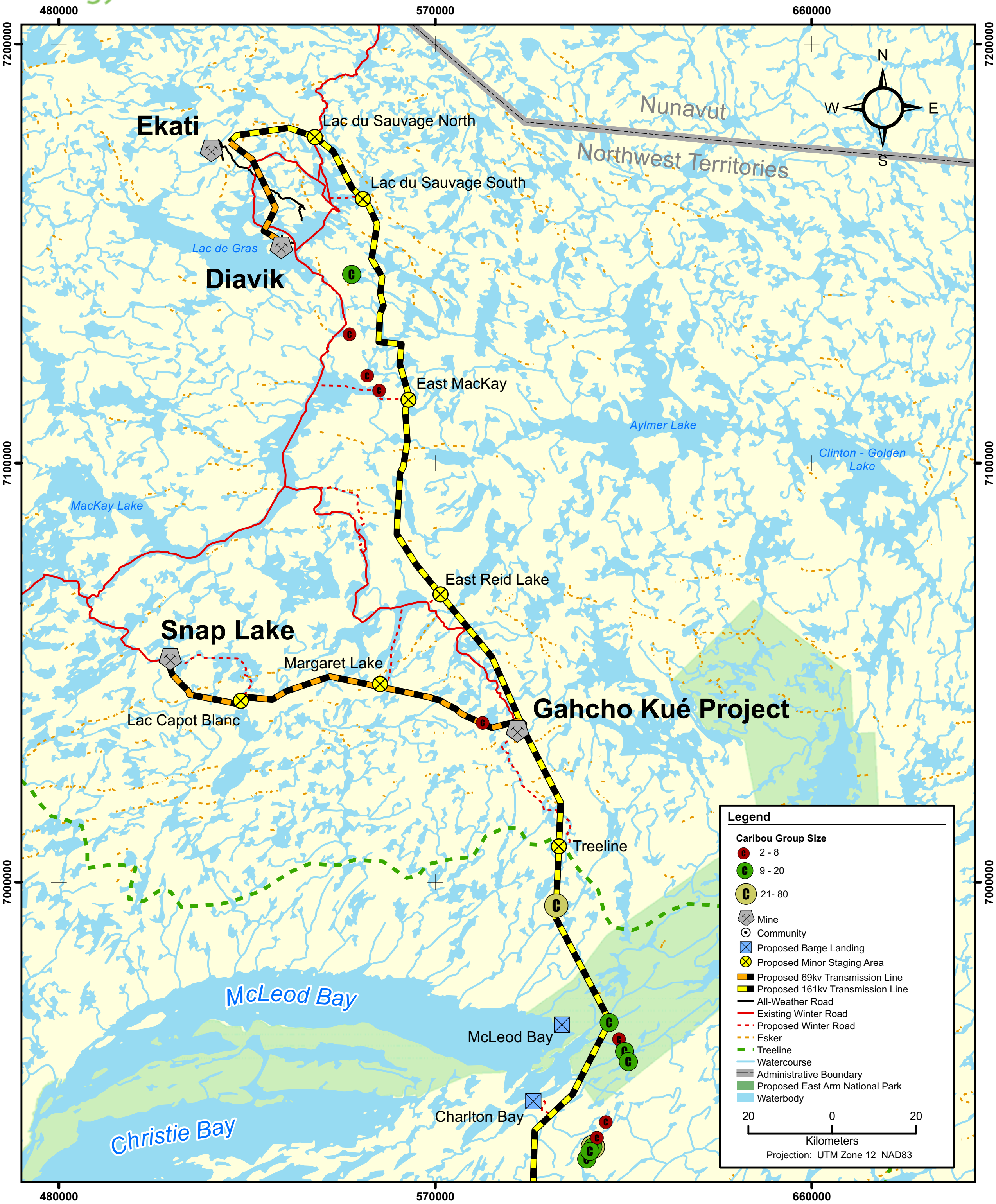
An additional three aerial surveys were conducted between September and November 2006, during the caribou post-calving movements (September 11), rut (October 2), and early winter (November 1) (Golder 2007) to document caribou abundance and distribution along the transmission line ROW north of the treeline, as caribou typically occur north of the treeline during these biological seasons (Gunn et al. 2002). These surveys included the current transmission line ROW which services the three existing diamond mines and the Gahcho Kué Project; however, some changes to the ROW alignment have occurred since these surveys to avoid sensitive areas.

Sections of the proposed transmission line alignment north of the treeline were covered on each survey, with the exception of the section approaching the Ekati Diamond Mine during the post-calving migration survey (September 11), and the section south of the Gahcho Kué Project during the beginning of winter survey (November 1). Survey methods (i.e., aircraft type, altitude, air speed, and survey swath) were all identical to the February and March 2006 surveys. Caribou snow track observations were collected during the November 1 survey, when sufficient snow was available. While flying the transmission line ROW, the presence of caribou trails was encountered within 200 m of the alignment. Each observation of caribou trails was categorized by the approximate number of parallel trails (i.e., less than 10, 10 to 20, 21 to 50, and greater than 50) and by the approximate length of the trail cluster (i.e., less than 200 m, 201 to 400 m, 401 to 600 m, and greater than 600 m). The categorization was conducted by means of a visual assessment.

9.5.4.4.2 Winter 2003/2004 Survey Results

In early October 2003, 60 caribou were observed 30 to 45 km south-southeast and southeast of the Snap Lake Mine. Caribou were not observed during the partial survey in late October, although a few single tracks were observed. Twenty-one caribou and over 400 caribou tracks were observed during the first helicopter survey in November; the caribou were observed between 25 and 40 km south of Snap Lake. In early December, 251 caribou and over 800 tracks were observed; caribou were observed along a band from 40 km south to 60 km southeast of Snap Lake. A single group of caribou was also observed 20 km northeast of the eastern tip of the East Arm of Great Slave Lake during this flight. By early December, no caribou or tracks were observed south of the East Arm. Approximately 2,000 caribou were seen during the early January survey, with the majority of animals concentrated in two areas: between Snap Lake and the East Arm (1,550 animals); and southeast to southwest of Reliance (450 animals). Far fewer caribou were observed in late January, north of the East Arm, and just east of the eastern tip of the East Arm. Over 2,500 tracks were recorded during this flight, with tracks being concentrated north of the East Arm, and east through southwest of Reliance. Fewer caribou and tracks were observed during the mid-February survey, but these were concentrated north of the East Arm and towards Artillery Lake, as well as south of Reliance near the north end of Nonacho Lake. This pattern generally held through the two March surveys, with the few caribou and variable numbers of tracks observed being concentrated in three areas: just north of McLeod Bay; surrounding the east end of the East Arm of Great Slave Lake; and near the north end of Nonacho Lake (Rescan 2004).

The caribou survey sampling design meant that varying distances from the transmission line ROW were sampled relatively equally. Caribou group distribution was not significantly proportional to distances that were available. Twenty percent of caribou groups were observed <5 km from the transmission line ROW, while 42% were observed 15 to 20 km from the transmission line ROW. Similarly, the distribution of caribou tracks was not significantly proportional to available distances, but in this case 40% of observed groups of caribou tracks were <5 km from the transmission line ROW and comparatively fewer tracks were observed at greater distances (Rescan 2004). Based on concurrent satellite-collar data from the ENR website, caribou observed during surveys appear to be members of the Bathurst herd. However, presence of caribou from other herds, in particular the Beverly and Ahiak herds, on the wintering grounds cannot be ruled out (Rescan 2004).



TALTSON Hydroelectric Expansion Project	**Developer's Assessment Report 2009**	**Caribou Observations and Group Size, Fall and Late Winter 2006**	**Figure 9.5.10**

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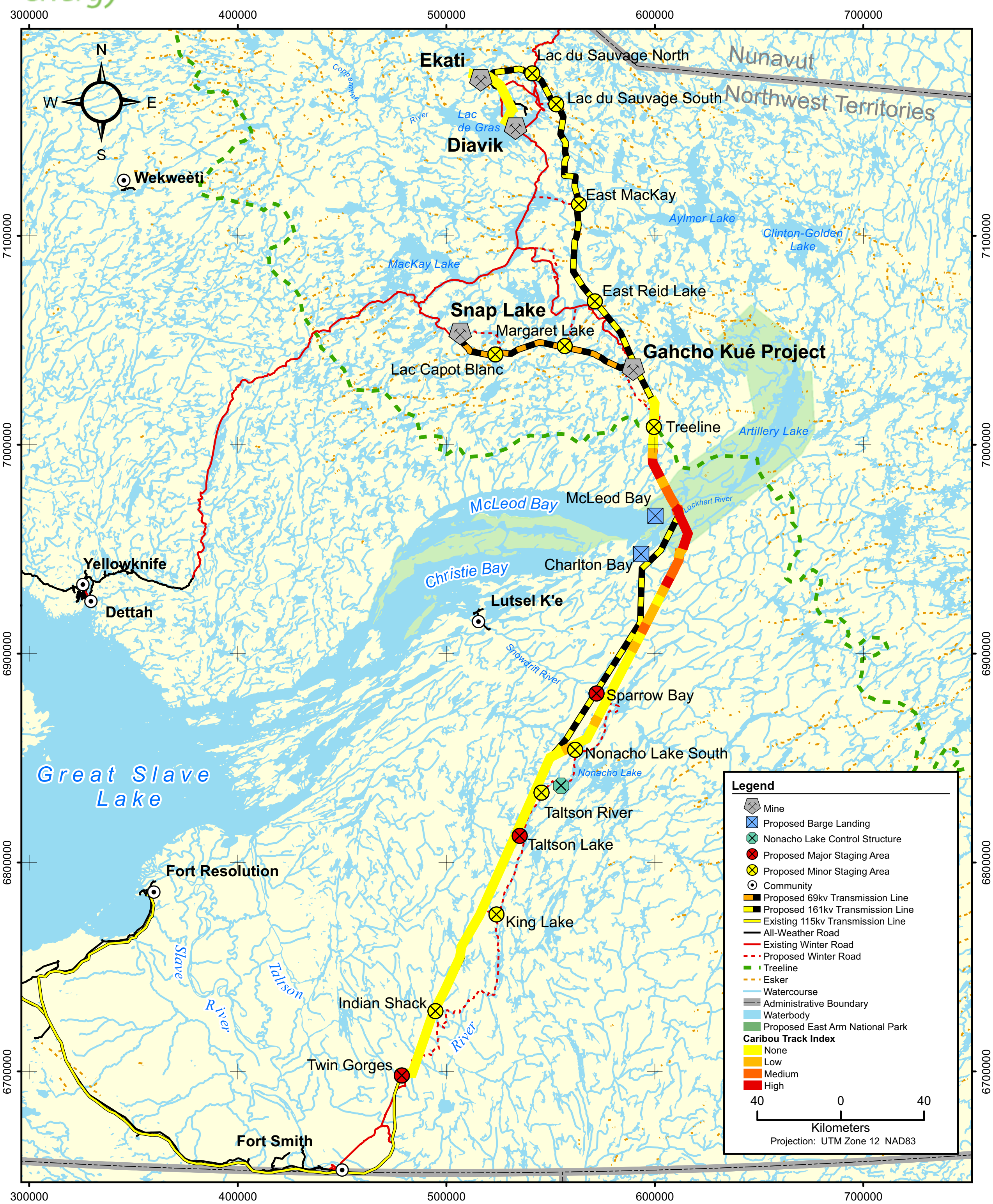

TALTSON Hydroelectric Expansion Project	Developer's Assessment Report 2009	Caribou Snow Track Index in the Bathurst Caribou Winter Range, February and March 2006	Figure 9.5.11

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Plate 9.5.1 — Pete Enzoe of Łutsel K'e during Aerial Survey: February 2006

Plate 9.5.2 — Caribou and Snow Tracks near the Lockhart River: February 2006

9.5.4.4.3 Winter 2006 Aerial Surveys Results

The two aerial surveys completed in winter 2006 recorded a total of 29 caribou groups (see Golder 2006, Plate 1). Twelve groups with a total of 261 individuals were observed during the February 2006 survey and 17 groups with a total of 159 individuals were observed during the March 2006 survey. The median group size was eight, and the associated 25th and 75th quartiles were 5 and 20, respectively. Fifty-five percent of the caribou groups had less than 10 individuals, 38% of the groups contained 10 to 20 individuals, and 7% contained greater than 75 individuals. There were no observations of group sizes between 21 and 74 caribou. During the survey, caribou were predominantly located along the McLeod Bay and Lockhart River area (Figure 9.5.10). This distribution was confirmed by the caribou snow track index observations (Figure 9.5.11, Plate 2). The snow track index data also identified the presence of caribou in two other areas, located approximately 100 km south of the Lockhart River where no animals were observed.

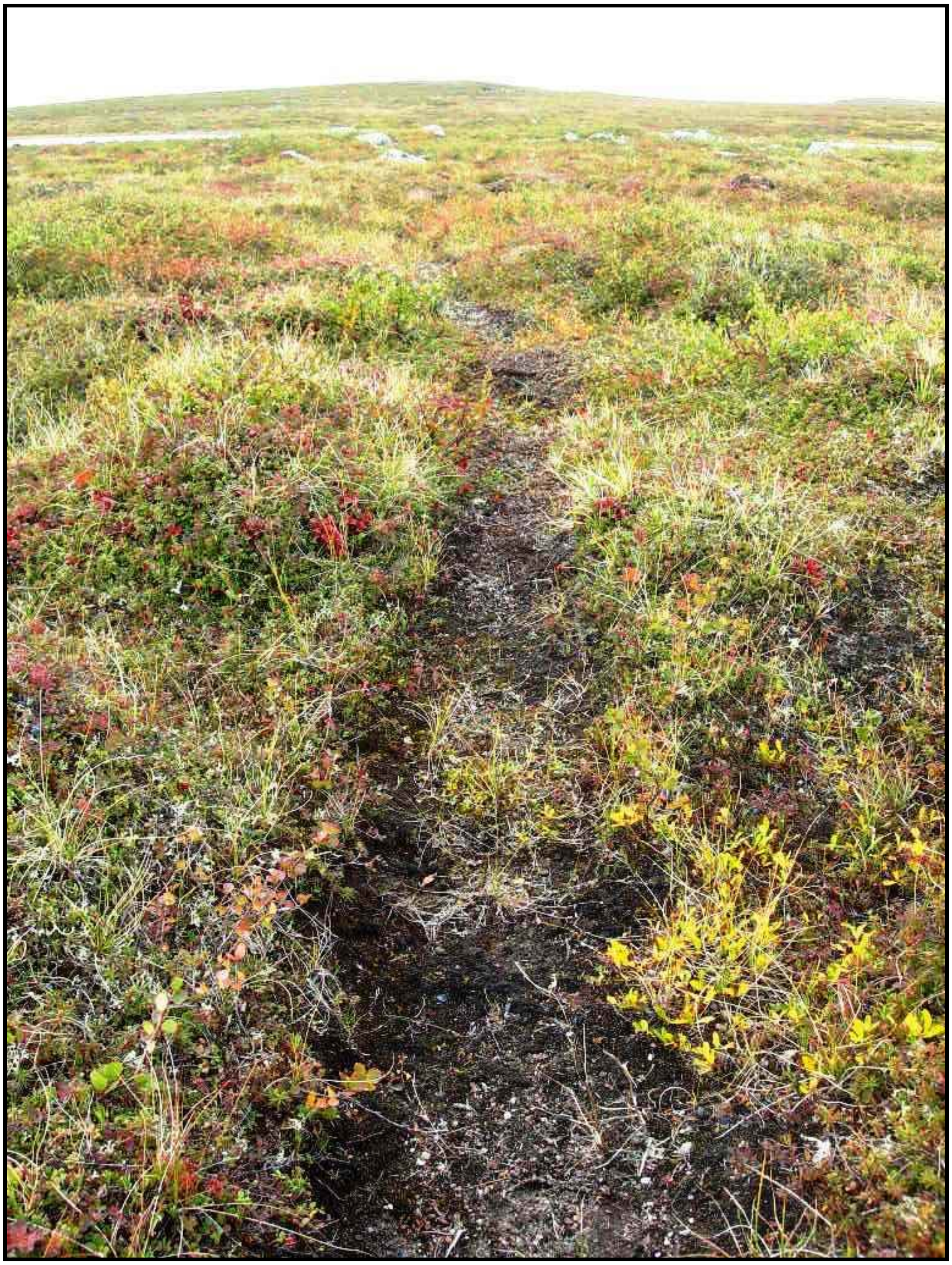
Caribou behaviour and habitat were recorded for 21 of the 29 groups observed during the 2006 aerial surveys. Caribou behaviour was described in the field, and later categorized into the following behaviour categories: resting (bedded or standing), feeding, and moving (walking or running). Sixty-seven percent of the groups were resting, 9% of the caribou groups were observed feeding and 24% were observed moving. Habitat was recorded for 25 of the 29 groups, of which 68% were on lakes and the remaining 32% were observed in forest.

9.5.4.4.4 Autumn and Early Winter 2006 Aerial Survey Results

During the three 2006 surveys, 18 caribou in five groups were recorded, and all groups were observed on heath tundra (Golder 2007). During the post-calving migration survey (September 11), three single males were observed. One male was observed between the Snap Lake Mine and the Gahcho Kué Project, while the two other lone males were observed at the eastern end of MacKay Lake between the Gahcho Kué Project and the Diavik Diamond Mine. No caribou were observed during the 2006 rutting season survey (October 2). During the 2006 early winter survey (November 1), two groups of caribou were observed. One group contained six adults (both females and males), and the other group consisted of nine males. No calves were observed during the surveys.

Historic caribou trails were observed frequently along the entire length of the proposed transmission line ROW north of the treeline (Figure 9.5.9, Plate 3). Particularly high densities were observed east of Lac de Gras and MacKay Lake, and between the east ends of these two lakes. The index for historic trails was also high near the Gahcho Kué Project. The frequency and density of caribou trails decreased as the transmission line ROW entered the forest below the treeline. The forest was discontinuous in this area, and the forest canopy remained open. As conditions were favourable, the aerial survey observers looked for caribou snow tracks during the early winter survey. Caribou snow tracks were only observed between MacKay Lake and Lac de Gras, and overall snow track density was low (11 of 14 observations). One high density observation was recorded east of Lac de Gras. Following changes to the alignment between the Gahcho Kué Project and the Ekati Diamond Mine, the new alignment was re-surveyed for caribou trails. Caribou trails along the proposed Project ROW are provided in Figure 9.5.9.

Plate 9.5.3 — Caribou Trail near Lac de Gras



9.5.4.5 EFFECTS OF DISTURBANCE

Caribou from the Bathurst herd come into contact with existing diamond mines (i.e., Ekati, Diavik and Snap Lake), mineral exploration camps, outfitting camps, winter roads, communities, and other developments during their annual movements from below treeline to calving areas near Bathurst Inlet in Nunavut (Johnson et al. 2005). This has led to concerns regarding the cumulative effects of development (e.g., winter and all-season roads, mine camps, transmission lines, seismic lines, and pipeline ROWs), contamination, commercial harvesting, climate change, and increased potential for over-hunting (BCMPC 2004). Determining the influence of developments on caribou movements and habitat use began in the 1990s. These developments may result in barriers to movement (e.g., Curatolo & Murphy 1986), indirect habitat loss though habitat avoidance (e.g., Dyer 1999; Dyer et al. 2001), direct habitat loss or alteration (e.g., Hornbeck & Eccles 1991), sensory disturbance (e.g., Harron 2003), and increased human and predator access (e.g., James & Stuart-Smith 2000). Known effects from each of these stressors are described below. The cumulative effects of these human developments on wide-ranging wildlife species is recognized (Johnson et al. 2005).

9.5.4.5.1 Barriers to Movement

Physical barriers to movement recorded for caribou include, but are not limited to, the following:

- roads with variable traffic levels and steep cuts (Dyer et al. 2001);
- berms and slash piles along roads and main highways (Bloomfield 1979 & 1980; Carlton 1982; van Zwoll 1983);
- snow berms (Klein 1971, van Zwoll 1983);
- snow fences to protect highways and railroads (Klein 1971; Skogland & Molmen 1980); and
- pipelines laid on, elevated above, or buried under the ground (Villmo 1975, Eccles & Duncan 1986).

With respect to the Project, physical barriers may include the transmission line and associated ROW, and winter roads. The influence of transmission lines as barriers has been investigated for a number of years on reindeer in Norway (e.g., Nellemann et al. 2001 & 2003; Reimers et al. 2007; Vistnes et al. 2004), and more recently around a hydroelectric project in Newfoundland (Mahoney & Schaefer 2002).

Reimers et al. (2007) investigated the effects of a 66 kV power line transecting a range of wild reindeer in south central Norway. Over a 31-year period, the authors concluded that the 66 kV power line transecting the reindeer habitat was not a barrier towards reindeer migration, that reindeer were not displaced by the power line, that reindeer crossed underneath, and that reindeer grazed under and on both sides of the power line. These results contrast with similar studies on wild reindeer which report strong barrier and aversion effects to similar power lines for reindeer migration and grazing behaviour (e.g., Vistnes et al. 2004). The combination of two parallel power lines and a closed winter road in alpine areas of Norway greatly reduced wild reindeer migration across the infrastructure, a result supported by both telemetry studies and differences in lichen biomass, reflecting relative grazing intensity (Vistnes et al. 2004). Conversely, a single road closed in winter without power lines was not perceived as a barrier by reindeer (Vistnes et al. 2004). Other research has indicated that the type of infrastructure (e.g., power line vs. road vs. above-ground pipeline), and the combination of infrastructure components (e.g., a road and pipeline in combination) influence reindeer movements differently.

In Alaska, caribou crossed a single road or single pipeline, but when a road with traffic and pipeline ran in parallel combination, caribou did not cross as readily (Curatolo & Murphy 1986). Crossing success increased at sections of buried pipe isolated from road traffic. Carruthers and Jakimchuk (1987) also considered the Trans-Alaska Pipeline to be properly constructed, having no effect on the traditional migration route of the Nelchina Herd. Buried sections of the pipeline at traditional migration passes and crossing structures (e.g., ramps) have helped to maintain the travel route by providing locations for caribou to cross the pipeline (Carruthers & Jakimchuk 1987). By comparison, Smith and Cameron (1985) reported that only 64% of caribou crossed the Kaparuk pipeline (after several attempts) and 247 caribou left the initial migrating group, changing the original herd composition and migration pattern. The authors concluded that the elevated pipeline created a physical barrier to the migrating caribou (Smith & Cameron 1985). Single roads with high traffic levels have also been reported to act as semi-permeable barriers to woodland caribou (Dyer et al. 2001). Woodland caribou crossed roads significantly less than random controls, during both high and low vehicle traffic levels (Dyer 1999). Seismic lines, however, were crossed by woodland caribou at a similar frequency to controls (Dyer 1999).

9.5.4.5.2 Indirect Habitat Loss

There is considerable evidence to suggest that caribou herds respond to diamond mine developments (Boulanger et al. 2004; Golder 2005, 2008a; Johnson et al. 2005; BHPB 2007; De Beers 2008) and transmission line developments (Nellemann et al. 2001, 2003; Reimers et al. 2007; Vistnes et al. 2004) by changing their distribution. These studies found a significant positive relationship between the occurrence of caribou and increased distance to the mine or transmission line. This reduced caribou occurrence has been called the zone of influence (ZOI).

Mine Development

At the Diavik Diamond Mine, the ZOI ranged from 16 to 36 km, and averaged 29 and 23 km for the northern and post-calving migrations respectively (Golder 2008a). Although there has been no temporal increase in the size of the ZOI, it greatly exceeds the original predictions of a ZOI between 3 and 7 km (DDMI 1998).

For the Snap Lake Mine, the ZOI ranged from 10 to 28 km and was on average 19 km and 17 km for the northern and post-calving migrations respectively. During the post-calving migration there was some indication that the ZOI has been increasing linearly with time from baseline through to current construction (De Beers 2008).

Resource selection models based on satellite-collared caribou, after controlling for vegetation, found that mines and other major developments might have a ZOI of up to 33 km (Johnson et al. 2005). A comparative study using satellite and aerial survey caribou locations around the three existing diamond mines in the NWT (i.e., Diavik, Ekati, and Snap Lake) estimated ZOIs ranging from about 16 to 50 km (Boulanger et al. 2004); aerial survey-based ZOI were generally smaller than those generated from satellite data.

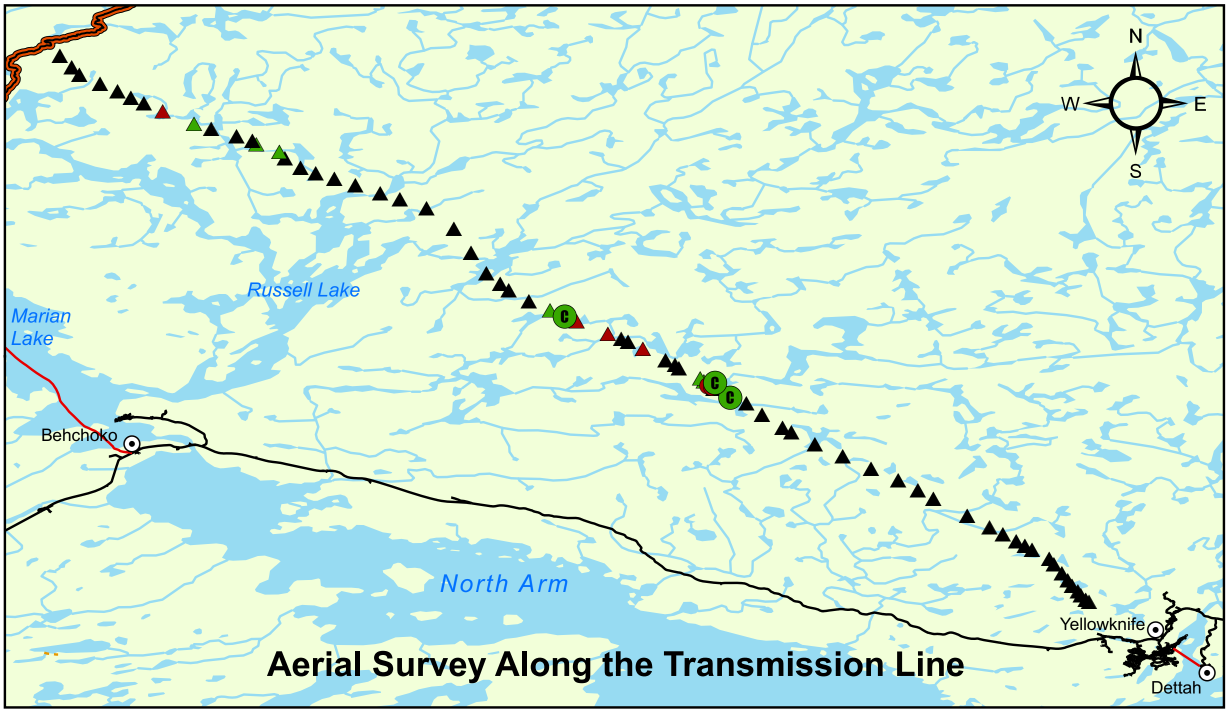
The high level of variability in the estimates for the ZOI from other developments is, in part, due to the highly variable annual distribution of caribou. In addition, variation in the predicted ZOI is likely associated with differences in the size of the mine footprint and level of activity for a project. Habitat, as well as the presence of large lakes, also influence the distribution of caribou near mine sites and have not always been included in the models (De Beers 2008; Golder 2008a).

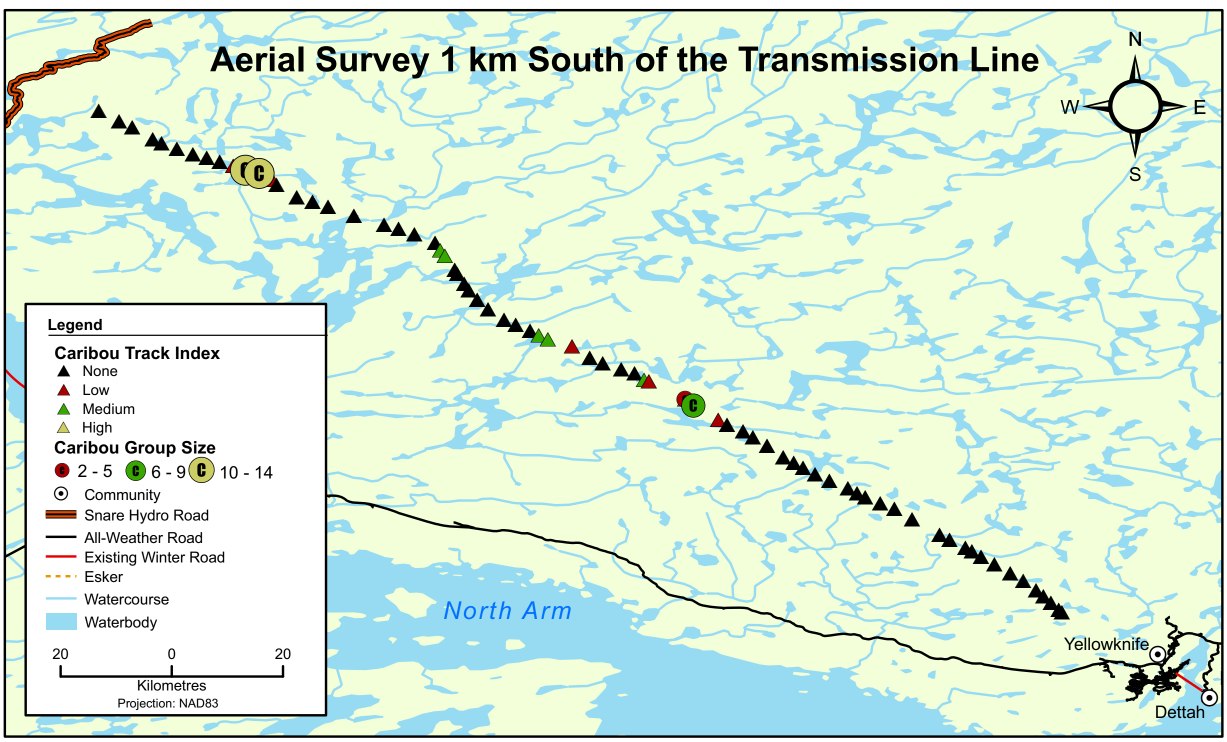
Overall the presence of caribou within the mine study areas has been variable among years, but has not declined as mine activity increased (BHPB 2007, De Beers 2008, Golder 2008a). However, it seems clear that spatial mine effects cause a behavioural response. Caribou appear to change their distribution and reduce habitat use within approximately 10 to 50 km from a mine site.

Transmission Line

Specific research into the influence of hydroelectric development and transmission lines on caribou movements and distribution is somewhat limited. This research has been conducted primarily in Norway on wild and domesticated reindeer, and to a lesser extent on caribou in North America.

During a 2008 winter aerial survey conducted for the existing Snare Hydro transmission line, one group of eight barren-ground caribou was observed directly under the transmission line, while groups of nine, six, three, and two were observed 100, 300, 300, and 500 m away from the transmission line ROW, respectively (Golder 2008b). Although there was insufficient data to conduct a statistical analysis, a parallel flight approximately 1 km south of the Snare Hydro transmission line resulted in a similar number of caribou and caribou track observations (Figure 9.5.12).





TALTSON Hydroelectric Expansion Project	Developer's Assessment Report 2009	Caribou Group Size and Track Observations on the Snare Transmission Line, January 2008	Figure 9.5.12

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Hydroelectric development in Newfoundland has represented a permanent loss of habitat, extending 1 to 5 km beyond the precise bounds of the development due to caribou avoidance (Mahoney & Schaefer 2002). Northcott (1985) reported that woodland caribou avoided the Upper Salmon Hydroelectric Development and the related access road during construction activity. After construction was completed, caribou resumed use of the road, but at a reduced frequency as compared to pre-development. It was suggested that the construction activities, rather than the physical presence of the infrastructure, were the major disturbance factor (Hill 1985). Similarly, Berger et al. (2000) concluded that the predicted avoidance of a 66 kV transmission line ROW by woodland caribou was not confirmed (as cited within Harron 2003). This study summarized that reduced use of habitats near linear features by woodland caribou was greatest near roads, followed by a natural river linear feature, and lastly, the transmission line had the least effect (Berger et al. 2000, as cited within Harron 2003).

As of 1996, there were greater than 23,000 km of high-voltage (>132 kV) power lines in Norway, covering approximately 75% of the land area (Nellemann et al. 2003). Vistnes and Nellemann (2001) reported that the mean density of semi-domesticated reindeer was 73% lower in areas less than 4 km from a 66 kV power transmission line (without traffic) compared to areas greater than 4 km from the power line, all within rugged terrain. The authors noted that the redistribution of reindeer to less disturbed areas may lead to potential overgrazing of already limited grazing grounds beyond the areas of disturbance, leading to a decline in nutrient uptake. Potential increases in competition for high-quality forage may affect lactation, body condition and reproductive success (Vistnes & Nellemann 2001). Therefore, fragmentation of ranges may lead to a reduction in available ranges and migration routes for Norwegian reindeer, causing a reduction in carrying capacity (Vistnes et al. 2004).

Nellemann et al. (2003) studied reindeer before and after construction of the Blue Lake hydroelectric reservoir, the largest hydroelectric power reservoir in northern Europe. After development, distribution surveys revealed that reindeer densities within a 4 km radius declined during winter to 8% of pre-development densities. During summer, reindeer gradually reduced use of areas within a 4 km distance from roads and power lines, to 36% of pre-development density, with a subsequent 217% increase in use of the few remaining habitats located greater than 4 km from infrastructure. Abandonment of central parts of the study area by reindeer coincided with the establishment of a power line. Additionally, reindeer reproduction declined progressively as habitat was lost.

The results of Nellemann et al. (2003) and others from Norway illustrate that there are cumulative effects of power lines, reservoirs, dams and roads, not only to reindeer movement and distribution, but also to reindeer populations. Additionally, it is apparent that an assessment of the effects of a proposed transmission line must consider all associated infrastructure such as roads and the density of developments over time.

9.5.4.5.3 Direct Habitat Loss

ROWs are the clearing of vegetation around linear disturbance infrastructure such as transmission lines. However, compared to mining and settlement activities, the direct habitat loss associated with the clearing of vegetation for linear developments is not substantial.

Effects of habitat alteration associated with linear disturbances depend on the specific situation. The type, width, surrounding vegetation and replanted vegetation all play a role in determining the level of habitat alteration. In Sweden, for example, domestic reindeer resist crossing under power lines. Researchers postulated that this may be due to either to the power line 'hum' noise (which the Taltson Project would not create, [Teshmont 2008]), or changes in snow conditions with large forest openings (Villmo 1975). Although caribou are adapted to movement in deep snow, depths of one metre or greater appear to affect woodland caribou feeding strategies (Brown & Theberge 1990, Bradshaw et al. 1997) and caribou distribution (Pruitt 1960). Caribou may move into denser forest stands during periods of high snow (Darby and Pruitt 1984, Stuart-Smith et al. 1997), likely due to the increased energetic costs associated with cratering and moving through deeper snow in open areas (Fancy & White 1987). The relationship between linear features within a forest and overall habitat alterations based on snow depths and caribou movements is not fully understood. For example, the Porcupine Caribou herd in the Yukon utilized seismic line clearings and winter roads for travel routes. Banfield (1971) felt that the clearings provided an unrestricted view and compact snow conditions for easy travel.

Incidental sightings of woodland caribou have indicated that ROWs are used for travel and as a forage source (Eccles et al. 1985, Eccles & Duncan 1986, Morton & Wynes 1997). Cameron and Whitten (1980) found that caribou were attracted to new shoots of *Equisetum* spp. and *Eriophorum* spp. growing in the dust-covered wet meadows along the Trans-Alaska pipeline haul road. Some forest harvest operations have reported enhanced availability of forage for caribou by providing openings in dense forests that allow for colonization by terrestrial lichens (Shidelar et al. 1986).

9.5.4.5.4 Sensory Disturbance

Sensory disturbance can be defined as any visual, auditory, tactile, or olfactory stimulus that changes the attractiveness of an area to wildlife. Examples of sensory disturbance most likely to occur from the proposed transmission line include human activity during construction or monitoring activities, noise from electrical discharge or wind action on the lines, noise from helicopters during construction, movements of vehicles or helicopters, and odours from camps.

Power lines have been hypothesized to represent a disturbance for reindeer through electromagnetic fields (Algers & Hennichs 1983), corona noise from electrical discharges in moist weather, and wind turbulence noise (Fletcher & Busnel 1978). Specific to the Project, audible noise levels generated by the lines during fair weather are below 30 dB. Noise levels may rise in humid conditions, but at no point would corona noise exceed 35 dB, and are unlikely to be audible from the ground (Teshmont 2008). Klein (1971) summarized that Norwegian reindeer herders were disturbed by newly constructed power lines as the 'hum' of the power lines was believed to disturb the reindeer and contribute to difficulties in herding, particularly during the first year or two after construction when reindeer were afraid to travel beneath the power lines. However, upon reassessment, Klein (1979) stated that caribou and reindeer appear to be less disturbed by elevated pipe and power lines in forested terrain and cross under them more readily than in open tundra. Elk, caribou, and Norwegian reindeer have all been reported to be disturbed by noise from power lines, especially in open tundra (Harron 2003). Conversely, one study has confirmed that reindeer are probably not reacting to the hum of transmission lines, as the frequency is outside of the range of reindeer hearing (Flydal et al. 2003). Similarly, Reimers et al. (2000) reported that if all human activity is removed, habituation of reindeer to power lines occurs shortly after construction.

Bradshaw et al. (1998) tested the behavioural response of woodland caribou to the noise generated from oil and gas exploration activities (i.e., seismic blasting). Upon exposure to a loud noise disturbance, animals demonstrated higher mean movement rates than did control animals. However, disturbance was considered relatively short-term with no significant effect on feeding or on energetic balance during crucial late winter periods (Bradshaw et al. 1998). This is consistent with the prediction that although animals may be responsive to changes in the acoustic environment, they may rapidly acclimate or habituate (Singer & Beattie 1986), particularly if the stimulus occurs repeatedly without adverse consequences.

9.5.4.5.5 Aircraft Effects

In remote areas, human activities often involve aircraft as a means of transportation. For the Project, helicopters would be used during the construction of the transmission line. Further, there would be one to two inspections of the transmission line by helicopter each year. Disturbance from aircraft is associated with potential short-term and long-term effects on caribou.

Miller and Gunn (1978) studied the reactions of Peary caribou to helicopter over-flights and landings. Flight altitude ranged from 20 to 400 m above ground level. The results led to the recommendation of 300 m above ground level as the minimum flying altitude for all aircraft. The authors suggested that additional protection should be afforded during the calving and post-calving periods (May to November), and suggested a minimum flying altitude of 600 m during these times. With respect to ground operations, the authors suggested that ground crews and vehicles should not approach within 1 km. Peary caribou bulls were found to be less responsive than cows, larger groups (greater than 20 animals) tended to be more responsive than smaller groups, and the presence of calves also makes the group more responsive. Observations were made within 24 minutes of the disturbance, but the duration of the reaction was not documented.

Gunn et al. (1983) studied the responses of cow-calf caribou pairs to helicopter landings. The helicopter approached from an altitude of 300 m above ground level, and landed on average 950 m from the cow-calf pairs. They found that more than half of the groups observed reacted by standing alert, walking or trotting away. The frequency and duration of nursing also appeared to decrease. The results suggested that caribou first reacted to the helicopter approach (from an altitude of 300 m) rather than the landing. Following a helicopter landing within several hundred metres, caribou were displaced to a distance of at least 1 to 3 km (Gunn et al. 1983). No analysis of the elapsed time to resumption of normal activities was conducted, but anecdotal remarks indicate that this ranged from 6 to 14 minutes (the maximum time was usually defined by the caribou having left sight, so the actual time was likely greater).

Caribou behavioural monitoring between 2001 and 2006 at the Ekati Diamond Mine found that 53.8% of caribou groups did not respond to aircraft over-flights. Among the groups that did respond, responses ranged from looking towards the disturbance (17.9%), walking away (16.7%), and trotting or running away (11.5%). When all types of stressors were grouped, nursery groups were found more likely to respond. The distance to the stressor was also a factor in determining the level of response. Again, the elapsed time before caribou returned to their original behaviour was not analyzed.

Most observations of caribou response to aircraft suggest that if the aircraft were to maintain a flight altitude of 300 m (1,000 ft) during most seasons, and 600 m (2,000 ft) during calving and post-calving, there would be a negligible effect on caribou energetics (Shideler et al. 1986). Anecdotal information suggests that animals from different herds, which have had different experiences with aircraft, may react differently to aerial harassment (Shidelar et al. 1986). Habituation to the stimulus of aircraft may be a valid prediction.

9.5.4.5.6 Increased Direct and Indirect Mortality

Linear developments, including transmission lines and roads, are used in some areas as access corridors for hunters (Bergerud et al. 1984) as well as for predators such as wolves (James 1999). A small fraction of increased moose hunting mortality, for example, is associated with improved human access along transmission line developments (Harron 2003).

It has been suggested that the failure of reindeer to cross two parallel power lines in combination with a winter-closed road is linked to hunting as the primary cause of mortality for reindeer, and that reindeer perceive danger associated with human-made structures (Vistnes et al. 2004). Reimers et al. (2007) also suggested that the lack of barrier or avoidance effect of a 66 kV power line in Norway was because there was not an associated road with human activity. Similarly, it has been proposed that woodland caribou avoid linear disturbances in the boreal forest as wolves have been documented to travel faster down linear corridors than in the surrounding forest (James 1999), and wolf predation occurs closer to linear corridors, but not significantly closer than random locations (James & Stuart-Smith 2000).

Linear developments have been deemed the most important factor in determining the level of hunting mortality that a caribou population experiences (Bergerud et al. 1984; Harrington 1996; Seip & Cichowski 1996). Linear developments, particularly roads, provide increased access for hunters into caribou ranges, thereby increasing legal and illegal hunting pressure (Bergerud et al. 1984; Jalkotzy et al. 1997; James & Stuart-Smith 2000; Shideler et al. 1986).

Wolf predation is often cited as a main cause of caribou mortality (Fuller 1989; Gasaway et al. 1989; Bergerud et al. 1984; Edmonds 1988, Seip 1992; Stuart-Smith et al. 1997). It has been speculated that linear developments provide increased access for predators, most notably wolves, into caribou habitat, particularly within forested areas (Bergerud et al. 1984; Edmonds & Bloomfield 1984; Thurber et al. 1994; Seip

& Cichowski 1996; James & Stuart-Smith 2000). Although wolves tend to avoid areas with high densities of roads (Theil 1985; Fuller 1989; Fuller et al. 1992), corridors that receive little human use may be attractive to wolves as easy travel corridors (Edmonds & Bloomfield 1984; Eccles & Duncan 1986; Horejsi 1981; James & Stuart-Smith 2000; Thurber et al. 1994). Use of linear developments by wolves has been documented to provide more efficient travel routes, particularly when snowmobile trails with packed snow are present (Edmonds & Bloomfield 1984; Cumming & Hyer 1996). Additionally, James (1999) discovered that not only were wolves utilizing linear corridors, but they were also traveling up to 2.8 times faster in corridors than in the forest, which may be improving their search efficiency for prey, and their kill sites were closer to corridors than expected. Banfield (1971) also noted that wolves hunted caribou from the Porcupine herd in the Yukon along cleared lines, where they had a clear advantage over their prey.

The consequence of increased predator mobility is the increased chance of prey encounters and ultimately, caribou predation (Bergerud 1983). Confounding this is the concern that landscape changes associated with resource development may affect the predator-prey dynamics to the detriment of caribou (Edmonds 1988). Bergerud et al. (1984) suggest that caribou selection of low productivity habitat creates a spatial separation from other prey species (commonly moose), as an anti-predator strategy against wolves. Results supporting this hypothesis have been reported for woodland caribou (Cumming & Hyer 1996; James 1999). Linear developments have been hypothesized to erode the effectiveness of these habitat refuges by providing suitable travel corridors within forested areas, ultimately leading to a predicted increase in caribou predation (Bergerud et al. 1984; Doucet & Thompson 2002; Jalkotzy et al. 1997; Harron 2003; Seip 1992).

9.5.4.5.7 Physiological Effects from Electromagnetic Fields

A literature review of the potential physiological effects from electromagnetic fields on reindeer and other ungulates indicates there is no convincing evidence to suggest that high voltage transmission lines and associated electromagnetic fields detrimentally affect ungulates exposed to fields for various periods of time, neither on their biological systems nor on their functions (Reimers et al. 2000). As reindeer do not remain in any place for extended periods of time, they probably choose to not remain in prolonged proximity to transmission lines. Therefore, the physiological effects from electromagnetic fields are considered of limited importance for this species (Reimers et al. 2000). An electromagnetic field study was conducted for the Taltson Project, assuming 161 kV at 60 Hz. Both the magnetic field and the electric field were found to be within guideline levels (Teshmont 2008).

9.5.5 Key Mammals

9.5.5.1 INTRODUCTION

The following section is a historical and regional perspective of ungulate (i.e., muskoxen [*Ovibos moschatus*] and moose [*Alces alces*]) and key furbearer (i.e. marten [*Martes americana*], lynx [*Lynx canadensis*], muskrat [*Ondatra zibethicus*], and beaver [*Castor canadensis*]) populations in the study area based on available literature and existing current knowledge. Baseline survey data were supplemented with ecological information from regional wildlife studies, published and unpublished scientific literature, and Traditional Knowledge. Results of regional effects monitoring and research programs in the NWT and Nunavut (e.g., Diavik Diamond Mine, Ekati Diamond Mine, and Snap Lake Mine) are also included.

9.5.5.2 MUSKOXEN

9.5.5.2.1 Habitat Use and Distribution

Forage requirements for muskoxen vary seasonally. The constraints for muskoxen are the time and energy required to locate forage, and additionally in winter, to uncover, chew, and then warm forage up to core body temperature (Gunn and Adamczewski 2003).

Calving occurs from late April to early May (Environment and Natural Resources [ENR] 2008). Calves are born several weeks before plant growth begins and cows lose considerable weight during the first six weeks of lactation (Sly et al. 2001). Ridges that are free of snow provide a better opportunity for the herd to protect newborn calves from predators, and muskoxen will seek out these areas (Gunn and Fournier 2000). Daily movements for cows with calves are reduced in the spring and through the summer period (Gunn & Fournier 2000).

Sedges (*Carex* spp.), grasses, and deciduous shrubs, especially willows (*Salix* spp.), dominate muskoxen diets in spring and summer across their circumpolar ranges (Larter and Nagy 1997; Klein 1992). As the spring and summer progress, muskoxen selectively feed based on plant emergence and nutritive value (Robus 1981). For example, in late May animals feed on cotton grass (*Eriophorum* spp.) heads, and then shift to the new leaves of sedges within riparian and wetlands habitats (Gunn and Adamczewski 2003). By mid-June, muskoxen select young willow leaves and flowering forbs, benefiting from the earlier peak in nitrogen, and later in the summer, from the increase in plant biomass. Both males and females increase weight rapidly with the new plant growth during the summer. In the summer, forage quantity is not usually limiting, but the pulse of highly-digestible nutrients is short (Gunn and Adamczewski 2003).

In winter, muskoxen feed on grasses, willow, birch (*Betula* spp.), crowberry (*Empetrum nigrum*), and bilberry (*Vaccinium myrtillus*). Muskoxen are subject to a scarcity of both forage quantity and quality in the winter, and can be expected to be strongly selective in their feeding (Gunn and Adamczewski 2003). In winter, muskoxen minimize energy and time expended on foraging by selecting for greater food abundance (e.g., graminoids or grasses and grass-like plants such as sedges and rushes), especially where the snow is shallow. They also select for shallower and softer snow. Thresholds of snow depth where muskoxen will crater vary between 20 and 50 cm, depending on snow hardness and density (Thomas and Edmonds 1984).

Forage availability in winter is limited primarily by hard-packed or deep snow cover, or by thick layers of ice that make cratering difficult (Gunn and Fournier 2000). Towards the end of March, snow becomes harder and denser with daytime heating. During this time, muskoxen can be found on eskers and plateaus where the vegetation has been exposed by wind (Sly et al. 2001), or by the warm spring sun.

Muskoxen are distributed across the tundra of the circumpolar Arctic (Gunn and Adamczewski 2003). There are about 105,000 muskoxen in the NWT, and most are found on Banks Island and northwest Victoria Island (ENR 2008). On the mainland, they are found in the area north of Great Bear Lake up to the Arctic coast, and in the Queen Maud Gulf area (ENR 2008). Lesser numbers are present in the Thelon Game Sanctuary and southwest to Artillery Lake (ENR 2008).

Surveys to determine the abundance and distribution of muskoxen within the Project area were carried out at three-week intervals from October 2003 through March 2004 (Rescan 2004a), and from February to March and September to November in 2006. Methods for the 2003-04 winter surveys varied between surveys and are outlined in Rescan (2004a). In 2006, aerial surveys were completed south of the treeline on February 14 and March 7, while surveys were completed north of the treeline on September 11, October 2, and November 1. A Bell 206 helicopter with 3 observers was used to fly over the proposed transmission line route at speeds of 80 to 100 km/h and at heights of 100 to 125 m above ground level. Observations were made along the center line by the observer in the front seat, and 200 m on either side of the alignment by the two observers in the back seats.

During the 2003-04 surveys, three males were observed at the eastern tip of the eastern arm of Great Slave Lake, one male was observed south of Snowdrift River, and two mixed-sex, mixed-age groups containing five and nine individuals were observed around the eastern tip of the eastern arm of Great Slave Lake (Rescan 2004a). In 2006, ten muskoxen were observed in the vicinity of the Gahcho Kué Project including a group of seven, and three lone males (Figure 9.5.13). Incidental observations of two large muskoxen groups (20 to 25 individuals) were also made in the vicinity of Nonacho Lake in summer 2008. These observations indicated that muskoxen are most numerous in the transition area between the boreal forest (i.e., Taiga Shield Ecozone) and the barren-grounds (i.e., Southern Arctic Ecozone).

Muskoxen distribution reflects the environmental conditions that support these animals, with the very northern and coastal parts of their range supporting the highest density (Sly et al. 2001). Seasonal movements typically depend on landscape and terrain features, forage availability, and snow characteristics (Gunn and Adamczewski 2003). Unlike caribou, muskoxen do not undertake long migrations; however in some areas, winter and summer ranges are distinct, and distances travelled can be over 160 km between these seasonal habitats (ENR 2008). Reynolds (1998) determined that the average size of core areas used by satellite-collared muskoxen was significantly larger ($P<0.05$) in summer (223 km^2) than in the calving or winter seasons (27 to 70 km^2). Population density may also influence dispersal of muskoxen and range expansion (Gunn and Fournier 2000).

