Iqaluit Marine Infrastructure

Terrestrial and Human Environment Baseline Report

18 May 2017

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Canada

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Project No: 307071-01148-02-EN-REP-0002 – Iqaluit Marine Infrastructure: Terrestrial and Human Environment Baseline Report

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Table of Contents

Figure List

Table List

Photo List

Appendix List

Abbreviations

Term	Definition
ABA	Acid Base Accounting
AIA	Archaeological Impact Assessment
ARD	Acid Rock Drainage
BWG	Boaters Working Group
CBD	Convention on Biological Diversity
CCG	Canadian Coast Guard
CCME	Canadian Council of the Ministers of the Environment
CGS	Community and Government Services
COSEWIC	Committee on the Status of Endangered Species in Canada
CWS	Canadian Wildlife Service
DDT	dichlorodiphenyltrichlorethane (pesticide)
DFO	Fisheries and Oceans Canada
DIS	Disturbed (for Vegetation)
DSP	Deep Sea Port
EBSA	Ecologically or Biologically Significant Marine Areas
ECCC	Environment and Climate Change Canada
EDT	Economic Development and Transportation
EDO	Economic Development Officer
ELC	Ecological Land Classification
ESWG	Ecological Stratification Working Group
GN	Government of Nunavut
GPS	Global Positioning System
HTA	Hunters and Trappers Association
IBAs	Important Bird Areas
IBP	International Biological Programme
IHT	Inuit Heritage Trust
ILMP	Iqaluit Land Use Mapping Project
INAC	Indigenous and Northern Affairs Canada
IQ	Inuit Quajimajatuqangit

Term	Definition
IUCN	International Union for the Conservation of Nature
SA	Study Area
ML	Metal Leaching
MPA	Marine-Protected Areas
NAICS	North American Industry Classification System
NEAS	Nunavut Eastern Arctic Shipping Inc.
NIRB	Nunavut Impact Review Board
NLCA	Nunavut Land Claims Agreement
NOC	National Occupation Classification
NPC	Nunavut Planning Commission
NRI	Nunavut Research Institute
NSSI	Nunavut Sealink & Supply
NTCL	Northern Transportation Company Limited
NWB	Nunavut Water Board
NWMB	Nunavut Wildlife Management Board
QEC	Qulliq Energy Corporation
SARA	*Species at Risk Act*
SCH	Small Craft Harbour
SFE	Shake Flask Extraction
UB-SS	Upland Bedrock Outcrop – Shallow Soils (Vegetation)
UDS	Upland Dwarf Shrub (Vegetation)
US	Upland Shoreline (Vegetation)
USC	Upland Shoreline Cliff (Vegetation)
USDA	United States Department of Agriculture Plants Database
WDS	Wetland Dwarf Shrub (Vegetation)
XRD	X-Ray Diffraction

1 Introduction

The Government of Nunavut (GN), through Economic Development and Transport (EDT) is developing a new deep sea port (DSP) and upgrades to the small craft harbour facilities (SCH) in Iqaluit, within Koojesse Inlet in Frobisher Bay (the Project). The construction of the Project will be managed by Community and Government Services (CGS) on behalf of EDT.

A deep sea port development for Iqaluit has been studied since the 1970s with the objective of improving sealift and fuel delivery reliability for Iqaluit. The most comprehensive study undertaken in 2010 confirmed the port site at Koojesse Inlet as the most favourable site because it balances ship access, current location of fuel tanks and pipeline, and lowest capital cost. Currently, there is no commercial or residential development at the area delineated as the proposed DSP footprint. However, the existing fuel pipeline runs outside and parallel to the proposed DSP area until it reaches the existing main storage tanks situated along the existing access road (Akilliq Road). In the DSP vicinity, a causeway, known locally as the existing Causeway, was built originally to support the unloading of barges from the sealift. This older structure is also used quite extensively by residents, hunters and fishermen for boat launching and for snowmobile/sled access.

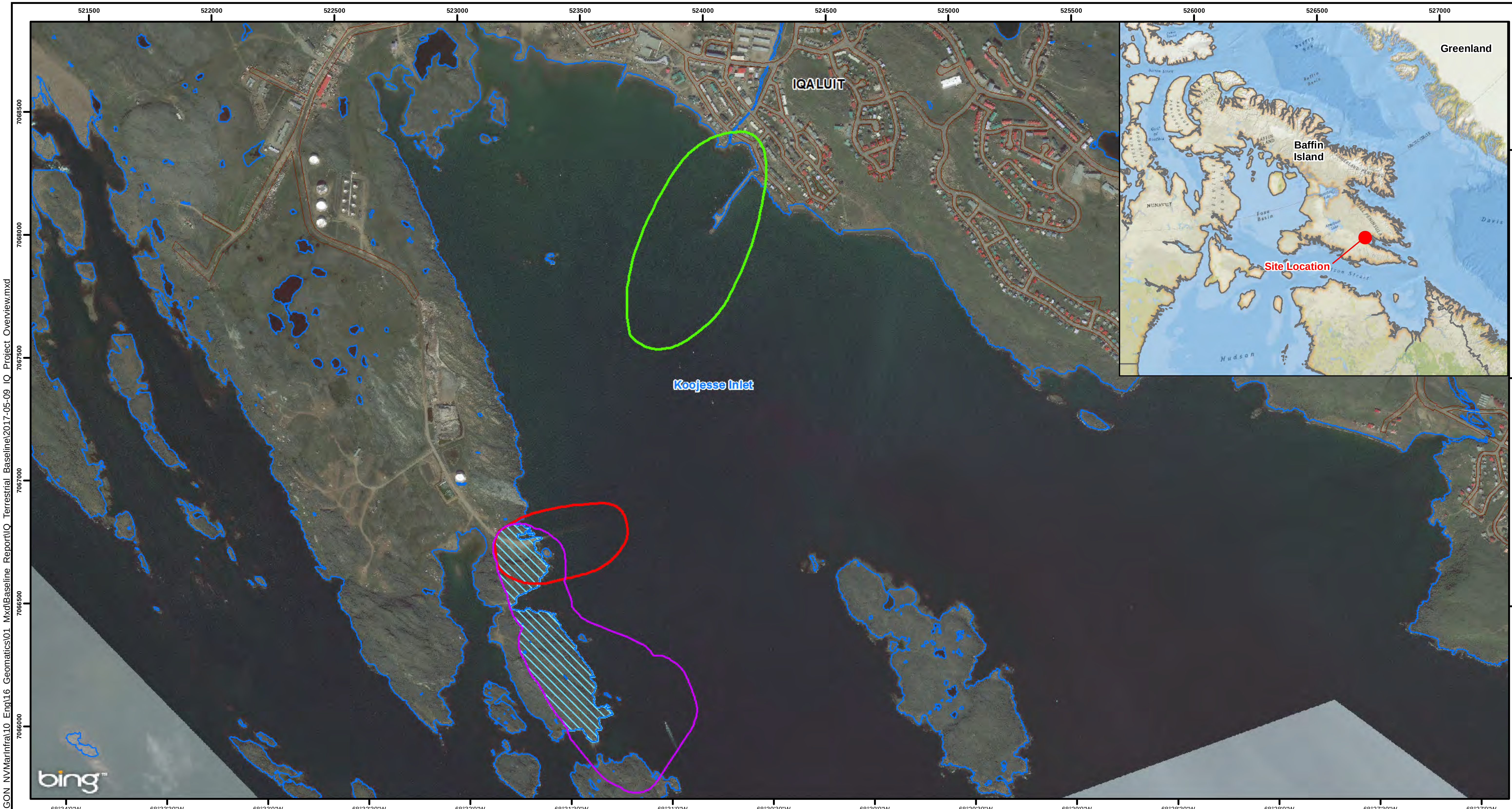
For the SCH development, the significant tidal range (11.9 m) and gently sloping mudflats near shore result in very limited time windows during high tide for boat users to access water. Generally, the municipal breakwater is used primarily at high tide and the existing Causeway is used primarily at low tide. Both sites present access constraints and safety risks, as well as limited parking and congestion.

