REPORT

Existing Environment for Pine Point Project

Pine Point Project

Submitted to:

Pine Point Mining Limited

Submitted by:

Golder Associates Ltd.

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1 February 2021

Distribution List

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Abbreviations and Units of Measure

Abbreviation	Definition
AAQS	Ambient Air Quality Standards
ABA	Acid Base Accounting
ARU	Autonomous Recording Unit
ASTt	Arctic Small Tool Tradition
BP	years before present
Ca^{2+}	calcium
CCME	Canadian Council of Ministers of the Environment
Cl^{-}	chloride anions
Cominco	Cominco Ltd.
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
EA	environmental assessment
ECCC	Environment and Climate Change Canada
GIS	Geographic Information System
GNWT	Government of Northwest Territories
Hwy	Highway
ITK	Indigenous Traditional Knowledge
K^{+}	potassium
LSA	local study area
MBCA	Migratory Birds Convention Act
Mg^{2+}	magnesium
MVEIRB	Mackenzie Valley Environmental Impact Review Board
NH_3, NH^{4+}	ammonia
NHN	National Hydrographic Network
NO^2	nitrogen dioxide
NO^{3-}	nitrate
non-PAG	non-potentially acid-generating
NPR	neutralization potential ratio
NWT	Northwest Territories
O^3	ozone
PAG	potentially acid-generating
PPML	Pine Point Mining Limited
Project	Pine Point Project
RSA	regional study area
SARA	*Species at Risk Act*
SO^2	sulphur dioxide
SO_4^{2-}	sulphate
spp.	multiple species
STIs	sexually transmitted infections
Tamerlane	Tamerlane Ventures Inc.
TLRU	traditional land and resource use
TSS	total suspended solids

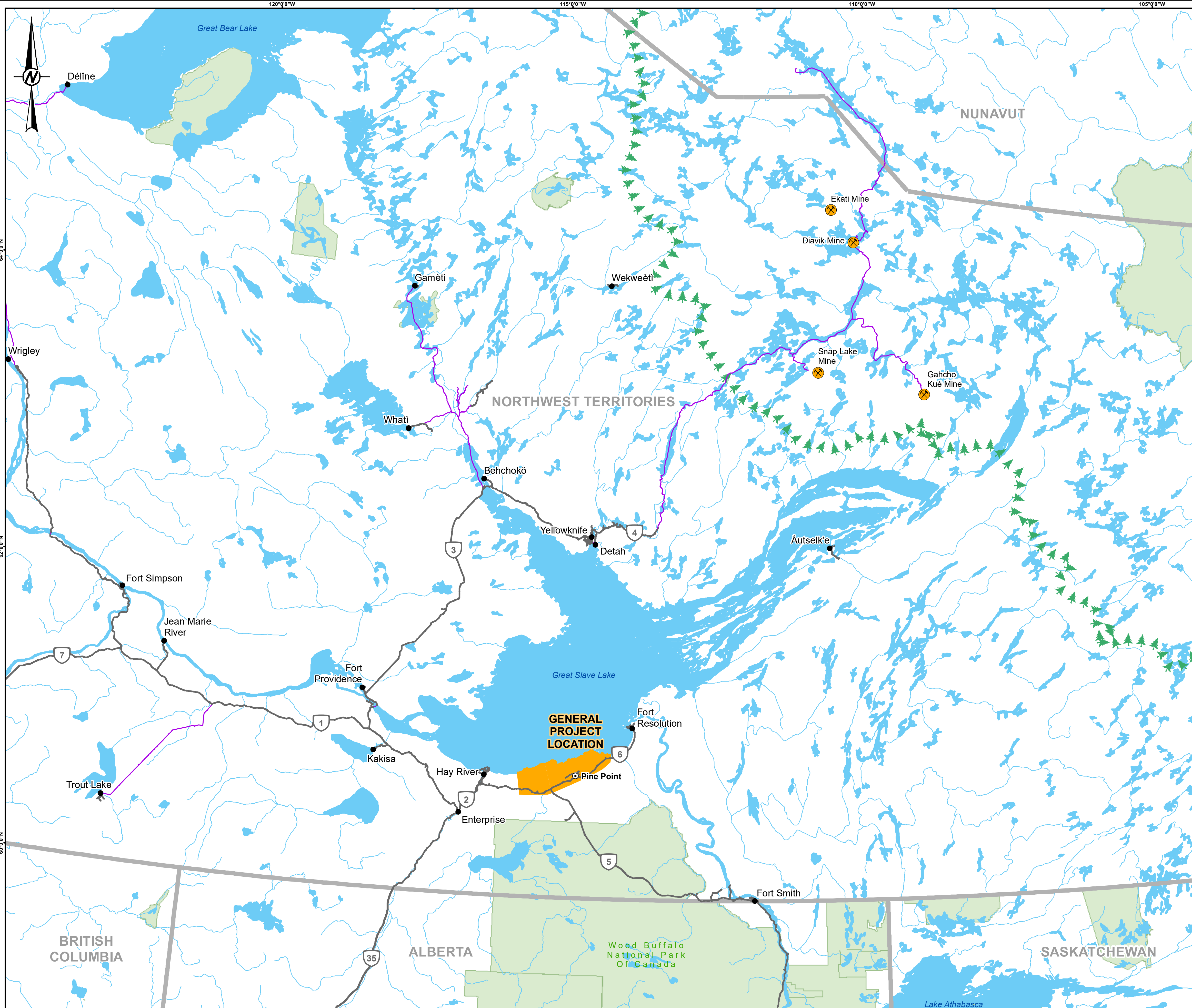
Units	Definition
%	percent
<	less than
>	more than
°C	degree Celsius
$\mu g/m^3$	micrograms per cubic metre
cm	centimetre
dBA	A-weighted decibels
ha	hectare
km	kilometre
km/h	kilometres per hour
km^2	square kilometre
km^3	cubic kilometre
Leq,24	24-hour average noise levels
Leq,day	average daytime noise levels
Leq,night	average nighttime noise levels
m	metre
m/s	metres per second
m^3	cubic metre
m^3/s	cubic metres per second
Ma	million years ago
masl	metres above sea level
$mg/dm^2/d$	milligrams per square decimetres per day
mg/L	milligrams per litre
mm	millimetre
ppb	parts per billion

1.0 INTRODUCTION

1.1 Overview

This document fulfills the requirement to provide a description of existing environmental conditions, as a component of the Environmental Assessment (EA) Initiation Package for the Pine Point Mining Limited (PPML or "the developer") Pine Point Project (Project), as outlined in the Mackenzie Valley Environmental Impact Review Board (MVEIRB) *Draft Environmental Assessment Initiation Guidelines for Developers of Major Projects* (MVEIRB 2018). The Project is located in the Northwest Territories (NWT) within the South Slave Mining District, approximately 175 km south of Yellowknife, 75 km east of Hay River, and 53 km southwest of Fort Resolution near the historical Pine Point town site (Figure 1-1 and Figure 1-2). Most of the anticipated Project infrastructure and facilities are located on a brownfield site associated with historical mining activity by Cominco Ltd. (Cominco). The Project will consist of open pit and underground mining for lead and zinc, construction and operation of a processing mill (or "concentrator"), and pre-concentration facilities, storage and management of processed mineralized material and waste materials, water management, construction and operation of ancillary support facilities including a camp for workers and the transportation of zinc and lead concentrates to global markets.

The summary of existing environmental conditions for the Project includes a preliminary description of: 1) the biophysical environment, which includes components such as air, soils, surface water, fish, and wildlife; and 2) the human environment, which includes components such as socio-economics, traditional land and resource use, and community well-being. Consistent with MVEIRB guidance (MVEIRB 2018), the description of the existing environment is intended to support understanding how the Project may interact with the environment, and how the potential effects to biophysical and human components can be mitigated as part of the EA Initiation Package. The existing environment section for the EA Initiation Package is intended to be an introduction to the more comprehensive characterization of existing environmental conditions that will be completed for each biophysical and human component in the Developer's Assessment Report for the Project. In the Developer's Assessment Report, the existing environment will provide context for analyzing effects from the Project and other developments on biophysical and human components, after applying mitigation and enhancement policies and actions.



LEGEND

- FORMER PINE POINT TOWN SITE
- POPULATED PLACE
- EXISTING MINE
- ALL-SEASON ROAD
- WINTER ROAD
- TREELINE
- WATERCOURSE
- PARK/PROTECTED AREA
- WATERBODY
- GENERAL PROJECT LOCATION

0 50 100

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REFERENCE(S)

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PROJECTION: ALBERS CONIC EQUAL AREA

CLIENT
PINE POINT MINING LTD.

PROJECT
PINE POINT PROJECT

TITLE
LOCATION OF PROJECT

CONSULTANT
GOLDER

YYYY-MM-DD	2020-05-15
DESIGNED	DC
PREPARED	BW
REVIEWED	LY
APPROVED	LY

PROJECT NO.	PHASE	REV.	FIGURE
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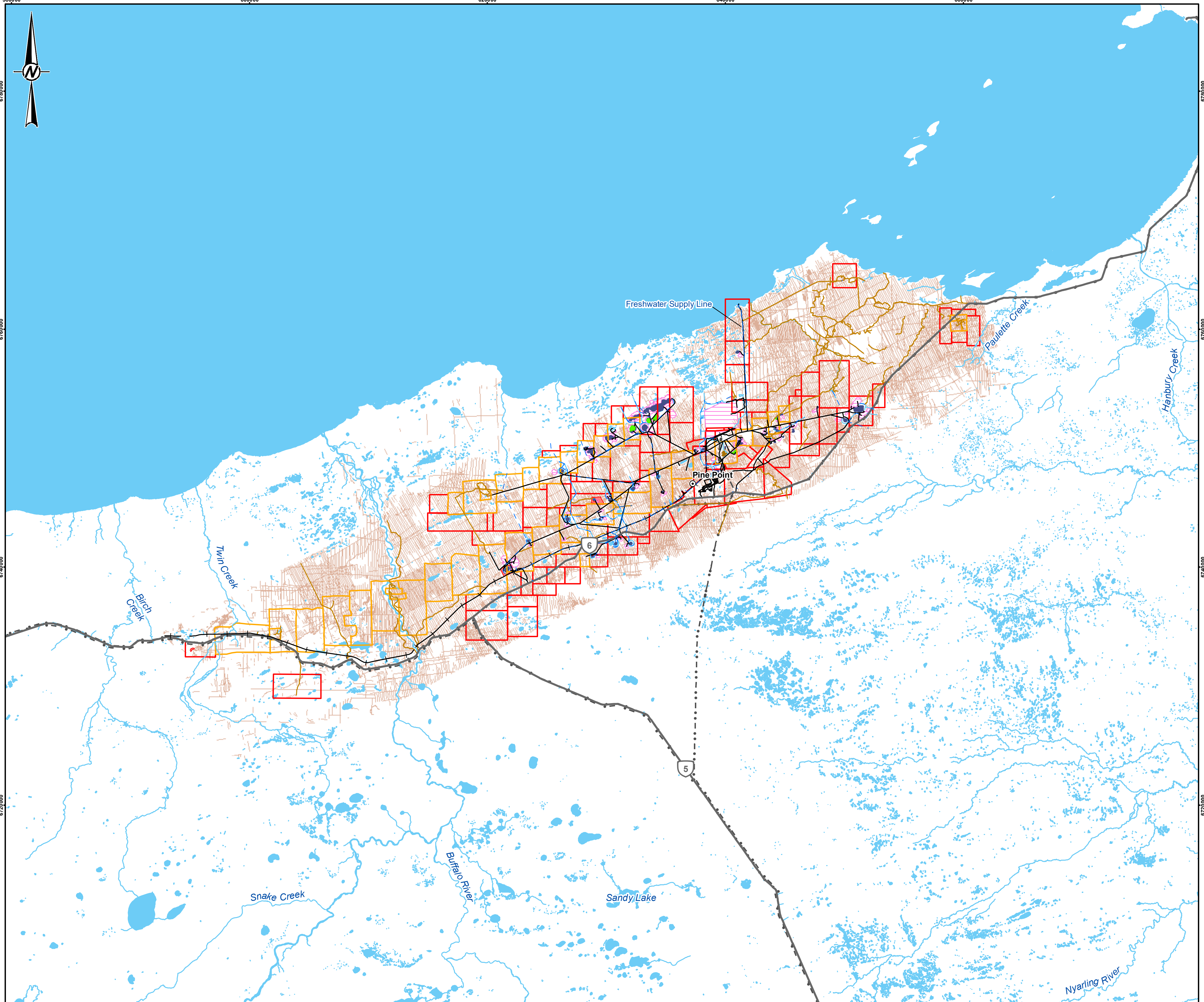

LEGEND

- FORMER PINE POINT TOWN SITE
- BUSH ROAD
- CUTLINE
- DRAINAGE DITCH
- HISTORIC RAILBED
- HIGHWAY
- TRANSMISSION LINE
- WATERCOURSE
- ACTIVE MINERAL LEASE
- ACTIVE MINERAL CLAIM
- CUTBLOCK
- WATERBODY

PINE POINT EXISTING MINING DISTURBANCE

- BACKFILLED PIT
- MINED PIT
- WASTE PILE

0 5 10

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PROJECTION: UTM ZONE 11N DATUM: NAD83

CLIENT
PINE POINT MINING LTD.

PROJECT
PINE POINT PROJECT

TITLE
PINE POINT PROJECT BOUNDARY, MINING LEASE AREAS, AND EXISTING DISTURBANCES

CONSULTANT
GOLDER

YYYY-MM-DD	2020-11-05
DESIGNED	JV
PREPARED	MM/PMT
REVIEWED	DP
APPROVED	DP

PROJECT NO.	CONTROL	REV.	FIGURE
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1.2 Background

The Pine Point lead-zinc deposit was first discovered in 1898 by prospectors heading to the Klondike gold rush. Prospectors learned of the presence of minerals in the area from the local Indigenous population (Locock et al. 2006). Cominco began exploration at Pine Point in 1929, with test-pitting, drilling, and shaft sinking. In 1948, Cominco began major exploration work. Cominco proceeded with construction in the early 1960s and historical operation ran between 1964 and 1987 producing 64 million tonnes grading 7.0% zinc + 3.1% lead from 52 deposits. The historic Pine Point Mine was an assemblage of 50 separate open pits and two underground deposits, distributed along a 70 km trend. The mining operation closed in 1987 and Cominco left substantial lower grade mineral resources in the ground at the site. Restoration of the mine was completed in 1991.

In the 2000s, the Pine Point property was purchased by Tamerlane Ventures Inc. (Tamerlane) with the intent to mine the existing resource. Tamerlane conducted additional exploration activities at the site and initiated regulatory applications to pursue longer-term development of the site. Tamerlane applied to the Mackenzie Valley Land and Water Board for a Land Use Permit (MV2006C0014) and Type B Water Licence (MV2006L2-0003) for the Pine Point Pilot Project in June 2006. Prior to the completion of the preliminary screening conducted by MVEIRB, Environment and Climate Change Canada (ECCC, formerly Environment Canada) referred the development to EA on the basis that the development "might have significant adverse impacts on the environment". ECCC cited a number of potential impacts and uncertainties related to the proposed development (MVEIRB 2008).

Tamerlane submitted its final Developer's Assessment Report for the Pine Point Pilot Project to MVEIRB in April 2007. In February 2008, MVEIRB determined that the development could proceed to the regulatory phase of approvals, provided that the commitments per the MVEIRB's Tamerlane Pine Point Pilot Project Report of Environmental Assessment and Reasons for Decision (MVEIRB 2008) were implemented; however, the Pine Point Pilot Project did not proceed due to low metal prices. Darnley Resources Bay Ltd. purchased the property in 2016 and continued with exploration. The property was acquired by PPML in February 2018. As described above and on Figure 1-2, the Project is predominantly located on previously developed land and is primarily a brownfield site.

2.0 APPROACH

In this report, baseline conditions are similar to existing environmental conditions, and comprise the current physical, chemical, biological, social, economic, and cultural setting in which the Project is located, and where Project effects might be expected to occur. As a result of past mining activities and the brownfield nature of the site, existing conditions do not necessarily reflect historical background conditions (i.e., before any industrial development occurred). Rather, existing conditions represent the outcome of historical and current environmental and socio-economic pressures or factors that have shaped the observed condition of biophysical, social, economic, and cultural components of the surrounding environment. Environmental and socio-economic pressures can be natural (e.g., weather, wildfire, predation, and disease) and human-related (e.g., previous mining development, remediation activities, fishing, and hunting). In the context of the proposed Project, existing conditions are characterized by recent environmental data collected in support of the Project, as well as information collected as part of previous activities at the Pine Point property.

Spatial boundaries for the existing environment were designed to approximate or be captured by the proposed study areas defined for components of the biophysical and human environments in Sections 4.2 of the Developer's Assessment Proposal included in the EA Initiation Package (Volume 5). In general, spatial scales consisted of a local study area (LSA) and a regional study area (RSA). The spatial boundaries of the local and regional study areas for assessing effects from the Project and other previous and reasonably foreseeable developments on each component will be finalized in the Developer's Assessment Report following feedback from communities and regulators on the Developer's Assessment Proposal. Data collected in the anticipated physical footprint and immediate vicinity of the Project (i.e., LSA) will be subsequently used in the Developer's Assessment Report to provide fine-scale measures of environmental conditions and predict the direct and indirect changes from the Project on components of the biophysical and human environments (e.g., changes to terrestrial and aquatic habitat from the physical Project footprint or from dust and air emissions). Data collected at larger scales, such as the RSA, will be used to measure broader-scale environmental conditions and provide regional context for the effects of the Project.

The description of the existing environment draws on data and information obtained from previous environmental and socio-economic studies completed within the study areas, as well as from publicly available information, and data and reports related to the regulatory process undertaken by Tamerlane for the Pine Point Pilot Project. Previous studies include:

- Studies completed by EBA Engineering Consultants Ltd. (EBA) on behalf of Tamerlane in 2005-2006 (EBA 2005a,b,c, 2006a,b,c,d).
- Indigenous Traditional Knowledge (ITK) study reports conducted in October 2006 with the cooperation of Indigenous groups (Swisher 2006a,b).
- The EA of the Pine Point Pilot Project by Tamerlane in 2007 (Environmental Assessment EA0607-002 and Water Licence MV2006L2-0003), in the area known as the West Zone.

Much of the information presented in these studies remains relevant for describing historical trends that have influenced existing conditions. This information was used along with data obtained from more recent baseline studies and from desktop sources (e.g., published material and environmental databases), to develop a preliminary summary of the existing environment for the Project. Recent studies include additional baseline investigations completed by Tamerlane following the approval of the Pine Point Pilot Project and reconnaissance level field surveys completed by PPML for the current Project in 2018 and 2019. Recent studies include:

- Studies completed by Rescan Environmental Services Ltd. (Rescan) on behalf of Tamerlane in 2011 (Rescan 2012a-n).
- Reconnaissance level field studies completed by Golder Associates Ltd. (Golder) on behalf of PPML in 2018 and 2019 (Golder 2018a, 2019a,b,c).

Section 3.0 provides a summary of historical and recent environmental data for the Project. A baseline study plan (Appendix C) was developed based on the results of a gap analysis completed of previous environmental data for the Project, and other publicly available information (Golder 2019d). The purpose of the gap analysis was to identify environmental data gaps or missing information, and provide recommendations for additional data collection that may be required to support the EA.

Summaries of existing environmental conditions are provided for biophysical and human environmental components that may or may not be considered in the Developer's Assessment Report. The Developer's Assessment Report will focus on specific intermediate and valued components that have been selected following feedback on the Developer's Assessment Proposal, community and regulatory engagement, and other selection criteria (e.g., sensitivity of a component to Project effects and presence in study areas) (Volume 5). Valued components represent physical, biological, cultural, social and economic properties of the environment that are either legally, politically, publicly or professionally recognized as ecologically and socially important to a particular region, community or by society as a whole.

3.0 DESCRIPTION OF EXISTING ENVIRONMENT

3.1 Spatial Boundaries

The study areas for collection of baseline data and preliminary descriptions of existing environmental conditions for biophysical and human components are defined in the following sections. These study areas may be refined in the Developer's Assessment Report based on updated Project information and the outcomes of feedback on the EA Initiation Package and engagement planned for the Project.

3.1.1 Geological Setting and Resources

Geological setting and resources have been included as it is a required component of the existing environment summary (MVEIRB 2018). The spatial boundary used in the existing environment summary for geology and resources is the same as the terrestrial RSA defined in Section 3.1.4.

3.1.2 Air Quality, Noise, and Climate

Details related to the location and size of existing and new facilities and infrastructure for the Project (i.e., physical Project footprint) are currently being developed through the design process, and as such, cannot be included in the EA Initiation Package. These Project Description details are expected to be available for the Developer's Assessment Report and the LSA for air quality would likely include a 10 km area beyond the Project footprint. The RSA for air quality will be defined to evaluate predicted Project emission concentrations to approximately 10% of the affiliated air quality standard. For example, if the nitrogen dioxide (NO_2) 1-hour standard is 213 parts per billion (ppb), the study area would be defined to enclose the 21 ppb predicted air quality prediction contour. The RSA for air quality will be defined once initial results of the modelling to support the effects assessment for air quality components are available. Existing climate data will be summarized in an assumed RSA that includes meteorological stations at the Project, historic Pine Point town site, Hay River, and Fort Resolution.

Similarly, once further details on the Project Description are available, the LSA for the noise component would include the anticipated Project footprint plus a 1.5 km buffer. The RSA for the noise component would likely include the anticipated Project footprint plus a 5 km buffer.

Study area boundaries have not been defined for climate because greenhouse gas emissions associated with climate change need to be considered in a global context. The greenhouse gas emissions directly associated with the Project will be calculated and considered in the context of published regional, territorial, and national totals.

3.1.3 Groundwater Quantity and Quality, Surface Water Quantity and Quality, and Fish and Fish Habitat

A single LSA and RSA were defined for aquatic resource components, which includes groundwater quantity and quality, surface water quantity and quality, and fish and fish habitat. The aquatic LSA includes all active mineral claims, existing bush roads, cutlines, historic railbed, waste rock piles, and backfilled and mined pits (Figure 3-1). The western and eastern boundaries of the LSA are defined by the western boundary of the Twin Creek watershed and the eastern boundary of the Paulette Creek watershed, respectively. The northern extent of the LSA includes a 10-m buffer north of the shoreline of Great Slave Lake and the outlets of the Twin Creek, Buffalo River, and Paulette Creek. The southern extent of the LSA includes Highway 6, connecting the western and eastern boundaries.

The aquatic RSA includes the LSA plus Birch Creek, which is located 5 km to the west of the LSA (Figure 3-1). The RSA boundary extends 2 km into Great Slave Lake and provides broader context for characterizing baseline conditions and capturing the maximum potential effects from the Project.

3.1.4 Terrain and Soils, Vegetation, and Wildlife

For existing conditions of the EA Initiation Package, a single LSA and RSA was defined for terrestrial environment components, which includes terrain and soils, vegetation, and wildlife. The terrestrial LSA includes the anticipated maximum extent of the Project footprint, plus a 500 m buffer (Figure 3-2). All active mineral claims, existing bush roads, cutlines, historic railbed, waste rock piles, and backfilled and mined pits are included in the LSA. The terrestrial RSA includes the LSA and is similar to the RSA for groundwater, hydrology, and surface water quality due to the ecological relationships among aquatic and soil and vegetation ecosystems, and wildlife habitats (e.g., wetland structure and function) (Figure 3-2). The RSA provides broader context for characterizing baseline conditions such as the presence of previous and existing developments, and natural disturbances (e.g., wildfire).

3.1.5 Heritage Resources

The LSA for the heritage resources component will include the Project footprint or areas of existing and future direct ground disturbance that could affect heritage resources. The RSA will include the area extending from Hay River in the west to Slave River in the east, and the shore of Great Slave Lake in the north to the Alberta border in the south. The RSA provides context for documented heritage resources in the LSA.

3.1.6 Traditional Land and Resource Use

The Project is located on the asserted territories of the Deh Cho and Akaitcho First Nations, and is within the traditional territories of the Deninu Kue First Nation, K'atl'odeeche First Nation, and Northwest Territory Métis Nation. The Hay River Métis Council and the Fort Resolution Métis Council were initially engaged separately; however, more recently, engagement has been through the Northwest Territory Métis Nation. Existing conditions for traditional land and resource use (TLRU) of these groups includes hunting and trapping, fishing, use of water, and plants and berry gathering. Therefore, study areas for TLRU correspond to those defined for aquatic (Section 3.1.3) and terrestrial (Section 3.1.4) disciplines. Consideration is also given to the noise study area (Section 3.1.2) when discussing effects on the experience of Indigenous land users. The TLRU component does not use a polygon-based study area for documenting existing conditions related to travel, access, and the use of the land for cultural and spiritual practices, as such practices are fluid and not confined to a single jurisdiction or spatial boundary. Areas of use for these purposes may overlap and change over time. overlap and change over time.

3.1.7 Socio-economics

As indicated in Section 3.1.6, the Project is within the traditional territories of the Deninu Kue First Nation, K'atl'odeeche First Nation, and Northwest Territory Métis Nation. The proponent has established agreements with these groups' respective communities as a means for securing local benefits. Agreements address both benefit capture and mitigation of adverse effects. The potential for employment with the Project, and the qualifications required to access employment opportunities, will be of key interest to these groups, and to communities within the South Slave Region. While Hay River, Hay River Dene 1 (K'atl'odeeche First Nation), and Fort Resolution are the closest communities to the Project, other communities in the region and the City of Yellowknife may also be impacted by the Project to varying degrees. Based on the factors above, the socio-economic LSA focuses on the following communities (Figure 3-3):

Communities Prioritized by PPML for Involvement and Closest to the Project (i.e., focal communities)

- Fort Resolution (South Slave community, Deninu Kų́ę́ First Nation, Northwest Territory Métis Nation [Fort Resolution Métis Council])
- Hay River Dene 1 (K'atl'odeeche First Nation)
- Hay River (South Slave community, Northwest Territory Métis Nation [Hay River Métis Council Government])

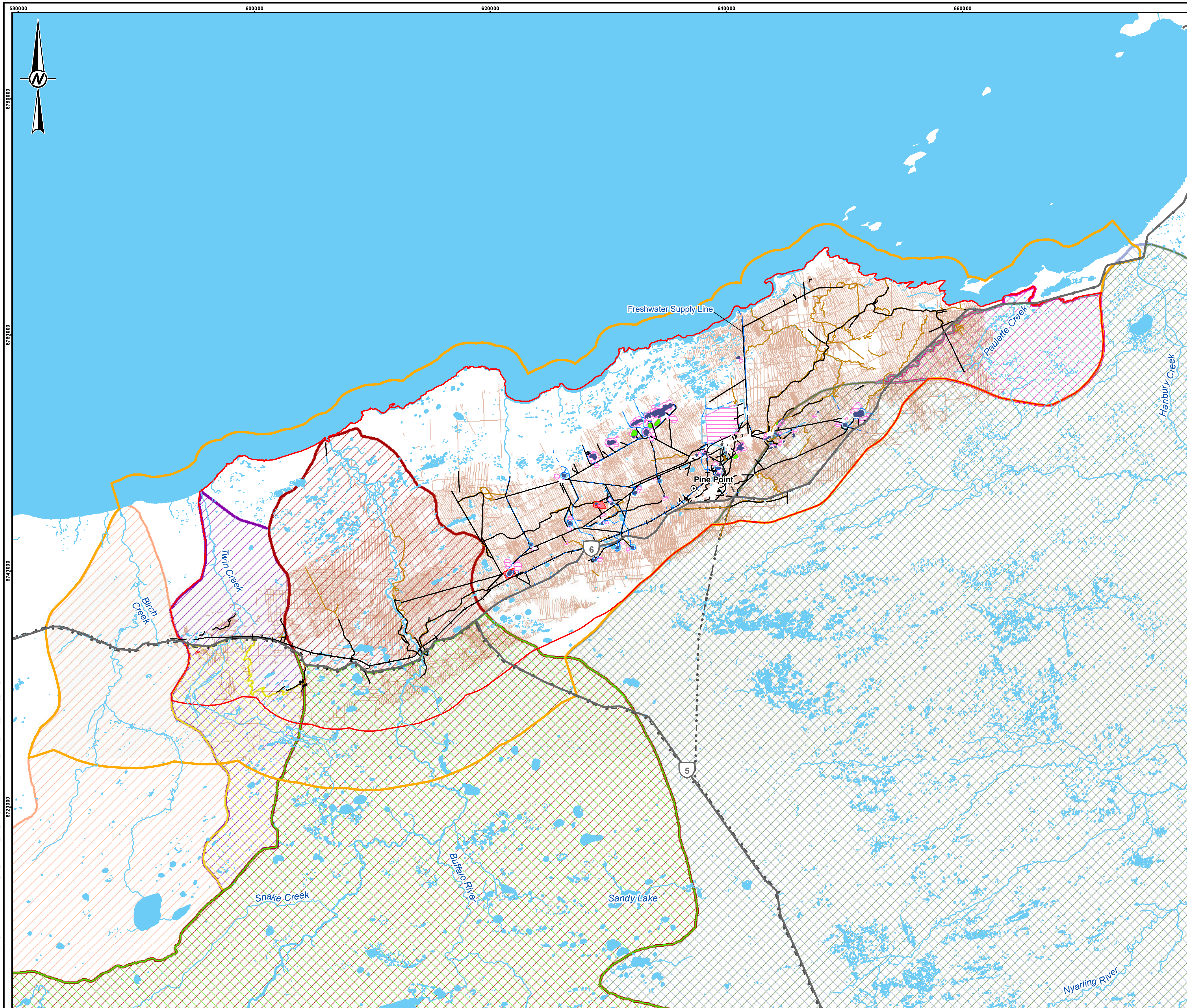
Other Communities for Inclusion

- Enterprise (South Slave community)
- Fort Providence (South Slave community)
- Fort Smith (South Slave community, Northwest Territory Métis Nation [Fort Smith Métis Council])
- Kakisa (South Slave community)
- Dettah (Akaitcho Dene [Yellowknives Dene First Nation])
- Łutsel K’e (Akaitcho Dene [Łutsel K'e Dene First Nation])
- Yellowknife (major population, economic and service hub)
- West Point First Nation (located within Hay River)

The socio-economic RSA is the NWT (Figure 3-3). Regional-level effects are largely related to broader economic changes such as Project-driven contributions to territorial Gross Domestic Product, labour force conditions, government revenues, industry and commercial activity, and population change.

3.1.8 Non-Traditional Land and Resource Use

Non-traditional land and resource use include non-Indigenous hunting, fishing, outfitting, tourism, recreation, and industrial and resource extraction opportunities. Therefore, the study areas for non-traditional land and resource use correspond to the local and regional study areas defined for aquatic and terrestrial disciplines (Sections 3.1.3 and 3.1.4) (i.e., the study areas within which resources accessed by land users are assessed). Consideration is also given to the noise study area (Section 3.1.2) when discussing effects on the experience of commercial and recreational land users.



LEGEND

- FORMER PINE POINT TOWN SITE
- BUSH ROAD
- CUTLINE
- DRAINAGE DITCH
- HISTORIC RAILBED
- HIGHWAY
- MINE ROAD
- TRANSMISSION LINE
- WATERCOURSE
- CUTBLOCK
- LOCAL STUDY AREA -
- REGIONAL STUDY AREA -
- WATERBODY

PINE POINT EXISTING MINING DISTURBANCE

- BACKFILLED PIT
- MINED PIT
- WASTE PILE

WATERSHEDS

- BIRCH CREEK
- BUFFALO RIVER
- BUFFALO RIVER AT HIGHWAY 5
- LITTLE BUFFALO RIVER
- LITTLE BUFFALO RIVER AT HWY 6
- PAULETTE CREEK
- PAULETTE CREEK AT HIGHWAY 6
- TWIN CREEK
- TWIN CREEK AT HIGHWAY 5

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CLIENT
PINE POINT MINING LTD.

PROJECT
PINE POINT PROJECT

TITLE
GROUNDWATER QUANTITY AND QUALITY, SURFACE WATER QUANTITY AND QUALITY, AND FISH AND FISH HABITAT LOCAL AND REGIONAL STUDY AREAS

CONSULTANT

GOLDER

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PREPARED	MM/PMT
REVIEWED	JV
APPROVED	JV

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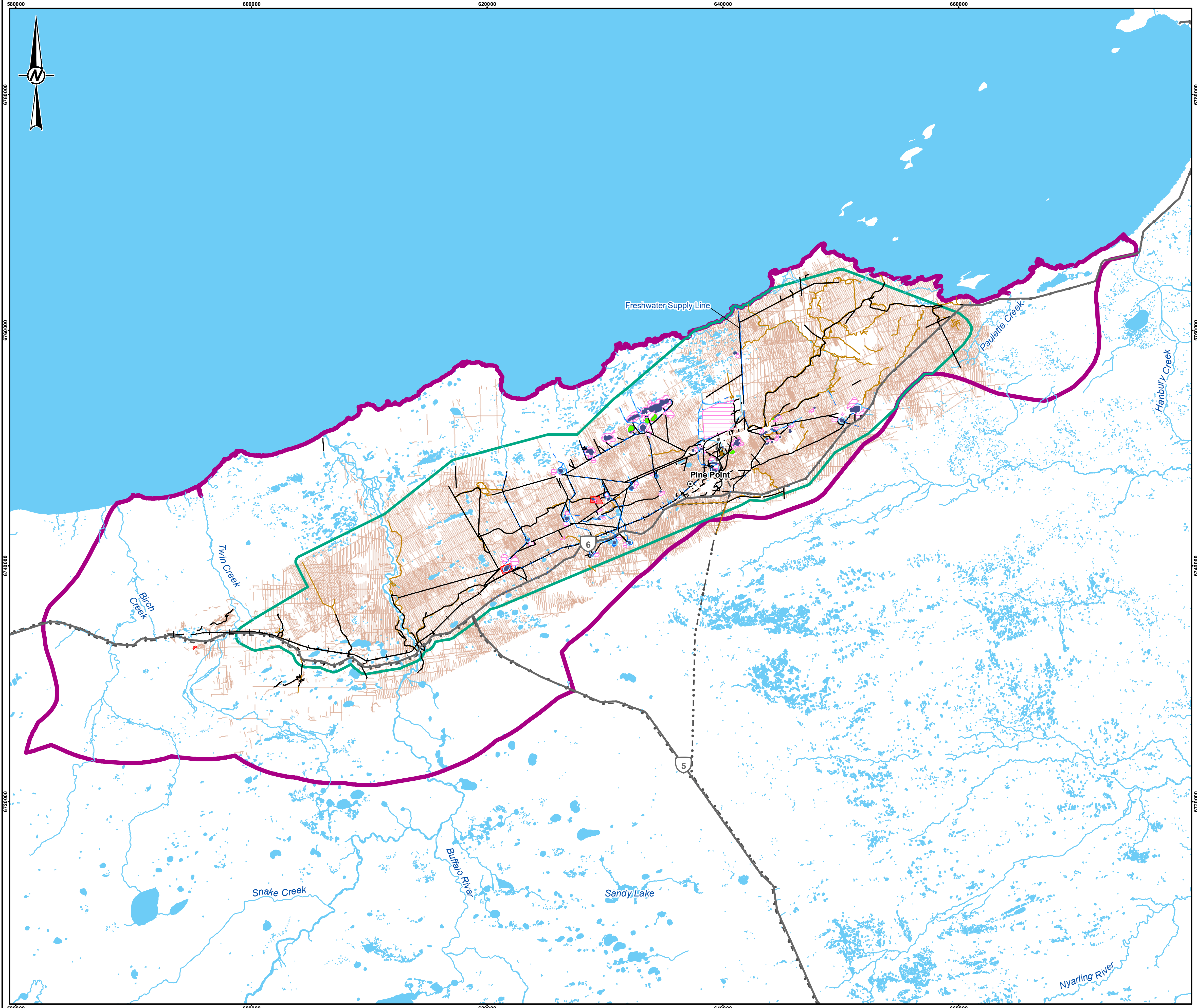

LEGEND

- FORMER PINE POINT TOWN SITE
- BUSH ROAD
- CUTLINE
- DRAINAGE DITCH
- HISTORIC RAILBED
- HIGHWAY
- MINE ROAD
- TRANSMISSION LINE
- WATERCOURSE
- CUTBLOCK
- LOCAL STUDY AREA - TERRESTRIAL
- REGIONAL STUDY AREA - TERRESTRIAL
- WATERBODY

PINE POINT EXISTING MINING DISTURBANCE

- BACKFILLED PIT
- MINED PIT
- WASTE PILE

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PROJECTION: UTM ZONE 11N DATUM: NAD83

CLIENT
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PROJECT
PINE POINT PROJECT

TITLE
TERRAIN AND SOILS, VEGETATION, AND WILDLIFE LOCAL AND REGIONAL STUDY AREAS

CONSULTANT

GOLDER

YYYY-MM-DD	2020-12-15
DESIGNED	JV
PREPARED	MM/PMT
REVIEWED	JV
APPROVED	JV

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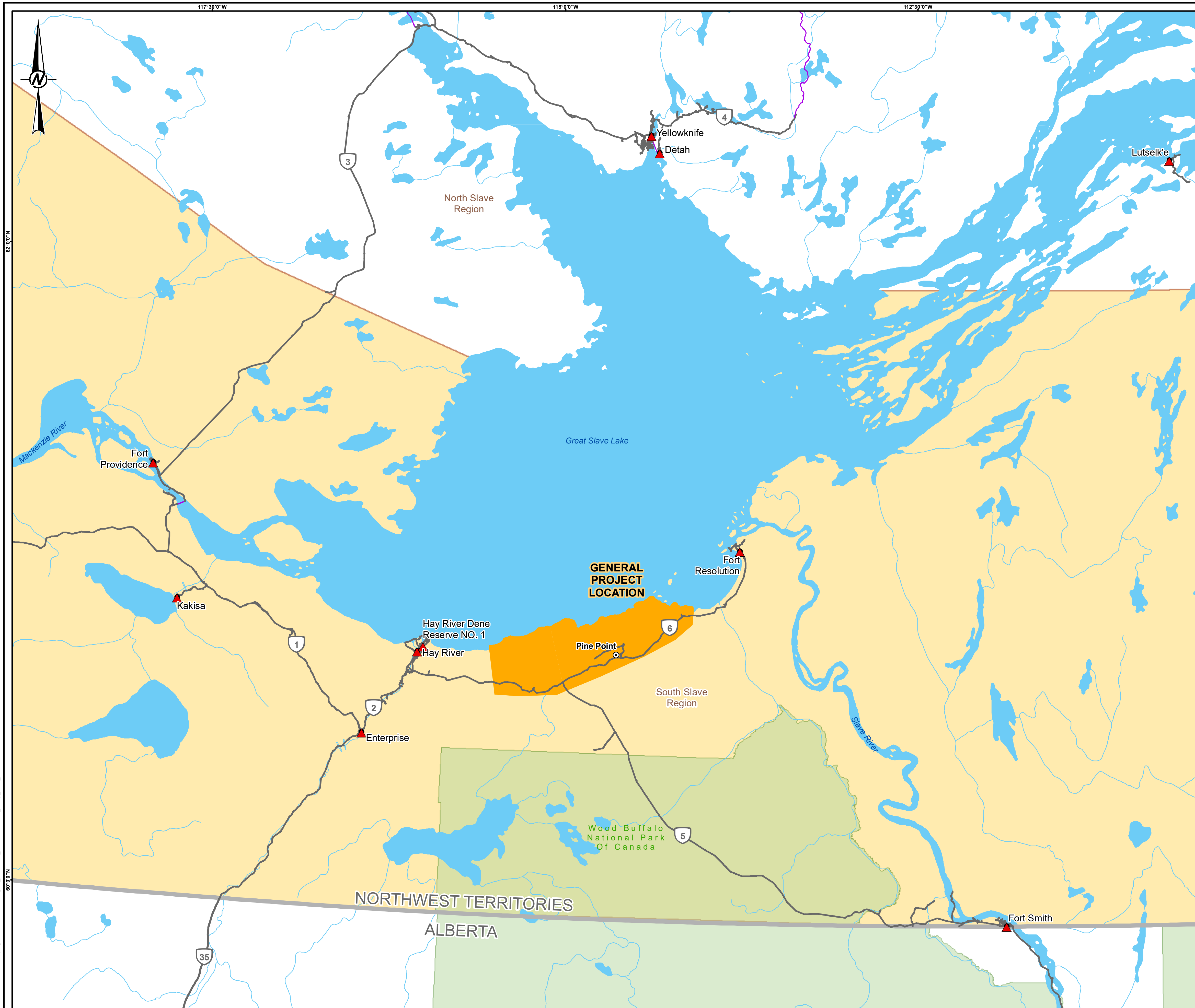

LEGEND

- FORMER PINE POINT TOWN SITE
- SOCIO-ECONOMIC STUDY AREA COMMUNITY
- ALL-SEASON ROAD
- WINTER ROAD
- TERRITORIAL/PROVINCIAL BOUNDARY
- WATERCOURSE
- GENERAL PROJECT LOCATION
- PARK / PROTECTED AREA
- REGIONAL BOUNDARY
- SOUTH SLAVE REGION
- WATERBODY

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PROJECTION: ALBERS CONIC EQUAL AREA

CLIENT
PINE POINT MINING LTD.

PROJECT
PINE POINT PROJECT

TITLE
SOCIO-ECONOMIC LOCAL STUDY AREA COMMUNITIES

CONSULTANT
GOLDER

YYYY-MM-DD	2020-12-15
DESIGNED	JO
PREPARED	MM
REVIEWED	JV
APPROVED	JV

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3.2 General Setting

The Project is located at the edge of the Boreal Plains and Taiga Plains Ecozones, and within the Slave River and Hay River Lowland Ecoregions. These ecoregions are classified as having a sub-humid, mid-boreal ecoclimate (Environment Canada 2000, as cited in EBA 2005b). The area is characterized by short, cool summers and long, cold winters. The average monthly temperatures in 2019 at the closest monitoring station (Hay River Airport) ranged from a minimum of -22.7°C in February to a maximum of 15.5°C in July. The winter months are typically the driest with the most precipitation usually occurring in August.

The two nearest drainages to the site are the Buffalo River and Twin Creek, located towards the western edge of the Project. These watercourses flow north into Great Slave Lake, which is situated immediately north of the Project boundary (Figure 1-2) and north of the mining lease areas. The water quality of Twin Creek and Buffalo River, and in Great Slave Lake is typical of natural background values for this area of the NWT, with concentrations of most parameters below the federal water quality guidelines for the protection of aquatic life and drinking water (CCME 1999; Health Canada 2006). Fish species that occur in the Buffalo River include Inconnu, Whitefish, Northern Pike, Walleye, and Burbot.

The Project is located in an area of sporadic discontinuous permafrost with generally subdued topography, which suggests that between 10% and 50% of the land area is underlain by permafrost, and the ground ice content in the upper 10 to 20 m of the ground (% by volume of visible ice) is low (<10%) (NRC 1995). Permafrost has not been intersected by any recent core drilling in the area; however, it was detected at one location during a soil/vegetation reconnaissance survey in 2019. The vegetation in the surrounding area is characterized by medium to tall, closed stands of jack pine and trembling aspen. White and black spruce dominate older stands of forest. Poorly drained fens and bogs in this region are covered with low, open stands of larch, black spruce, and ericaceous shrubs (Environment Canada 2000, as cited in EBA 2005b). Wildfires have been a common occurrence in the South Slave Region.

Moose, boreal caribou, and occasionally wood bison are the main ungulates found in the region where the Project is located, although none of these species are considered common. Hunting and trapping activities occur in the vicinity of the Project. Wildlife identified as being present and harvested include caribou, lynx, wolf, otter, black bear, rabbit, porcupine, ptarmigan, ruffed grouse, and waterbirds. Migratory songbirds typical of the boreal forest are also present in the area. The south shore of Great Slave Lake is considered to be an important concentration site for waterbirds during their annual migrations.

3.3 Biophysical Environment

3.3.1 Geological Setting and Resources

3.3.1.1 Bedrock Geology

The Project is located within the northern part of the Interior Plains, a low relief area between the Canadian Shield and the western Cordillera (Fulton 1989). The plains are underlain by flat-lying sedimentary bedrock, which is poorly consolidated or even unconsolidated in some areas (Fulton 1989). The sedimentary rocks in the area of the Project were deposited in a marine environment during the Givetian stage (387 to 283 million years ago [Ma]); one of two stages within the middle Devonian period (393 to 382 Ma).

The mineralized zinc and lead ore bodies that are of interest for the Project are part of the Pine Point barrier complex, which formed due to a gentle arching (emergence) of marine sediments (the underlying Keg River Formation) that initiated the formation of a carbonate shoal (Rhodes et al. 1984). The Pine Point Formation (also known as the Pine Point Group [Skall 1975]) lies conformably above the Keg River Formation and although the

Pine Point Formation was deposited as limestones, it has been dolomitized (i.e., dolomite has been formed due to the replacement of calcium ions by magnesium ions). The dolomite in this area is also known as the Presqu'ile Barrier Formation (Rhodes et al. 1984) (i.e., the Presqui'ile Barrier Reef Complex [PPML 2020]). Karst activity within the barrier complex caused the dissolution of minerals within the rocks resulting in subsidence and collapse, and the formation of a karst network of chimney like karst structures, thicker tabular karst, sinkholes, and caves (Rhodes et al. 1984) as well as intermittent creeks and natural springs (Dames & Moore 1976). Mineralization (galena, sphalerite, marcasite, and pyrite) within the karst network occurred as replacement of internal sediments and breccia fragments within the karst network (Rhodes et al. 1984).

The bedrock geology in the Pine Point area is described in the *Summary Report on the Geology of Pine Point Based on Drilling Conducted between 2017 and 2020 by Pine Point Mining Limited* (PPML 2020). The mineralization was the result of metal bearing brines mixing with sulphur-rich fluids and hydrocarbons under hydrostatic pressure (PPML 2020). Zinc, lead, and iron sulphides are mainly precipitated through sulphur from dissolved anhydrite/gypsum and/or reaction of hydrogen sulphide gas and/or bitumen dissolved with basinal fluids, or present within the host rock (PPML 2020). Mixing of these fluids resulted in a self-reinforcing chemical reaction that hydrothermally precipitated the zinc and lead sulphides (i.e., sphalerite and galena). Calcite is the last precipitated mineral and generally forms a permeability barrier (PPML 2020). The karst network within the barrier complex is a major control of mineralized material deposition (Rhodes et al. 1984), and therefore, the most intense centers of mineralization coincide with the best developed karst (Skall 1975).

Three other formations overlie the Pine Point Formation. There is a sharp contact between the Pine Point Formation and the overlying Watt Mountain Formation (shales, sandstones, limestone breccia), which in turn is disconformably overlain by the Slave Point Formation (limestone, dolomite and shale). Finally, the Hay River Formation (shale and minor sandstone) unconformably overlies the Slave Point Formation (Skall 1975).

3.3.1.2 Seismic Hazard

According to Natural Resources Canada (NRC 2006), the area including and surrounding the Project is geologically stable, of low seismic risk and with no natural landslides suggestive of seismic (earthquake) hazard. Based on LiDAR data from 2018 and 2019, the banks of the Buffalo River are the only area where visible landslides occurred. The Buffalo River meanders across the landscape eroding the material on the outside bends of the river resulting in failure of the banks in these areas.

The Canada Seismicity Map from Energy, Mines and Resources Canada plots significant earthquake locations for the years 1568 through 1991. Two relatively small events have been recorded in the region and both occurred to the west of the Project. No earthquake of Richter Magnitude M6 or greater has occurred within 1,000 km of the Project in recorded history.

The Indigenous Traditional Knowledge (ITK) interviews conducted in October 2006 indicated that none of the study participants had any specific knowledge of earthquakes in the South Slave area. However, several of the participants in the Fort Resolution ITK interviews noted that slight tremors had been felt in Fort Smith – once in the 1970s and once in the 1980s on Christmas Eve. According to the participants, the epicentre was in the Mackenzie Mountains (Tamerlane 2006a,b).

3.3.1.3 Geochemistry

Geochemical characterization data were compiled for the purpose of identifying the metal leaching (ML) and acid rock drainage (ARD) potential of the mined materials (TetraTech 2018). Geochemical characterization data are available for waste rock, mineralization, tailings, overburden, and soil material. Geochemical characterization data described in TetraTech (2018) were initially presented in Rescan (2011, 2012a,b). These data were collected for a 2011 geochemical characterization program conducted by Rescan as part of baseline environmental studies for the Pine Point Project and the data interpretation and analysis of the preliminary geochemical characterization results are presented in Rescan (2011, 2012a,b). pHase Geochemistry provided a draft review of these reports and compilation of available data (pHase Geochemistry 2017). In November 2017, PPML collected and submitted an additional sixteen samples from drill core from the L-65, N-42, M-40, and EX-17 deposits. These samples were analyzed for Acid Base Accounting (ABA) and trace element analysis.

The following analyses were completed and reported in TetraTech (2018): quantitative X-ray diffraction using the Rietveld method; ABA analysis; Net-Acid Generation test; solids trace element analyses using aqua-regia digestion with inductively coupled plasma mass spectrometry finish; whole rock analysis for major oxides using lithium metaborate fusion followed by X-Ray Fluorescence; and Shake Flask Extraction leachate analysis using a 3:1 liquid to solid ratio.

The potential for acid generation was tested by ABA analysis on a total of 82 samples and the results are presented in TetraTech (2018). ABA results are used to evaluate the classification of the analyzed samples as either potentially acid-generating (PAG) or as non-potentially acid generating (non-PAG). Material classification is based on the Mine Environment Neutral Drainage Guidelines (Price 2009). The analyzed samples are consistently classified as non-PAG, based on neutralization potential ratio (NPR) values of greater than 2. Eighty out of the eighty-two samples are classified as non-PAG. One sample reports an NPR value of less than 1 and is classified as PAG. One sample reports an NPR value of between 1 and 2 and classifies as Uncertain. These two samples were not provided with a lithology description but are assigned to the Watt Mountain and Slave Point formations, respectively. These two samples have significantly elevated sulphur contents when compared to the other samples in the database.

Waste rock samples from the Sulphur Point and Muskeg Formations generally report much lower values of total sulphur and sulphide sulphur. All the samples from these geologic formations came from the 2017 sampling of the L-65, N-42, M-40, and EX-17 deposits. Due to the low sulphur content, the associated maximum potential acidity value is lower than for other waste rock samples. The neutralization potentials are similar to other waste rock samples and, as a result of the above, the NPR values are generally higher than for other waste rock units.

The neutralization potential in the analyzed samples is almost entirely provided by carbonate sources, with an insignificant component of neutralization influenced by other minerals such as silicates. This finding is consistent with the observed rock types and the quantitative X-ray diffraction data. Carbonate minerals provide the most available and fastest reacting source of neutralization potential, and as such are more effective at neutralizing against acid production compared to other minerals.

The whole rock analyses indicate that the sampled rocks are dominated by calcium and magnesium with minor components of silicate minerals (silica, aluminum, and iron oxides). The results reflect the predominant mineralogy of dolomite and calcite, with minor quartz and micas, consistent with quantitative X-ray diffraction analyses. Additional details regarding geochemistry can be found in Section 2.1.3 of the Project Description.

3.3.2 Air Quality, Noise, and Climate

3.3.2.1 *Meteorology and Climate*

Historic weather and climate data for the air quality RSA (Section 3.1.2) are available from the former Pine Point weather station (Climate ID: 2203101) and the surrounding operating weather stations:

- Hay River Airport (Climate ID: 2202401)
- Fort Resolution Airport (Climate ID: 2202010)

The former Pine Point weather station was located within the historic Pine Point townsite from November 1975 to April 1988. The Hay River Airport station is located approximately 75 km west of the historic Pine Point townsite, while the Fort Resolution Airport station is approximately 50 km northeast. The Hay River Airport station began recording data in September of 2014, but a previous iteration of the station located at the same site was operated from 1953 to September 2014. Similarly, the current version of the Fort Resolution Airport station began recording at the end of December 2014 replacing the previous station that began recording in 1954 to 2014. Additionally, a meteorological station at the Project was installed by Golder and Aurora Geosciences Ltd. in October 2019, the data from which will be provided in the Developers Assessment Report. Table 3-1 summarizes the locations and the data available from these stations.