Muskoxen live together in loosely organized herds, averaging 15 animals (ENR 2008). Herd size and composition vary with season, range conditions, and the number of bulls in the population (ENR 2008). The rut begins in July and reaches its peak in late August (ENR 2008). After the rut, the herds increase as bulls and/or mixed groups join together. In severe winter conditions, large herds may break apart as a result of limited forage.

9.5.5.2.2 Population Characteristics

The muskoxen is currently listed as Secure within the NWT (Working Group on General Status of NWT Species 2006), and is not listed federally as populations appear to be increasing (Committee on the Status of Endangered Wildlife in Canada [COSEWIC] 2007; S*pecies at Risk Act* [SARA] 2008). The NWT musk oxen population numbers approximately 105,000 (ENR 2008), occurring mostly on Banks Island and northwest Victoria Island.

9.5.5.2.3 Issues Affecting Population Abundance and Distribution

No issues regarding muskoxen abundance and distribution have been identified in the Project area. Prior to the 18^{th} century, muskoxen were a minor food source for native people in the NWT. However, the arrival of Europeans, combined with the increased demand for meat and hides as well as the introduction of guns, led to serious declines in muskoxen populations in Canada by 1900 (ENR 2008). Muskoxen were put under complete protection in 1917 and since then have made a slow but steady comeback in numbers and occupied range (ENR 2008).

9.5.5.2.4 Human Use

Human use of muskoxen in the Project area is limited to Wildlife Management Area MX/01. The proposed transmission line route passes through the Wildlife Management Area MX/01, which has a quota of five muskoxen annually. Four muskoxen were harvested during the 2007/2008 season (J. Williams, pers. comm., ENR, 18 July 2008).

9.5.5.3 MOOSE

9.5.5.3.1 Habitat Use and Distribution

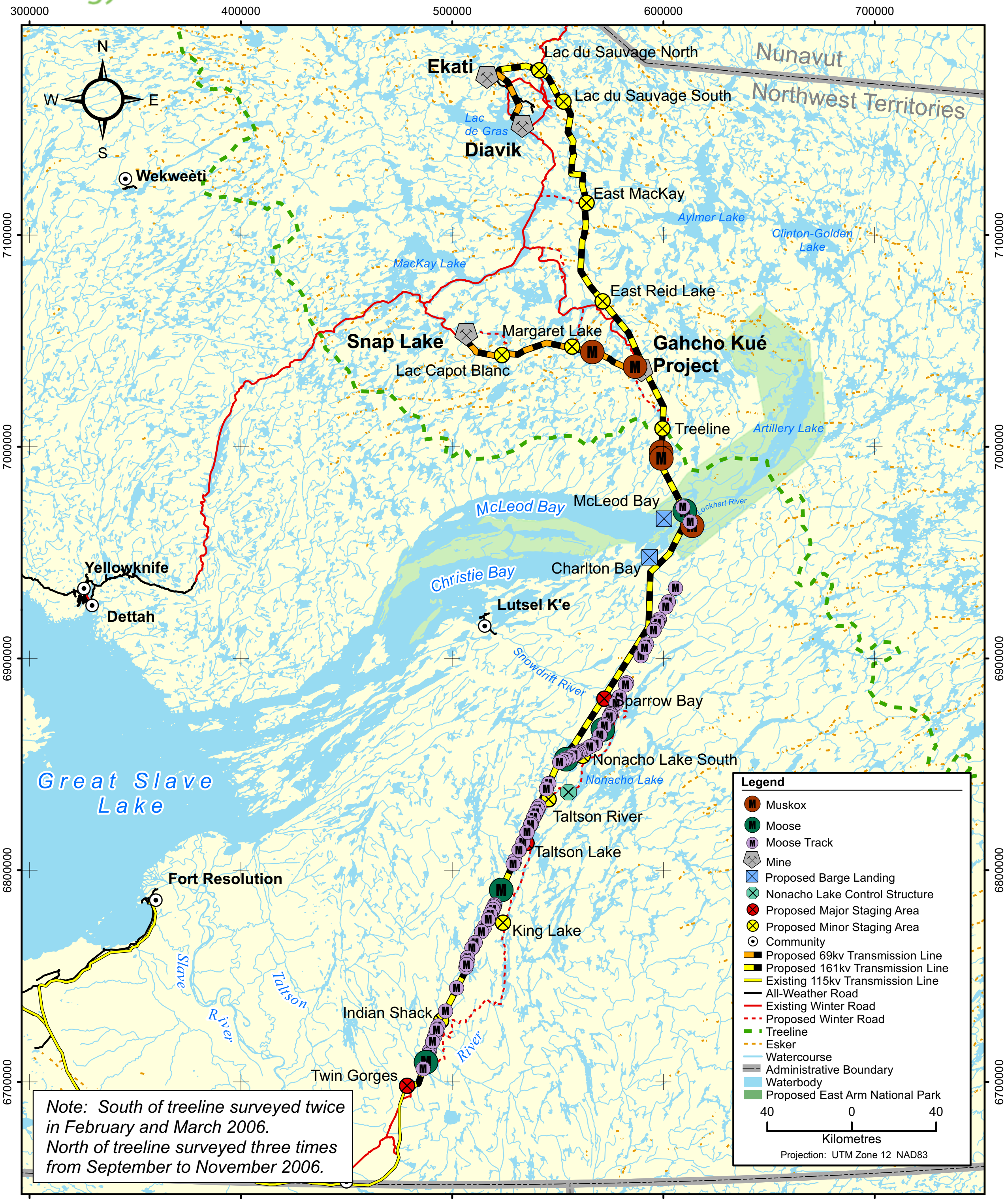
Moose are fire-dependent species and the best areas for moose are characterized by semi-open forest cover, an abundance of willow and trembling aspen stands, and are located close to lakes, river valleys, stream banks, or sand bars. Optimal moose habitat consists of deciduous shrub and ground layers within deciduous, mixed, and coniferous forests that offer edge or disturbed areas of early successional vegetation (Osko et al. 2004; Poole and Stuart-Smith 2003). Deciduous browse is the primary food source, varying from twigs and bark in the winter, to leaves in the spring and summer (URSUS and Komex 1997). In spring, moose tend to seek out low-elevation areas, usually wetlands, muskeg lowlands, and river floodplains, as this is typically where green-up occurs first (Stelfox 1993). Cows usually select areas in immediate proximity to small ponds and marshes for calving. Moose obtain most of their annual salt requirements from pond lilies and aquatic vegetation (Stelfox 1993). They tend to continue to use these areas in the summer periods, where they will also feed in adjacent forest stands.

During summer, moose use upland forests for eating fresh shoots and leaves from deciduous shrubs and young deciduous trees, mainly trembling aspen (*Populus tremuloides*) and balsam poplar (*Populus balsamifera*). However, moose are also known to browse on young coniferous trees in the summer such as balsam fir (*Abies balsamea*), if available. The moose diet in summer is typically made up of 74% shrubs and trees, 25% forbs, and 1% graminoids (Renecker 1987). During the summer in the NWT, moose may move into the tundra where they feed on semi-aquatic vegetation in wetlands and shallow lakes (Bromley & Buckland 1995).

During the fall and winter, moose typically prefer habitats where adequate browse is available. Preferred fall and winter browse includes red-osier dogwood (*Cornus sericea*), willow species (*Salix* spp.), trembling aspen, balsam poplar, bog/dwarf birch (*Betula glandulosa*), alder (*Alnus* spp.), and beaked hazelnut (*Corylus cornuta*), among others (Stelfox 1993). To access this forage, habitats with high cover of shrub species such as shrubby fens and bogs, and riparian habitats with open canopies are usually preferred, particularly in late winter. Shrub height is important during winter conditions, as forage shrub species must be higher than the snowpack to be available to moose. During periods of deep snow, cows, calves, and sometimes bulls will move from open areas to areas with low snow cover (Timmerman and McNicol 1988; Pierce and Peek 1984; Hauge and Keith 1981, Telfer 1970). Dense stands with greater than 60% coniferous species and greater than 10 m in height provide maximum thermal protection and lower snow depths (Allen et al. 1987).

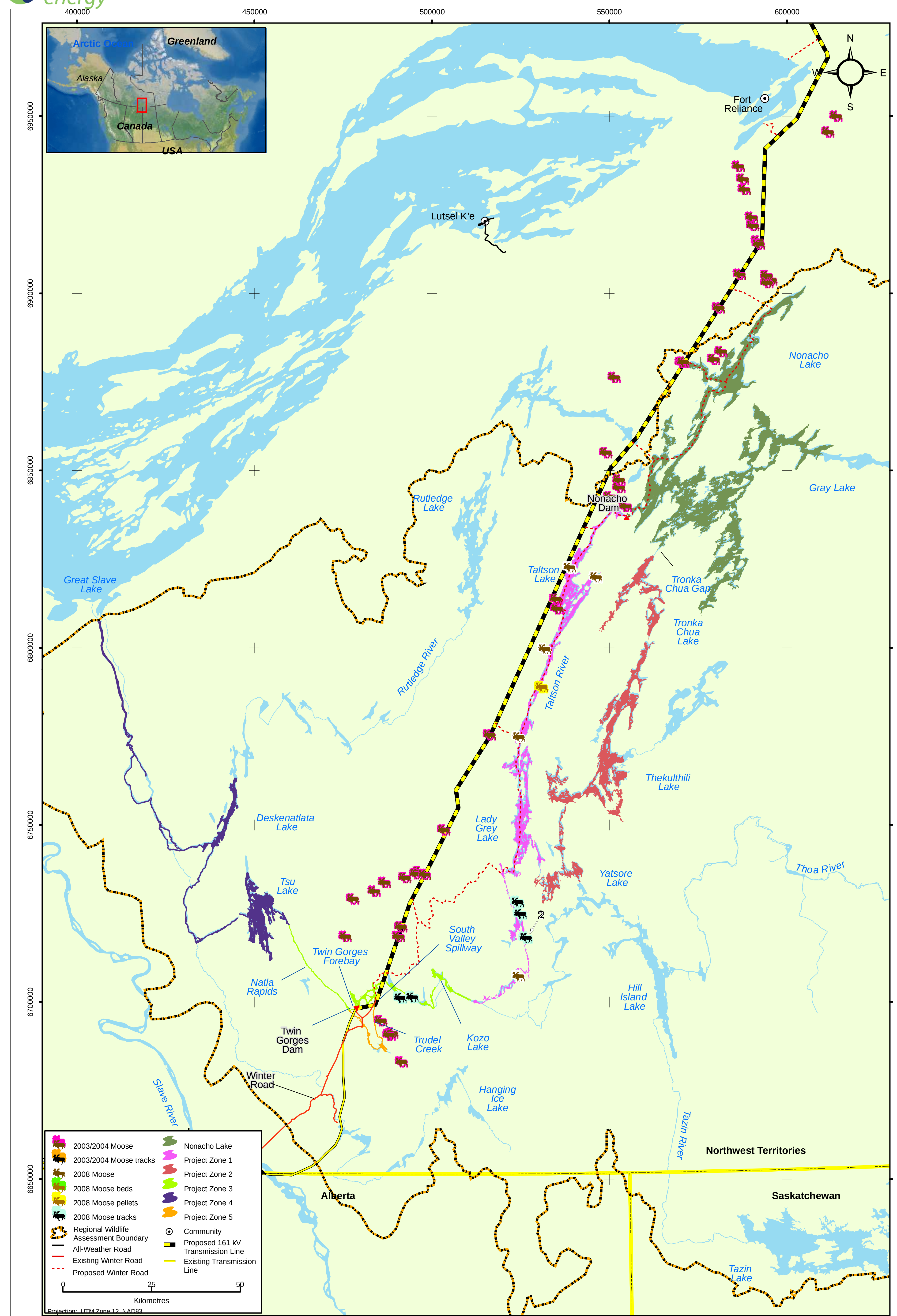
In North America, moose range from Alaska to the northern Rocky Mountains in the United States and east to Newfoundland. In the NWT, moose primarily inhabit the boreal forest; however, since the early 1900s, moose have been seen at numerous locations on the tundra where adequate forage is available (ENR 2008). South of the treeline, moose are widely distributed, although densities are relatively low (i.e., five to 15 moose per 100 km^2; ENR 2008) compared to the southern boreal forest regions (Sly et al. 2001). In the Project area, they may be found between Twin Gorges at the southern end, north to the treeline (Figure 9.5.13). Moose will occasionally cross the treeline into the barren-grounds in summer (Banfield 1974); this has been confirmed by several summer observations of moose at the Snap Lake Mine and Ekati Diamond Mine.

Surveys to determine the abundance and distribution of moose within the Project area were carried out in 2003 and 2004 (see Rescan 2004a for survey methods), as well as 2006 (see Section 9.1.1.2.1 for methods). Incidental observations of moose were noted in 2008 during field surveys (i.e., Figure 9.5.14). During the 2003 and 2004 winter surveys, there were 57 moose sightings and 299 moose track sightings, mainly concentrated around Nonacho Lake and southward (Figure 9.5.14). Densities within the Project area were determined to be two to three moose per 100 km^2 (Rescan 2004a). During the 2006 winter surveys, six moose were observed along the boreal sections of the transmission line alignment between Gahcho Kué and Twin Gorges, and tracks were frequently seen from Nonacho Lake southward. In 2008, five moose were observed incidentally between Twin Gorges and Nonacho Lake (Figure 9.5.14). Four moose were observed within the Trudel Creek area (Zone 5).



TALTSON Hydroelectric Expansion Project	Developer's Assessment Report 2009	Muskox, Moose, and Moose Track Observations 2006	Figure 9.5.13

N:\Active\GIS\2008\07-1328-0013 Taltson\Mapping\MXD\DAR_Figures/YK_107



TALTSON
Hydroelectric Expansion Project

Developer's Assessment Report
2009

Moose Observations within the Taltson River Watershed

Figure
9.5.14

9.5.5.3.2 Population Characteristics

Moose populations in the NWT are listed as Secure (Working Group on General Status of NWT Species 2006), and moose are not listed federally (COSEWIC 2007, SARA 2008). The estimated number of moose in the NWT is 20,000 (ENR 2008). Winter aerial surveys for moose in the Yellowknife region (Taiga Shield Ecozone) indicated a density of 2.75 moose per 100 km^2 and a ratio of 71 bulls and 64 calves to 100 cows. Densities were found to be relatively low in relation to the adjacent Taiga Plains Ecozone, where densities were close to four moose per 100 km^2 (ENR 2005).

9.5.5.3.3 Issues Affecting Population Abundance and Distribution

Moose abundance and distribution in the NWT are primarily affected by predator/prey relations and hunting. Their primary predators are wolves and bears, which most often kill calves, although adults can also become prey (Ballard and Van Ballenberghe 1997). Predation and snow conditions are interrelated factors that can affect moose survival and recruitment. When snow is deep, moose gather in areas of shallow snow, and therefore become more accessible in greater numbers to wolves (ENR 2008). In addition, snow depth of over 90 cm greatly hinders their movements and reduces the availability of suitable browse species above the snowpack (ENR 2008).

Development activities may have positive and negative effects on moose populations in the NWT. The clearing of land initiates forest regeneration and succession which provides excellent moose habitat. However, clearing too much forest in one area can reduce winter cover that moose need. Also, clearing land can increase hunter access into previously remote and unavailable areas (ENR 2008). Current trends indicate that moose are over-harvested in areas around communities, but healthy populations exist farther away from human settlement (ENR 2008). Currently in the NWT, moose are managed mostly by controlling the hunting season for residents and non-residents (ENR 2008).

9.5.5.3.4 Human Use

The estimated total NWT moose harvest is 1,000 to 2,000 animals per year, 96 to 98% of which is taken by subsistence hunters (ENR 2008). The remaining 2 to 4% of the moose harvest is taken by non-resident trophy hunters. Within the North and South Slave regions (but not including Yellowknife), the moose harvest by resident (i.e., non-aboriginal subsistence) hunters has averaged 80 moose per year, ranging from 36 to 170 moose, from 1983-84 to 2005-06. Moose are an important food source for the communities of Łutsel K'e, Fort Smith, and Fort Resolution (see Section 9.6). Moose and caribou are the two top-consumed land animals.

9.5.5.4 MARTEN

9.5.5.4.1 Habitat Use and Distribution

Although wide-ranging, marten select features that are associated with mature forests (e.g., wide-diameter snags [Porter et al. 2005]) and display a degree of selection against burn areas (Latour et al. 1994). Marten are closely associated with late-successional mesic coniferous forests that have complex physical structure near the ground and are intolerant of vegetation types with no overhead cover (Buskirk and Ruggiero 1994). Vertical and horizontal structure may be more important in providing suitable marten habitat than forest age or composition (Chapin et al. 1997).

Breeding occurs in July and August, and because of delayed implantation of the fertilized egg, young are born the following March or April (Markley and Bassett 1942). Female marten choose separate denning sites for parturition and raising their young. Both of these den types are generally found in old-growth forest (Ruggiero et al. 1998), but healthy marten populations have been documented in young forest (Poole et al. 2004; Porter et al. 2005).

Marten diet varies seasonally. In the summer, marten eat bird eggs and nestlings, insects, fish, and small mammals. Berries and other fruit are important in the fall. Their winter diet is more restricted and comprises small- to medium-sized mammals (Buskirk and Ruggiero 1994).

Marten range in North America extends from the spruce-fir forests of northern New Mexico to the northern limit of trees in arctic Alaska and Canada, and from the southern Sierra Nevadas of California to Newfoundland. The main part of their distribution occurs in the boreal and taiga zones of Canada and Alaska (Buskirk and Ruggiero 1994); they are not found on the barren-grounds. Since marten rely on coniferous forests, the northern limit of marten range coincides roughly with the northern limit of coniferous trees (Buskirk and Ruggiero 1994). Marten can occur in burned areas, as long as there is sufficient overstorey cover and an adequate prey base to support them (Latour et al. 1994).

Marten are generally solitary and are intrasexually territorial. Marten home ranges vary as a function of geographic area, habitat type, and prey density (Thompson and Colgan 1987; Soutiere 1979). Males occupy territories of 0.8 to 15.7 km^2 and females occupy territories of 0.4 to 8.3 km^2 (Burnett 1981; Mech and Rogers 1977).

A total of 132 and 187 marten tracks were recorded during aerial winter track surveys carried out in November 2003 and February 2004, respectively, along a previously-proposed transmission line alignment, which connected Twin Gorges to Snap Lake (Rescan 2004). The highest density of tracks was observed between the Twin Gorges dam and Nonacho Lake; however, many tracks were also seen around the East Arm of Great Slave Lake (Rescan 2004). During winter 2006 aerial surveys of the boreal section of the transmission line (see Section 9.5.5.2.1 for methods), marten tracks were observed along the Lockhart River to Snap Lake section, and the Lockhart River to Gahcho Kué section; however, the highest density was along the Twin Gorges to Lockhart River section (Figure 9.5.15).

9.5.5.4.2 Population Characteristics

Marten are listed as Secure in the NWT (Working Group on General Status of NWT Species 2006). Only the Newfoundland/Labrador population is listed as Threatened under COSEWIC (COSEWIC 2007) and Endangered under SARA (SARA 2008). Marten numbers fluctuate with their prey. There are currently no bag limits in the NWT but trappers are encouraged to self-monitor their harvest levels, especially in times of low marten numbers (ENR 2008). There are no marten population estimates for the NWT, but the density of marten in the Yukon has been reported as 0.6/km^2 (Archibald and Jessup 1984).

Snowshoe hare (*Lepus americanus*) populations cycle, ranging in density from approximately six per hectare (ha) to 0.18/ha according to one study in the NWT (Poole and Graf 1996). This cycle appeared to be synchronous from Fort Smith to Norman Wells. As snowshoe hare densities declined, marten were found to rely more on small mammals (e.g., voles and lemmings). Marten fat reserves and ovulation rates also declined in conjunction with declining snowshoe hare densities. Poole and Graf (1996) suggested that snowshoe hare populations have a significant effect on marten populations in the northern boreal forest. Fryxell et al. (1999) found that marten abundance increased threefold during a 20-year study, and that harvesting acted as a stochastic external variable that was additive to density-dependant and prey-dependant effects.

9.5.5.4.3 Issues Affecting Population Abundance and Distribution

No issues regarding marten abundance or distribution in the Project area were identified. Marten populations also fluctuate with prey abundance and may be especially susceptible to over-harvest during periods of low population numbers (ENR 2008).

Marten populations in North America have declined significantly since European contact and the current distribution is significantly smaller than in pre-settlement times (Buskirk and Ruggiero 1994). Population declines have been attributed to habitat loss and over-harvest (Buskirk and Ruggiero 1994).

9.5.5.4.4 Human Use

Marten are primarily trapped for their fur. Their wide distribution, the ease with which they are caught, and the stable price of their pelts make them an important resource for northern people (ENR 2008). Marten harvest in Canada is synchronized with those of snowshoe hares (Bulmer 1975, reported in Fryxall et al. 1999). The total harvest of marten in the NWT in 2003 and 2004 was 8,381 animals for a total value of $532,385. In 2007, the communities of Fort Smith, Fort Resolution, and Łutsel K'e harvested 580 marten for a total value of $41,091.73.

9.5.5.5 LYNX

9.5.5.5.1 Habitat Use and Distribution

Lynx favour old growth boreal forests with a dense undercover of thickets and windfalls. However, they will populate other types of habitat if there is minimal forest cover and adequate prey abundance (Keith 1993). Studies of lynx in the NWT indicated that lynx select dense coniferous and dense deciduous forests, and avoid wetlands-lake complexes and open black spruce forests (Poole et al. 1995). Lynx primarily feed on snowshoe hare, although their diet is supplemented by grouse, voles, mice, squirrels, and foxes in the summer (Brand and Keith 1979; Brand et al. 1976; Nellis et al. 1972; Saunders 1963). Lynx populations throughout North America fluctuate a year or two behind snowshoe hare population fluctuations (Brand et al. 1976).

Lynx are found throughout North America wherever suitable habitat (e.g., boreal forest) is found. Distribution in the NWT is limited to areas south of the treeline (ENR 2008). There can be mass emigrations of lynx from the boreal forest to the prairies in times of low snowshoe hare populations (Keith 1993).

Home range size varies with the abundance of prey and season. Larger home ranges are required when prey density is low, and lynx have larger ranges in the summer than the winter (Keith 1993). Winter home ranges have been reported to be between 12 and 47 km^2 whereas summer home ranges can vary between 27 and 32 km^2 (Keith 1993). Studies completed in the NWT found extensive home-range overlap between sexes and between certain pairs of female lynx, but the ranges of males and other individuals, or pairs, of females was almost exclusive (Poole 1995).

A total of 33 and 20 lynx tracks were observed during aerial winter track surveys in November 2003 and February 2004, respectively (Rescan 2004). The highest density of tracks was observed between the Twin Gorges dam and Nonacho Lake, although four track observations were made north of this area (Rescan 2004). A similar distribution of lynx tracks was found during winter aerial surveys along the transmission line route between Twin Gorges and the treeline in 2006 (Figure 9.5.15), with tracks becoming sparse north of Nonacho Lake (see Section 9.5.5.2.1 for methods).

9.5.5.5.2 Population Characteristics

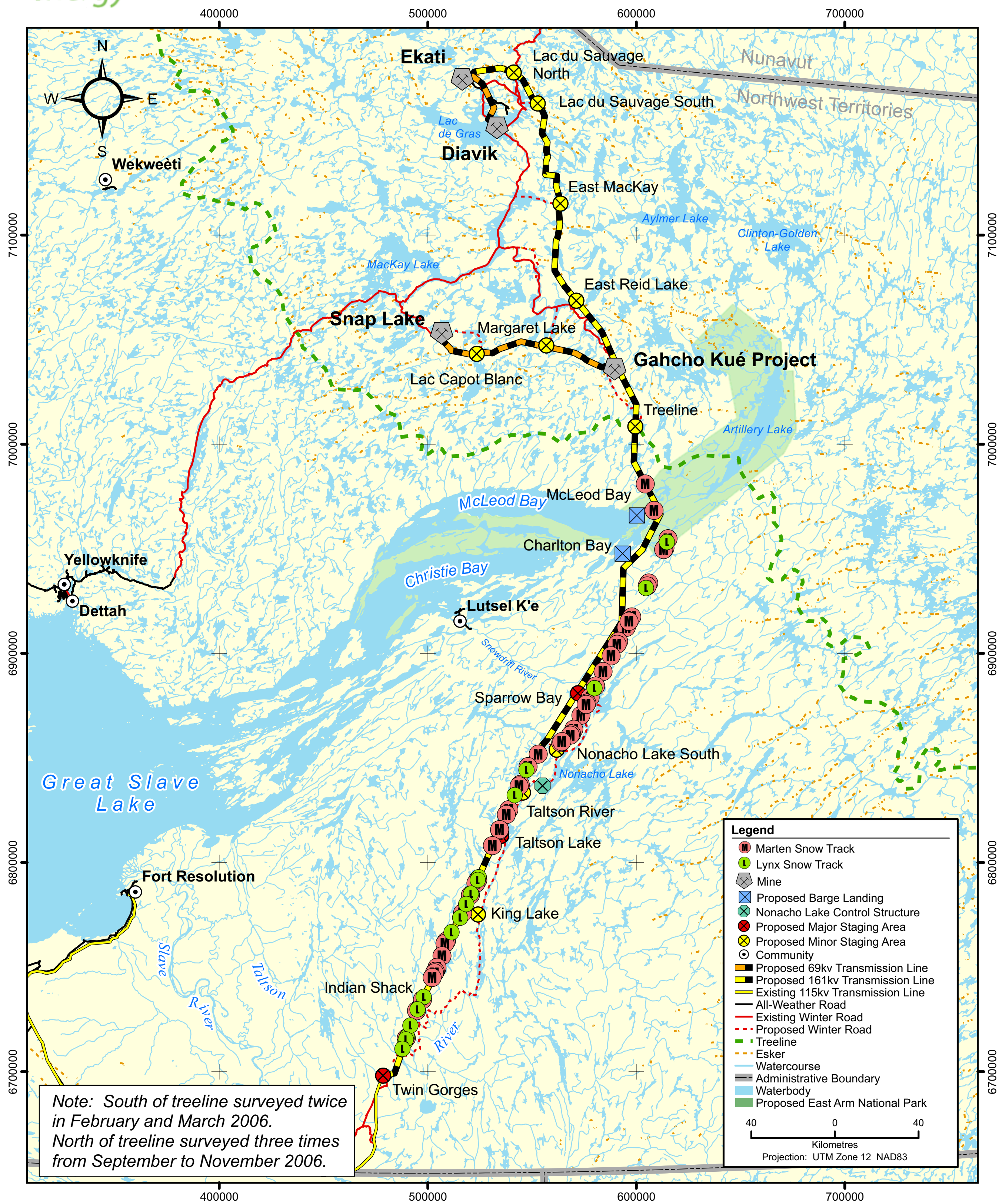
Lynx in the NWT are listed as Secure (Working Group on General Status of NWT Species 2006) and are Not at Risk under COSEWIC (2007). Trappers are encouraged to monitor their harvesting activities and shorten their trapping season in years when lynx populations are low (ENR 2008). Lynx refuges may also be set aside in times of low lynx population numbers (ENR 2008). Lynx densities in an unharvested population were observed to drop from about 30 to 3 per 100 km^2 during a snowshoe hare decline in the NWT (Poole 1994), indicating the importance of this prey item to the population. There are no lynx population estimates for the NWT.

9.5.5.5.3 Issues Affecting Population Abundance and Distribution

No issues regarding lynx abundance or distribution were identified in the Project area. High lynx pelt prices have both currently and historically increased pressure on lynx populations in North America (ENR 2008). Intense trapping can remove local populations, but in general lynx populations do not seem to be negatively affected by harvesting activities (Keith 1993).

9.5.5.5.4 Human Use

Lynx are harvested for their pelts. Lynx harvesting provides cash income and enables aboriginal people to continue a lifestyle that has been a tradition in the North for thousands of years (Keith 1993). Fort Resolution and Fort Smith reported a harvest of 257 lynx in 2007 for a total value of $36,910.28.



TALTSON Hydroelectric Expansion Project	Developer's Assessment Report 2009	Lynx and Marten Snow Track Observations 2006	Figure 9.5.15

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9.5.5.6 Muskrat

9.5.5.6.1 Habitat Use and Distribution

Muskrats occur in marshes, ponds, lakes, and slow-moving rivers. Water at a site must be deep enough to not freeze to the bottom in the winter, but shallow enough to allow the growth of aquatic vegetation; ideal water depth is between 1 m and 2 m (Aleksiuk 1986). In addition, muskrats require easy access to deep water, therefore, water depths must increase fairly rapidly from the shore where burrows are situated (Aleksiuk 1986).

Muskrats are primarily herbivores, although they will eat some animal matter (Allen and Hoffman 1984) including fresh-water mussels and small aquatic animals such as frogs (Banfield 1974). Broad-leaved cattail (*Typha latifolia*) is a preferred food source (Bellrose 1950) and can support two to seven times as many individuals than other vegetation types (Allen and Hoffman 1984); however, this plant species is not abundant within the Project area. Stream-dwelling muskrats tend to have more diverse diets than those that live in marshes. Individuals that inhabit lakes are more opportunistic feeders and may ingest more animal matter than other populations (Allen and Hoffman 1984).

Muskrats occur throughout most of North America, with the exception of portions of the arid southwest and the arctic tundra, and are present throughout the boreal regions of the NWT (Banfield 1974).

Surveys were completed in 2001 with a Cessna 185 aircraft flying at 30 m above ground level to determine the abundance and distribution of muskrat push-ups within the Taltson watershed (Rescan 2001). A total of 98 push-ups were found for an average density of 0.25 push-ups/km of shoreline (Figure 9.5.16). The Taltson River was not included in this calculation because an aerial survey was not completed as break-up had already occurred. Nonacho Lake had patches of suitable and good quality habitat for muskrats. The best areas were the northwest and northeast parts of the lake. Muskrats were associated with marshy bays. Areas with rocky shorelines that drop off quickly contained little littoral zone with appropriate habitat for muskrats. Porter Lake had the poorest muskrat habitat in the survey, due to deep and rocky shorelines with little suitable marsh area. The habitat found in the Twin Gorges Forebay (Zone 3) was not high-quality, due to rocky shorelines and steep banks. Fluctuating water levels within this area were also mentioned as suboptimal for muskrats. The western side of Trudel Creek contained low-quality muskrat habitat. No push-ups were found along this side of Zone 5; however, patches of suitable habitat with slow-flowing water and emergent vegetation did exist. Thus, there was likely a small muskrat population in this area. Elsewhere, water flow was too swift to provide good muskrat habitat. Parts of the eastern side of Trudel Creek were open (ice-free) and water was already flowing. Observers surveyed areas where the ice had not yet broken up as well as over the adjoining Unnamed Lake, which was still frozen. The eastern side of Trudel Creek provided poor-quality muskrat habitat as the banks are steep and rocky and the water flow is fast. As with the Taltson River, the fast water flow leads to earlier ice break-up, suggesting that the habitat is not ideal for muskrats (who require slow-flowing water). However, Unnamed Lake contained better muskrat habitat with shallower water, more suitable vegetation, and a less rocky shoreline. All push-ups were found in Unnamed Lake, not in the creek (Figure

9.5.17). Habitat within Hanging Ice Lake and Tethul River was found to have patchy high-quality habitat. Some areas were too rocky or water flow was too fast to provide suitable habitat. However, in slow moving reaches with marsh and wetland vegetation, suitable habitat was present. Muskrat push-ups, houses, and sign (e.g., bank tunnels) were observed incidentally in 2008 farther north along the Taltson River (Zones 1 and 3), at the edge of Trudel and Gertrude Lakes (Zone 5), and at Nonacho Lake (Table 9.5.8).

Table 9.5.8 — Abundance of Muskrat Push-ups within the Project Area: May 2001

Water Body	Linear km of Shoreline	Number of Push-ups	Number of Push-ups per Linear km of Shoreline
Nonacho Lake	237.50	67	0.28
Porter Lake[1]	66.25	1	0.15
Trudel Creek (Zone 5)	10.80	2	0.185
Taltson River[2] (not flown) (Zone 3)	0	0	0.00
Twin Gorges Forebay[3] (Zone 3)	22.25	5	0.23
Hanging Ice River/Hanging Ice Lake[4]	36.25	23	0.63

Source: Rescan 2001

[1] Reference site for Nonacho Lake.

[2] Taltson River includes that section between the confluence of Trudel Creek and Taltson River downstream to Tsu Lake. An aerial survey was not completed on this water body because break-up was underway.

[3] Twin Gorges Forebay includes the section of the Taltson River that has been flooded immediately behind the dam at Twin Gorges.

[4] Hanging Ice Lake includes the entire lake; Tethul River includes approximately 17.5 km and 7.5 km of river above and below Hanging Ice Lake, respectively; reference area for Trudel Creek, Taltson River and Twin Gorges Forebay.

Muskrats build a variety of structures depending on habitat conditions. Water depth, soil texture, and amount of aquatic vegetation influence their selection of sites for house construction (Danell 1978). Soil type and slope of the bank determine the permanence and complexity of a burrow (Earhart 1969; Beshears and Haugen 1953). Along rivers, where bank substrate is appropriate for digging, they dig extensive burrows with underwater entrances as a defense against predators. In marshes, muskrat build lodges out of vegetation and mud. They also build feeding platforms and "push-ups", which are shelters made of vegetation that cover a hole in the ice. These are used for feeding and as breathing holes.

Muskrats often build two types of lodges, dwelling lodges and feeding lodges; dwelling lodges tend to be larger than feeding lodges (MacArthur and Aleksuik 1979). Summer feeding lodges are thin-walled and may be simple platforms whereas winter feeding lodges are thick-walled to provide insulation. Muskrats begin building lodges during the ice-free period. Peak building activity occurs between late May and early June, and again during the early part of October (Danell 1978).

9.5.5.6.2 Population Characteristics

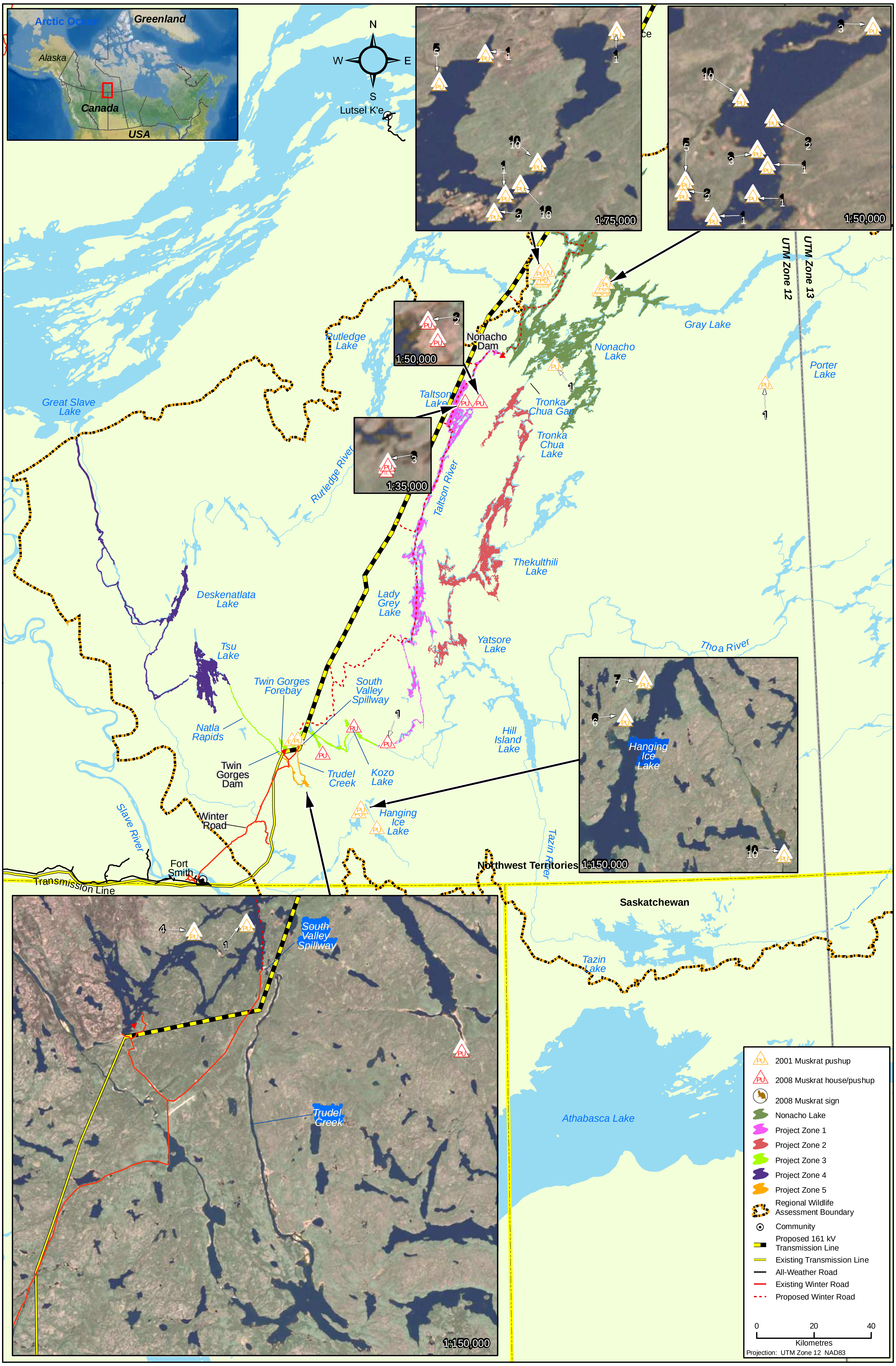
Muskrat are listed as Secure in the NWT and are not listed federally (COSEWIC 2007; SARA 2008). Muskrat populations appear to cycle but the periodicity is not clearly understood. Bulmer (1974) noted that an increase in muskrat populations was followed by an increase in mink populations a year later and the increase in mink was followed by a decrease in muskrats. Elton and Nicholson (1942) stated that populations generally follow a 10-year cycle. Butler (1962) compared fur harvest records from Saskatchewan to muskrat population densities and found a six-year cycle. Aleksiuk (1986) reported that muskrat populations fluctuate every seven to ten years. The causes of these fluctuations are still unknown. There are no muskrat population estimates for the NWT.

9.5.5.6.3 Issues Affecting Population Abundance and Distribution

No specific issues with regards to muskrat abundance and distribution were identified in the Project area. Human activities have not greatly affected muskrat populations in North America. However, some local populations have been extirpated because of extensive draining of wetlands for agriculture (Aleksiuk 1986). Other populations have increased because of the creation of irrigation ditches and canals (Aleksiuk 1986).

9.5.5.6.4 Human Use

Muskrat are an important species for harvesting both as a food source and as an economic source through sales of pelts (see Chapter 9.6; Aleksiuk 1986). The muskrat contributes more to the total combined income of North American trappers than any other mammal (Aleksiuk 1986). They were the top-harvested species for the communities of Fort Smith and Fort Resolution in 2005 and 2006. In Fort Smith and Fort Resolution, 1,167 muskrats were trapped in 2007 for a total value of $5,021.13. Concerns regarding the effects of changes in water levels to muskrat populations were raised during scoping sessions. Muskrat was identified as a valued ecosystem component following community consultation for the Water Effects Monitoring Program (Clark 1999). Local trappers were concerned about the abundance of muskrat in Nonacho Lake. Muskrat abundance, distribution, and condition have been identified as an important indicator of environmental change by the Łutsel K’e Dene First Nation (Łutsel K'e Dene First Nation 2002).



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TALSTON Hydroelectric Expansion Project	Developer's Assessment Report 2009	Muskrat Observations within the Taltson River Watershed	Figure 9.5.16

TALTSON Hydroelectric Expansion Project	Developer's Assessment Report 2009	Muskrat Observations within Trudel Creek (Zone 5)	Figure 9.5.17

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9.5.5.7 BEAVER

9.5.5.7.1 Habitat Use and Distribution

The beaver is an aquatic rodent found in the immediate vicinity of aquatic habitats (Allen 1983). Beavers occur in streams, ponds, and the margins of large lakes throughout North America, except for peninsular Florida, the Arctic tundra, and the south-western deserts (Allen 1983). The species is present throughout the boreal regions of the Project area. Beavers require water deep enough to not freeze to the bottom because their lodge entrances are built below water level and they require access to their food caches outside their lodges. In areas where water levels are low, beavers build dams to provide a constant water depth. In areas where water is naturally deep, lodges are built on lake or river margins (Allen 1983).

Diet of beavers will vary seasonally. Most of the beaver's diet is the bark, leaves and twigs of trembling aspen, willows, paper birch and poplar. In summer, this will be supplemented with water-lilies, cattails, and other aquatic vegetation. Beavers cache food to sustain them through the winter months (Banfield 1974).

Beaver lodges, made from mud and debarked trees and limbs, provide protection from predators, as well as thermal and reproductive cover (Allen 1983). During times of peak river flow, beaver dens can be flooded and dams and food piles can be washed away (Hill 1982). In the Arctic, peak river flows occur in the spring. Young beavers often disperse at this time because the loss of dams and food piles is offset by the growth of new vegetation (Nitsche 2001).

Beavers in northern environments tend to be more responsive to food quality and quantity (Wooley 1974). Greater beaver numbers are found within the Boreal Plains region of the Project area than in the Taiga Shield region (Rescan 2000) because the Boreal Plains region contain more favourable beaver habitat (i.e., more emergent vegetation, less rock outcrop, more shallow littoral zones, and gentler lake slopes) (Rescan 2000).

Beavers are colonial and there are usually between four and eight individuals in a colony. Colonies usually consist of a pair of monogamous adults, subadults, and young of the year (Parker et al. 2006; Allen 1983). Breeding occurs between January and February and young are born between April and May. Young usually stay with their parents for a year and disperse in the spring when vegetation is abundant (Allen 1983).

Aerial surveys were completed in 2000 (Rescan 2000) and 2003 (Rescan 2004b; Table 9.5.9) to collect baseline data on the abundance and distribution of beaver lodges in the Taltson watershed. Incidental observations of beaver and beaver sign were also collected in 2008. Surveys were conducted in a Cessna 185 aircraft at an altitude of 100-125 m above ground level and a speed of 100-150 km/h. A total of 44 active beaver lodges were documented in 2000 (Figure 9.5.18). Beaver lodges and sign observed in Trudel Creek are shown in Figure 9.5.19. Two days of aerial surveys were conducted as a follow-up study in September and October, 2003 (Rescan 2004b). The follow-up survey occurred at the same locations that were visited in 2000. Comparable numbers of active lodges were found during similar total survey hours between years (12.3 hr in 2000, 13.8 in 2003) (Rescan 2004b). Active beaver colonies were identified from the air by the presence of food caches (Fuller 1953; Hay 1958). It was concluded that beaver populations had remained constant between the survey years.

Nonacho Lake and Porter Lake (a reference lake) were the survey locations farthest north. It was concluded that neither location offered good quality beaver habitat (Rescan 2000). This was partly due to shorelines that contained exposed rock outcrops and boulders with little functional littoral zone. Twin Gorges Forebay (Zone 3) was found to contain moderate to good beaver habitat, due to the large number of bays that contained marsh habitat. The stretch of the Taltson River from Elsie Falls to Tsu Lake had high-quality beaver habitat, partly due to the presence of willows, poplars, and birches within the riparian zone. Habitat along Trudel Creek was characterized by low topography and extensive emergent vegetation, which contributes to moderate- to good-quality beaver habitat. The eastern side of Trudel Creek, including the Unnamed Lake into which it empties, provided good-quality beaver habitat. The riparian zone contained extensive amounts of quality forage for beavers including poplar, birch, and willow. This type of habitat generates favourable forage for beaver as the annual flooding and ice gouging processes provide opportunities for new vegetative growth, especially willow species. Hanging Ice Lake and Tethul River (reference sites) contained the most number of active beaver lodges per linear kilometre of shoreline. Hanging Ice Lake was shallow with a large functional littoral zone and Tethul River contained a series of wetlands providing excellent beaver habitat. Beaver lodges, dams, and sign (e.g., gnawed stumps) have also been observed farther north along the Taltson River (Zones 1 and 3), Trudel Lake, Unnamed Lake, within Zone 5 at Gertrude Lake, along the eastern side of Trudel Creek, and at Nonacho Lake in 2008.

Table 9.5.9 — Abundance of Active Beaver Lodges within the Taltson Project Area: October 2000

Water body	Linear km of Shoreline (2000)	# Active Lodges (2000)	# Active Lodges (2003)	# Active Lodges/ Linear km Shoreline (2000)	# Active Lodges /Survey Hour (2003)
Nonacho Lake	238	2	0	0.008	0
Porter Lake[1]	66	1	1	0.015	1.2
Trudel Creek (Zone 5)	42	8	11	0.119	11.19
Taltson River[2] (Zone 3)	38	5	7	0.133	13.1
Twin Gorges Forebay[3] (Zone 3)	22	4	5	0.180	6.3
Hanging Ice Lake and Tethul River[4]	36	24	19	0.662	17.5
Total	**442**	**44**	**43**		

[1] Reference site for Nonacho Lake.
[2] Taltson River includes that section between the confluence of Trudel Creek and Taltson River downstream to Tsu Lake.

[3]Twin Gorges Forebay includes that section of the Taltson River that has been flooded immediately behind the dam at Twin Gorges.

[4] Hanging Ice Lake includes the entire lake; Tethul River includes approximately 17.5 km and 7.5 km of river above and below Hanging Ice Lake, respectively; reference area for Trudel Creek, Taltson River and Twin Gorges Forebay

9.5.5.7.2 Population Characteristics

Beaver are listed as Secure in the NWT and are not listed in SARA (2008) or COSEWIC (2007). Beaver populations change slowly and lack the boom-bust population cycle typical of smaller rodents (Muller-Schwarze & Sun 2003). There are no beaver population estimates for the NWT.

9.5.5.7.3 Issues Affecting Population Abundance and Distribution

No specific issues regarding beaver abundance or distribution were identified in the Project area. Beaver were hunted almost to extinction during the 17th century when their pelts were highly valued by Europeans. Beaver numbers in North America have since recovered with the decrease in the fur trade (Allen 1983). Hunting may affect beaver populations beyond the removal of individuals because breeding may be delayed when there is heavy harvesting of males in an area (Parker et al. 2006). A delay in breeding may affect offspring survival, which may lead to population declines (Parker et al. 2006). In areas where beaver populations decline, the populations of their predators (e.g., mink, river otter, fisher) may also be negatively affected.

Beavers will live in close proximity to humans if all habitat requirements are met (Allen 1983). However, human activities adjacent to waterways may limit beaver habitat suitability (Slough and Sadleir 1977).

9.5.5.7.4 Human Use

Beavers are an important wildlife species with respect to subsistence lifestyles and traditional land use (see Chapter 9.6). Beavers are one of the most harvested animals in Fort Smith and Fort Resolution. They are an important food source for the communities of Łutsel K'e, Fort Smith, and Fort Resolution and their pelts are sold for economic return. Currently beavers are hunted for their fur, but usually only when pelt values are high. In 2007, Fort Smith and Fort Resolution reported harvesting 294 beaver for a total value of $8,390.72. Concerns regarding beaver populations were raised during scoping sessions with regards to changes in the hydrological regime of the Taltson River and potential flooding of beaver lodges and dams. Beaver were identified as a valued ecosystem component during consultation with community stakeholders for the initial Water Effects Monitoring Program (Clark 1999). Beaver abundance, distribution, and condition were identified as important indicators of environmental change by the Łutsel K'e Dene First Nation (Łutsel K'e Dene First Nation 2002).