Advisian (WorleyParsons Group) was retained by the Government of Nunavut to complete environmental baseline studies for the Project to support a Nunavut Land Claims Agreement (Nunavut Agreement, NA) Article 12, Part 4 Screening by Nunavut Impact Review Board (NIRB) and environmental permitting by regulatory agencies. Advisian conducted field programs in fall 2016 to determine the baseline conditions of the terrestrial environment in proximity to the proposed developments. These surveys will inform this baseline report, and the Part 4 Screening Assessment.

1.1 Project Overview

The proposed SCH is located on land situated on the Koojesse Inlet in Frobisher Bay on Baffin Island on Sinaa Street in the Lower Iqaluit neighbourhood of Iqaluit (63.7383333°, -68.5136111°). The proposed DSP is located southwest of the SCH to the south end of Polaris Reef, immediately northwest of the existing bulk fuels anchorage and receiving facilities at Inuit Head (63.7219939°, -68.5205444°)(Figure 1-1).

The permanent components of the DSP include a deep sea wharf structure and associated hardware (i.e. fenders, guardrails, moorings, etc.), a sealift cargo laydown area, auxiliary landing ramp for occasional sealift lightering, new fuel receiving manifold on the wharf structure, and new road segment connecting Akilliq Road to the new laydown area. The mobile site offices currently located at the existing sealift beach will be relocated to the new laydown area. The permanent components of the SCH include an extension of the existing breakwater, a boat launching ramp, parking/storage area at the municipal breakwater and potential improvements to the existing Causeway.



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Legend

- Deep Sea Port Study Area
- Small Craft Harbour Study Area
- Causeway Study Area
- Field Survey Area
- Road
- Major Shoreline

0 125 250 500
Metres

N

Note:
Coordinate System: NAD 1983 UTM Zone 19N
Aerial Photo and Basedata from City of Iqaluit, 2016

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OneWay to zero harm		Nunavut	Advisian WorleyParsons Group
DATE:	09/05/2017		IQALUIT MARINE INFRASTRUCTURE BASELINE REPORT LOCATION AND STUDY AREA
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EDITED:	Y.M.		
APPROVED:	M.M.		

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1.2 Study Overview and Area

This report was undertaken to support Project planning as well as future permitting and approval requirements. The objective was to describe baseline conditions within a Study Area with a focus on the terrestrial and human components of the Project through desktop and field studies. Detailed engineering designs were not available at the time of this baseline report, thus Study Areas for the SCH and DSP have been defined which encompass the maximum footprint of the proposed construction activities (Figure 1-1). Vegetation survey, habitat assessment and wildlife reconnaissance field surveys focussed on the proposed rock cut and laydown areas of the DSP, plus a 100 m buffer. This is referred to as the Field Survey Area (Figure 1-1).

Marine birds are included within the Terrestrial Baseline Study because they nest (a critical life phase) in terrestrial environments and most are also Migratory Birds.

In this report, seven major components are addressed:

1. Inuit Qaujimajatuqangit (Inuit Knowledge or [IQ])
2. Physical Setting
3. Vegetation, including Species at Risk
4. Terrestrial Wildlife, including Species at Risk
5. Migratory and Marine Birds, including Species at Risk
6. Archaeology
7. Socio-economic

1.2.1 Field Programs

Field programs were conducted in September 2016 to support the Terrestrial and Human Environment Baseline Assessment. Table 1-1 provides a summary of those programs. Further details on field methods and results are presented within applicable chapters in this report.

Table 1-1 Summary of Field Programs Conducted to Support Baseline Studies

Date	Discipline	Details
September 20, 2016 November 30, 2016	Inuit Qaujimajatuqangit	Meeting with Amaruq Hunter and Trappers Organization on the Project
September 17-20, 2016 October 15-17, 2016	Physical Setting	Soils information collected as part of geotechnical field studies
September 19-21, 2016	Vegetation	Ecological Land Classification and Rare Plant Surveys
September 19-21, 2016	Wildlife	Wildlife habitat assessment and reconnaissance survey completed in conjunction with vegetation surveys
September 28-October 1, 2016	Archaeology	Baseline information collected as part of Archaeological Impact Assessment

The following permits were obtained for the Baseline Field Programs listed in Table 1-1:

- Nunavut Planning Commission (NPC) (File number 148305) – case was ultimately transferred to NIRB.
- NIRB (File number 16YN041) – Screening Decision Report issued to allow commencement of baseline programs.
- Fisheries and Oceans Canada (DFO) – Licence to Fish for Scientific Purposes (File number: S-16/17-1039-NU).
- Indigenous and Northern Affairs Canada (INAC) – Land Use Permit #N2016N0010.
- Nunavut Research Institute (NRI) – Scientific Research Licence # 0103416N-M.

1.3 Environmental Setting

1.3.1 Ecozone and Ecoregion

Iqaluit is located within the Northern Arctic Ecozone and is one of the coldest and driest landscapes in Canada (Ecological Stratification Working Group, (ESWG, 1995)). Snow falls in all months of the year and persists on the ground for at least 10 months (September to June). The landscape is predominantly composed of exposed bedrock with discontinuous moraines and marine deposits of variable thickness. Water bodies are generally frozen and ice lasts through most of the year. In the south of the ecozone, where Iqaluit is located, open water is more common in the summer. Permafrost is continuous and soils are generally Cryosols (ESWG, 1995).

The cold, dry climate, high winds and lack of soils create conditions unsuitable for most vegetation except for sparse and dwarf plants. This Ecozone is a major breeding ground for migratory birds including snow geese, brant, Canada geese, eider and long-tailed ducks. Mammals in this Ecozone include Peary and barren-ground caribou, muskox, wolf, Arctic fox, polar bear, Arctic hare and brown and collared lemmings.