Table 3-1: Meteorological Stations in the Regional Study Area

Station Name	UTM (NAD83)			Elevation (masl)	Meteorological Parameters Monitored	Climate Normals Data Available	Station Operator	Data Source
	Easting (m)	Northing (m)	Zone					
Pine Point	642996	6750807	11	224	▪ Temperature ▪ Precipitation	N/D	ECCC	ECCC 2019a
Hay River Airport	566163	6745549	11	164.9	▪ Temperature ▪ Precipitation ▪ Wind ▪ Humidity ▪ Pressure ▪ Visibility	▪ 1961-1990 ▪ 1971-2000 ▪ 1981-2010	ECCC	ECCC 2019a,b
Fort Resolution Airport	355380	6795905	12	160.6	▪ Temperature ▪ Humidity ▪ Wind ▪ Pressure ▪ Visibility	N/D	Nav Canada	ECCC 2019c
Pine Point Project	639672	6750617	11	219	▪ Temperature ▪ Rain ▪ Wind ▪ Solar Radiation	N/D	Aurora Geosciences Ltd.	N/A

ECCC = Environment and Climate Change Canada; masl = metres above sea level; N/A = not applicable; N/D = data not available; NAD83 = North American 1983 datum; UTM = Universal Transverse Mercator.

3.3.2.2 Temperature

Figure 3-4 presents a summary of average monthly temperatures from the weather stations within the RSA compared with ECCC's 1981-2010 climate normals at the Hay River Airport and the historical average from 1976-1987 at the historical Pine Point station. The average monthly temperatures in 2019 at the Hay River Airport station ranged from a minimum of -22.7°C in February to maximum of 15.5°C in July. The minimum average monthly temperature in 2019 at the Fort Resolution Airport was -25.3°C in February and the maximum was 15.1°C in July. Average monthly temperatures at Hay River and Fort Resolution were similar throughout 2019, although Fort Resolution was slightly cooler for most months. In comparison to the Hay River 1981-2010 climate normals and the Pine Point 1976-1987 historical average, 2019 temperatures at both stations were relatively normal with the exception of March, which was atypically warm in Hay River.

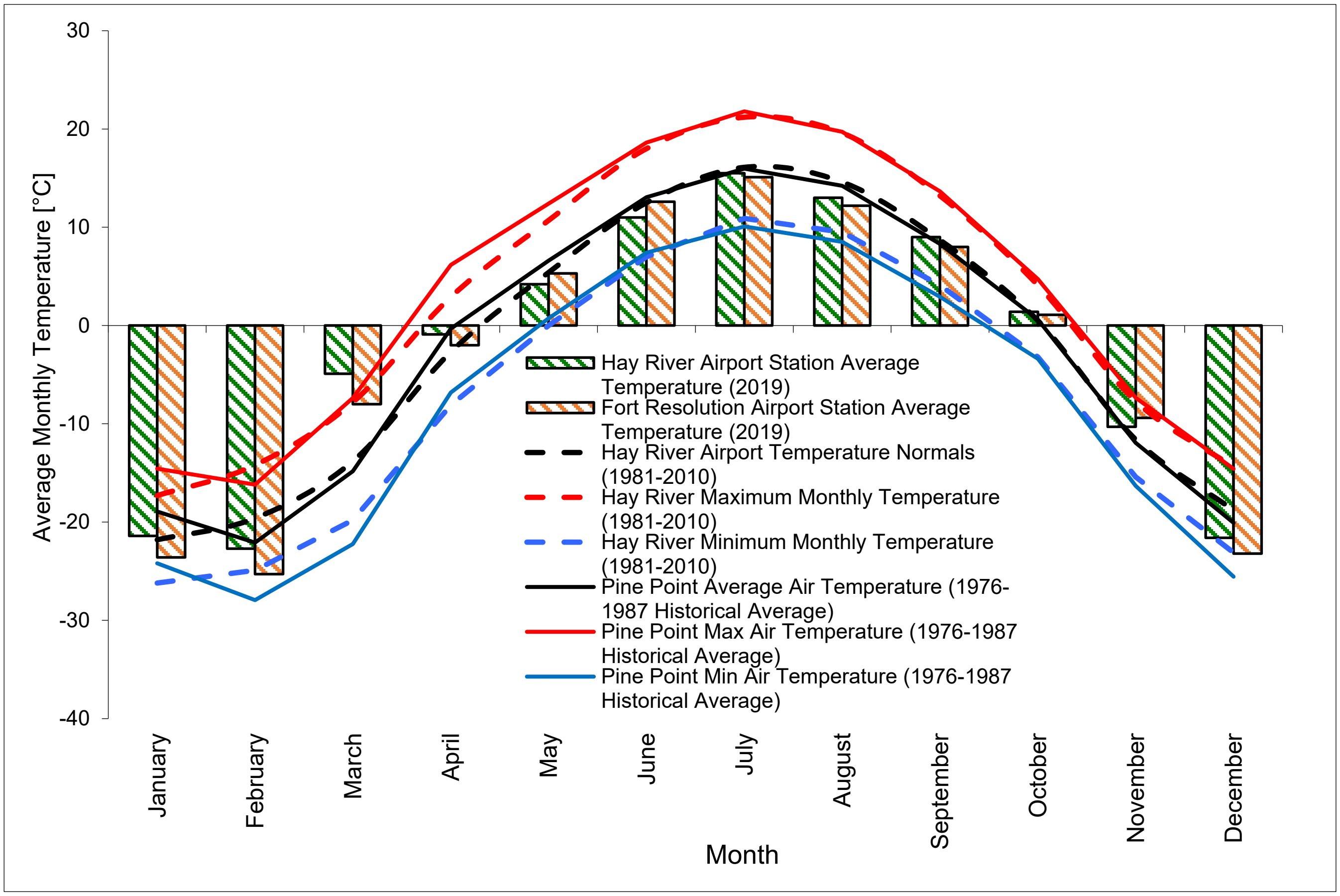


Figure 3-4: Average Monthly Temperatures in the Regional Study Area

3.3.2.3 Precipitation

Total monthly precipitation at Hay River is compared with the latest Hay River climate normals and the Pine Point historical average in Figure 3-5. The weather station at Fort Resolution does not record precipitation. As indicated in Figure 3-5, the winter months are typically the driest with the most precipitation usually occurring in August. The year 2019 was considerably drier than usual at Hay River especially in January, February, March, and August. In total, 228.5 mm of precipitation was recorded at the Hay River station in 2019 in comparison with the 1981-2010 climate normals of 336.4 mm and the Pine Point historical average of 313.5 mm.

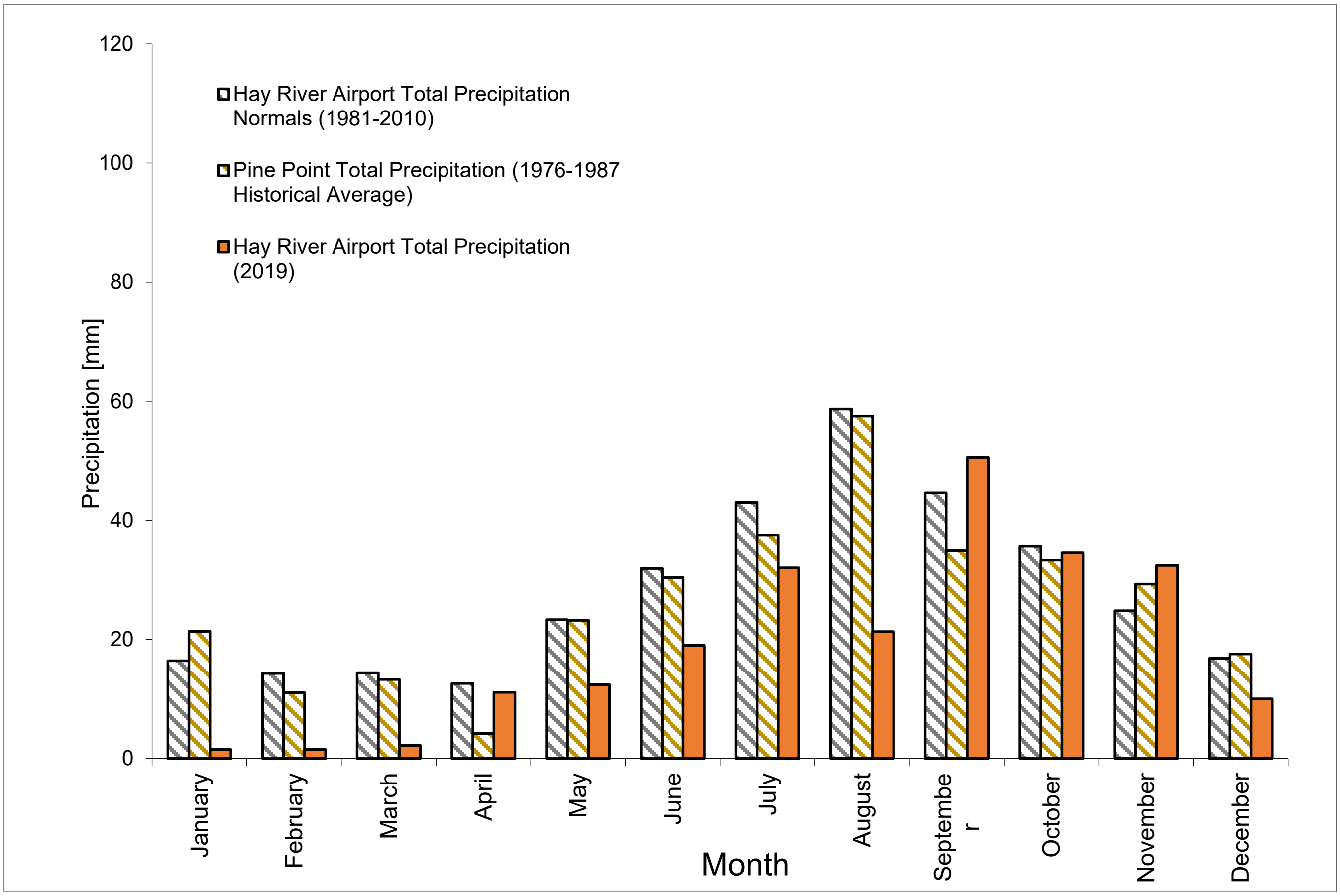


Figure 3-5: Monthly Precipitation in 2019 in Comparison with Historical Averages and Normals

3.3.2.4 Wind

Figure 3-6 and Figure 3-7 summarize the wind distribution in 2019 and during the winter and summer months using a wind rose at the Hay River and Fort Resolution weather stations. Wind flow in the wind roses is presented from the direction shown. In 2019, annual wind was predominantly from the east at Hay River with other major winds occurring from the northwest and south. In the winter months (November through March), winds were mostly from the northwest and south, whereas in the summer months (June through September), winds were mainly from the east and northeast. Annual winds in 2019 at Fort Resolution were largely from the north-northwest, and north, with other winds occurring from the south-southeast and southeast. The 2019 summer months at the Fort Resolution station were dominated by northerly winds. In the winter months, winds were more evenly distributed with the predominant wind occurring from the south-southeast and northwest, north-northwest.

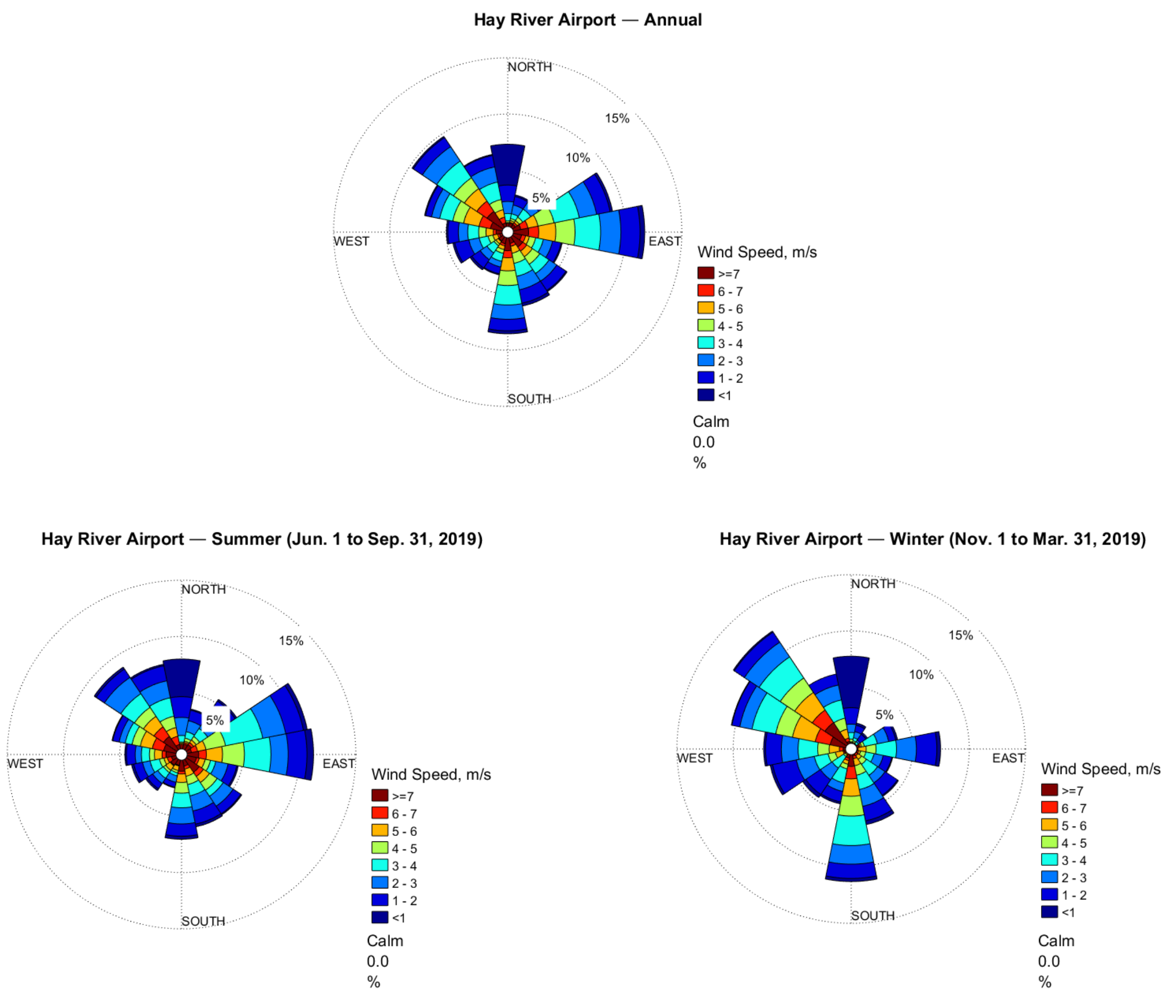


Figure 3-6: 2019 Hay River Airport Wind Roses

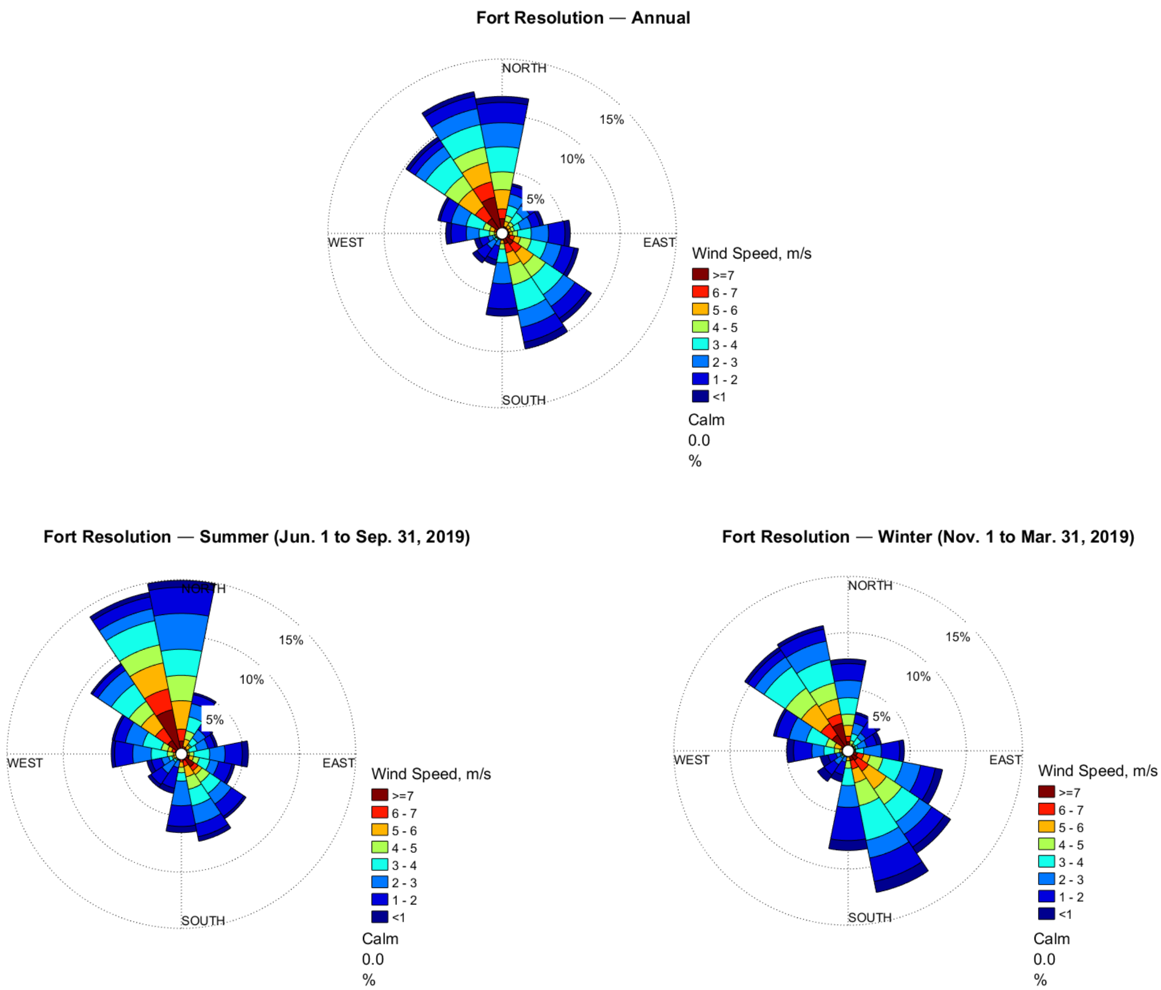


Figure 3-7: 2019 Fort Resolution Airport Wind Roses

Table 3-2 compares the wind speed observed at the Hay River Airport in 2019 with the Hay River 1981-2010 climate normals. Since ECCC reports wind direction in their climate normals using an 8-point compass (ECCC 2019b), the directions summarized in Table 3-2 are also presented based on an 8-point compass versus the wind roses, which are 16-point. Average wind speeds throughout the year, as observed at the Hay River station, range from 10.7 km/h in February to 23.7 km/h in October. In comparison to the climate normals, average wind speed in 2019 was similar during most months apart from September and October, which were much higher compared to the climate normals.

Table 3-2: 2019 Hay River Average Wind Speed and Predominant Wind Direction in Comparison with Climate Normals

Month	Average Wind Speed (km/h)		Predominant Wind Direction[(a)]	
	1981-2010 Hay River Airport Climate Normals	2019 Hay River Airport	1981-2010 Hay River Airport Climate Normals	2019 Hay River Airport
January	11.2	12.8	W	NW
February	11.4	10.7	NW	S
March	11.8	13.3	NW	NW
April	13.1	11.4	E	E
May	13.6	14.7	E	E
June	11.8	12.0	E	NW
July	11.2	12.1	E	NW
August	11.5	12.5	S	NW
September	13.2	19.9	S	E
October	13.5	23.7	S	E
November	13	15.3	W	NW
December	11.4	10.9	W	NW
Average	12.2		E	

(a) Wind directions based off an eight-point compass

3.3.2.5 Humidity

Relative humidity readings in 2019 from the stations located in the RSA are compared to the 1981-2010 Hay River climate normals in Figure 3-8. The former station located at the historic Pine Point townsite did not record humidity. The 2019 measurements from Hay River and Fort Resolution stations were similar to the Hay River climate normals.

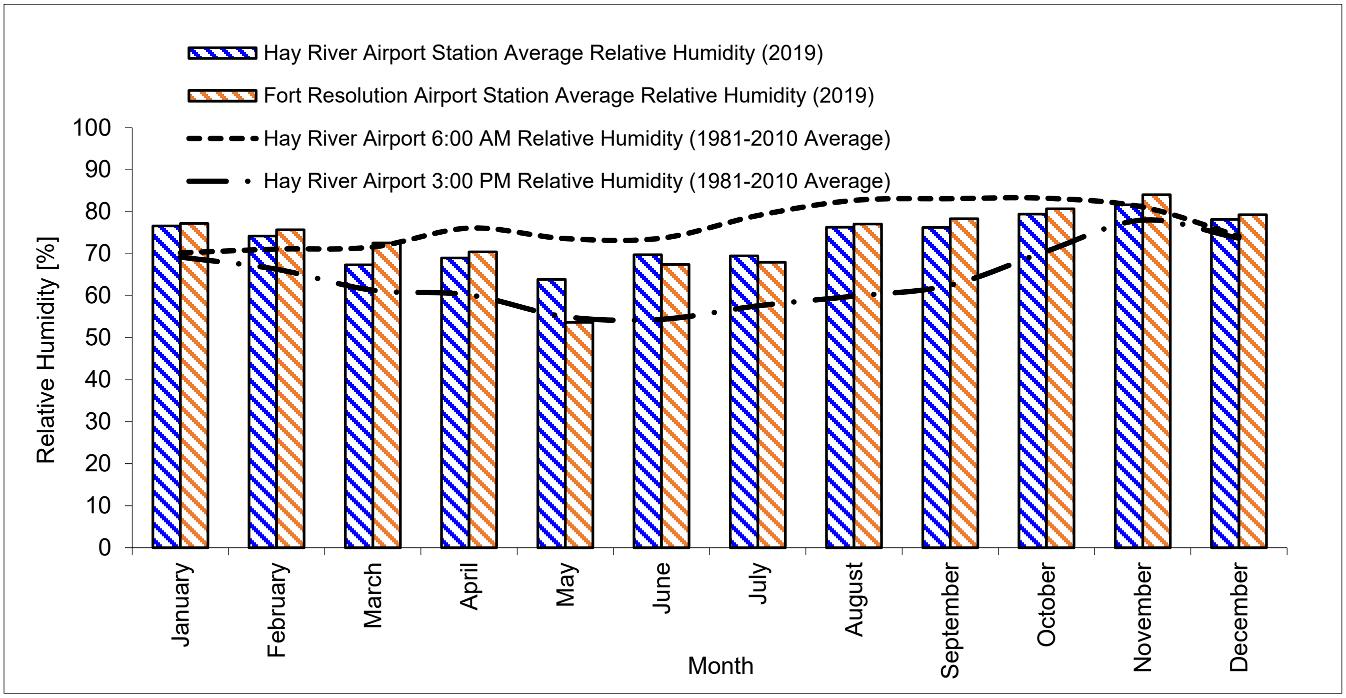


Figure 3-8: 2019 Relative Humidity in the Regional Study Area

3.3.2.6 Air Quality

Continuous air monitoring data are available from the NWT Air Quality Monitoring Network station located in Fort Smith and ECCC's National Air Pollution Surveillance station located in Yellowknife (GNWT 2020a). Background acid deposition data are available from the Canadian Air and Precipitation Monitoring Network's stations located at Snare Rapids and Wood Buffalo National Park (ECCC 2018a). Results from both stations are considered to be representative of background conditions (ECCC 2018a) in the LSA and region (Section 3.1.2). Previously, acid deposition was also monitored at a station near Hay River by the Canadian Network for Sampling Precipitation from 1979 to 1985 and is publicly accessible online (ECCC 2018b). In addition, two baseline air quality monitoring studies in the region were completed in 2011 (Rescan 2012c,d). The results of these studies are considered representative of the existing environment, as there have been no new developments in the region since the completion of the studies.

The baseline air quality studies consisted of dustfall monitoring and passive air sampling (Rescan 2012c,d). Dustfall monitoring was undertaken at seven locations, five of which were located close to the Project and the other two were located near the intersection of Highways 2 and 5, south of Hay River. Dustfall monitoring was conducted from July to October of 2011. At each dustfall monitoring station, two dustfall containers were placed on top of two-metre tall poles. One container's contents were analyzed for total particulate, soluble particulate, insoluble particulate, sulphate (SO_4^{2-}), nitrate (NO_3^-), ammonia (NH_3 and NH_4^+), and chloride anions (Cl^-). The other container's contents were analyzed for total metals and base cations (Mg^{2+}, Ca^{2+}, K^+). Passive air samples of sulphur dioxide (SO_2), nitrogen dioxide (NO_2), and ozone (O_3) were also collected monthly at three locations near the Project site from July to October of 2011 using a Passive Air Sampling System (PASS). Table 3-3 presents the locations of the dustfall and passive air sampling stations.

Table 3-3: Dustfall and Passive Air Sampling Locations

Dustfall Sample Location ID	PASS Sample Location ID	UTM (NAD83, Zone 11)		Study
		Easting (m)	Northing (m)	
DF-1	—	607729	6734415	Rescan 2012c
DF-2	PASS 1	602446	6733882	Rescan 2012c
DF-3	PASS 2	659585	6760609	Rescan 2012d
DF-4	PASS 3	612995	6735336	Rescan 2012c
DF-5	—	602278	6734305	Rescan 2012c
DF-6	—	562322	6737288	Rescan 2012c
DF-7	—	562553	6737260	Rescan 2012c

NAD83 = North American 1983 datum; PASS = Passive Air Sampling System; UTM = Universal Transverse Mercator.

Averaged results of total dustfall, NO_3^-, and SO_4^{2-} deposition from the 2011 dustfall studies are summarized in Table 3-4. No published dustfall criteria exist in the NWT, but total dustfall results were well below the Alberta Ambient Air Quality Guidelines of 1.77 milligrams per square decimetres per day ($mg/dm^2/d$) and 5.27 $mg/dm^2/d$ (averaged over 30 days) dustfall criteria for residential and commercial areas, respectively (AEP 2019). The results are indicative of baseline levels for an area with minimal disturbance to air quality.

Table 3-4: 2011 Total Dustfall, Nitrate, and Sulphate Deposition Results

Substance	Average Deposition Rate ($mg/dm^2/d$)						
	DF-01	DF-02	DF-03	DF-04	DF-05	DF-06	DF-07
Total Dustfall	0.28	0.28	0.27	0.16	0.28	0.28	0.47
NO_3^-	0.0036	0.0016	0.0010	0.0010	0.0017	0.0013	0.0012
SO_4^{2-}	0.0049	0.0073	0.0036	0.0044	0.0050	0.0054	0.0050

$mg/dm^2/d$ = milligrams per squared decimetres per day.

The Government of the Northwest Territories (GNWT) Ambient Air Quality Standards (AAQS [GNWT 2014]), are summarized in Table 3-5 and passive air sampling results from the 2011 studies are presented in Table 3-6. The passive air sampling results are presented as the average monthly concentrations, and since the AAQS are for 1-hour, 8-hour, 24-hour and annual timeframes, the sampling results can only be compared with the annual AAQS. All results were well below the relevant annual AAQSs.

Table 3-5: GNWT Ambient Air Quality Standards

Substance	NWT Ambient Air Quality Standard (µg/m^3)[(a)]			
	1-hr average	8-hr average	24-hr average	Annual Mean
CO	15,000	6,000	—	—
$PM_{2.5}$	—	—	28	10[(c)]
O_3	—	126[(b)]	—	—
NO_2	400	—	200	60[(c)]
SO_2	450	—	150	30[(c)]
TSP	—	—	120	60[(d)]

(a) Source: GNWT 2014
(b) Rolling average
(c) Arithmetic mean
(d) Geometric mean
"—" = No AAQS exists for this averaging period.
CO = carbon monoxide; NO_2 = nitrogen dioxide; µg/m^3 = micrograms per cubic metre; O_3 = ozone; $PM_{2.5}$ = fine particulate matter; SO_2 = sulphur dioxide; TSP = total suspended particulate.

Table 3-6: 2011 Passive Air Sampling Results

Substance	Average Monthly Concentration (µg/m^3)[(a)]		
	PASS 1[(a)]	PASS 2[(b)]	PASS 3[(a)]
NO_2	0.09	0.09	0.21
O_3	33.52	30.23	27.83
SO_2	0.52	0.36	0.65

(a) Average of four monthly sample results
(b) Source: Rescan 2012c
(c) Source: Rescan 2012d
NO_2 = nitrogen dioxide; O_3 = ozone; SO_2 = sulphur dioxide; PASS = Passive Air Sampling System.

A summary of the continuous carbon monoxide (CO), fine particulate matter ($PM_{2.5}$), O_3, NO_2, and SO_2 monitored data from the most recent five-year period (2015 to 2019) from the Yellowknife and Fort Smith stations is presented in Appendix A. No exceedances of CO, NO_2, O_3, or SO_2 AAQS were measured at either station from 2015 to 2019. There were exceedances measured for the $PM_{2.5}$ 24-hour AAQS. The exceedances in 2015 and 2016 were attributed to forest fire smoke in the GNWT air quality reports (GNWT 2017a, 2018a). All exceedances in 2017, 2018, and 2019 occurred in spring or summer and were likely caused by wildfire smoke or dust from dry gravel roads.

Figure 3-9 summarizes the 8-hr CO concentrations recorded at both stations in 2019. The maximum 8-hr CO concentration of 3,021 µg/m^3 during the 2015-2019 time period was recorded at the Yellowknife station in 2019. This maximum is still much lower than the CO AAQS of 6,000 µg/m^3 for the 8-hr averaging period. The 5-year average at Fort Smith was 179 µg/m^3 of CO averaged over eight hours, whereas the Yellowknife station 5-year average was higher at 282 µg/m^3.

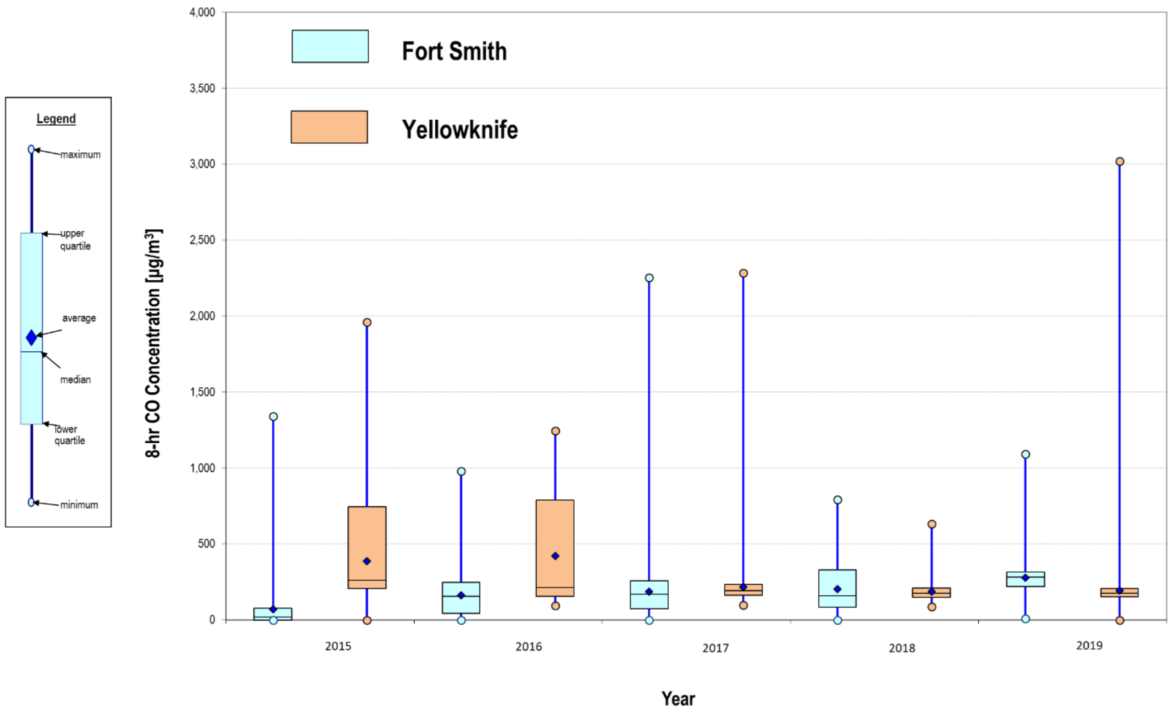


Figure 3-9: Box Plot of the 8-h CO Concentrations Recorded from 2015-2019

The 24-hour averaged NO_2 concentrations recorded during the 2015-2019 time period are presented in Figure 3-10. Maximum concentrations recorded at both stations were much lower than the 24-hr NO_2 AAQS of 200 µg/m^3. From 2015 through 2019, the Fort Smith station averaged 2.9 µg/m^3 of NO_2 over 24 hours, and the Yellowknife station averaged 4.7 µg/m^3.

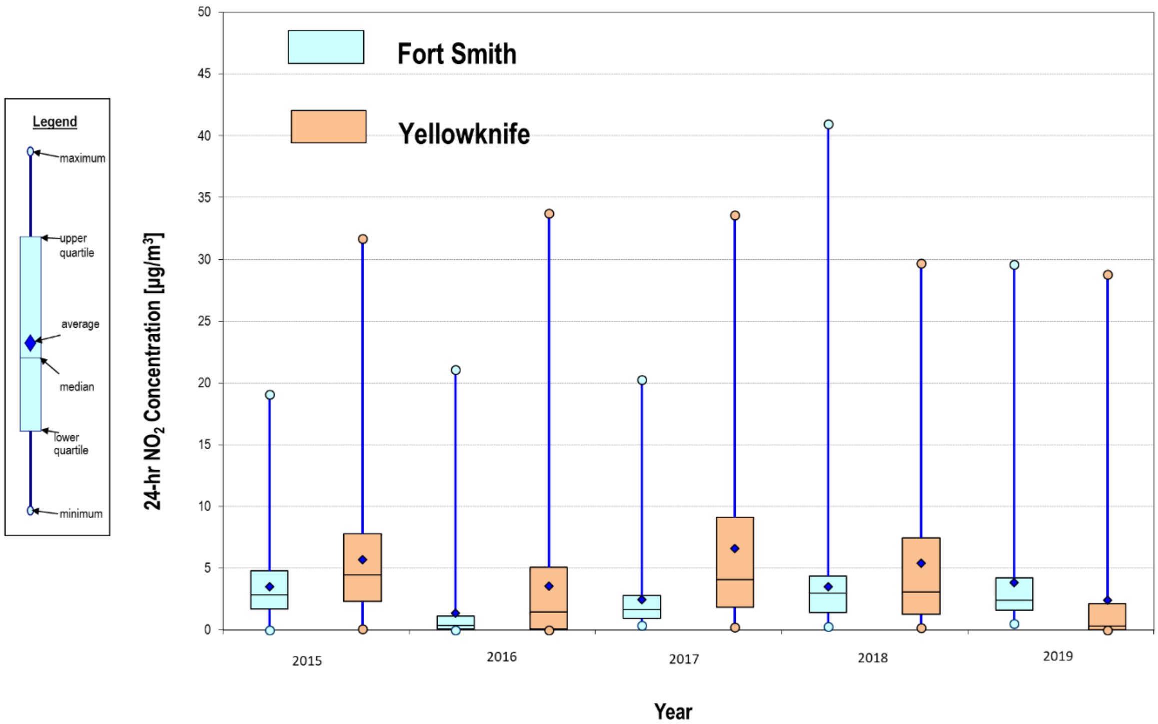


Figure 3-10: Box Plot of the 24-h NO_2 Concentrations Recorded from 2015-2019

The 8-hr rolling average of hourly O_3 concentrations measured at the Fort Smith and Yellowknife stations from 2015 through 2019 are compared with the AAQS in Figure 3-11. Ozone concentrations at both stations varied minimally year to year, with Fort Smith and Yellowknife 8-hour rolling average concentrations of 56.0 µg/m^3 and 56.9 µg/m^3, respectively.

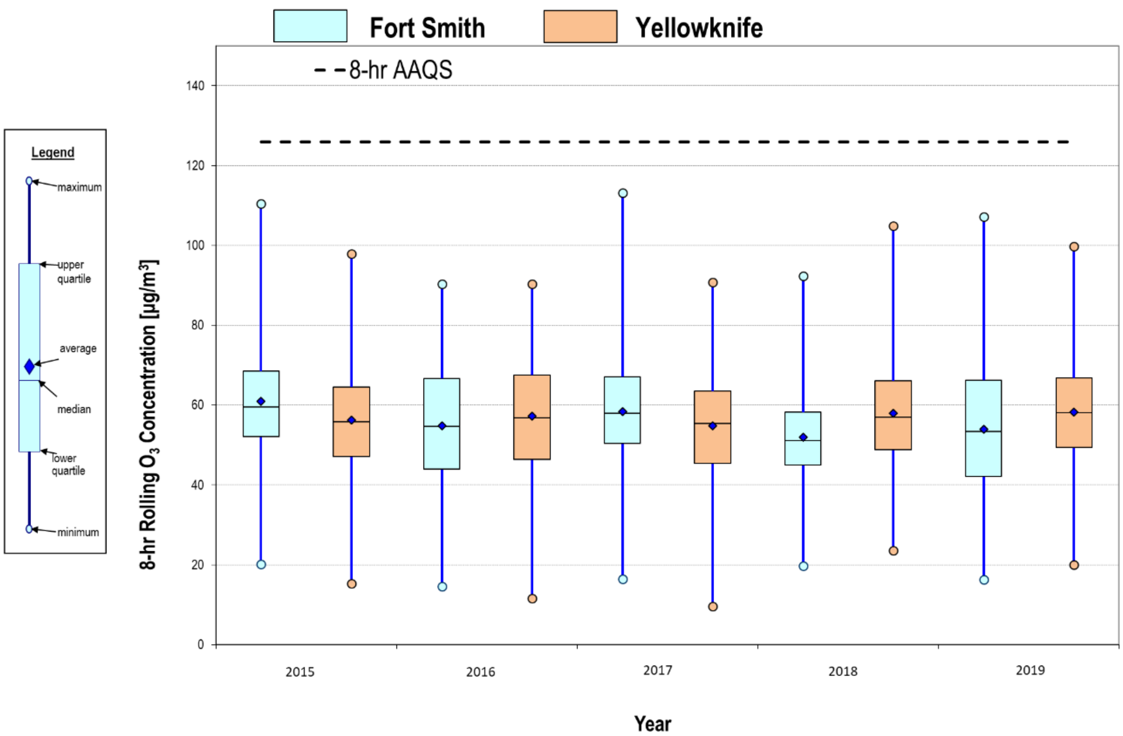


Figure 3-11: Box Plot of the 8-h Rolling Average O3 Concentrations Recorded in 2015-2019

The 24-hr $PM_{2.5}$ concentrations at the Fort Smith and Yellowknife stations are presented in Figure 3-12. Concentrations of $PM_{2.5}$ are greatly affected by wildfire smoke and road dust in the summer months as evident by the large variation in maximum values recorded versus the 75th percentiles. Typically 24-hr $PM_{2.5}$ concentrations at both stations were well below the AAQS, with 2015 through 2019 averages of 7.1 µg/m³ and 5.7 µg/m³ at Fort Smith and Yellowknife, respectively.

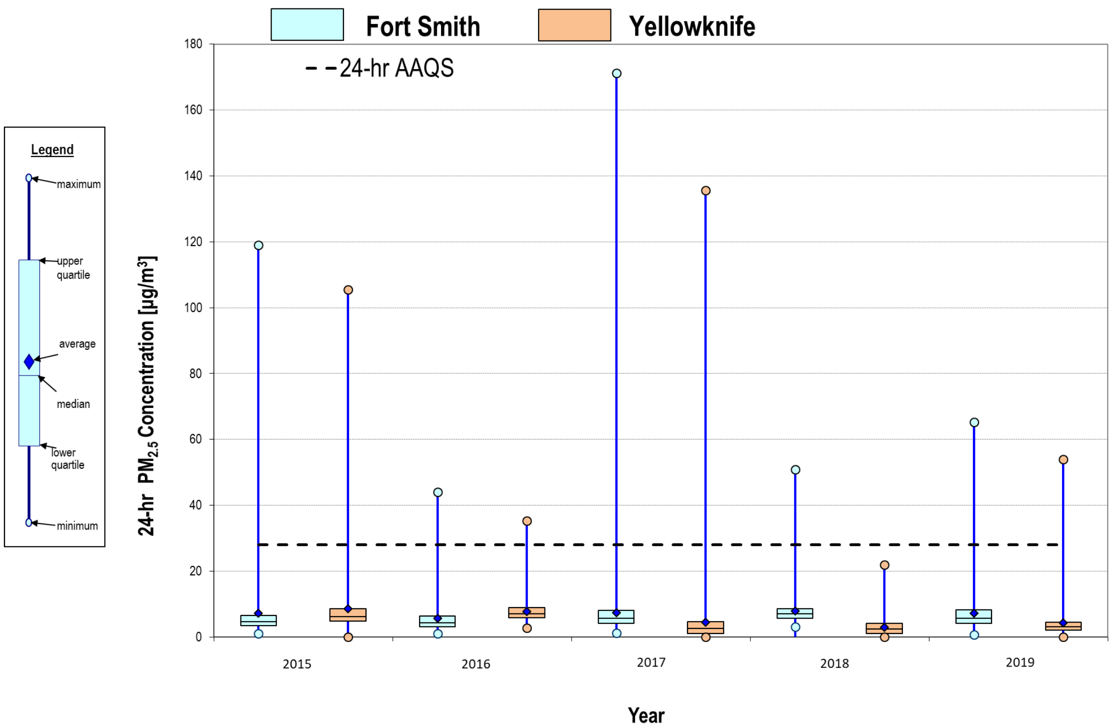


Figure 3-12: Box Plot of the 24-h $PM_{2.5}$ Concentrations Recorded in 2015-2019

Figure 3-13 presents the 24-hour concentrations of SO_2 from 2015 through 2019 recorded at the Fort Smith and Yellowknife stations. Measurements were well below the 24-hour SO_2 AAQS of 150 µg/m^3, with the maximum value of 19.0 µg/m^3 at Fort Smith in 2019. On average, Fort Smith and Yellowknife 24-hour SO_2 concentrations were less than 1 µg/m^3.

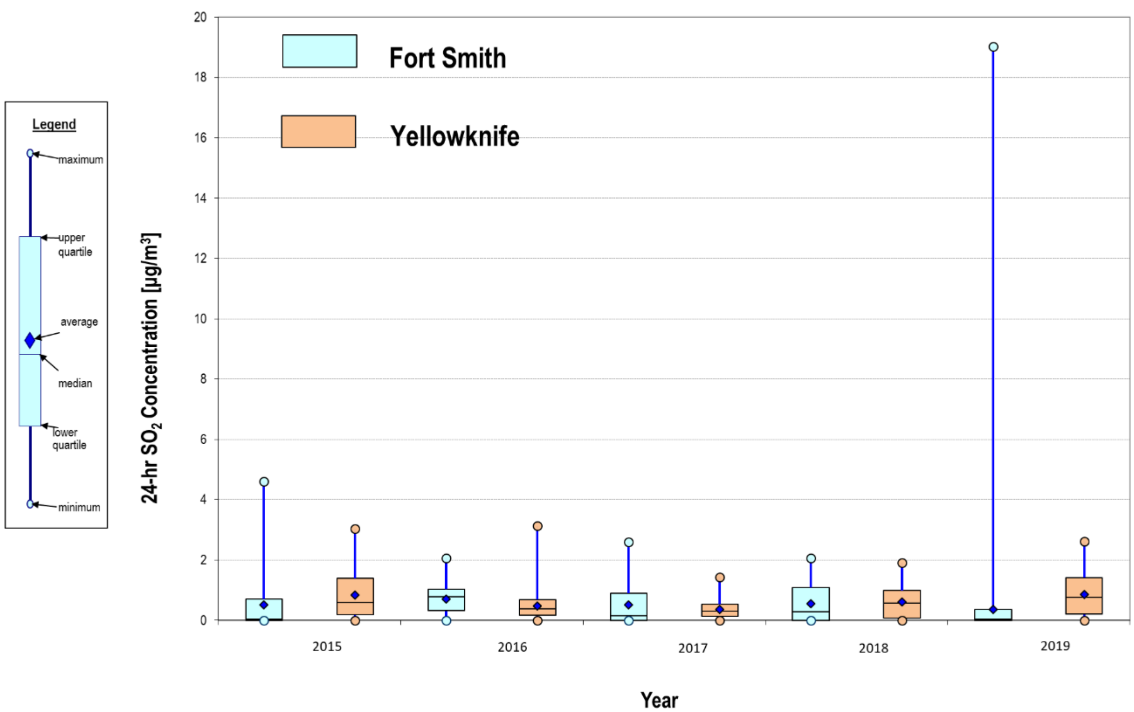


Figure 3-13: Box Plot of the 24-h SO_2 Concentrations Recorded from 2015-2019

3.3.2.7 Noise

A baseline noise survey was completed in the noise RSA in July and December 2011 (Rescan 2012c,d; Section 3.1.2). There have been no new developments in the RSA since 2011; therefore, the results of the 2011 survey provides representative information on noise levels for the existing environment.

The baseline noise survey measured noise levels at four monitoring stations in the RSA (S1, S2, S3, and S4). To characterize seasonal variability, noise levels were measured twice at each monitoring station: once during the summer with relatively low wind (July 2011), and once during the winter with relatively high wind (December 2011). To characterize daily variability, noise levels were measured for a period of approximately 24 hours at each monitoring station. All noise measurements were collected using Type I integrating sound level meters. Table 3-7 describes the noise monitoring stations and measurement periods captured during the baseline noise survey.

Table 3-7: Baseline Noise Monitoring Stations in the Regional Study Area

Baseline Noise Monitoring Station	Universal Transverse Mercator Coordinates (NAD83, Zone 11)		Description	Measurement Periods
	Easting (m)	Northing (m)		
S1	600004	6734214	The sound level meter was installed approximately 300 m south of Highway 5, in a grassy location with a row of young deciduous trees between the sound level meter and the highway.	19 to 20 July 2011; 6 to 7 December 2011
S2	607159	6735888	The sound level meter was installed at the intersection of two cut lines in a relatively flat grassy area, with no nearby sources of industrial noise.	19 to 20 July 2011; 6 to 7 December 2011
S3	659585	6760609	The sound level meter was installed approximately 500 m south of Highway 6, in a small cut block.	20 to 21 July 2011; 6 to 7 December 2011
S4	613469	6734287	The sound level meter was installed approximately 250 m east of the Buffalo River in a forest clearing along an access road.	20 to 21 July 2011; 6 to 7 December 2011

NAD83 = North American 1983 datum;

For each monitoring station and measurement period, Table 3-8 presents average daytime noise levels ($L_{eq,day}$), where daytime is defined as the period from 7:00 a.m. to 10:00 p.m., average nighttime noise levels ($L_{eq,night}$), where nighttime is defined as the period from 10:00 p.m. to 7:00 a.m., and 24-hour average noise levels ($L_{eq,24}$). All noise levels are expressed in A-weighted decibels (dBA), which is a logarithmic unit that reflects the sensitivity of the human auditory system. Table 3-8 also identifies noise sources that were audible during the survey and contributed to the measured noise levels.

Table 3-8: Baseline Noise Levels in the Regional Study Area

Baseline Noise Monitoring Station	Measurement Period	Baseline Noise Levels (dBA)			Audible Noise Sources
		Daytime ($L_{eq,day}$)	Nighttime ($L_{eq,night}$)	24-Hour ($L_{eq,24}$)	
S1	July 2011	43	37	41	highway traffic; birds; wind
	December 2011	51	53	51	
S2	July 2011	24	30	28	wildlife; wind
	December 2011	51	51	51	
S3	July 2011	29	32	30	highway traffic; wildlife; wind; rain/thunder[(a)]
	December 2011	53	54	53	
S4	July 2011	43	25	41	birds; wind; rain/thunder[(a)]
	December 2011	49	51	50	

(a) Rain and thunder were only audible during the July 2011 measurement period.

At each monitoring station, baseline noise levels were higher during the December measurement period than the July measurement period. Elevated noise levels during the December period are primarily the result of high wind speeds. As a result, baseline measurements from July 2011 are generally representative of the existing environment during periods of low to moderate wind, and baseline measurements from December 2011 are generally representative of the existing environment during periods of high wind.

3.3.3 Groundwater Quantity and Quality

Regional Hydrogeology

Regional groundwater occurs in both an unconfined aquifer in the overburden, as well as in a confined bedrock aquifer. The average depth to groundwater ranges from 1 to 18 m below ground surface (Tamerlane 2007). The groundwater recharge areas are from local topographic highs such as the Caribou Mountains located 200 km south of the Pine Point property, and to a lesser extent, Cameron Hills to the north, where groundwater flow is distributed radially. Durston (1979) and Stevenson (1984) postulated that a perched groundwater flow system exists within the Caribou Mountain uplands, which re-charges the lower Slave Point Formation. The groundwater flow in the overburden aquifer varies with topographic relief, but flows generally towards the northeast (Brown et al. 1981).

The groundwater in the bedrock aquifer generally flows towards the north and northeast, and discharges along lowlands adjacent to the western margin of the Canadian Shield, including the Hay River valley to the northwest and the Little Buffalo River and Slave River valleys to the northeast, and the south side of Great Slave Lake comprises a lowland area, which is considered a major regional groundwater discharge area (Tamerlane 2007). Discharge areas are evident through the presence of surface water features such as swamps and alkali flats, and springs discharging mineralized and sulphurous groundwater. High specific conductivity readings have also been observed along Slave River, Salt River, Little Buffalo River, Buffalo River, and along Great Slave Lake between Fish Point and Presqu‘ile Point. Groundwater discharge is also evident through the presence of swampy areas and sulphurous springs throughout the northern sections of the LSA (EBA 2011).

Site Hydrogeology

The bedrock units that represent the most productive aquifers are within the Sulphur Point Formation and the Pine Point Formation, consisting of highly porous, well fractured dolomite. According to Stevenson (1984), the aquifer is laterally confined by the Buffalo River shales to the north and the Muskeg evaporites to the south. Overlying clay till overburden and the Watt Mountain Formation limestones of generally low permeability act to confine the aquifer on top while the Chinchaga Formation evaporites underlying the Pine Point and Keg River formations form an effective vertical barrier below the aquifer. The hydraulic continuity is thought to be more predominant along the northeast-southwest trend of the Presqu’ile Barrier Reef Complex due to karstification, solution channelling, and jointing characteristics (GTC 1983).

Local groundwater recharge to the bedrock aquifer at the Pine Point site is likely to be variable and largely controlled by the overburden geology. High rates of recharge are expected in areas where sinkholes are present, but in general, recharge will be limited by the presence of till overburden. Several small ponds were observed in boggy areas that were several metres above the regional water table, indicating that recharge is relatively slow through the till. Local surface water/groundwater flows through the till, then downwards through fractured bedrock towards the water table. Groundwater within the saturated bedrock is expected to flow anisotropically along solution channels, bedding planes, and fractured zones (Brown et al. 1981) (i.e., there is a preferred direction of groundwater movement along these features as compared to across them). Several seepage points observed in historical pit walls indicate that there is some lateral flow within the unsaturated bedrock. Groundwater discharges locally towards the north to northeast, and springs discharging mineralized and sulphurous groundwater have been also observed along the south shore of Great Slave Lake (GTC 1983; Stevenson 1983), and sulphurous springs and artesian boreholes along the banks of the Buffalo River have been reported (GTC 1983; EBA 2005a). One participant in the Hay River ITK interviews indicated that he was aware of “artesian wells” in the Pine Point area (Tamerlane 2006b).

The permeability and porosity of the Presqu'ile aquifer is very high with hydraulic conductivity values on the order of 10^{-4} to 10^{-3} m/s (Stevenson 1983; GTC 1983). Based on work completed by Stevenson (1983), the water table in the LSA slopes northwards towards Great Slave Lake. Local gradients range from about 0.4% northwards along the north part of the area and about 0.25% westward along the south portion.

Interpretation of the bedrock groundwater potentiometric[1] contours in relation to the topography indicates that the depth of groundwater is up to 30 m below the ground surface along the northeastward trending ridge in the east-central part of the LSA. In the northwest portion of the LSA, the potentiometric surface is higher than the ground surface. High water levels have resulted in groundwater discharge as springs along the incised Buffalo River channel and other small tributary channels in the area.

Although the Presqu'ile aquifer has a high permeability, groundwater flow through it is likely to be relatively slow due to the low hydraulic gradient in the RSA. Due to the high porosity, the storativity of the aquifer is high. It is estimated that about 1 billion m^3 of water was removed during mining activities from 1968 to 1984. According to Stevenson (1984), this water was produced from storage within the aquifer (16%), recharge from local precipitation (76%), with the remainder from the regional groundwater flow.