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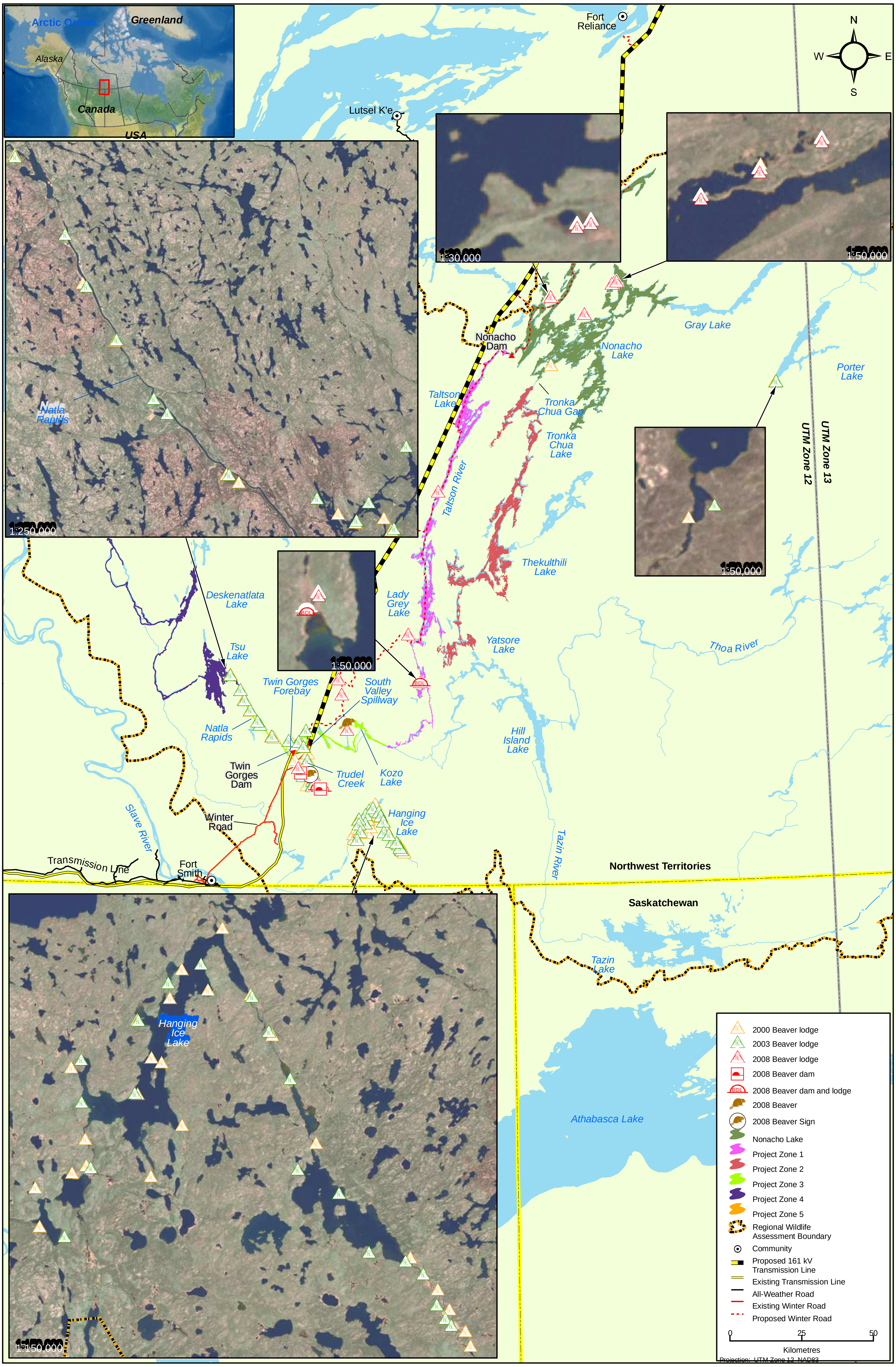

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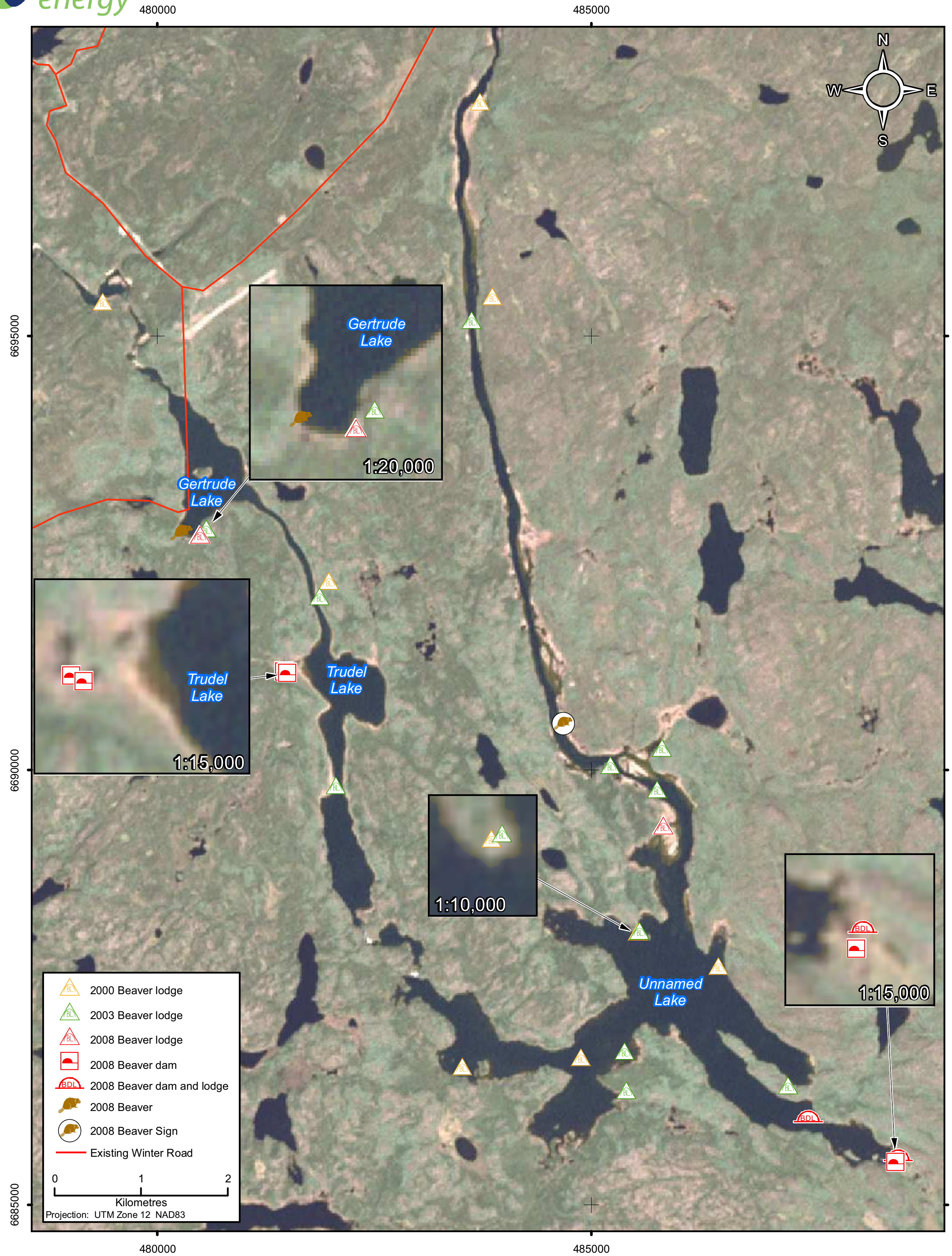
TALTSON Hydroelectric Expansion Project	Developer's Assessment Report 2009	Beaver Observations within the Taltson River Watershed	Figure 9.5.18



TALTSON Hydroelectric Expansion Project	Developer's Assessment Report 2009	Beaver Observations within Trudel Creek (Zone 5)	Figure 9.5.19

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9.5.5.8 RIVER OTTER

9.5.5.8.1 Habitat Use and Distribution

River otters exploit a variety of wetlands including lakes and ponds, as well as riverine habitat. Otters are predators of other aquatic furbearers and are capable of travelling large distances over land to access other aquatic environments. However, the otter's diet is mainly limited to aquatic prey, of which fish are the largest constituent; they rarely prey on terrestrial vertebrates (Melquist 1997). When fish are limited, otters will expand their diet to include other aquatic prey such as crayfish, amphibians, reptiles, and birds. Riparian habitat, in particular areas with fallen trees and woody debris, is important habitat for otters (Melquist 1997). Structural complexity in stream or shoreline areas often promotes prey species diversity, in that it provides shelter for fish and aquatic invertebrates. These areas are often exploited as foraging grounds by otters. Otters do not build houses or burrows (OFMF 2008). Instead, they will utilize abandoned beaver dams or established burrows and cavities along the shore for security and overwinter denning (Melquist 1997; OFMF 2008). The presence of beaver is important for otters because beaver dams create foraging and security habitat for otters (Martin 2001; Melquist and Hornocker 1983 in Melquist 1997).

Otters are associated with fish-bearing streams that have fast-flowing sections that remain unfrozen during the winter within the Taiga Shield Mid-boreal and High-boreal Ecoregions (Ecosystem Classification Group 2008). Otter tracks have been detected within the Taltson River watershed (Rescan 2004a). Otter tracks were recorded during late November 2003 and mid-February 2004 during carnivore track surveys (Rescan 2004a). During the November 2003 track count, the tracks of eight otters were observed. During the February 2004 track count survey, the tracks of seven otters were detected. Otter tracks were also observed incidentally during wildlife surveys in July 2008 (Appendix 13.10A).

River otters were broadly distributed across North America prior to human settlement, occurring in nearly every large water drainage system (Melquist 1997). Hunting and trapping pressures on river otters increased in the early nineteenth century, in addition to habitat destruction and alteration associated with colonization. As such, the river otter's range condensed across North America and the otter was extirpated from several provinces in Canada (Stenson 1986). Subsequent efforts to re-establish otters within their native range have had some success and otters are now present within all provinces and within the majority of their historic range in the United States (Raesly 2001).

9.5.5.8.2 Population Characteristics

River otters in the NWT are listed as Secure (Working Group on General Status of NWT Species 2006) and are not listed federally under either COSEWIC or SARA. There are complications in acquiring an accurate census of otter populations, perhaps due to the elusive nature of otters and difficulties in establishing effective survey techniques. Population characteristics are often inferred from fur harvest statistics. Stenson (1986) reported that from the 1950s to the 1980s, the number of river otters trapped was very similar per year (*ca*. 15,000 to 19,000). Demand for otter fur has decreased in more recent years, and the current harvest statistics for Canada may range in the low thousands. Sources identify this trend as evidence of stable and sustainable populations within Canada (Stenson 1986; Parker 1982); however, further research is needed to chart the true population characteristics of this species (Melquist 1997).

9.5.5.8.3 Issues Affecting Population Abundance and Distribution

As aforementioned, river otters were once widespread in North America. The marked population decline and range contraction documented during the 1800s and 1900s shows the sensitivity of the river otter to trapping and habitat degradation. Habitat disturbance and loss is recognized as a major contributing factor to these declines (Melquist 1997). As fish are a major constituent of the otter's diet, research suggests that otters may be subject to heavy metal and organochloride bioaccumulation, which affects the health of the species (Anderson-Bledsoe and Scanlon, 1983; Grove 2006).

9.5.5.8.4 Human Use

Harvest statistics from the communities of Łutsel K'e, Fort Smith, and Fort Resolution show that otters were among the least trapped species, along with wolves and wolverines (see Section 9.6 - TK). However, river otters are an integral part of the aquatic ecosystem. As such, otter abundance, distribution, and condition were identified as important indicators of environmental change by the Łutsel K'e Dene First Nation (Łutsel K'e Dene First Nation 2002).

9.5.5.9 MINK

9.5.5.9.1 Habitat Use and Distribution

While mink are typically an aquatic predator of wetlands, rivers and lakes, they will exploit upland habitats during parts of the year. Minks are active hunters in both upland and aquatic habitats and components of the mink's diet include aquatic invertebrates, fishes, insects, and a variety of small mammals and amphibians. Minks build shallow burrows alongside rivers and under logs and will often usurp burrows dug by other species, particularly muskrats (Melquist 1997). Riparian areas play the largest role in determining high quality habitat for mink (Martin 2001; Melquist 1997) providing necessary food and security elements. In particular, streamside areas with fallen trees and logjams, i.e., banks with high proportions of woody debris, are often used by mink as foraging sites for aquatic invertebrates and temporary security habitat from larger predators (Melquist 1997; OFMF 2008). As minks forage from the land, woody debris provides excellent security and cover while hunting. Along the shoreline, these areas also provide suitable burrowing habitat.

Mink are considered abundant near water bodies and other wetlands within the Taiga Shield Mid-boreal and High-boreal Ecoregions (Ecosystem Classification Group 2008). Mink tracks have been detected within the Nonacho Lake regional study area. The tracks of one mink were detected during the November 2003 aerial carnivore track survey and the tracks of two minks were detected during the February 2004 survey (Rescan 2004a).

In general, mink are a fairly ubiquitous species, distributed across North America from Alaska to Florida. Very limited information is available for the mink population and density estimates for the NWT (Larivière 2003). The most reliable source of information about the mink population in the arctic is derived from hunting and trapping statistics. Harvest statistics suggest that mink population density is low in the NWT (Erb et al. 2001; Larivière 2003). Declines in mink (as evidenced in lower trapping returns in the species) have been observed by the local First Nations and commercial trappers (See Section 9.6 - TK; Łutsel K'e Dene First Nation 2002; Eagle and Whitman 1987; Bowman et al. 2007).

9.5.5.9.2 Population Characteristics

Mink in the NWT are listed as Secure (Working Group on General Status of NWT Species 2006) and are not listed federally under either COSEWIC or SARA. Mink populations in the arctic have been thought to follow muskrat population cycles (Erb et al. 2001; Larivière 2003). Larivière (2003) investigated mink and muskrat harvest returns from the Hudson Bay Company between the years of 1925 to 1949, collected from 80 harvest posts distributed across Canada. Fluctuations in the mink harvest returns were observed to be strongly related to muskrat harvest returns in the Taiga Plains and Taiga Shield Ecozones, which encompass the Project area (Larivière 2003). This suggests that mink within the Project area may be dependent on muskrat as a primary food item.

9.5.5.9.3 Issues Affecting Population Abundance and Distribution

There are several pressures on mink populations. Historically, the greatest pressure affecting mink populations was hunting and trapping for the animal's luxurious fur. The demand for mink fur created the basis for the creation of mink farms. Mink farming became popular in Canada in the 1800s and has spread across the world since then (Larivière 2003; Bowman et al. 2007). These farms originally used wild caught North American mink to establish the farm population, and since then have selectively bred them to express certain coat colours and to maximize other qualities beneficial to the industry (e.g., good health and reproductive output). The mink farming industry may have alleviated the trapping pressures on wild mink somewhat; however, some research suggests that mink farming may cause problems for the wild mink population through the introduction of farmed mink into the wild (Bowman et al. 2007). Interbreeding with farmed mink would place wild mink at risk from introduced disease, and subject them to lower genetic diversity due to the inbred nature of farmed mink. (Bowman et al. 2007).

Mink also suffer from heavy metal and organochloride bioaccumulation, which can affect female reproductive output and offspring survival (Bäcklin and Bergman 1992; Poole et al. 1998). Current research suggests that mink in the NWT are not exposed to levels of heavy metals and organochlorides that could affect the health of the local population (Poole et al. 1998).

9.5.5.9.4 Human Use

Mink are a traditionally harvested furbearer species, although not to the level of other species such as muskrat and marten (see Section 9.6 - TK). This species is typically harvested during the fall. The trapping of mink has declined since 1995 in the communities of Łutsel K'e, Fort Smith, and Fort Resolution, and population declines in this species have been observed (see Section 9.6 - TK; Łutsel K'e Dene First Nation 2002). Mink abundance, distribution, and condition were identified as important indicators of environmental change by the Łutsel K'e Dene First Nation (Łutsel K'e Dene First Nation 2002).

9.5.6 Vegetation

9.5.6.1 INTRODUCTION

The Project area occurs in two Ecozones, the Taiga Shield Ecozone (southern portion) and the Southern Arctic Ecozone (northern portion). "Taiga" is a Russian term referring to the northern edge of the boreal coniferous forest. In northern Canada, this forest rests on the Canadian Shield, with much of the surface containing exposed bedrock. The boundary between the Taiga Shield and the Southern Arctic Ecozones is defined by the northern extent of continuous forest. The southern edge of the Southern Arctic Ecozone is the treeline, a transition zone north of which no full-sized trees are found. Low plant growth occurs in this ecozone as a consequence of low temperatures, low precipitation, and high winds. Numerous small lakes, ponds and wetlands dot the landscape. A description of the ecoregions the Project passes through is provided in Section 9.1.

9.5.6.2 OLD GROWTH FORESTS

Old growth forest stands within the Taiga Shield have unique structural attributes and ecological processes. Tree mortality leads to gaps in the forest canopy allowing direct sunlight to reach the understorey, enabling growth of herbaceous plants and immature trees. The accumulation of snags and downed woody debris adds to the high level of structural diversity (Schneider 2002). Old growth forests are also hotspots of biodiversity at genetic, species and ecosystem levels. Because of their high structural and functional diversity, old growth forests provide some of the highest habitat value available for plants and animals (Timoney 1998).

Old growth forests may be defined as having annual growth equal to annual loss (Davis and Johnson 1987), or where mean annual increment of timber volume equals zero (DeBell and Franklin 1987). They can also be defined as stands that are self-regenerating (i.e., having a specific structure that is maintained) (McCarthy 2001; McCarthy and Weetman 2006). The forest structure includes juvenile, mature, dying and decaying trees of the same species. Old growth forests develop at different rates depending upon tree species and factors such as site quality, climate, decay rates, stand history and disturbance type, magnitude and frequency. Structural characteristics, dominant processes, successional development stages, habitat quality and human values are also important factors in defining old growth forests (Hayward 1991). To summarize, old growth is often defined by a combination of the following variables:

- tree height and diameter,
- stem and snag density,
- cavity characteristics,
- mortality rates,
- nutrient cycling,
- energy flow characteristics, and
- structural heterogeneity.

Timoney (1998) states that old growth forests can simply be characterized by age, but characteristics vary depending on forest type and geographic location.

9.5.6.3 ECONOMIC IMPORTANCE

Economically-important forests are defined here as the portion of the land base capable of producing economically-viable timber for forest harvesting operations. Commercial species of importance to the NWT include jack pine (*Pinus banksiana*), white birch (*Betula papyrifera*), and white spruce (*Picea glauca*) (GNWT 2004). White spruce is the primary source of lumber in the NWT, but jack pine is also used as lumber for general construction. The wood of white birch is quite hard and used commercially in the NWT. Some species of trees are not considered economically important, such as black spruce (*Picea mariana*) and tamarack (*Larix laricina*). In addition, burn areas are excluded from the economic forest land base because trees in burns are too small.

9.5.6.4 LOWLAND AREAS

Wetlands occur where the water table is near, at, or above the land surface or where land is saturated for a long enough period to promote such features as wet-altered soils and water tolerant vegetation (Environment Canada 2006). Wetlands include organic wetlands or "peatlands" as well as mineral wetlands (i.e., swamps and marshes).

Peat-forming wetlands are defined as having greater than 40 cm of accumulated organics and include all types of fens and bogs (Halsey et al. 2003). Typically, peatlands in northern Canada are characterized by extensive areas of wooded, permafrost bogs (Vitt et al. 1994). Mineral wetlands are influenced by excess water, but produce little or no peat. Due to the limitations inherent in regional mapping, separation of peatlands and mineral wetlands was not possible.

9.5.6.4.1 Bog

A bog is a nutrient-poor, Sphagnum dominated peatland ecosystem in which the rooting zone is isolated from mineral-enriched groundwater, soils are acidic and few minerotrophic plant species occur. Bogs may be treed or tree-less and are usually covered with Sphagnum spp. and ericaceous shrubs. Precipitation, fog and snowmelt are the primary water sources. Precipitation does not usually contain dissolved minerals and is mildly acidic. Hence, bog waters are low in dissolved minerals and acidic in nature. Bog water is also acidic because organic acids form during the decomposition of peat. One bog association was identified in the study area and only in the Nonacho Lake Zone.

9.5.6.4.2 Fen

A fen is a nutrient-medium peatland ecosystem dominated by sedges and brown mosses, where mineral-bearing groundwater is within the rooting zone and minerotrophic plant species are common. Fens can have fluctuating water tables and are often rich in dissolved minerals. Surface water flow can be direct through channels, pools and other open features that can often form characteristic surface patterns. The vegetation in fens is closely related to the depth to and chemistry of groundwater. Shrubs occupy drier sites and minerotrophic graminoid vegetation (grass) is typically found in wetter sites. Two fen associations were identified in the study area.

9.5.6.4.3 Riparian Marsh

A marsh is a permanently to seasonally flooded non-tidal mineral wetland dominated by emergent grass-like vegetation. Marshes are the most heavily used wetland type for most wetland-using wildlife species. They are typically eutrophic and support large standing crops of palatable vegetation, plankton and aquatic invertebrates. They are the favoured wetland class for most waterfowl, amphibians and semi-aquatic mammals because they provide good cover, open water and food. Soils are typically mineral but can also have a well decomposed organic surface tier. This is the most abundant wetland class surveyed representing 79% of the field observations. Five vegetation community associations were observed in the study area and are described in the following sections.

9.5.6.5 Traditional Plants

Traditional plants include edible plants, medicinal plants, and plants used for construction or other purposes. A list of traditional plants potentially present in the Project area is provided in Table 9.5.10.

Table 9.5.10 — Traditional Plant Usage in the Northwest Territories

Common name	Latin name	Use	Reference
Aspen	*Populus tremuloides*	Food, medicine, tools, fuel	Marles et al. 2000
Black spruce	*Picea mariana*	Food, medicine, shelter, fuel, tools	Andre and Fehr 2002
Jack pine	*Pinus banksiana*	Food, medicine, tools, shelter, fuel	Marles et al. 2000
Paper birch	*Betula papyrifera*	Food, medicine, tools, bait	Andre and Fehr 2002
Tamarack	*Larix laricina*	Medicine, fuel	Andre and Fehr 2002
White spruce	*Picea glauca*	Food, medicine, shelter, fuel, tools	Andre and Fehr 2002
Willow (various)	*Salix spp.*	Fuel, food, tools, shelter, medicine, tobacco, insect repellent, mothball, fire starter	Andre and Fehr 2002
High-bush cranberry	*Viburnum edule*	Food, medicine, dye	Andre and Fehr 2002
Black currant (blackberry)	*Ribes hudsonianum*	Food	Andre and Fehr 2002
Blueberry	*Vaccinium uliginosum / caespitosum*	Food, medicine	Andre and Fehr 2002
Bog cranberry	*Vaccinium vitis-ideae*	Food, medicine, dye	Andre and Fehr 2002
Crowberry	*Empetrium nigrum*	Food, medicine	Marles et al. 2000
Gooseberry	*Ribes oxyacanthoides*	Food, medicine	Marles et al. 2000
Green alder	*Alnus crispa*	Medicine, fuel	Andre and Fehr 2002
Juniper (berries)	*Juniperus communis*	Medicine	Andre and Fehr 2002
Kinnikinnick (bear berry)	*Arctostaphylos uva-ursi / rubra / alpina*	Food	Andre and Fehr 2002
Labrador tea	*Ledum groenlandicum*	Food, medicine	Andre and Fehr 2002

Common name	Latin name	Use	Reference
Raspberry	*Rubus ideaus*	Food	Andre and Fehr 2002
Prickly rose	*Rosa acicularis*	Food, medicine	Andre and Fehr 2002
Cloudberry	*Rubus chamaemorus*	Food	Andre and Fehr 2002
Bulrush	*Schoenoplectus acutus*	Food, medicine, baskets	Marles et al. 2000
Sphagnum moss	*Sphagnum spp.*	Diapers, cleaner	Andre and Fehr 2002
Lichen	*Cladina spp., Centraria spp., Parmelina spp., Actinogyra spp.*	Food, medicine	Marles et al. 2000

General descriptions of vegetation found within plant associations were obtained during baseline field surveys (Rescan 2004); however, a traditional plant survey was not completed as part of the baseline field surveys. The types of traditional plants potentially occurring within specific plant associations for the two ecozones are provided in Table 9.5.11 and Table 9.5.12. This provides a coarse filter for assessing plant associations for their potential traditional plant value, and does not take into account the distribution of plant associations on the landscape.

Table 9.5.11 — Traditional Plants Potentially Occurring within Specific Plant Associations in the Taiga Shield Ecozone

Plant Associations in the Taiga Shield Ecozone		Potential Traditional Plants
Wetland	Bog	Sphagnum moss, black spruce, tamarack, green alder, Labrador tea, cloudberry, bog cranberry, lingonberry
	Fen	Willow, tamarack
Riparian Woodland	Shoreline	Sphagnum moss, black spruce, tamarack, green alder, Labrador tea, cloudberry, bog cranberry, lingonberry, willow, tamarack
Deciduous Forest	Birch Forest	Paper birch, Labrador tea, black currant, gooseberry
	Aspen Forest	Aspen, juniper, prickly rose, kinnikinnick, raspberry, white spruce, highbush cranberry, lingonberry
Coniferous Forest	Pine Forest	Jack pine, kinnikinnick, lingonberry
	Spruce Forest – open	White spruce, black spruce, willow, sphagnum moss Labrador tea, cloudberry, lichen
Lichen-Rock	Bedrock Outcrops	Lichen
	Felsenmeer, Boulder Fields, Boulder Streams	Lichen
Burns	Burns	Jack pine, aspen, willow

Table 9.5.12 — Traditional Plants Potentially Occurring within Specific Plant Associations in the Southern Arctic Ecozone

Plant Associations in the Southern Arctic Ecozone		Potential Traditional Plants
Wetland	Emergent	Bulrush
	Non-Tussock	Willow
	Tussock Meadow	Sphagnum moss
Riparian Birch Shrubland	Riparian Birch Shrubland	Green alder, willow, raspberry, cloudberry, lingonberry, blueberry, black spruce
Snowbanks	Snowbanks	Willow, Labrador tea
Heath Tundra	Heath Tundra	Blueberry, kinnikinnick, Labrador tea, lingonberry, crowberry
Esker Complex	Esker Crest	Black currant, blueberry, crowberry
	Esker Pond	Willow, crowberry, raspberry
Burns	Burns	Jackpine, aspen, willow

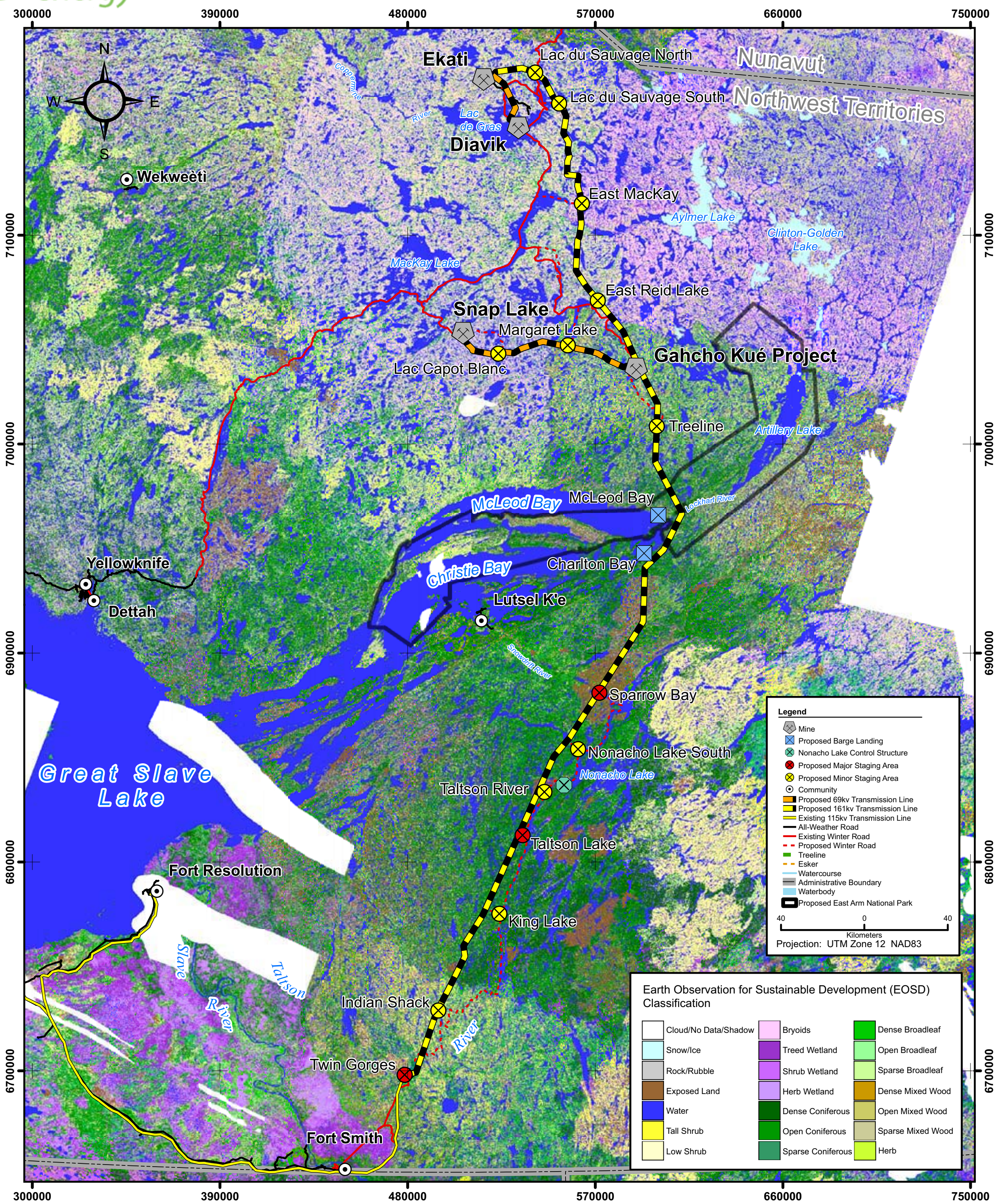
9.5.6.6 Land Cover Units Within the Project Footprint

Existing land cover in the Project Regional Study Area (RSA) was mapped using data obtained from Natural Resources Canada (Figure 9.5.20). These data are commonly known as Earth Observation for Sustainable Development of Forests (EOSD) and is primarily obtained from satellite imagery, such as Landsat-7 Enhanced Thematic Mapper. The description classes for EOSD are provided in Table 9.5.13.

Table 9.5.13 — Earth Observation for Sustainable Development of Forests Land Cover Class Descriptions

Class	Description
Water	Lakes, reservoirs, rivers, streams, or salt water
Snow/Ice	Includes glacier, snow, ice
Rock/Rubble	Bedrock, rubble, talus, blockfield, rubbley mine spoils, or lava beds
Exposed Land	River sediments, exposed soils, pond or lake sediments, reservoir margins, beaches, landings, burned areas, road surfaces, mudflat sediments, cutbanks, moraines, gravel pits, tailings, railway surfaces, buildings and parking, or other non-vegetated surfaces
Bryoids	Bryophytes (mosses, liverworts, and hornworts) and lichen (foliose or fruticose; not crustose); minimum of 20% ground cover or one-third of total vegetation must be a bryophyte or lichen
Shrub Tall	At least 20% ground cover which is at least one-third shrub; average shrub height greater than or equal to 2 m
Shrub Low	At least 20% ground cover which is at least one-third shrub; average shrub height less than 2 m
Wetland-Treed	Land with a water table near/at/above soil surface for enough time to promote wetland or aquatic processes; the majority of vegetation is coniferous, broadleaf, or mixed wood

Class	Description
Wetland-Shrub	Land with a water table near/at/above soil surface for enough time to promote wetland or aquatic processes; the majority of vegetation is tall, low, or a mixture of tall and low shrub
Wetland-Herb	Land with a water table near/at/above soil surface for enough time to promote wetland or aquatic processes; the majority of vegetation is herb
Herb	Vascular plant without woody stem (grasses, crops, forbs, gramminoids); minimum of 20% ground cover or one-third of total vegetation must be herb
Coniferous Dense	Greater than 60% crown closure; coniferous trees are 75% or more of total basal area
Coniferous Open	26 to 60% crown closure; coniferous trees are 75% or more of total basal area
Coniferous Sparse	10 to 25% crown closure; coniferous trees are 75% or more of total basal area
Broadleaf Dense	Greater than 60% crown closure; broadleaf trees are 75% or more of total basal area
Broadleaf Open	26 to 60% crown closure; broadleaf trees are 75% or more of total basal area
Broadleaf Sparse	10 to 25% crown closure; broadleaf trees are 75% or more of total basal area
Mixedwood Dense	Greater than 60% crown closure; neither coniferous nor broadleaf tree account for 75% or more of total basal area
Mixedwood Open	26 to 60% crown closure; neither coniferous nor broadleaf tree account for 75% or more of total basal area
Mixedwood Sparse	10 to 25% crown closure; neither coniferous nor broadleaf tree account for 75% or more of total basal area



TALTSON Hydroelectric Expansion Project	Developer's Assessment Report 2009	Earth Observation for Sustainable Development Classification	Figure 9.5.20

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To complete the land cover disturbance analysis, GIS shapefiles were created to estimate the layout and extent of all components of the Project (i.e., transmission line, winter roads, staging areas, barge landing sites, and improvements to the facilities at Twin Gorges and Nonacho Lake). The location and geographic extent of these components were determined using the most recent engineering plans where available, and estimated if no engineering plans were available. The transmission line right of way (ROW) was 30 m wide, winter haul roads were 15 m wide, temporary access trails were 5 m wide, and each laydown area was estimated at 5 ha. Where uncertainty existed in the geographic extent of the Project components, the maximum expected extent was used. For example, transmission line ROW clearing is estimated to range between 15 m and 30 m wide, while laydown areas are expected to range between 2 and 5 ha. These Project components were overlaid with the EOSD land cover classification and the resulting land cover disturbance for each Project component by land cover class was estimated.

The EOSD land cover classification indicates that 21 land cover classes (including biotic and abiotic classes) are present within 5 km of the Project (Table 9.5.14), encompassing an area of 1,003,443 ha. The area of each landscape class in each Ecozone (i.e., both north and south of the treeline) is also presented. In the Southern Arctic Ecozone (i.e., north of the treeline), water represents approximately 31% of the area, while bryoids and low shrubs together represent approximately 37% of the terrestrial classes. In the Taiga Shield Ecozone (i.e., south of the treeline), water is less dominant (23%), and terrestrial classes are dominated by exposed land (13%) and all coniferous forest classes (43% combined). Definitions for each EOSD class are provided in Table 9.5.14.

Table 9.5.14 — EOSD Classes within 5 km of the Taltson Project

Land Cover Classes[1]	Total Area (ha) [2]	Total Area (%)	North of Treeline Area (ha)[2]	North of Treeline Area (%)	South of Treeline Area (ha) [2]	South of Treeline Area (%)
No data	1	0.0%	0	0.0%	1	0.0%
Shadow	1,049	0.1%	7	0.0%	1,042	0.2%
Water	266,193	26.5%	133,064	31.3%	133,129	23.0%
Snow/Ice	201	0.0%	76	0.0%	125	0.0%
Rock/Rubble	28,026	2.8%	24,926	5.9%	3,100	0.5%
Exposed Land	87,486	8.7%	10,987	2.6%	76,498	13.2%
Bryoids	67,230	6.7%	66,802	15.7%	428	0.1%
Shrub Tall	17,795	1.8%		0.0%	17,795	3.1%
Shrub Low	125,062	12.5%	88,982	21.0%	36,080	6.2%
Wetland-Treed	23,874	2.4%	5,400	1.3%	18,474	3.2%
Wetland-Shrub	8,699	0.9%	5,953	1.4%	2,746	0.5%
Wetland-Herb	25,237	2.5%	14,594	3.4%	10,643	1.8%
Herb	5,462	0.5%	2,360	0.6%	3,102	0.5%

Land Cover Classes[1]	Total Area (ha) [2]	Total Area (%)	North of Treeline Area (ha)[2]	North of Treeline Area (%)	South of Treeline Area (ha) [2]	South of Treeline Area (%)
Coniferous Dense	70,984	7.1%	3,433	0.8%	67,551	11.7%
Coniferous Open	162,421	16.2%	21,596	5.1%	140,825	24.3%
Coniferous Sparse	74,284	7.4%	30,714	7.2%	43,570	7.5%
Broadleaf Dense	1,888	0.2%	351	0.1%	1,537	0.3%
Broadleaf Open	3,766	0.4%	2,112	0.5%	1,654	0.3%
Broadleaf Sparse	1,300	0.1%	916	0.2%	384	0.1%
Mixedwood Dense	9,006	0.9%	417	0.1%	8,589	1.5%
Mixedwood Open	22,617	2.3%	11,798	2.8%	10,819	1.9%
Mixedwood Sparse	862	0.1%	34	0.0%	828	0.1%
Total	1,003,443	100.00%	424,520	100.00%	578,922	100.00%

[1] Land cover classes were assessed within 5 km of the Project area.

[2] ha = hectare

9.5.7 Vulnerable Species

9.5.7.1 Determining Species at Risk for the Taltson Project

The Terms of Reference (TOR) (Mackenzie Valley Environmental Impact Review Board [MVEIRB] 2008a) requires discussion and assessment of vulnerable species (hereafter referred to as Species at Risk) within the Taltson Hydroelectric Expansion Project (the Project) area. Species at Risk are defined as those listed in the following documents:

- Any species listed in the *2006 to 2010 General Status Ranks of Wild Species in the Northwest Territories Report* (General Status Ranks in NWT) (Working Group on General Status of NWT Species 2006).
- Any species listed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC 2008).
- Any species listed in the *Species at Risk Act* (SARA 2008).

The General Status Ranks in NWT currently lists 202 species that May be at Risk, At Risk or Sensitive that occur within the Project area in the Taiga Shield and Southern Arctic Ecozones, Table 9.5.15). Although the importance of protecting species at risk is recognized, this list of species was too large to be able to provide a reasonable level of detail for each species.

Table 9.5.15 — Species Listed under the General Status Ranks for the Northwest Territories in the Southern Arctic and Taiga Shield Ecozones

Species Group	No. of Species At Risk	No. of Species that may be At Risk	No. of Species that are Sensitive	Total
Amphibian			1	1
Bird	1	5	38	44
Butterfly			5	5
Fish			5	5
Plant		48	92	140
Terrestrial Mammal	1		6	7
Grand Total	2	53	147	202

Source: Working Group on General Status of NWT Species (2006)

The MVEIRB has prepared draft guidelines outlining its expectations for effects assessment to species at risk (MVEIRB 2008b). The guidelines were produced with substantial input from Environment Canada and the GNWT Department of Environment and Natural Resources. These guidelines (MVEIRB 2008b) recommended that species at risk include:

- species listed as At Risk in the General Status Ranks in NWT (Working Group on General Status of NWT Species 2006);
- species listed as Endangered, Extirpated, Threatened, or of Special Concern under COSEWIC (2008); and
- species listed as Endangered, Threatened, or of Special Concern under Schedule 1 of SARA (2008).

Although not required by the MVEIRB species at risk guidelines, species listed as May Be at Risk under the Northwest Territories General Status Ranks were also included in the assessment.

These guidelines provided a better indication of the species that are truly at risk of extirpation or extinction in the NWT, and which could be adequately addressed within an environmental assessment. As such, these criteria were adopted over those described in the TOR. Using these guidelines, the following sections outline the plant, wildlife, and aquatic species at risk within the vicinity of the Project.

9.5.7.2 Rare Plants

There are currently no COSEWIC (2008) or SARA (2008) listed vascular plants, lichens or mosses in the NWT. Further, there were no vascular plant species considered At Risk in the General Status Ranks in NWT (Working Group on General Status of NWT Species 2006). However, there are plants that are considered to be rare, either because of limited habitat or because of limited information. Therefore, the list of plant species at risk was expanded to include the 48 vascular plant species that have been ranked as May Be at Risk in the General Status Ranks for NWT (Table 9.5.16 - Working Group on General Status of NWT Species 2006). Of these

48 species, 43 species may potentially occur within the Project area; five species were excluded on the basis that they are found only in salt plains associated with coastal regions. Of these 43 species, 24 species could potentially occur within the Taiga Shield Ecozone and 20 species within the Southern Arctic Ecozone. One species, the northern mudwort (*Limosella aquatica*), may be found in both ecozones.

Within the General Status Ranks of NWT (Working Group on General Status of NWT Species 2006), status ranks for plants in the NWT have been only assessed for vascular species. While there are hundreds of bryophytes and lichens known to occur in the NWT, information on their abundance and distribution is limited, making the task of assessing rarity for these non-vascular species difficult. Thus, rare plant potential within the study area was evaluated based only on the rankings of vascular plant species.

Table 9.5.16 — Rare Plant Species Potentially Occurring in the Taiga Shield and Southern Arctic Ecozones

Common Name	Scientific Name	Habitat Information	SPECIES PRESENCE	
			Taiga Shield	Southern Arctic
Several Vein Sweetflag	*Acorus americanus (Acorus calamus)*	Wetlands	Yes	No
Saltwater Cress	*Arabidopsis salsuginea (Thellungiella salsuginea)*	Salt plains and sandy beaches	No	Yes
Gmelin's Orache	*Atriplex gmelinii*	Gravelly beaches in river estuaries	No	Yes
Mingan's Moonwort	*Botrychium minganense*	Grassy meadows	No	Yes
Hairy Rockcress (Pilose Braya)	*Braya pilosa*	Sandy seashores; found only on Bathurst Cape (unglaciated area in last Glaciation)	No	Yes
Small-Flower Bitter Cress	*Cardamine parviflora*	Sandy, open places or rocky ledges	Yes	No
Northern Clustered Sedge	*Carex arcta*	Wet woodland bogs, marshes and sandy beaches	Yes	No
Mackenzie Sedge	*Carex mackenziei (Carex norvegica)*	Brackish marshes	No	Yes
Few-Seeded Sedge	*Carex oligosperma*	Wet, sandy lake shores	Yes	No
Three-seed Sedge	*Carex trisperma*	Bog	Yes	No
Red Pigweed	*Chenopodium rubrum*	Salt plains and disturbed soils	Yes	No
Leafy Thistle	*Cirsium foliosum*	Sedge and grass meadow	Yes	No
Swedish Dwarf Dogwood	*Cornus suecica*	Wet mossy areas	Yes	No
Water Pigmy-weed	*Crassula aquatica*	Shallow ponds	Yes	No
Slender Rock-brake	*Cryptogramma stelleri*	Moist shale slopes	No	Yes

Common Name	Scientific Name	Habitat Information	SPECIES PRESENCE	
			Taiga Shield	Southern Arctic
Pinnate Tansy-Mustard	*Descurainia pinnata*	Sandy beaches and disturbed areas	Yes	No
Yellowstone Whitlow-Grass	*Draba incerta*	Alpine tundra and rocky slopes	No	Yes
Spinulose Wood Fern	*Dryopteris carthusiana*	Rich woods	Yes	No
Horenmann Willow Herb	*Epilobium hornemannii*	Wet alpine tundra	Yes	No
Yukon Fleabane	*Erigeron yukonensis*	Calcareous, stony slopes	No	Yes
Pygmy Aster	*Eurybia pygmaea (Lindl.) Nesom. (Aster pygmaeus Lindl.; Aster sibiricus var. pygmaeus (Lindl.) Cody)*	Gravelly places	No	Yes
Dane's Gentian	*Gentianella tenella*	Sandy beaches and gravelly mud flats	No	Yes
Prairie-Smoke	*Geum triflorum*	Dry prairie and grassland spp - typical alvar species	Yes	No
Sea Milkwort	*Glaux maritima*	Saline sloughs	Yes	No
Western Stickseed	*Hackelia deflexa*	Thickets, woods, clearings and banks	Yes	No
Moss Heather	*Harrimanella hypnoides (Cassiope hypnoides)*	Sheltered, rocky places in arctic /alpine areas	No	Yes
Richardson Alumroot	*Heuchera richardsonii*	Woodland meadows	Yes	No
Beach Pea	*Lathyrus japonicus*	Sheltered beaches and river banks	No	Yes
Northern Mudwort	*Limosella aquatica*	Wet, muddy or sandy pond margins	Yes	Yes
Water Lobelia	*Lobelia dortmanna*	Shallow, sandy shores of lakes and ponds	Yes	No
White Adder's Mouth	*Malaxis monophyllos*	Damp calcareous fens	Yes	No
Drummond Bluebell	*Mertensia drummondii*	Sandy and gravelly ridges and sand banks	No	Yes
Alternate-Flower Water Milfoil	*Myriophyllum alterniflorum*	Shallow lakes and ponds	No	Yes
Yellow Owl's Clover	*Orthocarpus luteus*	Sandy riverbanks and lakeshores	Yes	No
Muskeg Lousewort	*Pedicularis macrodonta*	Bogs and marshes, fens	No	Yes
Seaside Plantain	*Plantago maritima (Plantago juncoides)*	Cliffs and sea-beaches or inland saline springs	No	Yes
Bristly Crowfoot	*Ranunculus pensylvanicus*	Disturbed and marshy places	Yes	No
Persistent-Sepal Yellow-Cress	*Rorippa calycina*	Low deltas	No	Yes
Oval-leaved Willow	*Salix ovalifolia*	Sand beaches and terraces	No	Yes

Common Name	Scientific Name	Habitat Information	SPECIES PRESENCE	
			Taiga Shield	Southern Arctic
Wedgeleaf Willow	*Salix sphenophylla*	Moist tundra	No	Yes
White Mountain Saxifrage	*Saxifraga paniculata (Saxifraga aizoon)*	Rocky ledges	Yes	No
Velvetleaf Blueberry	*Vaccinium myrtilloides*	In dry or acid soil	Yes	No
Purslane Speedwell	*Veronica peregrina*	Moist places of settled areas	Yes	No

The 43 selected rare plants represent a wide diversity of plant species. Included in the list are grasses, sedges, ferns, herbs, forbs and shrubs. Most of these plant species are low-lying plants. The exceptions to this are the only three shrubs listed: oval-leaved willow (*Salix ovalifolia*), wedgeleaf willow (*Salix sphenophylla*), and velvetleaf blueberry (*Vaccinium myrtilloides*).

9.5.7.3 WILDLIFE SPECIES AT RISK

A number of wildlife species were excluded from this analysis as a result of Project-specific field surveys and Traditional Knowledge studies, as well as communications with NWT Environment and Natural Resources (ENR) and Environment Canada (EC). The wildlife species excluded included the following:

- woodland caribou (*Rangifer tarandus caribou*) – woodland caribou are unlikely to be found in the Project area (ENR 2008a);
- wood bison (*Bison bison athabascae*) – the Slave River Lowlands wood bison population may be found near the Project (ENR 2008a), but is rarely found within the Taiga Shield Ecozone;
- yellow rail (*Coturnicops noveboracensis*) – was not detected during baseline field studies on the Taltson River conducted in 2008;
- red knot (*Calidris canutus*) – the range of the red knot does not overlap with the Project (Harrington 2001); and
- Eskimo curlew (*Numenius borealis*) – was not included as a species at risk as there have been no sightings in recent decades (EC 2007).

The final list of wildlife Species at Risk for the Project included nine species: two mammals, one amphibian, and six bird species (Table 9.5.17). All nine species are considered to be Endangered, Threatened, or of Special Concern under COSEWIC (2008), and two species (the whooping crane and short-eared owl) are included under the schedules of SARA. Under the General Status Ranks for NWT, only the whooping crane is considered At Risk (Working Group on General Status of NWT Species 2006). The remaining eight species included in Table 9.5.17 are considered Secure or Sensitive in the NWT indicating that the risk of extirpation for NWT populations of the species is less than populations elsewhere in Canada. For example, the common nighthawk (*Chordeiles minor*) is listed as Threatened under COSWEIC (2008), but is listed as Secure according to the General Status Ranks for NWT (Working Group on General Status of NWT Species 2006) (Table 9.5.17). This is likely due to differences in the scales of assessment; COSEWIC must consider the national status of a species; whereas the General Status Ranks considers populations only in the context of the largely undisturbed NWT.

Table 9.5.17 — Wildlife Species at Risk in the Taltson Project Area

Common Name	Scientific Name	COSEWIC Status[1]	SARA Status[2,4]	GNWT Status[3]	Rationale
Grizzly bear	*Ursus arctos*	Special Concern	—	Sensitive	Habitat fragmentation; sensitivity to human-caused mortality
Wolverine	*Gulo gulo*	Special Concern	—	Sensitive	Habitat fragmentation, increased harvester access
Northern leopard frog	*Rana pipiens*	Special Concern	Schedule 1	Sensitive	Limited distribution in NWT, contraction of range nationwide
Peregrine falcon	*Falco peregrinus anatum/tundrius*	Special Concern	—	Sensitive	Small population
Whooping crane	*Grus americana*	Endangered	Schedule 1	At Risk	Small population; restricted distribution
Rusty blackbird	*Euphagus carolinus*	Special Concern	—	May Be At Risk	Population declines
Short-eared owl	*Asio flammeus*	Special Concern	Schedule 3	Sensitive	Small, declining population
Common nighthawk	*Chordeiles minor*	Threatened	—	Secure	Long-term population declines
Olive-sided flycatcher	*Contopus cooperi*	Threatened	—	Sensitive	Long-term population declines

[1] Source: COSEWIC July 2008
[2] Source: SARA 2008
[3] Working Group on General Status of NWT Species 2006
[4] "-" indicates species not listed under SARA.

9.5.7.3.1 Grizzly Bear

Barren-ground grizzly bears are listed as Sensitive under the General Risk Ranks in NWT (Working Group on General Status of NWT Species 2006), and as a species of Special Concern by COSEWIC (2008).

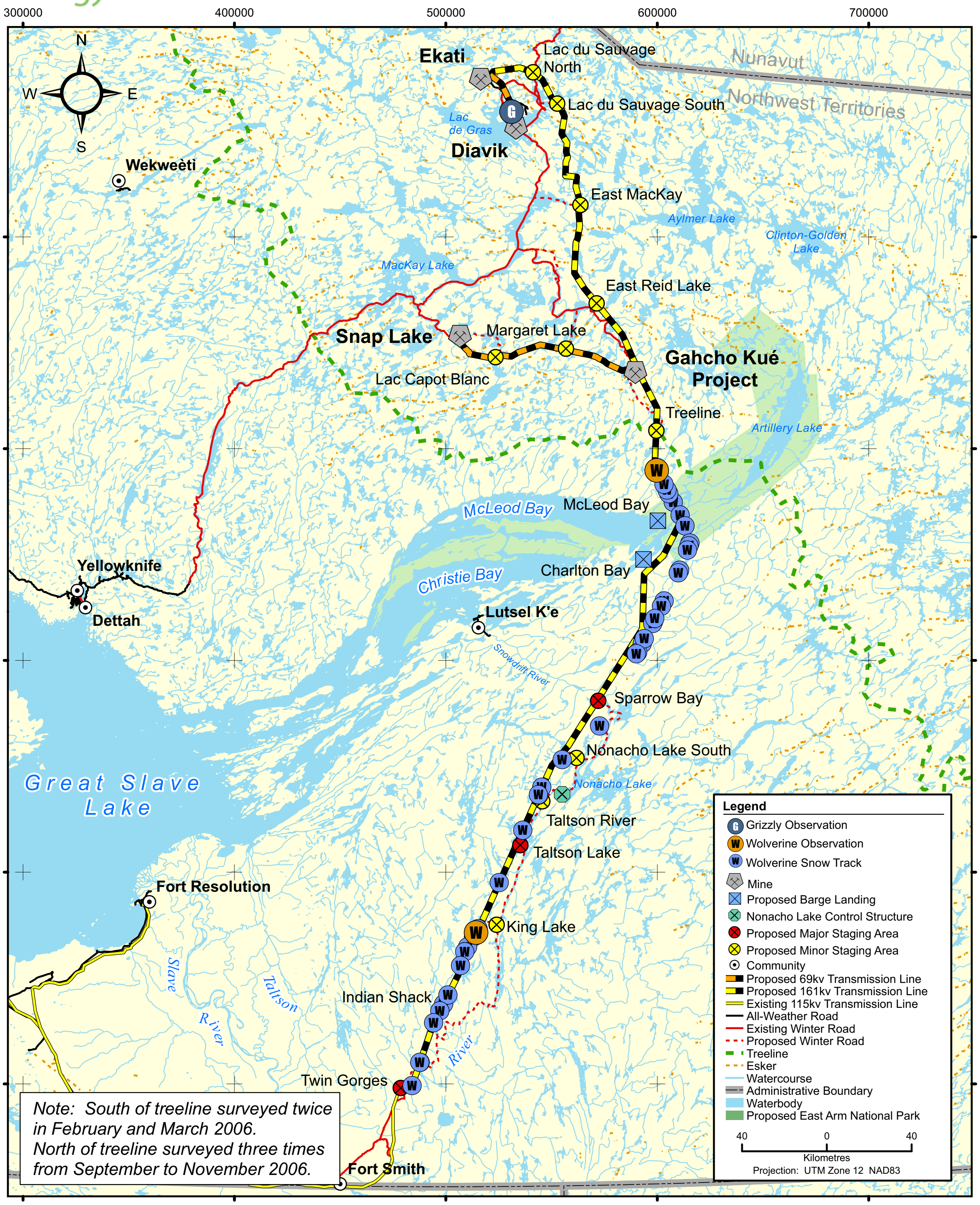
9.5.7.3.1.1 Habitat Use and Distribution

Within the NWT, grizzly bears are divided into four distinct populations based on the ecosystems they inhabit (ENR 2008a): the Arctic coastal, Arctic mountain, northern interior and barren-ground populations. Of the four populations, only the barren-ground grizzly bear, which occurs within the Slave Geological Province spanning the NWT and Nunavut and the eastern Keewatin, is found within the Project study area. Barren-ground grizzly bears prefer open or semi-forested areas. While they are most common on the tundra, sightings in the boreal forest are not unusual (ENR 2008a). Barren-ground grizzly bears are residents throughout the year although they are active only in the spring through fall; denning season is from approximately October through to April (ENR 2008a).