Iqaluit occurs in the Meta Incognita Ecoregion (ESWG, 1995). Mean annual temperature is -11.5°C with summer mean of 1°C and winter mean of -22.5°C. Mean annual precipitation ranges from 200 to 400 mm. Having a low-arctic ecoclimate, the landscape is dominated by shrub tundra vegetation with species such as dwarf birch, willow, northern Labrador tea, *Dryas* spp, and *Vaccinium* spp. Tall dwarf birch, willow and alder occur on warm microsites and wet sites are dominated by willow and sedges.

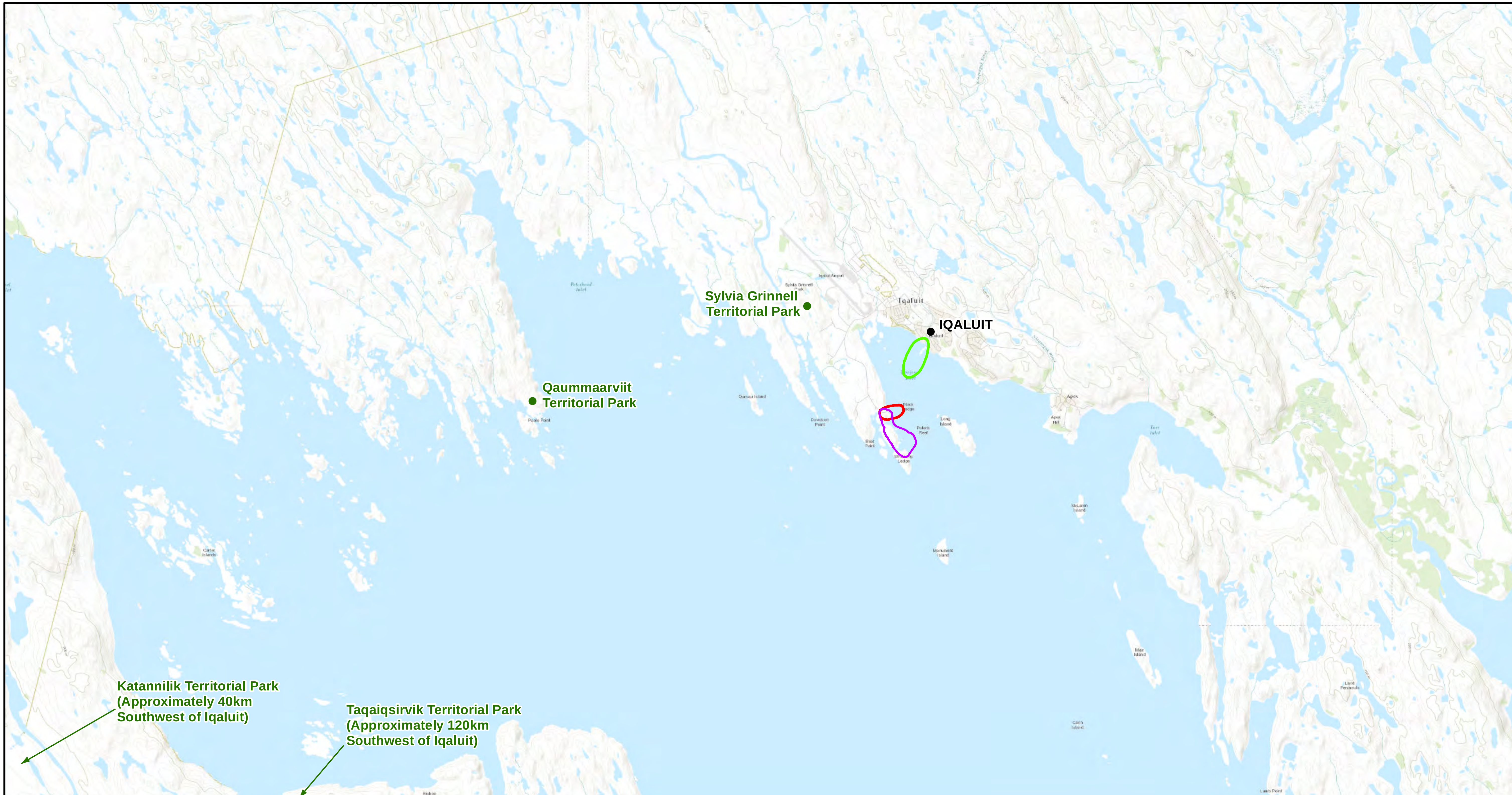
1.3.2 Protected Areas

No National Parks, National Wildlife Areas, or Migratory Bird Sanctuaries occur in or near the Study Area or Field Survey Area (Environment and Climate Change Canada, (ECCC, 2016e)); however, three Territorial Parks occur in proximity to Iqaluit and the Project site: Sylvia Grinnell, Quammaarviit, and Katannilik Territorial Parks (Figure 1-2).

Sylvia Grinnell Territorial Park (known as Iqaluit Kuunga in Inuktitut) is located 1 km from the town of Iqaluit. This park centres around the lower third of the Sylvia Grinnell River which empties into Frobisher Bay. The habitats in the park include low, rocky tundra and sedge meadows along the river and heath tundra on nearby slopes. More than 40 species of birds have been recorded in the Park and wildlife, including barren-ground caribou (*Rangifer tarandus groenlandicus*), Arctic hare (*Lepus arcticus*), Arctic fox (*Vulpes lagopus*) and lemmings (*Lemmus trimucronatus* and *Dicrostonyx groenlandicus*), are common (Nunavut Department of Environment, 2008a).

Qaummaarviit Territorial Park is a tiny rocky island located 12 km west of Iqaluit in Peterhead Inlet. This park protects valuable archaeological artefacts and structures. Peregrine falcons (*Falco peregrinus*), gyrfalcons (*Falco rusticolus*), and common ravens (*Corvus corax*) nest on the cliffs of the island and adjacent mainland (Nunavut Department of Environment, 2008b).

Katannilik Territorial Park is located between the village of Kimmirut and the southern shore of Frobisher Bay, about 45 km southwest of Iqaluit. In addition the Taqaiqsirvik Territorial Park campground is located near Kimmirut. The park is centred on the Soper Heritage River and has three distinct landscapes: deep gorges and sloping valleys near Frobisher Bay, gently rolling, level topography on the plateau of the Meta Incognita Peninsula, and the Soper River Valley (Nunavut Department of Environment, 2008c). Vegetation communities consist of dwarf shrubs and heath tundra, grassland tundra, among others. Caribou, Arctic fox, red fox (*Vulpes vulpes*), and Arctic wolves are known to inhabit the park and polar bears (*Ursus maritimus*) are occasionally seen along coastal areas. Between 30 to 40 bird species migrate through or use the park; common birds include raptors such as peregrine falcon, gyrfalcon, and snowy owl (*Bubo scandiacus*); songbirds such as Lapland longspur (*Calcarius lapponicus*) and horned larks (*Eremophila alpestris*), and snow buntings (*Plectrophenax nivalis*); waterfowl such as Canada geese (*Branta canadensis*) and red-breasted mergansers (*Mergus serrator*); loons (*Gavia* spp.), shorebirds, and marine birds such as thick-billed murres (*Uria lomvia*), black guillemots (*Cepphus grylle*), as well as gulls (*Larus* spp.) and terns (*Sterna* sp.) (Nunavut Department of Environment, 2008c).