Groundwater Quality

Sampling at the Pine Point site has consistently shown that the physical and chemical properties of the groundwater are consistent with the limestone, dolomite, sandstone, and shale, and evaporite formations regionally. Three basic types of groundwater have been reported in the RSA through previous studies, namely a calcium bicarbonate water found locally in glacial drifts, sulphur water commonly found in springs along the south shore of Great Slave Lake, and saline water described from groundwater contact with the Devonian evaporite layers. The chemistry of most groundwater samples collected in the RSA over the previous 30 years reflects mixing of these three groundwater types, although it should be noted that groundwater deeper than 25 m was not tested in previous studies (Tamerlane 2007).

Indigenous Traditional Knowledge suggests that groundwater in the area is poor, and described it as alkaline, sulphurous, and non-potable (Tamerlane 2007). Some people indicated that baseline groundwater quality had been non-potable prior to the start of mining activities, and others indicated that mining activities had worsened groundwater quality.

3.3.4 Surface Water Quantity

The landscape within and surrounding the aquatics RSA is largely composed of boreal forest, interspersed with extensive lakes and wetlands (Section 3.1.3). Rivers are generally associated with snowmelt, with peak flows dominated by snowmelt floods in the spring. Where present, permafrost acts as a barrier to deep groundwater recharge, which increases surface runoff and decreases sub-surface flow.

[1] Potentiometric surface is the theoretical level to which water in a confined aquifer will rise to and equalize in a well.

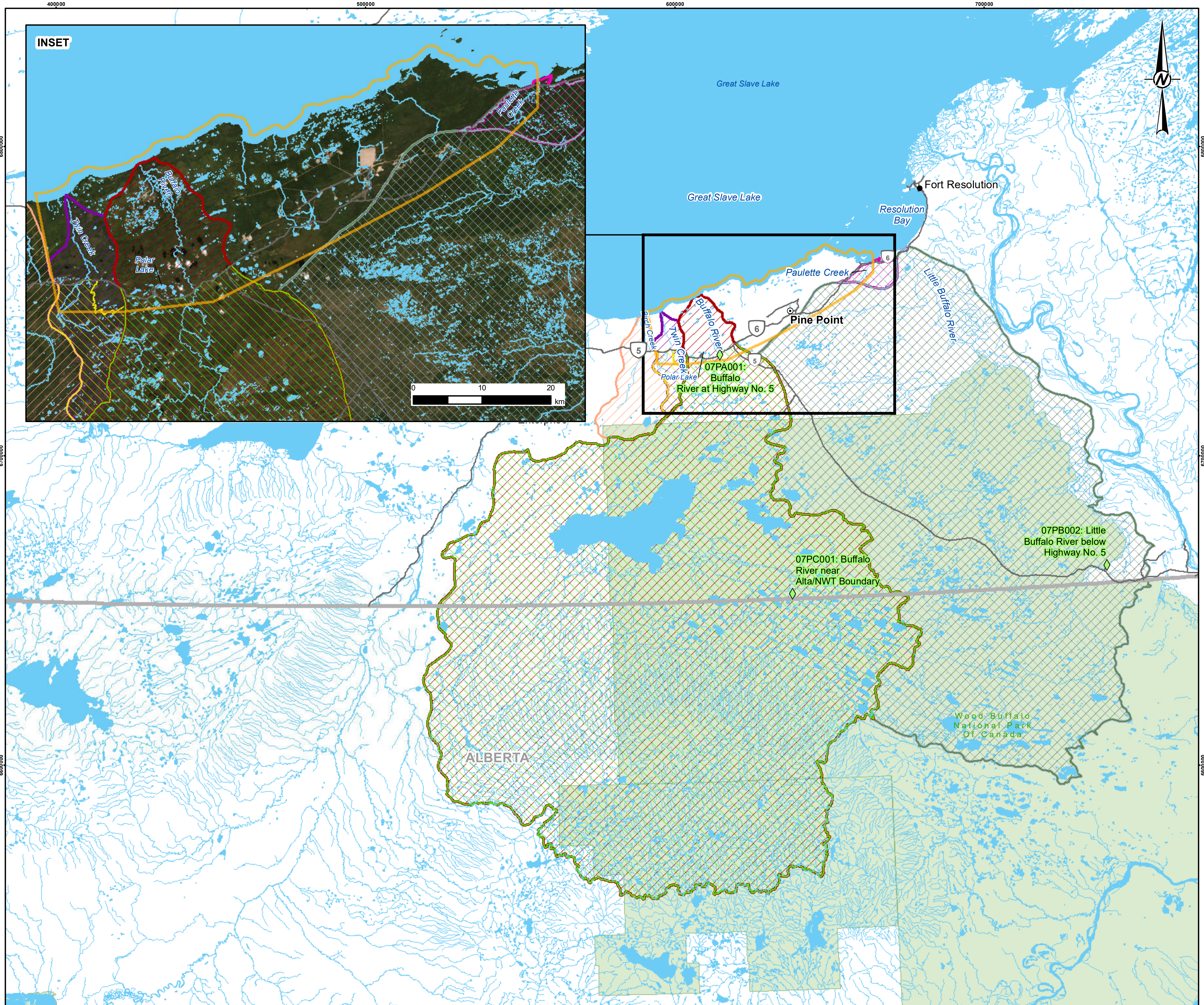
The local area around the Project is flat to gently sloping. A considerable area is covered by poorly drained muskeg up to 3 m deep in some areas (Beak 1980). Elevations range from approximately 262 m in the southwest part of the LSA to 156 m in the northeast (LSI 2018, 2019). Swamp, muskeg, and low gravel ridges are the main topographic features with several small lakes and numerous potholes (Beak 1980). Overall, the land gently slopes in a northeast direction toward the southern shore of Great Slave Lake.

The two main drainages located within the LSA are the Buffalo River and Twin Creek. Birch Creek, Paulette Creek and the Little Buffalo River are outside of the LSA, but within the RSA. All of the main watercourses in the RSA flow north into Great Slave Lake (Figure 3-14).

Watercourses

Watercourses are presented in order of location from west to east across the RSA and surrounding area: Birch Creek, Twin Creek, Buffalo River, Paulette Creek, and Little Buffalo River (see Figure 3-14). Each of these watercourses flow north, eventually draining into Great Slave Lake.

Boundaries for the Birch Creek watershed were adopted from the National Hydrographic Network (NHN) geospatial data (NRC 2020) and no further delineation was completed. Birch Creek drains several wetlands to the south of the Highway 5 northward into Great Slave Lake. The drainage area of Birch Creek at the mouth of Great Slave Lake is approximately 526 km^2.



LEGEND
- FORMER PINE POINT TOWN SITE
- HYDROMETRIC STATION - ENVIRONMENT CANADA
- POPULATED PLACE
- ALL-SEASON ROAD
- WINTER ROAD
- TERRITORIAL/PROVINCIAL BOUNDARY
- WATERCOURSE
- GENERAL PROJECT LOCATION
- PARK/PROTECTED AREA
- WATERBODY

WATERSHEDS
- BIRCH CREEK
- BUFFALO RIVER
- BUFFALO RIVER AT HIGHWAY 5
- LITTLE BUFFALO RIVER
- LITTLE BUFFALO RIVER AT HWY 6
- PAULETTE CREEK
- PAULETTE CREEK AT HIGHWAY 6
- TWIN CREEK
- TWIN CREEK AT HIGHWAY 5

REFERENCE(S)
1. BASE DATA OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.
2. PARKS AND PROTECTED AREAS OBTAINED FROM CONSERVATION AREAS REPORTING AND TRACKING SYSTEM (CARTS), CANADIAN COUNCIL ON ECOLOGICAL AREAS, 2017.
3. POTENTIAL EFFLUENT DISCHARGE LOCATIONS PROVIDED BY ANDRÉE DROLET, PPML, BY EMAIL ON 27 JUNE 2019.
PROJECTION: UTM ZONE 11 DATUM: NAD 83

CLIENT
PINE POINT MINING LTD.

PROJECT
PINE POINT PROJECT

TITLE
WATERSHEDS AND REGIONAL HYDROMETRIC STATIONS

CONSULTANT
GOLDER

YYYY-MM-DD	2020-12-15
DESIGNED	SB
PREPARED	MM
REVIEWED	JV
APPROVED	JV

PROJECT NO.	PHASE	REV.	FIGURE
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Twin Creek is located approximately 10 km to the east of Birch Creek within the LSA. Twin Creek is a small stream that drains several small lakes and wetlands to the south of the Highway 5 northward into Great Slave Lake. The drainage area for Twin Creek was delineated by a Geographic Information System (GIS) analysis using Green-Kenue software (CHC 2012) based on LiDAR collected in 2018 (LSI 2018) and 2019 (LSI 2019) supplemented with data from the Arctic digital elevation model (Porter et al. 2018). Boundaries with some adjacent watersheds (Birch Creek and Buffalo River watersheds) were also informed by NHN geospatial data (NRC 2020). Twin Creek originates approximately 20 km south of Highway 5 (Figure 3-14), and at Highway 5, drains an area of approximately 121 km^2. The drainage area of Twin Creek at the mouth of Great Slave Lake is approximately 220 km^2. The overall length of Twin Creek is approximately 45 km, with a typical seasonal water flow and higher flows occurring during spring snow melt (EBA 2005a). According to satellite imagery, maps, and onsite field studies, the stream channel is often undefined and flows through sphagnum bogs (EBA 2005a). After turning into a large, open, almost treeless, and swampy area, the stream re-emerges as a defined creek channel before reaching Great Slave Lake (Beak 1980).

Buffalo River is a large river originating from Buffalo Lake located in the southernmost portion of the NWT. It receives drainage from many other small lakes and wetlands upstream (south) and northward towards Great Slave Lake (Figure 3-14). The total drainage area of the Buffalo River at Highway 5 is about 18,100 km^2 and where the Buffalo River empties into Great Slave Lake, the total drainage area is approximately 18,400 km^2. The NHN geospatial data (NRC 2020) were used as the reference for the Buffalo River watershed as it extends far beyond the extent of available digital elevation model data and south of the Alberta – NWT border. Boundaries for the Buffalo River watershed were adopted from NHN geospatial data (NRC 2020) and no further delineation was completed. The overall length of Buffalo River is approximately 155 km. From the Highway 5 bridge to the mouth of the river, it is approximately 100 m wide and moderately incised at the highway bridge, which is approximately 19 km from the confluence with Great Slave Lake (Beak 1980). Water flows strongly and is generally turbid. The river has a mud bottom, with gravel and cobbles present in faster flowing areas (EBA 2005a; Beak 1980). Buffalo River water flows year-round with higher levels of flow occurring during the annual spring melt. The Buffalo River is moderately incised into the surrounding terrain. Based on discharge records from 1969 to 1990, it has a mean annual flow of 49 m^3/s, with a mean maximum daily flow of 187 m^3/s during May or June (WSC 2020).

The drainage area for Paulette Creek was delineated by a GIS analysis using Green-Kenue software (CHC 2012) based on LiDAR collected in 2018 (LSI 2018) and 2019 (LSI 2019) supplemented with data from the Arctic digital elevation model (Porter et al. 2018). Boundaries with some adjacent watersheds (Little Buffalo River watershed) were also informed by NHN geospatial data (NRC 2020). Paulette Creek originates 11 km southwest of Highway 6 that drains an area dominated by swamp and muskeg. Paulette Creek empties into Great Slave Lake approximately 1.6 km downstream of the highway. The Paulette Creek drainage area at Highway 6 is 79 km^2 and 81.4 km^2 where it empties into Great Slave Lake.

The Little Buffalo River is a large river originating in northern Alberta and flowing through the southernmost portion of the NWT. It receives drainage from many other small lakes and wetlands upstream (south) and northward towards Great Slave Lake (Figure 3-14). Boundaries for the Buffalo River watershed were adopted from NHN geospatial data (NRC 2020) and no further delineation was completed. The total drainage area of the Little Buffalo River at Highway 6 is about 12,700 km^2. The Little Buffalo River empties into Great Slave Lake approximately 2 km north of the Highway 6 crossing with negligible gains to drainage area downstream of Highway 6.

Waterbodies

Polar Lake is located approximately 2.9 km to the west of the LSA and about 0.8 km north of Highway 5 (Beak 1980). It is a shallow lake with no major surface feed streams or outlet drainages (Figure 3-14). It is approximately 1.6 km long, 0.6 km wide, and has a surface area of about 0.73 km^2. The lake may receive groundwater sources (Beak 1980). The estimated lake level of Polar Lake at the time of contour mapping conducted for Western Mines in the summer of 1979 was 214.6 metres above sea level (masl) (Beak 1980).

Great Slave Lake is the final receptor of the drainages from Twin Creek and the Buffalo River systems (Figure 3-14). Historical data available on lake levels at the Water Survey of Canada recording station at Hay River (Station 070B002) indicate that the mean lake level is 156.63 masl with normal seasonal variations between 156.34 and 156.96 masl, with the highest levels occurring in mid-summer (WSC 2020).

Great Slave Lake is the second largest lake in the NWT (after Great Bear Lake), the deepest lake in North America (616 m), and the sixth largest lake in the world. It is 456 km long, 19 to 109 km wide, and covers an area of 28,400 km^2 with an approximate lake volume of 2,090 km^3.

The southern shoreline area of Great Slave Lake between the mouths of Twin Creek and the Buffalo River is relatively regular in shape and has little terrestrial vegetation. The beach and nearshore area along the shoreline generally consist of fine sand and silt. Localized patches of emergent vegetation occur along the shoreline to about 10 m offshore in the lake. The nearshore lake water is often murky due to the regular suspension of shallow sediments (EBA 2007).

Regional Hydrometric Monitoring

Limited long-term hydrometric monitoring is available for the region, as none of the regional stations are currently active. Calculation of water yields was possible for three stations: the Buffalo River at Highway 5 (WSC Station 07PA001), the Buffalo River near the provincial – territorial border, and the Little Buffalo River below Highway 5. The Buffalo River at Highway 5 was selected as being representative of regional conditions due to the proximity to the Project as well as the length and completeness of the record. Comparing annual basin yields in Table 3-9 should be done with caution as not all the monitored years had complete data records and not all the periods of record overlap. Generally, the average annual water yield in the Little Buffalo River watershed is less than the Buffalo River watershed.

Table 3-9: Regional Water Survey of Canada Hydrometric Stations (WSC 2020)

Station Number	Station Name	Distance to Project and Direction	Watershed Area (km^2)[(a)]	Period of Record	Published Record Length[(b)] (years)	Record Length Suitable for Regional Analysis[(c)] (years)	Average Annual Basin Yield (mm)
07PA001	Buffalo River at Highway 5	28 km SW	18,100	1969 to 1990	22	22	84
07PB002	Little Buffalo River Below Highway 5	130 km SE	3,330	1966 to 1994	30	28	29
07PC001	Buffalo River Near Alberta/NWT Border	91 km S	4,350	1987 to 1994	8	6	172

(a) The watershed area published by WSC is 18,500 km^2. However, geospatial analysis for the Project based on the NHN geospatial data determined that the watershed area reporting to the Buffalo River at Highway 5 was 18,100 km^2.

(b) Full calendar years only.

(c) In some years, gaps were filled using a recession constant, or by linearly interpolating during short periods or during winter and were suitable for analysis. In some years, gaps were large or occurred during the open-water season and gaps were not able to be accurately filled.

High Level Water Balance

A high-level water balance, typical of conditions in the region has been estimated for the Buffalo River watershed draining to Highway 5 and is summarized in Table 3-10. The Buffalo River watershed at Highway 5 consists of 7% water surface and 93% land surface. There is annual net precipitation in excess of 84 mm water equivalent, which leaves the watershed as surface runoff. The primary inflow and source of runoff is snowmelt released in early spring.

The total evaporative losses from land and lake surfaces (lake evaporation and land evapotranspiration) in the watershed upstream of Highway 5 is 244 mm or approximately 230% of pre-snowmelt precipitation. When combined with the sublimation of snow, the total loss to the atmosphere is 269 mm or roughly 80% of total annual precipitation.

Table 3-10: Regional Representative Watershed (Buffalo River at Highway 5), Mean Annual Water Balance for Natural Conditions

Component	Magnitude (mm)	Comment
Total precipitation	336	1981 to 2010 Climate Normal Value for Hay River A
Rainfall	205	Estimated mean annual value for 1981 to 2010[a]
Snowfall as SWE	131	Estimated mean annual value for 1981 to 2010[a]
Sublimation Losses	25	Estimated mean annual value for 1981 to 2010[b]
Spring SWE	106	mean annual value accounting for losses due to sublimation
Net precipitation input	311	rainfall + spring SWE
Surface runoff	84	estimated mean annual value from Buffalo River at Highway 5 (Station 07PA001) (WSC 2020)
Lake evaporation at 330 mm	23	7% of Buffalo River watershed is lake surface[c]
Evapotranspiration at 237 mm	220	93% of Buffalo River watershed is land surface[d]
Net watershed output	328	surface runoff + lake evaporation + evapotranspiration

(a) Precipitation phase was partitioned based on air temperature using the Pipes and Quick (1977) method.

(b) Sublimation loss is calculated using the methods detailed by Kuchment and Gelfan (1996) based on meteorological inputs from ERAI (ECWMF 2020) for the period 1981 to 2010.

(c) Total evaporation loss from lake surfaces = (330 mm) x (0.07) = 23 mm. Evaporation is calculated using the methods documented by Priestley and Taylor (1972) based on meteorological inputs from ERAI (ECWMF 2020) for the period 1981 to 2010.

(d) Total evapotranspiration loss from land surfaces = (237 mm) x (0.93) = 220 mm. Evapotranspiration is calculated using the methods detailed by Granger and Gray (1989) based on meteorological inputs from ERAI (ECWMF 2020) for the period 1981 to 2010.

SWE = snow water equivalent.

3.3.5 Surface Water Quality

This section provides an overview of the general surface water quality and cultural uses of major watercourses and waterbodies located within and surrounding the aquatics RSA (Section 3.1.3). A review of the topography, vegetation, and hydrography as it relates to surface water drainage was detailed in Section 3.3.4, along with the physical characteristics of major watercourses and waterbodies located within the RSA. A review of the aquatic life present in select watercourses and waterbodies within the RSA is provided in Section 3.3.6.

Additional details on water quality studies completed to date within the region of the Project are presented in Appendix B, Table B1, and a summary of available water quality data is presented in Appendix B, Table B2 (watercourses) and Table B3 (waterbodies). All data are presumed to represent surface water quality, which has been collected during the open-water season (May to October).

Watercourses

Watercourses are presented in order of their location from west to east across the RSA and surrounding area: Birch Creek, Twin Creek, Buffalo River and Paulette Creek (Figure 3-14). Each of these watercourses flow north during the open-water season, eventually draining into Great Slave Lake. Based on a review of field data collected to date and historical long-term hydrometric monitoring data available for the region, it has been assumed that these watercourses partially or completely freeze periodically during winter.

Birch Creek is located 5 km to the west of the Project and was chosen as a reference station for a previous aquatic resources baseline study (Rescan 2012g). This creek was found to be slightly alkaline (pH >8) with very hard water (hardness >180 mg/L; hardness classification according to McNeely et al. 1979), particularly in August and September. The water is characterized as clear with low turbidity conditions and low total suspended solids (TSS) measurements. Birch Creek can be described as an oligotrophic watercourse (i.e., total phosphorus concentrations were less than 0.0010 mg/L; CCME 2004). Major ions and metal concentrations measured in Birch Creek were typically below guidelines, with total fluoride concentrations above the interim Canadian Council of Ministers of the Environment (CCME) guideline (0.12 mg/L; CCME 1999). Fluoride concentrations in Birch Creek were consistent with those measured in other small streams within the vicinity (Rescan 2012g).

Twin Creek is located approximately 10 km to the east of Birch Creek within the LSA. The water quality of Twin Creek has been assessed in several studies, including a historical study conducted in the late 1970s (Beak 1980; EBA 2005a; Rescan 2012f,g; Golder 2020). In general, Twin Creek was slightly alkaline with very hard water, particularly in September. Low turbidity and TSS concentrations were measured in Twin Creek, with low major ion and metal concentrations that were typically below CCME guidelines. Twin Creek is also an oligotrophic watercourse and as noted for Birch Creek, total fluoride concentrations were above the interim CCME guidelines; all other major ions and metal concentrations were below CCME guidelines. In general, the water quality in Twin Creek was consistent with the reported water quality in Birch Creek (EBA 2005a; Tamerlane 2007; Golder 2020).

Buffalo River, located approximately 18 km to the east of Twin Creek along Highway 5, is the largest watercourse that flows through the LSA. The water quality of Buffalo River has been assessed in several studies (Beak 1980; EBA 2005a; Rescan 2012g; Golder 2020). Overall, the Buffalo River was slightly alkaline with water hardness that is slightly lower than in Birch and Twin creeks (i.e., 121 to 180 mg/L). High turbidity and TSS concentrations were characteristic of the Buffalo River, particularly during September and October, with corresponding high metals concentrations measured during all sampling events. As a result, total aluminum, cadmium, chromium, copper, and iron concentrations were consistently above CCME guidelines (EBA 2005a; Rescan 2012g; Tamerlane 2007; Golder 2020). Aluminum is typically associated with the limestones, dolomites, sandstones, and shales that occur in the LSA, while elevated iron concentrations are commonly linked to the mafic minerals that occur across the region (EBA 2005a). The concentrations of all major ions and other metals were below CCME guidelines. Buffalo River can be characterized as eutrophic based on elevated total phosphorus concentrations (0.028 to 0.13 mg/L; CCME 2004); however, these levels are attributed to the elevated TSS in the river.

Paulette Creek is located southeast of Highway 6. Two studies investigating the water quality of Paulette Creek has been completed to date (Rescan 2012f; Golder 2020). Five stations along the creek were sampled in 2012, and one station was sampled in 2019. Paulette Creek was slightly alkaline with very hard water. Turbidity and TSS concentrations in Paulette Creek were low, and consistent with concentrations in Twin and Birch creeks. Metal concentrations were generally low and below CCME guidelines, with total cadmium and fluoride measured above CCME guidelines.

Waterbodies

There are numerous shallow lakes and ponds distributed throughout the LSA and RSA that comprise the wetland environment located along the southern shore of Great Slave Lake. Polar Lake is located approximately 2.9 km to the west of the LSA and about 0.8 km north of Highway 5. Water sampling conducted to date on Polar Lake was completed on 11 September 1979 (Beak 1980). This study classified Polar Lake as an ultra-oligotrophic waterbody. The water had a slightly basic pH with very hard water conditions, and low metal concentrations. Turbidity and TSS were not measured during this study.

Great Slave Lake is the receiving environment for all major watercourses within the region. The water quality of Great Slave Lake in the area adjacent to the Project has been assessed in several recent studies (EBA 2005a; Rescan 2012g; Golder 2020), which were limited to fall conditions (August to October). Samples from these studies indicated that waters were slightly alkaline, very soft to moderately soft, and eutrophic. High turbidity values and TSS concentrations were measured, with high variability between stations. As a consequence of the high TSS concentrations, metals concentrations were elevated with total aluminum concentrations above the CCME guideline at all stations, and total cadmium, chromium, copper, and iron were above CCME guidelines at some stations. The fluoride concentration was measured above the interim CCME guideline at one station only. Inflows from the highly turbid Buffalo River appear to contribute to the high turbidity and metal concentrations measured in Great Slave Lake (Rescan 2012g; Golder 2020).

Cultural Uses of Watercourses and Waterbodies

Many communities are located near to the Project, including Hay River, approximately 75 km to the west of the Project and Fort Resolution, approximately 53 km to the northeast of the Project, on Resolution Bay of Great Slave Lake. Information has been gathered on the cultural uses of major watercourses and waterbodies in the region, yet little is known about the cultural uses of smaller watercourses (e.g., creeks) located within the LSA. Great Slave Lake is known to be important traditional and commercial fishing area (Evans et al. 1998; Richardson et al. 2001; Rescan 2012g).

Pit Data Summary

Water quality was sampled in flooded pits in the LSA during field programs conducted in 2005, 2017, and 2018; a total of 14 mine pits, one tailings pond, and one natural waterbody were sampled in the sampling programs (EBA 2005a; PPML unpublished data; Maskwa 2018).

Physico-chemical sampling profiles were only conducted at five pits in 2018. pH ranged from 8.0 to 8.3, indicating all pits sampled were alkaline and within the CCME water quality guideline for the protection of aquatic life (CCME 1999). Dissolved oxygen measurements were above the lower bound CCME water quality guideline of 6.5 mg/L (CCME 1999). Specific conductivity ranged from 613 to 2,326 microsiemens per centimetre. Distinct thermoclines were noted at approximately 3 m depth in all pits sampled in 2018.

Based on water quality data from all sampled locations, the waters were clear, with low total suspended solids concentrations and turbidity. Total dissolved solids concentrations were between 468 and 2,570 mg/L. Major ions were dominated by sulphate, calcium, and bicarbonate. Fluoride ranged from 0.32 to 1.2 mg/L and exceeded the interim chronic guideline of 0.12 mg/L (CCME 1999) in all pits/years sampled. Hardness ranged from 315 to 1,810 mg/L, which characterized water from all pits as very hard (McNeely et al. 1979). Concentrations of total and dissolved metals were generally below water quality guidelines for the protection of freshwater aquatic life (CCME 1999). Water quality guideline exceedances for protection of aquatic life were measured for total aluminium, cadmium, copper, iron, lead, thallium, uranium, and dissolved zinc concentrations at one or more pits.

In general, metals that occasionally exceeded guidelines consistently between the pit and surface water stations in recent and historic data included total aluminum, cadmium, copper, iron, and dissolved zinc (Beak 1980; Evans et al. 1998; EBA 2005a, Rescan 2012f,g; Golder 2020), whereas guideline exceedances specific to the pit stations included total lead, thallium, and uranium concentrations (EBA 2005a; Rescan 2012g; Golder 2020).

3.3.6 Fish and Fish Habitat

The Slave River, Little Buffalo River, Paulette Creek, Buffalo River, Twin Creek, Birch Creek, Sandy River, and Hay River flow into the southern portion of Great Slave Lake. Twin Creek, the Buffalo River, and Paulette Creek are the primary watercourses near the predicted zone of influence of the Project, which could affect fish and fish habitat (Figure 3-14; Section 3.1.3). A large number of small, shallow lakes with no visible drainages are also present within the LSA (Beak 1980). Water is currently present throughout the historical decommissioned Pine Point mine area through a series of flooded and connected channels and pits.

Previous studies have been undertaken in the LSA, since the early 1970s (Tamerlane 2007). Many of these studies investigated concerns raised by the community of Fort Resolution related to the operation and decommissioning of the historical Pine Point mine. Concerns were centred around the possibility of contamination of the water, sediment, and fish in the Resolute Bay area by the historical mine (Evans et al. 1998).

3.3.6.1 Fish Habitat

Great Slave Lake

Great Slave Lake is the receiving environment for all primary watercourses in the region. Great Slave Lake is downstream from the historical Pine Point mine site and is the final receiving waterbody for the Buffalo River and Twin Creek drainages. Great Slave Lake is the second largest lake in the NWT, covering an area of 28,400 km^2, and deepest in North America at 616 m. It has an approximate volume of 2,090 km^3 (Tamerlane 2007). The nearshore area of Great Slave Lake between Twin Creek and Buffalo River consists of fine silt and sand, with patches of emergent vegetation. The nearshore water is turbid due to regular wave action and resulting suspension of sediments (Tamerlane 2007).

Twin Creek

Twin Creek is a poorly defined, low gradient (i.e., 0.1%) small stream that drains several small lakes and wetlands to the south of the RSA northward into Great Slave Lake (EBA 2005a; Rescan 2012e). It has typical seasonal water flow, with higher flows occurring during spring snow melt (Beak 1980; EBA 2005a). According to satellite imagery, maps, and onsite field studies, the stream channel is often undefined and travels through sphagnum bogs (EBA 2005a). After turning into a large, open, almost treeless, and swampy area, the stream re-emerges as a defined creek channel before reaching Great Slave Lake (Beak 1980).

Fish habitat assessments were completed in 2005 at nine locations in Twin Creek (EBA 2005a) and at five locations in 2011 (Rescan 2012e). The upstream reaches of Twin Creek flowed through a bog/wetland or underground channels and no visible channel was observed. The lower reaches of Twin Creek were low gradient (0.1%) (Rescan 2012e). Twin Creek had bankfull widths that ranged from 3 to 50 m, with the widest and slowest-flowing sections meandering through wetlands (EBA 2005a). Fish habitat in Twin Creek consisted predominantly of pools with water depths of 0.5 to 1 m, with some runs and riffles. Bed substrates consisted mostly of fines with some cobble (EBA 2005a; Rescan 2012e) and gravel with cover for fish provided by instream and overhead vegetation (EBA 2005a; Rescan 2012e). Potential barriers to fish movement (e.g., debris piles) were observed at several reaches in Twin Creek. Suitable habitat in Twin Creek was observed for Brook Stickleback (*Culaea inconstans*), Northern Pike (*Esox lucius*), White Sucker (*Catostomus commersonii*), and Longnose Sucker (*Catostomus catostomus*).

Buffalo River

The Buffalo River is a large river that originates from Buffalo Lake and receives drainage from many other small lakes and wetlands upstream (south) and as it flows northward towards Great Slave Lake. Water flows are strong and generally turbid. The river has a mud bottom, with gravel and cobbles present in faster flowing areas (EBA 2005a; Beak 1980). The Buffalo River flows year-round with higher levels of flow occurring during the annual spring melt.

Fish habitat assessments were completed in 2005 at six sites in the Buffalo River (EBA 2005a). The Buffalo River had bankfull widths that ranged from 50 to 204 m. Fish habitat in the Buffalo River was predominantly run habitat with some riffles and rapids. Bed substrates consisted mostly of gravel, with some fines and cobble. There was minimal cover for fish (less than 5% at most sites), but when cover was present, it consisted of boulders, depth, or large organic debris. No instream overhead vegetation was observed. Suitable habitat in the Buffalo River was observed for Inconnu (*Stenodus leucichthys*), Walleye (*Sander vitreus*), Northern Pike, Burbot (*Lota lota*), and Whitefish species (EBA 2005a; Tamerlane 2007).

Other Watercourses and Waterbodies

In addition to Twin Creek and the Buffalo River, fish habitat assessments were also completed in 2011 at eight additional unnamed watercourses in the LSA (Rescan 2012e). These small watercourses typically had low gradients (less than 1%) with wetted widths between 0.2 and 4.9 m. Bankfull depths were typically less than 0.5 m (range was 0.25 to 5.6 m) (Rescan 2012e). Cover for fish was sparse (less than 30%) and provided primarily by substrate (e.g., boulders) and instream vegetation. Riparian vegetation was less than 3% at nearly all of the watercourse sites sampled. Barriers to fish movement were observed at four watercourses and included boulder gardens, beaver dams, and underground flow (Rescan 2012e).

A total of 44 waterbodies (e.g., ponds, wetlands, and quarries) were assessed in 2011 (Rescan 2012e). Waterbodies typically had organic substrates and were located in marsh/bog terrain. Many of the waterbodies assessed for fish habitat were ephemeral and were dry at the time of sampling (i.e., July) (Rescan 2012e).

Fish and fish habitat assessments at Paulette Creek were completed on 18 May 2017 (Golder 2018b) and 18 May 2018 (Golder 2019c). Paulette Creek had wetted widths ranging from 8.4 to 70 m. Habitat was composed of flats, runs, and riffles with bed substrates of cobble, gravel, boulder, and fines. Suitable spawning habitat (i.e., riffle) and egg incubation sites (i.e., gravel, cobble, and boulder mix) were identified for White Sucker and Longnose Sucker.

A fish site reconnaissance survey was completed on 2 October 2019 (Golder 2019b). A number of old mining pits were characterized at the historical Pine Point mine off available access roads. Most of the pits were full of water at the time of the visit with riparian vegetation extending to the shoreline of a pit lake/pond. The diversion ditches and constructed channels around the pits and through the mine area were also typically full of water. The riparian zones of most channels were vegetated, with signs of recent use by beaver, including beaver dams. Depths of the channels were visually estimated to be less than 1.5 m. Channels were also stagnant with very little moving water observed at the time of the reconnaissance survey. Forage fish (i.e., Brook Stickleback) and potential habitat for forage fish were observed throughout the historical Pine Point mine based on the presence of water throughout the area and the high connectivity of the constructed channels.

Lower Trophic Communities

Benthic invertebrates were sampled in Paulette Creek, Twin Creek, and the Buffalo River in 2011 (Rescan 2012f,g). The benthic invertebrate community in Paulette Creek was dominated by amphipods (e.g., Hyalelidae and Gammaridae) and chironomids (e.g., Diptera) (Rescan 2012f). The benthic invertebrate community in Twin Creek was dominated by aquatic insects and chironomids (Rescan 2012g). The Buffalo River had higher total abundances of benthic invertebrates than Twin Creek and consisted of chironomids, true bugs (i.e., Hemiptera), gastropods, bivalve molluscs, and oligochaete worms (Rescan 2012g). Freshwater mussel shells were also observed at the Buffalo River during fish baseline studies in 2005 (EBA 2005a).

3.3.6.2 Fish Community

A total of 34 species of fish have been documented in Great Slave Lake (Scott and Crossman 1973; Rawson, 1951 [in Beak 1980]; Richardson et al. 2001; Reist et al. 2016), some of which have been documented in watercourses in the LSA (Table 3-11). However, few fish-bearing waterbodies are present in the vicinity of the Project. Paulette Creek, Twin Creek, Buffalo River, and Great Slave Lake are the only confirmed fish-bearing waterbodies (Beak 1980; MVEIRB 2008; Golder 2018b). There is potential for a documented fish species from Great Slave Lake to also potentially occupy Twin Creek, Buffalo River, and Paulette Creek. The potential for fish presence in the watercourses (Table 3-11) considered the historical capture of a fish from previous studies (e.g., Beak 1980; EBA 2005a; Rescan 2012e), as well as the presence of preferred habitat for feeding, rearing, overwintering, or spawning (Scott and Crossman 1998). If the preferred habitat was present in the watercourse, the fish species was considered to potentially be present.

White Sucker, Longnose Sucker, Northern Pike, and Brook Stickleback are known or likely to occur in Twin Creek (EBA 2005a; Tamerlane 2007). ITK interviews indicated that although Twin Creek is not used as a traditional harvesting area, Walleye, Sucker species (Catostomidae), and Stickleback species (Gasterostidae) were present. Lake Trout and Northern Pike were identified to potentially be present (Tamerlane 2007). Fish sampling was completed in 2011 at three watercourses (Twin Creek and two unnamed creeks) and 23 waterbodies (i.e., lakes, ponds, wetlands). Brook Stickleback were captured at one location in Twin Creek and one shallow pond located within the historical Pine Point mine footprint (Rescan 2012e).

In the Buffalo River, Burbot, Inconnu, Lake Whitefish, Northern Pike, Goldeye, and Walleye have been recorded (Beak 1980; Evans et al. 1998; Stewart 1999; Tamerlane 2007). The mouth of the Buffalo River has also been known as a key area for fishing of Inconnu, Lake Whitefish, and Lake Trout by residents of Fort Resolution during the open water season (Beak 1980; Stewart 1999).

Field investigations in Paulette Creek were completed in 2017 and 2018 and Longnose Sucker, White Sucker, Northern Pike, and Walleye were observed or captured (Golder 2018b, 2019c). Potential for Brook Stickleback in other waterbodies on the historical Pine Point mine site was also observed during a site reconnaissance visit in October 2019 due to the connectivity of the constructed channels in the mine area (Golder 2019b).

Polar Lake was historically stocked in the 1970s with Brook Trout (*Salvelinus fontinalis*) and Rainbow Trout (*Oncorhynchus mykiss*). As recent as 2007, Polar Lake was stocked with Arctic Char (*Salvelinus alpinus*) but is not used for traditional harvesting (Tamerlane 2007).

Table 3-11: Fish Species Documented in Great Slave Lake with Potential to be Present in Twin Creek, Buffalo River, and Paulette Creek

Fish Documented in Great Slave Lake[(a)]			Potentially Present in Twin Creek	Potentially Present in Buffalo River	Potentially Present in Paulette Creek	Potentially Present in LSA[(c)]
Family	Common Name	Scientific Name				
Catostomidae	Longnose Sucker	*Catostomus catostomus*	Yes*	Yes	Yes*	Yes
	White Sucker	*Catostomus commersonii*	Yes*	Yes	Yes*	Yes
Cottidae [(b)]	Deepwater Sculpin	*Myoxocephalus thompsonii*	No	No	No	No
	Slimy Sculpin	*Cottus cognatus*	Yes	Yes	Yes	Yes
	Spoonhead Sculpin	*Cottus ricei*	No	Yes	Yes	Yes
Cyprinidae	Emerald Shiner	*Notropis atherinoides*	No	Yes	Yes	Yes
	Fathead Minnow	*Pimephales promelas*	Yes	Yes	Yes	Yes
	Finescale Dace	*Chrosomus neogaeus*	Yes	No	No	Yes
	Flathead Chub	*Platygobio gracilis*	No	Yes	Yes	Yes
	Lake Chub	*Couesius plumbeus*	No	No	No	No
	Longnose Dace	*Rhinichthys cataractae*	No	Yes	Yes	Yes
	Peamouth	*Mylochelius caurinus*	Yes	Yes	Yes	Yes
	Northern Pearl Dace	*Margariscus nachtrebi*	Yes	Yes	Yes	Yes
	Spottail Shiner	*Notropis hudsonius*	No	No	Yes	No
Esocidae	Northern Pike	*Esox lucius*	Yes	Yes*	Yes	Yes
Gadidae	Burbot	*Lota lota*	Yes	Yes*	Yes	Yes
Gasterosteidae	Brook Stickleback	*Culaea inconstans*	Yes*	Yes	Yes	Yes
	Ninespine Stickelback	*Pungitius pungitius*	Yes*	Yes	Yes	Yes
Hiodontidae	Goldeye	*Hiodon tergisus*	No	Yes*	No	Yes
Percidae	Walleye	*Sander vitreus*	Yes*	Yes*	Yes	Yes
	Yellow Perch	*Perca flavescens*	No	Yes	Yes	Yes
Percopsidae	Trout-perch	*Percopsis omiscomaycus*	No	No	No	No
Petromyzontidae	Arctic Lamprey	*Lethenteron camtschaticum*	No	No	No	No

Table 3-11: Fish Species Documented in Great Slave Lake with Potential to be Present in Twin Creek, Buffalo River, and Paulette Creek

Fish Documented in Great Slave Lake[(a)]			Potentially Present in Twin Creek	Potentially Present in Buffalo River	Potentially Present in Paulette Creek	Potentially Present in LSA[(c)]
Family	Common Name	Scientific Name				
Salmonidae	Arctic Grayling	*Thymallus arcticus*	No	No	No	No
	Chum Salmon	*Oncorhynchus keta*	No	No	No	No
	Cisco	*Coregonus artedi*	No	No	No	No
	Inconnu	*Stenodus leucichthys*	No	Yes*	No	Yes
	Lake Trout	*Salvelinus namaycush*	No[(d)]	No	No	No
	Lake Whitefish	*Coregonus clupeaformis*	No	Yes*	Yes	Yes
	Least Cisco	*Corgeonus sardinella*	No	No	No	No
	Rainbow Trout	*Oncorhynchus mykiss*	No	No	No	No
	Round Whitefish	*Prosopium cylindraceum*	No	No	No	No
	Sockeye Salmon	*Oncorhynchus nerka*	No	No	No	No
	Shortjaw Cisco	*Coregonus zenithicus*	No	No	No	No

Note:

Fish potential in the watercourses was based either on the historical capture of a fish from a previous study (e.g., Beak 1980; EBA 2005a; Rescan 2012e) or the presence of preferred habitat for feeding, rearing, overwintering, or spawning (Scott and Crossman 1998).

(a) Reist et al. (2016), Richardson et al. (2001), Scott and Crossman (1998), Golder (2019a), Rescan (2012a), Rawson 1951 (in Beak [1980], Evans et al. (1998) and Stewart (1999).

(b) Arctic Sculpin (*Myoxocephalus scorpioides*) and Shorthorn Sculpin (*Myoxocephalus scorpius*) reported in the catch in Zhu et al. (2017)

(c) LSA includes Twin Creek, Buffalo River, and Paulette Creek.

(d) Although ITK interviews stated the potential presence of Lake Trout, previous habitat assessments suggest a lack of suitable habitat for Lake Trout (i.e., cold lakes and occasionally large watercourses with bankfull widths greater than 5 m) in Twin Creek.

* = presence confirmed from historical capture or ITK interviews

3.3.6.3 Species of Concern

Inconnu (Upper Mackenzie River and Great Slave Lake populations) have been classified as Sensitive by the NWT Species at Risk Infobase (GNWT 2020b). However, Inconnu have not been classified federally by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) and are not listed on Schedule 1 of the *Species at Risk Act* (SARA) (Government of Canada 2019a).

Shortjaw Cisco (*Coregonus zenithicus*) have been documented in Great Slave Lake and are classified as Threatened by COSEWIC but are not listed on Schedule 1 of SARA (Government of Canada 2019a). Shortjaw Cisco are found in deep (greater than 50 m), cool lakes (Scott and Crossman 1998; Richardson et al. 2001) and are unlikely to be found in the LSA due to lack of suitable habitat.

3.3.7 Terrain and Soils

The Project is within the northern part of the Interior Plains, a low relief area between the Canadian Shield and the western Cordillera (Vincent and Klassen 1989). The plains are underlain by flat-lying sedimentary bedrock (carbonates, shales, and sandstones), which is poorly consolidated (Vincent and Klassen 1989). The sedimentary rocks in the RSA (Section 3.1.4) were deposited in a marine environment during the middle Devonian period (393 to 382 Ma) (Rhodes et al. 1984). The topography is generally subdued with a gentle slope extending down in a northeast direction toward the southern shore of Great Slave Lake. Elevations range from approximately 262 m in the southwest part of the RSA to 156 m in the northeast (LSI 2018, 2019).

The Project is located in a generally level area (between 0% and 2% slope) with the exception of higher slope gradients associated with glaciolacustrine beach ridges (5% to 9%), eolian sand dunes (15% to 30%), and the steeper erosional banks of fluvial systems (LSI 2019). Previous surficial geology mapping by the Geological Survey of Canada (GSC 2016) at a scale of 1:250,000 suggests the RSA is dominated by glaciolacustrine sediments and till; however, previous baseline surveys at a scale of 1:100,000 and 1:25,000 by Rescan (2012a,b) indicate organic deposits are also dominant in this area. The main topographic features are the glaciolacustrine (beach) ridges composed of sand and gravel. These overlie gently nearly level to undulating uplands of varying soil texture (usually fine-textured glaciolacustrine and till sediments). The low-lying areas between the uplands are in-filled with poorly to very poorly drained mineral and organic materials. Lesser extents of eolian sediments, lacustrine deposits adjacent to Great Slave Lake, and fluvial sediments associated with Buffalo River are also present within the RSA (GSC 2016).

The Project is located in an area of sporadic discontinuous permafrost (NRC 1995) where between 10% and 50% of the land is underlain by permafrost and the ground ice content in the upper 10 to 20 m of the ground is less than 10% by volume of visible ice. Ice wedges are sparse (NRC 1995). Permafrost has not been intersected by any recent core drilling in the area; however, it was detected at one location during a soil/vegetation reconnaissance survey in 2019.

The LSA and RSA consists of existing undisturbed upland and wetland, and natural (e.g., burns) and human-related disturbed land cover types (i.e., forest ecosites). Much of the existing disturbance in the LSA is related to the historical Pine Point mine (i.e., brownfield site) and includes spoil piles, pits, and roads. Soil surveys have been limited to natural forest ecosites. Previous studies indicate that soils in the RSA are primarily Eluviated Eutric Brunisols in upland areas, and Gleysols and Terric Organics in lowland areas (EBA 2005b). Other work suggest that Eutric Brunisols are commonly found on glaciolacustrine beach ridges and eolian dune features, while Orthic Gray Luvisols have developed in finer-textured till and glaciolacustrine materials on moderately well to well drained, gently undulating topography (Rescan 2012a,b; Golder 2019a). However, due to the low degree of topography, much of the soils are imperfectly to very poorly drained forming Gleysols and Organic soils (Rescan 2012a,b; Golder 2019a). Soil textures are commonly fine-textured (heavy clay/clay) or coarse textured (sand/gravel) with little variation. Much of the coarser textured (sandier) soil has a high coarse fragment content and has likely been deposited as glaciolacustrine beach deposits or washed till processes. Both coarse and fine-textured parent materials were developed from calcareous bedrock, and therefore, the sediments are high in carbonates and have relatively high pH values.

3.3.8 Vegetation

Vegetation ecosystems or communities provide habitat for aquatic and terrestrial species and associated resources or ecological services for traditional and non-traditional land users, such as hunting, trapping, plants and berry gathering, outfitting and tourism. Field surveys of plants and vegetation communities have been completed in the LSA and RSA (Section 3.1.4) since 2005.

3.3.8.1 Ecoregions and Protected Areas

At the scale of the NWT, the Project and RSA for vegetation ecosystems are within the Level II Taiga Plains Ecoregion. At a smaller scale, the RSA is within the Level III Taiga Plains Mid-Boreal Ecoregion, which includes the Great Slave Lowland Mid-Boreal and Slave Upland Mid-Boreal Level IV Ecoregions (ECG 2009).

The Level III Taiga Plains Mid-Boreal Ecoregion is characterized by warm, moist summers, and cold and snowy winters. Vegetation cover consists predominantly of closed canopy mixedwood forests, with trembling aspen (*Populus tremuloides*), white spruce (*Picea glauca*), and occasional birch (*Betula papyrifera*) and jack pine (*Pinus banksiana*) stands in drier sites (ECG 2009). Permafrost in the Taiga Plains Mid-Boreal Ecoregion is largely discontinuous; peatlands, palsas, northern ribbed fens, and horizontal fens are the most common types of peatlands (ECG 2009).

Level IV Great Slave Lowland Mid-Boreal Ecoregion

Treed, shrubby, and sedge dominated fens are characteristic vegetation of low-lying areas in the Great Slave Lowland Mid-Boreal Ecoregion (ECG 2009). Jack pine and mixed jack pine-trembling aspen stands occur in well drained areas with coarse soils, whereas upland areas with finer textured soils support trembling aspen and mixedwood stands (ECG 2009). Open black spruce (*Picea mariana*) and common Labrador tea (*Rhododendron groenlandicum*) - lichen stands form complexes with sedge (*Carex* spp.) - cotton grass (*Eriophorum* spp.) collapse scars on peat plateaus (ECG 2009).

Level IV Slave Upland MB Ecoregion

Young post-fire jack pine-trembling aspen forests form dense stands with minimal understory species in dry uplands, with remnant white spruce stands occurring in the western portion of this ecoregion (ECG 2009). Transitional areas support mixed black spruce and white spruce stands, often containing tamarack (*Larix laricina*) (ECG 2009). Dominant wetland types included willow (*Salix* spp.) and dwarf-birch (*Betula glandulosa*), and sedge dominated horizontal fens on the wettest mineral soils. Peat plateaus with stunted black spruce are also present on raised permafrost areas and collapse scars (ECG 2009).

Protected Areas

No federally or territorially protected areas exist within the RSA. The closest protected area is Wood Buffalo National Park, located approximately 18 km to the south of the RSA.

3.3.8.2 Ecosite Phases

A stand-level or ground-based ecological classification system is not available for ecosystems in the NWT. Therefore, ecological communities were classified to ecosite phase according to the ecosites of Northern Alberta classification system (Beckingham and Archibald 1996), Canadian Shield ecological area. Ecological attributes from the NWT Forest Inventory Data (GNWT 2012) were used to classify forest inventory polygons to Canadian Shield ecosite phases in the LSA and RSA. Fifteen specific ecosite phases, including terrestrial and wetland types, and ten general ecosite types were identified through a combination of existing data and field sampling points (Table 3-12).

Table 3-12: Ecosite Phases identified within the Local and Regional Study Areas

Ecosite Phase/Type	Description
UPLAND	
a1	bearberry jack pine
b1	Canada buffalo-berry-green alder jack pine-aspen-white birch
b2	Canada buffalo-berry-green alder aspen
b3	Canada buffalo-berry-green alder aspen-white spruce-black spruce
c1	Labrador tea-mesic jack pine-black spruce
d1	Labrador tea-subhygric black spruce-jack pine
burned upland	undifferentiated burned upland
WETLAND	
e1	willow/horsetail aspen-white birch-balsam poplar
e2	willow/horsetail aspen-white spruce-black spruce
f1	treed bog
f2	shrubby bog
g1	treed poor fen
g2	shrubby poor fen
h1	treed rich fen
h2	shrubby rich fen
h3	graminoid rich fen
burned wetland	undifferentiated wetland
bryoid moss	mosses, liverworts, and hornworts greater than 50% of the bryoid cover
UNDEFINED[a]	
herb	herb dominated with no distinction between forbs and graminoids
low shrub	shrub dominated with average shrub height less than two metres
tall shrub	shrub with average shrub height greater than or equal to two metres
DISTURBANCE	
non-vegetated	total vegetation cover is less than 5% of the surface area
road	road
disturbance	anthropogenic disturbance
WATER	
Water	*Open Water*

(a) require additional ground truthing information to confirm ecosite phase/type

3.3.8.2.1 Upland Ecosites

Ecosystems were classified to ecosite phase following the Ecosites of Northern Alberta Field Guide (Beckingham and Archibald 1996) for the Canadian Shield ecological area. Seven upland ecosite phases were identified based on 2019 field observations (Golder 2019a) and previous studies (EBA 2005b; Rescan 2012a,b).

a1 – bearberry jack pine

The bearberry jack pine (a1) ecosite phase is characterized by submesic to xeric moisture regime and a poor to very poor nutrient regime. This ecosite is typically located in upper slope to mid-slope landscape positions, with rapidly drained, coarse textured acidic soils (Beckingham and Archibald 1996). A relatively open canopy of jack pine dominates the tree layer often with a characteristic white birch component. The shrub layer is dominated by bearberry (*Arctostaphylos uva-ursi*), common blueberry (*Vaccinium myrtilloides*), bog cranberry (*Vaccinium vitis-idaea*), green alder (*Alnus viridis*), and juniper (*Juniperus* spp.). The forb layer is poorly developed; however, bunchberry (*Cornus canadensis*), bastard toad-flax (*Geocaulon lividum*), and wild lily-of-the-valley (*Maianthemum canadense*) are characteristic of this ecosite phase. Graminoid cover and bryophyte cover are poorly developed with Schreber's moss (*Pleurozium schreberei*) and awned hair cap moss (*Polytrichium piliferum)* representing the most common moss. Lichen cover is high and dominated by reindeer lichen (*Cladonia* spp.) (Beckingham and Archibald 1996). Graminoid cover is typically low.

b1 – Canada buffalo-berry-green alder jack pine-aspen-white birch

The Canada buffalo-berry-green alder jack pine-aspen-white birch (b1) ecosite phase is characterized by a submesic to mesic moisture regime and medium to poor nutrient regime. Typically, this ecosite phase is located in upper to lower slope landscape positions (Beckingham and Archibald 1996). A combination of jack pine, aspen, and white birch make up the tree layer. The shrub layer is dominated by green alder, and to a lesser extent prickly rose (*Rosa acicularis*), low-bush cranberry (*Viburnum edule*), and aspen. Common low shrubs include bearberry, bog cranberry, and blueberry, while bunchberry, bastard toad-flax, wild sarsaparilla (*Aralia nudicaulis*) and twinflower (*Linnaea borealis*) are the characteristic forbs. Schreber's moss and stair-step moss (*Hylocomium splendens*) represent the most common moss. Lichen cover is moderate with reindeer lichen being the most common species (Beckingham and Archibald 1996). Graminoid cover is typically low.

b2 – Canada buffalo-berry-green alder-aspen

The Canada buffalo-berry-green alder jack pine-aspen (b2) ecosite phase is characterized by a mesic moisture regime and medium nutrient regime. Typically, this ecosite phase is located in level landscape positions (Beckingham and Archibald 1996). The canopy is dominated by aspen, and occasionally balsam poplar and characteristically includes minor amounts of jack pine and white spruce. The shrub layer is dominated by Canada buffalo-berry (*Shepherdia canadensis*), prickly rose, bog cranberry, and willow (*Salix* spp.), while bunchberry, wild sarsaparilla, fireweed (*Chamerion angustifolium*), and dewberry (*Rubus pubescens*) are characteristic of the forb layer. The graminoid layer includes hairy wild rye (*Leymus innovatus*) and bluejoint reed grass (*Calamagrostis canadensis*) species (Beckingham and Archibald 1996). Lichen and moss cover if present are inconspicuous.

b3 – Canada buffalo-berry-green alder aspen-white spruce-black spruce

The Canada buffalo-berry-green alder aspen-white spruce-black spruce (b3) ecosite phase is characterized by a submesic to mesic moisture regime and medium to poor nutrient regime. Typically, this ecosite phase is located in midslope landscape positions (Beckingham and Archibald 1996). The canopy is dominated by aspen, white spruce and black spruce (*Picea mariana*) and includes minor amounts of jack pine, balsam poplar, and white birch. The shrub layer is dominated by Canada buffalo-berry, Labrador tea (*Rhododendron groenlandicum*), green alder, prickly rose, bog cranberry, and white spruce, while bunchberry, dewberry, and fireweed are characteristic of the forb layer. (Beckingham and Archibald 1996). Graminoid cover is minimal, while feather mosses including stair-step moss, and Schreber's moss cover the forest floor (Beckingham and Archibald 1996).

c1 – Labrador tea-mesic jack pine-black spruce

The Labrador tea-mesic jack pine-black spruce (d1) ecosite phase generally occurs in level landscape positions where subhygric to mesic moisture conditions exist (Beckingham and Archibald 1996). Soils are usually well to moderately well-drained. A poor to medium nutrient regime for this ecosite phase is typical (Beckingham and Archibald 1996). The tree layer is composed of a moderate cover of black spruce and jack pine, with black spruce, bog cranberry, and Labrador tea dominating the shrub layer. The forb layer is poorly developed and composed of bastard toad-flax, while a carpet of feather mosses, including Schreber's moss, stair-step moss, knight's plume (*Ptillium crista-castrensis*), and juniper hair-cap moss (*Polytrichum juniperinum*) covers the forest floor (Beckingham and Archibald 1996). Graminoid cover is typically low.

d1 – Labrador tea-subhygric black spruce-jack pine

The Labrador tea-subhygric black spruce-jack pine (d1) ecosite phase generally occurs in level, lower and upper slope landscape positions where subhygric moisture conditions exist (Beckingham and Archibald 1996). Soils are usually imperfectly drained. A medium to poor nutrient regime for this ecosite phase is typical (Beckingham and Archibald 1996). The canopy is usually composed of a moderate cover of black spruce and jack pine, with black spruce, Labrador tea, common blueberry and bog cranberry, twin-flower and willow dominating the shrub layer. The forb layer is predominately composed of dwarf scouring rush (*Equisetum scirpoides*) and bunchberry. Feather mosses, including Schreber's moss and stair-step moss interspersed with reindeer lichen typically cover the forest floor (Beckingham and Archibald 1996). Graminoid cover if present is typically low.