Monitoring studies completed at mine sites have indicated that grizzly bears are present and active in areas surrounding each mine, and observations of grizzly bears and fresh grizzly bear sign are made annually at each mine site. At the Ekati, Diavik, and Snap Lake Mines, monitoring data show significant annual variation in the relative activity of grizzly bears within the study areas (Golder 2008a, 2008b; BHPB 2004, 2007). In the Snap Lake Mine study area, there were 13 incidental observations of barren-ground grizzly bears between 1999 and 2006 (Golder 2008a). Environment personnel at the Diavik Diamond Mine recorded 33 individual bears on 21 separate occasions in 2006 (DDMI 2007). Incidental observations of barren-ground grizzly bears near the Ekati Diamond Mine ranged from 36 in 2001 to 76 in 2005 (BHPB 2007). In addition, the probability of occurrence of grizzly bear sign was significantly related to distance from a project; there was more bear sign farther from the Project (Golder 2008a; BHPB 2007). Monitoring at Snap Lake indicated that fresh bear sign was significantly lower during the construction phase than the baseline phase of the mine in both habitat types (Golder 2008a), indicating that the grizzly bears may have been avoiding human activity.

Observations of grizzly bear and grizzly bear sign along the above-treeline sections of the transmission line were recorded during aerial wildlife surveys conducted in August, September and October 2006. Aerial surveys were conducted by helicopter, from an approximate altitude 120 m above ground level and at speeds of 80 to 120 km/h, and followed the alignment of the transmission line route as closely as possible. Flying speed was varied to obtain the best possible observations, and to account for daylight and fuel limitations (i.e., slower speed over closed forests, increased speed over unforested areas). The location and nature of all ungulates, carnivores, and their sign were recorded. When an observation was made, a GPS coordinate was recorded and the species, dominant behaviour, dominant land cover type and group size were noted, where possible. Habitat types were classified as bedrock, open pine forest, closed pine forest, open spruce forest, open mixedwood forest, lake ice, or heath tundra. More detailed classifications of habitat type were limited because of snow cover. Field crews were in continuous communication to avoid recording the same observation twice. The only observation of grizzly bear or grizzly bear sign was a sow and cub observed near Diavik on October 2, 2006 (Figure 9.5.21).

The presence of bear sign within and adjacent to seasonal high-quality (i.e., preferred) habitats has been used as an index of relative activity of grizzly bears within study areas for several projects in the NWT and Nunavut (e.g., BHPB 2007; DDMI 2007; De Beers 2007; Miramar 2007; Tahera 2007; Golder 2008b). Information obtained from these projects was used to assess the existing grizzly bear habitat and their potential presence within the Project area. Results from these studies indicate that grizzly bears are present within the study areas of each of these developments. For example, at Ekati, between 33% and 66% of sedge wetland plots and between 27% and 83% of riparian shrub plots contained fresh grizzly bear sign when surveyed between 2000 and 2006 (BHPB 2007). The evidence to date suggests avoidance of the mines by grizzly bears, but this effect is not definitive, and in some cases the data indicate attraction to the mine (BHPB 2007; Golder 2008a).



TALTSON Hydroelectric Expansion Project	Developer's Assessment Report 2009	Wolverine and Grizzly Bear Observations and Snow Tracks, 2006	Figure 9.5.21

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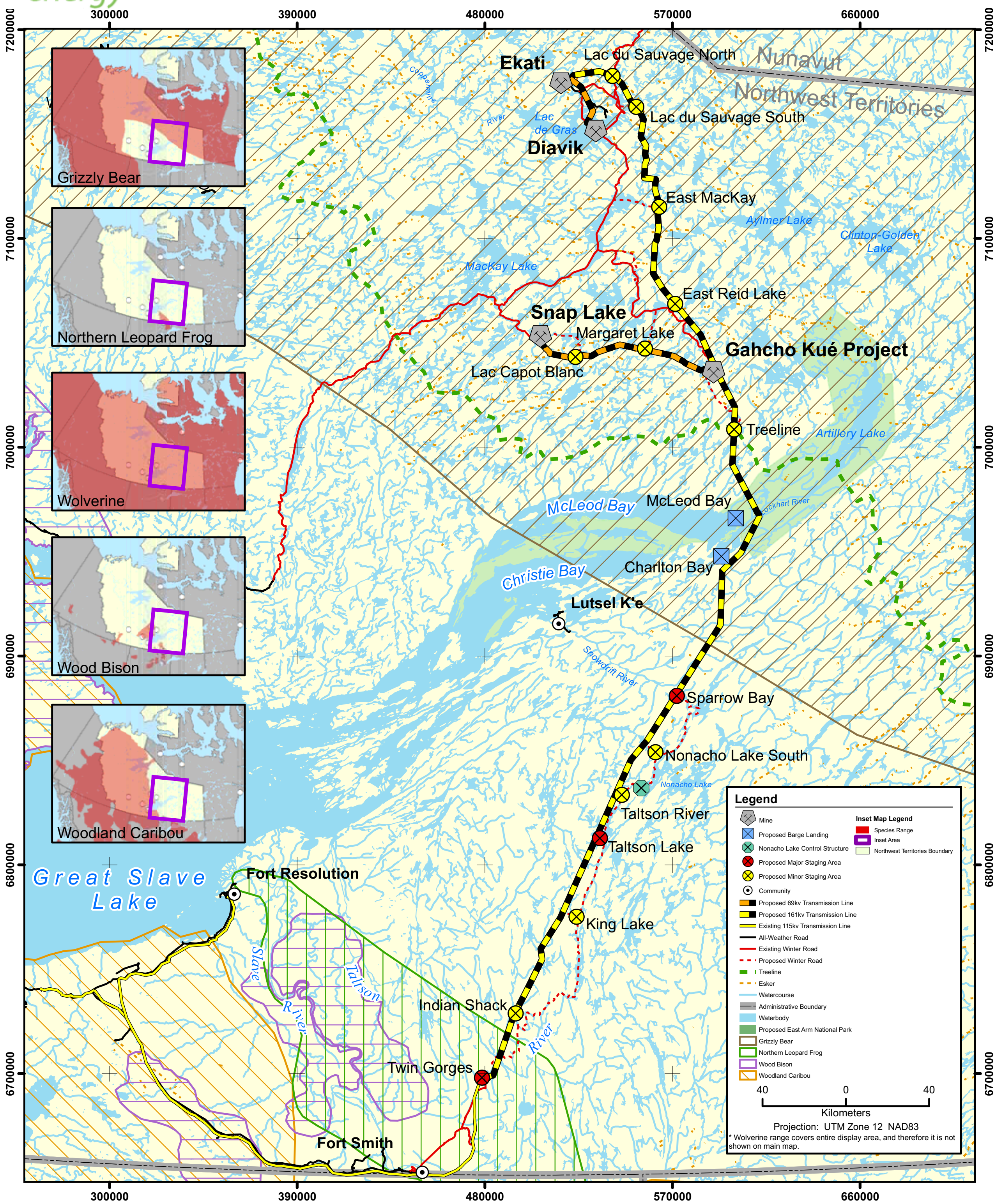
9.5.7.3.1.2 Population Characteristics

Barren-ground grizzly bears have the largest home ranges and, likely, the lowest population density of brown bears studied in North America (McLoughlin et al. 1999) (Figure 9.5.22). The population of barren-ground grizzly bears was estimated at 800 ± 200 (standard error [SE]) individuals within an approximate area of 235,000 km^2, which is roughly the area of the Slave Geological Province (McLoughlin et al. 2003).

In the Slave Geological Province, McLoughlin et al. (2002) found the mean annual range of adult male grizzly bears was 7,245 km^2 and the mean annual range of females was 2,000 km^2. The larger home range size for males is likely due to higher energy requirements and wandering to search for females for mating (McLoughlin et al. 2003). No differences in annual or seasonal range size were observed for females with or without cubs (McLoughlin et al. 2003).

Currently, the grizzly bear population in the Slave Geological Province appears stable, but increased human activity, along with natural factors, may place the population at risk of decline (McLoughlin et al. 2003). Low production rates, extreme environmental conditions, and low forage productivity may increase the risk of decline for barren-ground grizzly bear populations. However, factors other than adaptation to natural conditions (e.g., harvest biased towards male bears) appear to govern the life history of central Arctic populations. Increased losses associated with illegal hunting or the killing of nuisance bears may also place the population at risk of decline (McLoughlin et al. 2003). There have been four grizzly bears destroyed at the Ekati and Diavik mines between 1996 and 2007 (Section 15.4), while McLoughlin and Messier (2001) report 112 problem grizzly bears destroyed within the SGP between 1958 and 2000.



TALTSON Hydroelectric Expansion Project	Developer's Assessment Report 2009	Amphibian and Mammal Species at Risk Ranges	Figure 9.5.22

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9.5.7.3.1.3 *Issues Affecting Abundance and Distribution*

As harvesting of barren-ground grizzly bear in the Northwest Territories is limited to aboriginal subsistence hunts (which records indicate are rare, ITI 2007), threats to grizzly bear in the NWT are predominantly associated with increasing industrial development. This may have two effects to grizzly bears, increased mortality due to bear-human conflicts and habitat degradation (ENR 2008b). When disturbed by roads, camps, low-level aircraft activity, or industrial operations, bears may be forced into lower quality habitat (ENR 2008a).

9.5.7.3.1.4 *Human Use*

In the NWT, barren-ground grizzly bears are classified as big game species and a furbearer (ENR 2008a). Although there are quotas for other grizzly bear populations (e.g., Mackenzie Mountains), there is no quota for barren-ground grizzly bears in the NWT. Aboriginal hunters may harvest grizzly bear for subsistence, but records of furs or hides submitted to ENR indicate only a single grizzly bear was harvested in the North Slave region in the two years between 2005 and 2007 (ITI 2007). As the hide was submitted in Yellowknife, it is likely that this was a barren-ground grizzly bear from the SGP population. No grizzly bear hides were submitted to ENR in the South Slave region over this time.

In Nunavut, there is a quota of nine barren-ground grizzly bear per year from the SGP population, used for sport or commercial hunts, of which most is used (G. Atatahak, pers. comm. 2008). Inuit may also harvest further barren-ground grizzly bears if it is for subsistence purposes (G. Atatahak, pers. comm. 2008).

Combining the NWT and Nunavut harvest of barren-ground grizzly bear between 1958 and 2000, a total of 265 barren-ground grizzly bears have been harvested in NWT and Nunavut, or an average of approximately 6 animals per year (McLoughlin and Messier 2001). Of these, 112 were problem bears, 47 were sport hunts, 2 were illegal harvests, one was a subsistence harvest, and the remaining 48 cases were not classified. As there is no quota for grizzly bear in the NWT, and as only a single grizzly bear hide was submitted to ENR between 2005 and 2007, it appears that this species is not considered important for traditional or non-traditional use in the Project area.

9.5.7.3.2 Wolverine

Wolverines are listed as a species of Special Concern under COSEWIC (2008) and Sensitive under the General Status Ranks in NWT (Working Group on General Status of NWT Species 2006). This species currently has no status under SARA (2008).

9.5.7.3.2.1 *Habitat Use and Distribution*

Wolverine, the largest member of the weasel family, can be found in the tundra, taiga, plains, and boreal forests of North America (Weir 2004), Figure 9.5.22. Wolverine are also resident and active in the Project area throughout the year, in both the boreal and tundra regions. Wolverine tracks were observed during the aerial surveys completed in February and March 2006 and were most prevalent near McLeod Bay and the Lockhart River (Figure 9.5.21). Sightings of three wolverines were also documented during the February survey. No wolverine sign was noted during the above-treeline surveys conducted in 2006.

Habitat use typically depends on the availability of food resources and den sites. In tundra and boreal habitats, the availability and quality of natal den sites is not likely a limiting factor. Wolverine dens can vary from simple resting sites to complex natal dens with extensive tunnel networks that are frequently associated with rocky outcrops and deep snowdrifts (Lee and Niptanaitiak 1996; Landa et al. 1998; Magoun and Copeland 1998). Preferred landscape features in tundra environments appear to depend less on vegetation characteristics, and more on the structure of the terrain and availability of secure hiding cover for dens and food caching (Magoun and Copeland 1998; Landa et al. 1998; Lee and Niptanatiak 1996). Krebs et al. (2007) found that when food availability, predation risk, and human activity were used to predict habitat use by wolverines, males appeared to be primarily food-driven, while female habitat use was associated with a combination of all three factors. Specific to barren-ground wolverine in the SGP, diet consists primarily of caribou, with lesser amounts of muskox, Arctic ground squirrel, Arctic hare, fox, moose, ptarmigan, fish and seal (Mulders 2000). Dispersal distances are large, with a mean of 133 km for females and 231 km for males (Mulders 2000), although these averages are based on just eight individuals of both sexes.

There are numerous annual observations of wolverine at each of the existing mines. At the Ekati Diamond Mine, there were 23 incidental observations of wolverine reported in 2006, which decreased from 128 observations in 2005 (BHPB 2007). Results from the Snap Lake Mine track count surveys indicated that the proportion of transects with wolverine tracks was significantly lower during the construction phase of the Project than during baseline studies (Golder 2008a). In contrast to other studies which have documented avoidance of human activity by wolverine (e.g., Krebs et al. 2007), the probability of wolverine track occurrence was greatest within 7.2 km of the Snap Lake Mine, indicating attraction (Golder 2008a).

Observations of wolverine and wolverine sign along the proposed transmission line were recorded during aerial wildlife surveys completed in 2006, as described in Sub-Section 9.5.7.3.1. Observations of wolverine snow-tracks were only made during the winter surveys, which were conducted south of the treeline only (corresponding with caribou seasonal ranges). During these surveys, 3 wolverines, one solitary animal and one pair, were observed, and wolverine snow-tracks were found throughout the area surveyed in the winter of 2006. Aerial surveys of the tundra regions were conducted prior to snowfall or when little snow was present, and so wolverine snow-tracks could not be recorded. No wolverines were observed during the aerial surveys of the tundra region.

Wolverine track count surveys have been conducted annually at the Snap Lake Mine, Diavik Diamond Mine, Ekati Diamond Mine, and Jericho Diamond Mine. Although survey methods have varied, they generally involved surveying up to fifty 4 km transects, placed randomly in habitat preferred by barren-ground wolverine (i.e., shorelines and rocky areas, according to Traditional Knowledge). During these surveys, all wolverine tracks were recorded, as well as recent weather and snow conditions. The snow-track studies at Snap Lake offer the most consistent data set. This monitoring has indicated that the likelihood of encountering wolverine sign is related to distance from the Snap Lake mine. More wolverine sign was found closer to the mine with the probability of finding wolverine sign was greatest within 7.2 km (Golder 2008a). Further, the data indicated that between 2003 and 2007 when the mine entered the construction phase, overall wolverine activity in the Snap Lake study area has decreased. There have been no direct wolverine mortalities at the Snap Lake mine, but there are two outfitting camps in the study area which may harvest wolverine in the autumn (Golder 2008a).

To estimate the annual changes in abundance of wolverines within a study area, ENR has developed and implemented a successful program for estimating the abundance, density, and demographic parameters of wolverine at several mining projects in the NWT (Mulders et al. 2007) . The study design uses 284 baited posts, arranged in a 3 km by 3 km sampling grid, to capture wolverine hair, which are then analyzed using deoxyribonucleic acid (DNA) fingerprinting techniques. These studies identified 29 males and 24 females within a study area of 2,556 km^2. The results suggested a high degree of attraction to the posts by wolverine, with a capture probability of less than 0.5 for both sexes (Mulders et al. 2007). The method has been incorporated into the wildlife effects monitoring programs for the Ekati Diamond Mine and the Diavik Diamond Mine in the NWT, and the Jericho Diamond Mine and Doris North Projects in Nunavut. Results of these monitoring programs are not available to date.

9.5.7.3.2.2 Population Characteristics

Wolverine populations in the boreal forest and tundra are genetically independent and can be considered separate populations (Chappell et al. 2004; Wilson et al., 2000). Gene flow between populations does occur because males and females do make periodic long-distance movements (Mulders 2000; Gardner et al. 1986). However, most of the gene flow in the NWT is accomplished by males, with females contributing minimal gene flow between sites (Chappell et al. 2004; Wilson et al. 2000). Based on these conclusions, the tundra population and a boreal forest population are likely two separate populations of wolverines within the Project area.

Home range size is inversely related to the availability of food resources, and will fluctuate with season, year, habitat type, age and sex (Banci 1987). Satellite-collar wolverine studies on the central Canadian Arctic barrens estimated that adult female wolverines had a home range of 126 km^2, while the home range of adult males was 404 km^2 (Mulders 2000). In an Ontario boreal population, ranges were larger than reported for wolverine in other habitats. Average home ranges for males and females were 1,450 km^2 and 525 km^2, respectively (Magoun et al. 2005). In Alaska, annual home ranges for males range from 488 to 917 km^2, and average 666 km^2 (Peterson 1997). In central Idaho, adult males had an average home range size of 1,525 km^2 (Copeland 1996 in Weaver et al. 1996). Information on the boreal forest population in the southern NWT is limited; however, it is assumed that home ranges fall within the range sizes outlined above. In general, boreal forest populations generally exhibit low densities and wolverines occur primarily where there are large ungulate populations.

9.5.7.3.2.3 Issues Affecting Abundance and Distribution

Wolverine harvesting is permitted in the Northwest Territories and Nunavut, by resident, sport and aboriginal hunters alike. Resident and sport hunters may only harvest wolverine in accordance with the number of tags held, but this is typically limited to one per season. The harvest is managed through the use of hunting seasons. Human development is also a source of mortality for wolverine, and there have been eight such mortalities among the four operating diamond mines in the SGP between 1996 and 2007 (Section 15.4). Habitat loss and changes in habitat quality due to development have also been cited as threats to this species in the Northwest Territories (ENR 2008b).

9.5.7.3.2.4 *Human Use*

Wolverines are an important cultural and economic resource for people of the NWT. Wolverines were harvested primarily for their fur, although historically, they were sometimes killed as an emergency food source. Harvesting of wolverine may be conducted by resident or sport hunters with a tag (ENR 2008a) or by trappers. Reporting of the harvest is not mandatory, but is recorded through fur returns, questionnaires, and export permits. However, harvest levels within the Taltson region are difficult to determine as harvest locations are not recorded. Fur return records between 1990 and 2007 indicated that the number of wolverine harvested by trappers in the Fort Smith area ranged from 4 to 10 animals in the two winters between 2005 and 2007, and 19 wolverine in each of these winters by Yellowknife trappers. Some of these may have been harvested from populations which overlap the Taltson Project. The total value of this harvest has not exceeded $5,000 in any one year for either Yellowknife or Fort Smith. According to the Tibbitt Lake to Contwoyto Winter Road Monitoring Station Report (Ziemann 2007), wolverine harvest on the Tibbitt to Contwoyto winter road has ranged from zero to two between 2004 and 2006. Again, some of these wolverines may have been harvested from populations which overlap the Taltson Project, as the Tibbitt to Contwoyto winter road extends into the Taltson region.

Estimates of the wolverine harvest from resident hunters has ranged from two to eight individuals (for a total of 16) between 2002 and 2006, all of which were harvested by Yellowknife hunters (ENR 2006). No wolverines were reported harvested by resident hunters in any of the other North Slave or South Slave communities during that time (ENR 2006). Exact harvest locations are unknown.

Many wolverines are harvested in Nunavut including in the SGP region. A program to purchase carcasses from hunters has been a successful monitoring tool (Mulders 2000). From 1996 through 2001, 276 wolverines were harvested in the northern SGP (BHPB 2003). Many of these wolverines were harvested on the southern coastline of the Coronation Gulf and Bathurst Inlet, but some were harvested as far south as Contwoyto Lake, including some from populations which overlap with the Project. Considering the harvest within and beyond the SGP, but still limited to barren-ground wolverine, 473 wolverines have been harvested between 1995 and 1999 (Mulders 2000). Most (78%) were shot; the remainder were trapped.

Wolverines are occasionally attracted to human developments, in which case they may become problem wildlife. Between 1996 and 2007, there were eight wolverines harvested or found dead between the four operating mines in the SGP (Ekati, Diavik, Snap Lake and Jericho, Section 15.4). Diligent waste management practices are the most effective means of reducing these mortalities.

9.5.7.3.3 Northern Leopard Frog

The northern leopard frog is considered a species of special concern by COSEWIC (2008), and is ranked under Schedule 1 of SARA (2008). Within the NWT, the northern leopard frog is a Sensitive species (Working Group on General Status of NWT Species 2006).

9.5.7.3.3.1 Habitat Use and Distribution

The northern leopard frog is found through most of central and north-eastern North America (Seburn and Seburn 1998). Although the range of the northern leopard frog is limited in the NWT, it has been documented in the Taltson River Basin (Fournier 1997; GNWT 2008). The Taltson River Basin is at the very northern edge of the species' range (see Figure 9.5.22). Wildlife populations at the edge of their ranges are particularly important, due to potential genetic differences and adaptations, compared to populations within the centre of their range (Lesica and Allendorf 1995).

Northern leopard frogs require three kinds of distinct habitats: wetlands for spring breeding, terrestrial summer foraging habitat, and overwintering ponds that do not freeze solid and that are well oxygenated (Seburn and Seburn 1998). This species breeds in a variety of wetland types including ponds, quiet backwaters of streams, roadside ditches, borrow pits, channels, and permanently flooded meadows. Breeding occurs from mid to late spring and egg masses are attached to submerged vegetation (CARCNET, 2008). Breeding success is better in ponds not connected to other water bodies, which prevents the establishment of significant fish populations that prey on leopard frog eggs or larvae (Seburn and Seburn 1998). Although summer foraging habitat is typically terrestrial, northern leopard frogs stay close to water as an escape from predators (Kendell 2002). Heavily forested or open areas with little cover or dry conditions are not typically used. Northern leopard frogs will use areas far from major water bodies provided that they have sufficient moisture and protective vegetation. Mortality of northern leopard frogs during the winter due to insufficient oxygen levels, freezing, disease, and toxic exposures has been reported. The northern leopard frog is the only frog in NWT that overwinters under water (Seburn and Seburn 1998).

Visual encounter surveys were used to document the presence of the northern leopard frogs in the Taltson River basin (Zone 1, 3, and 5) during July 2008 (Figure 9.5.24 and Appendix 13.10A). Twenty-nine sites were surveyed for the species, which has been observed at a total of eight of these sites either during the survey or incidentally in the summers of 2007 and 2008. Northern leopard frogs were observed at one site in Zone 5, two sites in Zone 3, and five sites in Zone 1. One of the five locations in Zone 1 was a breeding site. The breeding pond was isolated from the Taltson River but was within the floodplain area and might become flooded in high water years. Northern leopard frogs observed during the surveys were primarily using riparian habitat along the Taltson River as summer foraging habitat and not as breeding habitat. The Taltson River system may also provide overwintering habitat for northern leopard frogs as water flow continues throughout the winter and would provide an aquatic environment that would not freeze solid.

9.5.7.3.3.2 Population Characteristics

Northern leopard frogs are known to disperse along stream corridors and metamorphs have been found to disperse up to 2 km from natal sites prior to the onset of winter and up to 8 km within a year of metamorphosing (Seburn et al. 1997). Annual movements for adults and sub-adults occur between the various types of habitat that are used over the course of a year. In the spring, adults migrate from overwintering aquatic sites to breeding wetlands (Seburn and Seburn 1998). After breeding, adults may remain close to the breeding habitat or move to summer foraging habitat. In late summer, newly-metamorphosed frogs will leave their aquatic habitat and during the fall frogs of all life stages will move to overwintering habitat. Large adult frogs have home ranges that are up to 615 m^2. Mortality rates are high at the tadpole stage; survivorship from egg stage to metamorphosis is typically lower than 10% (Seburn and Seburn 1998).

9.5.7.3.3.3 Issues Affecting Abundance and Distribution

The prairie populations of the northern leopard frog that extend up into the NWT are federally designated as a species of Special Concern by COSEWIC (2000) due to loss of populations, range contraction, and increased isolation of remaining populations. This species is designated as sensitive by the government of the NWT (ENR 2006). Threats to northern leopard frog populations vary greatly across its range. Threats include habitat loss, commercial over-exploitation as fish bait, and in some areas, probably competition and predation by bullfrogs or other introduced species. Laboratory results suggest that there might be an interaction between crowding, temperature, and mortality from bacterial infection (e.g., red-leg disease). Agricultural chemicals such as atrazine have caused feminisation of frogs in agricultural areas (Seburn and Seburn 1998). Potential threats to this species within the NWT include loss of over-wintering habitat due to hydroelectric development (ENR 2008b). Natural factors such as climate variability and disease may also play a role (ENR 2008b).

9.5.7.3.3.4 Human Use

Northern leopard frogs have been commercially harvested in Canada since at least 1920 and juvenile frogs are used as bait by anglers (Seburn and Seburn 1998). In the Project area they are purportedly used as fish bait by local guides (personal communication, J. Côté, October 2008). However, it has not been confirmed if the amphibians used as bait are northern leopard frogs or wood frogs. Wood frogs were more common and abundant at the sites that were surveyed for amphibians in July, 2008 (Appendix 13.10A).

9.5.7.3.4 Peregrine Falcon

Peregrine falcons are listed as a species of Special Concern under COSEWIC (2008) and Sensitive under the General Status Ranks in NWT (Working Group on General Status of NWT Species 2006). This species currently has no status under SARA (2008).

9.5.7.3.4.1 Habitat Use and Distribution

The peregrine falcon has a global distribution, and is found throughout North America occupying open areas, including the tundra. Peregrine falcons nest primarily on north-facing cliff faces near riparian areas or water bodies (Court et al. 1988).

With respect to the Project, peregrine falcons may be found around the East Arm of Great Slave Lake, and north of the treeline (Figure 9.5.23). The distribution of breeding peregrines is low and likely limited by cliff-nesting habitat. For example, there have been between four and seven occupied falcon nests within the Snap Lake study area (3,017 km^2), or up to one nest per 431 km^2 (Golder 2008a). By contrast, densities of up to one nest per 17 km^2 have been recorded at Rankin Inlet in Nunavut (Court et al. 1988). However, the distribution of raptors through the NWT and Nunavut is largely unknown, as less than 10% of these territories have been surveyed (Carriere et al. 2003). Diet consists largely of birds including ptarmigan, shorebirds and small passerines (White et al. 2000), although small mammals such as lemmings and young arctic ground squirrel may constitute up to a third of the diet among tundra populations (Bradley and Oliphant 1991).

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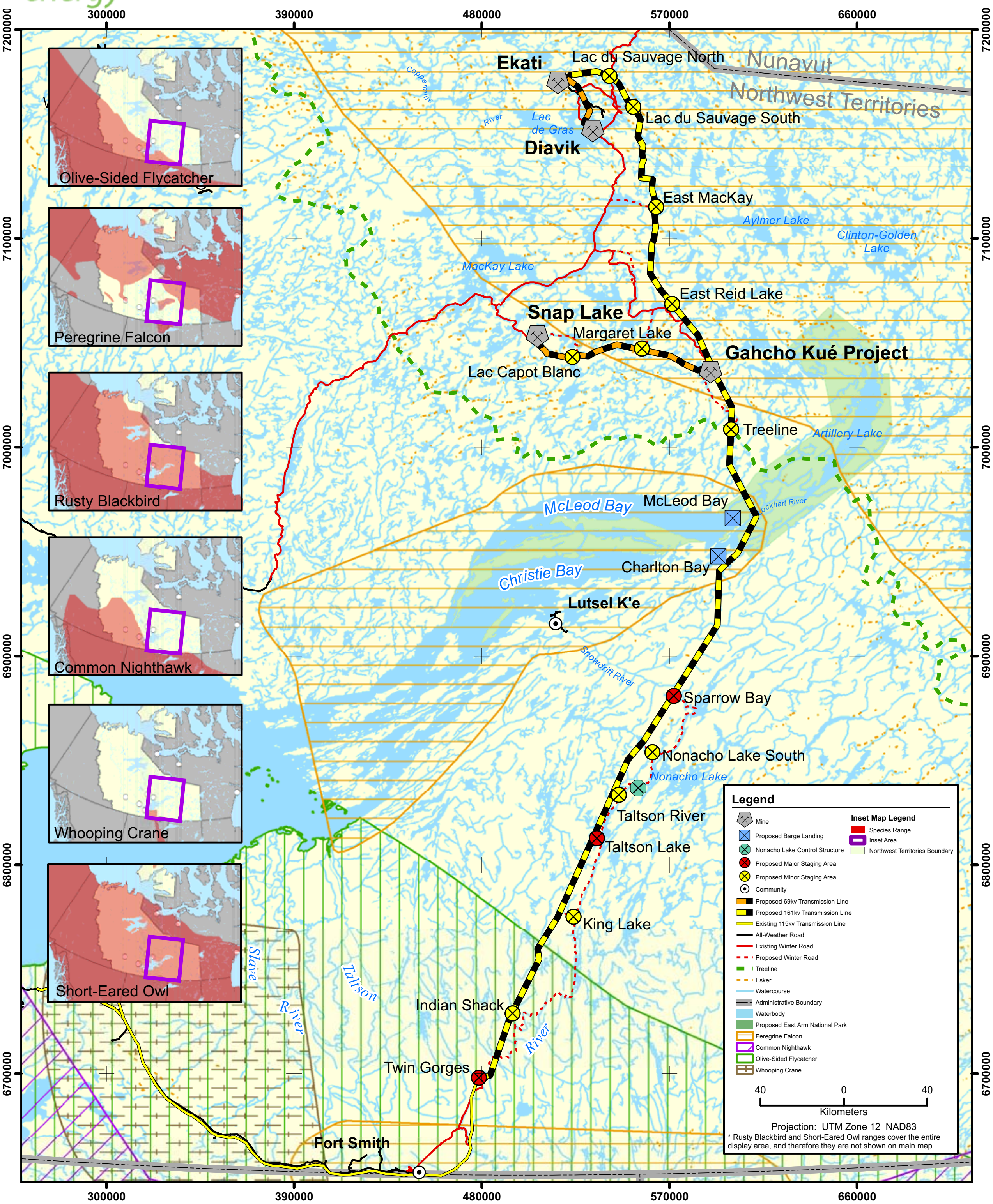

TALTSON Hydroelectric Expansion Project	Developer's Assessment Report 2009	Bird Species at Risk Ranges	Figure 9.5.23

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The Northwest Territories Department of Environment and Natural Resources (ENR) maintains a database of all known raptor nests in the Northwest Territories (Carriere et al. 2003). Prior to the survey, the database was searched to identify raptor nests near the proposed transmission line. The nearest nest to the Project was approximately 13 km from the proposed transmission line route.

Aerial surveys to identify potential peregrine nesting habitat were conducted by helicopter on September 11, October 2, and November 1, 2006 and 15-18 July, 2008. Survey altitude was 100 to 125 m and speed was 80 to 100 km/h. The proposed transmission line corridor north of the treeline was surveyed in 2006 while the whole corridor was surveyed in 2008. Locations of cliffs with suitable cliff faces for nesting and within 1.5 km of the proposed transmission line corridor were recorded. Cliffs were subsequently surveyed for raptors or their sign (i.e., jewel lichen, whitewash, stick nests, and/or the presence of adults, young or eggs). Any tree nests encountered were also recorded.

A total of 48 cliffs were recorded within 1.5 km of the transmission line, of which 15 had signs of raptor activity (i.e., whitewash or stick nests) (Figure 9.5.3). Raptor cliffs with sign were found to be largely concentrated in specific areas including the east arm of Great Slave Lake and south of the treeline staging area. Others were also observed near the Margaret Lake laydown area, near Lac de Gras, and near Nonacho Lake. None had signs of breeding activity (i.e., eggs or young). It was not possible to determine how many of these were or had been used by peregrine falcons as opposed to other raptors such as gyrfalcons and rough-legged hawks. One peregrine was observed during the surveys at a cliff near the proposed Indian Shack staging area, but no evidence of breeding was observed (Figure 9.5.3).

9.5.7.3.4.2 Population Characteristics

Though previously extirpated throughout much of its original range, peregrine falcons continue to reoccupy former habitat. Currently, peregrine falcons breed throughout much of coastal North America, along the western Cordillera and tundra regions of central and eastern Arctic. North America’s tundra and boreal regions currently maintain an aggregate population of approximately 13,000 pairs of both *anatumn* and *tundrius* subspecies (White et al. 2000). In North America, recovery of peregrine falcons has followed the restrictions on the use of organochlorines (e.g., the pesticide DDT), which was linked to declines in reproductive success (Johnstone et al. 1996). Currently, data from the few northern areas that are intensively surveyed suggests that peregrine falcon densities are near maximum occupancy of nest sites (Carriere et al. 2003). However, the north is a harsh environment, and severe weather events, particularly rain and late-season snow storms, have also been linked to peregrine breeding success in Arctic environments (Bradley et al. 1997).

Peregrine falcons arrive on the breeding grounds in early May, and return south by October (Court et al. 1988). Peregrine breeding is characterized by high fidelity to nesting sites and mates by older birds, which are also more successful at raising chicks than inexperienced breeders. Mortality within the first year is greater than 50% (Court et al. 1989).

9.5.7.3.4.3 *Issues Affecting Abundance and Distribution*

Pesticides were the major contributors to the drop in peregrine falcon numbers between the 1950s and 1970s. Because they are at the top of the food chain, chemicals ingested by their prey become concentrated in peregrines. This is especially true for organochloride compounds such as DDT, which are stored in the falcon's fat. Because of their short lifespan and high adult mortality, females need to produce an average of 2.2 chicks a year if the population is to remain stable. The effects of DDT tend to reduce the number of chicks per year to below this number. Following efforts to control DDT, surveys since the 1980s have indicated that in the NWT population levels and production of peregrines are now at healthy levels (ENR 2008a; Carriere et al. 2003). Poaching of eggs for falconry (ENR 2008b), human disturbance of nest sites, and increasing development (Working Group on General Status of NWT Species 2006) are among the other potential threats to this species.

9.5.7.3.4.4 *Human Use*

The peregrine falcon is a species that may be of interest to birdwatchers and other ecotourists. Possible threats include the poaching of eggs and nestlings for falconry (ENR 2008b), although this market has been largely eliminated by commercial falcon breeding programs.

9.5.7.3.5 Olive-sided Flycatcher

Olive-sided flycatchers are listed as Threatened under COSEWIC (2008) and Sensitive under the General Status Ranks in NWT (Working Group on General Status of NWT Species 2006). This species currently has no status under SARA (2008).

9.5.7.3.5.1 *Habitat Use and Distribution*

Breeding throughout much of boreal Canada, this medium-sized songbird (18 to 20 cm in length) inhabits forest edges, cleared areas, open forest and post-burn habitat. An obligate insectivore, this flycatcher typically nests in high conifers close to foraging sites (Altman and Sallabanks 2000). Olive-sided flycatchers are generally associated with sparse canopy cover, suggesting that they may respond positively to forest management such as timber harvest. Abundance is often higher in early to mid-successional stands derived from wildfire or commercial timber harvest (COSEWIC 2008). The range of the olive-sided flycatcher in the NWT is thought to extend beyond the Taiga Plains Ecozone and into the Taiga Shield (Figure 9.5.23). The species almost certainly does not pass north of the treeline, and has not been detected during upland bird surveys at either the Snap Lake Mine or Ekati Diamond Mine (De Beers 2002; BHPB 2007). Two incidental observations of olive-sided flycatchers were recorded on the Taltson River (Zone 1) and at Nonacho Lake during yellow rail surveys in June, 2008 (Appendix 13.10A).

9.5.7.3.5.2 *Population Characteristics*

This songbird has shown a widespread and consistent population decline over the last 30 years; the Canadian population is estimated to have declined by 79% between 1968 and 2006, and 29% from 1996 to 2006. Although the causes of this decline are uncertain (COSWEIC 2007), the loss of wintering habitat and fire suppression are suspected causes (Altman & Sallabanks 2000). Olive-sided flycatcher densities in the boreal forest were estimated by the Canadian Breeding Bird Census (BBC) at 0.064

birds/ha (0.072 standard deviation), based on the average of 37 estimates (Kennedy et al. 1999).

9.5.7.3.5.3 *Issues Affecting Abundance and Distribution*

Threats to this species in its southern breeding and wintering range are considered to be more significant than any such threats in the NWT. Potential threats to this species in the NWT may include fire suppression as a forest management practice (as the olive-sided flycatcher prefers young forest), and extreme weather events (ENR 2008b).

9.5.7.3.5.4 *Human Use*

This species may be of interest to birdwatchers and other ecotourists. No other human use of olive-sided flycatcher has been documented.

9.5.7.3.6 Rusty Blackbird

The rusty blackbird is listed as a species of Special Concern under COSEWIC (2008) and May be at Risk under the General Status Ranks in NWT (Working Group on General Status of NWT Species 2006). This species currently has no status under SARA (2008).

9.5.7.3.6.1 *Habitat Use and Distribution*

The rusty blackbird breeds throughout boreal Canada in a variety of moist habitats including swamps, sphagnum bogs, wet coniferous forests, and mixed and deciduous forests (Avery 1995). This species' broad diet includes nuts, fruit, seeds and insect matter (Avery 1995). Nest-site selection favours locations adjacent to forest openings. The rusty blackbird is thought to range throughout the length of the Project area (Figure 9.5.23). Two rusty blackbirds at two separate sites were observed incidentally on the Taltson River (Zone 1) during yellow rail surveys in June, 2008 (Appendix 13.10A).

9.5.7.3.6.2 *Population Characteristics*

Upland bird monitoring at diamond mines indicated that this species is not commonly found on the tundra (De Beers 2002; BHPB 2007). The rusty blackbird was detected at the Snap Lake Mine during baseline studies, at densities of approximately 12.5 per 0.25 km^2, but were not been detected at Ekati Diamond Mine, which is located farther from the treeline (De Beers 2002; BHPB 2007).

The current downward trend in the rusty blackbird's population compromised the species' already low densities throughout much of its range. However, a lack of information on this species due to the relative inaccessibility of its breeding habitat warrants caution with respect to population estimates (Avery 1995). There is evidence that the population has declined by approximately 85% since the mid-1960s (COSWEIC 2008), although there do not appear to be any declines in numbers in the NWT (ENR 2008b). Rusty blackbird densities in the Canadian boreal forest by the Canadian BBC, at 0.078 birds/ha (standard deviation of 0.105; Kennedy et al. 1999), based on the average of 28 estimates.

The most serious threat to the Rusty Blackbird is thought to be the conversion of its main wintering grounds (i.e., forests in the Mississippi Valley flood plains) for agricultural or human habitation purposes. Other activities, such as the conversion of wetlands and the creation of hydroelectric reservoirs, could lead to further habitat destruction in the species' breeding range (COSWIC 2008). There are no clear threats to this species in the NWT (ENR 2008b).

9.5.7.3.6.3 Issues Affecting Abundance and Distribution

No specific threats to this species within the NWT were identified. Environmental changes due to climate change are a possible threat to the rusty blackbird (ENR 2008b).

9.5.7.3.6.4 Human Use

This species may be of interest to birdwatchers and other ecotourists. No other human use of rusty blackbird has been documented in the NWT.

9.5.7.3.7 Short-eared Owl

The short-eared owl is considered a species of Special Concern (COSEWIC 2008) and is listed under Schedule 3 of SARA (2008). This species is considered Sensitive in the NWT (Working Group on General Status of NWT Species 2006).

9.5.7.3.7.1 Habitat Use and Distribution

Occurring throughout much of Canada, the short-eared owl is a medium-sized owl that employs a variety of breeding habitat including both tundra and boreal habitat. It is thought to arrive in the NWT in April or May, and migrate south by late October (ENR 2008b). With a diet largely consisting of small mammals, this owl inhabits open areas and is an obligate ground-nester (Wiggins et al. 2006). The short-eared owl may be found throughout the Project area (Figure 9.5.23), and incidental observations have been made at the diamond mines (De Beers 2002; BHPB 2007). A short-eared owl was documented in the Taltson River area (Zone 1) during yellow rail surveys in June, 2008 (Appendix 13.10A).

9.5.7.3.7.2 Population Characteristics

Short-eared owl population density estimates in the NWT have not been determined. Population levels tend to be cyclic and are assumed to be tightly linked to small mammal populations (Wiggins et al. 2006). This owl has suffered a continued population decline over the past 40 years, including a loss of 23% in the last decade alone. Habitat loss and degradation on its wintering grounds are most likely the major threats, while continuing habitat loss and degradation on its breeding grounds in southern Canada and pesticide use are secondary threats (COSEWIC 2008). Threats to this species population in the NWT are limited (ENR 2008b).

9.5.7.3.7.3 Issues Affecting Abundance and Distribution

Threats to the short-eared owl within the NWT are limited (ENR 2008b). Human disturbance during nesting and habitat loss in wintering and southern breeding grounds are possible threats outside of the NWT (ENR 2008b).

9.5.7.3.7.4 Human Use

This species may be of interest to birdwatchers and other ecotourists (Wiggins et al. 2006). No other human use of short-eared owl has been documented.

9.5.7.3.8 Common Nighthawk

The common nighthawk is listed as Threatened under COSEWIC (2008) but Secure under the General Status Ranks in NWT (Working Group on General Status of NWT Species 2006). This species currently has no status under SARA (2008).

9.5.7.3.8.1 Habitat Use and Distribution

The common nighthawk breeds throughout most of North America below the treeline. Common nighthawks generally nest on the ground, in open forests, prairie, and even urban rooftops. The common nighthawk feeds exclusively on flying insects during dawn and dusk, and is present in the NWT from mid-May until mid-September (ENR 2008b), but generally confined to the southern sections of the Project area (Figure 9.5.23). Two incidental observations of common nighthawks were made over Trudel Creek (Zone 5) and Taltson River (Zone 1) in June 2008 during yellow rail surveys (Appendix 13.10A).

9.5.7.3.8.2 Population Characteristics

Common nighthawk population density estimates in the NWT have not been determined. It is believed the species' continental breeding population is experiencing an overall downward trend, although specific reasons for population decline remain unknown. The common nighthawk is considered Threatened under COSWIC, but is Secure under the General Risk Ranks in NWT. A 49% decline in numbers was determined for areas surveyed over the last three generations, which is likely related to a decrease in food availability (COSWIC 2008). Identified threats to this species in the NWT include vehicle and aircraft collisions, and human activities that increase the number of predators (e.g., cats, foxes and gulls), which may prey upon the common nighthawk's ground nests (ENR 2008b). Common nighthawk densities were estimated by the Canadian BBC at 0.049 birds/ha (0.076 standard deviation), based on an average of 21 estimates (Kennedy et al. 1999).

9.5.7.3.8.3 Issues Affecting Abundance and Distribution

No major threats to the common nighthawk were identified within the NWT. Vehicle collisions, human activity, and reductions in prey due to pesticide use are considered possible threats (ENR 2008b).

9.5.7.3.8.4 Human Use

The species may be of interest to birdwatchers and other ecotourists. No other human use of the common nighthawk has been documented.

9.5.7.3.9 Whooping Crane

The whooping crane is considered to be At Risk under the General Status Ranks in NWT (Working Group on General Status of NWT Species 2006). COSEWIC (2008) confirmed whooping cranes as Endangered in November 2000 and the species is now listed under Schedule 1 of SARA (2008).

9.5.7.3.9.1 Habitat Use and Distribution

Whooping crane breeding habitat consists of visually open patchy wetland complexes containing semi-permanent and permanent wetlands with water depths averaging 25 cm (Timoney 1999). This diverse mosaic of wetlands contains a high proportion of bulrush marsh associated with mixed marsh (e.g., sedge and cattail), shrubby marsh (e.g., willow and birch) and diatomaceous ponds with bulrush. Whooping cranes breed in the large marshes adjacent to the Sass, Klewi, Nyarling, and Little Buffalo rivers in the north-eastern portion of Wood Buffalo National Park. The nesting area consists of six areas totalling approximately 400 km^2 (EC 2007). Areas with suitable breeding habitat outside of the Park extend north to the shore of Great Slave Lake and east to the Taltson River (Olson and Olson 2003). Wetland habitat in the Tazin Lake Upland Ecoregion, which the proposed transmission line and winter road run through, is not identified as potential breeding habitat. Suspected non-breeding whooping cranes have been recorded in the region and were most recently observed in June 2008. Waterfowl surveys on Trudel Creek and the Taltson River noted incidental observations of five and two whooping cranes, respectively.

9.5.7.3.9.2 Population Characteristics

The Wood Buffalo whooping crane flock has been steadily increasing to a current population estimated at 266 individuals (Environment Canada 2008). As the Wood Buffalo population continues to grow, occurrences in the region may become more common. This is important as collisions with power lines are known to be a significant cause of whooping crane mortality (Lewis et al. 1992). The whooping crane is considered to be At Risk under the General Status Ranks in NWT (Working Group on General Status of NWT Species 2006), due to a combination of a very small population size, number of occurrences, and a very restricted distribution. COSEWIC (2008) confirmed whooping cranes as Endangered in November 2000, and this species is now listed under Schedule 1 of SARA (2008). Reasons for designation include very small numbers of individuals and a very restricted breeding range (Lewis 1995, Wapple 2000).

9.5.7.3.9.3 Baseline Studies

Whooping cranes were not expected to be found within the Project area. However, incidental observations were recorded during other wildlife surveys along the Taltson River. As such, the whooping crane was included as a wildlife species at risk which may occur within the Project region. See Figure 9.5.24.

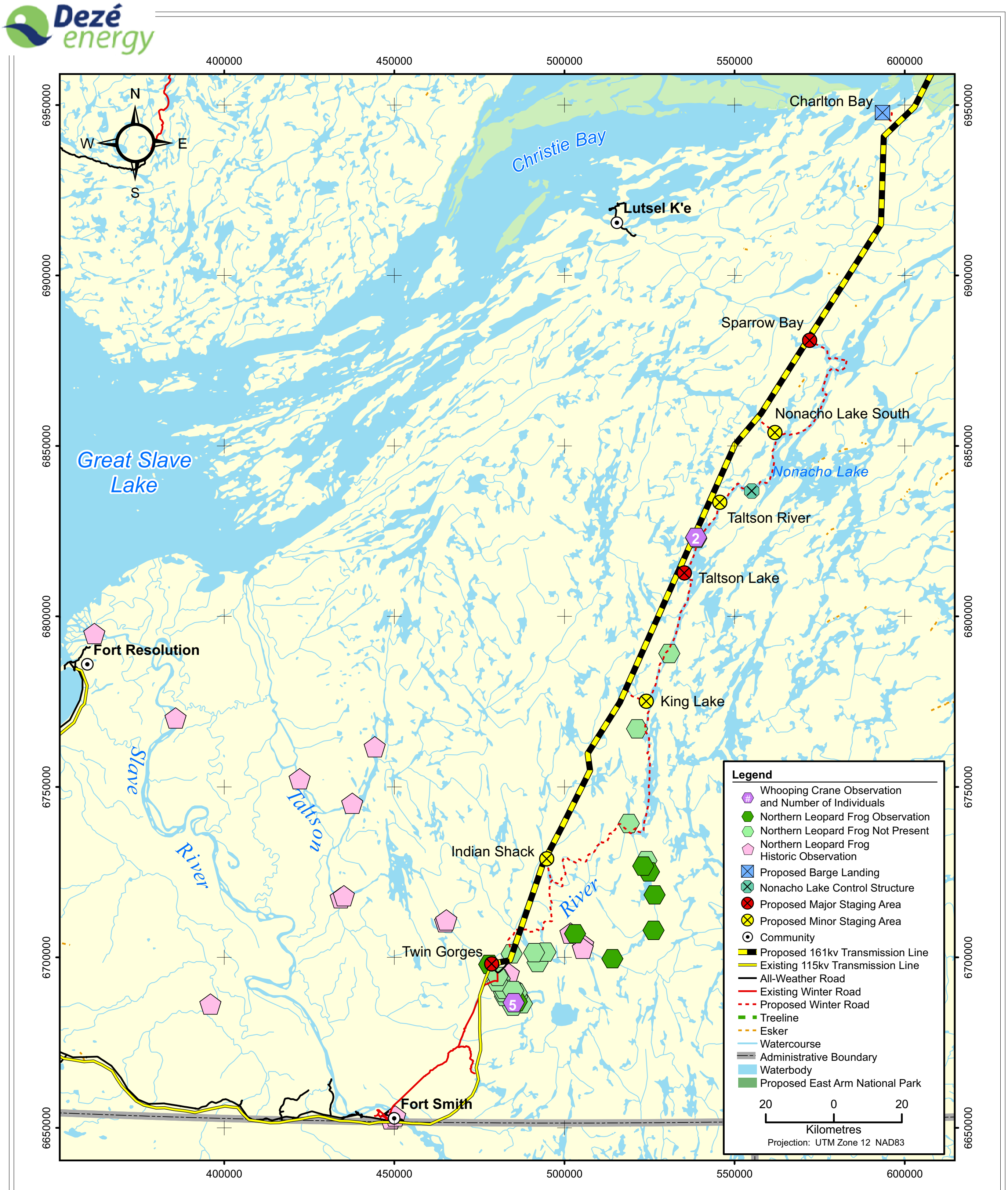
Seven whooping cranes were observed in the Taltson River system during waterfowl surveys in June, 2008 (Appendix 13.10A). Five whooping cranes were observed in Trudel Creek, they were not thought to be breeding in the area, but were thought to be young adults (Alyson McHugh, M.Sc., personal communication, August 22, 2008). Two whooping cranes were observed along the Taltson River (Zone 1).

9.5.7.3.9.4 Issues Affecting Abundance and Distribution

Potential threats to the whooping crane within the NWT include habitat loss and degradation, disturbance on the breeding grounds, collisions with transmission lines, and accidental shooting (ENR 2008b).

9.5.7.3.9.5 Human Use

Whooping cranes are not hunted or used by traditional people or other NWT residents.