Legend

- Deep Sea Port Study Area
- Small Craft Harbour Study Area
- Causeway Study Area

0 1 2 4
Kilometres

N

Note:
Coordinate System: NAD 1983 UTM Zone 19N

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IQALUIT MARINE INFRASTRUCTURE
BASELINE REPORT
PROTECTED AREAS

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2 Inuit Qaujimajatuqangit

2.1 Program Objectives

The objectives of the IQ baseline study are to obtain local Inuit knowledge of marine habitat, wildlife, land use, year round access for harvesting and areas of cultural value in and around the proposed Project to support project decision-making and the environmental screening process.

2.2 Methods

To date, IQ has been gathered during:

- One project meeting with the HTA in September 2016.
- One key elder meeting in November 2016.
- Two design workshops with the HTA in November 2016 and March 2017.
- A Boaters Working Group (BWG) meeting in April 2017.

The first meeting in September 2016 concentrated on updating the HTA on the proposed SCH and DSP projects and on gaining an understanding from HTA members of land use in the development areas and current conditions and locations for accessing water and ice in Iqaluit.

With the aid of an interpreter and maps/concept drawings, an open dialogue between HTA members and our team occurred during this meeting, allowing feedback and local knowledge from the most active users to be obtained. IQ information was noted and marked on maps during discussions on topics such as: wind direction and strength, seasonal changes to ice, water and ice access, and current boat traffic and ramp use.

Design workshops conducted with the HTA (November 2016 and March 2017) and with the BWG (April 2017) focused more obtaining feedback from hunters, fishers, outfitters, and recreational boaters on the conceptual designs for the SCH. Feedback received during these meetings also contributed to the team's knowledge and understanding of sea and access conditions, harvesting areas, and the presence of marine mammals in and around both the DSP and SCH study areas. With the aid of an interpreter and maps/concept drawings, the collaborative workshops allowed HTA members and local boaters to share their ideas, needs, and concerns directly with the lead engineer and team members designing the DSP and SCH.

During discussions, IQ and local information were noted and marked on maps on topics such as: fishing areas, disposal at sea, water and ice access, use of the existing causeway, construction schedule, potential navigational hazards, and archaeological/cultural sites.

In an effort to better understand the potential interactions between harvesting rights and Project activities, a meeting was also held with a key elder in November 2016 that identified harvest locations and access points in and around the Project site in relation to land use activities. The elder interviewed is recognized in the community as being especially knowledgeable about fish, marine mammals, and travel routes and is a current and active hunter. Harvesting and use locations were marked on a map and later digitized.

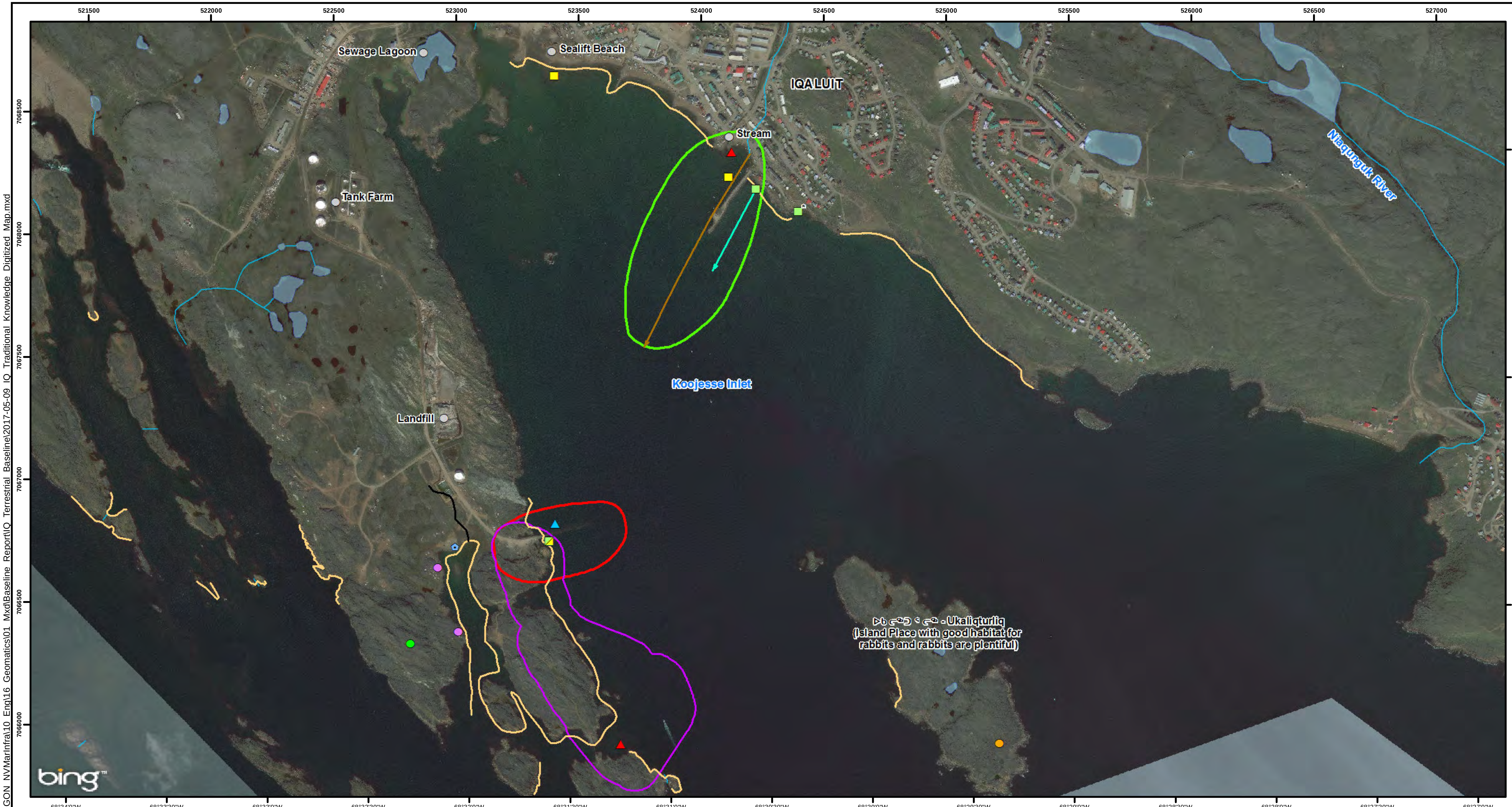
A review for existing and accessible ethnohistorical/traditional land use research relating directly to the Project area was also undertaken. This included:

- The Nunavut Wildlife Harvest Study (Priest and Usher, 2004) - Nunavut Wildlife Management Board.
- The Iqaluit Land Use Mapping Project (ILMP) website (Ford, 2017).
- Nunavut Wildlife Resources and Habitat Values (Nunami Stantec, 2012).