Burned upland

The burned upland ecosite phase occurs in variable landscape positions with moisture regimes ranging from subhygric to xeric, and variable nutrient regimes. This ecosite phase shows evidence of recent wildlife, either natural or prescribed. Vegetation of less than 5% crown cover is present at the time of polygon description and cannot be further refined.

Based on field observations, dominant terrestrial ecosite phases in the surveyed area include Canada buffalo-berry-green alder aspen-white spruce-black spruce (b3), bearberry jack pine (a1), and Canada buffalo-berry-green alder jack pine-aspen-white birch (b1). Summary descriptions of the dominant upland ecosites observed are presented in Table 3-13.

Table 3-13: Summary Descriptions of Dominant Upland Ecosite Phases Observed

Ecosite Phase	Slope Position	Moisture Regime	Nutrient Regime	Forest Characteristics	Characteristic Tree Species	Characteristic Understorey Species
a1 – bearberry jack pine	Level, midslope, upper slope, lower slope and crest	xeric to submesic	poor to very poor	dominated by jack pine with lichen covering much of forest floor	jack pine	bearberry, blueberry, bog cranberry, and reindeer lichen
b1 – Canada buffalo-berry-green alder jack pine-aspen-white birch	Upper slope, lower slope and midslope	submesic to mesic	medium to poor	dominated by jack pine and aspen	jack pine and aspen	green alder, bog cranberry, blueberry, bearberry, Schreber's moss, stair-step moss, reindeer lichen
b3 – Canada buffalo-berry-green alder aspen-white spruce-black spruce	Midslope, level, lower slope and upper slope	mesic	medium to poor	dominated by aspen, white spruce and black spruce	aspen, white spruce, black spruce	Canada buffalo-berry, Labrador tea, green alder, bunchberry, stair-step moss, Schreber's moss

3.3.8.2.2 Wetland Ecosites

Wetlands are ecosystems that are saturated with water long enough to promote formation of water-altered soils, growth of water-tolerant vegetation, and various kinds of biological activity adapted to wet environments (ESRD 2015). All wetlands in the LSA and RSA and surveyed area were classified according to the Canadian Wetland Classification System (National Wetlands Working Group 1997), which differentiates wetlands by their environmental and developmental characteristics (Table 3-14).

Bog

Bogs are acidic, mineral-poor peatlands that are raised above the groundwater by an accumulation of peat, with pH levels generally ranging between three and four (Crum 1992). In general, they are characterized by a hummocky ground surface covered with *Sphagnum* moss, ericaceous shrubs and black spruce. Bogs develop under ombrotrophic conditions where water, minerals and nutrients are derived solely from precipitation (Halsey et al. 2004). Groundwater and associated minerals are not able to reach the bog rooting layer because it is blocked by a layer of impermeable peat. Bogs are found along drainage divides, stagnation zones of peatland complexes and small isolated basins (Halsey et al. 2004). All bogs contain peat layers that are at least 40 cm thick.

Fen

Fens are peatlands that are influenced by mineral-rich groundwater or surface water. Fens receive minerals and nutrients from precipitation and groundwater. A distinguishing feature of fens is that they are characterized by a prominent layer of sedges. Soil chemistry in fens ranges widely with pH values varying from about four in extreme poor fens to more than seven in extremely rich fens (Crum 1992). Fens are divided on the basis of landform and forest cover that typically includes black spruce and tamarack, and the presence of peat plateaus and internal lawns in treed fens (Halsey et al. 2004). All fens contain peat layers that are at least 40 cm thick.

Marsh

Marsh wetlands are characterized by mineral soils, fluctuating water levels and a range of chemical gradients (ESRD 2015). Marshes are only graminoid in structure, with water levels at or above the ground surface for variable parts of the growing season (ESRD 2015). Nutrient levels in the water are high, providing greater amount of available nutrients for plants than peatland wetlands (Smith et al. 2007). Wetland permanence is defined by the vegetation community with greater than 25% cover in most years (ESRD 2015).

Swamp

Swamps are highly productive, mineral rich wetlands that are typically located at margins of wetlands, river floodplains, adjacent to waterbodies that are subjected to flooding, or in areas influenced by fluctuating water levels (Halsey et al. 2004). Fluctuating water levels within swamps may be the result of seasonal variation or slope drainage. The groundwater moving through the soil is typically well oxygenated and close to the surface within the rooting zone (ESRD 2015).

Shallow Open Water

Shallow open waters typically have an open water zone supporting floating and/or submersed aquatic vegetation in the deepest wetland zone covering more than 25% of the total area in the majority of years; however, wetlands with sparse vegetation (e.g., salt flats) also exist. Shallow open water wetlands are less than two metres deep at midsummer. Graminoid communities similar to those in marshes often surround the open water zone in shallow open water wetlands.

Four wetland classes (and eight wetland ecosite phases) were identified in the 2019 field program (Golder 2019b) and previous studies (EBA 2005b; Rescan 2012a,b).

Table 3-14: Wetland Classification Summary

Wetland Class	Wetland Category	Associated Ecosite	Wetland Characteristics
Bog	Organic[a]	f1 f2	▪ surface raised/level with surrounding terrain ▪ water table at or slightly below surface ▪ ombrogenous ▪ dominated by sphagnum mosses with tree, shrub, or treeless vegetation cover
Fen		g1 g2 g3 h1 h2 h3	▪ surface is level with water table, with water flow on surface and through subsurface ▪ fluctuating water table at or slightly below the surface ▪ minerogenous ▪ graminoids and shrubs characterize vegetation cover
Marsh	mineral	e1 e2	▪ shallow surface water which fluctuates dramatically ▪ minerogenous ▪ vegetation dominated by rushes, reeds, grasses, and sedges
Swamp			▪ water table at or below surface ▪ minerogenous ▪ coniferous or deciduous trees, or tall shrub vegetation cover
Shallow open water		N/A	▪ transition between seasonally wet/saturated wetlands (bog, fen, marsh or swamp) and permanent deep waterbodies

(a) organic wetlands = wetlands with greater than 40 cm of peat accumulation

Disturbance

The disturbance ecosite phase represents existing human disturbances, including brownfield areas in the historical Pine Point mine site. It also includes borrow pits, industrial areas, well sites, and clearings. Vegetation associated with disturbances may be absent or may be highly modified (e.g., regenerating borrow pits). Highly modified vegetation may range from low growing vegetation comprised of grasses and shrubs on more recently cleared sites (i.e., within the last 3 to 5 years) to young stands of regenerating trees and shrubs on older sites. Pre-existing vegetated linear features (i.e., seismic, exploration, cut lines) were not considered disturbances.

Water

A naturally occurring, static body of water, or a watercourse formed when water flows between continuous, definable banks. These flows may be intermittent or perennial; but do not include ephemeral flows where a channel with no definable banks is present.

Undefined

Ecosite phases requiring additional data in order to be classified.

3.3.8.3 Plant Species and Species of Concern

Based on 2019 field observations (Golder 2019b) and previous studies (Rescan 2012a,b; EBA 2005b), 142 vascular plants have been documented in the LSA, of which 124 were identified to species level and 18 were identified to genus level. A total of 40 non-vascular plants (22 bryophytes and 18 lichens) were identified, of which 33 were identified to species and 7 specimens were identified to genus level. The most common and widespread vascular species found were black spruce, white spruce, prickly rose, Canada buffaloberry, and trembling aspen.

Culturally important plant species and resources that occur in the LSA and identified by the communities of Deninu Kųę́ First Nation, Fort Resolution Métis, and Hay River Métis include Labrador tea, white rat root (*Acorus americanus*), spruce gum, tamarack, poplar buds, and birch trees (Swisher 2006a,b).

The Working Group on General Status Ranks of Wild Species in the NWT (2016) lists 99 sensitive plant species (71 vascular and 28 non-vascular) with potential to occur in the LSA and RSA. Previous field surveys have identified the presence of three sensitive species at eight locations within the LSA (Table 3-15). No federally listed (COSEWIC or SARA) plant species (threatened, special concern, or endangered) have been identified to date or are expected to occur in the LSA and RSA.

Table 3-15: Previously Identified Sensitive Plant Species Occurrences in the Local Study Area

Scientific Name	Common Name	NWT Status Rank[(a)]	Location		
			UTM Zone	Northing	Easting
Carex lasiocarpa	hairy-fruited sedge	Sensitive	11V	6734152	616346
			11V	6735535	618635
			11V	6743529	634484
Gentianopsis virgata	Macoun's fringed gentian	Sensitive	11V	6759660	660782
Salix discolor	pussy willow	Sensitive	11V	6760509	658948
			11V	6759822	658922
			11V	6761085	658116
			11V	6758957	659162

Source: (a) Working Group on General Status of NWT Species (2016)

3.3.9 Wildlife

The presence of specific land cover types or the composition and structure of vegetation communities (i.e., habitat types) influences the wildlife species that inhabit a region. Vegetation structure and composition is determined by the terrain, soil, climate, and hydrologic regime of an area. Wildlife species represent an integral part of the terrestrial ecosystem and many species have important cultural, social, and/or economical value (i.e., ecological services). The wildlife existing conditions section includes a review of current literature, as well as field data and information collected from 2005 to 2018. The information will be used to help select wildlife valued components to be assessed in the Developer's Assessment Report.

3.3.9.1 Species of Concern

Wildlife species of concern are those that are listed as endangered, threatened, or of special concern under the federal SARA, the *Species at Risk (NWT) Act*, and/or by the COSEWIC. As the *Species at Risk (NWT) Act* is implemented, it is expected that the NWT Species at Risk Committee will complete further species assessments and the Conference of Management Authorities will prepare the List of Species at Risk, providing legal protection for these species. This could mean changes to the species of concern for the Project.

Species of concern were identified that are known to be or are expected to be in the area of the historical Pine Point mine and could potentially interact with the Project (Table 3-16). ECCC has issued Species at Risk Recovery Strategies for seven of the species of concern: caribou (boreal population) (*Rangifer tarandus caribou*), wood bison (*Bison bison athabascae*), little brown myotis (*Myotis lucifugus*), northern myotis (*Myotis septentrionalis*), common nighthawk (*Chordeiles minor*), olive-sided flycatcher (*Contopus cooperi*), and whooping crane (*Grus americana*) (Environment Canada 2007, 2012, 2016a,b, ECCC 2018c,d). Critical habitat has been defined for caribou (boreal population; hereafter boreal or woodland caribou) (Government of Canada 2019a).

ECCC has also issued Species at Risk Management Plans for three of the species of concern: rusty blackbird (*Euphagus carolinus*), yellow rail (*Coturnicops noveboracensis*), and northern leopard frog (*Lithobates pipiens*) (Environment Canada 2013a,b, 2015a).

Table 3-16: Wildlife Species of Concern that may Interact with the Project

Species	NWT Species at Risk Committee Status[(a)]	Federal *Species at Risk Act* Schedule 1 Status[(b)]	Committee on the Status of Endangered Wildlife in Canada Status[(c)]	Observed in the Local Study Area?
Caribou (boreal population)	Threatened	Threatened	Threatened	Yes
Wood bison	Threatened	Threatened	Special Concern	Yes
Wolverine	Not at Risk	Special Concern	Special Concern	Yes
Little brown myotis	Special Concern	Endangered	Endangered	Yes
Northern myotis	Special Concern	Endangered	Endangered	Yes
Short-eared owl	Not applicable	Special Concern	Special Concern	No
Whooping crane	Not applicable	Endangered	Endangered	Yes
Bank swallow	Not applicable	Threatened	Threatened	Yes
Barn swallow	Not applicable	Threatened	Threatened	No
Common nighthawk	Not applicable	Threatened	Threatened	Yes
Horned grebe (western population)	Not applicable	Special Concern	Special Concern	Yes
Olive-sided flycatcher	Not applicable	Threatened	Threatened	Yes
Rusty blackbird	Not assessed	Special Concern	Special Concern	Yes

Table 3-16: Wildlife Species of Concern that may Interact with the Project

Species	NWT Species at Risk Committee Status[(a)]	Federal *Species at Risk Act* Schedule 1 Status[(b)]	Committee on the Status of Endangered Wildlife in Canada Status[(c)]	Observed in the Local Study Area?
Yellow rail	Not applicable	Special Concern	Special Concern	No
Northern leopard frog	Threatened	Special Concern	Special Concern	No
Gypsy cuckoo bumble bee	Data Deficient	Endangered	Endangered	No
Yellow-banded bumble bee	Not at Risk	Special Concern	Special Concern	No

Sources:
(a) GNWT (2018b)
(b) Government of Canada (2019a)
(c) COSEWIC (2019)

3.3.9.2 Ungulates

There are three ungulate species that may use habitats in the LSA and RSA (Section 3.1.4): caribou (boreal population), wood bison, and moose (*Alces alces*).

3.3.9.2.1 Boreal Caribou

Boreal caribou are a threatened species in the NWT and Canada (GNWT 2018b; Government of Canada 2019b; COSEWIC 2019). The boreal caribou in the NWT are all considered part of the same population (NT1). There are estimated to be 6,000 to 7,000 boreal caribou in the NT1 population (Conference of Management Authorities 2017). The density of boreal caribou in the Dehcho and South Slave Region of the NWT is estimated to be 3 caribou per 100 km^2 (Haas 2014).

Boreal caribou require large tracts of dense, mature or old growth pine (*Pinus* spp.) or spruce (*Picea* spp.) forests that contain an abundance of terrestrial and arboreal lichen (Environment Canada 2012; Conference of Management Authorities 2017). These habitat types are usually associated with wetlands such as marshes, peatlands, and lakes (Environment Canada 2012). Forests less than 40 years of age are considered unsuitable for boreal caribou (Environment Canada 2012). During the calving season, females generally select areas that are difficult for predators to access such as islands in the middle of lakes or upland areas in bog complexes (Environment Canada 2012). A boreal caribou habitat suitability model has been developed for the region, which could be used to assess effects from the Project (Golder 2018a).

The NT1 population is considered “likely self-sustaining” because, as of 2017, undisturbed habitat makes up 69% of the range (Government of Canada and GNWT 2019). Environment Canada (2012) identified 65% undisturbed habitat within a range as a threshold for providing measurable probability (60%) that a population is self-sustaining. To date, the NT1 range has not experienced substantial habitat loss or fragmentation and the risk of destruction of critical habitat by human activities (e.g., seismic lines, forestry cut blocks, and roads) in the NWT portion of the NT1 range is “likely low” (Government of Canada and GNWT 2019). Instead, wildfire is considered the largest threat to boreal caribou habitat in the NWT; approximately 23.7% of the NT1 range is currently disturbed by fire (Government of Canada and GNWT 2019). However, habitat disturbance in the NT1 range is unevenly distributed and most natural and human-related disturbance is in the Southern NWT region (Government of Canada and GNWT 2019), which intersects the RSA. Most of the human disturbance footprint in the Southern NWT region is from old seismic lines that were constructed prior to the implementation of modern best management practices (Government of Canada and GNWT 2019).

Natural and anthropogenic habitat disturbance increases the number of alternate prey (e.g., moose) and, subsequently, the number of carnivores in an area. Increased numbers of predators can lead to increased predation rates on caribou. High levels of habitat disturbance, and associated increases in predator numbers, are considered to be the main factors of boreal caribou population declines in Canada (Conference of Management Authorities 2017). Increasing harvest levels in certain areas, such as southern NWT, and climate change (e.g., increased fire frequency and intensity) may be exacerbating boreal caribou declines (Conference of Management Authorities 2017). Boreal caribou do not migrate. Instead, females space out throughout the forest for calving, which decreases predation risk (Conference of Management Authorities 2017).

One caribou was observed by workers at the existing exploration site in 2017. Two caribou and caribou tracks were observed by exploration personnel in 2018. Remote cameras deployed in brownfield and greenfield areas of the LSA in 2018 detected two boreal caribou (Golder 2018a). Caribou sign (e.g., hair, tracks, and pellets) was observed at four locations in September 2005 (EBA 2005c). In 2011, remote cameras captured images of caribou in the LSA (Rescan 2012h). Eight caribou were observed during aerial surveys in 2018 in the Fort Resolution Forest Management Area, which overlaps the RSA (ABMI 2018). Caribou tracks were observed during a reconnaissance survey between Buffalo River and Hay River in 1980 (Beak 1980). A total of 116 boreal caribou individuals and observations of sign were noted during aerial surveys in the Buffalo Lake, River, and Trails Candidate Area in 2010, which overlaps the RSA (Haas 2014). The Buffalo Lake, River, and Trails Candidate Area encompasses the section of Buffalo Lake that is not within the current boundaries of Wood Buffalo National Park, including the Yates and Whitesand Rivers, as well as traditional trails from Buffalo Lake to the Hay River Reserve, home of the K'atl'odeeche First Nation, and follows the Lower Buffalo River as it flows from the boundaries of Wood Buffalo National Park to Great Slave Lake.

3.3.9.2.2 Wood Bison

Wood bison are listed as a threatened species under the *Species at Risk (NWT) Act* (GNWT 2018b) and Species at Risk Public Registry (Government of Canada 2019a). The Northwest Territories Bison Control Area partially overlaps the RSA but the Project is outside of the range of the Greater Wood Buffalo Bison Metapopulation (GNWT 2020b). The Bison Control Area is managed as a bison-free zone to prevent bison from the Slave River Lowlands or Greater Wood Buffalo metapopulations that are infected with brucellosis and tuberculosis from coming into contact with the uninfected Mackenzie, Nahanni and Hay-Zama (Alberta) populations (GNWT 2020b).

Wood bison sign (i.e., scat, tracks, and feeding areas) was observed at two locations in the LSA in 2005 (EBA 2005c). No wood bison were recorded on remote cameras deployed in the LSA in 2018 (Golder 2018a). Four wood bison were observed during aerial surveys in 2018 in the Fort Resolution Forest Management Area, which overlaps the RSA (ABMI 2018).

Threats to wood bison habitat include fire suppression, forestry, and oil and gas development (COSEWIC 2013a). In addition, exclusion of bison from the Disease Control Area, where bison are diseased by brucellosis and tuberculosis, is functionally a form of habitat loss for wood bison (COSEWIC 2013a). A wood bison habitat suitability model has been developed for the region, which could be used to assess effects from the Project (Golder 2018a).

3.3.9.2.3 Moose

Moose is not a territorial or federal species at risk (GNWT 2018b; Government of Canada 2019a) but is a valued subsistence species for Indigenous peoples. Moose occur at low densities throughout the NWT. Moose density in the Buffalo Lake, River, and Trails Candidate Area, which overlaps the RSA, was calculated to be 5 moose per 100 km^2 (Haas 2014). Densities of moose near Yellowknife have been estimated to range from 2.0 to 3.5 moose per 100 km^2 (Cluff 2005). A total of 22 moose were observed in the LSA (EBA 2005c). Eighteen moose were observed during field surveys in the Buffalo Lake, River, and Trails Candidate Area in 2010, which overlaps the RSA (Haas 2014). One juvenile moose was observed by workers at the exploration site on 7 August 2018. No moose were recorded on remote cameras deployed in the LSA in 2018 (Golder 2018a). Ten moose were observed during aerial surveys in the Fort Resolution Forest Management Area in 2018 (ABMI 2018).

Moose are usually found in forested areas, but the species has recently expanded its range to include tundra and prairie habitats. In the summer, moose prefer semi-open forests with an abundance of shrubs that are located close to waterbodies. In the winter, moose prefer dense coniferous stands as these provide protection from inclement weather and predators. Forest regeneration is apparently optimal for moose at 10 to 26 years post-fire (Nelson et al. 2008). During spring, summer, and fall, moose primarily consume fresh shoots and leaves from deciduous shrubs, young deciduous trees, and wetland vegetation (Davidson-Hunt et al. 2012).

Preferred fall and winter browse includes willow, trembling aspen (*Populus tremuloides*), bog/dwarf birch (*Betula glandulosa*), and alder (*Alnus* spp.) (Stelfox 1993). In the spring and early summer, moose travel to bays, shorelines, and river and creek systems that have large quantities of aquatic plants to replenish their bodies with sodium.

3.3.9.3 Large Carnivores

Wolverine (*Gulo gulo*), gray wolf (*Canis lupus*), black bear (*Ursus americanus*), and Canada lynx (*Lynx canadensis*) are large carnivores that may use habitats in the LSA and RSA (Section 3.1.4).

3.3.9.3.1 Wolverine

Wolverine is a species of special concern under SARA but is not a listed species under the *Species at Risk (NWT) Act*. The highest densities of wolverine occur in the northern mountain and northern boreal ecosystem areas of the western sub-population (5 to 10 wolverines per 1,000 km^2), where vegetation associations, food resources, and large carnivores are most diverse and abundant (COSEWIC 2014). The number for wolverines in the NWT is unknown, but the population is considered stable with a sparsely distributed population consisting of thousands of individuals (ENR 2019a).

In general, studies within North America suggest that wolverines inhabit a variety of treed and treeless areas at all elevations including the northern forested wilderness, the alpine tundra of the western mountains, and the Arctic tundra (COSEWIC 2014). Habitat use is best described as a function of large undisturbed wilderness areas and seasonal variation in food abundance, denning requirements, or human disturbance (Johnson et al. 2005; May et al. 2006; Krebs et al. 2007; COSEWIC 2014). Their diet is extremely varied; however, ungulates (in the form of carrion) are a main food source across their range (COSEWIC 2014). Copeland et al. (2010) reported a strong correlation between global wolverine distribution and persistent spring snow cover. A wolverine habitat suitability model has been developed for the region, which could be used to assess effects from the Project (Golder 2018a).

One wolverine was observed during a muskrat aerial survey of the Buffalo Lake, River, and Trails Candidate Area in 2010, which overlaps the RSA (Haas 2014). Wolverines were not observed by field personnel or workers at the exploration site in 2005, 2011, 2017, or 2018 (EBA 2005c; Rescan 2012h,i). Wolverine were not recorded on remote cameras deployed in the LSA in 2018 (Golder 2018a).

3.3.9.3.2 Gray Wolf

There are three groups of gray wolves in the NWT: timber (boreal), tundra, and Arctic populations (ENR 2019b). The boreal population lives below the treeline and depends primarily on non-migratory prey such as moose, boreal caribou, bison, and deer (*Odocoileus* spp.) (ENR 2019b). The number of gray wolves in the NWT is unknown, but populations are considered stable (ENR 2019b). Wolf density in the Hay River Lowlands was estimated to be 1.6 wolves per 1,000 km^2 (Serrouya et al. 2016).

The gray (boreal) wolf prefers heavily forested areas and research shows that the species can adapt to the presence of humans (Mech 1995; Thiel et al. 1998; Boitani 2000; Hebblewhite and Merrill 2008), although studies have also demonstrated changes to habitat use in response to high levels of human activity (Houle et al. 2010). Gray wolf habitat preference is likely dependent on optimizing fitness by reducing travel costs, while maintaining potential for encountering prey (Alexander et al. 2005). Wolves will use cutlines and other linear disturbances for ease of movement (Paquet and Callaghan 1996; James and Stuart-Smith 2000; Gurarie et al. 2011).

Three wolves were observed near in the LSA in 2005 (EBA 2005c). One wolf was observed during a moose aerial survey of the Buffalo Lake, River, and Trails Candidate Area in 2010, which overlaps the RSA (Haas 2014). One wolf was observed in the LSA in 2011 (Rescan 2012h). No wolves were recorded on cameras deployed within the LSA in 2011 (Rescan 2012i). Wolf tracks were observed in the historical Pine Point mine footprint by staff in 2017. One wolf was observed by workers at the exploration site in 2018. One wolf was recorded on remote cameras deployed in the LSA in 2018 (Golder 2018a). Three wolves were observed during aerial surveys in the Fort Resolution Forest Management Area in 2018 (ABMI 2018).

3.3.9.3.3 Black Bear

Black bears are widely distributed below the treeline in the NWT (ENR 2019c). Although the number of black bears in the NWT is unknown, the population is considered stable (Pelton et al. 2003). Black bears prefer forested areas that are interspersed with open habitats (e.g., meadows), which provide berries, shrubs, and grasses. Males and females are not territorial where food is abundant (Horner and Powell 1990) and home ranges of many bears can overlap (Schenk et al. 1998).

A total of 37 black bear observations were recorded in the LSA by field personnel in 2005 (EBA 2005c). Many of these observations likely represent the same individuals. Three black bears were recorded on cameras deployed in the LSA in 2011 (Rescan 2012i). Seven and 57 black bear sightings were reported by workers at the exploration site in 2017 and 2018, respectively. Two black bear observations were recorded on remote cameras deployed in the LSA in 2018 (Golder 2018a).

3.3.9.3.4 Canada Lynx

Canada lynx is a common and abundant species in most of the NWT (ENR 2019d). Lynx primarily consume snowshoe hare (*Lepus americanus*), and as such, lynx numbers fluctuate with cycles of snowshoe hare populations. In western NWT, lynx prefer dense coniferous and dense deciduous forests and avoided wetland-lake complexes and open black spruce forests (Poole et al. 1996). Wildfire may have a positive effect on populations of lynx and snowshoe hare by maintaining or increasing the availability of dense forest habitats (Poole et al. 1996).

One lynx was observed in 2005 (EBA 2005c) and three individuals were observed by workers at the exploration site in 2017. One lynx was recorded on remote cameras deployed in the LSA in 2018 (Golder 2018a).

3.3.9.4 Furbearers

There are several furbearing mammal species that can be important resources for traditional use and may occur in habitats in LSA and RSA (Section 3.1.4) including red fox (*Vulpes vulpes*), American marten (*Martes americana*), beaver (*Castor canadensis*), and muskrat (*Ondatra zibethicus*).

3.3.9.4.1 Red Fox

Red fox populations are common throughout mainland Canada (Lariviére and Pasitschniak-Arts 1996; Reid 2006). They are not considered a species at risk in the NWT (GNWT 2018b) or Canada (Government of Canada 2019a). Habitat is typically not a limiting factor as the species is adaptable and have shown resilience to human disturbance (Adkins and Stott 1998; Gosselink et al. 2007; MNR 2007). Red foxes are commonly observed in the LSA, with site personnel reporting 14 sightings in 2017 and 9 sightings in 2018. Typically, red fox prefers mixed habitat of shrubland and fields, edges of forest and farmland, and marshy areas (Reid 2006). Lariviére and Pasitschniak-Arts (1996) reported that shrub habitats are selected in the winter because of lower snow accumulations and increased snow hardness.

3.3.9.4.2 American Marten

The American marten is not a territorial or federal species at risk (GNWT 2018b; COSEWIC 2019; Government of Canada 2019a). However, the species is often considered a valued resource for Indigenous people. Historically, marten have been trapped for fur in North America, and populations have declined since European contact (Buskirk and Ruggiero 1994). Marten occupy larger home ranges than would be expected for a mammal of their size (Buskirk and Ruggiero 1994), with adult males in Canada occupying ranges of 0.8 to 45 km^2, and adult females occupying ranges of 0.42 to 27 km^2 (Burnett 1981; Mech and Rogers 1977; Latour et al. 1994; Smith and Schaefer 2002). Home ranges vary as a function of geographic area, habitat type, and prey density (Soutiere 1979; Thompson and Colgan 1987). Nine sightings of unidentified Mustelidae (weasel family) species were reported by field personnel in 2005 (EBA 2005c) and one marten was observed by workers at the exploration site in 2018.

American marten are commonly associated with mature coniferous and mixed-coniferous forests with abundant coarse woody debris and a well-developed understory (Buskirk and Ruggiero 1994; Clark et al. 1987; Lyon et al. 1994; Thompson and Harestad 1994; Payer and Harrison 2000; Slauson et al. 2007; Thompson et al. 2012). They do not regularly occur in open habitats with low canopy cover such as bogs, meadows and burns, and recent clearcuts (Koehler and Hornocker 1977; Taylor and Abrey 1982; Godbout and Ouellet 2008; Cheveau et al. 2013). Structural complexity is important to marten because it creates quality conditions for foraging, resting, and reproduction.

3.3.9.4.3 Beaver

Beaver is not a territorial or federal listed species (GNWT 2018b; COSEWIC 2019; Government of Canada 2019a) but is often considered a valued traditional resource for Indigenous people. Beavers inhabit streams, ponds, and the margins of large lakes (Allen 1983). For waterbodies to be suitable for beaver, there must be a stable water supply, channel gradient less than 15%, and adequate food resources (Allen 1983). Beaver eat a variety of plants but prefer trembling aspen (*Populus tremuloides*), willow (*Salix* spp.), balsam poplar (*Populus balsamifera*), and alder (*Alnus* spp.) (Allen 1983). Four beavers were observed by field personnel in 2005 (EBA 2005c). Workers at the exploration site reported five beaver sightings in the LSA in 2018. Beaver dams were reported along the tributary streams of the Buffalo River and in Twin Creek in 1977 (BC Research 1977), and along unnamed watercourses in the RSA in 2011 (Rescan 2012e).

3.3.9.4.4 Muskrat

Muskrat is not a territorial or federal listed species (GNWT 2018b; COSEWIC 2019, Government of Canada 2019a). However, this species can be an important subsidence species for Indigenous peoples. Muskrat inhabit waterbodies that have water year-round and water levels that do not fluctuate more than 90 cm per year (Allen and Hoffman 1984). Muskrat habitat quality increases with an increase in emergent vegetation in waterbodies (Allen and Hoffman 1984). Few muskrat pushups were observed during aerial surveys in the Buffalo Lake, River, and Trails Candidate Area in 2010, which overlaps the RSA (Haas 2014). Most muskrat pushups were recorded in areas south of the LSA, specifically on the south side of Buffalo Lake, where the Whitesand and Yates rivers flow into the lake, and an unnamed lake south of Buffalo Lake (Haas 2014).

3.3.9.5 Bats

Several bat species may use areas in the LSA and RSA for foraging and roosting including little brown myotis (*Myotis lucifugus*), northern myotis (*Myotis septentrionalis*), hoary bat (*Aeorestes cinereus*), silver-haired bat (*Lasionycteris noctivagans*), and eastern red bat (*Lasiurus borealis*) (Golder 2018a). Hoary, silver-haired, and eastern red bats are not territorial or federal listed species but little brown myotis and northern myotis are listed as endangered under the SARA (Government of Canada 2019a) and are species of special concern under the *Species at Risk (NWT) Act* (GNWT 2018b).

Until the arrival of white nose syndrome in eastern Canada in the winter of 2009/2010, little brown myotis and northern myotis were common throughout much of Canada and the United States (COSEWIC 2013b). Currently white nose syndrome has not been recorded in the NWT (Canadian Wildlife Health Cooperative 2019). Eight detections of little brown myotis and three detections of northern myotis were recorded on autonomous recording units deployed in greenfield and brownfield areas of the LSA (Golder 2018a).

Little brown myotis and northern myotis are not habitat specialists and have been documented in a wide variety of coniferous and deciduous forest types (COSEWIC 2013b); however, Broders et al. (2006) found that male northern myotis preferred to roost in coniferous stands. Little brown myotis is well adapted to human disturbance and will use buildings, bat houses, and bridges for maternity roosts, indicating that they are resilient to changes in summer habitat. Northern myotis is more of a forest specialist than little brown myotis because it prefers undisturbed forest for roosting and foraging, and is less likely to roost in man-made structures. As aerial hawkers, little brown myotis and northern myotis forage in open areas, often over water (ECCC 2018c).

Winter hibernacula are likely more limiting than summer maternity roosting habitat because specific physiological requirements limit the number of sites that provide suitable overwintering habitat. In the Northwest Territories, caves harbour the greatest concentrations of hibernating little brown myotis, which often overwinter at the same locations as northern myotis (Environment Canada 2018c; NWT Species at Risk Committee 2017). It is suspected that most northern myotis and little brown myotis in the Northwest Territories overwinter in two hibernacula (Environment Canada 2018c; NWT Species at Risk Committee 2017). Minor hibernacula that harbour smaller concentrations of bats are poorly understood but have the potential to play a critical role in the recovery of the population from white-nose syndrome.

3.3.9.6 Birds

There is a wide range of bird species and species groups that may use habitats in the LSA and RSA (Section 3.1.4) seasonally and throughout the year. Surveys by Beak (1980) suggests that there is potential for 206 bird species to use habitats in the RSA, which includes 30 waterfowl, 18 raptor, 29 shorebird, and 87 passerine species.

3.3.9.6.1 Upland Breeding Birds

Upland breeding birds include grouse, ptarmigan, swallow, woodpecker, nighthawk, and passerines. Most upland breeding bird species are protected under the *Migratory Birds Convention Act, 1994* (MBCA).

A total of 19 upland breeding bird species were observed during field studies in September 2005 (EBA 2005c). Thirty upland breeding bird species were detected during point count surveys in the LSA in 2011 (Rescan 2012h,i). In 2018, 51 upland breeding bird species were recorded on autonomous recording units (ARUs) that were deployed in greenfield and brownfield portions of the LSA (Golder 2018a). Numerous sharp-tailed grouse (*Tympanuchus phasianellus*) were observed in shrub fens and mixed forest habitats during surveys in the Buffalo Lake, River, and Trails Candidate Area in 2010 (Haas 2014).

Common Nighthawk

Common nighthawk (*Chordeiles minor*) is an upland breeding bird species of concern that was recorded on ARUs in 2018 (Golder 2018a); common nighthawk is listed as threatened species under SARA (Government of Canada 2019a) but is not listed under the *Species at Risk (NWT) Act* (GNWT 2018b). Common nighthawks appear to be relatively abundant in the LSA with 81 recordings on 16 of the 20 ARUs deployed in 2018 (Golder 2018a). Common nighthawk was also detected during point count surveys in the LSA in 2011 (Rescan 2012h) and during surveys in the Buffalo Lake, River, and Trails Candidate Area in 2010, which overlaps the RSA (Haas 2014).

Common nighthawks are associated with a variety of open or semi-open habitats, including forest clearings, burned areas, grassy meadows, rocky outcrops, sandy areas, grasslands, pastures, peat bogs, marshes, lake shores, quarries, mines, and urban areas (Peck and James 1983; COSEWIC 2007a; Brigham et al. 2011). Wetlands and open water are often used as foraging locations (Brigham et al. 2011). Forested areas with low canopy closure may also provide habitat for the common nighthawk (COSEWIC 2007a). Critical habitat has not yet been identified for common nighthawk due to the diversity of nesting, roosting, and foraging habitats that have been reported (Environment Canada 2016b). Nighthawks eat a wide variety of insects but most commonly consume queen ants, beetles, caddisflies, moths, and true bugs (Brigham et al. 2011). Common nighthawks are generally crepuscular, foraging under low light conditions at dusk and dawn, and often forage in large groups at particular times of the year (Brigham et al. 2011).

Olive-sided Flycatcher

Olive-sided flycatcher (*Contopus cooperi*) is listed as threatened species under SARA (Government of Canada 2019a) but is not listed under the *Species at Risk (NWT) Act* (GNWT 2018b). Olive-sided flycatchers appear to be common in the LSA with 35 recordings on 8 of the 20 ARUs deployed in 2018 (Golder 2018a). Olive-sided flycatcher was also detected during point count surveys in the LSA in 2011 (Rescan 2012h) and during surveys in the Buffalo Lake, River, and Trails Candidate Area in 2010, which overlaps the RSA (Haas 2014).

Olive-sided flycatchers prefer tall trees and snags adjacent to open areas, which provide individuals with perches from which they hunt flying arthropods (Altman and Sallabanks 2012). Olive-sided flycatchers nest in forested stands but, because of their foraging behaviour, are associated with high contrast habitats including burned forests, logged areas, and natural forest openings such as gaps within old-growth forest stands, as well as meadows, rivers, and wetlands adjacent to forested habitat (Altman and Sallabanks 2012; COSEWIC 2007b). In the Yukon Territory, olive-sided flycatchers are primarily associated with low density, open forest, wet areas, and regenerating forest (Stelehin 2020).

The North American breeding bird survey data suggests an average annual decline of 3.4% in Canada's olive-sided flycatcher population between 1973 and 2012 (Environment Canada 2014). The consistent population decline across a wide breeding range suggests that habitat loss and alteration on migration and wintering grounds may be implicated (COSEWIC 2007b). Pesticide use may be detrimental to food supply in some areas, but data are deficient (Altman and Sallabanks 2012).

Canada Warbler

Canada warblers breed in forested areas in Canada and parts of the United States and overwinter in South America. Throughout their breeding range, Canada warblers nest in a variety of usually wet forest types, with a well-developed dense shrub layer (COSEWIC 2008a; Environment Canada 2016c). Canada warblers are associated with wet mixed wood forests and early successional forests (6 to 30 years) created by forest harvesting or natural disturbance (Ball and Bayne 2014; Environment Canada 2016c).

Canada warblers have not been reported in the LSA during field surveys in 2005, 2011, or 2018 (EBA 2005c; Rescan 2012h; Golder 2018a).

Rusty Blackbird

Rusty blackbird (*Euphagus carolinus*), which is listed under SARA as a species of special concern (Government of Canada 2019a), was detected during point count surveys in the LSA in 2011 (Rescan 2012h,i). Rusty blackbirds were also incidentally observed during field surveys in the LSA in September 2005 (EBA 2005c).

During the summer, rusty blackbirds inhabit boreal forested wetlands including bogs, marshes, and sedge meadows (COSEWIC 2006). Rusty blackbirds primarily feed in shallow, slow-moving water habitat, and along riparian edges (Avery 2013). Their diet is mostly composed of aquatic insect larvae, snails, and crustaceans (COSEWIC 2006). Recent population trends in Canada have indicated a large decrease in rusty blackbird numbers with an average annual decline of 6.3% recorded Canada-wide between 1970 and 2012 (Environment Canada 2014). Current threats for the rusty blackbird include extensive habitat loss in their overwintering range (southern United States) as well as conversion of wetlands to agricultural land and urban areas in their summer range (COSEWIC 2006).

Bank Swallow and Barn Swallow

Bank swallow (*Riparia riparia*), a federal listed threatened species (Government of Canada 2019a), was incidentally observed during field surveys in the LSA in September 2005 (EBA 2005c) and during surveys in the Buffalo Lake, River, and Trails Candidate Area in 2010, which overlaps the RSA (Haas 2014). Exploration site personnel observed bank swallows at deposits I46 and I48 in 2018. Bank swallows primarily breed in friable soils in vertical banks, cliffs, and bluffs along ocean coasts, rivers, streams, lakes, reservoirs, and wetlands (Garrison 1999). Most nesting colonies in natural habitats are found along low gradient, meandering waterways with eroding streamside banks (Garrison 1999). Nesting colonies are also commonly found in artificial habitats such as sand and gravel quarries and road cuts (Garrison 1999). Bank swallows avoid dense forests because of the lack of suitable nesting sites (Garrison 1999). Foraging habitats primarily include wetlands, open water, grasslands, riparian woodlands, agricultural areas, and shrublands (Garrison 1999).

Barn swallow (*Hirundo rustica*) is a federal listed threatened species. No barn swallows have been observed in the LSA during surveys in 2005, 2011, and 2018 (EBA 2005c; Rescan 2012h; Golder 2018a). Barn swallows typically nest in a vertical or horizontal substrate (often enclosed), near open areas (e.g., fields and meadows) for foraging, and a body of water that provides mud for nest building (Brown and Brown 1999). Barn swallow nests are typically found inside or outside of buildings, under bridges, and in road culverts and this species commonly forages in open habitats such as riparian habitats, road corridors, urban and residential areas, and clearings in wooded areas (Brown and Brown 1999; Heagy et al. 2014). Vegetation clearing can improve habitat by creating open habitats that can be used by barn swallow for foraging (Brown and Brown 1999; Heagy et al. 2014).

3.3.9.6.2 Shorebirds and Waterbirds

Shorebirds include sandpipers, plovers, dowitchers, yellowlegs, and snipes. Waterbirds include loons, grebes, ducks, geese, herons, bitterns, rails, cranes, coots, and gulls. All shorebird and waterbird species are protected under the MBCA.

Beak (1980) reported concentration of waterbirds on Great Slave Lake near the mouth of Twin Creek. Five waterbird and four shorebird species were observed in the LSA and along the shores of Paulette Bay during surveys in 2011 (Rescan 2012i). A total of 14 waterbird and 3 shorebird species were recorded in the LSA during waterbird surveys in 2011 (Rescan 2012h). Twelve species of waterbirds were observed during aerial surveys in the Buffalo Lake, River, and Trails Candidate Area in 2010, which overlaps the RSA (Haas 2014). A total of 11 waterbird and 7 shorebird species were recorded on ARUs deployed in brownfield and greenfield areas of the LSA in 2018 (Golder 2018a). Workers at the exploration site commonly observe waterfowl and loons using pits and ditches that contain water.

Horned Grebe

Horned grebe (*Podiceps auritus*), which is a federal species of special concern (Government of Canada 2019a), was recorded at one wetland in the LSA during waterbird ground surveys in 2011 (Rescan 2012h); an additional individual was observed approximately 20 km from the existing development in the RSA (Rescan 2012i).

For breeding habitat, horned grebes mainly select semi-permanent and permanent freshwater ponds and shallow bays or marshes containing open water and rich with emergent vegetation such as sedges, rushes and cattails (Stedman 2000). Nests are built within a few metres of open water and are generally floating in emergent vegetation (Stedman 2000). Horned grebes have also been shown to breed in constructed structures with water such as borrow pits in the boreal forest (Fournier and Hines 1999; Kuczynski 2009). Horned grebes have been reported using ponds up to about 18 ha in size for breeding, though most studies suggest smaller ponds up to about 2 ha in size are preferred (COSEWIC 2009).

The decline in the western population of the horned grebe has been largely attributed to the loss of wetland habitat in the prairies, most of which occurred before recent population declines; however, wetland conversion to agriculture and other development continues (COSEWIC 2009). Habitat loss is unlikely to be a major threat to northern populations, and changes to habitat availability in boreal and subarctic regions that have occurred have not likely contributed measurably to broad population declines.

Whooping Crane

Whooping crane (*Grus americana*), a federal listed endangered species (Government of Canada 2019a), was incidentally observed during field surveys in the LSA in September 2005 (EBA 2005c). Whooping crane was a key species of concern noted in ECCC’s referral for completion of an EA assessment for the Tamerlane Pine Point Pilot Project (EA0607- 002).

Whooping crane have a restricted known breeding range in Canada within Wood Buffalo National Park, which spans the NWT and Alberta borders near the Slave River. They inhabit marshes, bogs, and shallow lakes. Wetlands used for nesting are separated by narrow ridges that support an overstory of white spruce, black spruce, tamarack, and willows and an understory of dwarf birch, Labrador tea, and bearberry (COSEWIC 2010). Bulrush is the dominant emergent in the potholes used for nesting, although cattail, sedge, musk-grass, and other aquatic plants are common. Whooping cranes appear to be more limited by risks faced during migration and factors affecting their wintering grounds than environmental pressures affecting breeding grounds.

Yellow Rail

Yellow rail (*Coturnicops noveboracensis*) is listed under SARA as a species of special concern (Government of Canada 2019a). Yellow rail occupies wetlands dominated by sedges, true grasses, and rushes, where there is little or no standing water, and where the substrate remains saturated throughout the summer (COSEWIC 2009), which closely describes herbaceous wetland habitat in the LSA. No yellow rails have been detected in the LSA during field surveys in 2005, 2011, and 2018 (EBA 2005c; Rescan 2012h; Golder 2018a).

3.3.9.6.3 Raptors

Raptors are birds of prey and include hawks, eagles, falcons, and owls. Raptors are not protected under the MBCA, but are protected in the NWT under the *Wildlife Act* and *Wildlife General Regulation* R-051-2019. Nests are protected year-round but can be removed if authorized under a Wildlife General Permit. Several raptor species may use habitats in the LSA and RSA (Section 3.1.4).

Bald eagle (*Haliaeetus leucocephalus*), American kestrel (*Falco sparverius*), great horned owl (*Bubeo virginianus*), boreal owl (*Aegolius funereus*), golden eagle (*Aquila chrysaetos*), peregrine falcon (*Falco peregrinus*), red-tailed hawk (*Buteo jamaicensis*), northern harrier (*Circus cyaneus*), rough-legged hawk (*Buteo lagopus*), and sharp-shinned hawk (*Accipiter striatus*) were observed during field surveys in the LSA in 2011 (Rescan 2012h,i). Bald eagle, northern harrier, rough-legged hawk, American kestrel, and peregrine falcon were also recorded in the LSA in 2005 (EBA 2005c).

Raptor species that were observed during surveys in the Buffalo Lake, River, and Trails Candidate Area in 2010 were bald eagle, osprey (*Pandion haliaetus*), northern harrier, great horned owl, boreal owl, short-eared owl (*Asio flammeus*), and northern goshawk (*Accipiter gentilis*). Short-eared owl is a species of special concern under SARA (Government of Canada 2019a). All other raptor species that have been reported in the LSA are not species of concern in the NWT or Canada (GNWT 2018b; Government of Canada 2019a).

Bald Eagle

Bald eagles are found near major lakes or rivers (Armstrong 2014), often using perches within 500 m of open water when foraging at or near the surface of the water (Buehler 2000). Shallow water and near-shore emergent vegetation increases the likelihood that live fish prey will be available near the surface (Buehler 2000; Armstrong 2014). Quality of hunting habitat may also be higher in areas without human development and disturbance (Buehler 2000). Bald eagle breeding territories tend to be within 2 km of water near lakes greater than 1,000 ha with more than 11 km of shoreline, and average territory sizes range from 0.5 to 4 km² (Armstrong 2014). Bald eagle was the most numerous raptor species observed during surveys in the Buffalo Lake, River, and Trails Candidate Area in 2010 and was usually observed along watercourses, especially the Buffalo River (Haas 2014), which overlaps the RSA.

Short-Eared Owl

Short-eared owl nest in a variety of grassland and wetland habitats (Wiggins et al. 2006). Females prefer to nest in areas with short (<60 cm) dense grass (Wiggins et al. 2006), as well as in tundra with small willows (COSEWIC 2008b). Nest sites are often located on dry sites, such as small knolls or hummocks (Wiggins et al. 2006). Forested areas do not represent suitable breeding habitat (Wiggins et al. 2006).

3.3.9.7 Amphibians

Four amphibian species have potential to occur in the LSA and RSA (Section 3.1.4): Canadian toad (*Bufo hemiophyrs*), northern leopard frog (*Lithobates pipiens*), wood frog (*Lithobates sylvatica*), and boreal chorus frog (*Pseudacris maculata*). Wood frogs and boreal chorus frogs were the only amphibian species recorded in the LSA during amphibian surveys in 2011 (Rescan 2012h). Similarly, only wood frogs and boreal chorus frogs were recorded on ARUs in greenfield and brownfield portions of the LSA in 2018 (Golder 2018a).

Northern Leopard Frog

Northern leopard frogs are semi-aquatic and use both aquatic and terrestrial environments during their life cycle. Different habitats are required throughout the year: breeding occurs in shallow marshes, moist uplands are used for foraging, and permanent water bodies are required for overwintering (Environment Canada 2013b). These three habitat types must be located in close proximity to each other and must be connected because leopard frogs have limited dispersal capability (Environment Canada 2013b).

3.3.9.8 Insects

Bumble Bees

Both the yellow-banded bumble bee and gypsy cuckoo bumble bee are generalist foragers, feeding on the nectar and pollen of a wide variety of plant species (COSEWIC 2015a,b). The yellow-banded bumble bee (*Bombus terricola*) is a species of special concern under SARA (Government of Canada 2019a). Yellow-banded bumble bee is a habitat generalist that is found within a wide variety of open to semi-open habitats including open coniferous, deciduous, and mixed-wood forests, and wet and dry. They also occupy meadows and prairie grasslands, meadows bordering riparian zones, and along roadsides in taiga adjacent to wooded areas, urban parks, gardens and agricultural areas, and subalpine habitats (COSEWIC 2015a). Nests are typically established in abandoned rodent burrows, but also in grassy hummocks, rotting logs, or cavities in dead wood (COSEWIC 2015a).

The gypsy cuckoo bumble bee (*Bombus bohemicus*) is an endangered species under SARA (Government of Canada 2019a). Gypsy cuckoo bumble bees are obligate social parasites that use host colonies of bumble bees belonging to the subgenus *Bombus senso stricto* to raise their young (COSEWIC 2015b). Consequently, habitat preferences are strongly dependent on the host species.

3.4 Human Environment

The human environment baseline section presents a high-level overview of current socio-economic conditions and cultural features of potentially affected communities and the traditional territories of Indigenous communities, including important harvesting and cultural use areas. Information on conditions in most of the socio-economic LSA communities (Section 3.1.7) is publicly available to some extent, largely in the form of statistics from the GNWT Bureau of Statistics and Statistics Canada. More detailed, contextual information will be collected through future baseline studies.

Information presented in the EA Initiation Package has been based on preliminary desktop studies and review of publicly available information. Additional baseline information will be collected in support of the Developer's Assessment Report for the Project. Further, information presented below will be verified through additional engagement and revised, as required. Such work detailed in the Baseline Study Plan for 2020 (Appendix C). ITK regarding the traditional use of land and resources in the vicinity of the Project will be confirmed and expanded upon with Indigenous communities through the baseline study process pursuant to the ITK protocols of respective Indigenous groups and forthcoming Knowledge Sharing Agreements.

3.4.1 Heritage Resources

The Project is located on the south shore of Great Slave Lake between the Slave and Hay rivers. The history of the region extends from precontact times, through the fur trade and historical mining era. Several sources were reviewed to identify the existing environment for Heritage Resources within the LSA (Section 3.1.5). This included:

- The Northwest Territories Archaeological Sites Database maintained by the GNWT Department of Education, Culture & Employment, Cultural Places Program.
- The NWT Contaminated Sites website maintained by Crown-Indigenous Relations and Northern Affairs Canada, which contains information on historical infrastructure and abandoned mine sites that may be of heritage interest.
- The Canadian Register of Historic Places administered by Parks Canada that lists registered historic places throughout Canada.
- Relevant published and unpublished literature and reports pertaining to previous archaeological, historical, and cultural studies completed in the LSA.

A summary of previous archaeological studies and documented heritage resources is discussed below.