TALTSON Hydroelectric Expansion Project	Developer's Assessment Report 2009	Northern Leopard Frog and Whooping Crane Observations, April to October 2008	Figure 9.5.24

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9.6 HUMAN ENVIRONMENT

9.6.1 Traditional Knowledge

The Mackenzie Valley Environmental Impact Review Board (2005) provides guidance regarding the incorporation of Traditional Knowledge into the environmental assessment process.

These guidelines have been followed, and the use of Traditional Knowledge in the Project from its inception to baseline data acquisition and proposed environment management programs are reported herein. Traditional knowledge is incorporated throughout the DAR.

9.6.1.1 APPROACH

The Expansion Project ownership and directorship structure is unique because the majority of its owners and directors are the Aboriginal people most likely affected by the Project. Within this ownership and management context, Traditional Knowledge had a significant contribution to the conception and the environmental assessment of the Project.

9.6.1.2 TRADITIONAL KNOWLEDGE IN THE PROJECT AND PARTNERSHIP FORMULATION PERIOD (2002 TO 2006)

Joanne Barnaby (2003) delivered a Traditional Knowledge workshop to Project consultants and the Project management team to familiarize them with Traditional Knowledge and to enable better incorporation of that knowledge into their work.

Following the 2003 Traditional Knowledge workshop, a Contribution Agreement was established between the Akaitcho Treaty Tribal 8 Corporation and the South Slave Métis, now known as the Northwest Territory Métis Nation. The Contribution Agreement included a method of communicating Project developments and obtaining feedback from the parties' community leaders and members. The Akaitcho Corporation and Northwest Territory Métis Nation preferred that the parties themselves would conduct self-directed Traditional Knowledge gathering and bring to the attention of the developer any Traditional Knowledge that they felt was relevant to the Project. They also established Community Coordinators responsible for reporting their findings to the Project Coordinator, and providing Project information to their respective members and stakeholders. Consequently, as Community Coordinators conducted community consultation and the gathering of Traditional Knowledge up until the formation of the Dezé Energy Corporation, a formal database was not maintained of the ongoing communications and Traditional Knowledge incorporated into the Project.

With the guidance of Community Coordinators, the parties provided Project updates to, and sought feedback from, the South Slave region communities and the political leadership at the General Assemblies. This was accomplished through presentations, brochures, newsletters, and the placement of Project models in public buildings in each community. Feedback from the Community Coordinators, meetings and presentations were incorporated into both the proponent structure and the Project design.

As the Project and its ownership remained in a dynamic state up until late 2006, the parties agreed to continue with the Community Coordinators' method of providing Project information to the Akaitcho Corporation and Northwest Territory Métis Nation until a Project proponent was defined and a feasible Project determined. A limited amount of consultation occurred beyond the Annual General Assemblies prior to the finalization of the proponent formation process and the evolution of the Project design. The parties agreed to refrain from the engagement in public and membership consultations in the absence of a clearly-defined Project and ownership structure. Such engagement would result in the presentation of inconsistent information, or information that could rapidly become inaccurate or superseded as the Project was iteratively refined. Following this step, Traditional Knowledge studies were undertaken in response to needs identified through the design process.

9.6.1.3 Traditional Knowledge in the Project Design and Assessment Stage (2006 to 2009)

Upon creation of the Project partnership and the Dezé Energy Corporation, the partners appointed their respective directors. The directors in turn provided Dezé's management strategic direction regarding the preparation of the Project Description and the DAR. Beginning with the corporate values of Dezé's owners, as applied by their directors and implemented by management, Traditional Knowledge has been expressed throughout the Expansion Project. The Aboriginal values about the environment, Aboriginal knowledge about use and management of the environment, and Aboriginal knowledge of the environment were included in the environmental assessment process. The following section provides examples of these expressions of Traditional Knowledge.

9.6.1.4 Aboriginal Values About the Environment

The Dezé Energy Corporation is structured such that Aboriginal values about the environment have significant consideration at Board of Directors meetings and in the decision process. This empowered the Board of Directors to actively engage in the Project's design, to approve mitigation practices and design features, and participate in the baseline studies to instill a corporate culture that expresses Aboriginal values about the environment.

The majority of Dezé's owners and directors are Aboriginal in descent. Table 9.6.1 provides a list of past and present directors who have made significant contributions to the communities of the South Slave region. For example, former Director Mr. Sonny MacDonald was involved in the construction of the existing Twin Gorges power facility and worked throughout the South Slave region for the Government of the Northwest Territories, while maintaining a career as an artist and carver. Don Balsillie was the Chief of Deninu K'ue First Nation for seven years and Grand Chief for the Akaitcho Territory Government for a year. Currently, he is the Chair of Dezé Energy Corporation's Board of Directors. He has also been the owner of a fishing lodge on the lower Taltson River for the last 20 years. Robert Sayine was an MLA for Great Slave East from 1979 to 1983 and Chief of Deninu K'ue First Nation from 2001 to 2007. Vern Jones was President of the Northwest Territory Métis Nation from 2006 to 2008. Vern Jones, Kara King, and Lloyd Cardinal were past presidents of South Slave Métis locals. Ken Hudson is currently the President of the Northwest Territory Métis Nation, Fort Smith local. From the leadership shown by the Board of Directors, Aboriginal values and knowledge have shaped Dezé's corporate culture and attitude, which has been incorporated into the Project planning and design.

Table 9.6.1 — Status of Dezé's Directors: January 2009

Director	Status as of January 2009
Robert Sayine	Director, AEC
Peter Liske	Past Director, AEC
Sonny MacDonald	Past Director, AEC
Don Balsillie	Chairman, AEC
Gloria Villebrun	Director, AEC
Ken Hudson	Vice- Chairman, MEC
Vern Jones	Past Director, MEC
Kara King	Past Director, MEC
Lloyd Cardinal	Past Director, MEC
Gary Bailey	Director, MEC
Paul Harrington	Director, MEC
Richard Nerysoo	Past Director, NTEC 03
Leon Courneya	Past Director, NTEC 03
Peter Allen	Past Director, NTEC 03
Lew Voytilla	Director, NTEC 03
Louis Sebert	Director, NTEC 03
Dan Grabke	Director, NTEC 03

Before Dezé management embarked on the preparation of the Project Description for water and land use applications, a series of self-directed Traditional Knowledge studies were commissioned to identify Traditional Knowledge holders, approaches to community and Traditional Knowledge engagement, and feedback on development concepts considered by Dezé.

Traditional knowledge engagements were held by Deninu K'ue, the Akaitcho Territory Government and Thebacha under the guidance of Mr. Maurice Boucher (2006), and by Mr. Arthur Beck on behalf of the Northwest Territory Métis Nation (2006).

Deninu K'ue, the Akaitcho Territory Government and Thebacha decided that Dezé should hold a workshop to introduce the Project, develop questions for a Traditional Knowledge questionnaire, and document concerns regarding the proposed line route (Boucher 2006). As recommended, Dezé undertook follow-up workshops and meetings, provided Fort Resolution, Fort Smith and Lutsel K'e scale models of the proposed Project, and prepared a questionnaire based on the concerns expressed at the workshop. The questionnaires were subsequently approved and interviews were undertaken. This information is incorporated into the relevant Subjects of Note (SON) or Key Lines of Inquiry (KLOI).

The Northwest Territory Métis Nation retained Arthur Beck to prepare a Traditional Knowledge report. The report prepared by Beck (2006) was based on field data gathered through interviews with traditional and current land users of the Taltson River area. Audio tapes of the interviews accompanied this report. These interviews were the property of the authors, and were provided for the purpose of that study only. Interviews started on May 20, 2006 and were conducted in Fort Resolution, Hay River, and Fort Smith. A total of 25 interviews were conducted and recorded in Aboriginal and non-Aboriginal languages. There were 11 interviews conducted in Fort Resolution, 3 in Hay River, and 11 in Fort Smith.

In summary, the people of Fort Resolution, Rocher River and the traditional land users of the Taltson River watershed area would be most affected by the Project. In the interviewees' opinion, the proposed Expansion Project would present the most dramatic effect on the watershed since the original dam construction.

9.6.1.5 ABORIGINAL KNOWLEDGE ABOUT THE USE AND MANAGEMENT OF THE ENVIRONMENT

Knowledge on use of the environment and management of people's relationship with the environment is reflected in their cultural practices and social activities, land use patterns, archaeological sites, harvesting practices, and harvesting levels, both past and current (MVEIRB 2005). There is a significant body of research available through the West Kitikmeot Slave Study Society regarding Łutsel K'e. However there is less comparable information available for Fort Resolution, Fort Smith, Smith's Landing and the Salt River First Nation. To address this challenge, Dezé sponsored four discrete Traditional Knowledge studies over the course of the Project design and DAR submission.

Prior to the land and water licence applications, Dezé sponsored an issues scoping and information gathering study with the Deninu K'ue First Nation in 2004. The Project team from Fort Resolution selected individuals for a five-day trip to their traditional territory. The objective of the Taltson watershed study was to acquire traditional land use information. This was accomplished by individuals identifying the locations along the river where their families lived and harvested for their livelihood, before and after the Twin Gorges facility was constructed (TK studies 2004).

The second Traditional Knowledge study at the onset of the Project was self-directed by the Northwest Territory Métis Nation and its affiliate councils in Fort Resolution and Fort Smith, and by the Deninu K'ue First Nation. The purpose of this study was to scope Aboriginal valued socio-economic and environment components. The Traditional Knowledge work was undertaken soon after the Project moved from a conceptual stage to a pre-feasibility stage, and was drawn into the Project design through the direction of the Dezé Board.

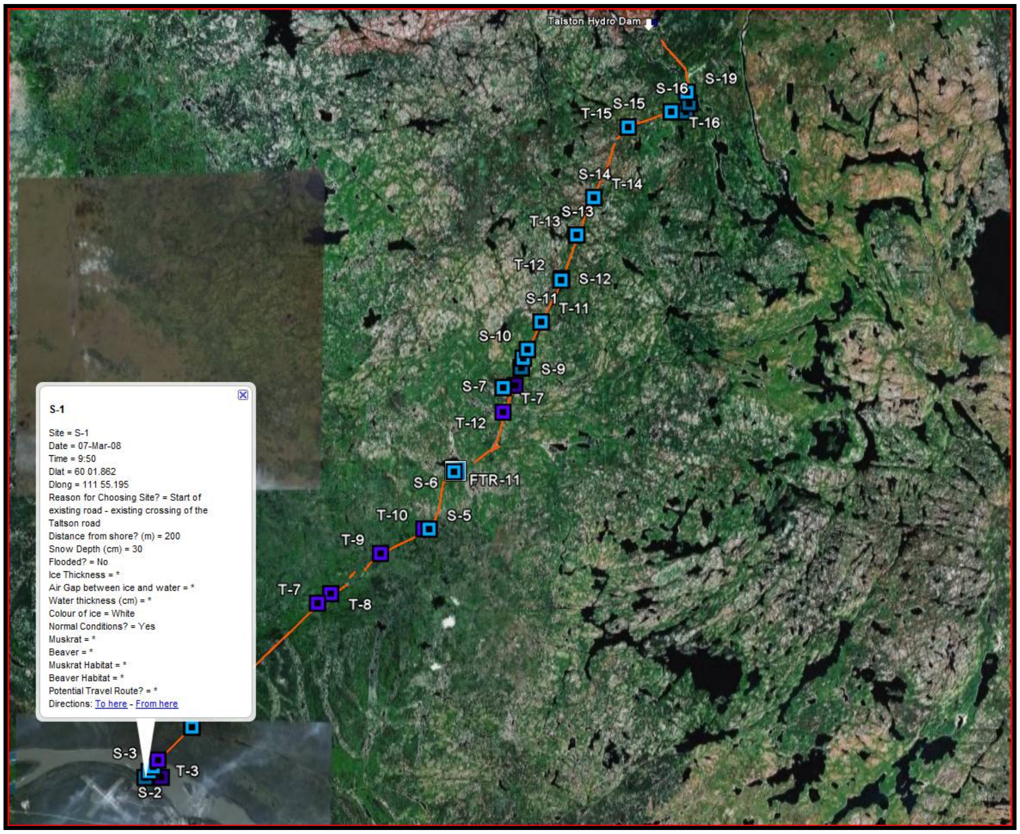
The third Traditional Knowledge study sponsored by Dezé focused on potential Project effects on winter travel routes, crossings and trap lines. The purpose of the study was to document winter and spring ice conditions along travel routes to the existing Twin Gorge hydroelectric facility used by the community members. Aboriginal participants from Fort Resolution and the Fort Smith area documented, photographed, and reported ice and habitat conditions on their most-used travel routes.

To facilitate the documentation of ice conditions and the immediate habitat of the travel routes, each participating community representative was provided a digital camera, Global Positioning System (GPS), maps and a data gathering form. The timing and route selection process was left to the discretion of the respective community participants. The resulting information was then provided to Dezé.

The participants from the Northwest Territory Métis Nation and the Akaitcho Territory Government both accessed the Twin Gorges area from Fort Smith along a well-known winter trail. The trail was used as a winter road from Fort Smith to haul heavy equipment for construction of the original Twin Gorges dam. The road has not been used for approximately 17 years. Representatives from Fort Resolution travelled in a southerly direction along the Taltson River.

The field results of the community ice studies were geo-located using Google Earth software. A complete record of information for ice and habitat observations was linked to each place mark. The resulting information was then integrated into a broader GIS Project information warehouse and provided to Dezé's project managers and consultants for integration into Project design and DAR preparation. Figure 9.6.1 shows the Fort Smith to Twin Gorges travel route, place mark ice and habitat observation points, and a record of observations.

Figure 9.6.1 — Fort Smith Traditional Knowledge Study: Ice Conditions along Winter Routes



Source: Akaitcho Territory Government and Northwest Territory Métis Nation (2008)

A fourth Traditional Knowledge study was commissioned in February 2008 to get a better understanding of the travel routes along the Taltson River and Trudel Creek. The study also investigated "species at risk" sightings by the Traditional Knowledge holders and the location of the sightings.

9.6.1.6 ABORIGINAL KNOWLEDGE OF THE ENVIRONMENT

This section focuses on Aboriginal factual or "rational" knowledge of the environment. This knowledge includes specific observations, knowledge of associations or patterns of biophysical, social and cultural phenomena, inferences or statements about cause and effect, and impact predictions. All of the above are based on the direct observation, experience and shared information within the community over generations (MVEIRB 2005).

Traditional knowledge studies relating to other developments or available through organizations such as the West Kitikmeot Slave Study Society were reviewed and used where appropriate. The research component included a literature review of publicly-available Traditional Knowledge relating to the area that could potentially be affected by the proposed Expansion Project. This research draws upon literature available via the Public and Territorial Government libraries in Yellowknife and a broad range of internet material. Several Traditional Knowledge practitioners from Yellowknife were also consulted.

9.6.2 Legacy Issues

Three significant forces shaped the history of the South Slave region: relations among Aboriginal groups, the governments, and the private capital interest. Before the 1950s, Aboriginal people carried out their livelihoods for the most part unaffected by external forces. During that time, Aboriginal people were for the most part independent of significant "outside" influences other than the fur traders and explorers. After World War II, Canada's involvement in the lives of Northern and particularly Aboriginal people increased, as did efforts to modernize the management and development of the North's natural resources.

Legacy issues have been brought forth during Dezé consultation with communities and during the MVEIRB scoping sessions. As a result, Dezé commissioned R. Freeman (Appendix 9.6A) to investigate the history of the area and of legacy issues, to enable Dezé to better understand the issues and any Project-legacy issue relationships.

Although Dezé cannot take responsibility for past legacy issues caused by existing developments, Dezé is committed to avoiding a repeat of activities that resulted in the legacy concerns and the introduction of new negative legacy issues, through Project planning and design that incorporate and embed the principles of sustainability, including economic, environmental, social and cultural well-being.

A brief history follows of the forces that shaped the South Slave regions in the Project area.

9.6.2.1 AREA EAST OF THE SLAVE RIVER BETWEEN GREAT SLAVE LAKE AND LAKE ATHABASCA

The area east of the Slave River between Great Slave Lake and Lake Athabasca has largely been a grey area overlooked by anthropologists, ethnographers, geographers and historians. The general pattern of occupation and use of the areas around Great Slave Lake and Lake Athabasca by northern Dene groups was, in very general terms, laid out by Anthropologist Diamond Jenness in 1932 and repeated in 1981 in the Smithsonian Institute's Handbook of North American Indians.

Simply put, these pivotal publications claim the "Slavey" during the 1700s occupied lands east of the Slave River but were pushed west by "Chipewyan" during the 1800s and that the Chipewyan continue to occupy these lands to the present day. Areas south of Great Slave Lake were not considered to be within the exploitive range of the Yellowknife.

In Beryl Gillespie's chapter on the "Yellowknife", her chronology of "Events and Conditions in Yellowknife History" (Smith 1981) ends with the year 1928 where she wrote "Influenza epidemic: native populations of Yellowknife River and eastward into the east arm of Great Slave Lake suffer many deaths" and goes on to claim that the "Yellowknife…were no longer an identifiable dialect or ethnic entity in the twentieth century" (Smith 1981). Gillespie had firmly, and apparently unequivocally, laid to rest the Tatsanottine people.

Yet, there are some obvious shortcomings in Gillespie's chapter on the Yellowknife – a work that has been very influential in shaping our perception of the history of the Tatsanottine people – and these become evident when she admits that her knowledge of these people was "based on published sources and on fieldwork among the Dogrib of Yellowknife Bay" (Smith 1981). It will become clear in the pages that follow that her examination of published sources, at least as they pertain to the Yellowknife/Tatsanottine Dene exploitive range south of Great Slave Lake, was cursory at best.

The earliest known published reference to the Tatsanottine Dene living on the south side of Great Slave Lake comes from Sir John Franklin's journal (Franklin 1823), a record of his first overland journey from the north shore of Great Slave Lake/Yellowknife Bay to the Arctic coast in 1819 to 1822. His guides, the "Copper Indians", told him that they originally lived on the south side of Great Slave Lake. Anthropologist Diamond Jenness, commenting on this claim by the Tatsanottine, suggested that "if true, this must have been before the eighteenth century." (Jenness 1932).

What we understand today concerning the effects of the fur trade makes this statement seem all the more likely. Traditional boundaries between native groups became meaningless after guns became available from fur-trading posts. Armed Cree took revenge on their traditional enemies the Chipewyan who, when they too became armed, pushed north-westward from their traditional lands along the Churchill River, forcing Slavey, Dogrib, Beaver and Tatsanottine from their land. When trading companies moved onto the Athabasca and Slave rivers in the late 1700s, guns became readily available to the Tatsanottine. They quickly gained a reputation for their aggressive behaviour and for taking revenge on their traditional enemies, the Dogrib and the Chipewyan.

During the late 1700s and early 1800s, it is believed the Tatsanottine Dene expanded their exploitive range to include large areas around the East Arm of Great Slave Lake, north towards the Barrens, and west beyond Yellowknife Bay and River. This is where Franklin met the now famous Tatsanottine Chief Akaitcho in 1819.

During the 1820s, the hostilities between the Dogrib and the Tatsanottine were often mentioned in Hudson's Bay Company trading post journals, and by end of that decade the Dogrib appear to have gained the upper hand. In 1833, Akaitcho and other Yellow Knives were employed as hunters for the Back Expedition (Back 1836), wintering at Fort Reliance on the extreme east end of the East Arm of Great Slave Lake. Back describes Akaitcho as,

> *"no longer the same active and important person that he was in those [Franklin Expedition] days … the Yellow Knives have drawn vengeance on themselves by their wonton [sic] and oppressive conduct towards their neighbours … the wretched remnant were driven from the rich hunting grounds about the Yellow Knife River to the comparatively barren hills bordering on [the East Arm of] Great Slave Lake … a degeneracy from which they will probably never recover. There cannot now be more than seventy families remaining."* (Back 1836).

Akaitcho died in the spring of 1838. Twenty-five years later, in the spring of 1863, Akaitcho's widow, along with four of her surviving children, visited St. Joseph's Mission on Moose Island, a short distance off shore from Fort Resolution. Fr. Émile Petitot, in charge of the mission, "saw his [Akaitcho's] widow Lisette Sha-ttséghé, Low Martin, on Moose Island, when she was about 60 years old, along with four remaining children: Ekzéar Tsinnay-tchôp, Big Orphan, 40 years old and childless … Élodie Épolal-dzaré, Iliac Bone and Legs, 38, four children … Marianne Ellloussé, Fish Bladder, 37, four children … Élie Kkpa-azè, Little Arrow, 25, two children." (Petitot 2005).

Oblate Missionary Fr. Émile Petitot traveled extensively during the years 1862-1882 in the areas around Great Slave and Great Bear lakes and, by "visiting and staying with various native groups in different localities, sharing their living conditions … [recorded] … in detail their life, legends, customs, beliefs, and languages" he was, for all intents and purposes, an "anthropologist," the first to compile information on the Dene of the Northwest Territories outside of the context of the fur trade. With Petitot, we get a glimpse of traditional Dene life and, of particular interest to this study, of the traditional exploitive ranges of northern Dene from more than a hundred years ago. Petitot produced, using little more than a compass and a watch, the first accurate and surprisingly detailed maps of much of today's Northwest Territories, which included many place names as they were known to the people of the time.

From December 1862 through August 1864, Petitot was stationed at St Joseph's Mission and travelled extensively on Great Slave Lake, across the Slave River Delta, and east of the Slave River Delta. He described the delta as swarming with big game and, in season, migratory birds of all types. Petitot had, in very short order, learned the often difficult languages of the north. His first written reference to the Tatsanottine comes from that first winter at St. Joseph's Mission. He spent considerable time with "an old blind man named Ekhounélyel, Warble Fly, [who] came to sit with me to tell me the legends of the Yellowknife" (Petitot 2005). Ekhounélyel lived in a cabin at the mouth of the Little Buffalo River on the southwest side of the Slave River delta.

Describing the geography of the Great Slave Lake area, Petitot wrote of "the Tpatsan ottinè-Nènè to the north or Land of the Yellowknives" (Petitot 2005). This presumably is a historical reference to their former exploitive range because in 1883 he produced a map showing the "Yellow Knives" as living east of the Slave River (Figure 9.6.2). This map also labels what we know today as the Taltson River as "Yellow Knives R or T'al'tsan-Déssé R" (Savoie 2001).

An earlier map labels the Taltson River as "R. du Rocher ou T'altsan-désse" and just beyond this river, around the extreme east end of the East Arm of Great Slave Lake, Petitot places the label "T'ALTSAN-OTTINÈ," literally, the land of the Tatsanottine (Figure 9.6.3) (Indian and Northern Affairs 2001).

Figure 9.6.2 — Portion of 1883 Map "British North America, Northwest Territory, District of Athabasca…" by Emile Petitot

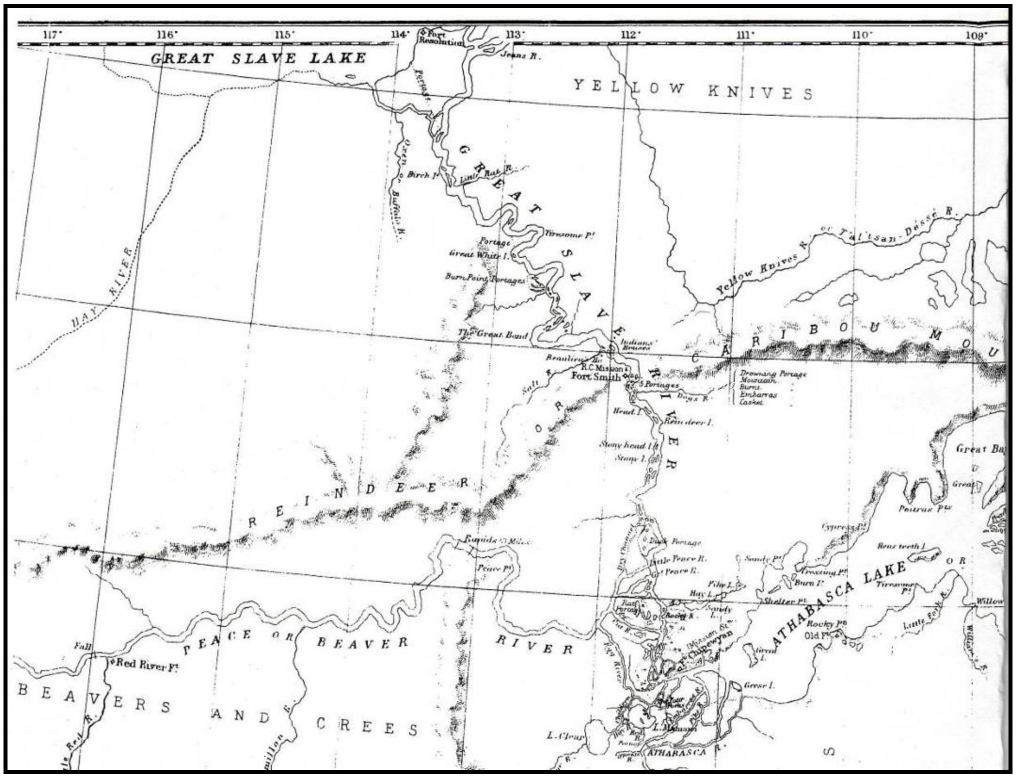
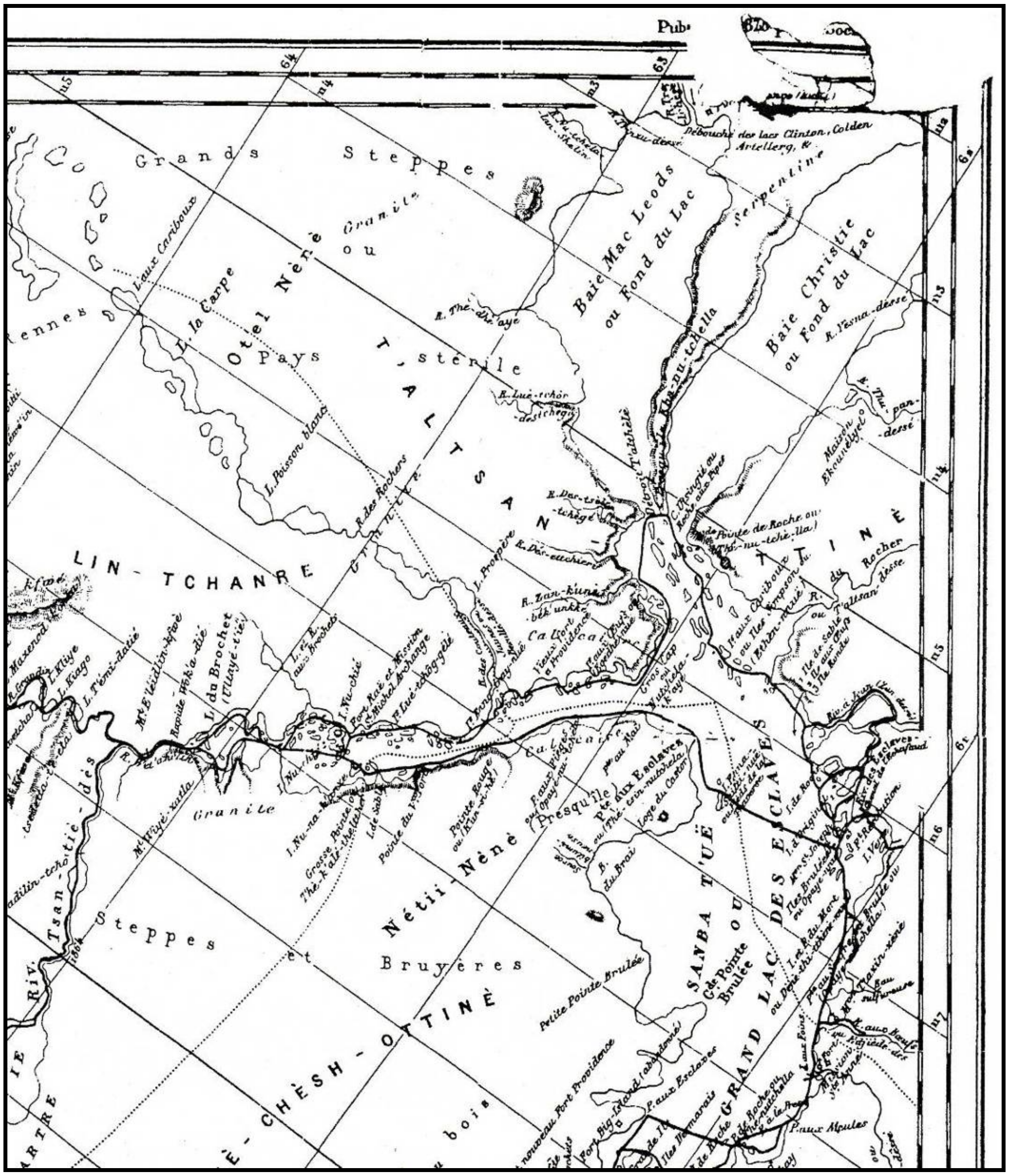


Figure 9.6.3 — Portion of Carte des Expéditions Chez Les Dindjié et les Déné Septentrionaux (1872)



Additional cartographic, toponymic and textual evidence of the traditional lands of the Tatsanottine Dene can be found in Donat Savoie's *Land Occupancy by the Amerindians of the Canadian Northwest in the 19th Century*, an exhaustive compilation of Petitot's work that has only recently been made available to the general public. Even more recently, the Champlain Society translation and publication, previously cited, of two of Petitot's rarest books has revealed a wealth of information on the Tatsanottine Dene and their relationship to the Taltson River and areas farther east along the East Arm of Great Slave Lake.

It is possible, and even highly likely, that Petitot gave the name T'al'tsan-Dessé – to the river we now call Taltson – specifically as a designator for where the Tatsanottine Dene lived. He acknowledges the use of older names for this feature, such as Back's "Thu-wu-desseh" or, as Petitot wrote it, Tthu-pan-déssé, literally "the river Des Seins [breasts]" and also Samuel Hearne's name for the river "des Mamelles [breasts]". Petitot's use the name "R. du Rocher", a description of the high, rounded hills of granite near the mouth of this river, is also presumably the origin of the reference to "breasts."

Less than twenty years after Fr. Petitot left the north, the Canadian Government sent in a treaty party to negotiate Treaty 8 with Dene groups living south of Great Slave Lake. While much of the treaty was negotiated and signed in 1899, the Dene of the Fort Resolution area did not sign until 1900. On July 25, representatives of the Dog Ribs, the Slaves of Hay River, the Chipewyans, and the Yellow Knives signed the treaty. For the Tatsanottine Dene (Yellow Knives) Chief Snuff, Tzin-tu and Ate-ee-zen made their marks.

Chief Snuff, a Tatsanottine Dene, lived along the lower Taltson River on a channel that people of the area called Snuff Channel. This local usage was given official recognition by the Geographic Board of Canada in 1936.

A hundred years ago, the line between who was Chipewyan and who was Tatsanottine had begun to blur. In 1907, naturalist Ernest Thompson Seton travelled down the Slave River to Fort Resolution where he hired a group of "Great Slave Lake Indians." He described them as "like a lot of spoiled and petulant children" (Seton 1911). Their job was to row his York boat and 1,300 pounds of supplies from the Slave River delta to the east end of the East Arm of Great Slave Lake, and to carry those supplies over Pike's Portage. He later referred to them as "these Chipewyans." Their guides were Louison 'Weeso' d'Noire, his son Francois d'Noire, William Freesay, Billy Loutit, Beaulieu, three others for whom he only used initials because he had nothing good to say about them, and finally, Chief Snuff, the leader of the Tatsanottine Dene. A few years later this confusion over "Yellowknife" versus "Chipewyan" is again apparent. In 1913, ethnologist J.A. Mason, conducting field work among the Chipewyan of Fort Resolution (Mason 1946), photographed a group of Dene lodges and identified them as "possibly Yellowknife."

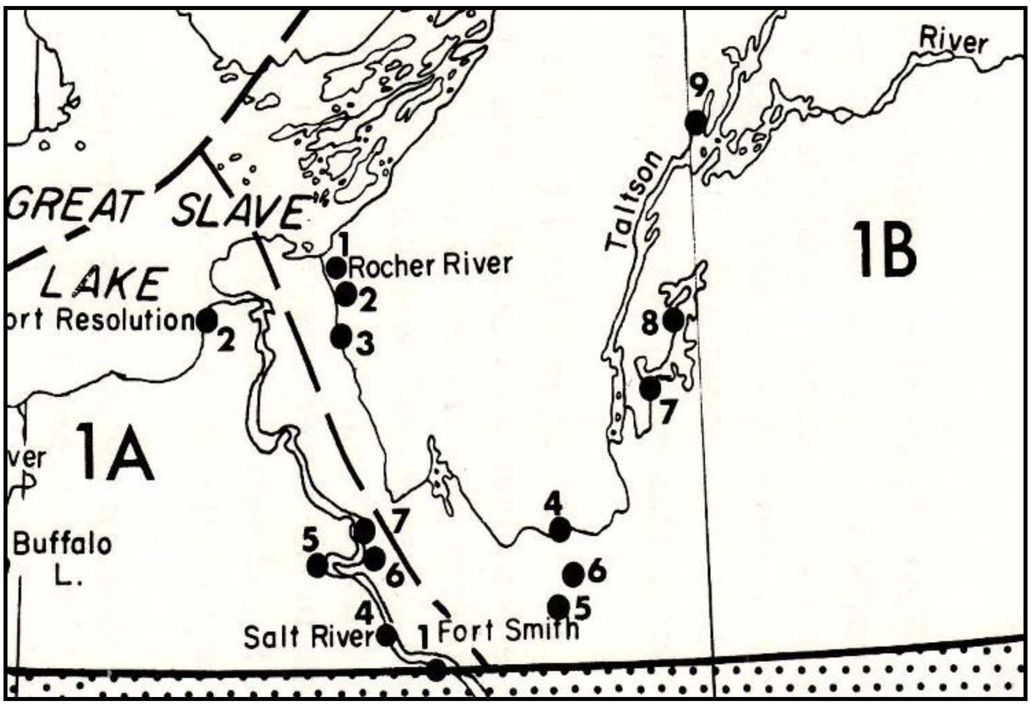
For the 50 years that followed, there continued to be Dene who specifically identified themselves as Tatsanottine and even Beryl Gillespie, the anthropologist who wrote so convincingly of the "disappearance" of the these people, grudgingly accepted that "in the 1960s the Chipewyan of Fort Resolution used tatsotine [diacritics not included], perhaps a phonetically evolved equivalent, for those Chipewyan who may be, in part, descendants of the Yellowknife branch and who have maintained their Indian heritage to a greater degree than those they identified as Métis" (Smith 1981).

9.6.2.2 ROCHER RIVER

Fifty years ago Rocher River was a bustling community, the centre of a rich hunting, fishing and trapping area on the east side of the Slave River delta. Residents of this community, located on the east bank of the Taltson River approximately 4 km upstream from the shores of Great Slave Lake, had easy access not only to the bounty of the delta but also to the lakes and streams of the Precambrian Shield to the east and southeast.

Prior to about 1920, these people lived in scattered camps throughout the region. They were trappers and hunters who conducted their trade at Fort Resolution. In 1921, the Hudson's Bay Company built a small trading post on the lower Taltson River (1B1 on Figure 9.6.4) (Usher 1971) to intercept trappers on their way to Fort Resolution to trade with rival independent trading companies.

Figure 9.6.4 — Portion of Map Showing Fur Trade Posts East of the Slave River



The Hudson's Bay post did well at this location and their competitors took notice and were soon also operating posts at Rocher River. Northern Traders Ltd. built a trading post there in 1923; it closed in 1936. Frank Morrison operated a trading post at Rocher River from 1924 to 1932; Ed DeMelt was there from 1935 until he sold to the Taltson River Trading Company in 1968.

Rival traders also operated posts in the immediate vicinity of Rocher River as well as much farther up the Taltson in the area northeast of Fort Smith. Posts close to Rocher River were built at Snuff Channel and Rat River (Areas 1B2 and 1B3 in Figure 9.6.4) and operated from the late 1920s through to the early 1940s.

Much farther up the Taltson River, approximately three kilometres above Napie Falls (1B4), Fred Robinson operated a post from 1933 to 1940. To the south, trading posts operated at Hanging Ice Lake (1B5) and Star Lake (1B6) from 1925 to 1927. Thekulthili and Nonacho lakes, near the upper reaches of the Taltson, had trading posts (Areas 1B7, 8 and 9 in Figure 9.6.4) that operated from the mid-1920s through to the early 1940s.

This was obviously a rich trapping area, yet the worldwide economic effects of the Second World War resulted in the closing of these outlying trading posts, and the years immediately following the war brought considerable change to the region east of the Slave River. The federal government built a school at Rocher River and began to enforce compulsory school attendance laws. Dene moved from outlying regions into Rocher River so their children could attend school while maintaining traditional trap lines and hunting territories on the east side of the Slave River delta and up the Taltson, Thoa and Tazin rivers. The community prospered; it had grown from a small Hudson's Bay Company trading post built in the early 1920s to a place that, by the mid-1950s, had two stores, a post office, a school and a population approaching 150.

In 1958, the school and teachers' residence burned to the ground and the federal government made the decision – likely based on a desire to consolidate and centralize services at Fort Resolution – not to rebuild. To comply with the law, families with school-age children were forced to move from Rocher River; most relocated to Fort Resolution, Fort Smith, Hay River or Yellowknife. The Hudson's Bay trading post and store at Rocher River closed in 1963 and construction of the Taltson River dam, which some "Rocher River people" claim flooded traditional trapping areas, added further impetus for people to move from the area.

Mr. Burke's (1981) statement at the NWT Water Board hearing in 1981 suggests there were ulterior reasons for the demise of Rocher River and suggested the Water Board locate,

> *…"such information on the Rocher River and as to why it was relocated, it could be in mission documents, it could be in Department of Indian Affairs files someplace in Yellowknife or in Ottawa or in the archives, but this should be pulled out and examined and it's just over the last couple of years that people have really gotten concerned about the reason as to why Fort Fitzgerald, Alberta was moved, the people from Alberta were moved to Fort Smith, and the reason was clearly stated that it was because of the proposed hydro development on the Slave, and so the question does come up, why was Rocher River moved? Was it just a thing over schooling or was it something much more than that?"*

The historical record, summarized in the following section, gives strong evidence that those who call themselves "Rocher River people" are descendents of Franklin's "Copper Indians"; that until very recently, the lands they occupied east of the Slave River were within their traditional exploitive range; and, that they moved from those lands for reasons largely beyond their control.

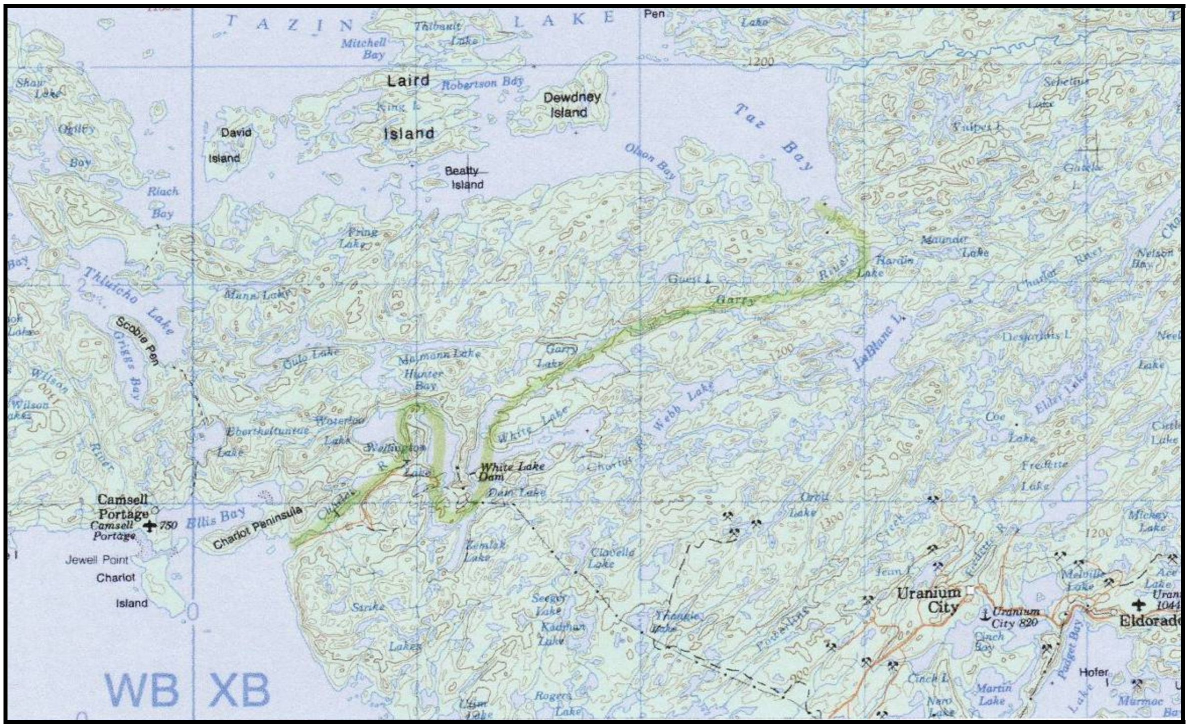
9.6.2.3 TAZIN RIVER DIVERSION

With the discovery in 1930 of pitchblende (uranium oxide) in the southeast corner of Great Bear Lake, prospectors quickly spread out over the north making discoveries on Yellowknife Bay (1934, gold) and on the north shore of Lake Athabasca (1934, gold and uranium). The Lake Athabasca gold discovery was developed by Consolidated Mining and Smelting Company (COMINCO, now Teck Cominco) during the mid-1930s. The nearby community of Goldfields was created and Cominco's Box Gold Mine began production in 1939. As part of this development, a dam was built at the outlet of White Lake, approximately 30 kilometres northwest of Goldfields. A 2.4 MW hydro station was built on Wellington Lake and water from White Lake was then diverted, presumably through a tunnel, to this station. A transmission line connected this Wellington Power Station with the mine and community at Goldfields, but this only lasted a few years as the Box Gold Mine closed in 1942.

In 1949, Eldorado Mining and Refining Limited (a Crown Corporation) began to develop the uranium deposits in the Goldfields/Beaverlodge and Eldorado areas. In 1952, to house workers and their families, work began on the model northern community of Uranium City. Some of the buildings from the nearby abandoned community of Goldfields were moved to the new town site. To supply power to its mine operations and this community, Eldorado Mining took over operation of the hydro station at Wellington Lake. Their mining and milling operation at Beaverlodge went into production in 1953. Two years later Gunnar Mines Limited, a private uranium mining company, also began production in the Beaverlodge area and was followed in 1957 by the Lorado Uranium Mine. Other small Beaverlodge mining operations, described in the literature as "numerous," fed the Eldorado and Lorado mills.

The generation of electricity from the Wellington Power Station proved inadequate for this frenzy of mining activity on the north shore of Lake Athabasca. In 1958 Eldorado Mining developed a plan to divert water from Tazin Lake, north of Lake Athabasca, into the Garry River and through White Lake to the Wellington Power Station. They built an earth-fill dam at the west end of Tazin Lake (at 59º 48' N, 109º 25' W), essentially preventing most or all water from entering the Tazin River. Raising the level of Tazin Lake allowed for the removal of water at Taz Bay (see map in Figure 9.6.5) on the southeast corner of the lake. This water, again presumably flowing through a tunnel, fed the Garry River and ended up in White Lake; from there it flowed through the penstock to the Wellington Power Station, continuing downstream through Waterloo Lake to the Charlot River. In 1959 Eldorado Mining, with the available increased water flow, was able to add an additional 2.4 MW generator (SaskPower 2008) to their Wellington Power Station.

Figure 9.6.5 — Route of Water Diverted from Tazin Lake to Lake Athabasca



In 1961, Eldorado again increased the generating capacity of the area by building a dam and power plant at the outlet of Waterloo Lake, a short distance downstream from their Wellington station. The Waterloo Power Station had a generating capacity of 8 MW.

In 1980, the generating capacity of the Garry/Charlot drainage system was again increased when Eldorado Mining, which by then was known as Eldorado Nuclear Ltd., built a dam and power station on the Charlot River downstream from Waterloo Lake. Two generating units, with a combined capacity of 10 MW, were installed at the Charlot Power Station, bringing the total generating capacity of the entire system to just under 23 MW. The volume of water flowing through these three power plants (and much of it presumably diverted from Tazin Lake) is reported by Ghassemi and White (2007) as 28 m^3/s. This rate is elsewhere reported as 0.89 km^3/year (National Water Development Agency 2008). By comparison, the volume of water diverted from the Caniapiscau and East Main rivers into the La Grande River in Quebec is reported as 50.14 km^3/year.

With the dramatic decline in the price of uranium in the early 1980s, Eldorado Nuclear closed its mine near Uranium City. In 1982, much of the community was also closed and the Wellington, Waterloo and Charlot River Power Stations were mothballed. In the mid-1980s the Saskatchewan Power Corporation acquired these power stations, brought them back online, and built a 138 kV transmission line connecting their output to the grid in southern Saskatchewan.

The effect of the 1958 construction of the dam blocking the natural outlet of Tazin Lake, and therefore providing the volume of water required to operate the power stations on the Charlot River drainage system, has been dramatic. In 1995 canoeists travelling across Tazin Lake and down the Tazin River described seeing a "large concrete dam blocking all drainage from [Tazin] lake" and after crossing this dam attempted to launch their canoes in the Tazin River immediately below the dam but found it was "four inches deep which included three inches of algae" (Peake 2008).

Jesse Jasper's presentation (1982) at a NWT Water Board public hearing in Fort Resolution confirmed the effects of the Tazin diversion by Eldorado when he said,

> *"[i]n 1939 Eldorado built a dam at the outlet of Tazin Lake and prior to that there was a few years of information collected on outflows from Tazin Lake. Since 1939 there have been records of lake levels collected. According to Eldorado, they are required to release a maximum of 100 cfs, mainly through seepage, through the dam. In certain years when the level of the lake is high enough there is also discharge over the spillway.*
>
> *According to Eldorado, and also according to the study conducted for N.C.P.C. by Pearce Bowden, since 1969 and up to 1973, when the study was done, very little flow occurred over the dam. The water levels, or precipitation, was low and there was no flow, basically, over the dam other than a small amount of seepage. Presumably, I think from the records on it, the Taltson River at Tsu Lake since 1969, it is probable only in 1975, and perhaps in 1974, that there was significant flow over the dam. So, basically, the information is that since 1939 there has been little flow out of Tazin Lake and since 1969 very little at all other than the seepage through the dam. So, basically, the entire flow of the Tazin River has been diverted to a river called Charlotte River and then into Lake Athabasca. The Tazin Lake at that point is roughly 3900 square miles, which is approximately one-sixth of the area of the total Taltson watershed. So flow from one-sixth of the watershed has been diverted and no longer flows through Tsu Lake and is measured at that point."*

9.6.2.4 Existing Twin Gorges Generating Facility

The existing Taltson Twin Gorges facilities were planned and constructed by the Northern Canada Power Commission and commissioned in 1965 to supply the Pine Point Mine with electrical power. The facilities were transferred to NTPC in 1988. Yewchuk's presentation at the August 13, 1974 NWT Water Board public hearing provided an overview of the Twin Gorges generating facility. His words follow:

> *"In the early sixties, the announcement by Cominco that they would be proceeding with the development of their mine at Pine Point sparked investigations of various power sources. Of the various possibilities, the Taltson River site at Twin Gorges, about 35 miles northeast of Fort Smith was judged to be the best choice. Some of the features which made this site attractive was sound foundation, good natural regulation, and storage potential, as well as the possibilities of applying both Fort Smith and Pine Point by one 170 mile transmission line at 115 kV.*
>
> *The construction of the plant and transmission line started early in 1964. The plant was commissioned on October 29, 1965. As the demand for power increased at both Fort Smith and Pine Point, a better control of*

water flow to the plant was needed. This was accomplished by the construction of a rock-fill storage dam at the outlet of Nonacho Lake during the winter of 1967-68."

In 1981, at a NWT Water Board Hearing in Fort Resolution, Frank Laviolette (1982) presented his concerns with the then-existing Twin Gorges and Nonacho Lake facilities. He said,

> *"I cannot see where they're going, even the past 19 years, what damage they've done to the country. I can hit a few points. I had spent something like nine, ten years along the Taltson River from September to late November, December along the summer Resolution traplines just above Lake. I seen, especially one time, what was the rat population was coming back thick, very thick, thick as it's been for the last probably 40 years, and during the winter there should have been a heck of a lot of muskrats on the Spring and Taltson River, but because of that dam and letting out water, water rushing through the wintertime, it drowned all the muskrat which means thousands of dollars lost; the trappers didn't get anything. The same thing in Fort Smith, maybe it's not worth sitting here for, but as far as Fort Smith and the Slave River, that dam in Peace River, the same thing happened there a few years ago. In the fall in the Snize and the Salt River where we figured next spring was a big spring for the muskrats because the low water in the sloughs, the snow and rain wasn't so much for years. The water came up seven feet in November after freeze-up and there wasn't one bloody rat swimming next spring in the Snize and the Salt River. This is how much it affects."*

R. Boucher (NWT Water Board, 1981) reiterated public concern regarding the 1965-1966 Twin Gorges and Nonacho Lake facilities when he said,

> *"it seems like N.C.P.C. put up that dam not even thinking about the people that are living downstream; and the people that are living downstream are not getting any benefits from that dam either except for what you see here, you know. And that's our livelihood, like Frank was saying, that's where we make our living out there. It's getting worse and our rat population has gone right down to just about nothing now where in the olden days, you can look at the game files, where people used to come in with a thousand rats per trapper and stuff like that. So it's really having a lot of effect on the downstream people."*.

9.6.2.5 CONCLUSION

The proposed Project is embedded in a socio-economic and cultural context that has undergone significant changes in the last 80 years. In 1939, the Tazin River was diverted, in the 1950s Canada became increasingly involved in the livelihoods of Aboriginal people, and then, in 1964-65 the existing Twin Gorges and Taltson facilities were constructed to supply electrical power to the Pine Point Mine. Underlying these external forces that shaped the livelihoods of Aboriginal people in the South Slave region were the territorial rivalries between Aboriginal peoples. They began with the Cree, who took revenge on their traditional enemies the Chipewyan; when they too became armed, they pushed north-westward from their traditional lands along the Churchill River, forcing Slavey, Dogrib, Beaver and Tatsanottine from their land. When trading companies moved onto the Athabasca and Slave rivers in the late 1700s, guns became readily available to the Tatsanottine. They quickly gained a reputation for their aggressive behaviour and for taking revenge on their traditional enemies, the Dogrib and the Chipewyan.