- Inuit Heritage Trust: Place Names Program.
- Inuit Knowledge Mapping and Podcast Project (Inuit Knowledge Podcast, 2017).
- Qulliq Energy Corporation Iqaluit Hydro-Electric Generation Sites (Knight Piésold, 2006).
- Draft Nunavut Land Use Plan (NPC, 2016a).
- Nunavut Arctic College Inuit Knowledge Oral History Book series: Interviewing Inuit Elders.
- Nunavut Research Institute: Compendiums of Research (available online) (Nunavut Research Institute, 2015).
- Medicinal Plants Used by the Inuit of Qikiqtaaluk (Baffin Island, Nunavut) (Black et al., 2008).
- Government of Nunavut. 2013. Inuit Societal Values Report – Department of Culture and Heritage (Government of Nunavut, 2013a).
- Inuit Land Use and Occupancy Project (Milton Freeman Research Ltd., 1976) – INAC.
- Inuit Qaujisarvingat: Inuit Knowledge Centre website via Inuit Tapiriit Kanatami (Inuit Knowledge Podcast, 2017).
- Baffin Island Caribou Consultations (Jenkins and Goorts, 2013).
- Can Local Ecological Knowledge Contribute to Wildlife Management? Case Studies of Migratory Birds (Gilchrist et al., 2005).
- Local Ecological Knowledge of Ivory Gull Declines in Arctic Canada (Mallory et al., 2003).

IQ has been integrated in to this report where applicable. Additionally, a map of land use and occupancy information compiled from interviews and workshops has been provided (see Figure 2-1). The map also includes place names in the area from the IHT database.

The IQ findings are based on a small number of interviews and workshops and a selection of readily available literature, and do not represent the full intensity and extent of Inuit use and occupancy of either the Study Areas or the surrounding region. However, for the scope of the Project, and in understanding potential effects due to construction and operation of the proposed facility, these efforts have been sufficient.



Legend

- Deep Sea Port Study Area
- Small Craft Harbour Study Area
- Causeway Study Area
- Waterbody
- River/Creek
- Creek Outfall
- Fishing (Primarily Arctic Char, Some Arctic Cod)
- Main Winter Route at Wharf
- Main Spring Route at Wharf
- Berry
- Bird Egg
- Cabin
- Canoe/Kayak
- High Tide Water Access
- Low Tide Water Access
- Spring Access
- Winter Access

* - New Spring Access
** - High Tide Water Access to River and Sheltered Channel During Storms

0 125 250 500
Metres

N

Note:
- Coordinate System: NAD 1983 UTM Zone 19N
- Aerial Photograph and Basedata from City of Iqaluit, 2016

Place Name Reference:
Inuit Heritage Trust: Place Names Program. Inuit Heritage Trust Incorporated. June, 2005.

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EDITED:	Y.M.
APPROVED:	D.P.

CUSTOMER: Nunavut

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IQALUIT MARINE INFRASTRUCTURE
BASELINE REPORT
LAND USE AND OCCUPANCY

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3 Physical Setting

3.1 Program Objectives

This section describes the ground conditions of the Study Areas. It provides a high-level desktop review of geological site conditions, including soils, landforms and permafrost, which form the foundation for the ecosystems of Baffin Island. This section also provides an assessment of the potential for Acid Rock Drainage (ARD) / Metal Leaching (ML) in association with the use and exposure of rock during construction.

3.2 Desktop Study and Literature Review

To support the assessment, a desktop review of existing literature was conducted. The following literature and publically available data was reviewed:

- Surficial Geology, Iqaluit, Nunavut (Allard et al., 2012).
- The Canadian System of Soil Classification (National Research Council of Canada, 1998).
- Soil Order Map of Canada (Agriculture and Agri-Foods Canada, 2017).
- Cryosolic soils of Canada: Genesis, distribution and classification (Tarnocai and Bockheim, 2011).
- Geology of Nunavut, 1:3 500 000 Map (de Kemp et al., 2006).
- A Homeowners Guide to Permafrost in Nunavut (Government of Nunavut, 2013b).
- Coastal geoscience field work near Iqaluit (Hatcher et al., 2014).
- Permafrost characterization at the Iqaluit International Airport, Nunavut, in support of decision making and planning (LeBlanc et al., 2013).
- Ground temperatures and spatial permafrost conditions in Iqaluit, Baffin Island, Nunavut (LeBlanc et al., 2015).
- Geophysical monitoring of permafrost conditions at Iqaluit International Airport, Baffin Island, Nunavut (Oldenborger et al., 2014).
- Permafrost and Related Engineering Problems in Alaska (Ferrians et al., 1970).
- Mapping ground movement and permafrost temperature, case studies from Nunavut and Nunavik (LeBlanc, 2013).
- Integrated seabed mapping of Frobisher Bay, southern Baffin Island, Nunavut to support infrastructure development, exploration and natural hazard assessment (Mate et al., 2015).
- Summary of knowledge report on valued ecosystemic and socio-economic components and valued land and water uses in Nunavut (Aarluk, 2012).
- A Map and Summary Database of Permafrost Temperatures in Nunavut, Canada (Smith et al., 2013).
- Public and project Aerial Imagery (Government of Nunavut, 2016c).

3.3 Fieldwork Methods

The literature review information was combined with data gathered from a site reconnaissance by a geotechnical crew and subsequent subsurface investigations. The geotechnical site visit that was conducted in September 2016 included a walkover and visual assessment of the Field Survey Area and the shoreline where the DSP, SCH and associate infrastructure is proposed. Additionally, five boreholes were drilled at the SCH location in October 2016.

3.3.1 ARD Methods

Ten (10) grab samples were collected from rock cut areas of the Field Survey Area. The analysis of the rock samples provides a preliminary evaluation of the potential for adverse environmental impacts associated with ARD or metal leaching from the weathering or leaching of the rock when exposed or excavated for construction purposes. Rock samples were collected as per standard procedures (e.g. documented, photographed, etc.) and tested for their static geochemical compositions and properties. The tests included Acid Base Accounting (ABA), ultra-trace metal analysis, shake flask extraction (SFE) tests and X-Ray diffraction (XRD). The ARD test program also included quality assessment and development of a quality control framework to assess the accuracy of laboratory tests results.

3.4 Results and Discussion

The following combines field observations with information gathered during the literature review, and laboratory test results of ARD rock samples (Appendix 1).