3.4.1.1 Previous Studies

A search of the archaeological sites database indicates that at least 13 archaeological studies have been carried out in the region between the mouth of the Hay River and Slave River beginning in 1966 through 2018 that resulted in the recording of more than 50 precontact and historic sites. This includes studies along the mouth of the Hay River (Noble 1966; Hanks and Irving 1987; Lobb 1998), along the Slave River (Heintzman 1980, 1981), within Wood Buffalo National Park along Buffalo Lake (Deck 2016), and within the K'atl'odeeche First Nation traditional lands (Smethurst 2017, 2018). However, most relevant were six Archaeological Impact Assessments and two Archaeological Overview Assessments conducted between 2006 and 2018. These latter studies resulted in the recording of 13 archaeological sites within the LSA (Table 3-17).

Table 3-17: Previous Research in the Local Study Area

Permit No./Year	Affiliation	Proponent	Relevant Assessment Area	Location	Recorded Sites
2006	J. Bussey Points West Heritage Consulting Ltd.	Tamerlane Ventures Inc.	Pine Point Pilot Project Study Area (R109)	West Zone	0
2011-009	D. Walker Rescan Environmental Services Ltd.	Tamerlane Ventures Inc.	Seven deposits (O556, P499, R190, X25, Z155, G03, N204)	West Zone and N204 Zone	JePr-1, 2, 3, 4
2016-003	M. Moors Stantec Consulting Ltd.	GNWT-INF	Fort Resolution Highway 6 Prospect 4, 5, 7, 11, 12, 14, 15	East Mill Zone and Central Zone	JfPp-1; JfPn-1,2; JfPo-3
2016-012	D. Finch	PWNHC	Pine Point Base Camp	East Mill Zone	JfPo-1, 2
2017 AOA	G. Prager Points West Heritage Consulting Ltd.	Pine Point Mining Limited	Pine Point Exploration Project Phase I: desktop evaluation of 11 mineral claims in proximity to the former Pine Point Mine and townsite; Claims D1 to D6; D9 to D13	East Mill Zone	N/A

Table 3-17: Previous Research in the Local Study Area

Permit No./Year	Affiliation	Proponent	Relevant Assessment Area	Location	Recorded Sites
2017-016	N. Smethurst GNWT-Education, Culture and Employment	K'atlo'deeche First Nation Archaeology Project	Buffalo River	West Zone	JePr-5, JfPs-1 and 2
2018 AOA	Soriak Consulting & Research Ltd.	Osisko Metals Incorporated	Pine Point Mine Exploration Project – Phase II: Desktop evaluation of remaining leases and claims	N204, East Mill, Central, North, and West Zone	N/A
2018-009	Soriak Consulting & Research Ltd.	Osisko Metals Incorporated	Pine Point Mine Exploration Project; Claims D1 to D4, D13; Leases M2 to M6	East Mill Zone	0

AOA = Archaeological Overview Assessment; INF = Department of Infrastructure; PWNHC = Prince of Wales Northern Heritage Centre; N/A = non applicable

In 2006, a Preliminary Archaeological Assessment of the Pine Point Pilot Project was undertaken on behalf of Tamerlane Ventures Inc. (Bussey 2006). The project proposed the development of underground bulk sampling and ancillary infrastructure. The project footprint area was visited to evaluate archaeological potential and it was determined to be low as a result of extensive disturbance from previous mine development. As a result, no field assessment was deemed necessary.

In 2011, heritage baseline studies were carried out to assess seven deposits that were feasible for development as part of an EA (Rescan 2012j,k). During the assessment, four archaeological sites (JePr-1 to 4) were recorded immediately east of the Buffalo River adjacent to Mellor Rapids. All sites were prehistoric lithic scatters initially observed in trail exposures, with two producing formed tools. Avoidance or further mitigation was recommended for JePr-1 to 4 sites, while there were no further concerns identified in the remaining deposits.

In 2016, an Archaeological Impact Assessment was carried out on proposed granular sources for road construction and maintenance on behalf of the GNWT Department of Infrastructure (Moors 2017). This included various sources along Highways 5 and 6, with several occurring within and adjacent to Pine Point claim and lease areas. A total of four sites were documented. This included a historic can scatter (JfPp-1) and a log lined stone cairn feature, which was identified as a potential historic grave (JfPo-3). The remaining sites are located outside mineral leases to the east and include another historic can scatter (JfPn-1) and an isolated historic bottle find (JfPn-2).

Also in 2016, a detailed recording of the historic mine camp used to support exploration activities between 1929 and 1952 was undertaken and designated archaeological site JfPo-1 (Finch 2017). Twenty-two dilapidated structures and 20 additional features including can middens, core piles, crates, cat train skids, and fire pits were documented. A dilapidated log structure (JfPo-2) identified as a historical archaeological structure was also recorded approximately 7.5 km to the north towards Great Slave Lake. It was built by the General Exploration Company in 1929 and used for one year during the early exploration period.

In 2017, an Archaeological Overview Assessment was conducted for the Phase I exploration drilling program within mineral claims D1 to D6 and D9 to D13 on behalf of Darnley Bay Resources, now PPML (Praeger 2017). This desktop study presented a summary of past archaeological studies and documented heritage resources, in addition to identifying high potential areas recommended for avoidance or further assessment prior to drilling.

Also in 2017, archaeologists from the Culture and Heritage Division, GNWT-Education, Culture and Employment were involved with the K'atlo'deeche First Nation Archaeology Project (Smethurst 2017, 2018). This included surveys within the K'atl'odeeche First Nation traditional lands along the Hay River as well as the shore of Great Slave Lake and Buffalo River. As a result of this program, three sites were recorded within the LSA. This included JePr-5, a lithic and faunal scatter site located on the west bank of Buffalo River adjacent to Mellor Rapids. The remaining two sites were recorded 14 km north at the mouth of Buffalo River on Great Slave Lake. These sites consisted of a prehistoric/historic lithic and faunal scatter site (JfPs-1) and a prehistoric lithic scatter site (JfPs-2).

In 2018, an Archaeological Overview Assessment was conducted for the Phase II Pine Point drilling program on behalf of Osisko Metals Incorporated (Soriak 2018). This desktop study examined areas within the remaining 40 mining leases and two claims stretching 70 km across three deposit trends. An updated summary of past archaeological studies and documented heritage resources was presented as well as high potential areas recommended for avoidance or further assessment.

Later in 2018, an Archaeological Impact Assessment was carried out on behalf of Osisko Metals Incorporated within the Phase I exploration drilling area in mineral claims D1 to D3 and D13, as well as areas east in leases M2 to M6 (Soriak 2019). Ten Areas of Interest were examined; however, no new archaeological sites were recorded. This was attributed to previous mine disturbance and generally featureless terrain. Three previously recorded sites were revisited to obtain status updates (JfPp-1, JfPo-1, and JfPo-3).

3.4.1.2 Documented Heritage Resources

As a result of these previous studies, 13 sites have been documented within the LSA including seven prehistoric sites and six historic sites (Table 3-18). The prehistoric sites (JePr-1 to 5; JfPs-1 and 2) relate to precontact Indigenous occupation of the area. All were identified along the Buffalo River, which is the area least disturbed by mining activity. It is also the most important drainage feature in the LSA exhibiting the greatest archaeological potential. All sites consist of lithic scatters or waste flakes produced as a result of stone tool manufacture. None of the sites produced diagnostic tools to indicate a potential age or cultural affiliation; however, the most productive site (JePr-1) produced two chert bifaces that were suggested to represent the Arctic Small Tool Tradition (ASTt) (Rescan 2012j). The ASTt is an archaeological tradition that dates from approximately 3,500 years before present (BP) to 2,600 BP with origins in the northern Arctic (Gordon 1996). This Tradition is known to occur throughout the NWT and as far south as northern Alberta, Saskatchewan, and Manitoba. It is considered to represent northern coastal peoples moving inland to hunt caribou during a particularly cold period.

Within the broader region, the Taltheilei Tradition is also present. This Tradition is considered to represent ancestral Dene and spanned from approximately 2,600 BP to 200 BP (Gordon 1996). Excavations have been carried out at a site (JePw-1) in Hay River that was discovered in a garden. Radiocarbon samples from two separate occupations at this site returned dates of approximately 1,860 +/-135 BP and 1,635 +/-280 BP (Hanks and Irving 1987), which corresponds with the Early to Middle Taltheilei Periods.

Although no fur trade sites were recorded in the LSA, it should be noted that the fur trade period has a long history in the region. Fort Resolution is a National Historic Site located 30 km to the east of the Project that is recognized as the oldest continuously occupied community in the NWT with origins in the fur trade, as well as being the principal fur trade post on Great Slave Lake (CRHP 2010). It was established by the Northwest Company near the mouth of the Slave River in 1791 and was soon followed by a Hudson’s Bay Company post. After the two companies merged in 1821, the forts also united and moved to the present-day community of Fort Resolution. The Hudson's Bay Company established another fur trade post at the mouth of the Hay River in 1868, which was soon followed by a Roman Catholic Mission in 1869 and an Anglican Mission in 1894. The Hay River Mission Sites are also designated as a National Historic Site (CRHP 2009).

The six historic sites documented in the LSA appear to be associated with 20th century mining activity related to the historical Pine Point mine site. All occur in areas surrounding the historical Pine Point mine and include the former mine base camp (JfPo-1), historical archaeological structure (JfPo-2), three can/bottle middens (JfPn-1 and 2; JfPp-1), and the log lined stone cairn feature (JfPo-3).

The historical Pine Point mine has a long history in the region. Lead-zinc deposits were first discovered in 1898 by prospectors heading to the Klondike gold rush (Silke 2009). This resulted in a claim staking period through the 1920s. Exploration began in earnest in 1929 when Cominco started test-pitting, drilling, and shaft sinking. A camp (JfPo-1) was built that same year and served as a base for operations through to 1953 (Finch 2017). In the early 1960s, Cominco proceeded to construction and in 1963 the mine and townsite were developed. A rail line between Pine Point and Peace River, Alberta was built at the same time to deliver lead and zinc concentrates to southern smelting plants. The historical Pine Point mine operated between 1964 and 1988 and included 50 separate open-pits and two underground deposits, distributed along a 70 km trend. At its peak, the town of support workers and families had a population of 1,900. The mining operation closed in 1988 followed soon after by the abandonment of the town (Finch 2017). Remediation of the historical Pine Point mine continued over several years. Pine Point houses were sold, and many moved to Fort Resolution, Hay River and northern Alberta. The remaining buildings were demolished and only the street and sidewalk layout remain (Soriak 2019). The Pinecrest Cemetery associated with the townsite still exists, which is a fenced 25 m by 20 m area located on the northwest side of town. The earliest grave dates to 1878, while the most recent dates to 2017 (Soriak 2019). Neither the contemporary town or cemetery are designated archaeological sites.

Table 3-18: Previously Recorded Heritage Resources in the Local Study Area

Borden No.	Classification	Location	Description	Age
JePr-1	Prehistoric	East of Buffalo River – Mellor Rapids; Lease G3H2B	Lithic workshop/camp:163 artifacts (2 chert bifaces, 1 core, 3 retouched flakes, 1 hammerstone and debitage)	Chert biface tentatively identified as ASTt
JePr-2	Prehistoric	East of Buffalo River – Mellor Rapids; Lease G3H2B	Lithic scatter: 8 artifacts (1 core, 7 debitage)	Unknown
JePr-3	Prehistoric	East of Buffalo River – Mellor Rapids; Lease G3H2B	Lithic scatter: 13 artifacts (1 biface, 12 debitage)	Unknown
JePr-4	Prehistoric	East of Buffalo River – Mellor Rapids; Lease G3H2B	Lithic scatter: 8 debitage	Unknown
JePr-5	Prehistoric	West of Buffalo River – Mellor Rapids; Lease M19	Lithic scatter	Unknown
JfPn-1	Historic	Located 2 km east of claim D12	Can scatter: 2 (1 tobacco can, 1 square can)	Mid 20th century
JfPn-2	Historic	2 km east of claim D12	Isolated bottle (1 medicine bottle)	Mid 20th century
JfPo-1	Historic	Lease M4/buffer	Former Mine Base Camp - 22 dilapidated structures, 20 features	1929 to 1953
JfPo-2	Historic	7 km north of Lease M5	Dilapidated prospector cabin	1929
JfPo-3	Historic	On flat upland terrain –Claim D12/buffer	Cairn/grave? (rectangular cairn lined with logs)	Mid 20th century
JfPp-1	Historic	On a small ridge -Lease M7	Can scatter (5 cans)	Mid 20th century
JfPs-1	Prehistoric/ historic	Mouth of Buffalo River – 13 km northwest of Lease M19	Lithic/bone scatter	Unknown
JfPs-2	Prehistoric	Mouth of Buffalo River – 13 km northwest of Lease M19	Lithic scatter	Unknown
N/A	Contemporary	Pine Point Townsite – Claim D6	Pine Point Townsite	1963 to 1988
N/A	Contemporary	Pine Point Townsite – Claim D-6	Pinecrest cemetery	1878 to 2017

3.4.2 Traditional Land and Resource Use

The Project is within the traditional territories of the Deninu Kue First Nation, K'atl'odeeche First Nation, and Northwest Territory Métis Nation. Previous studies related to ITK and traditional land and resource uses in the vicinity of the Project include ITK studies for the communities of Fort Resolution (Deninu Kų́ę́ First Nation and Fort Resolution Métis Council; Swisher 2006a) and Hay River (Hay River Métis Council and Northwest Territory Métis Nation; Swisher 2006b), and an ITK assessment for the Hay River Reserve (K'atl'odeeche First Nation; Eagle Eye Concepts 2007). These studies were conducted for Tamerlane Ventures Inc.'s Pine Point Pilot Project as part of the EA process. This section provides an overview of the TLRU in the terrestrial LSA (Section 3.1.4) and South Slave Region from these studies.

3.4.2.1 Deninue Kųę First Nation and Northwest Territory Métis Nation

Community members from Deninu Kų́ę́ First Nation, Fort Resolution Métis, and Hay River Métis have extensive familial roots in the South Slave Region and indicated that they or their family frequented the LSA or broader general area (Swisher 2006a,b). Some community members began to use the area for traditional activities after the highway was built in the 1960s, but others have been using the area since the 1920s, which was accessed in the winter by dog team and during the summer by boat or overland by cutlines (Swisher 2006a). Hay River Métis community members indicated their historical use of the area ranges from 26 years to many generations (Swisher 2006b).

The LSA is used by the Deninu Kų́ę́ First Nation, Fort Resolution Métis, and Hay River Métis for hunting, trapping, medical plant and berry gathering, collecting firewood and also for employment activities associated with the Tamerlane 2005 Drill Program (Swisher 2006a,b). Community members stated they have walked or travelled through the LSA or larger region in recent years, including actively snowmobiling in the South Great Slave region for traditional and work-related activities (Swisher 2006a,b).

Trapping areas are typically rotated, and the LSA is viewed as part of a larger traditional use area. Wildlife traditionally harvested by Deninu Kų́ę́ First Nation, Fort Resolution Métis, and Hay River Métis in the LSA and general South Slave Region are presented in Table 3-19. In general, terrestrial furbearers are typically harvested from November to mid-March, aquatic furbearers are harvested from mid-October to mid-May, waterfowl are hunted in the spring, game birds are hunted in the fall and winter, and large game are typically hunted year-round (Swisher 2006a,b).

Table 3-19: Traditionally Harvested Wildlife in the Local Study Area and South Slave Region

Local Name				
Birds	Large Game	Terrestrial Furbearers		Aquatic Furbearers
Waterfowl Upland game birds (e.g., prairie chicken, spruce chicken, and ruffed grouse)	Wood bison (buffalo) Moose Woodland caribou Barren-ground caribou Muskox Black bear White-tailed deer	Marten Lynx Mink Wolf Fox Wolverine	Squirrel Ermine Fisher Rabbit Coyote Porcupine	Muskrat Beaver Otter

Source: Swisher 2006a,b

Medicinal plants are used in the communities of Deninu Kų́ę́ First Nation, Fort Resolution Métis, and Hay River Métis, and species identified in the LSA include Labrador tea, white rat root, spruce gum, tamarack, popular buds, and birch trees (Swisher 2006a,b).

Some community members considered both groundwater and surface water in the terrestrial LSA to be poor quality, because it is alkaline and sulphurous, and not fit for consumption (Swisher 2006a,b). It was noted that the water was drinkable prior to the start of the historical Pine Point Mine, but some believed that the water quality was alkaline and had a high pH prior to the historical Pine Point Mine (Swisher 2006a).

Community members from Deninu Kų́ę́ First Nation, Fort Resolution Métis, and Hay River Métis either historically or currently fish in the South Slave Region, and fish were traditionally harvested for food, dog food, bait traps, and for trade (Swisher 2006a,b). Several community members were commercial fishermen on Great Slave Lake and at the mouth of the Rocher River, starting in the 1950s. Big Buffalo River was identified as a primary fish harvesting location, where Whitefish or Inconnu, were traditionally harvested. Twin Creek might also be used for fishing by some community members, where pickerel (i.e., Walleye), suckers (i.e., Longnose Sucker, White Sucker), and stickleback (i.e., Ninespine Stickleback) are present at the mouth of the creek. Polar Lake is generally not used for traditional purposes because it was a stocked lake (Swisher 2006a,b). Specific fish species traditionally harvested in Big Buffalo River include Whitefish, Inconnu, Pickerel, Lake Trout, Jackfish (i.e., Northern Pike), Arctic Grayling, Sucker (i.e., Longnose Sucker), Goldeye, Cisco, and Mullet (Swisher 2006a). Fish harvested by Deninu Kų́ę́ First Nation, Fort Resolution Métis, and Hay River Métis in the South Slave Region are presented in Table 3-20.

Table 3-20: Traditionally Harvested Fish in the South Slave Region

Local Name	
Whitefish (i.e., Lake Whitefish or Round Whitefish) Rocky Mountain Whitefish (i.e., Mountain Whitefish) Jackfish (i.e., Northern Pike) Pickerel (i.e., Walleye) Inconnu Lake Trout Dog-Face Salmon Sucker (i.e., Longnose Sucker, White Sucker, Mountain Sucker) Silver Sucker Goldeye	Tullibee (i.e., Cisco) Loche, Maria (i.e., Burbot) Arctic Grayling Mullet Chub (i.e., Lake Chub) Stickleback (i.e., Ninespine Stickleback) Lamprey (i.e., Arctic Lamprey)

Note: Common names of traditionally harvested fish are shown in parentheses in cases where colloquial names differ from common names. Dog-face Salmon and Silver Sucker are colloquial names for which the common name is uncertain (Adapted from Swisher 2006a,b).

Although Deninu Kų́ę́ First Nation, Fort Resolution Métis, and Hay River Métis community members did not specifically know of anyone living in the LSA, they had observed evidence of old prospector and hunting cabins, and it was noted that people historically used the area seasonally to hunt, and historic cabins existed (Swisher 2006a,b). It was also noted that evidence of people using the bush (e.g., axe marks) was commonly observed while out on the land. Although there were no known gravesites in the vicinity of the Project, community members noted that they had the potential to exist in the LSA since historically, people were buried at the site where they died (Swisher 2006a). Previously recorded heritage resources in the LSA align with ITK, as a cairn/wood feature was identified as a potential historic grave (JfPo-3; Section 3.3.1.2). The LSA is currently used for traditional harvesting, berry gathering, and cutting wood, and community members indicated there is a high potential that culturally significant sites occur in the area. It was also noted that trappers from Hay River and Fort Resolution must have used the area because of evidence of old cans they had observed (Swisher 2006a). A summary of previous archaeological studies and documented heritage resources is provided in Section 3.4.1.

Within the Métis community and culture, traditional harvesting grounds are considered to be cultural sites, and community members stated that as part of a broader area, the LSA is recognized by the Métis as a cultural site used for traditional harvesting activities (Swisher 2006b).

3.4.2.2 K'atl'odeeche First Nation

K'atl'odeeche First Nation community members reported use of the LSA for hunting and harvesting resources and the community has strong economic ties with the land (Eagle Eye Concepts 2007). Caribou, moose, and waterfowl (e.g., ducks and geese) are hunted for sustenance. Elék'eh is a muskeg area on the south shore of Great Slave Lake and east of Buffalo River, and supports beaver, muskrat, and other wildlife, and is an important waterfowl nesting area. Specific moose harvesting sites were identified along the southern shore of Great Slave Lake, High Point, Birch Creek, and Twin Creek. Hunting also occurs along the Buffalo River (Eagle Eye Concepts 2007).

K'atl'odeeche First Nation community members noted that water flows to the Great Slave Lake via creeks and rivers, and also accumulates in swamps in the south shores of the Great Slave Lake through other drainage systems that do not flow out into the Great Slave Lake (Eagle Eye Concepts 2007). Snow water and rain drains from the LSA into the Buffalo River and Great Slave Lake. During the spring runoff, the Inconnu and Suckers are reported to make their spawning run up the Buffalo River and then make their journey back to the Great Slave Lake in the fall in early October.

The LSA is used by the K'atl'odeeche First Nation for sustenance and economic well-being and has an abundance of resources on which they are dependent. The K'atl'odeeche First Nation also recognize themselves as stewards of their traditional lands and waters and are responsible for their protection for future generations (Eagle Eye Concepts 2007).

3.4.2.3 Additional Studies

Additional studies of land use and ITK in the area around the historical Pine Point mine include: a study of post-industrial land use at the historical Pine Point mine (LeClerc and Keeling 2015); a paper regarding the integration of biophysical sciences, social sciences, and ITK regarding the land around Fort Resolution (Wolfe et al. 2006); and a report on boreal caribou and their species at risk status (NWT Species at Risk Committee 2012). Other sources of ITK regarding TLRU of Indigenous communities in the broader region exist in the form of baseline studies for other industrial developments (e.g., the Gahcho Kué Mine) and academic and community-based literature.

3.4.3 Socio-economics

3.4.3.1 Population

The population of the NWT has grown in recent years by around 2% from 43,884 in 2014 to 44,826 in 2018, half of which are Indigenous people. Roughly a third of the territory's Indigenous population can speak an Indigenous language. The territory is projected to experience modest population growth over the next five years (GNWTBS 2018). Yellowknife (population 21,183) is the closest large regional centre to the Project and is the economic hub of the NWT. The city has experienced population growth of 4% over the past five years, and is forecasted to continue to grow, albeit at a more modest rate, in the years leading up to 2025[2]. Around one quarter of the city's population is Indigenous, 21% of which can speak an Indigenous language (Table 3-21).

[2] Population projections are basic straight-line considering birth and death rates, and do not factor in external drivers of population change.

Other than Yellowknife, the largest communities in the LSA are Hay River (population 3,749) and Fort Smith (population 2,639). Both communities are characterized by high non-Indigenous populations (roughly half) relative to the smaller communities in the LSA. Over the past five years, the population of the two communities has remained relatively stable, with marginal decline in Hay River (-0.3%) and modest growth (0.2%) in Fort Smith. The ability to speak an Indigenous language is low amongst the Indigenous population of both communities (15.7% and 16.1%, respectively) (Table 3-21).

The population of the smaller LSA communities ranges from 110 (Enterprise) to 684 (Fort Providence). Since 2014, there has been population growth in Fort Resolution, Fort Smith, the Hay River Reserve, and Dettah (4.1%, 0.2%, 5.4%, and 4.3%, respectively). During the same period, Enterprise and Fort Providence have experienced substantial population decline of 10.0% and 13.5%, respectively. Population growth is expected to occur in the small communities over the next five years, with the exception of Łutsel K'e, where the population is expected to decline by around 8% (Table 3-21).

While the majority of the population of Enterprise (57%) is not Indigenous, the populations of the other small communities in the LSA are largely Indigenous. With the exception of the Hay River Reserve, the small communities exhibit a high male to female ratio, with 1.24 to 1.34 males for every female, depending on the community. The ability to speak an Indigenous language is variable among the small communities, being lowest in Enterprise, the Hay River Reserve, and Fort Resolution (38%, 33%, and 30%, respectively) and highest in Dettah, Fort Providence, and Łutsel K'e (56%, 62%, and 64%, respectively) (Table 3-21).

Table 3-21: Population and Select Demographic Characteristics in Communities

Community	Total Population (2019)	Indigenous Population (%) (2019)	Male to Female Ratio (2019)	Population Change (2014-2019,%)	Population Projection (2025)	Population Speaking an Indigenous Language (%)[(a)]
Enterprise	110	42.7	1.24	-10.0	125	37.7
Fort Providence	684	93.0	1.31	-13.5	698	62.3
Fort Resolution	532	86.7	1.27	4.1	554	29.9
Fort Smith	2,639	58.7	1.03	0.2	2,650	16.1
Hay River	3,749	45.7	1.07	-0.3	3,966	15.7
Hay River Reserve	335	98.2	0.94	5.4	360	33.3
Dettah	234	97.4	1.07	4.3	280	55.9
Łutsel K'e	314	90.4	1.34	-1.0	289	64.3
Yellowknife	21,183	24.4	1.02	4.1	21,424	20.9
NWT	44,826	49.9	1.06	2.1	45,110	35.6

Source: GNWTBS 2018, 2019a-b.

Note: Hay River Reserve is also known as Hay River Dene 1, and is home to the K'atl'odeeche First Nation.

(a) Percentage of the Indigenous population in the community with the ability to speak an Indigenous language.

3.4.3.2 Economics and Employment

This section provides an overview of labour force conditions, incomes, educational attainment, and economic activities in the LSA communities and the NWT. Data regarding employment, incomes, and educational attainment have been drawn from the most recent Statistics Canada census in 2016 (2017a-j) and the GNWT Bureau of Statistics community statistical profiles (GNWTBS 2019c). Data on the traditional economy are sourced from the most recent surveys of participation in traditional activities (GNWTBS 2015a,b). Information regarding local business activity and economic development planning has been sourced from municipal and organizational websites and publications.

3.4.3.2.1 Employment, Incomes, and Cost of Living

In 2019, 25,785 people were active in the NWT labour force, representing a participation rate of 73.6% of the population aged 15 and over. Of those participating in the labour force, 10.9% are unemployed. Yellowknife's size and concentration of territorial economic and service provision activity creates an environment where participation in the labour force is high (78.9%), and unemployment is low (4.7%). In Hay River and Fort Smith, participation in the labour force (76.5% and 70.0%, respectively) and unemployment rates (6.6% and 10.2%) are in line with territorial averages, reflective of their larger size relative to the other South Slave communities, and the greater abundance of economic opportunities (Table 3-22).

Of the remaining communities, labour force participation rates are highest in Fort Resolution and Fort Providence (65.9% and 65.0%, respectively); however, the unemployment rate in both communities is high (29.7% and 30.6%, respectively). This reflects a labour market where a large portion of the population aged 15 and over is seeking work, but unable to secure employment. Participation in the labour force is lowest on the Hay River Reserve (58.9%), in Dettah (58.8%), Enterprise (55%), and Łutsel K'e (54.2%). With the exception of Enterprise, the unemployment rate in each community is high, suggesting that, as is the case in the larger South Slave communities, securing employment is a challenge for those participating in the labour force due to a lack of opportunities (Table 3-22).

Table 3-22: Labour Force Characteristics (2019) in Communities

Community	Population 15+	Labour Force	Employed	Unemployed	Participation Rate (%)	Unemployment Rate (%)
Enterprise	88	48	42	6	55.0	13.1
Fort Providence	635	413	286	126	65.0	30.6
Fort Resolution	433	285	201	85	65.9	29.7
Fort Smith	2,145	1,502	1,348	154	70.0	10.2
Hay River	3,172	2,427	2,267	160	76.5	6.6
Hay River Reserve	251	148	82	66	58.9	44.6
Dettah	178	105	81	24	58.8	22.7
Łutsel K'e	255	138	98	40	54.2	28.7
Yellowknife	16,561	13,073	12,464	610	78.9	4.7
NWT	35,046	25,785	23,034	2,750	73.6	10.7

Source: GNWTBS 2019c.
Note: Yellowknife includes N'Dilo.

Median household ($117,688) and individual ($46,864) incomes in the NWT are high relative to the rest of Canada. Median incomes are highest in Yellowknife, where households ($142,616) and individuals ($67,792) benefit from the availability of employment opportunities. The city also has the lowest percentage of families with incomes below $30,000 (6.9%). Median household incomes in Hay River and Fort Smith ($115,424 and $105,899, respectively) are slightly lower than the territorial average; however, individual incomes ($53,431 and $48,333, respectively) are higher. This could be indicative of a greater number of households including a single income earner. Of the remaining communities, household incomes are lower, ranging from $50,304 in Łutsel K'e to $79,104 in Enterprise (Table 3-23). Łutsel K'e and Fort Providence have the highest proportion of families with incomes less than $30,000 (37.5% and 27.3%, respectively).

Table 3-23: Incomes and Associated Indicators in Communities

Community	Median Total Household Income (2015, $)	Median Total Individual Income (2015, $)	Families with Incomes Less than $30,000 (2017,%)	Living Cost Differential (2018)[(a)]	Market Basket Measure (2017, $)
Enterprise	79,104	x	n/a	n/a	n/a
Fort Providence	59,008	19,984	27.3	137.5	n/a
Fort Resolution	55,424	23,360	15.4	152.5	n/a
Fort Smith	105,899	48,333	13.2	127.5	60,178
Hay River	115,424	53,431	12.0	n/a	64,105
Hay River Reserve	61,312	22,592	n/a	n/a	n/a
Dettah	59,264	x	n/a	157.5	n/a
Łutsel K'e	50,304	21,952	37.5	n/a	n/a
Yellowknife	142,616	67,792	6.9	138.6	59,304
NWT	117,688	46,864	12.9	n/a	n/a

Source: Statistics Canada 2017a-j.
x = area and data suppression; n/a = non applicable
(a) Edmonton = 100

The cost of living is high in the NWT. In the LSA communities, the cost of living is between 28% (Fort Smith) and 58% (Łutsel K'e) higher than the reference point of Edmonton, Alberta[3]. This is heavily influenced by the cost of transporting goods to the communities, particularly Łutsel K'e. The Market Basket Measure calculates the cost of food, clothing, transportation, shelter, and other basic expenses for a family of four representative of a modest, basic standard of living. While the cost of meeting this standard is substantial in Yellowknife ($59,304 per year), high household incomes help to offset the impact on household finances. In the communities large enough for the measure to be applied (i.e., Hay River and Fort Smith), the cost of these basic expenses is roughly equivalent to 80% of a household's median income after deductions such as income tax. While the measure is not applied in the smaller communities, it can be assumed that, given the lower household incomes and more remote locations the cost of meeting a basic standard of living is more challenging (Table 3-23).

3.4.3.2.2 Education and Training

Many employment opportunities in the economy require varying levels of educational attainment, with a high school education often serving as the basic requirement for access to entry-level opportunities, including those in the mining industry. It is not, therefore, unexpected that educational attainment is highest in LSA communities where participation in the labour force is high and unemployment is low. Yellowknife and Hay River have a low portion of the population aged 15 and over without a high school education (14.5% and 17.8%, respectively) relative to the NWT (27.4%). In Enterprise and Fort Smith, the proportion is lower but more in line with the territorial average (23.5% and 25.0%, respectively) (Table 3-24).

[3] Edmonton is used as a standard reference point for comparing cost of living to against northern communities, representing a moderate cost of living.

In the remaining communities, between half and two thirds of the population aged 15 and over have not completed high school, depending on the community. Most of the LSA communities have a larger portion of the population aged 15 and over in possession of a college certificate, an apprenticeship designation, or a trade than the overall territorial population aged 15 and over. This reflects a labour force trained in areas of employment valuable to, amongst other industries, construction and mining activity (Table 3-24). Semi-skilled and skilled employment opportunities are typically filled by candidates with some form of certification, apprenticeship, or trade, and are also those most associated with mining activities.

Table 3-24: Highest Level of Educational Attainment Amongst the Population Aged Fifteen and Over (2016)

Community	Population, Age 15 and Over	Less Than High School (%)	High School (%)	College Certificate (%)	Apprenticeship or Trade (%)	University Degree (%)
Enterprise	85	23.5	17.6	29.4	23.5	0.0
Fort Providence	580	54.3	18.1	8.6	13.8	4.3
Fort Resolution	375	49.3	13.3	14.7	17.3	6.7
Fort Smith	1,560	25.0	19.2	10.6	25.0	17.6
Hay River	1,995	17.8	20.1	17.3	24.8	17.5
Hay River Reserve	230	60.9	10.9	8.7	17.4	0.0
Dettah	180	63.9	19.4	5.6	8.3	0.0
Łutsel K'e	230	52.2	15.2	10.9	13.0	8.7
Yellowknife	15,400	14.5	24.3	8.4	20.3	29.1
NWT	32,325	27.4	21.4	9.8	18.9	20.0

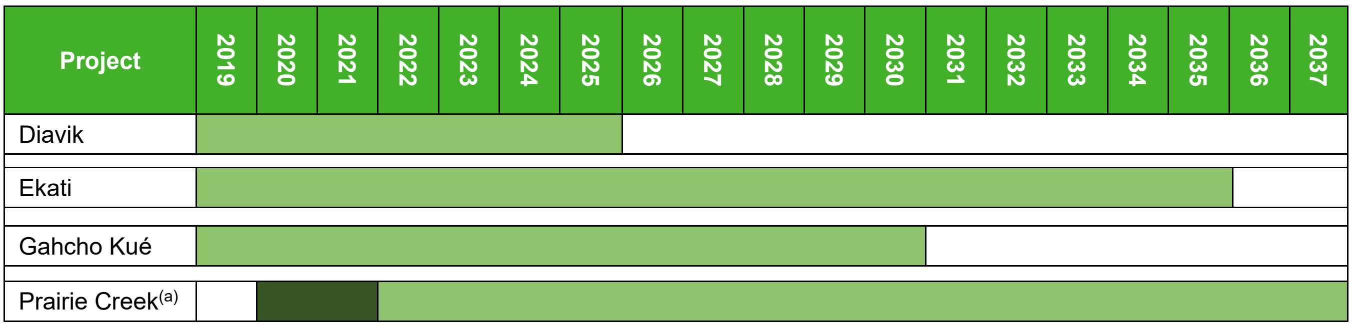
Source: Statistics Canada 2017a-j

Educational services are available in LSA communities through primary, secondary, and post-secondary institutions. Primary education is provided in all LSA communities, except Enterprise. Students in Enterprise are bussed to Hay River for school. In Dettah, school is available from kindergarten to Grade 9, with high school provided in Yellowknife. Kindergarten to Grade 12 schools are present in the other LSA communities. Learning centres that focus on the provision of mine training are available in all communities, except Enterprise and the Hay River Reserve. Career centres are available in Fort Smith, Hay River, and Yellowknife to offer career counselling and skills development programming. Thebacha Campus also operates in Fort Smith, providing courses in administration, trades, and mining. The Aurora College campus in Yellowknife is the territory's main post-secondary campus, offering university and college transfer courses.

3.4.3.2.3 Industrial Development

The NWT economy is heavily reliant on the mining industry for private investment and revenue generation (e.g., property taxes, taxes on production). Since its beginnings in the late 1990s, diamond mining continues to be the most important economic activity in the territory, with oil and gas extraction and tourism also playing large economic roles. The value of diamond mining production peaked in 2004 when the combined activities of the Ekati and Diavik mines produced $2.1 billion in diamonds. The global recession in 2009 brought temporary shutdowns at the Diavik and Snap Lake mines, reducing diamond production levels in the territory. The value of production returned to peak levels in 2010, but declined to below $2 billion between 2011 and 2016, before recovering again in 2017. Overall, diamond production values have grown to nearly $2.1 billion in 2018, representing a boom to the territorial economy as increased production influences employment and government revenues. Oil and gas production values, while remaining relatively stable and representing around a fifth of total territorial mineral production (including oil and gas) until 2015, have declined sharply in recent years to represent only 1% of mineral resource production in 2018 (GNWT 2019a).

The economic effect of the closure of existing, operational diamond mines in the NWT may be offset in part by the development of new mining operations such as the Prairie Creek Mine in the Dehcho Region, or other projects without defined future timelines (e.g., the NICO mine) (Avalon 2019; NorZinc 2019). Each will create employment and contracting opportunities that may be accessible to those communities most affected by the closure of the Diavik and Gahcho Kué mines. The Ekati mine is currently expected to continue to operate into the future (2035). In the South Slave Region, the development of the Taltson Hydroelectric Project is also expected to contribute to local economic activity (GNWT no date). The schedule for the existing and reasonably foreseeable mining developments is depicted in Figure 3-15.



(a) The Prairie Creek project is scheduled for construction between 2020 and 2021

Figure 3-15: Operational Mine Life for NWT Mines

The development and, subsequently, production timelines for the approved and likely projects presented in Figure 3-15 may change as developers evaluate construction feasibility in future years.

3.4.3.2.4 Local Business

There are a number of businesses associated with the K'atl'odeeche First Nation, most of which are based out of Hay River and the Hay River Reserve. Construction and contracting services are most prevalent, although other services such as transportation and forest firefighting are also available (Table 3-25).

Table 3-25: Local Businesses with Services Supporting Mining - K'atl'odeeche First Nation

Business	Services Offered	Location
Naegha Zhia Inc.	Real estate management and construction	Hay River
Evergreen Forestry	Forest firefighting	Hay River
Denedeh Helicopters	Aerial services	Yellowknife
Manny's Company	Construction	Hay River Reserve
Les Norn Contracting	General contracting, gravel delivery, heavy equipment operations, sewage removal	Hay River Reserve
Sunrise Contracting	General contracting, building construction	Hay River Reserve

Source: K'atl'odeeche 2009a,b.

The Deninu Kue Development Corporation is the economic development arm of the Deninu Kue First Nation. The Corporation supplies both goods (e.g., building construction materials, containers and packing material, lumber/plywood) and services (e.g., bus transportation, fence construction, rental and leasing of commercial space, taxi services) in the South Slave Region. The Hay River Metis Government Council (5323 NWT Ltd.) offers a number of services ranging from hospitality to transportation (water, bussing, trucking), construction, and consulting, and others (GNWTITI No date (a)).

The Densoline Corporation is based out of Yellowknife, offering a number of services that include transportation, material and equipment provision, and site maintenance (Table 3-26).

Table 3-26: Local Businesses with Services Supporting Mining Activities - Denesoline Corporation

Business	Services Offered	Location
Denesoline Corporation		
Denesoline - Acasta Heliflight	Helicopter services	Yellowknife
Denesoline - Arctic West Transport	Open deck, bulk transportation, and heavy haul applications	Yellowknife
Dene-Dyno Nobel Explosives	Explosives and blasting materials	Yellowknife
Denesoline Real Estate	Real estate management	Yellowknife
Denesoline - Air Tindi	Fixed-wing charter aviation	Yellowknife
Denesoline - Petro-Canada Lubricants	Equipment lubricants	Yellowknife
Dene - Gilbert NWT Contracting Ltd.	Mine site maintenance	Yellowknife
DTR First Nation's Construction Company	Ice road services	Yellowknife
Dene-Ryfan Limited	Mechatronics	Yellowknife
Denesoline Fire Fighting	Firefighting, forest fire management, community protection and hazard reduction, equipment and facility maintenance, and facility maintenance	Łutsel K'e
Dene - Aurora Manufacturing	Manufacturing and metalwork, equipment maintenance, repair and testing, fuel storage, handling, and dispensing	Hay River
Dene - Tire North	Supplier of tires and tire installation for northern mines	Not applicable

Source: Det'on Cho Companies no date; Denesoline Corporation 2018a,b.

Businesses associated with the Yellowknives Dene First Nation that could service the mining industry are based out of Yellowknife, and largely associated with the Det'on Cho Corporation. Services offered are varied, from housekeeping and camp services, to construction and site maintenance (Table 3-27).

Table 3-27: Local Businesses with Services Supporting Mining - Yellowknives Dene First Nation

Business	Services Offered	Location
Bouwa Whee	Management, housekeeping, and janitorial services with major diamond mine contracts	Yellowknife, NWT
Det'on Cho Construction Services	Construction	Yellowknife, NWT
Det'on Cho DT Electric	Construction and operation services such as wiring of new facilities, renovation and additions, preventative and restorative maintenance programs	Yellowknife, NWT
Det'on Cho Environmental	Environmental consulting	Yellowknife, NWT
Det'on Cho Logistics	Expedited logistics, freight forwarding, freight management and inventory control, and supply chain logistics	Yellowknife, NWT
Det'on Cho Landtran Transport	Transportation services	Yellowknife, NWT
Det'on Cho Medic North	Health care personnel, medical equipment, and supplies and emergency vehicles for northern employers and workers	Yellowknife, NWT
Det'on Cho Nahanni Construction	Pipe and mechanical installations, and mine site services including earthworks	Yellowknife, NWT
Det'on Cho NUNA	Giant Mine site management, maintenance, and remedial improvements and demolition	Yellowknife, NWT
Det'on Cho Scarlet Security	Security services to mine sites, pipelines, roadways, and building	Yellowknife, NWT

Table 3-27: Local Businesses with Services Supporting Mining - Yellowknives Dene First Nation

Business	Services Offered	Location
Det'on Cho Summit Aviation LP	Passenger and freight transportation	Yellowknife, NWT
Diamond International Canada / Aboriginal Diamonds Group	Rough diamond appraisals	Yellowknife, NWT
Kete Whii Ltd.	Full-service provider specializing in developments of open-pit, underground mining, and civil infrastructures	Yellowknife, NWT
We Le Dai Corp	Dietary, housekeeping, laundry, translation, and shuttle services	Yellowknife, NWT

Source: GNWTITI 2019a.

There are a number of local businesses in the LSA that offer services that could be of value to the construction and operation of a mine, including companies operating out of Enterprise, Łutsel K'e, and Fort Providence (Table 3-28).

Table 3-28: Local Businesses with Services Supporting Mining in Enterprise, Łutsel K'e, and Fort Providence

Business	Services Offered	Location
Lisa's Place	Accommodations, meals, and catering	Enterprise
Blackstone Homes	Building construction and maintenance	Enterprise
Key Contracting	Trucking transportation, general contracting, remediation services, road maintenance, and wrecking/demolition	Enterprise
Cliff's Custom Cutting	Forestry, landscaping/agricultural, material management, piling contractor, rental/leasing, snow removal, storage/warehouse, and wrecking/demolition	Enterprise
Tammy's Administrative Services	Computer services, graphic design, financial services, research services, word/data processing, and secretarial/clerical	Enterprise
Eric's Bobcat Service	Freight/cargo/moving services, earthmoving/excavating/bulldozing	Enterprise
Floyd's General Contracting	Road maintenance, equipment and vehicle rental and leasing, road construction, and airport/runway construction	Łutsel K'e
LK-RCS Resource Services Ltd.	Mining construction and contracting, remediation services, and technical services	Łutsel K'e
Northern Medical Travel	Road transportation	Fort Providence
Built Right Construction	Construction, general contracting	Fort Providence
Steadyflow Plumbing Services	General contracting	Fort Providence
The North West Company LP	Equipment	Fort Providence
Big River Service Centre Limited Partner Big River Service Centre LP	Catering	Fort Providence
Cherdon Enterprises	Boarding home, general contracting, road transportation and maintenance, equipment rental and leasing	Fort Providence
Digga Enterprises	Construction, janitorial, property management, real estate development, vehicle rental, leasing, repair, road maintenance	Fort Providence
Snowshoe Inn NWT Ltd.	Construction equipment and supplies	Fort Providence

Source: GNWTITI 2019a.

3.4.3.2.5 Traditional Economy

With the exception of Dettah and the Hay River Reserve, participation in traditional activities increased in all LSA communities in in the decade between 2004 and 2014. More recent comparable data are not publicly available. However, during the same period, these communities experienced a reduction in the number of households where 75% or more of the meat and fish they consumed came from traditional harvesting activities (Table 3-29). This could suggest that the nature of traditional activities changed over the decade with a decreased focus on hunting and fishing, that hunting and fishing activities yielded lower harvests for consumption, and/or that an increasing portion of meat and fish harvested was instead sold (GNWTBS 2015a,b). Recent bans on caribou harvesting in the NWT have also likely played a role in reduced participation in traditional hunting activities.

In 2014, the number of households where traditional harvesting was the main source of meat and fish was lowest was in Yellowknife (4%), Hay River (8%), and Fort Smith (9%), which are the communities with the highest participation in the wage economy and with the greatest access to consumer goods. Conversely, the number of households consuming primarily harvested meat and fish was highest in those communities where participation in the wage economy is less pronounced. In most of these communities, around a third of households consumed primarily traditionally harvested meat and fish. In Łutsel K'e, over half of all households relied on traditional harvesting to supply most of the meat and fish that they consume (Table 3-29).

Table 3-29: Participation in Traditional Economic Activities (Percentage) in Communities

Community	Participation in Traditional Activities (2004)[a]	Participation in Traditional Activities (2014)[a]	Consumption of Harvested Meat or Fish (2004)[b]	Consumption of Harvested Meat or Fish (2014)[b]	Change in Participation (2004-2014)	Change in Consumption (2004-2014)
Enterprise	28.1	46.2	-	-	64.1	n/a
Fort Providence	44.3	54.0	38.9	28.5	22.0	-26.7
Fort Resolution	53.3	62.2	43.6	32.4	16.8	-25.6
Fort Smith	33.3	41.2	10.9	9.4	23.9	-13.9
Hay River	26.4	48.0	8.5	7.5	81.8	-12.4
Hay River Reserve	37.7	37.7	21.6	33.4	0.0	55.0
Dettah	43.3	37.1	30.7	39.3	-14.4	27.9
Łutsel K'e	73.6	79.8	68.1	52.5	8.4	-23.0
Yellowknife	32.3	37.1	5.0	3.7	14.8	-27.5
NWT	36.7	44.7	17.5	13.8	21.7	-20.9

Source: GNWTBS 2015a,b.

- = indicates zero or too small to be expressed.

n/a = not applicable.

(a) Hunted or fished in the previous year.

(b) Households where 75% or more of the meat or fish eaten in the house was obtained through hunting or fishing.

3.4.3.2.6 Economic Development Planning

The GNWT Department of Industry, Tourism and Investment maintains the community economic development Support for Entrepreneurs and Economic Development initiative that seeks to provide funding to organizations pursuing regional economic development activities. The initiative invests in planning, infrastructure, media, and events promoting economic activities, and is open to NWT Indigenous organizations, NWT-based businesses, and municipalities. The initiative provides a maximum of $25,000 for the following (GNWTITI 2020a):

- Feasibility studies, strategic plans, evaluations and planning costs that investigate economic opportunities and build on existing community resources.
- The purchase or further development of physical infrastructure (i.e., capital assets) where the lack of infrastructure constrains business development.
- Improving access to business information.
- Host and promote community-based festivals and events that highlight NWT products or talent and are key to economic development for the community.

The GNWT Department of Industry, Tourism and Investment also maintains a network of Community Development Officers to promote economic activity and business development in the NWT. Community Development Officers are charged with supporting community economic development through (GNWTITI 2020b):

- New business development and existing business expansion.
- Access to field specialists, such as regional tourism officers, petroleum officers, and business development officers.
- Mentoring, funding and business network development.
- Business training, awareness and counseling.
- Sourcing information and market data.
- Development of opportunities in a wide range of economic sectors.

The City of Yellowknife's Economic Development Strategy for 2014 to 2019 identifies priority areas for economic development (City of Yellowknife 2014). The City has a goal of increasing its population to increase per capita federal transfer funding as a means of creating income to spend on economic development initiatives. The City currently operates as a key supplier of goods and services to other communities and industries in the NWT and the western regions of Nunavut. The Economic Development Strategy recognizes that continuing this role will be integral in building other areas of the economy.

The Strategy identifies tourism, and in particular that related to Indigenous culture and the natural environment, as a key current and future economic driver for the City and the surrounding region. Linked to this, the Strategy seeks to develop the local arts and culture industry, and to improve the condition of the downtown core to act as a draw for tourists from southern locales. Strengthening the local capture of employment, contracting, and other business opportunities associated with territorial mining activities is another priority outlined by the strategy, along with diversification away from dependency on mining into areas of environmental and alternative energy technology (e.g., hydro power, biomass, solar, and geothermal energy). Finally, stakeholder input into the Strategy indicated that the expansion of post-secondary education services to retain youth and attract workers is of key importance to the overall economic health of the City and the NWT (City of Yellowknife 2014).

The Town of Hay River has an Economic Development Division that focuses on developing the town's role as a transportation, shipping, and freight hub for the South Slave Region, and the NWT more generally (Town of Hay River 2020). In addition of being a hub for daily commercial flights and a staging area for charter air travel, the community is also the northernmost railhead in Canada, connecting to Edmonton via the RailLink route (Town of Hay River 2020). Hay River serves as a supply hub for mining operations, both historically (e.g., the historical Pine Point mine) and for operating mines in the North Slave Region. Maintaining this role as a supplier of goods ad services to the mining industry continues to be a priority. Commercial fishing is another economic development priority for Hay River. In 2019, the GNWT announced funding for the construction of a new fish processing plant in Hay River to replace the existing plant, which currently only receives fish that is transported to Winnipeg for processing (Cabin Radio 2019; GNWTITI 2019b).

The Economic Development Strategy in place for the Town of Fort Smith spans the period of 2018 to 2022 (Town of Fort Smith 2018). The Strategy lays out a vision of the town working with partners to enhance quality of life by respecting values, traditions, and healthy lifestyles, and centres around the concepts of business development, attracting residents, and developing tourism potential. The Strategy contains detailed implementation plans to achieve the town's targeted economic development goals (Town of Fort Smith 2018).

The Yellowknives Dene are in the process of developing an Economic Development Strategy, and a joint strategy with the City of Yellowknife to capture mutual economic benefits associated with each community's individual economic development planning. Ongoing economic development for the Yellowknives Dene is addressed through the Yellowknife Dene First Nation Chamber of Commerce, and the Deton'Cho Corporation (YKDFN 2020).

3.4.3.3 Health and Well-being

The physical and mental health of an individual is influenced by a myriad of social determinants of health (Government of Canada 2019c), including:

- Income and social status
- Employment and working conditions
- Education and literacy
- Childhood experiences
- Physical environments/housing
- Social supports and coping skills
- Healthy behaviours
- Access to health services
- Biology and genetics
- Gender
- Culture
- Race/Racism

Many of the social determinants of health have been discussed based on publicly available statistical data in other sections (e.g., income, employment, and education presented above, while housing and access to services are presented below). While useful to understand high-level health conditions in the territory, statistical data are complemented by contextual, community-specific information that addresses the social determinants of health in greater detail. The Draft EA Initiation Guidelines for Developers of Major Projects (MVEIRB 2018) require a discussion of health rates, addictions, and crime rates. Information on these topics has been summarized and provided below based on publicly available statistics and will be expanded on in the Developer's Assessment Report following further engagement with communities.

3.4.3.3.1 Healthcare System Overview

The Northwest Territories Health and Social Services Authority was created in 2016 when the six operating health authorities were merged into the territorial body. In the South Slave Region, the Hay River Health and Social Services Authority is outside the Northwest Territories Health and Social Services Authority. The Northwest Territories Health and Social Services Authority and Hay River Health and Social Services Authority, along with the Tlicho Community Service Agency, operate as an integrated territorial health and social services system with a shared governance structure (GNWTHSS 2018). The Authorities provide the following services:

- diagnostic and curative services
- mental health and addictions services
- promotion and prevention services
- long-term care, supported living, palliative care and home and community care
- child and family services
- in-patient services
- critical care services
- diagnostic and therapeutic services
- rehabilitation services
- specialist services

Other diagnostic and specialized treatment services are provided outside of the NWT through contractual arrangements with Alberta Health Services (GNWTHSS 2018).

3.4.3.3.2 Health Rates

The prevalence of chronic conditions in the NWT is not substantially different from Canada. The rate of hypertension in the territory amongst the population aged 12 and over was 13.1% in 2014, while the diabetes rate was 7.4% (compared to 17.7% and 6.7% nationally) (GNWTBS 2014). The leading causes of death in the NWT include neoplasms typically associated with cancer (death rate[4] of 14.43) and diseases of the circulatory system, many linked to hypertension and diabetes (death rate of 11.89). Diseases of the respiratory system and accidental death (including suicide) are other high-contributing causes of death (death rates of 5.21 and 5.72, respectively) (GNWTBS 2019d).

Overall, the rate of sexually transmitted infections (STIs)[5] in the NWT population is approximately six times higher than the national average. Sexually transmitted infections are most prevalent amongst the youth demographic, with nearly 6% of males and 11% of females between the ages of 15 and 24 having at least one STI (GNWTHSS 2019a). Chlamydia remains the most prevalent STI in the territory, with an infection rate (3,653) approximately eleven times higher than the national average (334). Rates of gonorrhea have climbed in recent years, with the territorial rate (1,051) measuring nearly 17 times the national rate (65) (Health Canada 2016).