The Project is not the root of the lingering legacy issues that have shaped the socio-economic and cultural context of the Project. It is, however, an additional element in the unfolding history of the region whose effects can be either beneficial or adverse. In the past, affected Aboriginal people had little influence over the external development forces that shaped their lives. This is no longer the case as evidenced by the proposed Project itself, wherein the Dezé Energy Corporation consists of the Akaitcho Energy Corporation (AEC); the Métis Energy Corporation (MEC); and the NWT Energy Corporation (03) Ltd.; each with a share of ownership in the company.

The Dezé Energy Corporation brings together groups that historically were reluctant to enter into joint business development agreements. It represents a unique opportunity for the creation of a sustainable business opportunity in the South Slave region of the NWT – a region where economic growth has lagged behind that growth witnessed across much of the territory as a whole.

9.6.3 Communities and Regional Economics

Most of the Aboriginal residents of the South Slave region are descendents from the Chipewyan, part of the broader Dene (Northern Athapaskan) linguistic group. In 2005, the South Slave region had a population of approximately 7,457 persons, of which about 60% were Aboriginal (GNWT 2007). A large proportion of the population in the South Slave region is in the 25 to 59 year-old cohort, indicating that nearly 51% are either already in, or are currently entering their prime working years (GNWT 2007).

The population of all South Slave communities except the Hay River Dene Reserve has declined over the last ten years. For example, between 1996 and 2007, Fort Resolution's population declined by 56 (9.9%) persons, Fort Smith by 128 (5%), Hay River by 143 (3.8%) and Łutsel K'e by 42 (10%) from its peak of 421 in 2004. Meanwhile, between 1996 and 2007, the Hay River Dene Reserve grew by 37 (13.9%) persons (Bureau of Statistics 2008). There is a distinct out-migration trend that, if left unchecked, could erode the economic viability and livelihood choices of the South Slave region communities.

The proportion of the South Slave region population holding at least a high school diploma has been trending upward over the past decade. However, the average still lags behind that of the NWT and Canada. If the communities of Łutsel K'e, Fort Resolution and the Hay River Reserve are excluded, the level of educational attainment in Fort Smith and Hay River more closely matches the Canadian average (GNWT 2007). In the South Slave region, about 67% of adults have a high school diploma. This is identical with the overall rate in the NWT.

Most employment in the South Slave region is concentrated in public sector services such as government, health, and education, except in Hay River where other industries account for 45.5% of employment activity (GNWT 2007). Fort Resolution, Łutsel K'e and the Hay River Dene Reserve consistently trail Hay River and Fort

Smith with respect to employment rates. Study area communities are characterized by small economics that produce few new employment opportunities.

Average employment and average household incomes in Fort Smith, Łutsel K'e and Fort Resolution are below those of the NWT. There is also a distinct divide in average family income, with the average family income in Fort Resolution and Łutsel K'e about half of that in Hay River, Fort Smith and the NWT. The trend in lone-parent average family incomes mirrors that of average family incomes in the South Slave region with one notable exception: lone-parent average family incomes are notably lower.

Incidents of crime in the South Slave region increased from about 1999 to 2004, and then plateaued. This mirrors the trend in the NWT. Conversely, incidents of crime in Łutsel K'e have remained stable over the same period, while Fort Resolution has the highest rate of all South Slave region communities at nearly 1,000 incidents per 1,000 persons.

A total of 383 individuals are identified as unemployed in the South Slave region, with a further 1,515 identified as not in the labour force. This latter group includes individuals who have ceased to look for work. In many smaller communities, one reason people may be listed as "not in the labour force" is that they have stopped looking for work as there are no jobs to find. Presumably, when Project jobs do become available, some of the persons in this category would once again begin looking for work.

The South Slave region's short-term economic outlook is neutral, as the prospects for development of mining and oil and gas projects are limited. The South Slave region is expected to grow slightly between 2007 and 2012. This would add about 150 persons during this time. This anticipated growth rate falls below the NWT average. The South Slave region also has the least demand for additional workers in the next five years.

The proposed Project is located in a remote area with limited access. Access into the study area is provided by winter roads, air travel, and marine services. Winter roads within the Project footprint include part of the Tibbitt to Contwoyto winter road, which links Tibbitt Lake (70 km east of Yellowknife) to the Lupin Mine on Contwoyto Lake, Nunavut. There is a winter road from Fort Smith to Twin Gorges, which has been out of commission for over a decade. Air traffic and marine services also provide services into the Project footprint.

9.6.4 Traditional Land and Resource Use

In the NWT, traditional lifestyles consist of hunting, trapping, fishing and gathering of plant resources from the land. Traditional harvesting has declined in most Aboriginal communities in part due to lifestyle changes and access to alternative food sources. Nonetheless, engaging in traditional activities remains vitally important to Aboriginals and their families.

Indicative of the importance of traditional harvesting to Aboriginal people, "[i]n most areas approximately 90% of households consume harvested meat and fish. The South Slave area at 74.9% of households and Yellowknife at 63.7% have lower percentage of households consuming harvested meat and fish. In the Sahtu, Tlicho and Dehcho areas, more than 40% of households indicated that most or all of their meat and fish was obtained through hunting and fishing" (GNWT Bureau of Statistics 2002).

GNWT grants and contributions in support of the fur industry have increased over the same period. The trend suggests trapping is increasingly becoming a part-time cultural and recreational pursuit. Paralleling the decline in trapping, there appears to be a decline in the consumption of harvested meat and fish (except Fort Resolution) suggesting increased reliance on purchased food and engagement in wage-oriented activities.

Łutsel K'e appears to be the most traditional community in terms of engaging in traditional subsistence harvesting activities, followed closely by Fort Resolution and not so closely by Fort Smith. This is not unexpected, given the comparatively isolated nature and limited employment opportunities in Łutsel K'e in relation to Fort Smith and Fort Resolution.

In the NWT, hunting, trapping, fishing and the gathering of resources from the land is the cultural expression of Canada's Aboriginal people. Over time, that expression has changed in response to the socio-economic effects associated with European exploration, the fur trade, and permanent settlement life. That change has not lessened the cultural, spiritual and personal value of hunting, trapping, fishing and gathering resources from the land. Rather, it has intensified Aboriginal people's concern about the well-being of their culture and identity.

Traditional livelihood practices are well represented in Łutsel K'e and Fort Resolution, and less so in Fort Smith. Overall, the South Slave is one of the most traditional regions of the NWT in terms of participation in traditional activities, and Łutsel K'e is one of the more traditional communities in the South Slave region as evidenced by its residents' consumption rate of harvested meat and fish. The trappers who sell their furs are doing better in that their average returns have increased for the species most harvested, including muskrat, marten, and beaver. However, the need to participate in traditional livelihood practices is declining, as is the number of trappers selling furs, and the household consumption rate of harvested meat and fish. Consumption of harvested meat and fish continues to be focused on caribou, moose, beaver, muskrat, whitefish, trout, loch, grayling and northern pike. Ducks and ptarmigan are popular in their own season.

It appears that hunting and trapping is now a livelihood strategy that provides significant social, cultural and dietary benefits, and to a lesser extent, financial returns. In the north, the value of resource harvesting and all it represents has not diminished – but it has changed. Once resource harvesting was the dominant livelihood strategy. In 2008, it is only one among several livelihood strategies that individuals, families and communities choose to exercise. Those choosing resource harvesting as a livelihood strategy are supported financially by GNWT grants and contributions designed to help sustain the NWT fur industry.

The information in this section was synthesized from existing documents and Traditional Knowledge provided over the course of the Project design. It encompasses research related to traditional land and resource use, as it relates to First

Nations and Métis populations in the Project area. These populations include Łutsel K'e, Fort Resolution and Fort Smith communities, whose harvesters would be most likely affected by the proposed Project.

9.6.4.1.1 Overview of Traditional Harvesting Activities

The importance of trapping to the economy of the South Slave region is illustrated in Table 9.6.2, which compares revenues from trapping in the South Slave to those of the entire NWT. In 2005-06, the South Slave region accounted for about 27% of the NWT total income generated from trapping.

Table 9.6.2 — Revenue from Trapping, Comparing South Slave region to NWT for 2005/06

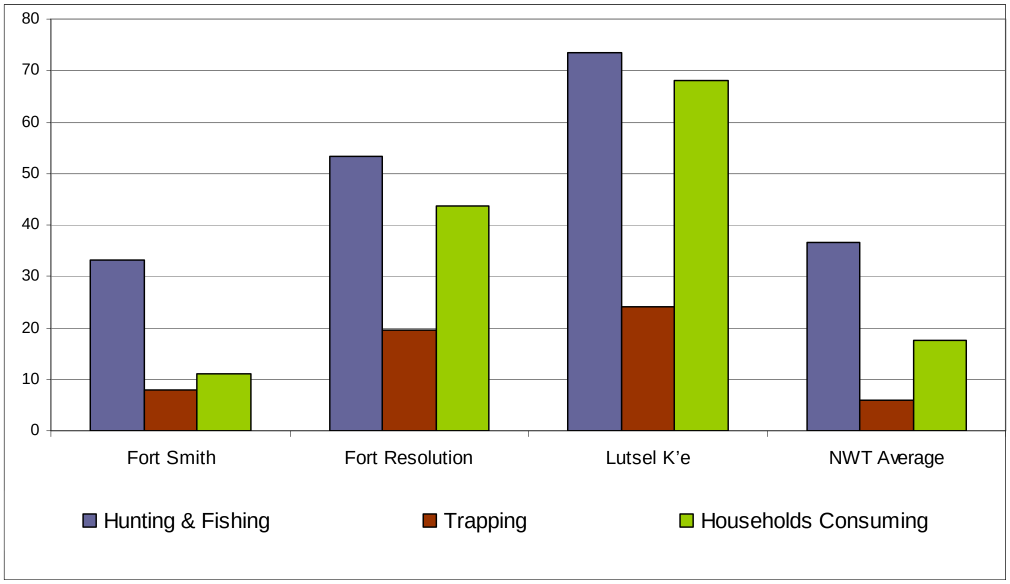
Area	Total Value Sold	Fur Bonus	Grubstake	Total Income
South Slave region	$344,962	$99,215	$35,950	$480,127
Northwest Territories	$1,400,604	$252,577	$94,670	$1,747,852

Source: Dezé 2007a

In the NWT, traditional lifestyles consist of hunting, trapping, fishing and gathering of plant resources. Traditional harvesting has declined in most Aboriginal communities, partially due to lifestyle changes and access to alternative food sources. However, engagement in traditional activities remains vitally important to Aboriginal families.

Indicative of the importance of traditional harvesting to Aboriginal people, "[i]n most areas approximately 90% of households consume harvested meat and fish. The South Slave area at 74.9% of households and Yellowknife at 63.7% have lower percentage of households consuming harvested meat and fish. In the Sahtu, Tlicho and Dehcho areas, more than 40% of households indicated that most or all of their meat and fish was obtained through hunting and fishing" (GNWT Bureau of Statistics 2002). Figure 9.6.6 indicate that the percentage of population involved in traditional activities is higher in Łutsel K'e and Fort Resolution than in Fort Smith and average NWT households.

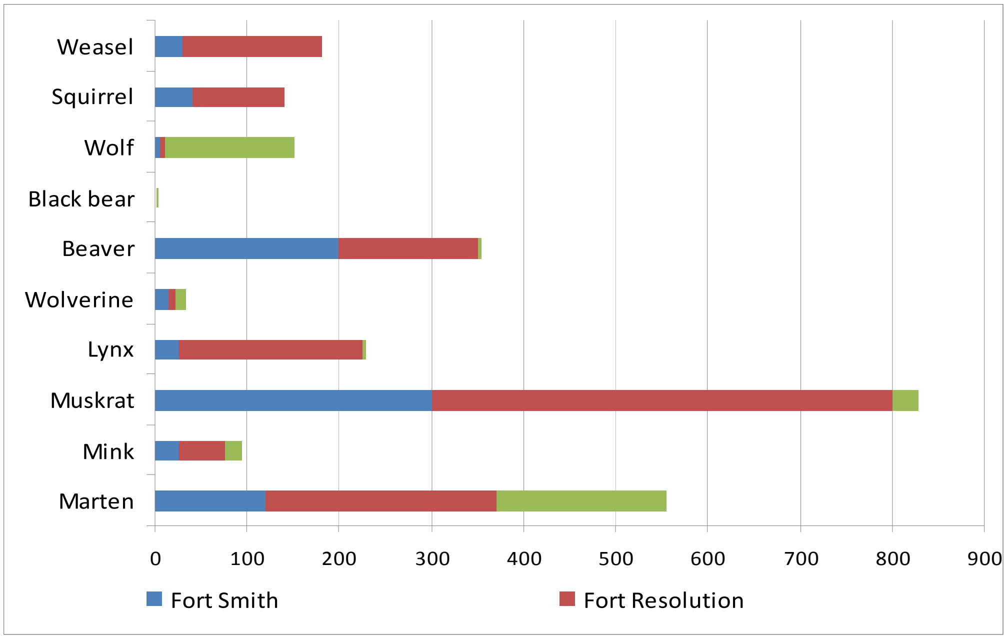
Figure 9.6.6 — Percentage of People 15 Years of Age or Older, Engaged in Traditional Activities in 2007



Source: NWT Bureau of Statistics (2008)

In addition to being a source of country foods, trapping also provides an income through fur sales, focusing mostly on marten, muskrat and beaver pelts. Residents of Łutsel K'e harvested mainly marten and wolf species. Fort Resolution accounted for most pelts harvested in 2005-06 in the South Slave region. Harvest statistics for all three communities for 2005-06 are shown in Figure 9.6.7.

Figure 9.6.7 — Pelts Harvested by Type and Community in 2005-06



Source: Dezé (2007a)

As an intermediary fur buyer, the GNWT Department of Industry, Tourism and Investment (ITI) maintains fur harvest records. The records report the type and quantity of species harvested and the sale value of furs. The information is maintained for each trapper. Only aggregate information is publicly available, therefore safeguarding the confidentially of the trappers. Table 9.6.3 shows the number of trappers that sold furs to the GNWT in 1995 to 1996 and between 2006 and 2008, and Table 9.6.4 indicates the economic return from the sale of furs. There is a consistent trend of fewer individuals from the RSA communities engaging in fur harvesting activities. Conversely, trappers are seeing an increase in financial returns, particularly in Łutsel K'e and Fort Smith communities.

Table 9.6.3 — Number of Trappers Selling Fur to the GNWT

	NUMBER OF TRAPPERS			
	1995/1996	2005/2006	2006/2007	2007/2008
Łutsel K'e	57	28	26	15
Fort Resolution	69	53	48	43
Fort Smith	46	30	24	26

Source: F. Rossouw Department of Industry Tourism and Investment, personal communication, August 15, 2008. NWT Resources, Wildlife, and Economic Development, 1996a and 1996b.

Table 9.6.4 — Fur Sales Information

Community	1995/1996			2006 to 2008 (3 WINTER SEASONS)			
	Number of Trappers	Total Returns from Furs ($)	Average Return per Trapper ($)	Number of Trappers	Total Returns from Furs ($)	Average Annual Return from Furs ($)	Average Return per Trapper per Year ($)
Łutsel K'e	57	33,385.61	585.71	23	66,626.63	22,208.88	965.60
Fort Resolution	69	136,100.56	1,972.47	48	119,639.59	39,879.86	830.83
Fort Smith	46	76,944.93	1,672.72	30	354,624.68	118,208.23	3,940.27

Source: F. Rossouw Department of Industry Tourism and Investment, personal communication, August 15, 2008. NWT Resources, Wildlife, and Economic Development 1996a and 1996b.

Stabler et al. (1989) found that trappers making $2,316 (constant 2006 dollars CIP factor 1.158) or less viewed trapping mainly as a part-time occupation, depending on the availability of wage employment and the severity of the winter. However, the participation of trappers with real gross production of $2,316 or more would increase trapping during high-return periods. The individuals whose primary source of income was trapping had the greatest commitment to the trapping industry. Their participation is directly related to the income-generating potential of the trapping activity (Stabler et al. 1989).

9.6.4.1.2 GNWT Support of the Trapping Industry

The GNWT Department of Industry, Tourism and Investment provides grants and contributions in support of the NWT fur industry. Over twelve years (1995-96 to 2006-07) the number of pelts harvested and sold and the value of those furs in constant 2006 dollars has declined in all RSA communities (Table 9.6.5). GNWT grants and contributions in support the fur industry have increased over the same period. The trend suggests that trapping is becoming increasingly a part-time cultural and recreational pursuit. Paralleling the decline in trapping, there appears to be a decline in the consumption of harvested meat and fish in communities except Fort Resolution, suggesting increased reliance on purchased food and engagement in wage oriented activities.

Łutsel K'e appears to be the most traditional community in terms of engaging in traditional subsistence harvesting activities, followed by Fort Resolution and Fort Smith. This could be explained by the comparatively isolated nature and limited employment opportunities in Łutsel K'e in relation to Fort Smith and Fort Resolution.

Table 9.6.5 — Grants and Contributions in Support of Community Harvesters in the South Slave Region

Programs [1]	2005/2006			2004/2005		
	Łutsel K'e	Fort Resolution	Fort Smith	Łutsel K'e	Fort Resolution	Fort Smith
Community Harvesters Support Program	13,500	22,837	18,104	13,500	37,582	21,344
Fur Pricing Program	6,247	45,938	38,664	1,140	2,745	109,456
Western Harvesters Support Program	71,000	0	105,000	71,000	0	200,000
Local Wildlife Committees	14,000	0	8,400	14,000	-2,250	8,400
Trappers Training	5,000	3,000	9,000	1000	1000	20,000
Support to the Fur Industry	0	0	0	0	0	0
Total	**$109,747**	**$71,775**	**$179,168**	**$100,640**	**$39,077**	**$359,200**

Source: F. Rossouw (Department of Industry Tourism and Investment), personal communication, August 15, 2008

[1] The program expenses also include shipping cost, auction sales commission, drumming (cleaning) and debt, which are not reflected in these numbers.

9.6.4.1.3 Traditional Land Use in Łutsel K'e

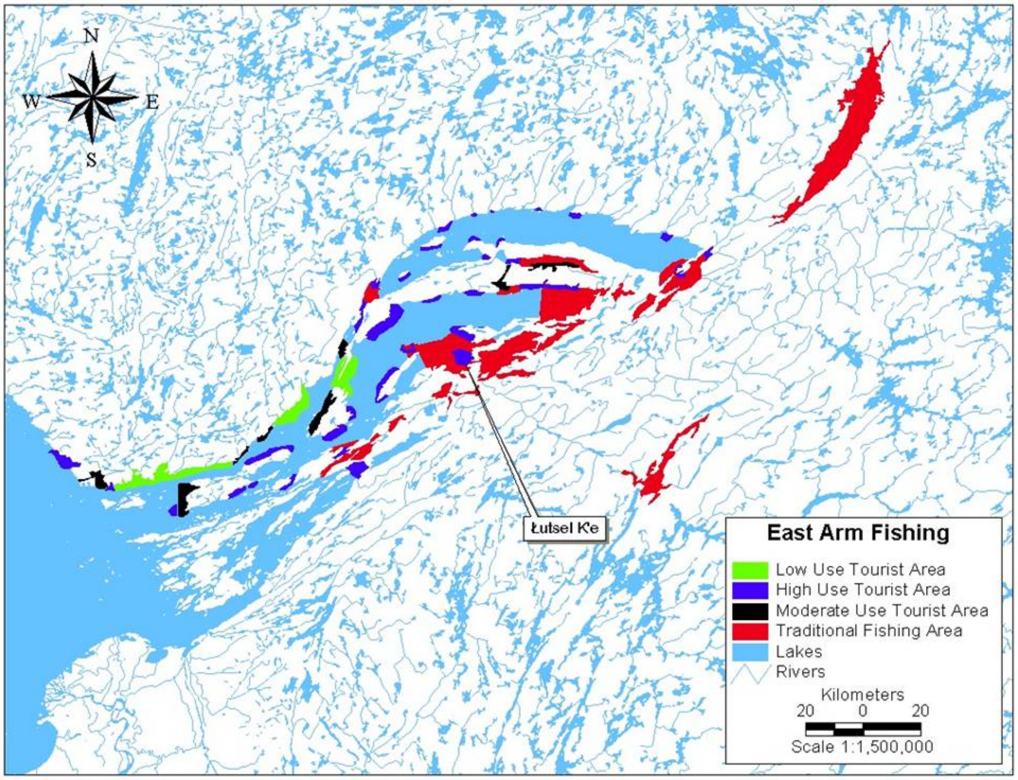
Traditionally, subsistence harvesters in the Łutsel K'e area were nomadic and followed the movements of wildlife. Spring harvesting focused on muskrats, summers and the early fall were often spent in the barren lands harvesting caribou, while fall was spent smoking and drying fish for the winter. During winter, trappers visited the barren lands to harvest all types of fur (LKEAC 2002).

Although being a more traditional community, Łutsel K'e had experienced declines in traditional activities. Łutsel K'e elders report that fishing was a daily necessity in the past, as fish were required to feed a harvester's dog team (five to seven fish per day would be sufficient to feed seven dogs). With the replacement of dog teams by snowmobiles, fishing became less frequent (LKEAC 2002).

9.6.4.1.3.1 Fishing

Although fishing has declined in Łutsel K'e, it is possibly the most pronounced form of traditional resource harvesting (LKEAC 2002). In areas of abundance, subsistence needs are quickly met by gillnetting. On the Snowdrift River, for example, fish are so abundant that one or two days of netting can provide enough food for an entire season (LKEAC 2002). In fact, fish resources are often so abundant that fishermen often welcome "snarls" in their nets, as this prevents them from catching too much fish. One informant suggested that jackfish is particularly easy to catch and can be harvested with an old bag or "even with your socks" (LKEAC 2002). Figure 9.6.8 shows the prime netting and fishing areas reported by Łutsel K'e.

Figure 9.6.8 — East Arm Fishing Locations Map



Source: LKEAC (2002)

Whitefish (*Coregonus clupeaformis*) and cisco (*Coregonus artedi*) are often used to bait trout and moria (*Lota lota*) when angling (LKEAC 2002). Moria (burbot) is a food preferred by elders and is usually found in shallow bays and muddy/grassy areas along the shore. This species is rare compared to whitefish and trout, which are typically caught in gillnets set by community members (LKEAC 2002). In addition to the use of nets and angling, traditional fishing techniques include the use of spears and baited traps (such as hooks rigged inside of a hollow log). In winter, fishers may jig through a single hole (ice fishing) or set gill nets beneath the lake ice by using a series of holes.

Myles Carter (2008), owner and operator of the Nonacho Lake Fishing Lodge, provided local knowledge of Nonacho Lake. Mr. Carter noted that prior to the installation of the Nonacho facility lake trout, northern pike, white fish, suckers, maria/ling cod (local name) and grayling were present in Nonacho Lake. Subsequently, all but grayling species remained in the lake.

With respect to Nonacho Lake, Mr. Carter (2008) noted that:

- Arctic grayling were abundant in Nonacho Lake before the flooding of Nonacho and the Taltson dam; currently no grayling are found in the system.
- Lake trout remain in the shallow waters until July. They move to deeper waters after the water begins to warm.

- In June, lake trout are caught in the shallower areas at the edge of the drop-off. They are harder to catch as they are spread along the large shoreline.
- In August, lake trout are found in the deepest areas of the lake. They are easy to catch as they congregate in these areas.
- Pike of various sizes are found along the lake margins. They are never caught in the open and deeper waters.
- Water fluctuations increased in the recent years, possibly due to the decreased control of the sluice gates. High flows typically occur in June. The water level in June (2008) was lower than in typical years.

Mr. Carter believes the overall health of the fish populations is good, but that fish in Nonacho Lake have more lesions, parasites, and cysts than before the construction of the Nonacho Lake facility. He has also noticed fewer fish in the 15-20 lbs range (accounting for trout growth rates, the age of this group approximately dates back to the Taltson facility installation). Fish behaviour, however, has not changed except for timing of the fish migration into deeper water and their return to spawn.

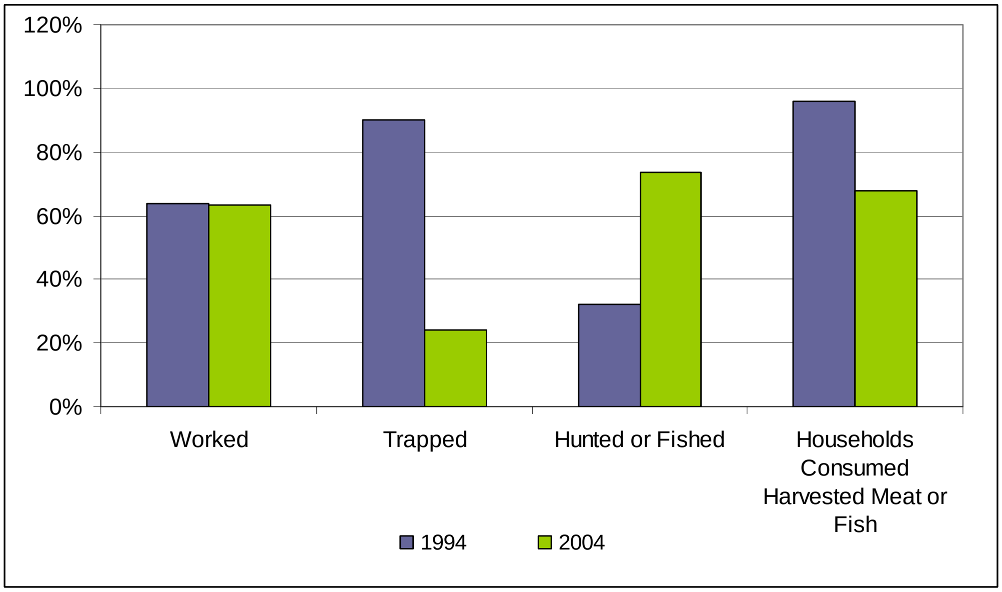
> *"It seems like they start going deeper earlier mid-July, (used to be end of July/1st part of August), and don't start to come back into the shallows until first part of September (previously it was the end of August)."*

Mr. Carter did not notice any changes to other species such as beaver, muskrat or waterfowl, but received information about trappers from Łutsel K'e speaking about trap lines affected by the Taltson facility.

9.6.4.1.3.2 Hunting and Trapping

As shown in Figure 9.6.9, trapping and household consumption of harvested meat and fish in Łutsel K'e has declined. At the same time, the rate of wage employment remained stable, and the percentage of residents hunting or fishing increased. This may indicate the shift from the communal hunting and fishing to the individual harvesting of country food. It is also possible that comparatively low fur prices during this period discouraged trapping and shifted activity to hunting and fishing. There is a low certainty regarding the cause of changes to people's meat and fish consumption in Łutsel K'e, as there are significant complex socio-cultural relationships that are not captured by statistics.

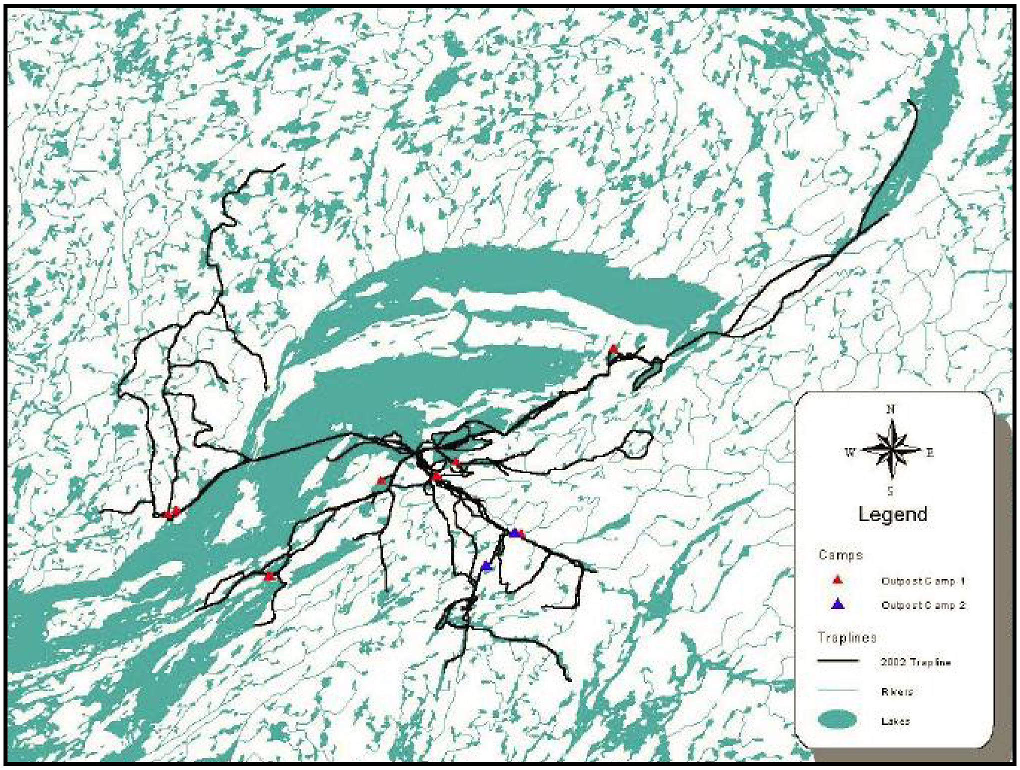
Figure 9.6.9 — Participation in Traditional Economy in Łutsel K'e (1993 to 2004)



Source: NWT Bureau of Statistics (1994 and 2006)

For a number of years income from fur selling was low, possibly causing a shift towards a part-time occupation. The total income from furs in the South Slave region was lower than the total amount of government grants and contributions. However, trapping is seldom carried out in isolation from other productive harvesting activities. While out on a trap line, a harvester could also hunt and fish for food in addition to harvesting for commercial or cultural purposes. Figure 9.6.10 shows the locations of traplines and indicate the spatial extent of trapping undertaken by residents of Łutsel K'e.

Figure 9.6.10 — Small Mammal Traplines in Winter 2002/03



Source: LWLED (2003)

In the NWT, Aboriginal hunting and gathering areas are often part of a long historical chain of extended family stewardship, where each extended family has a community-recognized management responsibility of an area. The shared use by other families is dependent on consent of the managing family.

Table 9.6.6 reports Łutsel K'e fur harvest/sold from 1995 to 1996, and 2006 to 2007. Over this 12-year reporting period, harvest levels declined by about 36%, and income from fur sales declined about 26%. Marten pelts provided the greatest source of income.

Table 9.6.6 — Hunting and Trapping (General Hunting Licence Holders): 1995/96 and 2006/07

Pelts Sold by Species	1995/1996	2006/2007	2006/2007
	Harvest/ Sold	Harvest/ Sold	Sold Price ($)
Black bear	6	1	119.90
Beaver	17	2	52.32
Coyote	0	0	0
Ermine	2	0	0
Fisher	0	0	0

Pelts Sold by Species	1995/1996	2006/2007	2006/2007
	Harvest/ Sold	Harvest/ Sold	Sold Price ($)
Red fox	14	0	0
Silver fox	0	2	115.77
White Fox	0	1	22.7
Lynx	1	1	101.76
Marten	321	275	21,813.02
Mink	54	48	943.06
Muskrat	136	25	171.25
Otter	10	0	0
Northern flying squirrel	0	3	6.81
Red squirrel	0	0	0
Wolf	14	3	614.65
Wolverine	4	7	1,507.53
Total harvest/sold	**579**	**368**	
Total Returns from Furs	**$34,385.61**[1]		**$25,468.77**
Total Contributions from RWED / ITI	**$18,675.00**[1]		**$109,747**
Constant 2006 dollars CIP factor 1.245[2]			

Sources:

[1]F. Rossouw Department of Industry Tourism and Investment, personal communication, August 15, 2008; and, NWT Resources, Wildlife, and Economic Development, 1996a and 1996b

[2] http://www.uleth.ca/analysis/CPI/PDF/canada.pdf

Hunting and trapping also occurs at Fort Reliance, an outpost that is used by a local trapper to harvest tundra wolves and wolverine. Fort Reliance is an outpost camp that has historic value, but is not an RSA community. Harvest figures for Fort Reliance during 2006-07 were 104 Tundra Wolf and 50 Wolverine, with income of $24,351 and $8,309.63, respectively. (F. Rossouw, personal communication, August 15, 2008).

Based on client success forms for the Łutsel K'e Dene First Nation (LKDFN) outfitting license (non-resident big game), the Łutsel K'e Band holds the only license for big game hunts within Wildlife Management Unit U, and retains outfitting operators on their behalf and under their License. Big game outfitting in the Łutsel K'e area started in 1997. The total caribou quota is 150. The Department of Environment and Natural Resources has not issued any commercial tags for caribou in the last two years and does not track meat sales among GHL holders.

9.6.4.1.3.3 *Country Food Consumption*

In 1994, the Centre for Indigenous Peoples' Nutrition and Environment (CINE) at McGill University conducted a dietary survey of 1,012 individuals in 16 Dene/Métis communities. The major finding of the study was that "in no instance was the average contaminant intake above the guidelines for tolerable daily intake" (Receveur et al. 1996). The study results also provide valuable information regarding the relative contribution of country food to nutrition of RSA residents. The survey concluded that caribou, moose, rabbit, beaver, whitefish, trout and grayling were some of the most preferred species in Łutsel K'e.

9.6.4.1.3.4 *Traditional Knowledge of Harvested Resources*

Traditional resource harvesters have specific knowledge of the resources they hunt, trap, fish or gather, such as resources location, health or behaviour. This information can be valuable in the environmental assessment process. This section presents information pertaining to Łutsel K'e's Traditional Knowledge of harvested resources as researched, documented and reported by the residents of Łutsel K'e.

Fish

The original Twin Gorges hydroelectric Project was seen as the cause of many changes to fish and fish health. For example,

> *"Long ago at Nanula Tué before they build the dam there were good fish just like Great Slave Lake fish. Now they have a dam [on Nanula Tue] and fish are different. I remember before they build the dam I trapped around there….when the dam was built there – there were lots of changes. You can't eat the fish now because it's soft [and] skinny (PM 1999)."* (Łutsel K'e Dene First Nation 2001).

The fish from Stark Lake (typically whitefish and trout) are generally known by the residents of Łutsel K'e to be less healthy (with higher levels of disease and parasitism) than fish from other areas (LKEAC 2002). Community informants mentioned the physical condition (thinness, unusual proportions - "big heads with small tails") and lack of taste, compared to fish from elsewhere. However, limited fishing does occur on this lake because it is the first to freeze in the winter and the first to break up in the spring (it allows for safer harvesting during seasonal transition periods). The harvesters carefully inspect their catch and throw back any questionable fish. LKEAC (2002) notes that Łutsel K'e women often have considerable skill at assessing fish health because they immediately recognize any abnormalities after years of processing (drying and smoking) experience. In addition to the indicators noted above, odour and the condition of the liver (a small, white liver indicates sickness) also provide points of reference.

Opposite to Stark Lake fish, the large lake trout found in Great Slave Lake (GSL) are often felt to be almost too rich to eat. The preferred "family serving size" is a lake trout of 8 to 12 pounds (LKEAC 2002). Fish caught near Fort Reliance and along the northern shore of the East Arm have red flesh, good texture (firmness) and are generally considered to taste better than fish caught near the south shore and the community, which have a paler-coloured flesh. There is also a preference for female lake trout and whitefish, explicitly due to eggs and "tubes" associated with the reproductive system (LKEAC 2002). Noticeable differences were also observed between whitefish in McLean Bay (which are "bigger and different") and the rest of Great Slave Lake. Among the thirty interviews conducted by LKEAC (2002), one harvester reported that the health of trout has declined in the East Arm since the 1980s.

In reference to the general harvesting locations, Łutsel K'e elders reported that the wind influences fish movements by generating near-surface lake currents. During periods of strong wind, fish can be found on the leeward (sheltered) side of islands. Lake trout and jackfish (pike) are often found in shallow, grassy bays, and can be speared by harvesters at these locations (LKEAC 2002). After the spring ice break-up, trout feed near shore. During the late summer, when the water is at its warmest, large lake trout migrate into deeper, cooler water and thus become more difficult to catch (LKEAC 2002).

In the East Arm of Great Slave Lake, jackfish (*Esox lucius*) spawn in the spring (between late May and early June) whereas lake trout (*Salvelinus namaycush*) tend to spawn in the fall; however, in the Murky Channel area (near Łutsel K'e), trout and jackfish sometimes spawn at nearly the same time (LKEAC 2002). Adult fish in the East Arm can grow to be exceptionally large and the area is considered to offer world class sport fishing opportunities.

Caribou

Dragon (2002) noted the temperament (approachability) of individual caribou depends on the size of the herd and the ambient temperature. The animals tend to be more skittish in smaller groups or when the temperature is colder than normal (-35 °C to -55 °C) (Dragon 2002). Traditional Knowledge of caribou is discussed further in Section 9.5.4.2.3 – Caribou: Traditional Knowledge and Resource Use.

Plants

Aboriginal people in the RSA use plants as part of their traditional lifestyle for food (e.g., berries), ceremonial and medicinal purposes, shelter and other uses.

Plant species were not identified in the Traditional Knowledge specific to the Project. Table 9.6.7 provides a list of traditional plants potentially found in the Project area.

Table 9.6.7 — Traditional Plants Potential in the NWT

Common Name		Traditional Use	Reference
Trees	Aspen	Food, medicine, tools, fuel	Marles et al. 2000
	Black spruce	Food, medicine, shelter, fuel, tools	Andre and Fehr 2002
	Jack pine	Food, medicine, tools, shelter, fuel	Marles et al. 2000
	Paper birch	Food, medicine, tools, bait	Andre and Fehr 2002
	Tamarack	Medicine, fuel	Andre and Fehr 2002
	White spruce	Food, medicine, shelter, fuel, tools	Andre and Fehr 2002
Shrubs	Willow (various)	Fuel, food, tools, shelter, medicine, tobacco, insect repellent, moth ball, fire starter	Andre and Fehr 2002
	Black currant (black berries)	Food	Andre and Fehr 2002
	Blueberries	Food, medicine	Andre and Fehr 2002
	Bog birch (dwarf birch)	Flooring	Andre and Fehr 2002

Common Name		Traditional Use	Reference
	Cranberries	Food, medicine, dye	Andre and Fehr 2002
	Crowberries	Food, medicine	Marles et al. 2000
	Gooseberry	Food, medicine	Marles et al. 2000
	Green alder	Medicine, fuel	Andre and Fehr 2002
	Juniper (berries)	Medicine	Andre and Fehr 2002
	Kinnikinnick (bear berries)	Food	Andre and Fehr 2002
	Labrador tea	Food, medicine	Andre and Fehr 2002
	Lingonberry (bog cranberry)	Food, medicine, dye	Marles et al. 2000
	Raspberries	Food	Andre and Fehr 2002
	Rose	Food, medicine	Andre and Fehr 2002
Other	Cloudberries	Food	Andre and Fehr 2002
	Bulrushes	Food, medicine, baskets	Marles et al. 2000
	Liquorice root	Food	Marles et al. 2000
	Sphagnum (moss)	Diapers, cleaner	Andre and Fehr 2002
	Lichen	Food, medicine	Marles et al. 2000

The information on traditional plant use provided by Marles et al. (2000) and Andre and Fehr (2002) is consistent with the results of a 1993 research project on traditional Dene medicine completed by a research team composed of Marie Adele Rabesca, Diane Romie, Martha Johnson and Joan (Rabesca et al. 1993).

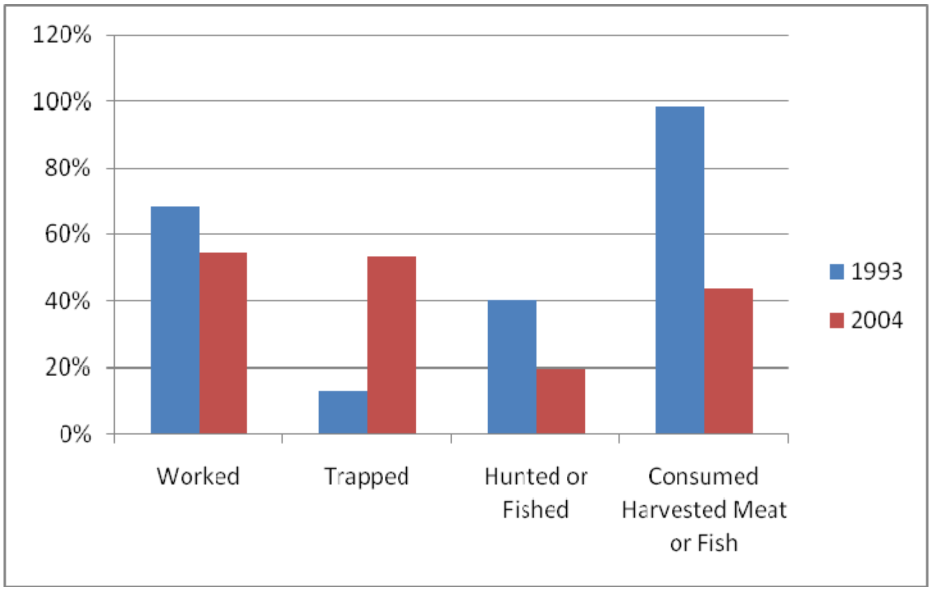
The analysis of plants associations found both north and south of the treeline in the taiga shield (south of the treeline) that were ranked high in terms of traditional plant potential included: deciduous and coniferous forest, wetland and riparian woodland. Burns, lichen-rock and disturbed sites were ranked low. North of the treeline, the plant associations that were ranked high in terms of traditional plant potential included: esker complex, riparian birch shrubland and heath tundra. Burn, wetlands, snowbanks and disturbed sites were ranked low.

9.6.4.1.4 Traditional Land Use in Fort Resolution

Almost the entire population of Fort Resolution consumes caribou year round, while moose is equally preferred in the summer. Bison are also consumed, but no information is available on its consumption rate. Whitefish is the most commonly consumed fish species year-round, and northern pike consumption equals that of white fish in the summer. Ptarmigan and Canada goose are the most preferred bird species.

Figure 9.6.11 shows that over a ten-year period (1993 to 2004) the rate of hunting, fishing and the consumption of harvested meat and fish fell by almost half, while trapping increased four-fold.

Figure 9.6.11 — Participation in the Traditional Economy in Fort Resolution



Source: NWT Bureau of Statistics (1994 and 2006)

As it is unlikely that the fur return data accounts for the value of all furs harvested and/or sold. At a minimum, additional furs are gifted, shared, bartered, or sold within the household, kin-group or community, primarily as an input into arts and crafts manufacturing. However, trapping appears to have become a part-time occupation chosen by an increasing percentage of the population in Fort Resolution.

9.6.4.1.4.1 Fishing

In 1994, Canada Fisheries and Oceans conducted domestic fishing surveys in Resolution Bay, Great Slave Lake and the Little Buffalo River. The combined surveys indicate a considerable domestic harvest of over 40,000 kg. However, this figure likely represents a fraction of the total domestic fish harvest, since not all fishing grounds were considered and not all harvesters were surveyed (Fisheries and Oceans Canada 1997). Table 9.6.8 presents commercial and domestic fish harvest and survey results.

Table 9.6.8 —Fish Harvests and Value (Domestic and Commercial): 1994

Local Domestic Fishery	Resolution Bay, Great Slave Lake (represents unknown % of actual harvest)	Little Buffalo River (represents 90% of actual harvest)
Species Harvest (kg)		
Lake whitefish	3,040	8,040
Northern pike	5,434	16,810
Inconnu	1,704	9
Longnose/White suckers	3,008	113
Burbot	2,736	92
Walleye	113	1
Other	19	2
Total	**16,054**	**25,067**
Local Commercial Fishery		
	None local, but 1-6 seasonal commercial fishing jobs out of Hay River.	

Source: Canada, Fisheries and Oceans 1996

In 1987-88, 100% of surveyed households (n = 31) in Fort Resolution reported fishing in the previous two years. In addition, most households reported that country foods represented between 25% and 75% of their total diet and almost all households reported that fish represented as much as 25% of the total country foods consumed (Lutra Associates Ltd. 1989). Although this data indicates the considerable value of domestic production, specifically domestic fishery, the data must be treated with caution since they are based on respondents' perceptions and not actual harvest survey results.

9.6.4.1.4.2 *Hunting and Trapping*

The number of furs harvested and the income derived from trapping declined between 1995 and 2007. In the same period, the diversity of species harvested increased to include squirrel and weasel As shown in Table 9.6.9, returns from trapping declined by about 65% while the number of furs sold declined about 23%.

Table 9.6.9 — Hunting and Trapping (General Hunting Licence Holders) in 1995-96 and 2006-07

Pelts Sold by Species	1995/1996	2006/2007	2006/2007
	Harvest/Sold	Harvest/Sold	Sold Price ($)
Black bear	0	0	0
Beaver	56	217	6,595.63
Coyote	0	0	0

Pelts Sold by Species	1995/1996	2006/2007	2006/2007
	Harvest/Sold	Harvest/Sold	Sold Price ($)
Ermine	66	0	0
Fisher	6	31	2,264.62
Cross fox	0	1	37.1
Red fox	33	3	94.29
Lynx	15	107	12,705.56
Marten	1,454	274	19,371.36
Mink	332	70	1,120.68
Muskrat	41	612	1,839.47
Otter	5	1	73.78
Squirrel	0	50	91.2
Weasel	0	173	1,161.09
Wolf	6	13	1,050.06
Wolverine	6	4	1,166.35
Total harvest/sold	2,020	1,556	
Total Returns from Furs	**$136,100.56**		**$47,571.19**
Total Contributions from RWED / ITI	**$38,595.00**		**$71,775.00**[1]
constant 2006 dollars CIP factor 1.245[2]			

Sources: NWT Resources, Wildlife, and Economic Development (1996a and 1996b. F. Rossouw Department of Industry Tourism and Investment, personal communication, August 15, 2008.

[1] 2005-2006 fiscal year grants and contributions

[2] Source: http://www.uleth.ca/analysis/CPI/PDF/canada.pdf

9.6.4.1.4.3 *Country Food Consumption*

In 1994, the CINE Study (Receveur et al. 1996) provided increased understanding of relative country food contribution to nutrition of the Fort Resolution residents. Whitefish was the most commonly consumed fish species year-round, closely followed by northern pike in the summer. Among land animals, caribou is actively consumed by in the winter, followed closely by moose. The opposite trend is seen in the summer (Table 9.6.10).

Due to seasonal migrations, overall consumption of birds is considerably higher in the summer. Consumption of ptarmigan, one of the few resident birds of the NWT, ranks highest both in the summer and in the winter.

Table 9.6.10 — Percentage of Population Consuming Country Food in 1994

Fish Species	Winter	Summer
Whitefish	98	76
Connie	22	28
Cisco	0	0
Trout	59	46
Loche	59	61
Northern pike	65	67
Grayling	0	0
Walleye	0	0
Longnose sucker	33	46
Land Animal Species	**Winter**	**Summer**
Caribou[1]	100	82
Moose	96	94
Rabbit	78	48
Beaver	16	11
Muskrat	29	46
Lynx	0	0
Porcupine	0	0
Dall sheep	0	0
Bear	0	4
Bird Species	**Winter**	**Summer**
Spruce hen	4	2
Prairie chicken[2]	37	39
Ptarmigan	67	76
Black duck[3]	0	0
Mallard	29	59
Fish duck	0	0
Squaw duck	0	0
Whistling duck	0	0
Canvasback	2	35
Canada goose	43	52
Snow goose	10	0

Bird Species	Winter	Summer
Pintail	2	26
Swan	2	20

Source: Receveur et al. 1996

[1] woodland and barren-land caribou

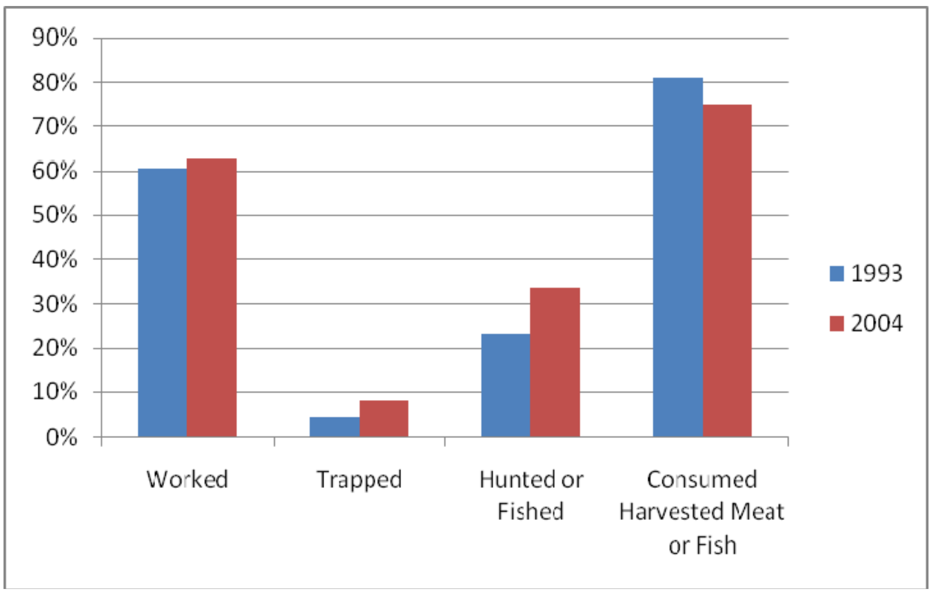
[2] local name for sharp-tailed grouse

[3] local name for surf scoter and white-winged scoter

9.6.4.1.5 Traditional Land Use in Fort Smith

Fort Smith's rates of employment, hunting, trapping and fishing increased between 1993 and 2004, while the consumption of harvested meat and fish declined (Figure 9.6.12). Fort Smith is not as traditional as other South Slave region communities and the overall NWT, as measured by the household consumption rate of harvested meat and fish.

Figure 9.6.12 — Participation in Traditional Economy in Fort Smith (1993)



Source: NWT Bureau of Statistics (1994)

The exploitation of country food species is influenced by resource availability and traditional harvesting territories. A heavy reliance on large mammals is characteristic of Aboriginal groups in the northern boreal forest, and the consumption of bison is unique to the Wood Buffalo National Park (WBNP) region (Wein et al. 1991). Wein et al. (1991) documented the consumption patterns of country foods for Aboriginal communities near WBNP and found that resource use varied from community to community. In Fort Smith, large mammals were consumed more frequently, while fish, berries, waterfowl and small mammals were consumed less frequently than in Fort Chipewyan, Alberta. On average, households consumed country food 0.6 times daily, or about 0.5 kg per week. The most frequent consumers of country food averaged twice daily. Wein found that country food was consumed less by youth than it was by elders. Males consumed larger quantities of meat and county food was consumed by people of all socio-economic levels. Survey respondents expressed a strong preference for country food but noted its limited availability (Wein et al. 1991). Access to country food is linked to the presence of a skilled hunter in the household and the economic means to harvest (e.g., means of transportation, fuel, ammunition, time away from paid work).