3.4.1 Geological Site Conditions

The Project components are situated over the Pre-Cambrian rock of the Canadian Shield (Geological Survey of Canada, 2012), comprising granulite facies granitoids (de Kemp et al., 2006). Within Koojesse Inlet, the tidal flats were formed proglacially and the surface veneer is characterized by a mixture of fine silty sand with coarser sand and pebble clasts, with varying density and groupings of boulders (Hatcher et al., 2014).

Along the immediate shoreline of the SCH Study Area, exposed bedrock and postglacial littoral and nearshore sediments deposited during sea-level regression are present. Southeast of the exposed bedrock on the shoreline, recent littoral and nearshore sediments are present. Within the intertidal area, there are minor areas of exposed bedrock at surface, with numerous cobbles and boulders. Five boreholes drilled at this location ranged in depth from 6 to 10 m below the ground surface and encountered mainly sand, gravelly sand, sandy silt and silty clay material. The boulders, cobbles and the bedrock exposed along the shoreline at this location had an estimated field strength ranging from very strong to extremely strong.

Within the intertidal area of the DSP Study Area, there are numerous cobbles and boulders on the ground surface, and zones of bedrock exposed at surface level also occur. The surface veneer is predominantly sand sized particles with shell fragments to gravel size and fine grained organic material. Ten shallow test pits ranging in depth from refusal to 0.40 m depth below ground surface were hand dug during October, 2016 and encountered mainly sand, sandy gravel and clayey silt material. In addition to these test pits, dynamic cone penetration tests were conducted within the DSP Study Area to get an estimation of the strength of the *in-situ* soil. The depths of these tests ranged from 0.22 m to 2.50 m before encountering refusal; with refusal associated with gravelly ground, cobbles or boulders.

The shoreline region of the DSP Study Area is characterized by generally massive to blocky bedrock. Observations along this area of outcrop showed variable granitoid type rocks, predominantly feldspar and quartz rich. Variable textures within this outcropping bedrock occur, with some zones having more of a metamorphic or gneissic texture (foliation fabric) and other zones have a massive texture (interlocked crystals). Minor zones of shearing and mafic dykes associated with these zones also occur. The cobbles, boulders and exposed bedrock had an estimated field strength ranging from mainly very strong to extremely strong. Small zones of estimated weaker strength rock were associated with minor zones of shearing, where weathering of the rock had occurred.

3.4.2 Soils

Generally four major Soil Orders are found in project area; Brunisols, Cryosols, Gleysols and Regosols (Aarluk, 2012). Cryosols are found in material where permafrost is present within 1 m of the surface. Brunisols show poor and thin soil development. Gleysols are soils were the water table is shallower than 1 m. from the surface. Regosols are landforms or surface where there has been no soil development and are usually found on bedrock, or young and active landforms such as beaches, floodplains, landslides and other active or dynamic landforms. All soils names discussed are based on the Canadian Soil Classification System (National Research Council of Canada, 1998).

The dominant soil order in Iqaluit is Cryosols (Agriculture and Agri-Foods Canada, 2017). Due to the presence of permafrost and shallow active layer, Brunisolic Cryosols, both Static and Turbic are expected to be present on the variable nearshore and littoral deposits exposed on the shoreline, with Regosols present as thin and weakly developed in areas of bedrock exposure.

Generally, the soils in the project area are low in nutrients and cold, with shallow surface horizons available for root and vegetation development.

Surface disturbance of high-ice content permafrost affected soil can result in long term thawing and surface instability.

3.4.3 Surface Features

The SCH Study Area is comprised of a low shoreline, characterized by a prominent bedrock outcrop to the immediate southeast of the Study Area. The tidal flats are low gradient and are covered with boulders and cobbles of varying densities and groupings. Some isolated outcropping bedrock at ground surface level occurs within the tidal flats and these tidal flats extend seaward leading into the deeper channels of the inlet. There has been no significant shoreline change in SCH Study Area due to natural events (erosion), with any modifications to the shoreline due to human intervention; therefore no significant erosion or deposition have been identified in the SCH Study Area (Hatcher et al., 2014).

The DSP Study Area is comprised of two prominent bedrock exposures that extend seaward from the shoreline, creating a small embayment. Within this embayment area, there are minor wave cut platforms with sloping cliff faces up to 45 degrees coincident with rock defects. The shoreline is characterized by whale-back outcrops, generally massive to blocky and inferred to be smoothed by glacial processes. Sub-vertical to vertical cliffs and ravines traverse the area associated with variations in the rock type and structural defects. A review of aerial imagery identifies dominant surface joint sets trending northeast/southwest and north northwest/south southeast, and some of these may have been exacerbated by freeze and thaw.

From the shoreline in the DSP Study Area, the surface extends seaward across low gradient tidal flats towards the deeper channels of the inlet; and boulders and cobbles are also present along the tidal flats. No significant erosion or deposition was observed by sidescan surveys within Koojesse Inlet (Hatcher et al., 2014).

A review of the available aerial imagery did not identify any evidence of thermokarsts or standing water in the proposed DSP or SCH Study Areas; additionally no features were observed in the ground surface that may be derived from ice lenses such as cracks. The surface at this location shows nothing that would be characterized as an esker or kame. No obvious surface features were observed associated with permafrost, however ice wedges in permafrost may be occasionally present in the shoreline sediments (Allard et al., 2012).

3.4.4 Permafrost

Iqaluit is in the Continuous Permafrost Zone; ground that remains at or below 0°C for at least two consecutive years (Tarnocai and Bockheim, 2011). The ground may consist of one or more of the following: soil, rock, ice or organic material. The permafrost of Baffin Island uplands has been estimated to be 400 to 700 m thick (Aarluk, 2012) with a surface active layer that can vary widely from less than 1 m in wet soils to greater than 5 m in rock outcrop. However, permafrost conditions in Iqaluit, such as in ice-rich soils, are highly variable spatially and with depth (LeBlanc et al., 2015). A generalized map (that does not show localized changes in permafrost) does not indicate any ice rich permafrost in the DSP study area and shows ice rich permafrost in the silt rich shoreline deposits of the SCH Study Area (Government of Nunavut, 2013b).

A permafrost monitoring borehole was established in Iqaluit in relatively dry littoral and nearshore sediments (LeBlanc et al., 2015), with the exact location unknown. Thermistor cable readings in this borehole showed the mean annual ground temperature (over five climatic years) is approximately -3.0°C at 8.0 m. The annual range of the ground temperature at this location is 7°C (from approximately 1.0°C to -6.0°C) and the estimated active layer thickness is approximately 1.50 m (LeBlanc et al., 2015).

The majority of the SCH Study Area is marine including subtidal seabed and the intertidal flats. The geotechnical investigation undertaken in October 2016 focused on soil conditions in the intertidal areas by drilling on the tidal flats. Based on the initial assessment of the borehole samples collected, there was no indication of permafrost in boreholes drilled up to 10 m below ground surface. Additionally, surficial geological mapping has indicated that permafrost is not expected at the intertidal deposits (Allard et al., 2012).