[4] The death rate is calculated as the number of deaths per 10,000, averaged over the three-year period of 2016 to 2018.
[5] The STI rate measures the number of people affected by an STI per 100,000.

3.4.3.3.3 Substance Use and Addictions

Addictions can affect both the physical and mental health of individuals, and the well-being of families and communities. They can also lead to cascading effects on other determinants of health, affecting the ability to maintain employment, access stable incomes, or connect with social and institutional support networks.

Around a third (33%) of the NWT population aged 15 and over smoke tobacco regularly. Males have a higher rate of smoking (36%) than females (31%). Those aged 24 to 39 had the highest rate of smoking (41%), while those 15 to 24 had the lowest (29%) (GNWTHSS 2019b). More than one quarter (26%) of the NWT population over the age of 15 has used cannabis in the past 12 months. Use of cannabis is highest amongst the population aged 15 to 24 (36%), and more prevalent amongst males. Of those who used cannabis in the past year, the majority use it daily or almost daily (GNWTHSS 2019c). Nearly half of the NWT male population over the age of 15 (47%) and over one third of females (39%) are considered to be heavy drinkers[6]. Overall, 43% of the NWT population over the age of 15 drink heavily. Heavy drinking rates are relatively consistent across age groups between 15 and 60, but are highest (47%) amongst those aged 25 to 39 (GNWTHSS 2019d). The use of crack/cocaine in the NWT is high (11% of the population aged 15 and above) relative to the national rate (7%), and is more prevalent amongst males (12%) than females (9%) (GNWTHSS 2019e).

Nearly half of all mental health hospitalizations in the NWT are due to substance abuse, with 86% of substance abuse-related hospitalizations being associated with alcohol. At the national level, alcohol accounts for 53% of substance abuse-related hospitalizations. Hospitalizations due to cannabis or cocaine use are similar to those nationally, while hospitalizations due to use of opioids, other controlled stimulants and depressants, or multiple drug interactions are lower (GNWTHSS 2019f). Around 75% of those who enter residential addiction treatment in the NWT complete treatment (GNWTHSS 2019f).

3.4.3.3.4 Crime Rates

The crime rate is the number of police-reported offences per 1,000 people in a community. The rate of violent and property crimes in the NWT is high (83.2 and 198.0, respectively). While lower than those of the territory, the crime rates in Yellowknife are still high (45.3 [violent crimes] and 146.5 [property crimes]). With the exception of Fort Smith, violent crime rates are higher in the smaller communities, with the rate in Fort Providence (249.4) tripling that of the territory. Property crime rates are similarly much higher in the South Slave communities, with the exception of Łutsel K'e, than in the territory overall. The highest rate of property crime is experienced in Fort Resolution, where the rate is over three times that of the territory (Table 3-30).

[6] The NWT Department of Health and Social Services defines heavy drinking as consuming four to five or more alcoholic beverages in a single sitting or occasion at least once a month, within the past 12 months.

Table 3-30: Criminal Activity in Communities

Community	Police Reported Crimes (2018)	Violent Crime Rate[a] (2017)	Property Crime Rate[a] (2017)
Enterprise	-	-	-
Fort Providence	615	249.4	355.8
Fort Resolution	358	159.8	457.6
Fort Smith	787	63.6	207.7
Hay River	1,592	94.0	143.0
Hay River Reserve	-	-	-
Dettah	-	-	-
Łutsel K'e	93	130.3	97.0
Yellowknife	6,330	45.3	146.5
NWT	20,353	83.2	198.0
Canada	1,958,023[b]	11.0	32.5

Source: GNWTBS 2018. Statistics Canada 2018.
- = data not available
(a) Crime rate is the number of police-reported offences per 1,000 people in a community.
(b) 2017.

3.4.3.3.5 Healthcare and Protective and Services

Healthcare services are available in most LSA communities. The Stanton Territorial Hospital in Yellowknife is a full medical service facility and operates as a hub for healthcare services in the region. Treatment for chronic and acute care is available through health centres in Fort Providence, Fort Resolution, Fort Smith, Hay River, and Łutsel K'e. Those needing care in Enterprise and Dettah are referred for treatment at healthcare facilities in Hay River and Yellowknife, respectively. The Hay River Reserve has a wellness centre, but residents are referred to healthcare services in Hay River for diagnosis and treatment of some conditions (GNWT 2013b, 2019b). Protective and emergency services in the LSA communities include fire and police. With the exception of Dettah, all LSA communities have a fire hall, and all but Dettah, the Hay River Reserve, and Enterprise have an RCMP detachment for the provision of protective services (City of Yellowknife 2019; GNWT 2013b, 2019b).

3.4.3.3.6 Recreational Services

Recreational services are present in all LSA communities. Each community has a community hall and gymnasium (10 in the Yellowknife). Other recreational facilities are present in the larger LSA communities, such as arenas, curling rinks, and swimming pools (GNWT 2013b; GNWT-ECE 2019; Aurora College 2020; South Slave Divisional Educational Council 2020).

3.4.3.4 Infrastructure and Housing

3.4.3.4.1 Physical Infrastructure

The LSA communities use a combination of hydroelectric connection and diesel generators for power. The Snare Hydro System, based from the Snare River, provides power to Yellowknife and Dettah (NTPC 2014). Additional power for Yellowknife is provided by the Bluefish Hydro Transmission Line, based from the Yellowknife River (NTPC 2014). Between Fort Smith, Hay River, Hay River Reserve, Fort Resolution, and Enterprise, is the Taltson Hydro Transmission Line (NTCP 2014). These hydroelectric transmission lines are owned by the Northwest Territories Power Corporation.

Drinking water is sourced from nearby rivers and treated with conventional Class II water treatment facilities (Fort Providence, Fort Resolution, Fort Smith, and Hay River) or membrane filtration and chlorination (Łutsel K'e, Yellowknife). Water is then piped to buildings for use.

All LSA communities are accessible through all-season access roads, and most have airports. Those communities on Great Slave Lake also have access to marine re-supply facilities (GNWT 2013b, 2015, 2016a). Most LSA communities are accessible through the territorial highway system year-round, with the exception of Łutsel K'e.

3.4.3.4.2 Housing

Housing in the NWT is split roughly in half between owned (54%) and rented (46%) property. With the exception of Dettah, where the ownership rate is 44%, the majority of housing in Yellowknife and the smaller LSA communities is owned. Ownership rates are highest in Hay River (65%), Enterprise (67%), and the Hay River Reserve (82%). Roughly a fifth of all housing in the NWT, Yellowknife, Fort Smith, and Enterprise is in need of repair, while in the remaining smaller communities, the core need[7] rate increases to between 25% (Fort Resolution) and 40% (Hay River Reserve). The exception is in Hay River, where 8% of housing needs repair. Hay River also has the lowest portion of households with six or more people (3%) in the LSA. This is low relative to the territory, where around 6% of households have more than six people. More than 10% of households in Enterprise and the Hay River Reserve have over six people (Table 3-31). Houses with six or more people may not have a suitable number of bedrooms for the residents of the household, and may qualify as being of core need.

Table 3-31: Housing Conditions in Communities

Community	Total Housing (2016)	Owned (2016)		Rented (2016)		Housing in Core Need (%) (2014)	Households of 6+ (%) (2014)
		#	%	#	%		
Enterprise	45	30	66.7	15	33.3	20.7	10.3
Fort Providence	250	125	50.0	115	46.0	31.3	6.7
Fort Resolution	190	110	57.9	80	42.1	24.9	8.0
Fort Smith	955	560	58.6	395	41.4	17.3	5.6
Hay River	1,385	905	65.3	480	34.7	8.3	3.2
Hay River Reserve	85	70	82.4	15	17.6	39.8	11.6
Dettah	75	35	46.7	40	53.3	37.2	6.7
Łutsel K'e	110	60	54.5	50	45.5	29.8	7.8
Yellowknife	7,130	4,010	56.2	3,120	43.8	17.9	4.5
NWT	14,980	8,045	53.7	6,920	46.2	19.8	6.1

Note: the sum of rented and owned houses may not equal total housing in a community due to Statistics Canada rounding conventions.
Source: GNWTBS 2018.

[7] "A household is said to be in 'core housing need' if its housing falls below at least one of the adequacy, affordability, or suitability standards and it would have to spend 30% or more of its total before-tax income to pay the median rent of alternative local housing that is acceptable. Adequate housing is reported by their residents as not requiring any major repairs. Affordable housing has shelter costs equal to less than 30% of total before-tax household income. Suitable housing has enough bedrooms for the size and composition of resident households according to National Occupancy Standard (NOS) requirements". (Statistics Canada 2017k).

3.4.4 Non-Traditional Land and Resource Use

The communities of Enterprise, Fort Providence, Fort Resolution, Fort Smith, Hay River and Hay River Reserve are within the South Slave Administrative Region. The communities of Dettah, Łutsel K'e, and Yellowknife are within the North Slave Administrative Region. While no regional Land Use Plan exists for either region (GNWT 2016b), the Dehcho Land Use Plan (Dehcho Land Use Planning Committee 2006) outlines land use priorities in the vicinity of Hay River, the Hay River Reserve, and Enterprise, including conservation and special management zones, protected areas, and proposed industrial use areas.

Numerous outfitters and tour operators operate around Great Slave Lake with most companies are based in the City of Yellowknife (GNWTITI No date [b]). Between 2014 and 2019, 30 tourism operator licences were issued in the South Slave Region and over 80 in the North Slave Region (GNWTITI No date [c]). Some of the recreational activities offered include guided hunting, angling, boat tours, wildlife viewing, and northern lights viewing. Game species commonly hunted in the area include wood bison, black bear, wolf, and moose. Snowshoe hare, beaver, porcupine, wolverine, ermine, mink, marten, and lynx are also present in the area.

Numerous parks and campgrounds are also found in many of the LSA communities, with the exception of the Hay River Reserve and Łutsel K'e. Territorial parks in the vicinity of the communities include Lady Evelyn Falls Territorial Park near Enterprise, and the Little Buffalo River Crossing Territorial Park near Fort Resolution. Visitor centres are present in Yellowknife, Fort Smith, and Hay River (GNWT 2013b).

Commercial fishing is centred on Great Slave Lake with hubs in Yellowknife and Hay River (GNWTITI No date [d]). While commercial fishing production in the NWT has been in decline for several years with production less than half of historical levels, recent efforts have been made to reverse this trend with the release of the GNWT's Strategy for Revitalizing the Great Slave Lake Commercial Fishery (GNWT 2017b). The revitalization will seek to increase production, fish processing in the NWT, grow the NWT market and access export markets.

Signature Page

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4.0 REFERENCES

Acts and Regulations

Species at Risk Act. SC. 2002, c 29. Last amended 18 December 2019. Available at: https://laws-lois.justice.gc.ca/eng/acts/s-15.3/

Species at Risk (NWT) Act. SNWT 2009, c 16. Last amended 31 October 2017. Available at https://www.justice.gov.nt.ca/en/files/legislation/species-at-risk/species-at-risk.a.pdf

Migratory Birds Convention Act, 1994. SC 1994, c 22. Last amended 12 December 2017. Available at https://laws-lois.justice.gc.ca/eng/acts/m-7.01/

Wildlife Act. SNWT 2017, c 19. Last amended 31 October 2017. Available at https://www.justice.gov.nt.ca/en/files/legislation/wildlife/wildlife.a.pdf

Wildlife General Regulations. R-051-2019 under the *Wildlife Act.* In force 30 June 2019. NWT Gazette, Volume 4, No 6. Available at https://www.justice.gov.nt.ca/en/files/northwest-territories-gazette/2019/06_2.pdf?t1601558594987

Literature Cited

ABMI (Alberta Biodiversity Monitoring Institute). 2018. Counting wolves to determine associations between human ABMI (Alberta Biodiversity Monitoring Institute). 2018. Counting wolves to determine associations between human footprint, habitat, and boreal caribou population growth rates: Interim Report for the 2018 Fort Resolution wolf surveys. 5 pp.

Adkins C, Stott P. 1998. Home ranges, movements and habitat associations of red foxes *Vulpes vulpes* in suburban Toronto, Ontario, Canada. Journal of Zoology 244: 335-346.

AEP (Alberta Environment and Parks). 2019. Alberta Ambient Air Quality Objectives and Guidelines Summary. Environmental Protection and Enhancement Act. January 2019.

Alexander SM, Paquet PC, Logan TB, Salier DJ. 2005. Snow-tracking versus radiotelemetry for predicting wolf-environment relationships in the Rocky Mountains of Canada. Wildlife Society Bulletin 33: 1216-1224.

Allen AW. 1983. Habitat suitability index models: beaver (FWS/OBS-82/10.30). U.S. Fish and Wildlife Service. Fort Collins, Colorado, USA.

Allen AW, Hoffman RD. 1984. Habitat suitability index models: Muskrat. U.S. Fish and Wildlife Service, FWS/OBS-82/10.46.

Altman B, Sallabanks R. 2012. Olive sided Flycatcher (*Contopus cooperi*). The Birds of North America (Rodewald PG Ed.). Ithaca: Cornell Lab of Ornithology. https://doi.org/10.2173/bna.502

Armstrong TER. 2014. Management Plan for the Bald Eagle (*Haliaeetus leucocephalus*) in Ontario. Ontario Management Plan Series. Prepared for the Ontario Ministry of Natural Resources and Forestry, Peterborough, Ontario. vii + 53 pp. Accessed: February 2020. Available at http://files.ontario.ca/environment-and-energy/species-at-risk/mnr_sar_mp_bldegl_en.pdf.

Aurora College. 2020. Programs by Location. Accessed February 2020. Available at http://www.auroracollege.nt.ca/_live/pages/wpPages/ProgramsByLocation.aspx#CLC.

Avalon (Avalon Advanced Materials Inc.). 2019. Nechalacho Mine. Accessed January 2020. Available at http://avalonadvancedmaterials.com/nechalacho/nechalacho_overview/

Avery ML. 2013. Rusty Blackbird (*Euphagus carolinus*), The Birds of North America Online (P. G. Rodewald, Ed.). Ithaca: Cornell Lab of Ornithology. https://doi.org/10.2173/bna.200

Ball JR, Bayne EM. 2014. Status of Canada warbler (Cardellina canadensis) in Alberta. Alberta Wildlife Status Report No. 70. Prepared for Alberta Environment and Sustainable Resource Development (ESRD) and Alberta Conservation Association (ACA).

BC Research. 1977. Environmental survey and assessment, Pine Point, NWT. Prepared for Cominco Ltd. 99 pp + appendices.

Beak (Beak Consultants Ltd.). 1980. Initial environmental evaluation for the Great Slave Reef Project. Prepared for: Western Mines Ltd. vi + 119 pp + appendices.

Beckingham JD, Archibald JH. 1996. Field guide to ecosites of Northern Alberta. Natural Resources Canada, Northern Forestry Centre, Northwest Region. Special Report 5. Edmonton AB.

Boitani L. 2000. Action plan for the conservation of the wolves (Canis lupus) in Europe. Nature and Environment 13. 84 pp. Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention).

Brigham RM, Ng J, Poulin RG, Grindal SD. 2011. Common Nighthawk (*Chordeiles minor*). The Birds of North America (Rodewald PG, Ed.). Ithaca: Cornell Lab of Ornithology. https://doi.org/10.2173/bna.213

Broders HG, Forbes GJ, Woodley S, Thompson ID. 2006. Range extent and stand selection for roosting and foraging in forest-dwelling Northern Long-Eared Bats and Little Brown Bats in the Greater Fundy Ecosystem, New Brunswick. The Journal of Wildlife Management 70: 1174-1184.

Brown CR, Brown M. 1999. Barn swallow. The Birds of North America Online (Poole A, Ed.). Ithaca: Cornell Lab of Ornithology. https://doi.org/10.2173/bna.452.

Brown, Erdman & Associates Ltd. 1981. R-190 Zone Aquifer Test Analysis and Preliminary Design. Report submitted to Western Mines Ltd., February 1981.

Buehler DA. 2000. Bald Eagle (*Haliaeetus leucocephalus*), The Birds of North America Online (Poole A, Ed.). Ithaca: Cornell Lab of Ornithology. https://doi.org/10.2173/bna.506.

Burnett GW. 1981. Movements and habitat use of the American marten in Glacier National Park, Montana. Missoula, MT. University of Montana. MSc Thesis. 130 pp. Cited in Buskirk, S.W. and L.F. Ruggiero. 1994. American marten. U.S. Forest Service General Technical Report GM-254. p. 7-37.

Buskirk SW Ruggiero LF. 1994. American Marten. In: The Scientific Basis for Conserving Forest Carnivores: American Marten, Fisher, Lynx and Wolverine in the Western United States. General Technical Report RM-254. US Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station.

Bussey J. 2006. October 2, 2006 letter report to Tom Andrews. Preliminary Archaeological Assessment of the Tamerlane Venture Inc.'s Pine Point Project. Prepared for Pine Point Mining Ltd by Points West Heritage Consulting Ltd. Langley, British Columbia.

Cabin Radio. 2019. Hay River to finally receive a new commercial fish plant. Accessed February 2020. Available at: https://cabinradio.ca/12329/news/economy/hay-river-to-finally-receive-a-new-commercial-fish-plant/

Canadian Wildlife Health Cooperative. 2019. White nose syndrome occurrence by country/district. Accessed: December 10, 2019. Available at: http://www.cwhc-rcsf.ca/surveillance_data_wns.php#maps

CCME (Canadian Council of Ministers of the Environment). 2004. Canadian water quality guidelines for the protection of aquatic life: Phosphorus: Canadian Guidance Framework for the Management of Freshwater Systems. In: Canadian environmental quality guidelines, 2004, Canadian Council of Ministers of the Environment, Winnipeg.

CCME. 1999. Canadian Water Quality Guidelines for the Protection of Freshwater Aquatic Life (Updated October 2005). Available at: http://st-ts.ccme.ca/en/index.html. Accessed March 2020.

CIRNAC (Crown-Indigenous Relations and Northern Affairs Canada [formerly Aboriginal Affairs and Northern Development Canada]). 2012. NWT Land Information Related to Aboriginal Groups. Accessed December 2019. Available at https://www.aadnc-aandc.gc.ca/DAM/DAM-INTER-NWT/STAGING/texte-text/consult-map_1366755518930_eng.pdf.

City of Yellowknife. 2014. Economic Development Strategy 2014-2019. Accessed January 2020. Available at: https://www.yellowknife.ca/en/doing-business/resources/Economic_Development_and_Tourism_Strategy/2014_-_2019_Economic_Development_Strategy_Background_Report.pdf.

City of Yellowknife. 2019. Fire Division. Available at: https://www.yellowknife.ca/en/living-here/Fire-Division.asp. Accessed January 2020.

CHC (Canadian Hydraulics Centre – National Research Council). 2012. GreenKenue Visualization and Analysis for Hydrological Applications. Version 3.3.10.

Cheveau M, Imbeau L, Drapeau P, Belanger L. 2013. Marten space use and habitat selection in managed coniferous boreal forests of eastern Canada. The Journal of Wildlife Management 77: 749-760.

Clark TW, Anderson E, Douglas C, Strickland M. 1987. *Martes americana*. Mammalian Species No. 289.

Cluff HD. 2005. Survey of moose abundance in the boreal forest around Yellowknife, Northwest Territories. Final Report to the West Kitikmeot/Slave Study Society, Yellowknife, NT Canada.

Conference of Management Authorities. 2017. Recovery Strategy for the Boreal Caribou (Rangifer tarandus caribou) in the Northwest Territories. Species at Risk (NWT) Act Management Plan and Recovery Strategy Series. Environment and Natural Resources, Government of the Northwest Territories, Yellowknife, NT. 57 + x pp.

Copeland J, McKelvey K, Aubry K, Landa A, Persson J, Inman R, Krebs J, Lofroth E, Golden H, Squires J, Magoun A, Schwartz M, Wilmot J, Copeland C, Yates R, May R. 2010. Does spring snow cover define the bioclimatic envelope of the wolverine? Canadian Journal of Zoology 88: 233-246.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2006. COSEWIC assessment and status report on the rusty blackbird Euphagus carolinus in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vi + 28 pp.

COSEWIC. 2007a. COSEWIC Assessment and Status Report on the Common Nighthawk Chordeiles minor in Canada. Ottawa. vi + 25 pp.

COSEWIC. 2007b. COSEWIC Assessment and Status Report on the Olive-sided Flycatcher Contopus cooperi in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vii + 25 pp.

COSEWIC. 2008a. COSEWIC assessment and status report on the Canada warbler Wilsonia canadensis in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vi + 35 pp.

COSEWIC. 2008b. COSEWIC Assessment and Update Status Report on the Short-eared Owl *Asio flammeus* in Canada. Accessed: February 2020. Available at: http://www.sararegistry.gc.ca/virtual_sara/files/cosewic/sr_shorteared_owl_0808_e.pdf

COSEWIC. 2009. Assessment and Status report on the Yellow Rail Coturnicops noveboracensis in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vii +32 pp.

COSEWIC. 2010. COSEWIC Assessment and Update Status Report on the Whooping Crane *Grus americana* in Canada. Ottawa. ix + 36 pp

COSEWIC. 2013a. COSEWIC assessment and status report on the Plains Bison (*Bison bison bison*) and the Wood Bison (*Bison bison athabascae*) in Canada. Ottawa. xv + 109 pp.

COSEWIC. 2013b. COSEWIC assessment and status report on the little brown myotis *Myotis lucifugus*, northern myotis *Myotis septentrionalis*, Tri-colored bat *Perimyotis subflavus* in Canada – 2013. Committee on the Status of Endangered Wildlife in Canada. Ottawa. xxiv + 93 pp.

COSEWIC. 2014. COSEWIC assessment and status report on the Wolverine *Gulo gulo* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. xi + 76 pp.

COSEWIC. 2015a. COSEWIC Assessment and Status Report on the Yellow-Banded Bumble Bee *Bombus terricola* in Canada. ix + 56 pp.

COSEWIC. 2015b. COSEWIC Assessment and Status Report on the Gypsy Cuckoo Bumble Bee *Bombus bohemicus* in Canada. ix + 56 pp.

COSEWIC. 2019. COSEWIC wildlife species assessments (short version), May 2019. Accessed September 4, 2019. Available at http://cosewic.ca/index.php/en-ca/assessment-process/short-version-mai-2019

CRHP (Canadian Register of Historic Places). 2009. Hay River Mission Sites National Historic Site of Canada. Available at https://www.historicplaces.ca/en/rep-reg/place-lieu.aspx?id=15669&pid=0. Accessed January 2020.

CRHP. 2010. Fort Resolution National Historic Site of Canada. Available at https://www.historicplaces.ca/en/rep-reg/place-lieu.aspx?id=15669&pid=0. Accessed January 2020.

Crum H. 1992. A focus on peatlands and peat mosses. The University of Michigan Press. Ann Arbor, MI.

Dames & Moore. 1976. Report on Pre-Feasibility Groundwater/Geotechnical Assessment, Great Slave Reef Project, N.W.T. Report prepared for Western Mines Limited, Job. No. 9131-001-32, May 1976.

Davidson-Hunt IJ, Deutsch N, Miller A. 2012. Pimachiowin Aki Cultural Landscape Atlas: Land that Gives Life. Pimachiowin Aki Corporation, Winnipeg, MB.

Deck D. 2016. Wood Buffalo National Park - Buffalo Lake Survey. Parks Canada Research Permit WB-2016-21556.

Dehcho Land Use Planning Committee. 2006. Respect for the Land: The Dehcho Land Use Plan. Accessed January 2020. Available at http://www.dehcholands.org/docs/dehcho_final_draft_june_02_06/Final%20Draft%20Dehcho%20Land%20Use%20Plan_June%202-06.pdf

Denesoline Corporation. 2018a. Companies. Available at: https://www.dcnwt.com/partners. Accessed January 2020.

Denesoline Corporation. 2018b. Services. Available at: https://www.dcnwt.com/services. Accessed January 2020.

Det'on Cho Companies. No date. Det'on Cho Companies. Accessed January 2020. Available at: https://www.detoncho.com/companies.html.

Durston KJ. 1979. Open pit dewatering at Pine Point in Mine Drainage – Proceedings of the First International Mine Drainage Symposium, Denver, Colorado, May 20-23, 1979. Miller Freeman Publications, Inc., San Francisco, California, pp. 275-303.

Eagle Eye Concepts. 2007. Katlodeeche First Nation Traditional Knowledge Assessment. June 2007.

EBA (EBA Engineering Consultants Ltd). 2005a. Tamerlane Pine Point Project: Water Quality and Stream Assessment Baseline Studies. Report prepared by EBA Consultants Ltd. for Tamerlane Ventures Inc.

EBA. 2005b. Tamerlane Pine Point Project: Vegetation Ecosystem Baseline Studies. Report prepared by EBA Consultants Ltd. for Tamerlane Ventures Inc.

EBA. 2005c. Tamerlane Pine Point Project: Wildlife Baseline Studies. Report prepared by EBA Consultants Ltd. for Tamerlane Ventures Inc.

EBA. 2006a. Tamerlane Pine Point Project: 2006 Water Quality Sampling Program Pine Point, Northwest Territories. Report prepared by EBA Consultants Ltd. for Tamerlane Ventures Inc.

EBA. 2006b. 2006 Rare Plant Survey, Tamerlane Pine Point Project, Northwest Territories. Report prepared by EBA Consultants Ltd. for Tamerlane Ventures Inc.

EBA. 2006c. Tamerlane Pine Point Project: 2006 Wildlife Surveys, Pine Point, NT. Report prepared by EBA Consultants Ltd. for Tamerlane Ventures Inc.

EBA. 2006d. Desktop Evaluation of Natural Groundwater Flow Velocities – Pine Point Mine Ground Freezing Project. Letter Report submitted to Tamerlane Ventures Inc. September 2006.

EBA. 2007. Developer's Assessment Report: Pine Point Pilot Project. Report prepared by EBA Consultants Ltd. for Tamerlane Ventures Inc.

EBA. 2011. Developer’s Assessment Report, Thor Lake Project, Northwest Territories. Report prepared by EBA Consultants Ltd. for Avalon Rare Earth Metals Inc.

ECCC (Environment and Climate Change Canada). 2018a. Environment and Climate Change Canada Data: Major Ions. Accessed February 2020. Available at http://donnees.ec.gc.ca/data/air/monitor/monitoring-of-atmospheric-precipitation-chemistry/major-ions/?lang=en.

ECCC. 2018b. Environment and Climate Change Canada Data: Major Ions Legacy Canadian Networks. Accessed February 2020 Available at http://donnees.ec.gc.ca/data/air/monitor/monitoring-of-atmospheric-precipitation-chemistry/major-ions/LegacyCanadianNetworks/?lang=en.

ECCC. 2018c. Recovery Strategy for Little Brown Myotis (*Myotis lucifugus*), Northern Myotis (*Myotis septentrionalis*), and Tri-colored Bat (*Perimyotis subflavus*) in Canada. *Species at Risk Act* Recovery Strategy Series. Environment Canada, Ottawa. ix + 172 pp. Available at https://wildlife-species.canada.ca/species-risk-registry/virtual_sara/files/plans/Rs-TroisChauveSourisThreeBats-v01-2019Nov-Eng.pdf

ECCC. 2018d. Recovery Strategy for the Wood Bison (*Bison bison athabascae*) in Canada. *Species at Risk Act* Recovery Strategy Series. Environment Canada, Ottawa. vii + 59 pp. Available at https://wildlife-species.canada.ca/species-risk-registry/virtual_sara/files/plans/Rs-WoodBison-v00-2018Aug-Eng.pdf

ECCC. 2019a. Past Weather and Climate: Historical Data. Available at: https://climate.weather.gc.ca/historical_data/search_historic_data_e.html. Accessed: February 2020.

ECCC. 2019b. Canadian Climate Normals 1981-2010 Calculation Information. Available at: https://climate.weather.gc.ca/doc/Canadian_Climate_Normals_1981_2010_Calculation_Information.pdf. Accessed: February 2020.

ECCC. 2019c. Canadian Climate Normals. Available at: https://climate.weather.gc.ca/climate_normals/. Accessed: February 2020.

ECG (Ecosystem Classification Group). 2009. Ecological Regions of the Northwest Territories – Taiga Plains. Department of Environment and Natural Resources, Government of the Northwest Territories, Yellowknife, NT, Canada. 173 pp.

ECMWF (European Centre for Medium-Range Weather Forecasts). 2020. ERA-Interim Data. Accessed February 2020. Available at: http://aps.ecmwf.int/datasets/data/interim-full-daily/levtype=sfc/

ENR. 2019a. Wolverine. Accessed December 2019.Available at https://www.enr.gov.nt.ca/en/services/wolverine

ENR. 2019b. Wolves. Accessed December 2019. Available at https://www.enr.gov.nt.ca/en/services/wolves

ENR. 2019c. Black Bear. Accessed December 2019. Available at https://www.enr.gov.nt.ca/en/services/black-bear

ENR. 2019d. Lynx. Accessed December 2019. Available at: https://www.enr.gov.nt.ca/en/services/lynx.

Environment Canada. 2007. Recovery strategy for the whooping crane (*Grus americana*) in Canada. *Species at Risk Act* Recovery Strategy Series, Ottawa. vii + 27 pp. Available at https://wildlife-species.canada.ca/species-risk-registry/virtual_sara/files/plans/rs_whooping_crane_final_1007_e.pdf

Environment Canada. 2012. Recovery strategy for the woodland caribou (*Rangifer tarandus caribou*), boreal population, in Canada. Species at Risk Act Recovery Strategy Series. Environment Canada, Ottawa. xi + 138 pp. Available at https://wildlife-species.canada.ca/species-risk-registry/virtual_sara/files/plans/Rs-CaribouBorealeAmdMod-v00-2019Jun-Eng.pdf

Environment Canada. 2013a. Management Plan for the Yellow Rail (Coturnicops noveboracensis) in Canada. Species at Risk Act Management Plan Series. Environment Canada, Ottawa. iii + 24 pp.

Environment Canada. 2013b. Management Plan for the Northern Leopard Frog (Lithobates pipiens), Western Boreal/Prairie Populations, in Canada. Species at Risk Act Management Plan Series. Environment Canada, Ottawa. iii + 28 pp.

Environment Canada. 2014. Bird conservation strategy for bird conservation region 8 in Ontario region: boreal softwood shield. Abridged Version. 32 pp. Available at http://ec.gc.ca/mbc-com/CAE0D8F8-FC7B-4CA4-863A-7B417D47B7D9/BCR8_ON_abridged_11September2014.pdf.

Environment Canada. 2015a. Management Plan for the Rusty Blackbird (Euphagus carolinus) in Canada (Proposed). Species at Risk Act Management Plan Series. Environment Canada, Ottawa. iv + 22 pp.

Environment Canada. 2016a. Recovery strategy for the olive-sided flycatcher (Contopus cooperi) in Canada – 2016. Species at Risk Act Recovery Strategy Series. Environment Canada, Ottawa. vii + 52 pp. Available at https://wildlife-species.canada.ca/species-risk-registry/virtual_sara/files/plans/rs_olive-sided%20flycatcher_e_final.pdf

Environment Canada. 2016b. Recovery Strategy for the Common Nighthawk (Chordeiles minor) in Canada. Species at Risk Act Recovery Strategy Series. Environment Canada, Ottawa. vii + 49 pp. Available at https://wildlife-species.canada.ca/species-risk-registry/virtual_sara/files/plans/rs_common%20nighthawk_e_final.pdf

ESRD (Alberta Environment and Sustainable Resource Development). 2015. Alberta Wetland Classification System. Water Policy Branch, Policy and Planning Division, Edmonton, AB.

Evans MS, Lockhart L, Muir D. 1998. Investigations of Metals and Persistent Organochlorine Contaminants in Predatory Fish from Resolution Bay, Great Slave Lake. National Hydrology Research Institute Contribution Series.

Finch D. 2017. Pine Point Base Camp Documentation. Report on Research conducted under NWT Class 1 Archaeologist Permit # 2016-012. Yellowknife, Northwest Territories.

Fournier MA, Hines JE. 1999. Breeding ecology of the horned grebe *Podiceps auritus* in subarctic wetlands. Canadian Wildlife Service, Occasional Paper Number 99. 34 pp.

Fulton RJ (ed.). 1989. Quaternary Geology of Canada and Greenland. Geological Survey of Canada, Geology of Canada Series no. 1.3114-5

Garrison B. 1999. Bank swallow (*Riparia riparia*). The Birds of North America Online (P.G. Rodewald, Ed.). Ithaca: Cornell Lab of Ornithology. https://doi.org/10.2173/bna.414

GNWT (Government of Northwest Territories) 2012. Northwest Territories Forest Vegetation Inventory Standards v. 4.1. Forest Resources, Forest Management Division, Department of ENR.

GNWT. 2013b. Community Infrastructure Profiles. Available at: https://www.statsnwt.ca/community-data/. Accessed January 2020.

GNWT. 2014. Guideline for Ambient Air Quality Standards in the Northwest Territories. Available at: https://www.enr.gov.nt.ca/sites/enr/files/guidelines/air_quality_standards_guideline.pdf. Accessed February 2020.

GNWT. 2015. Drinking Water Summary. Accessed January 2020. Available at https://www.maca.gov.nt.ca/sites/maca/files/resources/2015_primer_final.pdf

GNWT. 2016a. Report on Drinking Water 2016. Accessed January 2020. Available at https://www.maca.gov.nt.ca/sites/maca/files/resources/2016_drinking_water_report_-_feb_28th_0.pdf

GNWT. 2016b. Regional Land Use Planning. Accessed January 2020. Available at https://www.lands.gov.nt.ca/sites/lands/files/resources/regional-land-use-planning_guidelines_final-september-19-2016.pdf

GNWT. 2017a. Northwest Territories Air Quality Report 2015. Accessed February 2020. Available at https://www.enr.gov.nt.ca/sites/enr/files/air_quality_report_2015.pdf.

GNWT. 2017b. Strategy for Revitalizing the Great Slave Lake Commercial Fishery. Accessed February 2020. Available at https://www.iti.gov.nt.ca/en/commercial-fishing.

GNWT 2018a. Northwest Territories Air Quality Report 2016. Accessed February 2020. Available at https://www.enr.gov.nt.ca/sites/enr/files/resources/128-air_quality_report_2016_press.pdf

GNWT. 2018b. General Status Ranks of Wild Species in the Northwest Territories. Accessed March 2019. Available at https://www.nwtspeciesatrisk.ca/sites/default/files/nwtspecies_2016_2020_report_final_w_properties.pdf.

GNWT. 2019a. NWT Annual Mineral, Oil and Gas Production, 1999-2018. Table 1. Accessed August 2019. Available at http://www.statsnwt.ca/economy/minerals/

GNWT. 2019b. Health and Social Services Help Directory Available at: https://www.hss.gov.nt.ca/sites/hss/files/help-directory.pdf. Accessed January 2020.

GNWT. 2020a. NWT Air Quality Monitoring Network. Accessed February 2020. Available at http://aqm.enr.gov.nt.ca/

GNWT. 2020b. NWT Species Infobase. Accessed January 2020. Environment and Natural Resources, GNWT, Yellowknife, NT. Available at: https://www.nwtspeciesatrisk.ca/content/search-infobase

GNWT. no date. Taltson Hydroelectricity Expansion Project. Accessed January 2020. Available at: https://www.inf.gov.nt.ca/en/Taltson.

GNWT-ECE (Government of the Northwest Territories - Education, Culture and Employment). 2019. Programs and Services. Available at https://www.ece.gov.nt.ca/en/services

GNWTBS (Government of the Northwest Territories Bureau of Statistics). 2014. General Health Indicators. Accessed February 2020. Available at: https://www.statsnwt.ca/health/health-conditions/.

GNWTBS. 2015a. Households Eating Meat or Fish from Hunting or Fishing by Community, 1999-2014. Accessed January 2020. Available at: https://www.statsnwt.ca/Traditional%20Activities/

GNWTBS. 2015b. Hunted or Fished by Community, 1999 to 2014, 1999-2014. Accessed January 2020. Available at: https://www.statsnwt.ca/Traditional%20Activities/

GNWTBS. 2018. Community Data. Accessed January 2020. Available at: https://www.statsnwt.ca/community-data/

GNWTBS 2019a. Community Population Estimates by Ethnicity. 2001-2019. Accessed January 2020. Available at: https://www.statsnwt.ca/population/population-estimates/bycommunity.php.

GNWTBS 2019b. Community Population Estimates by Gender. 2001-2019. Accessed January 2020. Available at: https://www.statsnwt.ca/population/population-estimates/bycommunity.php.

GNWTBS 2019c. Community Labour Force Activity. 1986-2019. Accessed January 2020. Available at: https://www.statsnwt.ca/labour-income/labour-force-activity/

GNWTBS. 2019d. Deaths per 10,000 Population, by Cause 2000-2018. Accessed February 2020. Available at: https://www.statsnwt.ca/population/vital-statistics/

GNWTHSS (Government of the Northwest Territories Health and Social Services). 2018. Annual Report 2017-2018 NWT Health and Social Services System. Available at: https://www.hss.gov.nt.ca/sites/hss/files/resources/hss-annual-report-2017-18.pdf. Accessed March 2020.

GNWTHSS. 2019a. Chlamydia in the Northwest Territories. Available at: https://www.hss.gov.nt.ca/sites/hss/files/resources/chlamydia-rates.pdf. Accessed January 2020.

GNWTHSS. 2019b. Cigarette Use in the Northwest Territories. Available at: https://www.hss.gov.nt.ca/sites/hss/files/resources/smoking.pdf. Accessed January 2020.

GNWTHSS. 2019c. Cannabis Use in the Northwest Territories. Available at: https://www.hss.gov.nt.ca/sites/hss/files/resources/cannabis.pdf. Accessed January 2020.

GNWTHSS. 2019d. Heavy Drinking in the Northwest Territories. Available at: https://www.hss.gov.nt.ca/sites/hss/files/resources/heavy-drinking.pdf. Accessed January 2020.

GNWTHSS. 2019e. Crack/Cocaine Use in the Northwest Territories. Available at: https://www.hss.gov.nt.ca/sites/hss/files/resources/crack-cocaine.pdf

GNWTHSS. 2019f. 2018-2019 Annual Report. Accessed January 2020. Available at: https://www.hss.gov.nt.ca/sites/hss/files/resources/hss-annual-report-2018-19.pdf.

GNWTITI (Government of Northwest Territories - Industry, Tourism and Investment). 2019a. Business Incentive Policy Registry. Accessed January 2020. Available at: https://www.iti.gov.nt.ca/en/services/business-incentive-program-bip/search-bip-registry.

GNWTITI. 2019b. New Processing Plan for Hay River. Accessed February 2020. Available at: https://www.iti.gov.nt.ca/en/newsroom/new-fish-processing-plant-hay-river

GNWTITI. 2020a. Community Economic Development, Support for Entrepreneurs and Economic Development. Available at: https://www.iti.gov.nt.ca/en/services/community-economic-development-seed. Accessed January 2020.

GNWTITI. 2020b. Economic Development Officers. Accessed January 2020. Available at: https://www.iti.gov.nt.ca/en/services/economic-development-officers.

GNWTITI. No date (a). Business Incentive Policy Registry. Accessed December 2020. Available at: https://www.iti.gov.nt.ca/en/services/business-incentive-program-bip/search-bip-registry.

GNWTITI. No date (b). Highways, Ferries, and Winter Roads. Accessed February 2020. Available at; https://www.inf.gov.nt.ca/en/transportation.

GNWTITI. No date (c). Tourism Operator Licences Issued by Region. Accessed February 2020. Available at: https://www.iti.gov.nt.ca/en/tourism-research

GNWTITI. No date (d). Commercial Fishing. Accessed February 2020. Available at: https://www.iti.gov.nt.ca/en/commercial-fishing.

Godbout G, Ouellet JP. 2008. Habitat selection of American marten in a logged landscape at the southern fringe of the boreal forest. Ecoscience 15: 332-342.

Golder (Golder Associates Ltd.). 2018a. Pine Point Project 2018 Wildlife Studies. December 2018. Yellowknife, Northwest Territories.

Golder. 2018b. Spring 2017 Paulette Creek Scoping Study for the Jay Project Offsetting Plan. Prepared for Dominion Diamond Ekati ULC. 8 pp.

Golder. 2019a. Pine Point Mine Soil and Vegetation 2019 Post Field Interim Findings. Submitted to: Pine Point Mining Limited. v + 12 pp.

Golder. 2019b. Pine Point Mine – Water Quality and Fish Site Reconnaissance Survey Field Memo, October 2019. Submitted to: Pine Point Mining Limited. v + 3 pp.

Golder. 2019c. Spring 2018 Longnose Sucker Study at Paulette Creek. Prepared for Dominion Diamond Ekati ULC. 18 pp.

Golder. 2019d. Baseline Data Gap Analysis for the Pine Point Mine. Submitted to: Pine Point Mining Limited. v + 23 pp. + appendices.

Golder. 2020. 2019 Water Quality Sampling Data Collected for the Pine Point Project. Unpublished data.

Gordon BC. 1996. People of the Sunlight, People of the Starlight: Barrenland Archaeology in the Northwest Territories of Canada. Archaeological Survey of Canada Mercury Series 145. Canadian Museum of Civilization, Ottawa, ON.

Gosselink TE, Van Deelen TR, Warner RE, Mankin PC. 2007. Survival and cause-specific mortality of red foxes in agricultural and urban areas of Illinois. Journal of Wildlife Management 71: 1862–1873.

Government of Canada. 2019a. Species at Risk Public Registry - A to Z Species Index. Accessed: March 6, 2019. Available at https://wildlife-species.canada.ca/species-risk-registry/sar/index/default_e.cfm.

Government of Canada. 2019b. Species at risk public registry. Accessed January 14, 2020. Available at https://www.canada.ca/en/environment-climate-change/services/species-risk-public-registry.html

Government of Canada. 2019c. Social determinants of health and health inequalities. Accessed: March 11, 2020. Available at: https://www.canada.ca/en/public-health/services/health-promotion/population-health/what-determines-health.html.

Government of Canada and GNWT. 2019. *Species at Risk Act*, Conservation Agreement for the Conservation of the Boreal Caribou. Available at: https://www.canada.ca/en/environment-climate-change/services/species-risk-public-registry/administrative-agreements/agreement-conservation-woodland-caribou-boreal-northwest-territories.html. Accessed: December 10, 2019.

Granger RJ, Gray DM. 1989. Evaporation from natural non-saturated surfaces. Journal of Hydrology 111: 21-29.

GSC (Geological Survey of Canada). 2016. Surficial geology, Buffalo Lake, Northwest Territories, NTS 85-B; Geological Survey of Canada, Canadian Geoscience Map 220 (2nd edition, preliminary, Surficial Data Model v. 2.1 conversion of Map 1906A), scale 1:250 000. doi:10.4095/298705. Available at: https://geoscan.nrcan.gc.ca/starweb/geoscan/servlet.starweb?path=geoscan/fulle.web&search1=R=296509

GTC (Geologic Testing Consultants Ltd.). 1983. Hydrogeologic Evaluation of the Pine Point – Great Slave Lake Region. Report submitted to National Hydrology Research Institute, Environment Canada. March 30, 1983.

Gurarie E, Suutarinen J, Kojola I, Ovaskainen O. 2011. Summer movements, predation, and habitat use of wolves in human modified boreal forests. Oecologia 165: 891-903.

Haas CA. 2014. Phase II Ecological Assessment for the Buffalo Lake, River, and Trails Candidate Area. Environment and Natural Resources, Government of the Northwest Territories. xi + 66 pp + appendices.

Halsey LA, Vitt DH, Beilman D, Crow S, Mehelcic S, Wells R. 2004. Alberta Wetland Inventory Standards Version 2.0. Resource Data Division, Alberta Sustainable Resource Development.

Hanks C, Irving S. 1987. Implications of the Desnoyers Site (JePw-1). Permit Report on file at the Prince of Wales Northern Heritage Centre, Yellowknife.

Heagy A, Badzinski D, Bradley D, Falconer M, McCracken J, Reid RA, Richardson K. 2014. Recovery Strategy for the Barn Swallow (Hirundo rustica) in Ontario. Ontario Recovery Strategy Series. Prepared for the Ontario Ministry of Natural Resources and Forestry, Peterborough, Ontario. vii + 64 pp.

Health Canada. 2006. Guidelines for Canadian Drinking Water Quality Summary Table. Prepared by the Federal-Provincial-Territorial Committee on Drinking Water of the Federal-Provincial-Territorial Committee on Health and the Environment. www.healthcanada.gc.ca/waterquality.

Health Canada. 2016. Update on Sexually Transmitted Infections in Canada, 2016. Available at: https://www.canada.ca/en/health-canada/services/publications/diseases-conditions/update-sexually-transmitted-infections-canada-2016.html#4. Accessed January 2020.

Hebblewhite M, Merrill E. 2008. Modelling wildlife-human relationships for social species with mixed-effects resource selection models. Journal of Applied Ecology 45: 834-844.

Heintzman R. 1980. Slave River Hydro Feasibility Study. NWT Class 2 Permit No. 1980-479.

Heintzman R. 1981. Slave River Hydro Feasibility Study. NWT Class 2 Permit No. 1981-503.

Horner MA, Powell RA. 1990. Internal structure of home ranges of black bears and analyses of home –range overlap. Journal of Mammalogy 71: 402-410.

Houle M, Fortin D, Dussault C, Courtois R, Ouellet J-P. 2010. Cumulative effects of forestry on habitat use by gray wolf (Canis lupus) in the boreal forest. Landscape Ecology 25: 419-433.

James ARC, Stuart-Smith AK. 2000. Distribution of caribou and wolves in relation to linear corridors. Journal of Wildlife Management 64:154-159.

Johnson CJ, Boyce MS, Case RL, Cluff HD, Gau RJ, Gunn A, Mulders R. 2005. Cumulative effects of human developments on Arctic wildlife. Wildlife Monographs 160: 1-36

K'atl'odeeche First Nation. 2009a. Businesses. Accessed January 2020. Available at https://www.katlodeeche.com/index.php/kfn-community/kfn-business.

K'atl'odeeche First Nation. 2009b. Local Businesses. Accessed January 2020. Available at https://www.katlodeeche.com/index.php/kfn-community/local-business

Koehler GM, Hornocker MG. 1977. Fire effects on marten habitat in the Selway-Bitteroot Wilderness. Journal of Wildlife Management 41: 500-505.

Krebs J, Lofroth EC, Parfitt I. 2007. Multiscale habitat use by wolverines in British Columbia, Canada. Journal of Wildlife Management 71: 2180-2192.

Kuchment LS, Gelfan AN. 1996. The determination of the snowmelt rate and the meltwater outflow from a snowpack for modelling river runoff generation. J. Hydrol. 179: 23-36.

Kuczynski EC. 2009. Habitat selection and food-web relations of horned grebes (Podiceps auritus) and other aquatic birds on constructed wetlands in the Peace Parkland, Alberta, Canada. M.Sc. Thesis. Department of Biological Sciences, University of Alberta. 188 pp.

Lariviére S, Pasitschniak-Arts M. 1996. *Vulpes vulpes*. Mammalian Species 537: 1-11.

Latour PB, Maclean N, Poole KG. 1994. Movements of martens, *Martes americana*, in burned and unburned taiga in the Mackenzie Valley, Northwest Territories. Canadian Field-Naturalist 108:351-354.

LeClerc E, Keeling A. 2015. From Cutlines to Traplines: Post-industrial Land Use at the Pine Point Mine. available at: https://www.sciencedirect.com/science/article/pii/S2214790X14000665.

Lobb M. 1998. Aerial Photograph Interpretation for Use in the Subarctic Environment. NWT Class 2 Permit No. 1998-873.

Locock A, Mussieaux R, Tyson R. 2006. Minerals of the Pine Point lead-zinc deposits Northwest Territories Canada. In Rocks and Minerals. Volume 81, Issue 1, Pages 24-32.

LSI (LiDAR Services International Inc.). 2018. LiDAR Survey Report for Pine Point Mining Limited.

LSI. 2019. LiDAR Survey Report for Pine Point Mining Limited.

Lyon LJ, Aubry KB, Zielinski WJ, Buskirk SW, Ruggerio. LF 1994. The scientific basis for conserving forest carnivores: considerations for management. In: The scientific basis for conserving forest carnivores: American marten, fisher, lynx and wolverine in the western United States. Edited by Ruggiero LF, Aubry KB, Buskirk SW, Lyon LJ, Zielinski WJ. U.S. Forest Service Rocky Mountain Forest and Range Experiment Station, General Technical Report RM-254.

Maskwa (Maskwa Engineering Ltd.). 2018. Full Pit, Bathymetric Survey and Water Sampling for Pits N31-EXT, N32, L37, N38, N42, J44, I46, and Natural Lake at Pine Point Site. Prepared for Pine Point Mining Limited. Fort Smith, Northwest Territories.

May R, Landa A, van Dijk J, Linnell JDC, Andersen R. 2006. Impact of infrastructure on habitat selection of wolverines Gulo gulo. Wildlife Biology 12: 285-295.

McNeely RN, Neimanis VP, Dwyer L. 1979. Water Quality Sourcebook – A Guide to Water Quality Parameters. Inland Waters Directorate, Water Quality Branch, Minister of Supply and Services Canada. Ottawa, ON.

Mech LD. 1995. The challenge and opportunity of recovering wolf populations. Conservation Biology 9:270–278.

Mech LD, Rogers LL. 1977. Status, distribution, and movements of martens in northeastern Minnesota. Res. Pap. NE-143. Radnor, PA: U.S. Department of Agriculture, Northern Forest Experiment Station. 7 pp. Cited in Buskirk SW, Ruggiero LF. 1994. American marten. U.S. Forest Service General Technical Report GM-254. pp. 7-37.

MNR (Ontario Ministry of Natural Resources). 2007. Backgrounder on the red fox (*Vulpes vulpes*). Queen's Printer for Ontario.

Moors M. 2017. Archaeological Impact Assessment, Highway Corridor Granular Supply Sources, Eastern Segment, Highways 3, 5 and 6, Department of Transportation, Permit 16-003, Final Report. Prepared for Department of Transportation GNWT by Stantec Consulting Ltd.: Calgary, Alberta.

MVEIRB (Mackenzie Valley Environmental Impact Review Board). 2008. Report of Environmental Assessment and Reasons for Decision on Tamerlane Ventures Inc.'s Pine Point Pilot Project. EA0607-002. 127 p.

MVEIRB. 2018. Draft Environmental Assessment Initiation Guidelines for Developers of Major Projects. 48 p.

National Wetlands Working Group. 1997. The Canadian Wetland Classification System, 2nd Edition. Warner BG, Rubec CDA (eds.), Wetlands Research Centre, University of Waterloo, Waterloo, ON, Canada. 68 p.

NRC (Natural Resources Canada). 1995. The National Atlas of Canada, Permafrost. 5th Edition. Available at: http://ftp.geogratis.gc.ca/pub/nrcan_rncan/raster/atlas_5_ed/eng/environment/land/mcr4177.jpg. Accessed January 2020.

NRC. 2006. Significant Earthquakes and Seismic Hazard. Atlas of Canada 6th edition.

NRC. 2020. National Hydro Network – NHN – Geobase Series. Available online at: https://open.canada.ca/data/en/dataset/a4b190fe-e090-4e6d-881e-b87956c07977. Accessed March 15, 2020

Nelson JL, Zavaleta ES, Chapin III FS. 2008. Boreal fire effects on subsistence resources in Alaska and adjacent Canada. Ecosystems 11:156–171.

Noble WC. 1966 - 1969. Archaeological Sites in the Northwest Territories. Compiled Fieldnotes. Manuscript No. 615. on file Prince of Wales Northern Heritage Centre, Yellowknife.

NorZinc. 2019. Prairie Creek. Accessed January 2020. Available at: https://www.norzinc.com/projects/prairie-creek/highlights/

NTPC. 2014. Hydro. Accessed February 2020. Available at: https://www.ntpc.com/smart-energy/how-we-supply-power/hydro.

NWT Species at Risk Committee. 2012. Species at Risk Report. Boreal Caribou. December 2012.

NWT Species at Risk Committee. 2017. Species status report: big brown bat, little brown myotis, northern myotis, long-eared myotis, and long-legged myotis (*Eptesicus fuscus, Myotis lucifugus, Myotis septentrionalis, Myotis evotis, and Myotis volans*) in the Northwest Territories. Species at Risk Committee, Yellowknife, NT.

Paquet P, Callaghan C. 1996. Effects of linear developments on winter movements of gray wolves in the Bow River Valley of Banff National Park, Alberta. Chapter 7 in J. Green, C. Pacas, S. Bayley, and L. Cornwell (eds.). A Cumulative Effects Assessment and Futures Outlook for the Banff Bow Valley.