9.6.4.1.5.1 Fishing

There are no local commercial fisheries in Fort Smith. The total open water domestic harvest from the Slave River was estimated at 2,567 round kg in the summer of 1994. Whitefish and inconnu accounted for about 70% of the fish harvested, with lesser numbers of northern pike, suckers, burbot, walleye and goldeye (Canada, Fisheries and Oceans 1996)

9.6.4.1.5.2 Hunting and Trapping

In Fort Smith between 1995 and 2007, the value of fur harvest sales was $76,944.93 in 1995/1996 and $47,571.19 in 2006/2007. This represents a decline in value of the harvest by 40%. The total contributions from the FWED/ITI was $28,635.00 in 1995/1996 and increased to $71,775.00 in 2006/2007.

The commercial use of wildlife is managed through GNWT Wildlife legislation, principally the Wildlife Act and associated Regulations; these include the *Wildlife Business Regulations*, *Sale of Wildlife Regulations, Wildlife Licences and Permits Regulation* and *Big Game Hunting Regulations*. A commercial quota of 250 barren-ground caribou is in place for wildlife management unit U/BC/01. In 2006, a total of 60 commercial-tags were issued in Fort Smith. No commercial tags have been requested since (T. Ellsworth, GNWT ENR, personal communication, September 8, 2008). Likewise, Łutsel K'e and Fort Resolution have not issued any commercial tags in the last two years.

The *Wildlife Licences and Permits Regulations* create Border 'A' and Border 'B' Licences. Border Licence A enables an applicant who lives in the northern half of Saskatchewan or Manitoba to hunt and trap in the NWT. Border B Licence enables applicants who live at or in the immediate vicinity of Fort Chipewyan, Alberta to hunt Barren Ground Caribou in the NWT. Both licences have eligibility requirements. There is a quota of 400 Border B Licences, and no Licence A quota.

Hunting and trapping activity in Wood Buffalo National Park by traditional users (individuals of Aboriginal descent) from Fort Smith is regulated by Park authorities. Only the number of licenses is monitored and there is no data available for the amount of animals harvested. Fur returns are registered with the GNWT and are included in their counts. A total of 263 hunters in 1996 and 111 hunters in 2007-08 renewed their permits.

Several factors that affect 2008 hunting statistics may not have been in place in 1996. A major change is that the Treaty 8 Akaitcho Aboriginal hunters are no longer required to have a Park hunting permit, as treaty rights to hunt and trap in the Park are now recognized by Parks Canada. In addition, hunters 65 years of age and older are eligible for a Seniors Permit that does not need to be renewed every year.

Furthermore, there are fewer younger people requesting permits, as interest in trapping has declined (L. Scott, personal communication, August 15, 2008).

In 1996, 38 trappers used the Northern section (Area 1) of Wood Buffalo National Park (Parks Canada 1997); in 2007-08 there were 34 trappers, identified as follows: Fort Smith (14), Fort Fitzgerald (6), Hay River (12) and Fort Resolution (2) (L. Scott, personal communication, August 15, 2008).

9.6.4.1.5.3 *Country Food Consumption*

Some of the most popular foods consumed in Fort Smith included moose, caribou, whitefish, northern pike, ducks, geese, hare, and beaver (Wein et al. 1991).

Table 9.6.11 shows the percentage of Fort Smith residents consuming fish, bird and animal species in the summer. No winter data for Fort Smith are available.

The most commonly consumed fish species are whitefish, trout, walleye and northern pike. Among land animals, moose is consumed by 92% of the Aboriginal population in Fort Smith, followed closely by caribou. Additionally, 29% of the 73 interviewees stated that they had eaten bison in the summer of 1994 (Receveur et al. 1997). Resident spruce hen and prairie chicken were the most commonly consumed bird species. Less commonly consumed birds included swans, canvasback, squaw duck and black ducks.

Table 9.6.11 — Percentage of Fort Smith Population Consuming Country Foods

Fish Species	% of Population Consuming	Land Animal Species	% of Population Consuming	Bird Species	% of Population Consuming
Whitefish	80	Caribou[1]	85	Spruce hen	52
Connie	26	Moose	92	Prairie chicken[2]	43
Cisco	4	Rabbit	21	Ptarmigan	14
Trout	55	Beaver	15	Black duck[3]	6
Loche	7	Muskrat	7	Mallard	37
Northern pike	37	Lynx	3	Fish duck	0
Grayling	8	Porcupine	0	Squaw duck	3
Walleye	44	Dall sheep	1	Whistling duck	6
Longnose sucker	12	Bear	10	Canvasback	3
				Canada goose	27
				Snow goose	4
				Pintail	4
				Swan	3

Source: Receveur et al. 1996

[1] Woodland and barren-land caribou

[2] Local name for sharp-tailed grouse

[3] Local name for surf scoter and white-winged scoter

9.6.4.2 2008 HUMAN ACTIVITY SURVEY, NONACHO LAKE

A survey of Nonacho Lake was performed by aircraft on April 25, 2008, to look for signs of wildlife and human activity. The entire area of the lake was flown in a zigzag pattern and covered all major inlets. Trails leading from Łutsel K'e to Nonacho Lake were also investigated. Pete Enzoe, a resident of Łutsel K'e, was the observer for the survey.

Daylight and spring snow conditions were ideal for observing snowmachine trails and other signs of human activity. The snow had settled, making all tracks created throughout the winter obvious. Pete did not observe any signs of human use, and confidently concluded that no one had visited Nonacho Lake this past winter. Further, Pete had not heard of anyone travelling to Nonacho Lake during the winter. Caribou were near Łutsel K'e in 2008, which may be one reason for the lack of activity on Nonacho Lake in 2008.

9.6.5 Non-Traditional Land and Resource Use

Non-traditional land and resource uses include protected areas, environmentally significant areas, access and transportation, mining, oil/gas, power generation, and renewable resource uses such as timber harvesting, commercial fishing, recreational fishing, commercial/sports hunting, and tourism.

9.6.5.1 OIL, GAS, MINING AND MINERAL EXPLORATION

The historic Pine Point Mine site is situated about 42 km east of Hay River and is owned by Tamerlane Ventures Inc. The existing hydroelectric facility at Twin Gorges Dam on the Taltson River was constructed in 1965 to supply power to the Pine Point Mine. Currently, there are three active mines in the region, the Snap Lake, Ekati and Diavik Diamond mines. The Gahcho Kué Project is a prospective fourth diamond mine that is currently under environmental review. In the South Slave region, Tamerlane Ventures Inc. is a publicly-owned company that is currently involved in the Pine Point Pilot Project, which includes confirming the feasibility and conducting full-scale underground mining of the remaining 34 known deposits of lead-zinc ore.

There is a range of mineral exploration activities within the vicinity of the Project. Currently, most mineral exploration activities are within the Slave Geological Province, particularly in the vicinity of MacKay Lake and Lac de Gras. South of the Lockhart River in the proposed East Arm National Park, there is currently no mineral exploration activity within 50 km of the Project (MVLWB 2008). Maps of historic and current mineral exploration are provided in Chapter 19.

There is no oil and gas potential within the Taiga Shield or Southern Arctic ecozones, hence there is no oil and gas activity within the Project study area. The nearest oil and gas activity currently under way is in the Cameron Hills area, west of the Hay River and near the NWT-Alberta border, approximately 300 km west of Fort Smith (MVLWB 2008).

9.6.5.1.1 Existing and Potential Diamond Mines

The Project owners would like to supply electricity to four diamond mining operations: Diavik, Ekati, Snap Lake and the proposed Gahcho Kué Project. The first three mines are in operation, while the Gahcho Kué Project is undergoing an environmental review.

9.6.5.1.1.1 Diavik Mine

At the beginning of 2007, ore reserves at Diavik were estimated to contain 81.7 million carats (MacFarlane et al. 2007). By the third quarter of 2007, this joint venture between Diavik Diamond Mine (60% ownership) and Aber Diamond Ltd. (40%) produced nine million carats of diamonds (year-to-date). Feasibility studies have begun to examine the engineering and economic viability of underground mining at the site (MacFarlane et al. 2007). Exploratory drilling and surveys continued in 2007 and the total number of known kimberlite bodies on the property increased to 68 (MacFarlane et al. 2007).

9.6.5.1.1.2 Ekati Mine

By the third quarter of 2007, this joint venture between BHP Billiton (80% ownership), Stu Blusson (10%) and Chuck Fipke (10%) produced 3.528 million carats of diamonds (year-to-date) (MacFarlane et al. 2007). Operations are transitioning from open pit to underground mining. In 2007, exploration continued at the “Pigeon Pipe” on the Ekati Core Zone property, and at the “Jay Pipe” and “Cardinal Pipe” of the Ekati Buffer Zone Property, owned by BHP Billiton (58.8%), Archon Minerals (31.2%) and Chuck Fipke (10 %). A total of 156 kimberlites have been confirmed to date across both zones of the Ekati property (MacFarlane et al. 2007).

9.6.5.1.1.3 Snap Lake Mine

In 2007, De Beers Canada continued with infrastructure construction and underground development with production commencing in 2008 (MacFarlane et al. 2007). The deposit has 1.4 million tons of indicated resources and 25 million tons of inferred resources, at a recoverable grade of 1.2 carats per tonne.

9.6.5.1.1.4 Gahcho Kué Project

In 2007, exploration activities and bulk sampling continued at the Gahcho Kué property owned by De Beers Canada (51%) and Mountain Province Diamonds Inc. (49%) (MacFarlane et al. 2007). The Gahcho Kué Project is currently under environmental review, although submission of an environmental impact statement has been deferred. A project update is expected in late 2009.

9.6.5.2 TIMBER HARVESTING

Economic forests are the portion of the land base capable of producing economically viable timber for forest harvesting operations. Within the vegetation study area, commercial species of importance in the NWT include jack pine (*Pinus banksiana*), white birch (*Betula papyrifera*) and white spruce (*Picea glauca*). Jack pine is used in general construction as lumber. White birch is also used commercially, but white spruce is the most important tree in the NWT in terms of lumber use.

The Forest Management Division of ENR indicated that the proposed transmission line corridor does not appear to be located near areas where commercial timber harvest has occurred, or where there has been an interest in commercial timber harvest activity; however, there may be private interests (Smith 2008). The Department of Environment and Natural Resources (ENR) does not have any forest research plots in the vicinity of the Project (Smith 2008).

ENR is currently revising its Forest Management Regulations to address forest effects caused by land uses other than commercial or private forest harvesting. Pending the regulation revisions, forest clearing for development projects would require an authorization from ENR prior to any forest disturbance. Smith (2008) advised that proponents would be requested to supply information including, but not limited to, timing of clearing activities; amendments to the authorization; pre- and post-harvest spatial information; assessment of timber effects; details of timber transport; use of the resource; and treatment of waste.

9.6.5.3 ACCESS AND TRANSPORTATION

Outside of the territorial highways and the Tibbitt-to-Contwoyto winter road access to the area is limited. Existing access to the area proposed for the new transmission line consists of the old Fort Smith to Twin Gorges winter road, which has been out of commission for over 17 years, as well as float- and ski-equipped planes. Residents of Łutsel K'e travel to Yellowknife by boat in the summer and snowmobile in the winter. Travel between the two communities occurs regularly throughout the year.

9.6.5.3.1 Water Access

Boat access in the East Arm of Great Slave Lake is restricted to the summer months, as thick ice forms on the lake during the winter. Northern Transportation Company Limited (NTCL) uses a fleet of tug boats and barges to deliver cargo across northern Canada. In late July, Łutsel K'e is re-supplied by a large tug that typically tows three 1500-Series barges, each with a load capacity of 2,190 tonnes. Through special charters, NTCL also services outfitter lodges and other land-based operations in the East Arm of Great Slave Lake (T. Maher, personal communication, 6 February 2008). East Arm Freighting is a small company consisting of one barge with two to three crew members, and is based in Yellowknife. The company services the community of Łutsel K'e about once a year, depending on the demand for supplies and the size of shipment being made. During the same trip, East Arm Freighting also hauls fuel to Fort Reliance. In addition to commercial barging and shipping operations, personal watercraft also have access to Great Slave Lake.

9.6.5.3.2 Air Access

Table 9.6.13 lists the airports within the Project footprint. There are two government-operated airports and seven private airports in the area. Government airports are located at Fort Smith and Łutsel K'e. Information on existing flight volumes is provided below.

Table 9.6.12 — Registered Airports in the Study Area

Location	Airport Name	Usage	Runway Length (m)	Runway Surface
Diavik Diamond Mine	Diavik Airport	Private	1,585	Gravel
Ekati Diamond Mine	Ekati Airport	Private	1,950	Gravel
Fort Smith	Fort Smith Airport	Public	1,830	Asphalt
Łutsel K'e	Łutsel K'e Airport	Public	913	Gravel
MacKay Lake Lodge	True North Safaris Mackay Lake Lodge Airstrip	Private	1,300	Sand
Plummer's Great Slave Lodge	Taltheilei Narrows Airstrip	Private	1,706	Gravel
Snap Lake	Snap Lake Airstrip	Private	1,600	Gravel
Taltson River	Twin Gorges Dam Airstrip	Private	1,155	Sand
Tundra/Salamita Mine	Tundra/Salamita Mine Airstrip	Private	1,200	Sand

Source: Transport Canada 2008

9.6.5.3.2.1 *Fort Smith Airport*

The Fort Smith airport was built in 1938, and is located 4 km northwest of the community. The airport has an asphalt runway (1,830 x 61 m) and a secondary asphalt/gravel runway (610 x 30 m). Traffic volumes at the Fort Smith airport are shown in Table 9.6.14. Northwestern Air Lease is the only carrier with scheduled flights at this airport. Two to three scheduled flights from Yellowknife or Edmonton occur daily from Sunday through Friday (Northwestern Air Lease 2008). No infrastructure or traffic related issues were identified for the Fort Smith airport (R. Alty, personal communication, 11 February 2008).

Table 9.6.13 — Air Traffic Volumes at the Fort Smith Airport: 2002 to 2006

Year	Aircraft Movements
2002	7,623
2003	11,684
2004	8,856
2005	6,079
2006	6,553

Source: R. Alty, personal communication, 11 February 2008

9.6.5.3.2.2 *Łutsel K'e Airport*

The Łutsel K'e Airport has a single gravel airstrip (915 x 30 m) located 1.8 km northeast of the community. Although the airport operations are contracted to the LKDFN Council, the airport is administered by the Yellowknife airport. Aviation fuel is not currently available at this airport. Air carriers include Air Tindi and Arctic Sunwest. Air Tindi currently operates daily flights between Yellowknife and Łutsel

K'e (Air Tindi 2008). Arctic Sunwest offers one to two return flights daily (except Saturdays) (R. Mayne, personal communication, 7 February 2008). Table 9.6.15 shows air traffic volumes from 2002 to 2006. Air traffic to Łutsel K'e airport decreased from a high of 2,853 movements in 2003 to 1,450 movements in 2006.

Table 9.6.14 — Air Traffic Volumes at the Łutsel K'e Airport: 2002 to 2006

Year	Aircraft Movements
2002	1,950
2003	2,853
2004	2,656
2005	1,239
2006	1,450

Source: R. Alty, personal communication, 11 February 2008

9.6.5.3.2.3 Non-Government Operated Airports

There are seven private airstrips within 100 km of the Project (Table 9.6.13). The land is also very easily accessible with float planes in the summer and with ski-equipped planes in the winter. The existing Twin Gorges power facility maintains a gravel airport on a large esker about 5 km from the Twin Gorges site. The airstrip is the main access to the Twin Gorges dam for staff and delivery of equipment and supplies. The airport is maintained throughout the year, and can support large aircraft such as the Hercules. In addition to the airstrip, there is float plane access in the Twin Gorges Forebay, where there is a small dock.

9.6.5.3.3 Winter Road Access

9.6.5.3.3.1 Tibbitt to Contwoyto Winter Road

There is road access into the study area via the Tibbitt to Contwoyto winter road. The winter road was first operated by Echo Bay Mines Ltd. in 1982, and since 1999, it has been operated as a joint venture between Echo Bay Mines Ltd., BHP Billiton, and Diavik Diamond Mines Inc. (Nuna Logistics 2008). The winter road operates between February and March each year, for an average of 67 days. The 568 km route passes over 495 km of frozen lakes (87% of the route) and 73 km of land bridges. There are three road camps located on the route. Table 9.6.16 summarizes commercial truck traffic on the Tibbitt to Contwoyto winter road, by destination, from 1998 to 2007 (DOT 2007). Since 1998, there has been a trend towards increased total commercial vehicle traffic associated with the various existing mines and exploration work on the winter road.

Table 9.6.15 — Commercial Truck Traffic on the Tibbitt to Contwoyto Winter Road: 1998 to 2007

Year	NUMBER OF COMMERCIAL VEHICLES PER YEAR[1]						
	Lupin Mine	Ekati Diamond Mine	Diavik Diamond Mine	Snap Lake Mine	Tahera Mine	Exploration Traffic	Total Vehicle Traffic
2007	55	3,937	4,573	2,355	500	236	11,656
2006	35	3,152	2,094	1,623	258	148	7,310
2005	251	3,434	2,848	703	n/a	614	7,850
2004	288	2,984	1,572	295	n/a	117	5,256
2003	702	3,003	2,202	n/a	n/a	87	5,994
2002	698	3,913	3,339	n/a	n/a	218	8,168
2001	688	2,912	4,127	n/a	n/a	363	8,090
2000[2]	557	3,402					3,959
1999[2]	85	1,759					1,844
1998[2]	112	2,431					2,543

Source: DOT 2007

[1] n/a = not available or not applicable

[2] Data was not broken down by individual mine, with the exception of the Lupin mine.

The Tibbitt to Contwoyto winter road also provides non-commercial traffic access to the Project footprint. Since 2003, the GNWT's Department of Environment and Natural Resources (ENR), in partnership with the Yellowknives Dene First Nation, has surveyed non-commercial users of the winter road. The survey is conducted at a check station at Ross Lake, and uses a one-page questionnaire to record information on non-commercial use of the winter road (including animal harvests). This has allowed ENR to monitor activities by non-commercial road users, and may help to determine what impacts the road users have on wildlife and the surrounding environment (Ziemann 2007). The Bathurst Caribou Management Plan and the Barren Ground Caribou Management Strategy have identified harvest numbers through winter road monitoring as a tool to determine how winter roads impact caribou herds (Ziemann 2007).

Table 9.6.17 shows the number of people and vehicles using the Tibbitt to Contwoyto winter road in 2004, 2005, and 2006, and the types of activities in which they are engaged. For each year surveyed, the highest non-commercial uses of the Tibbitt to Contwoyto winter road included hunting, followed by sightseeing and fishing. In addition, there has been a year-over-year decline in non-commercial use of the winter road. Except for camping, all 2006 activity levels were at 50% or less than the levels reported in 2004 (Ziemann 2007).

Table 9.6.16 — Non-Commercial Traffic and Activities on the Tibbitt to Contwoyto Winter Road: 2004, 2005, and 2006

Activity	2004		2005		2006	
	No. of Persons	No. of Vehicles	No. of Persons	No. of Vehicles	No. of Persons	No. of Vehicles
Camping	109	55	77	30	82	39
Fishing	384	180	334	135	157	62
Hunting	1,206	573	731	326	640	284
Other	12	8	6	8	1	1
Sightseeing	420	210	337	144	190	78
Unknown	134	102	30	25	30	24
Wood cutting	19	13	14	8	8	2
Working	5	4	0	0	0	0
Total	**2,289**	**1,136**	**1,529**	**676**	**1,108**	**490**

Source: Ziemann 2007

The number of persons and number of vehicles using the Tibbitt to Contwoyto winter road for non-commercial purposes has declined between 2004 and 2006 (Table 9.6.18). Reasons may include shorter operating seasons and fewer numbers of caribou along the road to attract hunters. The North Slave communities of Yellowknife and Detah account for most of the winter road use. The South Slave communities of Fort Smith and Hay River account for most of the South Slave region's use of the winter road. As of 2008, ENR planned to continue the use of the check station at Ross Lake (Ziemann 2007).

Table 9.6.17 — Community of Origin for Non-Commercial Vehicle Traffic on the Tibbitt to Contwoyto Winter Road: 2004, 2005, and 2006

Community	2004		2005		2006	
	No. of Persons	No. of Vehicles	No. of Persons	No. of Vehicles	No. of Persons	No. of Vehicles
Detah	106	51	84	48	32	16
Fort Providence	8	3	0	0	0	0
Fort Resolution	5	3	16	7	0	0
Fort Simpson	8	4	0	0	0	0
Fort Smith	27	9	68	30	22	14
Hay River	34	15	55	19	14	5
Łutsel K'e	0	0	6	2	0	0
N'Dilo	80	28	34	12	34	8
Behchokò	18	8	4	2	2	1
Rae Lakes	0	0	4	2	0	0

Community	2004		2005		2006	
	No. of Persons	No. of Vehicles	No. of Persons	No. of Vehicles	No. of Persons	No. of Vehicles
Unknown	141	109	34	28	35	26
Yellowknife	1,848	897	1,188	514	931	406
Out of Territory	6	3	30	10	33	13
Out of Country	8	6	6	2	5	1
Total	**2,289**	**1,136**	**1,529**	**676**	**1,108**	**490**

Source: Ziemann 2007

A study prepared for the JVC in 2007 (EBA 2007) concluded that the combined effects of a clear winter warming trend and potential high traffic volumes beyond the winter road's historic limits increased the risk of the road failing to meet the demands placed on it. That same report (EBA 2007) shows that during cold winters, the winter road is capable of delivering 8,000 truck loads (this does not include non-commercial users of the winter road), and that a benchmark capacity of 10,000 loads was achievable.

Future traffic projections (EBA 2007) conclude that the 8,000 and possible 10,000 truck-load benchmarks could be exceeded. The promising new projects such as Peregrine DO 27, the possible expansion of the Ekati or Diavik mines, and advancement of current exploration projects would add to projected traffic loads. Sixty per cent of all the JVC's winter road transport is diesel fuel, of which about a half is used for stationary power generation. This cargo has the potential of being replaced by alternative power sources (EBA 2007). That is, 30% of all winter traffic loads is burned for stationary power generation and about 50% of the diesel fuel purchased by the mines is burned for stationary power generation (EBA 2007).

In the short term (0 to 5 years) truck traffic is reduced from previous years because of the closing of the Jericho Diamond Mine in Nunavut, the demobilization of the Peregrine Diamonds mine, and improvements in freight movements. However, the long-term (operational life of the diamond mines) capacity constraint remains a pressing concern for existing and possible future developments that would have to rely on the winter road.

9.6.5.3.3.2 *Fort Smith to Twin Gorges Winter Road*

The existing Twin Gorges power facility was constructed on the Taltson River in 1965 to provide power to the Pine Point lead and zinc ore mine. During construction and operation of the Twin Gorges dam, a 60 km long winter road was built from the community of Fort Smith to the Twin Gorges site. After the mine closed in 1986, the winter road was no longer utilized.

9.6.6 Hunting, Fishing and Tourism

9.6.6.1 HUNTING

Hunting in the NWT can be divided into three categories; aboriginal hunters, resident hunters, and sport hunters. Each has different hunting privileges and rights. For example, sport hunters may hunt caribou only in the fall and through a licensed outfitter and require a tag for each caribou, residents may hunt caribou during fall, winter and spring and require a tag for each caribou, while aboriginal hunters may harvest caribou throughout the year and do not require a tag. Data regarding the number of aboriginal hunters and the level of harvest is not collected, but is described tangentially in Section 9.6.4, Traditional Land and Resource Use. Unfortunately, little no is available on the area where this hunting occurs, so land use activities in the vicinity of the Project are difficult to ascertain. It is assumed that most hunting and fishing takes place in the vicinity of the communities, of which the South Slave communities of Fort Smith, Fort Reliance and Łutsel K'e are closest to the Project. North Slave communities may also hunt and ice fish in the vicinity of the Project in winter via the Tibbitt to Contwoyto winter road.

The number of resident hunters and the number of big and small game hunting licences issued in the NWT from the 1989-90 hunting season to the 2005-06 season are shown in Table 9.6.19 (data has been adjusted to the post-1999 territorial boundary). The number of resident hunters in the NWT, as well as the number of big game and small game licences issued to resident hunters, has decreased since the 1989-90 season.

Table 9.6.18 — Number of Resident Hunters and Small Game and Big Game Licences Issued in the Northwest Territories: 1989/90 to 2005/06 Hunting Seasons

Licence Year	Total Number of Hunters[1]	Small Game Licences[1]	Big Game Licences[1]
1989/1990	2,065	1,842	1,769
1990/1991	2,172	1,838	1,903
1991/1992	2,091	1,687	1,833
1992/1993	2,138	1,598	1,918
1993/1994	1,891	1,379	1,663
1994/1995	2,028	1,453	1,751
1995/1996	1,702	1,333	1,482
1996/1997	1,752	1,300	1,576
1997/1998	1,579	1,189	1,385
1998/1999	1,597	1,303	1,394
1999/2000	n/a	n/a	n/a
2000/2001	1,403	1,101	1,225
2001/2002	1,359	847	1,269
2002/2003	1,275	960	1,139

Licence Year	Total Number of Hunters[1]	Small Game Licences[1]	Big Game Licences[1]
2003/2004	1,095	811	920
2004/2005	1,276	942	1,101
2005/2006	1,110	801	952

Source: S. Carriere, personal communication, 28 January 2008

[1] n/a = not available or not applicable

For the purposes of wildlife management, the NWT is divided into wildlife management areas. Management Area 'U' encompasses much of the Project area. A section of the northern part of the study area overlaps Management Area 'R'. Tables 9.6.20 and 9.6.21 shows the hunting season and harvest limits for resident and non-resident big game hunters, respectively. The bag limit of caribou for resident hunters has been reduced from five (regardless of sex) to one male since 2005 when indications became apparent that the Bathurst caribou herd was in decline.

Table 9.6.19 — 2007/08 Northwest Territories Resident Big Game Hunting Regulations

Species	Bag Limit	Hunting Season	Management Area
Black bear	1 adult	15 Aug to 30 June	U, R
Barren-ground caribou	1 male	15 Aug to 30 April	U, R
Woodland caribou	1	15 July to 31 Jan	R
Moose	1	1 Sept to 31 Jan	U, R
Muskoxen	Total of 1 tag on a draw system	1 July to 15 April and 15 June to 30 June	U/MX/01 (East of Łutsel K'e between Reliance and the Thelon Wildlife Sanctuary)
Wolf	1 or more (depending on number of tags held)	15 Aug to 31 May	U, R
Wolverine	1 or more (depending on number of tags held)	25 July to 30 April	U, R

Source: ENR 2007

Table 9.6.20 — 2007/08 Northwest Territories Non-Resident Big Game Hunting Regulations

Species	Bag Limit	Hunting Season	Management Area
Black bear	1 adult	15 Aug to 30 June	U, R
Barren-ground caribou	Up to 2 males (depending on number of tags held)	15 Aug to 30 Nov. (15 Aug to 30 Oct. for non-resident aliens in Zone R/BC/01)	U, R
Muskoxen	1 or more (depending on number of tags held)	1 Aug to 15 April	U/MX/01 (East of Łutsel K'e between Reliance and the Thelon Wildlife Sanctuary)
Wolf	2	15 Aug to 31 May	U, R
Wolverine	1	1 Dec to 15 March and 15 Aug to 31 Oct	U, R

Source: ENR 2007

Table 9.6.22 shows the harvest levels for the 1983-84 hunting season to the 2005-06 season by resident hunters residing in the North and South Slave regions. Barren-ground caribou is the most hunted large game species, followed by moose and woodland caribou. The number of barren-ground caribou harvested increased from 77 in the 1983-84 hunting season to a peak of 385 in the 1992-93 season, after which the harvest numbers trended downward to 39 in the 2005-06 season. Moose harvests have trended downward from a high of 170 in the 1983-84 hunting season to 44 in the 2005-06 season. Similarly, the number of woodland caribou harvested has decreased from a high of 66 in the 1983-84 hunting season to 13 in the 2005-06 season. Lower numbers of black bear, wolverine and wolf are also harvested by resident hunters.

Table 9.6.21 — Estimated Harvest Levels for Tags Sold in the South and North Slave regions to Resident Hunters: 1983/84 to 2005/06 (Excludes Hunters from Yellowknife)

Licence Year	Moose	Barren Ground Caribou	Woodland Caribou	Black bear	Wolverine	Wolf
1983/1984	170	77	66	11	4	44
1984/1985	95	38	41	16	0	61
1985/1986	128	65	36	11	4	54
1986/1987	105	83	15	4	0	13
1987/1988	105	201	31	11	n/a	n/a
1988/1989	72	203	38	13	n/a	n/a
1989/1990	97	206	37	10	n/a	n/a
1990/1991	95	376	19	5	n/a	n/a

Licence Year	Moose	Barren Ground Caribou	Woodland Caribou	Black bear	Wolverine	Wolf
1991/1992	98	274	49	9	0	0
1992/1993	112	385	15	0	0	7
1993/1994	100	299	23	9	1	7
1994/1995	103	333	26	12	0	14
1995/1996	82	211	25	9	0	2
1996/1997	75	166	26	5	0	2
1997/1998	61	111	15	2	3	12
1998/1999	50	262	15	2	0	3
1999/2000	50	156	15	4	0	2
2000/2001	48	135	11	2	0	0
2001/2002	51	161	14	2	2	5
2002/2003	43	102	12	0	0	2
2003/2004	36	77	8	2	0	0
2004/2005	42	156	2	2	0	0
2005/2006	44	39	13	3	0	0

Source: S. Carriere, personal communication, 28 January 2008

n/a = not available or not applicable

Non-resident hunters of big game use hunting lodges and outfitters located throughout the NWT (see Figure 9.6.6). Hunting lodges and outfitters are allocated tags for various species. In 2006, due to perceived declines in the barren ground caribou populations, the NWT government reduced the total number of tag allocations to lodges and outfitters from 1,500 to 750 (CBC 2007). Since big game licensing in GNWT management unit “U” began in 1999, LKDFN has been allocated 150 caribou tags annually for outfitting purposes (J. McLinton, personal communication, 2008). The LKDFN is also allocated 29 muskoxen tags to be used for either outfitting or for community hunts in management area “U” (“U/MX/01”) (J. McLinton, personal communication, 2008). The LKDFN operate the Artillery Lake Adventures Lodge and Aylmer Lake Lodge. Although there are other hunting lodges near the Project, tag allocations from these lodges are provided as an example in Table 9.6.23. Tag allocations at Artillery Lake Adventures Lodge peaked at 51 for 2002 and 2003, and have since declined to 36 in 2006. The number of caribou tag allocations for Aylmer Lake Lodge peaked at 95 in 2003 and declined to 60 in 2006.

Table 9.6.22 — Tag Allocations for Artillery Lake Adventures and Aylmer Lake Lodge: 1999 to 2006

Species Tags by Lodge Location	1999	2000	2001	2002	2003	2004	2005	2006	Total Per Species
Artillery Lake									
Caribou Tags	30	43	37	51	51	39	44	36	**331**
Wolf Tags	0	2	0	1	2	0	0	5	**10**
Muskoxen Tags	0	0	0	1	0	0	0	1	**2**
Aylmer Lake									
Caribou Tags	0	0	56	84	95	82	71	60	**448**
Wolf Tags	0	0	0	0	0	0	0	0	**0**
Muskoxen Tags	0	0	0	1	2	5	1	9	**18**
Total Tags	**30**	**45**	**93**	**138**	**150**	**126**	**116**	**111**	**809**

Source: J. McLinton, personal communication, 2008

In addition to big game, small game is hunted by both resident and non-resident hunters. After a small decline from 3,240 in the 1990-91 hunting season, spruce grouse harvests increased, with peaks between 5,415 and 4,720 birds in the 1994-95 and 1998-99 seasons, respectively. Following the peaks, harvest levels declined to 1,511 in the 2005-06 seasons. During the same period, harvests of ruffed grouse and sharp-tailed grouse exhibited a similar pattern. Ruffed grouse harvests peaked between 2,696 and 2,009 birds in the 1994-95 to 1997-98 seasons, respectively, after which they declined to 579 birds in the 2005-06 season. Sharp-tailed grouse harvest levels peaked between 1,276 and 1,303 birds in the 1995-96 to 1997-98 seasons, respectively. From the 1990-91 to 1998-99 hunting season, ptarmigan harvest levels showed peaks of between 5,530 and 5,180, respectively (considering changes to the NWT boundaries in 1999). Harvest levels declined to 1,325 in the 2005-06 season. Harvest levels for snowshoe hare showed a decline from 1,736 in the 1990-91 hunting season to a low of 273 in the 1993-94 season. Following the low, harvest levels increased to a peak of 1,286 in the 1998-99 season, and then declined to 220 in the 2003-04 season. For the 2004-05 and 2005-06 seasons, harvest levels were 468 and 321, respectively.

9.6.6.2 FISHING

Table 9.6.24 shows the number and origin of licensed anglers in the NWT for 1995, 2000, and 2005. The number of resident anglers decreased from 8,452 in 1995 to 5,268 in 2000. The number of non-resident Canadian anglers showed a small decline from 4,487 in 1995 to 4,417 in 2000. The number of non-resident, non-Canadian anglers was 2,866 in 2005, which was a decline from 4,116 in 2000. From 1995 to 2000 the total number of licensed anglers in the NWT declined by 14% from 16,104 to 13,801.

Table 9.6.23 — Number and Origin of Licensed Anglers in the Northwest Territories: 1995, 2000, and 2005

Year	NWT Resident	Non-Resident Canadian	Non-Resident Non-Canadian	Total
1995[1]	8,452	4,487	3,165	16,104
2000[2]	5,268	4,417	4,116	13,801
2005[3]	n/a	n/a	2,866	n/a

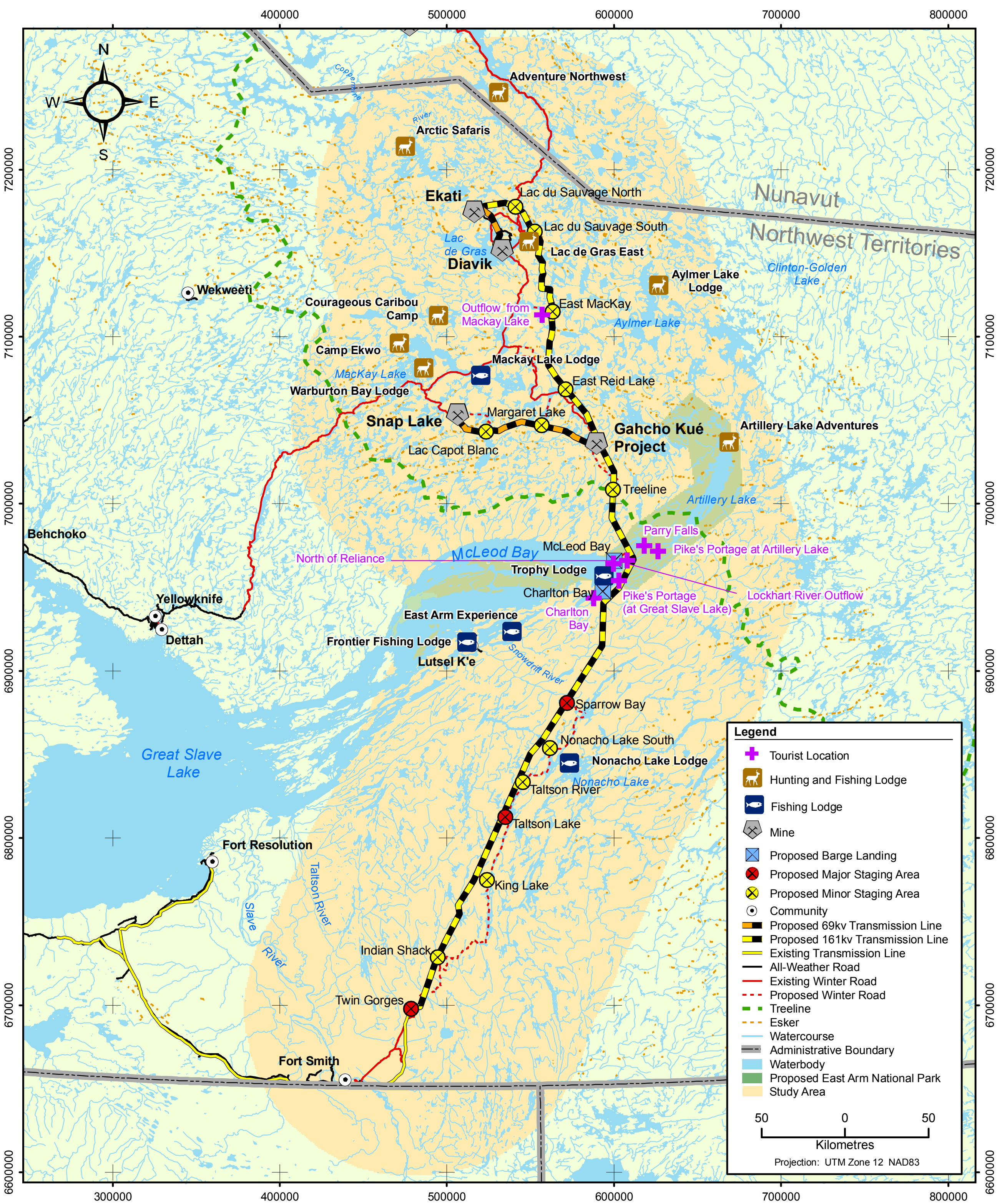
[1] DFO 1995

[2] DFO 2000

[3] St. Louis 2006

n/a = not available or not applicable

Sport fishing within the study area is conducted through one of the various remote fishing lodges. The locations of fishing lodges within 100 km of the Project are shown in Figure 9.6.13. In a 2006 study (St. Louis 2006), sport fishing outfitters and lodges in the NWT indicated that approximately 60% of clients originate from the United States, but with significant numbers also coming from southern Canada.



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Tourism Facilities

Figure 9.6.13

The study indicated that a considerable number of non-resident licences sold in the NWT were purchased by independent, non-resident anglers, a group composed of self-guided anglers who travel to the NWT specifically for a fishing holiday (St. Louis 2006). The study further indicated a "sizeable" decline in the number of independent anglers visiting the NWT from the United States and elsewhere in Canada during the years 2001 to 2005. In 2005, the number of non-resident, independent angler tourists to the NWT was 41% lower in comparison to the 2001 season (St. Louis 2006).

The report summarizes some reasons for the decline in sport fishing in the NWT (St. Louis 2006):

- a general decline in the post- "September 11, 2001" Canadian tourism industry;
- post- "September 11 2001" changes in domestic and American travel habits;
- increases in flight and fuel costs (i.e., raising the cost for U.S. and southern Canadian clients to travel to the NWT);
- an unfavourable exchange rate with the U.S. dollar;
- tensions within Canada-U.S. political relations; and
- developing competition for angling tourism dollars from non-traditional sources (e.g., Russia and South America.

A description of the fishing lodges near the Project is provided below.

9.6.6.2.1 Nonacho Lake Fishing Camp

The Nonacho Lake Fishing Camp was established in 1962 by bush pilot Merlyn Carter. The main camp consists of six cabins that can accommodate up to 36 guests. Approximately 350 tourists visit this lodge annually. An outpost camp is located about 32 km to the northeast of the main camp.

The peak operating season is from mid-June to September; however, ice fishing excursions by American tourists have occurred during some winters (Carter 2008). Visiting sport fishermen target lake trout and northern pike. Arctic grayling were once common on the Taltson River between Nonacho Lake and Gray Lake, but there has been limited sport fishing of this species since approximately 1974 (Carter 2008). The majority of visitors to Nonacho Lake are from the United States and other parts of Canada, attracted by the remoteness and beauty of the area. Other visitors include government and industry personnel working in the area and the occasional tourists traveling by private aircraft or by canoe down the Taltson River (Carter 2008).

Access to the lodge is by float-equipped aircraft, or occasionally by ski-equipped aircraft in the winter. During the peak operating season, weekly aircraft charters (Twin Otters) bring tourists to and from the camp. The Nonacho Lake Fishing Camp has a government lease to construct an airstrip at the main camp; however this option has not yet been pursued (Carter 2008). In response to local demand (in Łutsel K'e), Carter Air Services is considering the re-establishment Twin Otter operations in the Łutsel K'e and East Great Slave Lake regions. The Nonacho Lake would be the primary base of operations, as it has been in the past (Carter 2008).

9.6.6.2.2 Res Delta Tours/Taltson Bay Big Pike Lodge

Taltson Bay Big Pike Lodge is located on the isolated Taltson River Bay where it empties into the south shore of Great Slave Lake. This camp is especially known for the massive northern pike which are mostly found in the shallow Taltson delta waters, but one can also find lake trout, inconnu, and whitefish here. It is opened from June 1st to October 1st every year. It is easy to access this camp, as it is based out of Fort Resolution and guests are brought over by boat, while guests from Yellowknife are brought over by float plane. The camp consists of several small private cabins on one main lodge, accommodating up to 12 people.

9.6.6.2.3 Canadian Wild Wilderness Outfitters - Lady Grey Lake Lodge and Thekulthili Lodge

Lady Grey Lake Lodge is located on Lady Grey Lake just south of King Lake along the Taltson River. It is a popular spot for kayakers passing through, as well as avid anglers. Thekulthili Lake is located just a few kilometres northeast of Lady Grey Lake and even though the lakes are not directly linked, they both lie within the Nonacho watershed. Both lodges are extremely attractive because they offer guests world class fishing for lake trout and northern pike as well as bird watching tours for bald eagles and golden eagles. Visitors also enjoy the sandy beaches and hand built log cabins. About 11 flights per season (June to September) bring visitors to these lodges.

9.6.6.2.4 Plummer's Arctic Lodges – Great Slave Lake Lodge (East Arm Lodge)

Located at Taltheilei Narrows on the East Arm of Great Slave Lake, this lodge operates between June and September and can accommodate up to 45 visitors at a time. Approximately 500 guests visit annually. Access to the site is by air. Weekly scheduled flights and some mid-week charters use the lodge private airstrip. Clients come from all over United States and Canada come to fish for lake trout, grayling and jackfish. Visitors are attracted by the impressive geology of the Taltheilei Narrows on the East Arm.

9.6.6.2.5 True North Safaris - Mackay Lake Lodge and Warburton Bay Lodge

The True North Safaris fishing/hunting lodges are both located on Mackay Lake, which is about 50 km south of Lac de Gras. Mackay Lake Lodge is located in the center of Mackay Lake and can accommodate up to 30 guests. Visitors are attracted by the world-class hunting and fishing. Species include caribou, muskox, wolves, wolverine, huge lake trout, northern pike, and arctic grayling. This camp has all of the luxuries of home including private cabins, electricity, indoor plumbing, a licensed lounge, a restaurant style kitchen, laundry service and modern boats. This camp shares a private airstrip with Warburton Bay Lodge just down the lake.

Warburton Bay Lodge is located along the East Arm of Mackay Lake and is a much rougher camp than Mackay Lake Lodge. Warburton Bay Lodge has electricity and permanent insulated cabins. Visitors must bring their own fishing gear, food, beverages, and sleeping bags to this camp. Anglers and hunters who prefer more independence and enjoy camping choose this location over the others. This camp offers guests access to fish such as lake trout, northern pike, and arctic grayling. Hunting is also very popular at this site, especially for large game such as caribou, muskox, wolves, and wolverine. This camp is open from July 6th to August 3rd only, and float planes arrive daily from Monday to Friday.

9.6.6.2.6 Trophy Lodge

Trophy Lodge is located on the very tip of the East Arm of Great Slave Lake, in Fort Reliance. Trophy Lodge has an interesting history. It used to be an old RCMP outpost from the 1920s to the 1940s, and was renovated into a fishing lodge in the 1960s. Much of the infrastructure and cabins are original buildings from the old RCMP outpost. This camp can accommodate up to 18 people and is open from late June to September. Not only does Trophy Lodge offer exceptional fishing (trout, jackfish, and grayling), it also offers spectacular views of the impressive cliffs of the Pethei Peninsula located along the East Arm of Great Slave Lake. Guests also have the opportunity to explore Old Fort Reliance historical sites by boat and use the beautiful picnic area located across the bay on Maufelly Point.

9.6.6.3 Other Tourism

In addition to providing important hunting and fishing opportunities through the various lodges, the NWT also provides a variety of non-consumptive tourist activities. The following sections describe the variety of tourist activities within the NWT and focuses on those opportunities.

While the main tourism season runs from May 15 to September 15 (ITI 2007), the GNWT promotes a variety of activities throughout the year, such as hiking, fishing, boating, camping and wildlife viewing in the summer months, and snowmobiling, snowshoeing, and aurora borealis (northern lights) viewing in the winter months.

Ecotourism is one of the main attractions to visitors to the NWT, as well as for residents who wish to explorer Canada's north. They are attracted by the unique and pristine flora, fauna, and cultural heritage that the NWT has to offer. Tourists are also seeking ways in which to learn more about surviving on the land with minimal supplies, and how to leave the smallest ecological footprint possible. Residents of the NWT have taken advantage of this market by offering guided tours and northern activities to tourists that are also considered eco-friendly, such as dog mushing, snowshoeing, kayaking, canoeing, skiing, hiking, camping, wilderness viewing, aurora borealis viewing, cultural heritage camps, and sustainable fishing and hunting. As indicated earlier, hunting and fishing lodges also offer opportunities for non-consumptive tourism. Within the Project area, Trophy Lodge offers spectacular views of the impressive cliffs of the Pethei Peninsula located along the East Arm of Great Slave Lake, and Plummer's Arctic Lodge provides spectacular views of the Taltheilei Narrows on the East Arm.

The guided canoe trip industry depends upon both the qualities of the river and the wilderness through which the river travels. Major rivers that are intercepted by the Project include the Taltson River, the Snowdrift River, the Lockhart River, and the upper Coppermine River. Of these, only the Coppermine River is used as a regular destination for canoe outfitters (see Blackfeather 2008 and Wanapitei 2008). However, the Project would cross the upper Coppermine, upstream of Lac de Gras, a reach not used by canoe outfitters. Of the top 12 rivers recommended by the NWT tourism website (GNWT 2008), neither the Taltson, Snowdrift, nor Lockhart rivers receive mention. Bathurst Arctic Services lists the Taltson and Snowdrift Rivers among the boreal forest rivers for which they offer guided canoe trips on demand (Bathurst Arctic Services 2008).

Table 9.6.25 shows the levels of participation in the various visitor segments for the North Slave region. Total visits to the North Slave region in 2006 declined to about 57% of 2002 levels. Excluding business visits, total leisure visits in 2006 were about 55% of 2002 levels. The percentage of total visits to the North Slave region, compared to the total visits to the NWT, declined from about 77% in 2002 to about 43% in 2006 (see Tables 9.6.25 and 9.6.26).

Table 9.6.24 — Tourist Participation in North Slave Lake Visitor Segments: 2002 and 2006

Visitor Segment[2]	2002		2006	
	Total Individuals	Percent[1] (%)	Total Individuals	Percent[1] (%)
Fishing	2,942	10.9	2,357	15.4
Hunting	481	1.8	798	5.2
Outdoor adventure	826	3.0	509	3.3
General touring	10,834	40.0	4,602	30.0
Visiting friends and relatives	6,530	24.1	3,706	24.1
Total leisure	21,613	79.7	11,972	78.0
Business	5,499	20.3	3,374	22.0
Total Individuals	**27,112**	**100.0**	**15,346**	**100.0**

Sources: 2002 data: RWED 2002; 2006 data: ITI 2007

[1] Percentages have been rounded to the nearest 1/10 percent.

[2] Visitors could identify participation in more than one segment. Therefore, total number participants in the various segments will differ from the total number of visitors.

Table 9.6.26 shows the levels of participation in the various visitor segments for the South Slave region. Total visits to the North Slave region in 2006 increased by 24% over 2002 levels. Excluding business visits, total leisure visits in 2006 increased by about 24% over 2002 levels. The percentage of total visits to the South Slave region compared to the total visits to the NWT increased from about 28% in 2002 to about 36.7% in 2006 (see Tables 9.6.25 and 9.6.26).

Table 9.6.25 — Tourist Participation in South Slave Lake Visitor Segments: 2002 and 2006

Visitor Segment[2]	2002		2006	
	Total Individuals	Percent[1] (%)	Total Individuals	Percent[1] (%)
Fishing	1,930	18.2	2,172	16.5
Hunting	74	0.6	2	<0.1
Outdoor adventure	361	3.4	677	5.1
General touring	5,075	47.8	5,642	42.8
Visiting friends and relatives	2,186	20.6	3,454	26.2
Total leisure	9,625	90.7	11,947	90.6
Business	986	9.3	1,237	9.4
Total Individuals	**10,612**	**100.0**	**13,184**	**100.0**

Sources: 2002 data: RWED 2002; 2006 data: ITI 2007

[1] Percentages have been rounded to the nearest 1/10 percent.

[2] Visitors could identify participation in more than one segment. Therefore, total number participants in the various segments will differ from the total number of visitors.

The reasons people chose for visiting the NWT in 2006 are summarized in Table 9.6.27. The single largest reason people choose to visit the NWT in 2006 was its wilderness, isolation, landscape or wildlife. By way of comparison, when people were surveyed on the activities in which they participated while in the NWT, people identified the following participation rates for wildlife-related activities:

- wildlife viewing – 49%
- bison viewing – 27%
- bird watching – 24%

Sport hunting and sport fishing are important contributors to the NWT economy, and were discussed in Sections 9.6.6.1 and 9.6.6.2 respectively. Most of the hunting and fishing lodges in the Project Area also provide opportunities for non-consumptive activities, such as wildlife viewing and photography.

Table 9.6.26 — Reasons for Choosing to Visit the Northwest Territories: 2006

Reasons for Choosing the NWT	Percent (%)
Wilderness, isolation, landscape, or wildlife	43.6
General interest	33.4
Always wanted to visit	24.6
Family or friends	21.0
Fishing	18.3
Natural phenomena, event or attraction	18.2
Culture or history	16.1

Reasons for Choosing the NWT	Percent (%)
Other	5.4
Outfitter reputation	2.6
Specific species of animal (hunters)	1.3
Hunting	1.2
Other hunter/friends' recommendation	1.0
Location	0.4
Booking agent recommendation	0.3
Previous visit	0.3
Cost/price	0.1

Source: ITI 2007

9.6.7 Heritage Resources

9.6.7.1 INTRODUCTION

All known and undiscovered heritage resources are protected by law in the Northwest Territories (NWT) by the Northwest Territories Archaeological Sites Regulations (Government of the Northwest Territories [GNWT], 2001). An archaeological artifact refers to an object that has "any tangible evidence of human activity that is more than 50 years old, in respect of which an unbroken chain of possession cannot be demonstrated" (GNWT 2001). Further protection for heritage resource sites on Crown Lands are contained within Sections 10 and 16 of the Territorial Land Use Regulations (Government of Canada 2008a). Heritage resources are broadly defined as "archaeological or historic sites, burial sites, artifacts and other objects of historical, cultural or religious significance, and historical or cultural records" (Mackenzie Valley Land Use Regulations [MVLUR], Government of Canada 2008b).