The geotechnical investigations undertaken in the DSP Study Area in September and October, 2016 focused on soil conditions in the intertidal areas by hand digging shallow test pits on the tidal flats. No boreholes were drilled, however similar results obtained from boreholes drilled in the SCH Study Area would be expected. The soils are also saline such that permafrost would not be expected and marine components of the Project will likely not encounter permafrost and/or ground ice (Geological Survey of Canada, 2012). The shoreline deposits are bedrock and where rock cuts will be made in this area and fill materials utilized, it is not expected that the behaviour of the bedrock will be affected significantly if the bedrock is frozen at these intervals.

Additional drilling and sampling has been conducted recently in 2017 to assess the potential presence of permafrost within the DSP Study Area as well as evaluate soil and rock conditions. Results were not available at the time of report preparation.

3.4.5 Acid Rock Drainage / Metal Leaching

The rock samples collected for ARD/ML testing were representative of the major rock types identified within the proposed rock cut area, and consisted of four charnockite five, monzogranite and one tonalite samples. Visual examination of the samples indicated the presence of carbonate minerals up to 1% by weight but no sulphide minerals, the primary source of ARD, were identified. X-ray diffraction (XRD) test results (Appendix 1) confirmed the visual information and further indicated that the bulk rock composition consists of quartz, plagioclase and k-feldspar (89 to 92% by weight) with some carbonates mainly in the form of calcite (i.e. 0.4 to 1.2%). No sulphide minerals were identified in any of the rock samples by XRD.

Static ARD/ML testing of the rock samples indicated:

- Very low sulphide sulphur content (i.e. median value equals the method of deflection limit of = 0.01%).
- Adequate neutralization potential (NP) in the form of carbonate and reactive aluminosilicate minerals (i.e. median carbonate NP = 4.4 kg $CaCO_3$/t).

- Relative depletion of the metal concentrations in the rock samples in comparison to a reference granitic composition.
- No acidity and very low sulphate concentrations (i.e. median = 0.6 mg/L) measured during the leach test.
- Only pH and aluminum could potentially exceed the current water quality guidelines set by the Canadian Council of the Ministers of the Environment (CCME) for the protection of fresh water and marine aquatic life under leaching conditions.

These test results (Appendix 1) indicate low long-term potential for acid generation and metal release related to rock materials from the proposed rock cut locations.

4 Vegetation

4.1 Program Objectives

The purpose of the Vegetation baseline was to determine the plant species (including lichens), plant communities and plant species at risk that occur within the Field Survey Area. Information was gathered from data sources available for Nunavut applicable to the area and from field studies conducted in 2016. The information obtained from desktop reviews and field studies were used with local IQ knowledge to determine species occurring that are important to the Inuit people.

4.2 Desktop Study and Literature Review

To support the assessment of the existing conditions of vegetation, a desktop review of existing literature and databases was conducted to determine vegetation species with historical occurrences, or potential to occur near the Project. The following literature, guidelines and publically available data were reviewed:

- Ecozones of Canada (Environment Canada, 2010).
- Nunavut General Monitoring Plan – Summary of Knowledge Report on Valued Ecosystemic and Socio-Economic Components and Valued Land and Water Uses in Nunavut (Aarluk, 2012).
- Non-Native and Invasive Species in Nunavut (Government of Nunavut, 2016d).
- Common Plants of Nunavut (Mallory and Aiken, 2012).
- Flora of the Canadian Arctic Archipelago (Aiken et al., 2007).
- Species at Risk Public Registry, Species List (Species at Risk Public Registry, 2016b).
- Committee on the Status of Endangered Species in Canada (COSEWIC), Wildlife Species Search (COSEWIC, 2016).
- Salix (Salicaceae) Distribution Maps and a Synopsis of Their Classification in North America, North of Mexico (Harvard Papers in Botany, 2007).
- Recovery Strategy for the Porsild's Bryum (*Haplodintium macrocarpum*) in Canada (ECCC, 2016c).

This information was used to inform the field program, identify data deficiencies and focus the information required to complete a baseline study of plant species and communities, and species at risk occurring in the Study Area.

4.3 Inuit Qaujimajatuqangit

IQ was incorporated into this baseline, and was gathered from the following sources (as described in Section 2):

- Design workshops held with local HTA (see Section 2).
- Summarization of information gathered during community consultations.
- Community Priorities and Values Interactive Map (NPC, 2016b).
- Conversations with Inuit Field Technicians during vegetation field survey.
- Additional regional literature summarizing related IQ knowledge:
  - Atlas of Plants of the Nunavik Villages (Blondeau and Roy, 2004)
  - Medicinal plants used by the Inuit of Qikiqtaaluk (Baffin Island, Nunavut) (Black et al., 2008)

4.4 Fieldwork Methods

4.4.1 Study Area

Vegetation field studies covered the proposed rock cut and laydown areas of the DSP, plus a 100 m buffer. This is referred to as the Field Survey Area (Figure 4-1). Field studies were not conducted in the SCH Study Area due to the general absence of vegetation species.

4.4.2 Data Collection

Field surveys were conducted from September 19 to 21, 2016. An ecological land classification survey (ELC) was completed to identify the vegetation communities in the Field Survey Area. Field studies also focussed on identifying each species encountered to obtain a species inventory for the area.

4.4.2.1 Ecological Land Classification

During the field surveys, quantitative data were collected to assist in classification and delineation of vegetation communities through an ELC survey. As there is not an official vegetation classification system which is used in Nunavut, vegetation communities were grouped based on similar characteristics such as vegetation species composition, topographical position, moisture regime, and percent cover of bedrock. Vegetation communities were delineated using a combination of field verification and desktop aerial imagery interpretation.

Within the Field Survey Area, vegetation ground plots were located within each vegetation community encountered. Within each plot, three 1 metre square (m^2) sub-plots were surveyed and were orientated so that it contained a homogeneous vegetation community representative of the typical composition of the polygon. Vegetation plots were demarcated with measuring tape to ensure accuracy. Vegetation data collected at each plot included:

- General site characteristics such as slope, aspect, and surface substrate.
- Vegetation species and percent cover.
- Global positioning system (GPS) coordinates.
- Photographs.

4.4.2.2 Vegetation Species at Risk

The Species at Risk Public Registry (Species at Risk Public Registry, 2016b) was searched before the field survey for rare vascular and non-vascular plants with potential to occur within the Field Survey Area. Available research on species distributions was evaluated for vegetation species with potential to occur within the Field Survey Area to determine if any high potential habitats were present.