Payer DC, Harrison DJ. 2000. Structural differences between forests regenerating following spruce budworm defoliation and clear-cut harvesting: implications for marten. Canadian Journal of Forest Research 30: 1965-1972.

Peck GK, James RD. 1983. Breeding birds of Ontario: nidiology and distribution. Vol. 2. Toronto: Royal Ontario Museum, 1987.

Pelton MR, Coley AB, Eason TH, Doan Martinez DL, JPederson JA, van Manen FT, Weaver KM. 2003. American black bear conservation action plan. Accessed: December 10, 2019. Available at: http://wildpro.twycrosszoo.org/000ADOBES/Bears/Bears_IUCN_ActionPlan/bearsAP_chapter8.pdf

pHase Geochemistry. 2017. Review of Geochemical Data for the Pine Point Project – Draft. Vancouver, BC. 8 May 2017. Report prepared for Knight Piesold.

Pipes A, Quick M. 1977. UBC Watershed Model Users Guide. Department of Civil Engineering, University of British Columbia.

Poole KG, Wakelyn LA, Nicklen PN. 1996. Habitat selection by lynx in the Northwest Territories. Canadian Journal of Zoology 74: 845-850.

Porter Claire; Morin Paul; Howat Ian; Noh Myoung-Jon; Bates Brian; Peterman Kenneth; Keesey Scott; Schlenk Matthew; Gardiner Judith; Tomko Karen; Willis Michael; Kelleher Cole; Cloutier Michael; Husby Eric; Foga Steven; Nakamura Hitomi; Platson Melisa; Wethington Michael Jr.; Williamson Cathleen; Bauer Gregory; Enos Jeremy; Arnold Galen; Kramer William; Becker Peter; Doshi Abhijit; D'Souza Cristelle; Cummens Pat; Laurier Fabien; Bojesen Mikkel. 2018. "ArcticDEM", https://doi.org/10.7910/DVN/OHHUKH, Harvard Dataverse, V1, [April 30, 2019].

PPML (Pine Point Mining Limited). 2020. Summary Report on the Geology of Pine Point based on Drilling Conducted between 2017 and 2020 by Pine Point Mining Limited.

Praeger G. 2017. Pine Point Exploration Project Archaeological Overview Assessment, Phase 1. Prepared for Pine Point Mining Ltd by Points West Heritage Consulting Ltd. Langley, British Columbia.

Price WA. 2009. MEND Prediction Manual for Drainage Chemistry from Sulphidic Geologic Materials.

Priestley CHB, Taylor RJ. 1972. "On the Assessment of Surface Heat Flux and Evaporation Using Large Scale Parameters," Mon. Weather Rev., vol. 100, pp. 81-92. 1972.

Rawson DS. 1951. Studies of the fish of Great Slave Lake. Journal of Fisheries Research Board of Canada 8: 207-240.

Reid FA. 2006. A Field Guide to Mammals of North America North of Mexico: Fourth Edition. Houghton Mifflin Company, New York.579 pp.

Reist JD, Sawatzky CD, Johnson L. 2016. The Arctic "Great" Lakes of Canada and their fish faunas - An overview in the context of Arctic change. Journal of Great Lakes Research 42:173–192.

Rescan (Rescan Environmental Services Ltd.). 2011. Pine Point Project: Metal Leaching / Acid Rock Drainage Characterization: Static Testing Results from Borehole R190-11-GT1.

Rescan. 2012a. Pine Point Project: 2011 Terrestrial Ecology Baseline Study — X-25, P-499, O-556, Z-155, and G-03. Prepared for Tamerlane Ventures Inc. by Rescan Environmental Services Ltd.: Vancouver, British Columbia

Rescan. 2012b. Pine Point Project: 2011 Terrestrial Ecology Baseline Study — N-204. Prepared for Tamerlane Ventures Inc. by Rescan Environmental Services Ltd.: Vancouver, British Columbia

Rescan. 2012c. Pine Point Project: 2011 Meteorology, Air Quality, and Noise Baseline Study – R-190, X-25, P-499, O-556, Z-155, and G-03. Prepared for Tamerlane Ventures Inc. by Rescan Environmental Services Ltd. Vancouver, British Columbia.

Rescan. 2012d. Pine Point Project: 2011 Meteorology, Air Quality, and Noise Baseline Study – N-204. Prepared for Tamerlane Ventures Inc. by Rescan Environmental Services Ltd. Vancouver, British Columbia.

Rescan. 2012e. Pine Point Project: 2011 Fish and Fish Habitat Baseline Studies. Prepared for Tamerlane Ventures Inc.

Rescan. 2012f. Pine Point Project: 2011 Aquatic Resources Baseline Study – N-204. Prepared for Tamerlane Ventures Inc.

Rescan. 2012g. Pine Point Project: 2011 Aquatic Resources Baseline Study – X-25, P-499, O-556, Z-155, and G-03. Prepared for Tamerlane Ventures Inc.

Rescan. 2012h. Pine Point Project 2011 Wildlife Baseline Studies — X-25, P-499, O-556, Z-155, AND G-03

Rescan. 2012i. Pine Point Project: 2011 Wildlife Baseline Studies – N-204. Prepared for Tamerlane Ventures Inc.

Rescan. 2012j. Pine Point Project: 2011 Heritage Baseline Studies – X-25, P-499, O-556, Z-155, and G-03. Prepared for Tamerlane Ventures Inc. by Rescan Environmental Services Ltd. Vancouver, British Columbia.

Rescan. 2012k. Pine Point Project: 2011 Heritage Baseline Studies – N-204. Prepared for Tamerlane Ventures Inc. by Rescan Environmental Services Ltd. Vancouver, British Columbia.

Rescan. 2012l. Pine Point Project: 2011 Socio-economic Baseline Study. Prepared for Tamerlane Ventures Inc. by Rescan Environmental Services Ltd.: Vancouver, British Columbia.

Rescan. 2012m. Pine Point Project: 2011 Metal Leaching / Acid Rock Drainage Baseline Study – N-204. Prepared for Tamerlane Ventures Inc. by Rescan Environmental Services Ltd.: Vancouver, British Columbia.

Rescan. 2012n. Pine Point Project: 2011 Metal Leaching / Acid Rock Drainage Baseline Study – X-25, P-499, O-556, Z-155, and G-03. Prepared for Tamerlane Ventures Inc. by Rescan Environmental Services Ltd.: Vancouver British Columbia.

Rhodes D, Lantos EA, Lantos JR, Webb RJ, Owens DC. 1984. Pine Point Orebodies and Their Relationship to the Stratigraphy, Structure, Dolomitization, and Karstification of the Middle Devonian Barrier Complex. Economic Geology. Vol. 79, pp 991-1055.

Richardson ES, Reist JD, Minns CK. 2001. Life history characteristics of freshwater fishes occurring in the Northwest Territories and Nunavut, with major emphasis on lake habitat requirements. Canadian Manuscript Report of Fisheries and Aquatic Sciences 2569. July 2001. 158 pp.

Schenk A, Obbard ME, Kovacs KM. 1998. Genetic relatedness and home-range overlap among female black bears (Ursus americanus) in northern Ontario, Canada. Canadian Journal of Zoology 76: 1511-1519.

Scott WB, Crossman EJ. 1973. Freshwater Fishes of Canada. Bulletin 184. Fisheries Research Board of Canada. 966 pp.

Serrouya R, van Oort H, DeMars C, Boutin S. 2016. Human footprint, habitat, wolves, and boreal caribou population growth rates. 23 pp. Accessed: February 2020. Available at: https://cmu.abmi.ca/wp-content/uploads/2017/09/REPORT_Serrouya_et_al_2016_Human-footprint_-habitat_-wolves-and-boreal-caribou-population-growth-rates.pdf

Silke R. 2009. The Operational History of Mines in the Northwest Territories, Canada. Yellowknife, Northwest Territories.

Skall H. 1975. The Paleoenvironment of the Pine Point Lead-Zinc District. Economic Geology, 70,22-47.

Slauson KM, Zielinski WH, Hayes JP. 2007. Habitat selection by American martens in coastal California. The Journal of Wildlife Management 71:458 468.

Smethurst N. 2017. K'atlo'deeche First Nation Archaeology Project. NWT Prince of Wales Northern Heritage Center. Class 2 Permit No. 2017-016.

Smethurst N. 2018. K'atlo'deeche First Nation Archaeology Project - 2018. NWT Prince of Wales Northern Heritage Center. Class 2 Permit No. 2018-005.

Smith AC, Schaefer JA. 2002. Home-range size and habitat selection by American marten (*Martes americana*) in Labrador. Canadian Journal of Zoology 80:1602-1609.

Smith KB, Smith CE, Forest SF, Richard AJ. 2007. A Field Guide to the Wetlands of the Boreal Plains Ecozone of Canada. Ducks Unlimited Canada, Western Boreal Office, Edmonton, AB.

Soriak (Soriak Consulting & Research Ltd.). 2018. Archaeological Overview Assessment. Pine Point Mine Exploration Project Phase II. Northwest Territories. Prepared for Pine Point Mining Ltd. by Soriak Consulting & Research Ltd. Sturgeon County, Alberta.

Soriak. 2019. Archaeological Impact Assessment. Pine Point Mine Exploration Project. Class 2 Permit 2018-009.

Soutiere EC. 1979. Effects of timber harvesting on marten in Maine. Journal of Wildlife Management 43:850-860.

South Slave Divisional Educational Council. 2020. Deninu School. Available at: https://www.ssdec.net/deninu-school. Accessed January 2020.

Statistics Canada. 2017a. Enterprise, HAM [Census subdivision], Northwest Territories and Region 5, REG [Census division], Northwest Territories (table). Census Profile. 2016 Census. Statistics Canada Catalogue no. 98-316-X2016001. Ottawa. Released November 29, 2017. Accessed January 9, 2020.

Statistics Canada. 2017b. Fort Providence, HAM [Census subdivision], Northwest Territories and Region 4, REG [Census division], Northwest Territories (table). Census Profile. 2016 Census. Statistics Canada Catalogue no. 98-316-X2016001. Ottawa. Released November 29, 2017. Available at: https://www12.statcan.gc.ca/census-recensement/2016/dp-pd/prof/index.cfm?Lang=E. Accessed January 9, 2020.

Statistics Canada. 2017c. Fort Resolution, HAM [Census subdivision], Northwest Territories and Region 5, REG [Census division], Northwest Territories (table). Census Profile. 2016 Census. Statistics Canada Catalogue no. 98-316-X2016001. Ottawa. Released November 29, 2017. Available at: https://www12.statcan.gc.ca/census-recensement/2016/dp-pd/prof/index.cfm?Lang=E. Accessed January 9, 2020.

Statistics Canada. 2017d. Fort Smith [Population centre], Northwest Territories and Northwest Territories [Territory] (table). Census Profile. 2016 Census. Statistics Canada Catalogue no. 98-316-X2016001. Ottawa. Released November 29, 2017. Available at: https://www12.statcan.gc.ca/census-recensement/2016/dp-pd/prof/index.cfm?Lang=E. Accessed January 9, 2020.

Statistics Canada. 2017e. Hay River, T [Census subdivision], Northwest Territories and Region 5, REG [Census division], Northwest Territories (table). Census Profile. 2016 Census. Statistics Canada Catalogue no. 98-316-X2016001. Ottawa. Released November 29, 2017. Available at: https://www12.statcan.gc.ca/census-recensement/2016/dp-pd/prof/index.cfm?Lang=E . Accessed January 9, 2020.

Statistics Canada. 2017f. Hay River Dene 1, IRI [Census subdivision], Northwest Territories and Region 4, REG [Census division], Northwest Territories (table). Census Profile. 2016 Census. Statistics Canada Catalogue no. 98-316-X2016001. Ottawa. Released November 29, 2017. Available at: https://www12.statcan.gc.ca/census-recensement/2016/dp-pd/prof/index.cfm?Lang=E. Accessed January 9, 2020.

Statistics Canada. 2017g. Detah, SET [Census subdivision], Northwest Territories and Region 6, REG [Census division], Northwest Territories (table). Census Profile. 2016 Census. Statistics Canada Catalogue no. 98-316-X2016001. Ottawa. Released November 29, 2017. Available at: https://www12.statcan.gc.ca/census-recensement/2016/dp-pd/prof/index.cfm?Lang=E. Accessed January 9, 2020.

Statistics Canada. 2017h. Łutsel k'e, SET [Census subdivision], Northwest Territories and Region 5, REG [Census division], Northwest Territories (table). Census Profile. 2016 Census. Statistics Canada Catalogue no. 98-316-X2016001. Ottawa. Released November 29, 2017. Available at: https://www12.statcan.gc.ca/census-recensement/2016/dp-pd/prof/index.cfm?Lang=E. Accessed January 9, 2020.

Statistics Canada. 2017i. Yellowknife, CY [Census subdivision], Northwest Territories and Region 6, REG [Census division], Northwest Territories (table). Census Profile. 2016 Census. Statistics Canada Catalogue no. 98-316-X2016001. Ottawa. Released November 29, 2017. Available at: https://www12.statcan.gc.ca/census-recensement/2016/dp-pd/prof/index.cfm?Lang=E. Accessed January 9, 2020.

Statistics Canada. 2017j. Northwest Territories [Territory] and Canada [Country] (table). Census Profile. 2016 Census. Statistics Canada Catalogue no. 98-316-X2016001. Ottawa. Released November 29, 2017. Available at: https://www12.statcan.gc.ca/census-recensement/2016/dp-pd/prof/index.cfm?Lang=E. Accessed January 9, 2020.

Statistics Canada. 2017k. Dictionary. Census of Population, 2016. Core Housing Need. Available at https://www12.statcan.gc.ca/census-recensement/2016/ref/dict/households-menage037-eng.cfm

Statistics Canada. 2018. Table 2b Police-reported crime rate, by province and territory, 2017. Accessed January 2020. Available at: https://www150.statcan.gc.ca/n1/pub/85-002-x/2018001/article/54974/t/tbl02b-eng.htm.

Stedman SJ. 2000. Horned grebe (*Podiceps auritus*). The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology. https://doi.org/10.2173/bna.505.

Stelehin T. 2020. The effects of climate change on two birds (olive-sided flycatcher [*Contopus cooperi*] and western wood-pewee [*Contopus sordidulus*]) in the northwest. Yukon College Lecture Series, Wednesday, 26 February 2020.

Stelfox JB. 1993. Hoofed Mammals of Alberta. Lone Pine Publishing, Edmonton, AB.

Stevenson (Stevenson International Groundwater Consultants Ltd.). 1983. Hydrogeology of R190 Mineralized Region, Great Slave Reef Project, Westmin Resources Limited. Report submitted to Westmin Resources Limited, November 1983.

Stevenson. 1984. A study of the Great Slave Reef Pine Point Mines Aquifer, based on analyses of selected Pine Point Mines pumping test data. Report prepared by Stevenson International Groundwater Consultants Ltd. for Westmin Resources Ltd.

Stewart DB. 1999. A Review of Information on Fish Stocks and Harvests in the South Slave Area, Northwest Territories. Canadian Manuscript Report of Fisheries and Aquatic Sciences 2493. Central and Arctic Region. Department of Fisheries and Oceans. Winnipeg, Manitoba.

Swisher S. 2006a. Traditional Knowledge Summary Report. Pine Point Pilot Project. Fort Resolution, NWT. December 2006.

Swisher S. 2006b. Traditional Knowledge Summary Report. Pine Point Pilot Project. Hay River, NWT. December 2006.

Tamerlane. 2006a. Traditional Knowledge Study Summary Report – Pine Point Pilot Project – Fort Resolution, NWT. Report prepared for Tamerlane Ventures Inc. by S. Swisher. December 2006.

Tamerlane. 2006b. Traditional Knowledge Study Summary Report – Pine Point Pilot Project – Hay River, NWT. Report prepared for Tamerlane Ventures Inc. by S. Swisher. December 2006.

Tamerlane. 2007. Developers Assessment Report: Pine Point Pilot Project. Report prepared by EBA Consultants Ltd. for Tamerlane Ventures Inc., submitted to the Mackenzie Valley Environmental Impact Review Board. April 2007.

Taylor ME, Abrey N. 1982. Marten (*Martes americana*) movements and habitat use in Algonquin Provincial Park, Ontario. Canadian Field Naturalist 96: 439-447.

TetraTech. 2018. Summary of Geochemical Characterization Data for the Pine Point Project, NWT by TetraTech Canada Inc, Vancouver, British Columbia.

Thiel RP, Merrill, S Mech LD. 1998. Tolerance by denning wolves, Canis lupus, to human disturbance. Canadian Field-Naturalist 122: 340-342.

Thompson ID, Colgan PW. 1987. Numerical responses of martens to a food shortage in northcentral Ontario. Journal of Wildlife Management 51: 824-835.

Thompson ID, Harestad AS. 1994. Effects of logging on American martens, and models for habitat management. In: Buskirk SW, Harestad AS, Raphael MG, Powell RA. (eds.), Martens, sables, and fishers: biology and conservation. Pacific Southwest Research Station, USDA Forest Service General technical report PSW-GTR 157.

Thompson ID, Fryxell J, Harrison DJ. 2012. Improved insights in use of habitat by American martens. In: Aubry KB, Zielinski WJ, Raphael MG, Proulx G, Buskirk SW (eds.). Biology and Conservation of Martens, Sables, and Fishers: A New Synthesis. Ithaca, NY: Cornell University Press.

Town of Hay River. 2020. Economic Development. industry Profile. Accessed January 2020. Available at: https://hayriver.com/economic-development/industry-profile/

Town of Fort Smith. 2018. Economic Development Strategy. Accessed January 2020. Available at: https://www.fortsmith.ca/sites/default/files/Economic%20Development%20Strategy%20-%20Town%20of%20Fort%20Smith.pdf.

Vincent J-S, Klassen RW. 1989. Introduction (Quaternary geology of the Canadian Interior Plains). In, Chapter 2 of Quaternary Geology of Canada and Greenland. R.J. Fulton (ed.), Geological Survey of Canada, Geology of Canada, No.1.

Wiggins DA, Holt DW, Leasure SM. 2006. Short-eared Owl (*Asio flammeus*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology. https://doi.org/10.2173/bna.62.

Wolfe B, Armitage D, Wesche S, Brock B, Sokal M, Clogg-Wright K, Mongeon C, Adam M, Hall R, Edwards T. 2006. From Isotopes to TK Interviews: Towards Interdisciplinary Research in Fort Resolution and the Slave River Delta, Northwest Territories. ARCTIC. VOL. 60, NO. 1 (MARCH 2007) P. 75–87

Working Group on General Status of NWT Species. 2016. NWT Species 2016-2020 – General Status Ranks of Wild Species in the Northwest Territories, Department of Environment and Natural Resources, Government of the Northwest Territories, Yellowknife, NT. 304 pp.

WSC (Water Survey of Canada). 2020. Historical Hydrometric Data. Accessed February 2020. Available at: https://wateroffice.ec.gc.ca/download/index_e.html?results_type=historical

YKDFN (Yellowknife Dene First Nation). 2020.Community Economic Development. Available at: https://ykdene.com/government/economic-development/community-economic-development/. Accessed January 2020.

Zhu X, Chapelsky A, Carmichael TJ, Leonard DL, Lea E, Tallman RF, Evans M, Podemski C, Low G. 2017. Establishment of Ecological Baseline Metrics for Integrated Ecomonitoring and Assessment of Cumulative Impacts on Great Slave Lake Fisheries. Canadian Technical Report of Fisheries and Aquatic Sciences 3223:1–58

APPENDIX A

2015-2019 Ambient Background Summary

Table A1: 2015-2019 Summary of Ambient CO Concentrations at Fort Smith

Location	Avg. Period	Parameter	2015	2016	2017	2018	2019	Average
CO								
Fort Smith	1-hr	Max Conc. [µg/m³]	3,029.1	2,036.2	4,812.2	1,683.5	2,169.1	2,746.0
		90th percentile Conc. [µg/m³]	239.4	323.0	367.6	406.6	363.0	339.9
		Average Conc. [µg/m³]	69.0	162.8	185.7	201.4	276.2	179.0
		Median Conc. [µg/m³]	11.5	151.2	166.1	154.6	280.6	152.8
		AAQS [µg/m³]	15,000	15,000	15,000	15,000	15,000	15,000
		#> AAQS	0	0	0	0	0	0
	8-hr	Max Conc. [µg/m³]	1,338.9	977.9	2,254.1	793.6	1,091.0	1291.1
		90th percentile Conc. [µg/m³]	236.9	322.1	366.5	410.2	372.9	341.7
		Average Conc. [µg/m³]	69.2	162.8	185.7	201.3	276.2	895.3
		Median Conc. [µg/m³]	20.2	155.6	168.5	158.6	282.6	157.1
		AAQS [µg/m³]	6,000	6,000	6,000	6,000	6,000	6,000
		#> AAQS	0	0	0	0	0	0

= number; AAQS = Government of the North-West Territories' Ambient Air Quality Standards; Avg. = averaging; CO = carbon monoxide; Conc. = concentration; hr = hour; µg/m³ = micrograms per cubic meter.

Table A2: 2015-2019 Summary of Ambient CO Concentrations at Yellowknife

Location	Avg. Period	Parameter	2015	2016	2017	2018	2019	Average
CO								
Yellowknife	1-hr	Max Conc. [μg/m³]	3,623.5	2,060.3	4,041.5	1,219.7	3,375.0	2,864.0
		90th percentile Conc. [μg/m³]	792.5	817.7	285.2	255.4	261.1	482.4
		Average Conc. [μg/m³]	390.9	422.4	218.2	187.1	194.1	282.5
		Median Conc. [μg/m³]	255.4	215.3	189.0	172.9	171.8	200.9
		AAQS [μg/m³]	15,000	15,000	15,000	15,000	15,000	15,000
		#> AAQS	0	0	0	0	0	0
	8-hr	Max Conc. [μg/m³]	1,961.8	1,245.7	2,282.3	633.6	3,020.7	1,828.8
		90th percentile Conc. [μg/m³]	800.3	816.2	284.9	257.6	261.0	484.0
		Average Conc. [μg/m³]	387.7	422.1	218.2	187.0	194.2	281.8
		Median Conc. [μg/m³]	261.8	214.6	191.3	176.0	176.9	204.1
		AAQS [μg/m³]	6,000	6,000	6,000	6,000	6,000	6,000
		#> AAQS	0	0	0	0	0	0

= number; AAQS = Government of the North-West Territories' Ambient Air Quality Standards; Avg. = averaging; CO = carbon monoxide; Conc. = concentration; hr = hour; μg/m³ = micrograms per cubic meter.

Table A3: 2015-2019 Summary of Ambient NO_2 Concentrations at Fort Smith

Location	Avg. Period	Parameter	2015	2016	2017	2018	2019	Average
NO_2								
Fort Smith	1-hr	Max Conc. [µg/m³]	62.6	62.1	54.2	78.8	63.0	64.1
		90th percentile Conc. [µg/m³]	7.9	3.4	7.0	7.5	8.5	6.8
		Average Conc. [µg/m³]	3.5	1.4	2.4	3.5	3.8	2.9
		Median Conc. [µg/m³]	1.9	0.0	0.0	1.9	1.7	1.1
		AAQS [µg/m³]	400	400	400	400	400	400
		#> AAQS	0	0	0	0	0	0
	24-hr	Max Conc. [µg/m³]	19.0	21.1	20.2	40.9	29.6	26.2
		90th percentile Conc. [µg/m³]	6.8	3.3	5.5	6.3	7.9	5.9
		Average Conc. [µg/m³]	3.5	1.3	2.5	3.5	3.8	2.9
		Median Conc. [µg/m³]	2.8	0.4	1.6	3.0	2.4	2.0
		AAQS [µg/m³]	200	200	200	200	200	200
		#> AAQS	0	0	0	0	0	0
	Annual	Average Conc. [µg/m³]	3.5	1.4	2.4	3.5	3.8	2.9
		AAQS [µg/m³]	60	60	60	60	60	60

= number; AAQS = Government of the North-West Territories' Ambient Air Quality Standards; Avg. = averaging; NO_2 = nitrogen dioxide; Conc. = concentration; hr = hour; µg/m³ = micrograms per cubic meter.

Table A4: 2015-2019 Summary of Ambient NO_2 Concentrations at Yellowknife

Location	Avg. Period	Parameter	2015	2016	2017	2018	2019	Average
NO_2								
Yellowknife	1-hr	Max Conc. [µg/m³]	64.3	62.4	68.8	75.4	58.1	65.8
		90th percentile Conc. [µg/m³]	14.1	10.5	17.3	15.2	7.9	13.0
		Average Conc. [µg/m³]	5.7	3.6	6.6	5.4	2.4	4.7
		Median Conc. [µg/m³]	3.0	0.9	3.2	2.3	0.0	1.9
		AAQS [µg/m³]	400	400	400	400	400	400
		#> AAQS	0	0	0	0	0	0
	24-hr	Max Conc. [µg/m³]	31.7	33.7	33.6	29.7	28.8	31.5
		90th percentile Conc. [µg/m³]	11.9	10.0	16.9	14.7	9.5	12.6
		Average Conc. [µg/m³]	5.7	3.6	6.6	5.4	2.4	4.7
		Median Conc. [µg/m³]	4.5	1.5	4.1	3.1	0.3	2.7
		AAQS [µg/m³]	200	200	200	200	200	200
		#> AAQS	0	0	0	0	0	0
	Annual	Average Conc. [µg/m³]	5.7	3.6	6.6	5.4	2.4	4.7
		AAQS [µg/m³]	60	60	60	60	60	60

= number; AAQS = Government of the North-West Territories' Ambient Air Quality Standards; Avg. = averaging; NO_2 = nitrogen dioxide; Conc. = concentration; hr = hour; µg/m³ = micrograms per cubic meter.

Table A5: 2015-2019 Summary of Ambient O3 Concentrations at Fort Smith and Yellowknife

Location	Avg. Period	Parameter	2015	2016	2017	2018	2019	Average
O_3								
Fort Smith	8-hr Rolling	Max Conc. [µg/m³]	110.5	90.4	113.1	92.4	107.2	102.7
		90th percentile Conc. [µg/m³]	79.1	74.2	75.3	68.3	74.9	74.4
		Average Conc. [µg/m³]	61.0	54.9	58.4	51.9	54.0	56.0
		Median Conc. [µg/m³]	59.5	54.6	57.9	51.2	53.4	55.3
		AAQS [µg/m³]	126	126	126	126	126	126
		#> AAQS	0	0	0	0	0	0
Yellowknife	8-hr Rolling	Max Conc. [µg/m³]	97.8	90.3	90.7	104.9	99.7	96.7
		90th percentile Conc. [µg/m³]	74.4	77.4	72.6	76.9	74.3	75.1
		Average Conc. [µg/m³]	56.2	57.3	54.8	58.0	58.2	56.9
		Median Conc. [µg/m³]	55.8	56.8	55.4	56.9	58.1	56.6
		AAQS [µg/m³]	126	126	126	126	126	126
		#> AAQS	0	0	0	0	0	0

= number; AAQS = Government of the North-West Territories' Ambient Air Quality Standards; Avg. = averaging; O_3 = ozone; Conc. = concentration; hr = hour; µg/m³ = micrograms per cubic meter.

Table A6: 2015-2019 Summary of Ambient PM2.5 Concentrations at Fort Smith

Location	Avg. Period	Parameter	2015	2016	2017	2018	2019	Average
$PM_{2.5}$								
Fort Smith	24-hr	Max Conc. [µg/m³]	119.1	44.1	171.3	50.8	65.3	90.1
		90th percentile Conc. [µg/m³]	9.8	9.7	11.2	11.4	11.9	10.8
		Average Conc. [µg/m³]	7.2	5.6	7.3	8.0	7.2	7.1
		Median Conc. [µg/m³]	4.7	4.4	5.7	7.0	5.6	5.5
		AAQS [µg/m³]	28	28	28	28	28	28
		#> AAQS	12	2	3	1	7	5
	Annual	Average Conc. [µg/m³]	7.2	5.6	7.4	8.0	7.2	7.1
		AAQS [µg/m³]	10	10	10	10	10	10

= number; AAQS = Government of the North-West Territories' Ambient Air Quality Standards; Avg. = averaging; $PM_{2.5}$ = fine particulate matter; Conc. = concentration; hr = hour; µg/m³ = micrograms per cubic meter.

Table A7: 2015-2019 Summary of Ambient PM2.5 Concentrations at Yellowknife

Location	Avg. Period	Parameter	2015	2016	2017	2018	2019	Average
$PM_{2.5}$								
Yellowknife	24-hr	Max Conc. [μg/m³]	105.4	35.4	135.7	22.0	54.0	70.5
		90th percentile Conc. [μg/m³]	13.5	10.8	7.9	5.9	7.0	9.0
		Average Conc. [μg/m³]	8.7	7.8	4.5	2.9	4.4	5.7
		Median Conc. [μg/m³]	6.3	7.1	2.6	2.4	3.2	4.3
		AAQS [μg/m³]	28	28	28	28	28	28
		#> AAQS	9	2	5	0	5	4
	Annual	Average Conc. [μg/m³]	8.6	7.8	4.6	2.9	4.4	5.6
		AAQS [μg/m³]	10	10	10	10	10	10

= number; AAQS = Government of the North-West Territories' Ambient Air Quality Standards; Avg. = averaging; $PM_{2.5}$ = fine particulate matter; Conc. = concentration; hr = hour; μg/m³ = micrograms per cubic meter.

Table A8: 2015-2019 Summary of Ambient SO2 Concentrations at Fort Smith

Location	Avg. Period	Parameter	2015	2016	2017	2018	2019	Average
SO_2								
Fort Smith	1-hr	Max Conc. [μg/m^3]	7.6	3.9	5.5	2.4	282.1	60.3
		90th percentile Conc. [μg/m^3]	1.8	1.6	1.8	1.8	1.0	1.6
		Average Conc. [μg/m^3]	0.5	0.7	0.5	0.6	0.3	0.5
		Median Conc. [μg/m^3]	0.0	0.8	0.0	0.0	0.0	0.2
		AAQS	450	450	450	450	450	450
		#> AAQS	0	0	0	0	0	0
	24-hr	Max Conc. [μg/m^3]	4.6	2.1	2.6	2.1	19.0	6.1
		90th percentile Conc. [μg/m^3]	1.7	1.3	1.7	1.5	1.0	1.4
		Average Conc. [μg/m^3]	0.5	0.7	0.5	0.6	0.4	0.5
		Median Conc. [μg/m^3]	0.0	0.8	0.2	0.3	0.0	0.3
		AAQS [μg/m^3]	150	150	150	150	150	150
		#> AAQS	0	0	0	0	0	0
	Annual	Average Conc. [μg/m^3]	0.5	0.7	0.5	0.6	0.3	0.5
		AAQS [μg/m^3]	30	30	30	30	30	30

= number; AAQS = Government of the North-West Territories' Ambient Air Quality Standards; Avg. = averaging; SO_2 = sulphur dioxide; Conc. = concentration; hr = hour; μg/m^3 = micrograms per cubic meter.

Table A9: 2015-2019 Summary of Ambient SO2 Concentrations at Yellowknife

Location	Avg. Period	Parameter	2015	2016	2017	2018	2019	Average
SO_2								
Yellowknife	1-hr	Max Conc. [µg/m³]	10.2	7.5	4.8	4.2	7.4	6.8
		90th percentile Conc. [µg/m³]	2.0	1.1	0.8	1.3	1.9	1.4
		Average Conc. [µg/m³]	0.8	0.5	0.4	0.6	0.9	0.6
		Median Conc. [µg/m³]	0.6	0.3	0.2	0.6	0.7	0.5
		AAQS	450	450	450	450	450	450
		#> AAQS	0	0	0	0	0	0
	24-hr	Max Conc. [µg/m³]	3.0	3.1	1.4	1.9	2.6	2.4
		90th percentile Conc. [µg/m³]	2.0	1.1	0.7	1.4	1.8	1.4
		Average Conc. [µg/m³]	0.8	0.5	0.4	0.6	0.9	0.6
		Median Conc. [µg/m³]	0.6	0.4	0.3	0.6	0.8	0.5
		AAQS	150	150	150	150	150	150
		#> AAQS	0	0	0	0	0	0
	Annual	Average Conc. [µg/m³]	0.8	0.5	0.4	0.6	0.9	0.6
		AAQS [µg/m³]	30	30	30	30	30	30

= number; AAQS = Government of the North-West Territories' Ambient Air Quality Standards; Avg. = averaging; SO_2 = sulphur dioxide; Conc. = concentration; hr = hour; µg/m³ = micrograms per cubic meter.

APPENDIX B

Water Quality Data Summary from Previous Studies

Table B1: Summary of Previous Water Quality Studies Conducted on or near the Project

Watercourse/Waterbody	Study[a]	Number of Stations	Number of Samples per Station	Sampling Year	Sampling Months	Additional Data Collected?
Birch Creek	Rescan 2012g	1	3[b]	2012	May, August, October	Sediment Quality (September), Benthic Invertebrates (August)
	Golder 2020	1	1	2020	October	-
Twin Creek	Beak 1980	2	1	1979	September	-
	EBA 2005a	3	1	2005	September	Stream Habitat Data
	Rescan 2012g	2	3[b]	2012	May, August, October	Sediment Quality (September), Benthic Invertebrates (August)
	Golder 2020	1	1	2020	October	-
Buffalo River	Beak 1980	2	1	1979	September	-
	EBA 2005a	4	1	2005	September	Stream Habitat Data
	Rescan 2012g	3	3[b]	2012	May, August, October	Sediment Quality (September), Benthic Invertebrates (August)
	Golder 2020	1	1	2020	October	-
Paulette Creek	Rescan 2012f	2	2	2012	May[c], August, October	Sediment Quality (September), Benthic Invertebrates (August)
	Golder 2020	1	1	2020	October	-
Little Buffalo River	Evans 1998	1	1	1996	September	Sediment Quality
	Golder 2020	1	1	2020	October	-
Polar Lake	Beak 1980	1	1	1979	September	-
Great Slave Lake	EBA 2005a	3	1	2005	September	-
	Rescan 2012g	5	1	2012	August	-
	Golder 2020	1	1	2020	October	-

a) An additional baseline study was conducted by EBA Engineering Consultants Ltd in 2006, in which water quality samples were collected for Buffalo River, Twin Creek and Great Slave Lake. These data were not available for use in this report; however, general water quality parameter concentrations were generally consistent with those provided in the EBA 2005 report (Tamerlane 2007).

b) One sample collected at each station per month.

c) One station, N-204-S1, was only sampled in May due to low water levels in August and October.

Table B2: Summary of Water Quality Data for Watercourses located on or near to the Project

Parameter	Units	Birch Creek[a]				Twin Creek[b]				Buffalo River[c]				Paulette Creek[d]				Little Buffalo River [e]
		Count	Min	Median	Max	Count	Min	Median	Max	Count	Min	Median	Max	Count	Min	Median	Max	
Conventional Parameters																		
Specific Conductivity	µS/cm	4	350	448.5	491	10	246	432.5	559	13	155	246	325	6	122	687	792	3,670
pH[f]	pH	4	8.2	8.4	8.4	9	7.9	8.1	8.4	12	8.0	8.1	8.2	6	7.4	8.2	8.4	8
Hardness	mg/L	4	8.3	223.5	277	11	179	271	415	14	60	129.5	226	6	60	355	430	1,600.0
Total Suspended Solids	mg/L	4	<1	<3	<3	7	<3	4.75	6.8	10	25	54	130	6	<3.0	12.9	39	3.3
Total Dissolved Solids	mg/L	4	234	276.5	326	7	221	312	338	10	109	167	214	6	96	502.5	523	2,670
Turbidity	NTU	4	0.23	0.32	0.56	7	0.16	0.31	2.2	10	25	43	130	6	0.6	1.7	4.0	2.7
Major Ions																		
Total Calcium	mg/L	4	56	72	80	7	51	77	86.8	10	19	34	43	6	13	85	94	440
Dissolved Calcium	mg/L	4	54	72	82	9	51	77	110	12	16	34	44	6	13	81	93	480
Bromide	mg/L	4	<0.01	<0.05	<0.25	7	<0.01	<0.01	<0.01	10	<0.050	<0.050	0.011	6	<0.25	<0.25	0.02	0.22
Chloride	mg/L	4	3.4	4.9	6.0	7	1.4	4.3	17	12	2.3	3.1	6.4	6	4.7	9.7	17	450
Fluoride	mg/L	4	0.14	0.14	0.20	9	0.15	0.22	0.26	12	0.12	0.15	0.18	6	0.14	0.22	0.24	0.76
Total Magnesium	mg/L	4	13	17	19	7	13	20	22	10	6	10	13	6	6.7	38	44	83
Dissolved Magnesium	mg/L	4	12	17	19	9	12	20	34	12	5	10	13	6	6.5	37	48	90
Total Potassium	mg/L	4	0.65	1.3	19	7	0.38	0.55	1.3	10	0.99	1.2	2.7	6	1.2	2.4	4.2	3.6
Dissolved Potassium	mg/L	4	0.63	1.2	19	9	0.36	0.56	1.2	12	0.60	0.98	1.2	6	1.1	2.3	4.1	3.6
Total Sodium	mg/L	4	4.8	6.4	19	7	3.9	5.5	11.0	10	3.8	6.7	9.7	6	2.1	13	17	290
Dissolved Sodium	mg/L	4	4.5	6.3	19	9	3.7	5.6	11	12	3.7	7.0	8.9	6	2.1	12	16	280
Sulfate	mg/L	4	0.66	2.4	19	7	0.96	8.5	54	10	13	28	63	6	5.4	55	160	1,200
Nutrients																		
Ammonia	mg-N/L	4	0.014	0.016	0.017	7	0.017	0.020	0.028	9	0.0090	0.014	0.035	6	0.017	0.024	0.048	0.019
Nitrate	mg-N/L	4	<0.0050	<0.0050	<0.010	7	<0.0050	0.052	0.066	12	0.0072	0.0082	0.0110	6	<0.025	<0.025	0.059	<0.010
Nitrite	mg-N/L	4	<0.0010	<0.0010	<0.010	7	<0.0010	<0.0050	<0.010	10	<0.0010	<0.0010	<0.01	6	<0.0050	<0.0050	0.0062	<0.010
Total Kjeldahl Nitrogen	mg-N/L	4	0.70	0.81	1.2	7	0.67	0.88	0.97	9	0.48	0.70	0.89	6	0.73	1.3	2.0	0.61
Total Nitrogen	mg-N/L	4	0.75	0.86	1.1	7	0.74	0.88	1.25	9	0.61	0.69	0.90	6	0.75	1.3	2.2	0.61
Dissolved Orthophosphate	mg-P/L	4	<0.0010	<0.0010	<0.0030	7	<0.0010	<0.0010	<0.0030	10	<0.0010	<0.0010	0.0034	6	0.0021	0.0050	0.0077	0.0031
Total Phosphorus	mg/L	4	0.0032	0.0038	0.0050	9	0.0028	0.0035	0.0090	12	0.028	0.056	0.13	6	0.010	0.031	0.059	0.0078
Total Organic Carbon	mg/L	4	19	21	25	9	19	22	42	9	14	15	18	6	18	33	45	14
Total Metals																		
Aluminum	mg/L	4	0.0038	0.00485	0.013	7	0.0030	0.0060	0.043	13	0.41	1.9	7.7	6	0.027	0.035	0.094	0.059
Arsenic	mg/L	4	0.00032	0.00036	0.00045	9	0.00036	0.00043	0.000574	10	0.00091	0.0012	0.0031	6	0.00045	0.00090	0.0017	0.00057
Barium	mg/L	4	0.044	0.046	0.060	10	0.021	0.028	0.29	12	0.042	0.059	0.12	6	0.014	0.027	0.03	0.022
Boron	mg/L	4	0.0070	0.0088	0.011	9	0.0055	0.0068	0.0084	10	0.017	0.027	0.030	6	0.014	0.026	0.034	0.39
Cadmium	mg/L	4	<0.000010	<0.000010	<0.000020	9	<0.000010	<0.000010	<0.0050	10	0.000029	0.000041	0.00043	6	<0.000010	<0.000010	0.000040	<0.000020
Chromium	mg/L	4	0.00013	0.00014	0.00015	9	0.00011	0.00013	0.00016	10	0.00080	0.0019	0.0084	6	0.00018	0.00020	0.00033	<0.0010
Copper	mg/L	4	0.00064	0.00064	0.00064	9	<0.00050	<0.00050	0.00029	10	0.0018	0.0028	0.0064	6	<0.00050	<0.00050	0.0010	0.001
Iron	mg/L	4	0.049	0.055	0.075	10	0.018	0.0455	0.12	13	0.89	2.9	6	6	0.11	0.19	0.22	0.290
Lead	mg/L	4	<0.000050	<0.000050	<0.00020	9	<0.000050	0.00015	0.00017	10	0.00053	0.0011	0.0034	6	<0.000050	<0.000050	0.00010	<0.00020
Manganese	mg/L	4	0.0046	0.013	0.017	7	0.0010	0.015	0.075	10	0.027	0.047	0.11	6	0.0092	0.07	0.19	0.020
Mercury	mg/L	4	<0.0000020	<0.000010	<0.000010	9	<0.0000020	<0.000010	<0.000010	10	<0.0000092	<0.000010	<0.000010	6	<0.0000020	<0.000010	<0.000010	<0.0000020
Nickel	mg/L	4	0.00010	0.00016	0.00020	7	0.00012	0.00017	0.0007	10	0.0018	0.0031	0.0074	6	0.0004	0.0005	0.0014	0.00074
Silver	mg/L	4	<0.000010	<0.000010	<0.00010	7	<0.000010	<0.000010	<0.00010	10	<0.00010	0.000016	0.000035	6	<0.000010	<0.000010	0.000024	<0.00010
Zinc	mg/L	4	<0.0030	<0.0030	<0.0030	9	<0.0030	<0.0030	0.0051	10	0.0037	0.0082	0.020	6	<0.0030	0.0037	0.0039	<0.0030

Table B2: Summary of Water Quality Data for Watercourses located on or near to the Project

Parameter	Units	Birch Creek[a]				Twin Creek[b]				Buffalo River[c]				Paulette Creek[d]				Little Buffalo River [e]
		Count	Min	Median	Max	Count	Min	Median	Max	Count	Min	Median	Max	Count	Min	Median	Max	
Dissolved Metals																		
Aluminum	mg/L	4	<0.0030	0.0046	0.0050	7	<0.0030	<0.0030	<0.0030	13	<0.0030	0.017	0.37	6	<0.0030	<0.0030	0.019	<0.0030
Arsenic	mg/L	4	0.00032	0.00036	0.00045	9	0.00035	0.00047	0.013	12	0.00029	0.00046	0.012	6	0.00043	0.00061	0.0011	0.00046
Barium	mg/L	4	0.042	0.044	0.061	10	0.021	0.025	0.0325	14	0.026	0.043	0.063	6	0.013	0.026	0.029	0.021
Boron	mg/L	4	0.0058	0.0084	0.0090	7	<0.0050	0.0065	0.0067[g]	12	<0.010	0.024	0.028	6	0.014	0.023	0.030	0.42
Cadmium	mg/L	4	<0.000010	<0.000010	<0.000020	9	<0.000010	<0.000020	<0.0050	12	<0.000010	<0.000010	0.000018	6	<0.000010	<0.000010	0.000010	<0.000020
Chromium	mg/L	4	<0.00010	<0.00010	<0.0010	9	<0.00010	<0.0010	<0.010	11	<0.00010	0.00013	0.00017	6	0.00012	0.00012	0.00025	<0.0010
Copper	mg/L	4	<0.00020	<0.00050	<0.00050	9	<0.00020	0.00107	0.0011	12	<0.0050	0.0016	0.0024	6	<0.00050	<0.00020	0.0010	0.00040
Iron	mg/L	4	0.018	0.032	0.034	10	<0.010	0.030	0.08	14	0.027	0.079	2.3	6	0.054	0.071	0.086	0.097
Lead	mg/L	4	<0.000050	<0.000050	<0.00020	9	<0.000050	<0.00020	<0.010	12	<0.000050	<0.000050	0.00011	6	<0.000050	<0.000050	<0.00020	<0.00020
Manganese	mg/L	4	0.0025	0.0078	0.0136	7	0.00073	0.0075	0.067	10	0.00017	0.00039	0.0037	6	0.0016	0.040	0.16	0.019
Mercury	mg/L	4	<0.0000020	<0.000010	<0.000010	9	<0.0000020	<0.000010	0.0013	12	<0.0000020	<0.000010	0.0010	6	<0.0000020	<0.000010	<0.000010	<0.0000020
Nickel	mg/L	4	0.00016	0.00018	0.00021	7	<0.00050	0.00018	0.00031	10	0.00094	0.0017	0.0022	6	<0.00050	0.00042	0.0013	0.00066
Silver	mg/L	4	<0.000010	<0.000010	<0.00010	7	<0.000010	<0.000010	<0.00010	10	<0.000010	<0.000010	<0.00010	6	<0.000010	<0.000010	<0.000010	<0.00010
Zinc	mg/L	4	<0.0030	<0.0030	<0.0030	9	<0.0030	<0.0030	0.070	12	<0.0030	<0.0030	<0.0030	6	<0.0030	<0.0030	<0.0030	<0.0030
Other																		
Total Cyanide	mg/L	4	0.010	0.011	0.011	7	<0.0020	0.012	0.013	10	<0.002	0.0087	0.012	6	0.015	0.017	0.019	<0.0020

a) Rescan 2012g, Golder 2020

b) Beak 1980, EBA 2005a, Rescan 2012g, Golder 2020

c) Beak 1980, EBA 2005a, Rescan 2012g, Golder 2020

d) Rescan 2012f, Golder 2020

e) Golder 2020

f) Includes both lab and field pH values.

g) Dissolved boron concentrations from Beak 1980 and Golder 2020 study removed as the DL is 0.01 and 0.02 mg/L respectively, which is above the maximum concentration from the 2012 study.

- = no data; µS/cm = microSiemens per centimetre; NTU = Nephelometric Turbidity Units; mg/L = milligrams per litre; mg-N/L = milligrams of Nitrogen per litre; mg-P/L = milligrams of Phosphorus per litre.

Table B3: Summary of Water Quality Data for Waterbodies Located on or near to the Project

Parameter	Units	Polar Lake[(a)]		Great Slave Lake[(b)]			
		Count	Value	Count	Min	Median	Max
Conventional Parameters							
Specific Conductivity	µS/cm	1	325[(c)]	7	237	250	322
pH[(d)]	pH	1	8.5	6	8.2	8.2	8.3
Hardness	mg/L	1	328[(e)]	8	98	102	150
Total Suspended Solids	mg/L	0	-	6	3.6	27	74
Total Dissolved Solids	mg/L	0	-	6	147	163	186
Turbidity	NTU	0	-	6	6.8	23	53
Major Ions							
Total Calcium	mg/L	0	-	6	28	30	39
Dissolved Calcium	mg/L	1	87	6	27	29	41
Bromide	mg/L	0	-	2	<0.050	<0.050	<0.050
Chloride	mg/L	1	0.40[(e)]	6	5.6	7.5	10
Fluoride	mg/L	1	0.18[(e)]	6	0.080	0.088	0.14
Total Magnesium	mg/L	0	-	6	6.8	7.3	10
Dissolved Magnesium	mg/L	1	27	6	6.4	7.2	11
Total Potassium	mg/L	0	-	6	1.1	1.1	1.3
Dissolved Potassium	mg/L	1	0.91	6	0.93	0.90	1.2
Total Sodium	mg/L	0	-	6	7.7	8.7	10.0
Dissolved Sodium	mg/L	1	1.6	6	7.9	8.5	9.7
Sulfate	mg/L	0	-	6	25	29	52
Nutrients							
Ammonia	mg-N/L	0	-	6	<0.0050	<0.0050	0.0065
Nitrate	mg-N/L	1	<0.050	6	<0.0050	<0.0050	0.0072
Nitrite	mg-N/L	0	-	6	<0.0010	<0.0010	<0.0010
Total Kjeldahl Nitrogen	mg-N/L	0	-	6	0.24	0.44	0.92
Total Nitrogen	mg-N/L	0	-	6	0.24	0.5	0.67
Dissolved Orthophosphate	mg-P/L	0	-	6	<0.0010	<0.0010	<0.0010
Total Phosphorus	mg/L	1	<0.0030	6	0.010	0.038	0.099
Total Organic Carbon	mg/L	0	-	6	5.2	10	15
Total Metals							
Aluminum	mg/L	0	-	9	0.31	0.47	1.9
Arsenic	mg/L	0	-	6	0.00051	0.00090	0.0012
Barium	mg/L	0	-	6	0.046	0.051	0.053
Boron	mg/L	0	-	6	0.019	0.020	0.024
Cadmium	mg/L	0	-	6	0.000016	0.000034	0.000061
Chromium	mg/L	0	-	6	0.00053	0.00074	0.0011
Copper	mg/L	0	-	6	0.0016	0.002245	0.0030
Iron	mg/L	0	-	7	0.29	0.74	1.2
Lead	mg/L	0	-	6	0.00016	0.00046	0.00085
Manganese	mg/L	0	-	6	0.0055	0.030	0.060
Mercury	mg/L	0	-	6	<0.000010	<0.000010	<0.000010
Nickel	mg/L	0	-	6	0.0013	0.0024	0.0029
Silver	mg/L	0	-	6	<0.000010	<0.000010	0.000019
Zinc	mg/L	0	-	6	0.0036	0.0047	0.0059
Dissolved Metals							
Aluminum	mg/L	0	-	6	0.0051	0.013	0.020
Arsenic	mg/L	1	0.006	5	0.00034	0.00045	0.00059
Barium	mg/L	0	-	7	0.040	0.043	0.044
Boron	mg/L	1	<0.010	5	0.017	0.019	0.024
Cadmium	mg/L	1	<0.0050	5	<0.000010	<0.000010	0.000011
Chromium	mg/L	1	<0.010	5	<0.00010	<0.00010	0.00010
Copper	mg/L	1	<0.0050	5	0.0008	0.0015	0.0018
Iron	mg/L	1	0.020	5	0.022	0.038	0.047
Lead	mg/L	1	<0.010	5	<0.000050	<0.000050	<0.000050
Manganese	mg/L	0	-	5	0.00032	0.00047	0.00070
Mercury	mg/L	1	0.0016	5	<0.000010	<0.000010	<0.000010
Nickel	mg/L	0	-	5	0.0012	0.0014	0.0019
Silver	mg/L	0	-	5	<0.000010	<0.000010	<0.000010
Zinc	mg/L	1	<0.0050	5	<0.0030	<0.0030	<0.0030
Other							
Total Cyanide	mg/L	0	-	5	0.0055	0.0056	0.0075

a) Beak 1980; surface water sample.

b) EBA 2005a, Rescan 2012g, Golder 2020; near-shore surface water samples.

c) Recorded as 'conductivity' in study, not specific conductivity.

d) Includes both lab and field pH values.

e) Dissolved species analysed only.

APPENDIX C

Pine Point Project 2020 Baseline Study Plan

GOLDER

REPORT

Baseline Study Plan for 2020

Pine Point Project

Submitted to:

Pine Point Mining Limited

Submitted by:

Golder Associates Ltd.

9, 4905 - 48 Street, Yellowknife, Northwest Territories, X1A 3S3, Canada

+1 867 873 6319

Doc 012-19125747

30 March 2020

Distribution List

1 Digital Copy to Pine Point Mining Limited

Table of Contents

TABLES

FIGURES

Abbreviation List

Abbreviation	Definitions
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
EA	environmental assessment
ELC	ecological land classification
GNWT	Government of the Northwest Territories
ITK	Indigenous Traditional Knowledge
MVEIRB	Mackenzie Valley Environmental Impact Review Board
NWT	Northwest Territories
PPML	Pine Point Mining Limited
QC	Quality Control
SEIA	Socio-Economic Impact Assessment
the Project	the Pine Point Project
TLRU	Traditional Land and Resource Use

1.0 INTRODUCTION

This document outlines suggested environmental studies for the Pine Point Project (the Project) on behalf of Pine Point Mining Limited (PPML) in anticipation of an environmental assessment (EA) and permitting under the *Mackenzie Valley Resource Management Act*.

The Project is located in the Northwest Territories within the South Slave District, south of Great Slave Lake, approximately 175 km directly south of Yellowknife, 75 km east of Hay River, and 53 km southwest of Fort Resolution. Access to the Project is presently via Highway 5 (Figure 1).

Golder reviewed existing environmental information available for the Project in a Gap Analysis Report (Golder 2019) and made suggestions for additional field surveys that may be required to support the EA. As this Project will be constructed and operated in predominantly a brownfield (i.e., previously disturbed) area, the data requirements and effort required for the EA are anticipated to be less than for a greenfield project.