A variety of sources were used to obtain information on existing heritage resources. This included a literature review, government records review, and input from local assistants who were part of the archaeological team during the baseline survey. Table 9.6.28 summarizes correspondence during this process.

Table 9.6.27 — Archaeological Correspondence Summary

Date	From	To	Discussion Topic
13-Mar-08	Brad Novecosky – Golder Associates Ltd.	Glen MacKay - Prince of Wales Northern Heritage Centre	Request for consultation list for permit application.
13-Mar-08	Shelley Crouch - Prince of Wales Northern Heritage Centre	Brad Novecosky – Golder	Consultation list for permit application.
31-Mar-08	Brad Novecosky – Golder Associates Ltd.	Prince of Wales Northern Heritage Centre	Archaeological permit application.
13-May-08	Shannon Hayden - North Slave Métis Alliance	Brad Novecosky – Golder	Request for information for reviewing archaeology permit application.
22-May-08	Sheryl Grieve - North Slave Métis Alliance	Prince of Wales Northern Heritage Centre	Request for additional information for archaeological permit application.
27-May-08	Shelley Crouch - Prince of Wales Northern Heritage Centre	Brad Novecosky – Golder	Request for additional information for archaeology permit application.
05-Jun-08	Brad Novecosky – Golder Associates Ltd.	Shelley Crouch - Prince of Wales Northern Heritage Centre	Response to request for information.
11-Jun-08	Prince of Wales Northern Heritage Centre	Brad Novecosky – Golder	Issuance of Class 2 Archaeological Permit 2008-005.
18-Jun-08	Golder Associates Ltd.	Prince of Wales Northern Heritage Centre	Archaeological sites data request.
10-Jul-08	Prince of Wales Northern Heritage Centre	Golder	Receipt of Archaeological Sites Database Licence Agreement (DR2008-293).

9.6.7.2 ARCHAEOLOGICAL SETTING

The Project falls within the north-central area of the subarctic cultural region identified by Donald Clark (Clark 1991). According to Clark, the north-central area stretches from Hudson Bay's Northern Manitoban shores in the east to Great Bear Lake in the west, and from Lake Athabasca in the Prairie provinces to lands north of the Nunavut-NWT border. The cultural history is believed to have been reasonably consistent across the region. To date, archaeological studies have identified a succession of four generally accepted archaeological traditions representing groups living in the area as many as 8,000 years before present (B.P.) (Gordon 1996). Variations in the archaeological assemblages exist between the northern and southern portions. However, Gordon (1996) addresses this variation not as a geographical variation in tool traditions among different groups, but as a seasonal adaptation of tool assemblages within single groups corresponding with annual migrations of caribou to areas below the treeline.

The earliest known evidence of people in the region is the archaeological tool tradition known as Northern Plano. Dating between 8,000 and 6,500 years B.P. and identified primarily by the presence of Agate Basin and similar long, lanceolate spear points, the appearance of the Northern Plano tradition is believed to represent an influx of people following the glacial retreat and the spread of vegetation and game into the area (Gordon 1996). The argument for a northward migration of both peoples and tool technology is supported by the age gradient of Agate Basin projectile points ranging from 9,000 to 10,000 years B.P. in Wyoming, 8,000 to 9,000 years B.P. in the Prairie provinces, and eventually 6,500 to 8,000 years B.P. in the barren lands (Gordon 1996). Sites with diagnostic Northern Plano points are relatively sparse in the region, possibly representing smaller populations or a low emphasis on big game hunting. It is possible that Northern Plano sites lacking diagnostic tools have been sometimes mistakenly associated with later traditions (Stewart 1991).

Around 6,500 B.P., temperatures in the region began to rise. This period, which lasted for approximately 3,000 years, is known by several names, including the Mid-Holocene Climactic Optimum, the Altithermal, and the Hypsithermal. The change in climate appears to have allowed the advance of the treeline and people into more northern areas (Gordon 1996). At sites dating to the beginning of this period, Northern Plano sites begin to give way to another archaeological tradition referred to as the Shield Archaic. The long, finely worked, lanceolate projectile points of the Northern Plano tradition were replaced by shorter, rougher, side-notched points. Gordon (1996) and others (e.g., Clark 1991; Wright 1981) maintain that these represent the evolution of Northern Plano styles, rather than the arrival of a new population. Gordon (1996) suggests that such a technological evolution could have been due to changes in subsistence strategies, such as earlier ice break-ups, which allowed people to hunt caribou at water crossings.

According to Clark (1991), when climates began to cool around 4,000 years ago, the treeline and barren lands moved south once more, and the people associated with the Shield Archaic tradition seem to have shifted accordingly, apparently to avoid increasingly harsh conditions. While these changes would have made the area less favourable for some, they were appealing to the Arctic-adapted peoples known as the Paleo-Eskimos or the Pre-Dorset culture (Clark 1991). Pre-Dorset is the Canadian version of a widespread technological tradition called Arctic Small Tool, which is associated with the High Arctic, and traceable to the Siberian Neolithic (Gordon 1996; Irving 1970). According to Gordon (1996), the cooling temperatures had a negative effect on maritime hunting, and Pre-Dorset peoples were forced south from the coast in search of food. There they adapted to wintering in the forests and hunting caribou, and ranged as far south as Lake Athabasca (Clark 1991; Gordon 1996).

Pre-Dorset tools are distinguishable from earlier and later traditions found in the area by their manufacture and material, as well as the presence of tool types seen as unique to a Pre-Inuit people (Gordon 1996). These toolkits included blades and microblades (elongate, parallel-sided flakes knapped from specially prepared cores that served as cutting edges for spears, arrows and harpoons), burins, gravers, and small quartzite knives, among others (Gordon 1996). Whether the influx of Pre-Dorset peoples had a role in forcing those associated with the Shield Archaic out of the area is not clear, but according to Clark (1991), the radiocarbon dates suggest the lands were unoccupied when they arrived.

Some Middle Plains projectile point types, dating to Pre-Dorset and later periods, are also found at sites in the area, which is far from the regions they are generally associated with (Gordon 1996). Gordon (1996) indicates that this does not represent the presence of Plains hunters in the area, but instead indicates some amount of contact between the northern and Plains populations while wintering in the forests to the south.

After several hundred years, the climate began to warm again, and the Paleo-Eskimos left the area. The area was gradually repopulated by a group known archaeologically as the Taltheilei (Clark 1991). As when they moved into the area, it is unclear whether the Pre-Dorset peoples were forced out of the area by their successors, but a gap in the radiocarbon dates leaves no evidence for contact between the two (Clark 1991). Taltheilei sites appear in the area around 2,600 B.P., and continue to make up the archaeological record in the area until around 200 B.P. At this time, they become differentiated from historic Dene sites mainly by their lack of trade metals, as well as by their association with the caribou migration route. The historic Dene stopped following because of pressure from peoples to the north and the lure of the fur trade to the south (Gordon 1996).

Gordon divides known Taltheilei sites into four phases:

- Earliest Phase (approximately 2,600 to 2,485 B.P.)
- Early Phase (2,450 to 1,800 B.P.)
- Middle Phase (1,800 to 1,300 B.P.)
- Late Phase (1,300 to 200 B.P.)

Sites from the Earliest Phase are distinguished from later phases by thick, narrow projectile points with incipient notching, which evolved in the Early Phase to have more distinctive shoulders (Gordon 1996).

Middle Phase Taltheilei sites correspond with a warmer climate and represent the broadest exploitation of all the caribou followers in the area throughout the archaeological record (Gordon 1996). A good deal of radiocarbon dates have been established for the Middle Phase, as well as several clearly diagnostic tool types, including symmetrical ground stemmed lance heads, knives, and triangular scrapers (Gordon 1996).

Late Phase Taltheilei sites document the appearance of the bow and arrow for caribou hunting (only the Pre-Dorset peoples had used the bow and arrow in the area up to this point in time). During this phase, tool quality generally falls, with tools appearing asymmetric and crude when compared to earlier phase assemblages (Gordon 1996). Some objects of Aboriginal worked copper have been dated to this period, such as beads, semilunar knife blades, and points (Clark 1991).

9.6.7.3 HISTORIC SUMMARY

During the historic period, there were several well-used regions within the currently proposed Project area. The southern portion of the transmission line route passes near several extant communities that were first established as forts and posts, including Fort Smith, Fort Resolution, Łutsel K'e, and Reliance. Great Slave Lake and nearby waterways supported a good deal of traffic by various fur traders, explorers, surveyors, and prospectors.

The endeavours of Samuel Hearne between 1769 and 1772 to find the source of Aboriginal worked copper in the area are considered to be the earliest example of a non-Native presence in the vicinity (Hearne & Tyrell 1911). Hearne made several attempts to access the area around what is now known as the Coppermine River, passing through the currently proposed Project area north and east of Great Slave Lake.

In 1790 and 1791, Philip Turnor travelled in the Great Slave Lake area, visiting a post at the mouth of the Slave River. In his journal, transcribed by J.B. Tyrrell and published in 1934, Turnor mentions a portage route and provides a description of the lakes to the northeast as told to him by an Aboriginal resident of the area. Tyrrell points out in his notes that the portage was likely the traditional route that later came to be known as Pike's Portage, and that the waters described were likely the Lockhart River, Artillery Lake, Aylmer Lake, and Back (Great Fish or Thlewey choh) River (Hearne & Tyrell 1911).

Turnor spent time at a post in the area referred to in his journal as the "Canadians' house" and the "Canadians' settlement," and documented some often hostile relations between the traders and the local populations (Hearne & Tyrell 1911). The noted Hudson's Bay Company (HBC) surveyor, Peter Fidler, also travelled to the area with Turnor. Once there, Fidler opted to spend a good deal of time with a group of Chipewyans, reporting later to Turnor on the plentiful bison to the west of Great Slave Lake, the existence of the Taltson River, and the good beaver populations there (Hearne & Tyrell 1934).

Captain George Back travelled extensively in the North between 1833 and 1835 in a Crown-funded attempt to locate the expedition of Sir John Ross, who had not been heard from since sailing to the Arctic to find Franklin in 1829. He spent a good deal of time within the Taltson study area in 1833 and 1834, and published an account of his experiences soon after in the book *Narrative of the Arctic land expedition to the mouth of the Great Fish River, and along the shores of the Arctic Ocean, in the years 1833, 1834, and 1835* (Back & Richardson 1836). Back sailed to Canada and was outfitted by the HBC in Montreal before travelling north to Great Slave Lake. Once there, he set out east from Fort Resolution and paddled along the eastern side of the lake before crossing to the northern shore. From Great Slave Lake, he travelled along the Hoarfrost River to Cook and Walmsley Lakes (Back & Richardson 1836; Rescan 2004). Unaware of the traditional route (Pike's Portage) to the south, he attempted to paddle the Lockhart River, but deemed it impossible to navigate by canoe, and noted that even walking on the shore was difficult (Rescan 2004). Back was responsible for numerous place names still used today, including Point Keith, Christie Bay, Beverly Falls, Cook Lake, Walmsley Lake, Clinton-Colden Lake, Aylmer Lake, Artillery Lake, Parry Falls, and Anderson Falls (Back & Richardson, 1836; Rescan 2004).

During his travels in the area, Back spent two winters at Fort Reliance, which had been built for the purposes of his expedition by Alexander McLeod of the HBC (Rescan 2004). Fort Reliance is the closest historic fort to the proposed Project area, and the fort's chimneys, still standing, were visible from the helicopter during the archaeological surveys conducted by Golder Associates Ltd. (Golder) in June, 2008.

After Back, two HBC officers named James Anderson and James Stewart travelled to the area to investigate Inuit reports of the existence of Franklin expedition remains in the vicinity. They followed a portage route on the north shore of Great Slave Lake marked by a landform known as "The Mountain" (Rescan 2004). This landform was previously described by George Back as a place where the Aboriginal people used to leave their canoes when travelling to the barren lands to hunt (Back & Richardson 1836; Rescan 2004), and was later included on a map of the exploits of Warburton Pike (1892). For their journey back, Anderson and Stewart travelled via Artillery Lake. Here, they were met by James Lockhart, who had rebuilt Fort Reliance for their purposes and been led to Artillery Lake by an Aboriginal person familiar with the traditionally used canoe route, to be known later as Pike's Portage (Rescan 2004).

British adventurer Warburton Pike is the namesake for Pike's Portage; he came through Fort Resolution into the area in August, 1889, on his way north to observe and hunt the muskoxen (Cockburn 1985). Pike spent five months exploring and hunting with Chipewyan and Métis guides, both in the subarctic forest and north of the treeline on the barren lands (Cockburn 1985; Pike 1892). Pike and his companions paddled a good deal of the Project area and a map from his 1892 account of the experience depicts such places as the east arm of Great Slave Lake, Fort Reliance, the Lockhart River (with the famous portage route to the south and a Yellowknife encampment where it meets Artillery Lake), Artillery Lake, Walmsley Lake, Clinton-Golden Lake, Lac de Gras, and Lac du Sauvage, before finally finishing north of the 66th parallel where he noted: "Musk Ox Numerous" (Pike 1892).

In 1899, Hanbury detailed the landscape and geology of the area on his way to Hudson Bay via Pike's Portage, Artillery Lake, Campbell Lake, and the Thelon River (Hanbury 1904; Rescan 2004). In 1900, J.B. Tyrrell conducted a survey of the lands east of Great Slave Lake, characteristically photographing his progress as he went. Images still exist of his visits to Pike's Portage (including graves located there), the chimneys and ruins of Fort Reliance, and Anderson Falls on the Lockhart River (University of Toronto Libraries, Digital Collections).

Dr. Charles Camsell also travelled the area in 1914 (Camsell 1916). He left Lake Athabasca with eight men in three canoes, reaching Tazin Lake by a series of five portages and connecting lakes, and eventually followed the Taltson system to Great Slave Lake (Camsell 1916). Dr. Camsell, later a Deputy Minister of Mines for Canada, made detailed notes of the geology and landscape as he went, and commented on the local peoples' various seasonal use of the Taltson system and the associated trails.

9.6.7.4 PREVIOUS ARCHAEOLOGICAL STUDIES

Since the late 1940s, there have been numerous archaeological investigations conducted near the Project area, including both industry-related surveys and research studies. In general, most of the investigations conducted in the southern portion of the Project area have been academic research studies conducted by the Canadian Museum of Civilization (Gordon 1975; Gordon 1996; Noble 1967; Noble 1969; Noble 1971), whereas most of work farther north has been industry-related surveys conducted as part of impact assessments for diamond mine developments in the area (Hanna 2007).

The first archaeological work conducted near the Project's current footprint was a canoe survey carried out by R. MacNeish in 1949 between Artillery Lake and Caribou Narrows, during which he recorded 21 sites (MacNeish 1951). The next surveys carried out were those of William Noble, between 1966 and 1971. Noble surveyed the east arm of Great Slave Lake, including the area of Fort Reliance, Łutsel K'e, the north shore of MacLeod Bay, Artillery Lake, and Taltheilei Narrows. Noble recorded hundreds of sites, most near major rivers or lakes such as the north and east shore of Great Slave Lake (Charlton Bay and Sunken River areas), along Pike's Portage, and at the south-western end of Artillery Lake (Noble 1967; Noble 1969; Noble 1971). Only one site was found between Tyrrell and Parry Falls on the Lockhart River, possibly because this was a less desirable travel route than Pike's Portage to the south (Rescan 2004).

Brian Gordon conducted major surveys along the Taltson, Elk, and Dubawnt river systems in the 1970s and recorded almost 200 sites. Some of these sites are near the Project area on Nonacho and Noman Lakes (Gordon 1975; Gordon 1996).

Bostock recorded one site on the Taltson River in 1980. However, according to the *Taltson Hydro Expansion Project 2003 Baseline Report* (Rescan, 2004), Bostock's report could not be located for review at either the Canadian Museum of Civilization or the Prince of Wales Northern Heritage Centre.

In 1982, David Morrison recorded almost 50 sites, mostly historic and late-prehistoric, but some of greater age and with stratified contexts, along the Lockhart River system. The *Taltson Hydro Expansion Project 2003 Baseline Report* (Rescan 2004) notes that the presence of these sites confirms the importance of the Lockhart River System to heritage studies in the area (Morrison 1982; Rescan 2004).

With the onset of diamond exploration and mining in the northern part of the Project area, several environmental assessments have been conducted that included archaeological components. Archaeological investigations relating to the De Beers Snap Lake Mine began in 1998 and were conducted by Bussey and Thomson (Bussey 2000b, 2002a, 2003c; Thomson 2001). These investigations yielded over 50 sites, mostly lithic scatters and lookouts on elevated areas near large lakes (Hanna 2007). East of Snap Lake, the development of the De Beers Gahcho Kué Project at Kennady Lake instigated several seasons of archaeological assessments that resulted in the discovery of a few hundred sites, mostly on eskers near lakes and streams (Fedirchuk 1996; Thomson 2000a, 2000b, 2000c, 2003).

The Tibbitt to Contwoyto Winter Road Project, part of the infrastructure related to the local diamond mining developments, also required archaeological investigations and, in some cases, mitigation (Bussey 2003d). Bussey (2002b) recorded over 50 sites and revisited a number of those previously recorded during the assessment. According to the *Taltson Hydro Expansion Project 2003 Baseline Report* (Rescan 2004), a number of these were tested and mitigated, as required because of their proximity to portages, gravel pits, and work areas (Bussey 2003d). Again, most sites identified during this assessment were on eskers and other elevated areas and were mostly lithic scatters, lithic workshops, and in some cases, tent rings and lookouts (Bussey 2000a). Monitoring of the Tibbitt to Contwoyto Winter Road was completed in 2003 (Bussey 2004b).

The development of the Diavik Diamond Project on an island in Lac de Gras in the northern part of the Project area resulted in extensive archaeological surveys in the vicinity, which has subsequently yielded almost two hundred archaeological sites (Fedirchuk 1995, 1997; Fedirchuk McCullough & Associates Ltd. 1999, 2000). The early investigations focused on two large islands in Lac de Gras and selected mainland areas, while subsequent work expanded to a broader range of topography. The majority of the sites identified were lithic scatters, lookouts, and isolated finds on eskers, elevated areas, and similar landforms of high archaeological potential.

Archaeological assessments associated with the BHP Billiton Ekati Diamond Mine, north of Lac de Gras, began in 1994 and continued annually until 2003 (Bussey 1994, 1995, 1997, 1998, 1999a, 1999b, 2000a, 2001a, 2003a, 2004a). More than two hundred sites were recorded, mostly on elevated landforms and consisting of lithic scatters and workshops (Rescan 2004).

Gold explorations near Courageous Lake have also instigated archaeological assessments. Bussey (2003b) conducted potential assessment and ground-truthing for the direction of future studies (Rescan 2004).

In 2004, NTEC 03 commissioned a baseline study of heritage resources near the proposed development footprint. At that time the transmission line design terminated at Snap Lake. The report summarized the available information about known sites and previous archaeological investigations in the area, and identified potential areas where the development could affect heritage resources (Rescan 2004). In 2007, NTEC 03 commissioned a further historical resources overview (Hanna 2007). This report also summarized previous archaeological investigations and described known heritage resources near the Project area up to Ekati and Diavik Mines, and recommended areas for future field investigation

In 2008, Dezé commissioned a baseline field survey of the Project area based on the current Project design. The survey encompassed a 1 km wide corridor along the full length of the proposed power line route, as well as all associated laydown areas and developmental footprints. The survey's objective was to identify any areas where the proposed development could potentially affect heritage resources; special attention was paid to known areas of high site density and to areas of perceived high archaeological potential, such as river crossings, portages, shorelines, and elevated topography. Nine new sites of various ages were recorded, including lithic workshops, tent rings, lookouts, individual artifact finds, and more recent historical sites. An overview map of archeological sites near the proposed East Arm transmission line route is presented in Figure 9.6.14.

TALTSON **Hydroelectric Expansion Project**	**Developer's Assessment Report** **2009**	**Archaeological Sites**	**Figure** **9.6.14**

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9.6.7.5 KNOWN HERITAGE RESOURCES

9.6.7.5.1 Sites Associated with Proposed Transmission Line

Based on archaeological records searches and preliminary field investigations, several sites have been identified near the proposed transmission corridor. These sites are variable in their size, age, and material composition. The sites are identified in Table 9.6.28 and further described in the section below.

Table 9.6.28 — Proposed Transmission Line Route

Map Reference	Borden Number	Site Type
75D/6	JcOt-1	lithic scatter, workshop
75K/10	KeNo-23	lithic workshop
	KeNo-24	lithic workshop
	KeNo-25	lithic scatter
	KeNo-33	campsite, lithic workshop
	KeNo-34	campsite, lithic workshop
75K/15	KeNo-8	campsite, lithic workshop
75M/10	KjNu-1	lithic scatter
	KjNu-2	lithic scatter
	KjNu-3	lithic scatter
	KjNu-4	campsite, lithic scatter
	KjNu-7	isolated find
75N/6	KiNp-12	lithic scatter, lookout
	KiNp-13	lithic scatter, lookout
	KiNp-14	lithic scatter, lookout
	KiNp-40	lithic scatter, lookout
	KjNt-12	campsite
	KjNp-9	lithic scatter
75N/7	KhNp-1	lithic scatter
	KhNp-2	lithic scatter
75N/13	KlNr-3	lookout
76C/4	LaNr-4	historic wood cuttings
76D/9	LeNs-24	lithic scatter
	LeNs-25	lithic scatter
	LeNs-31	lithic scatter
	LeNs-32	lithic scatter

Map Reference	Borden Number	Site Type
76D/9	LeNt-15	lithic scatter
	LeNt-38	isolated find

Wooden Food Cache Frame

Near the centre proposed transmission line's 1 km corridor, approximately 500 m north of the first point of intersection, 100 m east of a nearby access road, and adjacent to the existing road near the airstrip at Twin Gorges, is a collapsed 5.8 m high, three-level wooden structure. Identified as a food cache frame by Fort Smith resident Johnny Desjarlais, the structure was found lying on its side in a clearing in the jackpine forest on June 22, 2008, during archaeological investigations of the Project area. The structure was constructed from three main poles and a number of smaller ones, which were cut by a saw and held together by wire nails. There was a pile of rocks at the bottom end of the frame. No artifacts were collected. It is most likely less than 50 years old. As such, no Borden number was assigned to this location.

JcOt-1

According to the original site notes, JcOt-1 was recorded in 1980 and is on the eastern bank of the Taltson River diversion, approximately 2.4 km below the weir, West of Methleka Lake. Following a forest fire and unusually high waters coming over the Taltson River weir, an area approximately 60 m long was scoured below the Nonacho weir on the eastern bank. Eighteen kilograms of quartz flakes and one small biface were collected. While a definitive time period cannot be ascertained for this site based on the artifacts currently recorded, it is probable that the site predates the arrival of Europeans in the region. Golder revisited the location described in the notes in 2008. Despite an examination of the shoreline and through numerous shovel tests, the site could not be positively relocated.

KeNo-23

Recorded in 1966, KeNo-23 is 2.7 km inland from Charlton Bay on Lobo Creek. The site consists of several choppers and a surface scatter of quartz and quartzite flakes in sand blowout patches south of a low rock ridge. While a definitive time period cannot be ascertained for this site based on the artifacts currently recorded, it is probable that the site predates the arrival of Europeans in the region.

KeNo-24

Recorded in 1966, KeNo-24 is 3.2 km east of Charlton Bay on the southern side of Lobo Creek. The site overlooks a steep sand bluff dropping into the creek bottom where there is a bedrock dyke approximately 2 m wide cutting across the river in a north-south direction. The site extends roughly 45 m, and artifacts include a biface, a good deal of quartzite debitage, retouched flakes, and a few silicious shale flakes. While a definitive time period cannot be ascertained for this site based on the artifacts currently recorded, it is probable that the site predates the arrival of Europeans in the region.

KeNo-25

This site was recorded in 1966, and lies on a sand point at the confluence of Lobo Creek and a tributary, approximately 200 m northeast of KeNo-24. The site overlooks a large bend up the valley towards a small pond. KeNo-25 is a surface scatter that, when recorded, contained one green quartzite flake and a concentration of quartz debitage, as well as three pieces of fire-broken rock. While a definitive time period cannot be ascertained for this site based on the artifacts currently recorded, it is probable that the site predates the arrival of Europeans in the region.

KeNo-33

Recorded in 1966, KeNo-33 is on Pike's Portage route, on the trail to Harry's Lake, which is on top of the first steep incline beyond Pike's Juncture. The site has been designated a single campfire stopover site and yielded two artifacts: one mauve-coloured retouched quartzite flake and one quartz flake. While a definitive time period cannot be ascertained for this site based on the artifacts currently recorded, it is probable that the site predates the arrival of Europeans in the region.

KeNo-34

Recorded in 1966, KeNo-34 is 8 km east of KeNo-33 on Pike's Portage route. The site is on sand exposures on the east side of the first major creek valley encountered on the portage, leading to Harry Lake from Charlton Bay. The site consists of fire-broken rock from three hearths at the north-eastern end of a sand plateau in blowout depressions. Two pink quartzite flakes were also recovered. While a definitive time period cannot be ascertained for this site based on the artifacts currently recorded, it is probable that the site predates the arrival of Europeans in the region.

KeNo-8

Recorded in 1966, KeNo-8 is on the northern side of the Lockhart River about 1.6 km above Tyrrell Falls, on top of an abandoned interfleuve boulder ridge. The site yielded two pieces of debitage in association with two hearth areas. This location was revisited in 2008 by Golder; however, despite a thorough examination of the shoreline and numerous shovel tests along the lower terrace, the site could not be positively relocated. While a definitive time period cannot be ascertained for this site based on the artifacts currently recorded, it is probable that the site predates the arrival of Europeans in the region.

KjNu-1

Recorded in 1999 during the Snap Lake Mine archaeological assessment, KjNu-1 is on the west side of a small lake that drains south through an esker. The site is on exposed sand and gravel on a relatively level, broad, terrace-like landform north of the esker crest. A single grey quartz flake was observed near the eastern edge of the site, and a small lithic scatter containing less than 10 pieces of quartz debitage was observed near the southern edge. While a definitive time period cannot be ascertained for this site based on the artifacts currently recorded, it is probable that the site predates the arrival of Europeans in the region.

KjNu-2

Recorded in 1999 during the Snap Lake Mine archaeological assessment, KjNu-2 is northeast of KjNu-1 on a continuation of the same landform. The terrain is level, but the landform is wider in this area. The site is a lithic scatter visible in areas of exposed sand and gravel, though parts of the site were still vegetated when recorded, implying reasonable potential for additional cultural material. While a definitive time period cannot be ascertained for this site based on the artifacts currently recorded, it is probable that the site predates the arrival of Europeans in the region.

KjNu-3

Recorded in 1999 during the Snap Lake Mine archaeological assessment, KjNu-3 is approximately 70 m northeast of KjNu-2 on a continuation of the same landform, overlooking a gully and an esker crest to the south. The site consists of a light lithic scatter of less than 10 quartz flakes strewn across the entire width of the exposed surface of the landform. While a definitive time period cannot be ascertained for this site based on the artifacts currently recorded, it is probable that the site predates the arrival of Europeans in the region.

KjNu-4

Recorded in 1999 during the Snap Lake Mine archaeological assessment, KjNu-4 is on a lower terrace north of KjNu-1, south of Snap Lake. KjNu-4 is a large camp/lithic scatter site consisting of three areas of lithic concentrations, bone fragments, and a possible hearth. The site is partly vegetated, and sand and fine gravel is visible in the exposed areas. While a definitive time period cannot be ascertained for this site based on the artifacts currently recorded, it is probable that the site predates the arrival of Europeans in the region.

KjNu-7

Recorded in 1999 during the Snap Lake Mine archaeological assessment, KjNu-7 is an isolated artifact find south of a large kettle near the northern edge of an esker, south of Snap Lake. The site was found near proposed gravel sources and a single piece of grey quartz debitage was collected. While a definitive time period cannot be ascertained for this site based on the artifacts currently recorded, it is probable that the site predates the arrival of Europeans in the region.

KiNp-12

Recorded in 1999 during the Gahcho Kué Project archaeological assessment, KiNp-12 is a lithic scatter/lookout on a neck of land between a large pond and the northeast corner of the west arm of Gahcho Kué (Kennady Lake), 2.7 km north-northeast of the exploration camp. The site is 50 m from the highest point of a ridge with a good lookout over the north end of the lake. One large, asymmetric transverse biface perform was recovered in two pieces. While a definitive time period cannot be ascertained for this site based on the artifacts currently recorded, it is probable that the site predates the arrival of Europeans in the region.

KiNp-13

Recorded in 1999 during the Gahcho Kué Project archaeological assessment, KiNp-13 is a lithic scatter/lookout on a neck of land between a large pond and the northeast corner of the west arm of Gahcho Kué (Kennady Lake), 2.7 km north-northeast of the exploration camp. The site consists of a scatter of quartz debitage and one possible tent ring. Two site areas are recorded, entitled Locus 1 and Locus 2, with Locus 1 145 m from the shore of the lake and Locus 2 104 m northeast of Locus 1. While a definitive time period cannot be ascertained for this site based on the artifacts currently recorded, it is probable that the site predates the arrival of Europeans in the region.

KiNp-14

Recorded in 1999 during the Gahcho Kué Project archaeological assessment, KiNp-14 is a lithic scatter/lookout on a high point at the north end of a ridge running north-south. The site is 225 m south of a long pond north of the north end of the west arm of Gahcho Kué (Kennady Lake), 3.7 km northwest of the exploration camp. A concentration of quartz debitage and one biface fragment were observed, but no artifacts were collected. Local elevation of the site was approximately 15 m above lake level when recorded. While a definitive time period cannot be ascertained for this site based on the artifacts currently recorded, it is probable that the site predates the arrival of Europeans in the region.

KiNp-40

Recorded in 1999 during the Gahcho Kué Project archaeological assessment, KiNp-40 is a lithic scatter/hunting station 210 m east of the tip of a peninsula at narrows 2 km east of the exploration camp. The site is about 5.4 m above the lake level on a bedrock/blowout ridge 35 m from the shore, with a good view of the lake and across the narrows. The site is in an excellent hunting location, as many caribou trails come up the peninsula and pass within 100 m of the site en route to the narrows crossing. One white quartz biface edge was collected. While a definitive time period cannot be ascertained for this site based on the artifacts currently recorded, it is probable that the site predates the arrival of Europeans in the region.

KjNt-12

Recorded in 2008 by Golder during the baseline archaeological assessment for the Project, KjNt-12 is on a level area atop a sandy/gravely ridge 100 m northwest of a small, unnamed lake, and 8.5 km northeast of Haywood Lake. The site consists of five tent rings on a large flat gravely ridge. No artifacts were collected or observed. While a definitive time period cannot be ascertained for this site based on the artifacts currently recorded, it is probable that the site predates the arrival of Europeans in the region.

KjNp-9

Recorded in 2008 by Golder during the baseline archaeological assessment for the Project, KjNp-9 consists of a small quartz scatter on an exposed esker immediately north of a small inlet of Murdock Lake. Ten quartz flakes were observed but no artifacts were collected. While a definitive time period cannot be ascertained for this site based on the artifacts currently recorded, it is probable that the site predates the arrival of Europeans in the region.

KhNp-1

Recorded in 2008 by Golder during the baseline archaeological assessment for the Project, KhNp-1 is on a narrow esker near a small pond and 140 m north of a small lake. A total of 15 pieces of debitage were observed, including 11 pieces of quartz and 4 pieces of a pink, fine-grained sandstone or quartzite. No artifacts were collected. While a definitive time period cannot be ascertained for this site based on the artifacts currently recorded, it is probable that the site predates the arrival of Europeans in the region.

KhNp-2

Recorded in 2008 by Golder during the baseline archaeological assessment for the Project, KhNp-2 consists of a small quartz scatter on an exposed sandy area 50 m northeast of a small lake inlet, and approximately 10 km northwest of Cook Lake. Fifteen pieces of quartz debitage and one large quartz core were observed. No artifacts were collected. While a definitive time period cannot be ascertained for this site based on the artifacts currently recorded, it is probable that the site predates the arrival of Europeans in the region.

KlNr-3

Recorded in 2008 by Golder during the baseline archaeological assessment for the Project, KlNr-3 is on the highest part of an esker between two small, unnamed lakes, approximately 3.4 km southwest of Zyena Lake. The site consists of a cairn, composed of four large rocks clustered together and stood on end. No artifacts were observed or collected. Because of the lack of supplementary artifacts at this site, little is known about its relative age.

LaNr-4

Recorded in 2008 by Golder during the baseline archaeological assessment for the Project, LaNr-4 is immediately north of a prominent cluster of boulders near the western end of an east-west running esker, approximately 2.5 km west of the Outram Lakes' western extent. The site consists of several old axe-cut tree branches spread approximately 20 m across the esker. No live trees were visible in the area, and large amounts of lichen growing upon the cut wood implied considerable age. No artifacts were observed or collected. While a definitive time period cannot be ascertained for this site based on the artifacts currently recorded, it is probable that the site predates the arrival of Europeans in the region.

LeNs-24

Recorded in 1996 during archaeological investigations associated with the Ekati Diamond Mine Project, LeNs-24 is a lithic scatter on an east-west trending esker approximately 2 km north of the northernmost edge of the eastern half of Duchess Lake, in the upper Coppermine River drainage north of Lac de Gras. The site overlooks a very small lake/pond to the southwest and an outcrop of rock to the south. While a definitive time period cannot be ascertained for this site based on the artifacts currently recorded, it is probable that the site predates the arrival of Europeans in the region.

LeNs-25

Recorded in 1998 during archaeological investigations associated with the Ekati Diamond Mine Project, LeNs-25 is a lithic scatter found on a level, discontinuous section of northwest-southeast trending esker, which is not identified on the 1:50,000 topographic map of the area, overlooking a small lake to the south. While a definitive time period cannot be ascertained for this site based on the artifacts currently recorded, it is probable that the site predates the arrival of Europeans in the region.

LeNs-31

Recorded in 2002 during archaeological investigations associated with the Ekati Diamond Mine, LeNs-31 is on the western edge of a high section of the Duchess East Esker. The site is a lithic scatter of approximately 40 pieces of quartz debitage and the presence of vegetation suggests the possibility of further buried cultural material. No artifacts were collected. While a definitive time period cannot be ascertained for this site based on the artifacts currently recorded, it is probable that the site predates the arrival of Europeans in the region.

LeNs-32

Recorded in 2002 during archaeological investigations associated with the Ekati Diamond Mine Project, LeNs-32 is a lithic scatter of less than 25 pieces of quartz debitage on the western edge of a high section of the Duchess East Esker. The site is on two levels, and overlooks the southeast corner of an unnamed lake. The presence of vegetation on the surface suggests the possibility of further buried cultural material. No artifacts were collected. While a definitive time period cannot be ascertained for this site based on the artifacts currently recorded, it is probable that the site predates the arrival of Europeans in the region.

LeNt-15

Recorded in 1997 during archaeological investigations at the Ekati Diamond Mine, LeNt-15 is approximately 8.5 km north of Paul Lake's drainage into Lac de Gras. The site is scattered lightly with white quartz debitage with a concentration in the central area. One shovel probe conducted at the base of an esker proved sterile. While a definitive time period cannot be ascertained for this site based on the artifacts currently recorded, it is probable that the site predates the arrival of Europeans in the region.

LeNt-38

Recorded in 2000 during archaeological investigations at the Ekati Diamond Mine, LeNt-38 is north of Lac de Gras on the north-western portion of the Lac du Sauvage esker east of the mine. This well-defined esker runs from Lac de Gras north along the west shore of Lac du Sauvage, then heads west and north. One medium-sized rectangular biface/knife was collected on the gravely surface. While a definitive time period cannot be ascertained for this site based on the artifacts currently recorded, it is probable that the site predates the arrival of Europeans in the region.

9.6.7.5.2 Sites Associated with Proposed Winter Road and Laydown Areas

Based on archaeological records searches and preliminary field investigations several sites have been identified that are near the proposed winter road and laydown areas. These sites are variable in their size, age, and material composition. The sites are identified in Table 9.6.29 and descriptions are provided in the section below.

Table 9.6.29 — Archeological Sites near Proposed Winter Road and Laydown Areas

Map Reference	Borden Number	Site Type
75F/3	KaNq-2	lithic quarry, lithic scatter
75F/4	JlOi-1	campsite, lithic scatter
75F/13	JlOj-2	campsite, lithic scatter
75K/3	KaNp-1	burial, lithic scatter
	KaNp-2	lithic scatter, lithic quarry
	KaNp-3	artifact scatter
	KaNq-9	lithic scatter
75K/4	KaNq-4	campsite, lithic scatter
	KaNq-5	artifact find
	KaNq-8	campsite, lithic scatter, historic scatter
	ZAVR-086	historic campsite
76K/3	KaNq-10	lithic scatter

KaNq-2

Recorded in 1975 on a prominent ridge on the north shore of the mouth of Sparrow Bay, KaNq-2 is a lithic quarry and lithic scatter. Feldspar may have been quarried here for cultural use. Lithic artifacts and debitage were collected. While a definitive time period cannot be ascertained for this site based on the artifacts currently recorded, it is probable that the site predates the arrival of Europeans in the region.

JlOi-1

Recorded in 1975, JlOi-1 is on the beach of a peninsula jutting to the northeast from the eastern shore of Nonacho Lake, approximately 4 km southwest of the mouth of Sparrow Bay. JlOi-1 is a lithic scatter/campsite recorded in 1975. One quartzite point and several flakes were observed. While a definitive time period cannot be ascertained for this site based on the artifacts currently recorded, it is probable that the site predates the arrival of Europeans in the region.

JlOj-2

Recorded in 1975, JlOj-2 is on an island dividing north Nonacho Lake from south Nonacho Lake. A nearby area once used as a portage was flooded when the site was recorded. The site is designated as a surface lithic scatter/campsite with two artifact concentrations at a game crossing. Lithic artifacts and debitage were collected. While a definitive time period cannot be ascertained for this site based on the artifacts currently recorded, it is probable that the site predates the arrival of Europeans in the region.

KaNp-1

Recorded in 1975, KaNp-1 is a burial site and lithic scatter on a ridge blowout in the centre of an island on Nonacho Lake. Intensely blown out and almost entirely excavated, the site contained two burial components with three points, six scrapers, an adze, and other lithic artifacts. While a definitive time period cannot be ascertained for this site based on the artifacts currently recorded, it is probable that the site predates the arrival of Europeans in the region.

KaNp-2

Recorded in 1975, KaNp-2 is a lithic scatter/quarry on a ridge northeast of KaNp-1 on the shores of Nonacho Lake. A few scattered pieces of lithic debitage were collected on a granite outcrop. The ridge possesses a commanding view of the water crossing from the north-eastern side of an island chain. While a definitive time period cannot be ascertained for this site based on the artifacts currently recorded, it is probable that the site predates the arrival of Europeans in the region.

KaNp-3

Recorded in 1975 and on a spit on the eastern shore of Nonacho Lake, KaNp-3 is a flooded artifact scatter near a historic gravesite that lays farther inland to the southeast. The site is underwater on the north face of the spit. Lithic artifacts and debitage were collected. While a definitive time period cannot be ascertained for this site based on the artifacts currently recorded, it is probable that the site predates the arrival of Europeans in the region.

KaNq-9

Recorded in 1975, KaNq-9 is on the north end of an island in the middle of the channel at the entrance to Sparrow Bay. The site comprises a scatter of white quartzite cores and flakes on the surface.

KaNq-4

Recorded in 1975, KaNq-4 is a lithic scatter/campsite on the north shore of Sparrow Bay. The site comprises a light scatter of Taltheilei tools and debitage on a flat area along the shore. While a definitive time period cannot be ascertained for this site based on the artifacts currently recorded, it is probable that the site predates the arrival of Europeans in the region.

KaNq-5

Recorded in 1975, KaNq-5 is on an island along a historical portage route to Knox Lake from Sparrow Bay. The site consists of an isolated find of a single flake. While a definitive time period cannot be ascertained for this site based on the artifacts currently recorded, it is probable that the site predates the arrival of Europeans in the region.

KaNq-8

Recorded in 1975, KaNq-8 is near the proposed path of the Project transmission line, the proposed winter road, and an associated laydown area. The site is a lithic scatter/campsite halfway along a traditional portage route between Knox Lake and Sparrow Bay. Metal goods from the historic period are also visible near the lithic scatter, which comprises a few flakes on the surface.

ZAVR-086

Recorded in 1977, ZAVR-086 is a campsite from the historic period at the southwest end of a small island in the mouth of Sparrow Bay on Nonacho Lake. Artifacts at the site included a "family box" containing solid brass shotgun shells, as well as a washtub and other camp remains.

KaNq-10

Recorded in 2008 by Golder during the baseline archaeological assessment for the Project, KaNq-10 is next to the water on a small bedrock point at Sparrow Bay, on the western side of Nonacho Lake. A total of 51 pieces of quartz debitage were observed, but no artifacts were collected. The site is 0.5 m from the water's edge, and may be submerged for part of the year. While a definitive time period cannot be ascertained for this site based on the artifacts currently recorded, it is probable that the site predates the arrival of Europeans in the region.

9.6.7.6 SITES OF TRADITIONAL / CULTURAL SIGNIFICANCE

9.6.7.6.1 The Lady of the Falls (Ts'ankui Theda)

During community scoping sessions in Fort Smith in November 2007, concerns were expressed regarding the routing of the transmission line across the Lockhart River (Desnedhe Che) due to the presence of a sacred place at Parry Falls called "The Old Lady of the Falls" (Ts'ankui Theda), east of Fort Reliance (MVEIRB 2008a).

Ts'ankui Theda is an impressive landmark and a site of cultural and spiritual importance to the Dene people of the area. This site exemplifies the powerful and complex connection that exists between the Dene people and their landscape. One telling of the legend associated with Ts'ankui Theda is summarized here:

> *A big man named Hachoghe was hunting a beaver at Artillery Lake, and attempted to dig into the beaver's lodge, moving soil and piling it to one side as he dug (the location of this pile is said to be still visible today). The beaver escaped, and followed the Lockhart River to Tu Nedhé (Great Slave Lake), where the people were starving. The people at Tu Nedhé saw the beaver, and hoped to catch it for food. Hachoghe also saw the beaver at this point, and attempted to kill it by throwing a shovel into the water. The beaver swam away, and the shovel broke and had to be left behind, creating the rocky landmark known as Hachoghe's Shovel. Hachoghe chased the beaver back up the Lockhart River, with the starving Dene following behind. The strong river was too tiring for the beaver, and Hachoghe was able to catch and kill it. The hungry people immediately began to eat, with enough meat to last for two to three days. However, one woman asked for the beaver's blood. Hachoghe told her that he could not give her any because there was not very much left, and so she sat down at the falls and*

waited. Soon, Hachoghe and all the other Dene were chasing another beaver downriver towards Tu Nedhé. Eventually, they realized that the woman was missing, and Hachoghe sent two people to go back and find her. They found her still seated at the falls, where she had been sitting so long that her body was stuck to the earth. She told them that she could not return with them, for she would remain there for eternity, and sent them back to inform Hachoghe. From that day on, the Dene people have visited the Ts'ankui Theda to pay respects, share worries, and ask for help (paraphrased from Zepp Casaway, WLEC 2002).

The proposed transmission line crosses the Lockhart River approximately 7 km downstream from Parry Falls near Tyrrell Falls. Concerns have been raised by people regarding any possibility of physical or visual effects to this location or to the rest of the Lockhart River, because its waters' connection to the site causes it to be considered sacred (Mackenzie Valley Environmental Impact Review Board [MVEIRB] 2003). In 2008, Golder conducted a viewshed analysis to determine whether any proposed developments associated with the Project would be visible from the site area. The analysis concluded that no developments would be visible (for further details, see the viewshed analysis in Section 15.10).

Ts'ankui Theda has been established in numerous works and meetings as a unique site of strong significance to the Dene people (Bell 2003; Kendrick 2003; LKCSS 2008; LKDFN Elders, WLEC, Ellis, Boucher, & Catholique, 2001; MVEIRB 2003; Parlee, Manseau, & Łutsel K'e Dene First Nation, 2005; Parlee & Marlowe 1999; Parlee, O'Neil, & Łutsel K'e Dene First Nation 2007), and has been tied to a variety of cultural practices and beliefs. A destination of annual pilgrimages for many years, the "Old Lady of the Falls" is believed to have healing properties and many people visit the site to be cured of diseases (LKCSS 2008). The site is also closely tied to the belief that the land, when respected, would provide for its people (LKDFN Elders et al. 2001). Ts'ankui Theda is said to hear the prayers of those in need and to help them with their problems, from pointing hunters towards the elusive migratory caribou with the direction of its rising mists, to drowning game and sending them downriver as provision for the hungry (WLEC 2002). The continued influence of this culturally and spiritually significant location to the people of the area is evident in its appearance in the modern media, such as on cbc.ca's "The Seven Wonders of the Northwest Territories," an extension of CBC's "The Seven Wonders of Canada" series (2007).

9.6.7.6.1.1 Historical Use of the Area

One of the most famous and best preserved archaeological sites in Old Fort Reliance is Back's Chimneys. They are part of the original Fort Reliance site that was created during the Arctic land expedition lead by George Back in 1833 (Back & Richardson 1836). The fort consisted of a main cabin and smaller cabins, heated with chimneys constructed from stone and clay. An observatory for scientific work was also built there. It was intended to provide winter quarters for an overland journey down the Back River to the Arctic Ocean in search of the lost John Ross expedition. In 1855, it was used by Chief Factor James Anderson of the Hudson's Bay Company while searching for the missing Franklin expedition. Later, in 1897, it was rebuilt by an American hunter named Buffalo Jones, who built his residential log cabin around one of the chimneys. Today all that remains are the chimneys, storage pits, and the outlines of the log buildings in the earth. These remains are protected from disturbance by the *Northwest Territories Archaeological Sites Regulations* (GNWT 2001). There are also several unmarked graves in Old Fort Reliance that are most likely from the early 1900s (S. Decorby, personal communication, October 2008).

There is a historic Aboriginal village in Old Fort Reliance, which was a community of about 15 people in the early 1900s. It is suspected that a smallpox outbreak wiped out the entire population (S. Decorby, personal communication, October 2008).

9.6.7.6.1.2 Current Use of the Area

Today, people of the Łutsel K'e community use the area of Old Fort Reliance as a traditional spiritual gathering place. Located at the mouth of the Lockhart River, the Łutsel K'e people have been using this area as a spiritual gathering place since the late 1980s (S. Decorby, personal communication, October 2008). These gatherings usually consist of about 50 to 75 people that gather once a year in August for about 10 days. Several traditional ceremonies are held such as drum dancing, healing circles, storytelling, feasts, sweat lodges, and other spiritual/traditional activities. Attendees include many members of the community including elders and youth (S. Decorby, personal communication, October 2008).

9.6.7.7 Grave Sites

There are numerous documented grave sites on Nonacho Lake and the surrounding area, many of which are reported to have been previously flooded by earlier developments on the Taltson River System. None of the known sites fall within the 1 km corridor investigated for the proposed transmission line, winter road, or other Project components.

9.6.7.8 Traditional Travel Routes and Portages

Great Slave Lake remains a long-distance travel route for people in the South Slave region. A traditional trail links Fort Reliance to Artillery Lake and provides access into the barren lands (LKEAC 2002). Pike's Portage on the Lockhart River is named after famous author Warburton Pike (1861-1915), who traveled for 14 months throughout the area between Fort Resolution and Lac de Gras and documented his adventure in the classic book "The Barren Ground of Northern Canada" (Arctic Profiles). A traditional portage route exists between the outflow of Nonacho Lake and the Taltson River system, at the site of the proposed Nonacho Lake control structure.

More recent documentation of traditional travel routes and portages is derived from a Traditional Knowledge study undertaken by the partnership of Dezé, Northwest Territory Métis Nation, Akaitcho Territory Government and Fort Resolution. The purpose of the study was to document winter and spring ice conditions along travel routes to the existing Twin Gorge Hydroelectric facility.

To facilitate the documentation of ice conditions and the immediate habitat along the travel routes, each participating community representative was provided with a digital camera, Global Positioning System (GPS), maps and a data gathering form. The timing and route selection process was left to the discretion of the respective community participants. The resulting information was then provided to Dezé.

The NWT Métis Nation and the Akaitcho Territory Government participants accessed the Twin Gorges area from Fort Smith along a well-known winter trail. The trail was used as a winter road from Fort Smith to haul heavy equipment for original construction of the Twin Gorges dam and has been abandoned at the end of development. The representatives from Fort Resolution travelled in a southerly direction along the Taltson River. The field results of the community ice studies were mapped and a complete record of information was created for each ice and habitat observation. The resulting information was then integrated into a broader GIS information warehouse and made available to Dezé's project managers and consultants for integration into Project design and DAR preparation activities.

9.6.7.9 TRADITIONAL CABINS AND CAMP SITES

Timber Bay on Artillery Lake is a "cultural homeland" to the people of Łutsel K'e and was the location of a winter settlement (LKEAC 2002). Traditional summer fishing camps were located along the McDonald Fault, and near Meridian Lake, Macleod Bay, Snowdrift River and Fort Reliance (LKEAC 2002). The people of Łutsel K'e consider Parry Falls to be a very spiritual site (see description next section), and thus traditional camp sites may have been located nearby (LKEAC 2002).

During the November 2007 community scoping session in Fort Smith, it was noted that there is a camp near the proposed access road that is used for student cultural activities (MVEIRB 2008a).

The GNWT Department of Environment and Natural Resources (ENR) Forest Management Division maintains a sophisticated fire management and response system. To assist in the allocation of fire fighting resources, ENR has prepared a "values at risk" database that describes important values on the landscape that could be affected in the event of a forest fire. The database includes the location of fuel caches, cabins, lodges and cultural/traditional sites (RWED 2002). The location of the proposed transmission line was overlaid onto the values at risk map and a 2,500 m buffer on either side of the proposed transmission was established as a basis for analysis. No Values at Risk (cabins or cultural/traditional sites) were found within the 5 km span along the entire length of the transmission line. Information on the visual and tourism effects of the proposed Project is provided in Section 15.10 Tourism and Wilderness Character.