1.1 Purpose

Based on the Gap Analysis (Golder 2019), this document outlines the baseline environmental studies proposed for each environmental discipline to prepare the EA and engage regulators and community groups in the process. Disciplines include air quality and noise, surface water quantity, surface water quality, fish and fish habitat, vegetation, wildlife and species at risk, socio-economics, traditional land and resource use, and archaeology.

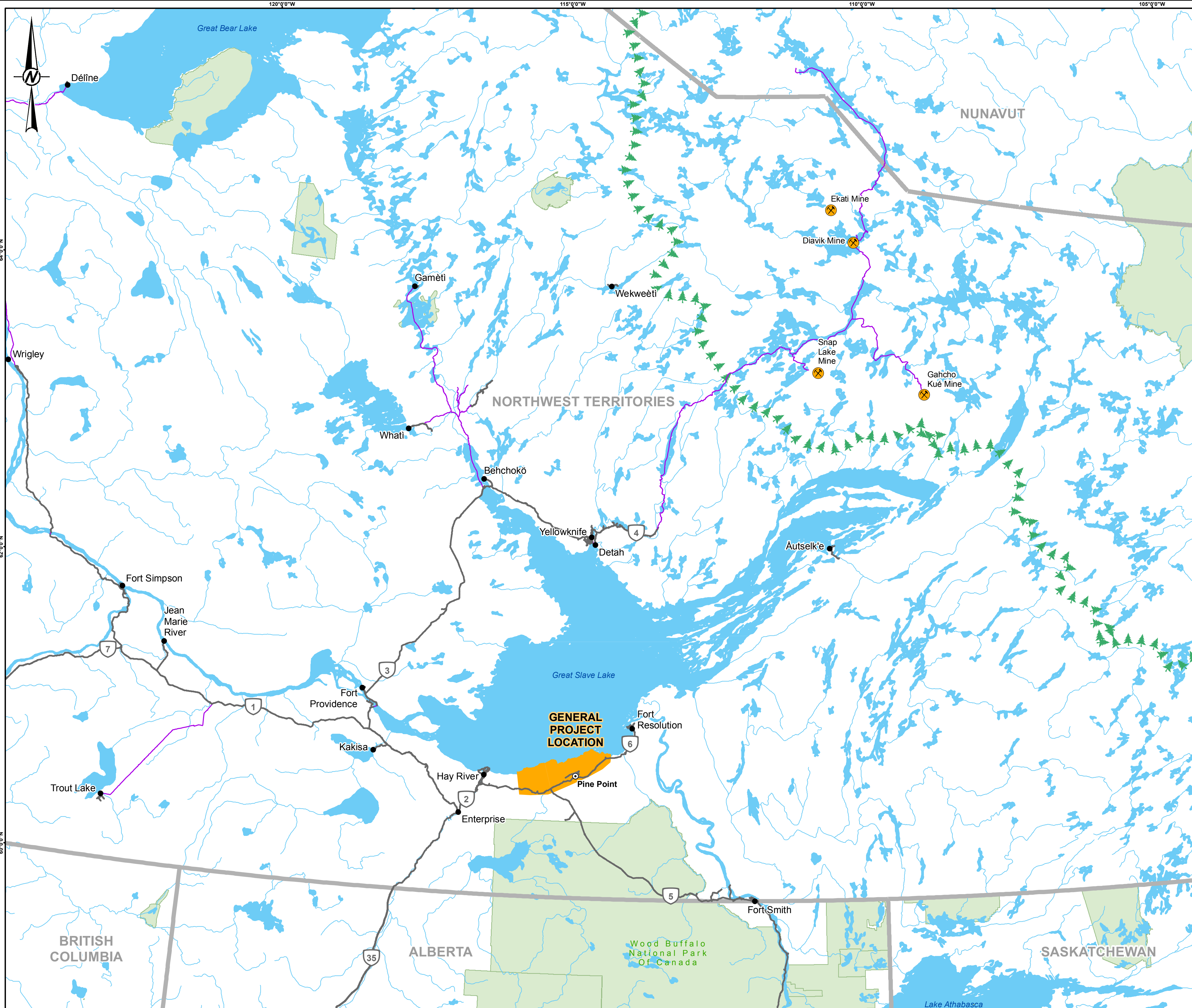
Sections 2 to 10 provide a high-level summary of the available information, the potential environmental effect pathways based on initial Project information, and the proposed environmental studies.

1.2 Project Understanding

Table 1 provides an overview of the activities that are anticipated for each project phase (construction, operations, closure, and post-closure).

Table 1: Anticipated Activities

Anticipated Activities	Construction	Operations	Closure and Post-closure
Site preparation	✓		
Infrastructure development	✓		
Water supply	✓	✓	✓
Workforce requirements and procurement	✓	✓	✓
Fleet movement		✓	
Ore processing		✓	
Mine Waste disposal		✓	
Water management	✓	✓	✓
Pit development		✓	
Decommissioning of infrastructure			✓
Project area reclamation			✓



LEGEND

- FORMER PINE POINT TOWN SITE
- POPULATED PLACE
- EXISTING MINE
- ALL-SEASON ROAD
- WINTER ROAD
- TREELINE
- WATERCOURSE
- PARK/PROTECTED AREA
- WATERBODY
- GENERAL PROJECT LOCATION

0 50 100

1:3,000,000 KILOMETRES

REFERENCE(S)

1. BASE DATA OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.
2. PARKS AND PROTECTED AREAS OBTAINED FROM CONSERVATION AREAS REPORTING AND TRACKING SYSTEM (CARTS), CANADIAN COUNCIL ON ECOLOGICAL AREAS, 2017.

PROJECTION: ALBERS CONIC EQUAL AREA

CLIENT
PINE POINT MINING LTD.

PROJECT
PINE POINT PROJECT 2020 BASELINE STUDY PLAN

TITLE
LOCATION OF PROJECT

CONSULTANT
GOLDER

YYYY-MM-DD	2020-02-24
DESIGNED	DC
PREPARED	BW
REVIEWED	LY
APPROVED	LY

PROJECT NO.	PHASE	REV.	FIGURE
19125747	7000	0	1

2.0 AIR QUALITY AND NOISE

2.1 Background

Existing air quality and noise data were collected in the summer of 2011 and reported in 2012 (Rescan 2012a,b). The dataset is reasonable to characterize baseline conditions for these disciplines, but it is becoming dated and based on previous experience with the environmental assessment process in the Northwest Territories. New data may need to be collected for the compounds of potential concern for air quality.

Local meteorological data have not been collected for several decades; meteorological data collection will be required to support the air quality assessment and the hydrology assessment.

2.2 Potential Effects Pathways

Construction, operations, and closure related activities all have the potential to release emissions to the atmosphere. The operations phase of the work typically results in the highest intensity of emissions. Emissions released can change ground level concentrations of the contaminants of concern, which in turn can result in effects to people, vegetation, wildlife, soils, and water. Greenhouse gas emissions have the potential to contribute to the global matter of climate change.

2.3 Proposed Studies and Monitoring

A professional grade meteorological station was installed at the Project in October 2019 and will be calibrated in September 2020.

3.0 SURFACE WATER QUANTITY

3.1 Background

Local hydrological monitoring is recommended to characterize the current regional and local water balance and to provide a basis for assessment of Project effects on local hydrology. The collection of surface water quantity data is important to characterize the range of natural climatic variability, support water quality and fish studies, and collect data that could support the eventual development, parameterization, and calibration of hydrological models. The Project area is primarily a brownfield site that has been previously disturbed and much of site located in low-lying, poorly drained area. Historic local water quantity data include historical Water Survey of Canada data at Station 07PA001 (Buffalo River at Highway No. 5) from 1968 to 1990. and from 2011 (Rescan 2012a). No small-watershed data are available except for a single year of data from Twin Creek in 2011 (Rescan 2012a). The focus of the surface water quantity program will be to resume monitoring at the historic Buffalo River and Twin Creek stations, with an additional station on Paulette Creek, a small, local watercourse, to further characterize local small watershed runoff. The key periods of study are expected to include during the spring freshet, in the spring post-freshet, late summer, and fall sampling periods with automated measurements of water level completed between the freshet and fall field campaigns. A targeted under-ice water quantity field program may be necessary in the future when additional Project design details are available, and surface water flows across the Project area have been further delineated.

3.2 Potential Effects Pathways

- Site development and closed circuiting may affect runoff water quantity and timing.
- Site development may cause changes to runoff patterns, including watercourse diversions.

- Construction, operations, closure, and post-closure phases may have water supply requirements that affect local water quantity.
- Water management (e.g., runoff capture, diversion, storage, and consumptive use) may cause a change in surface water quantity.
- Pit development may affect groundwater, resulting in additional surface water.
- Ore processing may have a consumptive use of water; exported ore may include water.
- Waste rock and tailings management may represent a water demand.

3.3 Proposed Studies and Monitoring

An open-water hydrological field program will take place on Paulette Creek and Twin Creek (local) as well as the Buffalo River (regional). The field program will commence prior to freshet in 2020. However, desktop analysis of existing regional data started in 2019.

The hydrometric monitoring is intended to characterize local and regional runoff dynamics. The hydrological program proposed at the Buffalo River, Paulette Creek, and Twin Creek in 2020 will include a minimum of four field visits in the open water season: one in mid May to capture the spring freshet and deploy continuous water level monitoring instrumentation; one in late May to capture receding conditions post-freshet (combined with surface water quality); one in August to capture summer low flows (combined with surface water quality); and one in late September (combined with surface water quality) to retrieve continuous water level monitoring instrumentation prior to freeze-up. Water level will be surveyed relative to local benchmarks established at each station. Multiple field trips improve the quality of the rating curves by providing additional high discharge data before or after the freshet peak. The approximate locations of monitoring stations are shown in Figure 2 and summarized in Table 2.

The proposed hydrometric stations will be established at locations accessible from major roads (Highway 5 or Highway 6), if possible. The hydrometric station established on the Buffalo River will be at or near the site of the currently inactive WSC hydrometric station 07PA001. Detailed information on station 07PA001 will be compiled prior to the first field trip.

Table 2: Proposed Baseline Hydrometric Monitoring Stations

Station ID	Watercourse	Station Name	Latitude (°)	Longitude (°)	Continuous Water Level Recording	Water Level Surveys	Instantaneous Discharge
PP_HYD_TC1	Twin Creek	Twin Creek at Hwy 5	60.7327	-115.1877	✓	✓	✓
PP_HYD_PC1	Paulette Creek	Paulette Creek at Hwy 6	60.9655	-113.9647	✓	✓	✓
PP_HYDFFH_BR1	Buffalo River	Buffalo River at Hwy 5	60.7137	-114.9039	✓	✓	✓

° = degrees

LEGEND

- FORMER PINE POINT TOWN SITE
- HYDROMETRIC MONITORING STATION
- HYDROMETRIC MONITORING STATION WITH FISH SAMPLING LOCATION
- WATER SURVEY OF CANADA HYDROMETRIC STATION (INACTIVE)
- ALL-SEASON ROAD
- WATERCOURSE
- GENERAL PROJECT LOCATION
- WATERBODY

0 5 10
1:300,000 KILOMETRES

REFERENCE(S)
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2. PARKS AND PROTECTED AREAS OBTAINED FROM CONSERVATION AREAS REPORTING AND TRACKING SYSTEM (CARTS), CANADIAN COUNCIL ON ECOLOGICAL AREAS, 2017.
3. POTENTIAL EFFLUENT DISCHARGE LOCATIONS PROVIDED BY ANDRÉE DROLET, PPML, BY EMAIL ON 27 JUNE 2019.

PROJECTION: UTM ZONE 11 DATUM: NAD 83

CLIENT
PINE POINT MINING LTD.

PROJECT
PINE POINT PROJECT 2020 BASELINE STUDY PLAN

TITLE
SURFACE WATER QUANTITY MONITORING STATIONS

CONSULTANT
GOLDER

YYYY-MM-DD	2020-03-30
DESIGNED	SB
PREPARED	MM
REVIEWED	LY
APPROVED	LY

PROJECT NO.	PHASE	REV.	FIGURE
19125747		0	2

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

4.0 SURFACE WATER QUALITY

4.1 Background

The collection of Project-related water quality baseline data is important, as changes to water quality may ultimately affect fish, wildlife, and human health, and water quality is typically a concern to regulators and communities. The Project must also adhere to the requirements regarding effluent release as per the federal *Fisheries Act* and the NWT *Waters Act*.

Existing water quality data for Buffalo River, the Great Slave Lake mixing zone area, Twin Creek, Little Buffalo River, and Paulette Creek are generally robust for the purposes of an EA. However, while there are multiple years worth of data, there are some limitations; including limited in situ seasonal physico-chemical data in the watercourses.

An updated seasonal water quality baseline dataset is expected to be required for the EA, as well as for subsequent water licence applications.

4.2 Potential Effects Pathways

- Hazardous substance spills may cause a change in surface water quality.
- Construction activities leading to air emissions (including dust), may cause a change in surface water quality.
- Water management effects (i.e., discharge of effluent) may cause a change in surface water quality.
- Use of industrial equipment in or near waterbodies during construction may cause a change in surface water quality.
- The operation of the Project (e.g., generation of acidifying air emissions, runoff from site [waste rock and tailings inputs], and treated effluent discharge) and closure activities may cause a change in surface water quality.

4.3 Proposed Studies and Monitoring

The surface water quality baseline characterization will be carried out through a combination of a desktop review on the existing available information and data collected in 2019 and 2020.

Prior to sampling for the Project in 2019, spring, summer, and fall surface water quality data were last collected in 2011; therefore, updated seasonal surface water quality data will be collected from waterbodies and watercourses, which are expected to receive direct influence (e.g., surface water drainage, discharge of effluent, and aerial emissions deposition) from the Project, including one potential discharge location in Great Slave Lake. The study area and sampling stations for the surface water quality component of the baseline study are based off of information gathered during the 2019 site reconnaissance study (Figure 3).

In fall 2019, surface water quality samples and field physico-chemical data were collected from one station in Great Slave Lake (i.e., near Paulette Creek in Resolution Bay; PP_WQ_GSL1) and one station in Buffalo River (i.e., upstream of the potential discharge location; PP_WQ_BR1). Additional samples and field data were collected from one station in each of the following watercourses: Birch Creek (PP_WQ_BC1), Twin Creek (PP_WQ_TC1), Paulette Creek (PP_WQ_PC1) and Little Buffalo River (PP_WQ_LBR1). Adequate flow was present for sampling at all of these watercourses during the October 2019 surface water quality sampling program. Additional surface water quality samples were collected at three creeks that drain through the Project area (PP_WQ_CR1, PP_WQFFH_CR2, and PP_WQ_CR4) and from several waterbodies within the Project area (PP_WQ_PD1 and PP_WQ_WL1). Note that at station PP_WQFFH_CR2 both water quality and fish habitat data are collected. Based on the results of the fall 2019 site reconnaissance program and sampling data review, it was determined that most of the proposed sampling stations (i.e., creeks and ponds) would be frozen to bottom in winter due to their shallow depths; therefore, sampling for under-ice water quality was not conducted in winter 2020.

In 2020, the proposed surface water quality field work includes three open-water programs (i.e., May 2020 [spring or freshet], August 2020 [summer], and September 2020 [fall]). During each sampling event, field parameters will be documented, including supporting environmental data (e.g., ambient conditions at the time of sampling, etc.), and water samples will be collected for laboratory analysis.

4.3.1 Water Quality Samples

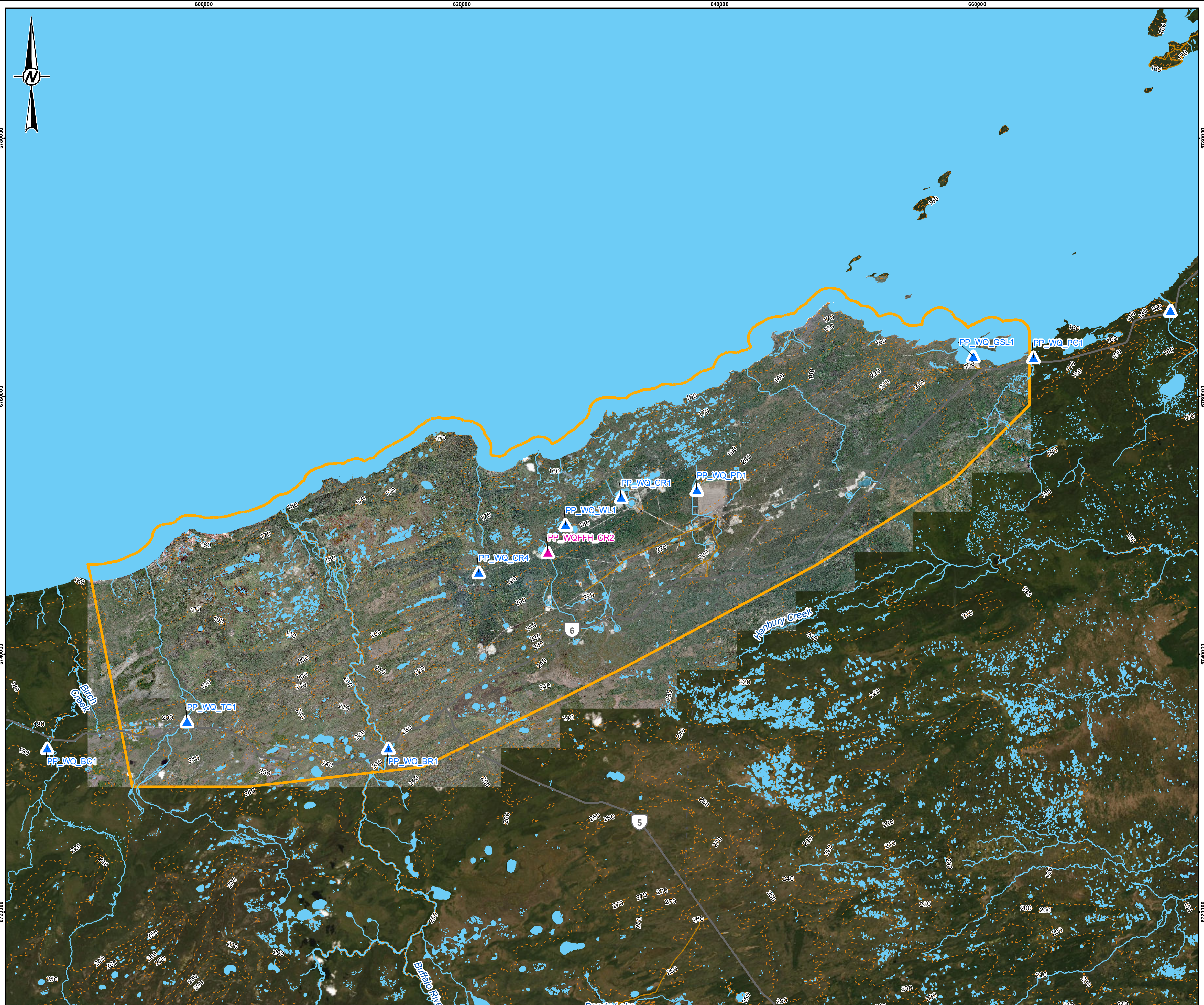
For all water quality sampling programs, quality control (QC) samples (blanks and duplicates) will represent approximately 10% of the total number of samples collected in the program. The QC samples will be analyzed for the same parameters of normal samples.

It is recommended that the standard Northwest Territories water samples analyses be completed (Table 3).

Table 3: Water Samples Standard for Analyses

Conventional Parameters	Nutrients	Total and Dissolved Metals, Metalloids, and Non-Metals
Bicarbonate alkalinity, chloride, carbonate alkalinity, turbidity, conductivity, hardness, calcium, potassium, magnesium, sodium, sulphate, pH, total alkalinity, total dissolved solids (TDS), and total suspended solids (TSS).	Ammonia-nitrogen, total Kjeldahl nitrogen, nitrate-nitrogen, nitrite-nitrogen, ortho-phosphate, total phosphorus, total organic carbon, dissolved organic carbon, and reactive silica.	Aluminum, antimony, arsenic, barium, beryllium, bismuth, boron, cadmium, cesium, chromium, cobalt, copper, iron, lead, lithium, manganese, mercury, molybdenum, nickel, selenium, silver, strontium, thallium, tin, titanium, uranium, vanadium, and zinc.

Water quality data will be compared to various guidelines, which include protection of aquatic life, protection of water for wildlife consumption, and protection of source for drinking water (as applicable).



LEGEND

- WATER QUALITY SAMPLING STATION
- WATER QUALITY SAMPLING STATION WITH FISH SAMPLING LOCATION
- HIGHWAY
- LOCAL ROAD
- TRANSMISSION LINE
- WATERCOURSE
- CONTOUR
- GENERAL PROJECT LOCATION
- WATERBODY

0 5 10
1:300,000 KILOMETRES

REFERENCE(S)
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PROJECTION: UTM ZONE 11N DATUM: NAD83

CLIENT
PINE POINT MINING LTD.

PROJECT
PINE POINT PROJECT 2020 BASELINE STUDY PLAN

TITLE
SURFACE WATER QUALITY STUDY AREA AND SAMPLING LOCATIONS

CONSULTANT
GOLDER

YYYY-MM-DD	2020-03-30
DESIGNED	SB
PREPARED	MM
REVIEWED	JL
APPROVED	LY

PROJECT NO.	CONTROL	REV.	FIGURE
19125747		0	3

5.0 FISH AND FISH HABITAT

5.1 Background

Fish have been historically documented or their preferred habitat identified in the Project area in the Buffalo River, Twin Creek, Paulette Creek, Great Slave Lake, and one pond near the existing disturbance area. Shortjaw Cisco (*Coregonus zenithicus*), is an aquatic species at risk listed under the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) and the Northwest Territories Species at Risk Registry. Shortjaw Cisco are found in Great Slave Lake but are unlikely to be present within the Project area.

Historical fish and fish habitat data exist for Twin Creek, the Buffalo River, Paulette Creek, and several small watercourses and waterbodies in the Project area. The 2020 baseline field work will be designed to collect site-specific data at waterbodies and watercourses affected by Project activities (e.g., road crossings), verify fish and fish habitat at a subset of historically sampled sites (e.g., Twin Creek), and collect new data in locations not previously sampled for fish. Sampling locations will also be selected to investigate the connectivity of the channels and pits in the Project area to fish-bearing waters.

Baseline fish and fish habitat data collected for the EA will also be used to support future regulatory applications. For example, a Request for Project Review to Fisheries and Oceans Canada will be required under the *Fisheries Act* during the permitting stage of the Project. An Application for Authorization under the *Fisheries Act* may also be required, depending on level of disturbance to fish and fish habitat.

5.2 Potential Effects Pathways

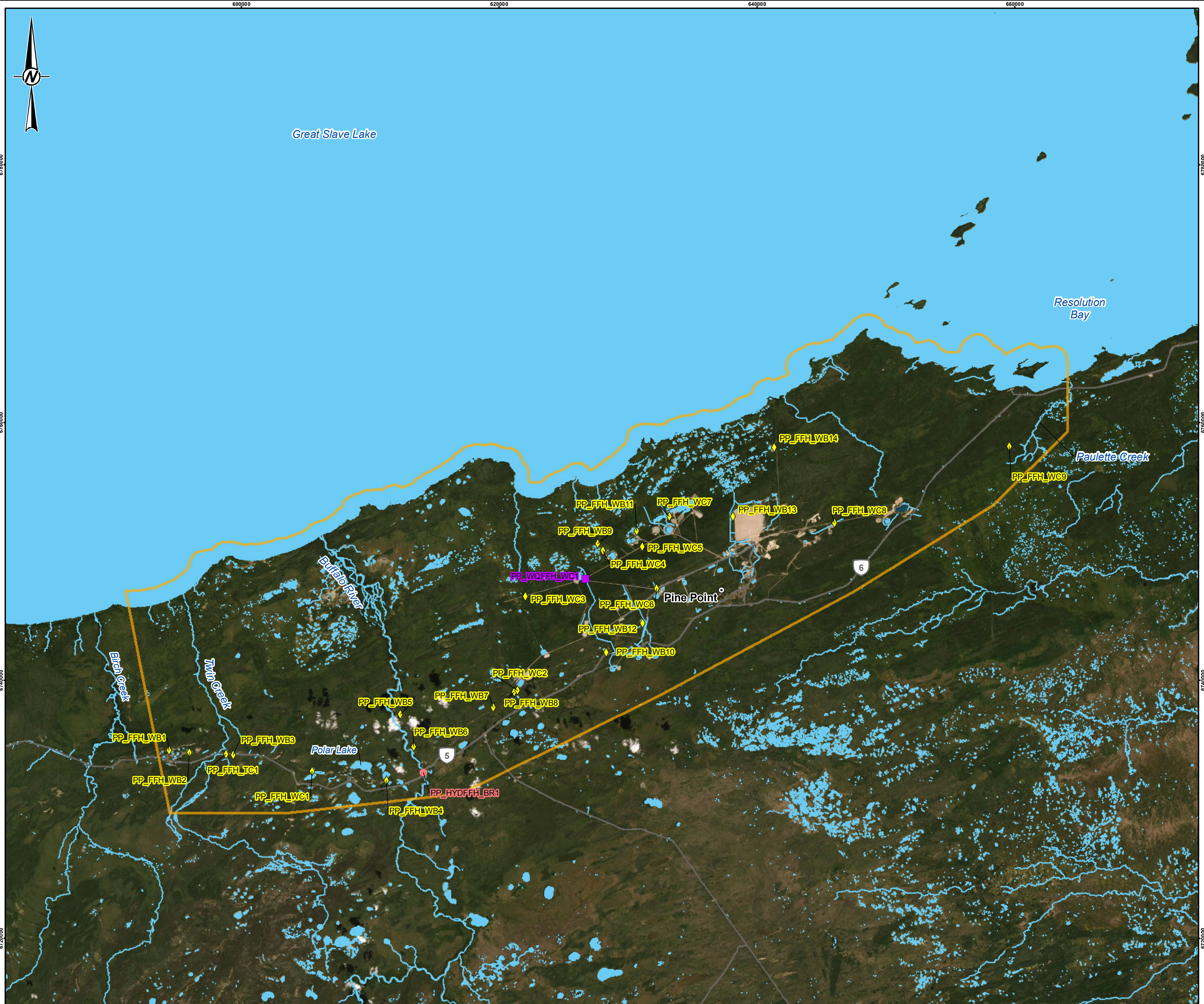
- Construction activities, including the development of open pits and related infrastructure (e.g., road crossings and water intakes), will result in a direct loss or alteration of fish habitat, which may affect fish habitat quantity and quality.
- The construction of water crossing structures for the mine site roads may alter stream hydraulics and geomorphology, which may affect fish passage, alter habitat connectivity and fish distribution.
- Hazardous substance spills can alter fish habitat quantity and quality and affect fish health, survival, and reproduction.
- Construction activities may cause air emissions (e.g., dust), which may affect habitat quality and fish health.
- Changes in site drainage may lead to changes in sediment concentration and deposition, which can alter fish habitat quality and quantity in downstream habitats (e.g., Twin Creek).
- Water management activities may alter local hydrology and affect fish habitat quantity and quality in downstream habitats (e.g., Twin Creek)
- Use of industrial equipment in or near waterbodies during construction may lead to changes in sediment concentrations and deposition, which can alter fish habitat quality and quantity in downstream habitats (e.g., Twin Creek).
- The operation of the Project (e.g., treated effluent discharge) may affect downstream water quality in the Resolution Bay area, which can alter fish habitat quality and affect fish health, survival, and reproduction.

5.3 Proposed Studies and Monitoring

The fish and fish habitat field program will be completed in the summer of 2020 and be combined with the surface water quantity component if feasible. Six sites previously sampled by EBA in 2005 or Rescan in 2011 will be revisited to verify historical fish and fish habitat conditions These locations include four Rescan ponds/waterbodies (P-15, P-16, P-38, P-45) which have been renamed PP_FFH_WB2, PP_FFH_WB3, PP_FFH_WB5, PP_FFH_WB6, respectively (Figure 4), and one location in Twin Creek (S-11), which has been renamed PP_FFH_TC1 (Figure 4) (Rescan 2012c) and one site at the Buffalo River (BRS1) which has been renamed PP_HYDFFH_BR1 (EBA 2005). An additional 20 new locations have been proposed for sampling across the Project area and include watercourses or waterbodies at potential road crossings, near diversions and open pits, and where no fish and fish habitat data have been historically collected (Figure 4). One sampling location for fish and fish habitat overlaps with a water quality sampling location (PP_WQFFH_WC1) and another with a hydrology monitoring station on the Buffalo River (PP_HYDFFH_BR1). 2020 baseline studies and sampling locations will be refined when a detailed Project Description is available.

The field program will include:

- Collection of site-specific baseline data (e.g., detailed habitat data and fish community inventory) to address the Project activities in or near fish-bearing waters or potentially fish-bearing water, including Twin Creek.
- Spatial scope will include waterbodies and watercourses affected by discharge pipelines (or diffusers), intake pipelines, road crossings, and open pits.
- Scoping level evaluation of connectivity of diversions and open pits to potentially fish-bearing habitats.



LEGEND

- FISH SAMPLING LOCATION
- FISH SAMPLING LOCATION WITH WATER QUALITY SAMPLING STATION
- FISH SAMPLING LOCATION WITH HYDROMETRIC MEASURING STATION
- FORMER PINE POINT TOWN SITE
- ALL-SEASON ROAD
- WATERCOURSE
- GENERAL PROJECT LOCATION
- WATERBODY

0 7.5 15

1:300,000 KILOMETRES

REFERENCE(S)

1. BASE DATA OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.
2. PARKS AND PROTECTED AREAS OBTAINED FROM CONSERVATION AREAS REPORTING AND TRACKING SYSTEM (CARTS), CANADIAN COUNCIL ON ECOLOGICAL AREAS, 2017.
3. POTENTIAL EFFLUENT DISCHARGE LOCATIONS PROVIDED BY ANDREE DROLET, PPML, BY EMAIL ON 27 JUNE 2019.

PROJECTION: UTM ZONE 11 DATUM: NAD 83

CLIENT
PINE POINT MINING LTD.

PROJECT
PINE POINT PROJECT 2020 BASELINE STUDY PLAN

TITLE
FISH AND FISH HABITAT SAMPLING LOCATIONS

CONSULTANT
GOLDER

YYYY-MM-DD	2020-03-30
DESIGNED	BF
PREPARED	MM
REVIEWED	LY
APPROVED	LY

PROJECT NO.	PHASE	REV.	FIGURE
19125747		0	4

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IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

6.0 VEGETATION

6.1 Background

An ecological land classification (ELC) map is required to evaluate direct and indirect Project effects on vegetation resources, as well as soils and terrain, within the Project area. The Project area ELC map is also used to assess effects to wildlife habitat. As a stand-level or ground-based ecological classification system is not available for ecosystems in the Northwest Territories, ecological attributes from the Northwest Territories Forest Inventory Data (GNWT 2012) were used to classify forest inventory polygons to Canadian Shield ecosite phases for the Project area.

A regional study area ELC map is required to evaluate indirect and cumulative Project effects on vegetation resources. The regional study area map is also used to assess effects to wildlife habitat.

Invasive plant surveys will be completed as part of the baseline vegetation surveys for the Project. Considering the history of development at the Project area and equipment being brought for construction and operational phases, it is expected that invasive species are present in the Project area.

Plant species listed under the COSEWIC and the Northwest Territories Species at Risk Registry with the potential to occur in the Project area will be identified prior to any field surveys.

If Knowledge Sharing Agreements are agreed upon between PPML and the communities, then it would be beneficial to have community members develop a list of traditional plant use species in the local study area. This list would be used to support traditional plant in the Project area and species use surveys documenting.

6.2 Potential Effects Pathways

- Direct loss of vegetation communities, rare vascular plants, and traditional use plants from vegetation clearing in areas of new open pits and associated infrastructure.
- Changes to soil quantity and quality.
- Vegetation community fragmentation.
- Vegetation effects due to changes in hydrology and hydrological regime resulting from water management activities.
- Wetland hydrology and functional changes due to mine dewatering and water management activities.
- Changes to vegetation and soils from changes in water quality.
- Construction activities leading to air emissions (including dust), which may affect vegetation communities and vegetation health.
- Hazardous substance spills leading to changes to degraded soil or vegetation community quality.
- Increased access leading to the introduction or spread of regulated weed or invasive, non-native species.

6.3 Proposed Studies and Monitoring

- Baseline soils and terrain field program for the local study area focusing on spatial gaps from 2012 programs in undisturbed areas.
- Baseline ELC/wetland, listed plant, and regulated weed/invasive plant program for a local study area, focusing mainly on spatial gaps from 2012 programs in undisturbed areas.

7.0 WILDLIFE AND SPECIES AT RISK

7.1 Background

Baseline studies completed in 2018 (Golder 2019) and previous studies to support exploration projects (Rescan 2012d,e) provide useful information to support the EA. These studies have identified the presence of boreal caribou, other large mammals, many migratory birds, bats, amphibians and species at risk. Table 4 provides wildlife species of concern that may interact with the Project.

Table 4: Wildlife Species of Concern that may Interact with the Project

Species	NWT Species at Risk Committee Status[(a)]	Federal *Species at Risk Act* Schedule 1 Status[(b)]	Committee on the Status of Endangered Wildlife in Canada Status[(c)]	Observed at Pine Point?
Caribou (boreal population)	Threatened	Threatened	Threatened	Yes
Wood bison	Threatened	Threatened	Special Concern	Yes
Wolverine	Not at Risk	Special Concern	Special Concern	Yes
Little brown myotis	Special Concern	Endangered	Endangered	Yes
Northern myotis	Special Concern	Endangered	Endangered	Yes
Short-eared owl	Not applicable	Special Concern	Special Concern	No
Whooping crane	Not applicable	Endangered	Endangered	Yes
Bank swallow	Not applicable	Threatened	Threatened	Yes
Barn swallow	Not applicable	Threatened	Threatened	No
Common nighthawk	Not applicable	Threatened	Threatened	Yes
Horned grebe (western population)	Not applicable	Special Concern	Special Concern	Yes
Olive-sided flycatcher	Not applicable	Threatened	Threatened	Yes
Rusty blackbird	Not assessed	Special Concern	Special Concern	Yes
Yellow rail	Not applicable	Special Concern	Special Concern	No
Gypsy cuckoo bumble bee	Data Deficient	Endangered	Endangered	No
Yellow-banded bumble bee	Not at Risk	Special Concern	Special Concern	No
Northern leopard frog	Threatened	Special Concern	Special Concern	No

a) GNWT (2019)
b) Government of Canada (2019)
c) COSEWIC (2019)

Existing roads related to previous mining and exploration are frequently used for harvesting, creating potential land use conflict.

7.2 Potential Effects Pathways

- Habitat loss (changes in habitat quantity) and habitat fragmentation from the Project.
- Hazardous substance spills leading to negative changes to health or mortality of individual animals.
- Sensory disturbance from construction activities leading to changes in wildlife habitat quality and survival and reproduction.
- Vegetation clearing leading to destruction of migratory bird nests.
- Wetland hydrology and functional changes due to water management activities, which may alter the abundance, distribution, and survival and reproduction of wildlife.
- Attraction to camps leading to problem wildlife and injury or mortality to individual animals.
- Improved access leading to increased predation on/harvesting of wildlife.
- Construction activities leading to air emissions (including dust), which may affect vegetation communities and thereby alter the abundance, distribution, and survival and reproduction of wildlife.

7.3 Proposed Studies and Monitoring

Based on work previously completed (Golder 2018; Rescan 2012d,e) in the Project area, the wildlife data that have been collected previously are considered sufficient for the completion of an EA. Consultation with the Environment and Climate Change Canada and Government of Northwest Territories – Environment and Natural Resources will be conducted to discuss the potential need for additional baseline studies related to Project species at risk. If necessary, additional baseline studies will be planned according to the feedback from engagement meetings with communities and regulators in April and May 2020. Habitat suitability indices developed for Project species at risk will be further refined with more recent landcover information.

8.0 SOCIO-ECONOMICS

8.1 Background

Socio-Economic Impact Assessment (SEIA) is the process of determining the impact of a project on communities and other stakeholder groups. It is participatory and involves working with communities to characterize the existing environment, determine potential effects, identify appropriate mitigation and benefit enhancement measures, and assess residual project impacts. Recent regulatory proceedings have indicated that the GNWT, Mackenzie Valley Environmental Impact Review Board (MVEIRB), and Crown-Indigenous Relations and Northern Affairs Canada are changing the expectations of mining operators for their impact on socio-economic conditions in the territory.

The Project, although brownfield, represents a new economic activity in the Northwest Territories that will generate economic benefits and employment, but also potential for associated deleterious social impacts in communities. Given the nature of the Project (i.e., resource development), it is expected to trigger a comprehensive SEIA per MVEIRB's Guidelines for SEIA (2007). The Guidelines include requirements for socio-economic baseline data collection that would ultimately support the assessment of the Project's impacts on existing conditions.

8.2 Potential Effects Pathways

- Construction and operations workforce requirements could generate direct local employment opportunities and associated incomes.
- The requirement for a workforce skilled in mine construction and operation will require some level of out-of-area workers who will be housed in camps while on-shift.
- Construction and operations procurement and hiring could result in indirect and induced employment.
- Procurement of materials, goods, and services during construction and operations could affect local and regional business revenues.
- Construction and operations employment incomes could increase access to equipment and materials required to participate in traditional and recreational activities.
- Construction and operations employment incomes could be used to fund poor lifestyle choices (e.g., gambling and substance abuse) and associated social maladies (e.g., crime, family violence, parental absenteeism).
- The requirement for construction and operations workers to stay in camps while on rotation can create family conflict and reduced time for volunteering and other community activities.
- The use of both local and out-of-area personnel during construction could result in workplace or cross-cultural conflict.
- The Project's out-of-area construction and operations workforce could increase demand for emergency medical services.
- The transportation of materials, goods, and the workforce during construction and operations will result in increased traffic and access restrictions on roads used to access the Project-related winter roads and staging areas.
- Increased Project traffic on roads shared with other users introduces greater risk of collisions.
- The Project's use of air transportation for materials, goods, and out-of-area workers during construction and operations will place additional demand on air transportation services.
- Project construction will generate solid waste requiring disposal, thereby potentially increasing demand for waste management services and on waste management infrastructure.
- Project construction and operations camps will increase demand for potable water and wastewater disposal.
- Project operations will generate property taxes and other government revenues.
- Project operations will contribute to territorial economic activity and gross domestic product.
- Project operations will likely yield Impact Benefit Agreements with local communities, securing local benefits.
- Project operations will influence forthcoming economic shocks associated with other mine closures in the Northwest Territories.

- Changes in the abundance, quality, and distribution of fish, plants, and wildlife, can impact the availability or suitability or resources for outfitted and recreational hunting and angling, camping, or lodge experiences.
- Sensory disturbance during construction and operations can influence outfitted and recreational hunting and angling, camping, or lodge experiences in the vicinity of the Project.
- Access restrictions during construction and operations can influence the access to resources and the ability of people to participate in outfitted and recreational hunting, angling or camping in the vicinity of the Project.
- Hazardous substance spills leading to degraded soils, vegetation communities, and wildlife health can impact the availability or suitability or resources for outfitted and recreational hunting and angling.
- The Project decommissioning and closure could bring about an end to positive economic impacts associated with employment, incomes, taxes, and economic contributions to the territory. At the same time, adverse social impacts are unlikely to dissipate with closure, and out-migration is a possibility.

8.3 Proposed Studies and Monitoring

Social and economic conditions in communities change rapidly. Much socio-economic data and information is publicly available and can be drawn from statistical databases, publications, and government and non-governmental organization websites. Secondary data collection (desktop) will occur in 2020. This will involve the review and analysis of publicly available sources (e.g., Statistics Canada census data, GNWT Bureau of Statistics data and reports, and literature and publications regarding socio-economic conditions in study area communities). Where data gaps exist, telephone interviews will be conducted. It is anticipated that more detailed information regarding contemporary community dynamics, challenges, and opportunities will not be publicly available, instead requiring engagement to obtain the information required to assess the Project's impacts.

MVEIRB's Guidelines for SEIA note that socio-economic engagement should "involve[e] … potentially affected communities … early and extensively" and use "experts from government and communities" and "information from primary and secondary sources". The Guidelines go on to note that the method of engagement should allow communities and vulnerable subpopulations to be involved in the collection of baseline data (MVEIRB 2007). Involving impact communities in the social baseline process connects their experience with the description of existing conditions against which a project's potential impacts are evaluated.

Following desktop studies and preliminary engagement, socio-economic engagement is expected to involve two phases: 1) Meeting with government and service providers in the regional hub, Yellowknife; and 2) engagement with communities acting as hubs for other smaller communities. Meetings will be planned and scheduled with relevant municipal contacts, the business community, and community service organizations, and will be organized around the socio-economic topics covered in the SEIA. The socio-economic lead will conduct the engagement, and local content will be sourced to assist in facilitation, note-taking and recording as required.

Meetings will also be planned and scheduled with representative study area communities through consultation. The outcome of early engagement may result in the refinement of this list of communities engaged. The goal of socio-economic baseline engagement with communities will in part be to identify perceived trends in Indigenous health, wellbeing, and community life since mining began in the Northwest Territories, and to acquire information on features of the community such as community infrastructure, service, and condition. Given the necessarily high level of involvement of communities in the development of the socio-economic baseline approach, the methods proposed here will be re-evaluated based on community feedback and revised as required.

9.0 TRADITIONAL LAND AND RESOURCE USE

9.1 Background

According to the Mackenzie Valley Land and Water Board's Engagement and Consultation Policy, developers are required to engage with potentially affected communities early in the EA process to identify, consider, and address issues and concerns. Early engagement with potentially affected communities will also help to identify components of the environment that are important to Indigenous groups and facilitate the earlier collection of baseline information.

Although the site is brownfield, according to MVEIRB's Guidelines for SEIA and the EA Initiation Guidelines (MVEIRB 2018), both historic and current land use information of potentially affected communities should be included in the description of baseline conditions. Land use information includes a description of harvesting activities and their importance to potentially affected communities, harvest species, levels, and importance of the traditional economy, places of cultural and spiritual value, and access to land use areas.

MVEIRB requires developers to consider and incorporate Indigenous Traditional Knowledge (ITK) during project development and throughout the EA process and has developed the Guidelines for Incorporating ITK in Environmental Impact Assessment as a resource that outlines MVEIRB's expectations and processes for incorporating ITK in the EA. In addition, EA Initiation Guidelines indicate that developers should provide a description of how ITK was considered and incorporated into project planning as part of the Project overview.

9.2 Potential Effects Pathways

- Changes in the abundance, quality and distribution of fish, plants, and wildlife, can impact the availability or suitability or resources for traditional harvesting.
- Direct mortality of wildlife from the Project (e.g., collisions with Project vehicles leading to changes in the abundance of wildlife, which may alter the availability of resources for traditional harvesting).
- Habitat loss and fragmentation from the Project area can alter the availability or movement patterns of traditionally harvested species.
- Changes in water quality can influence consumption during on-the-land activities.
- Sensory disturbance during construction and operations can influence traditional harvesting and land access in the vicinity of the Project.
- Access restrictions during construction and operations can influence the access to resources and the ability of people to participate in traditional activities in the vicinity of the Project.
- Access restrictions during construction and operations can interfere with use of cabins, camp sites, travel routes, and culturally/spiritually important sites.
- Increased access associated with Project access roads can increase the number of people involved in traditional harvesting activities, but also competition for resources.
- Hazardous substance spills leading to degraded soils, vegetation communities, and wildlife health can impact the availability or suitability or resources for traditional harvesting.
- Changes to participation in traditional land use activities can lead to changes in cultural values and practices.

9.3 Proposed Studies and Monitoring

Desktop literature review will occur in early 2020. This will involve a review of publicly available sources (i.e., reports or other documents prepared by or on behalf of Indigenous communities for other industrial projects, and regional traditional land use studies prepared by or on behalf of Indigenous communities). Data collection will focus on those Indigenous groups which land claims and/or traditional territories overlapping with the Project area. The desktop review will help to identify gaps, and where more detailed information is required for the baseline report. Feedback provided during preliminary engagement will also inform the scope for Traditional Land and Resource Use (TLRU) and ITK literature review (e.g., which potentially affected communities to include). It is anticipated that more detailed contextual information regarding current TLRU will not be available through desktop sources, and that further information gathering will be required to obtain the information required to assess the Project's impacts on TLRU.

Communities will be engaged to determine the most appropriate and effective approach to gather information. Information gathering can be conducted through consultation with communities representing the Indigenous groups noted above. Ideally, and at this preliminary stage, a series of maps would be created with the Project area and traditional territories overlain for mark-up at community meetings, or in the Indigenous groups' preferred forum per their ITK protocols. Participants would be provided the opportunity to identify preferred traditional harvesting sites, relevant ITK (e.g., caribou migration routes, furbearer denning sites, fish habitat), culturally important sites and landscapes, and other aspects of TLRU on the maps, for inclusion in the TLRU baseline. Maps and reports themselves may not be made publicly available; however, information therein would inform the TLRU baseline and impact assessment, which ultimately become public documents.

Recently, communities prioritized for involvement by PPML (i.e., Deninu Kue, K'atl'odeeche, and Northwest Territories Metis Nation) have expressed interest in leading their own ITK studies. Golder will work with communities in the capacity determined appropriate to support community-led ITK studies.

10.0 ARCHAEOLOGY

10.1 Background

Archaeological sites are considered unique and highly cherished resources by the federal and territorial governments, as well as local communities and organizations of the Northwest Territories.

As a result, archaeological sites are protected by legislation, regulation, and policy in the Northwest Territories. This includes the NWT *Archaeological Sites Act* and the NWT Archaeological Sites Regulations, the *Mackenzie Valley Resource Management Act* and the Mackenzie Valley Land Use Regulations.

The Project, through development of mining infrastructure, has the potential to impact both documented and undocumented archaeological resources within undeveloped Project areas.

10.2 Potential Effects Pathways

Activities related to project construction, operations, and closure leading to ground disturbance has potential to impact known and unknown archaeological sites.

10.3 Proposed Studies and Monitoring

Baseline studies are proposed for 2020 when a detailed Project Description is available and impacts to the ground surface are known.

Baseline archaeology field program for the local study area will focus on spatial gaps from 2006 to 2018 programs in undisturbed areas of high archaeology potential that may be impacted by the Project. The approach and extent of baseline studies will be determined in consultation with the Culture and Heritage Division of the Government of Northwest Territories - Department of Education, Culture and Employment.

11.0 PRELIMINARY BASELINE STUDIES SCHEDULE

The preliminary schedule for the field programs is presented in Table 5.

Table 5: Preliminary Schedule for Field Programs

Discipline	Location	Date
Air Quality and Noise		
Calibration of the grade meteorological station	Grade meteorological station in Pine Point (installed in 2019)	September 2020
Surface Water Quantity		
Open-water hydrological field program - freshet	Buffalo River, Twin Creek, and Paulette Creek	May 2020
Open-water hydrological field program - post-freshet survey	Buffalo River, Twin Creek, and Paulette Creek	May 2020 / June 2020
Open-water hydrological field program – late summer	Buffalo River, Twin Creek, and Paulette Creek	August 2020
Open-water hydrological field program - fall survey	Buffalo River, Twin Creek, and Paulette Creek	September 2020
Surface Water Quality		
Open-water program (spring)	Waterbodies and watercourses which may receive direct influence and flow through the Project area	May 2020
Open-water program (summer)	Waterbodies and watercourses which may receive direct influence and flow through the Project area	August 2020
Open-water program (fall)	Waterbodies and watercourses which may receive direct influence and flow through the Project area	September 2020

Table 5: Preliminary Schedule for Field Programs

Discipline	Location	Date
Fish and Fish Habitat		
Collection of site-specific fish and fish habitat baseline data	Waterbodies and watercourses affected by discharge pipelines (or diffusers), intake pipelines, road crossings, and open pits	August 2020
Evaluation of connectivity of diversions and open pits to potentially fish-bearing habitats.	Waterbodies and watercourses throughout the Project area	August 2020
Vegetation		
Baseline soils and terrain field program	Focus on spatial gaps from 2012 programs in undisturbed areas within the local study area	July to Mid-August 2020
Baseline ELC/Wetland and soils map	Desktop – integrate existing and field data to complete detailed soils and ELC/wetland map of the local study area	July to November 2020
Baseline ELC/wetland, listed plant and regulated weed/invasive plant program	Focus on information gaps from previous programs, ground truthing ELC/wetland mapping and listed/invasive plants in undisturbed areas within the local study area	July to Mid-August 2020
Socio-Economics		
Secondary data collection	Desktop study	January to June 2020
Primary data collection	Yellowknife, Fort Resolution, Fort Smith, Hay River/Hay River Dene 1 (pending engagement) - Government and community service providers, and other participants as considered appropriate through consultation	August through November 2020 (depending on engagement and scoping activity schedules)
Traditional Land and Resource Use and Indigenous Traditional Knowledge		
Information and ITK gathering	Fort Resolution, Fort Smith, Hay River/Hay River Dene 1 with First Nations and Métis groups (pending engagement, with potential for expansion as required) - Land users and Elders, and other participants as considered appropriate through consultation	August to early November 2020 (depending on engagement and scoping activity schedules)
Archaeology		
Baseline archaeology field program	Focus on spatial gaps from 2006 to 2018 programs in undisturbed areas that may be impacted by the Project	July to September 2020 (depending on understanding of disturbance)

12.0 REFERENCES

COSEWIC. (Committee on the Status of Endangered Wildlife in Canada). 2019. COSEWIC wildlife species assessments (short version), May 2019. Available at: http://cosewic.ca/index.php/en-ca/assessment-process/short-version-mai-2019. Accessed: September 4, 2019.

EBA (EBA Engineering Consultants Ltd.). 2005. Tamerlane Pine Point Project: Water Quality and Stream Assessment Baseline Studies. Report prepared by EBA Consultants Ltd. for Tamerlane Ventures Inc.

Golder (Golder Associates Ltd.). 2018. Pine Point Project 2018 Wildlife Studies. Submitted to: Pine Point Mining Limited. v + 37 pp. + appendices.

Golder. 2019. Baseline Data Gap Analysis for the Pine Point Mine. Submitted to: Pine Point Mining Limited. v + 23 pp. + appendices.

GNWT (Government of Northwest Territories) 2012. Northwest Territories Forest Vegetation Inventory Standards v. 4.1. Forest Resources, Forest Management Division, Department of ENR.

GNWT. 2019. Species at Risk Act, Conservation Agreement for the Conservation of the Boreal Caribou. Available at: https://www.canada.ca/en/environment-climate-change/services/species-risk-public-registry/administrative-agreements/agreement-conservation-woodland-caribou-boreal-northwest-territories.html. Accessed: December 10, 2019.

Government of Canada. 2019. Species at risk public registry. https://www.canada.ca/en/environment-climate-change/services/species-risk-public-registry.html Accessed January 14, 2020.

MVEIRB. 2007. Socio-Economic Impact Assessment Guidelines. March 2007. Available at: http://reviewboard.ca/file/1024/download?token=1DDLP3jP. Accessed January 2020.

MVEIRB. 2018. Environmental Assessment Initiation Guidelines for Developers of Major Projects. Available at: http://reviewboard.ca/file/1132/download?token=c5tFrEqL. Accessed January 2020.

Rescan. (Rescan Environmental Services Ltd.). 2012a. Pine Point Project: 2011 Meteorology, Air Quality, and Noise Baseline Study – R-190, X-25, P-499, O-556, Z-155, and G-03. Prepared for Tamerlane Ventures Inc. by Rescan Environmental Services Ltd. Vancouver, British Columbia.

Rescan. 2012b. Pine Point Project: 2011 Meteorology, Air Quality, and Noise Baseline Study – N-204. Prepared for Tamerlane Ventures Inc. by Rescan Environmental Services Ltd. Vancouver, British Columbia.

Rescan. 2012c. Pine Point Project: 2011 Fish and Fish Habitat Baseline Studies. Prepared for Tamerlane Ventures Inc.

Rescan. 2012d. Pine Point Project 2011 Wildlife Baseline Studies — X-25, P-499, O-556, Z-155, AND G-03

Rescan. 2012e. Pine Point Project: 2011 Wildlife Baseline Studies – N-204. Prepared for Tamerlane Ventures Inc.

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https://golderassociates.sharepoint.com/sites/111329/project files/5 technical work/001_mveirb_ea initiation package/existing environment/2020 baseline study plan/final/doc012_19125747__pine point project_2020 baseline study plan.docx

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