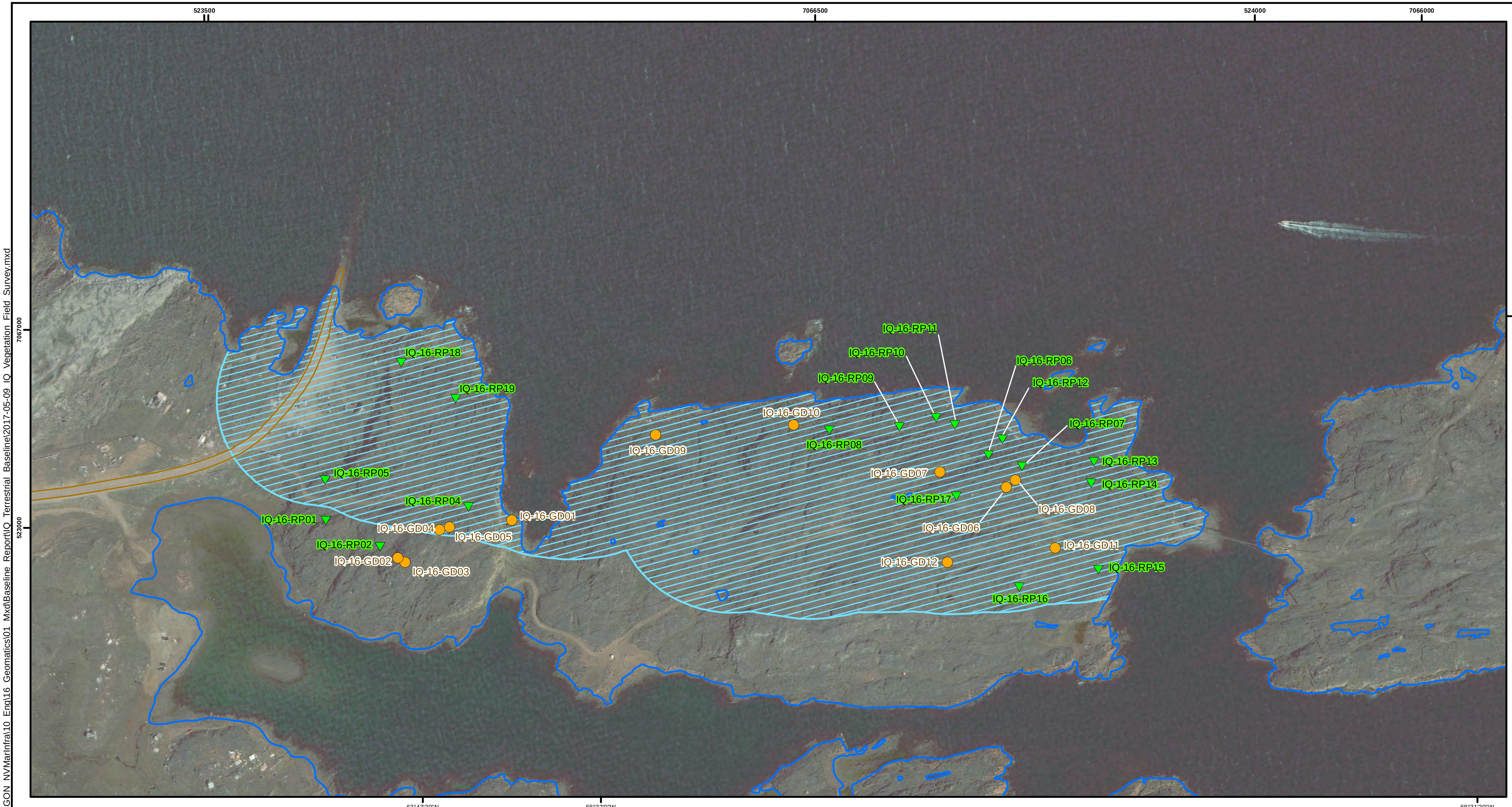
One rare plant survey was completed within the Field Survey Area on September 19 to 21, 2016. During the survey, aerial photograph interpretation was used to identify unique habitats in and around the Field Survey Area. Each vegetation community identified was surveyed using a random meander technique, and all vascular and non-vascular species encountered were recorded (or collected for identification). Survey search methods followed the standards outlined by the Alberta Native Plant Council (2012). If rare plants were located, a 50 m diameter buffer from the plant location was investigated to determine the extent and size of the population. Detailed habitat and population information, photographs, and GPS coordinates were obtained at each observation site.

Figure 4-1 displays the data points collected along the random meander coverage in and around the Field Survey Area.

The following guidebooks were used to identify any vegetation species:

- Common Plants of Nunavut (Mallory and Aiken, 2012)
- Vascular Plants of Continental Northwest Territories (Porsild and Cody, 1980)
- Barrenland Beauties: Showy Plants of the Canadian Arctic (Page, 2000)
- Atlas of Plants of the Nunavik Villages (Blondeau and Roy, 2004)
- Wildflowers of Churchill and the Hudson Bay Region (Johnson, 1987)
- Mosses, Lichens and Ferns of Northwest North America (Vitt et al., 1988)
- Lichens of North America (Brodo et al., 2001)

If unable to identify in the field, a vegetation sample was collected for identification by an expert. A total of 105 lichen samples were collected and sent to Janet Marsh, PhD of JMarsh Environmental for identification. Nomenclature and authorities for each plant species recorded followed the United States Department of Agriculture Plants Database (USDA, 2016). Invasive species were defined according to Government of Nunavut (2016d).



Legend

- Ecological Land Classification - Ground Plot
- Rare Plant Survey Location
- Field Survey Area
- Major Shoreline
- Gravel Road

0 25 50 100
Metres

Note:
- Coordinate System: NAD 1983 UTM Zone 19N
- Aerial Photo and Basedata from City of Iqaluit, 2016

B SHEET	
OneWay to zero harm	
DATE:	09/05/2017
DRAWN:	Y.M.
EDITED:	Y.M.
APPROVED:	M.M.

CUSTOMER: Nunavut

Advisian
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IQALUIT MARINE INFRASTRUCTURE
BASELINE REPORT
VEGETATION FIELD SURVEY AREA

WORLEYPARSONS PROJECT No:	FIG No:	REV
307071-01148	4-1	1

Service Layer Credits:

4.4.3 Quality Assurance / Quality Control

The field program was conducted by experienced field staff. To ensure the quality of data, datasheets were checked for any errors or inconsistencies upon return from the field. In addition, data were entered into a project database and verified for any errors or inconsistences prior to further analysis, including spatial mapping and identification of communities or species.

4.5 Results

4.5.1 Desktop Study and Literature Review

Most of Nunavut, including the Project is located within the Tundra Biome and the Northern Arctic Ecozone (ESWG, 1995). The Northern Arctic Ecozone is among the largest arctic ecosystems in the world and is divided into a number of ecoregions. The Project occurs within the Ecoregion 28 – Meta Incognita Peninsula. The dominant vegetation communities are herbaceous and lichen communities. Lichen communities are typical in rocky areas and occur within and near the Project area. Vegetative cover is greater on wetter and sheltered sites. Taller shrub species occur in warmer microsites with wet sites dominated by sedges and willow species. Approximately 200 species of flowering plants occur within Nunavut, north of the tree line (Aarluk, 2012).

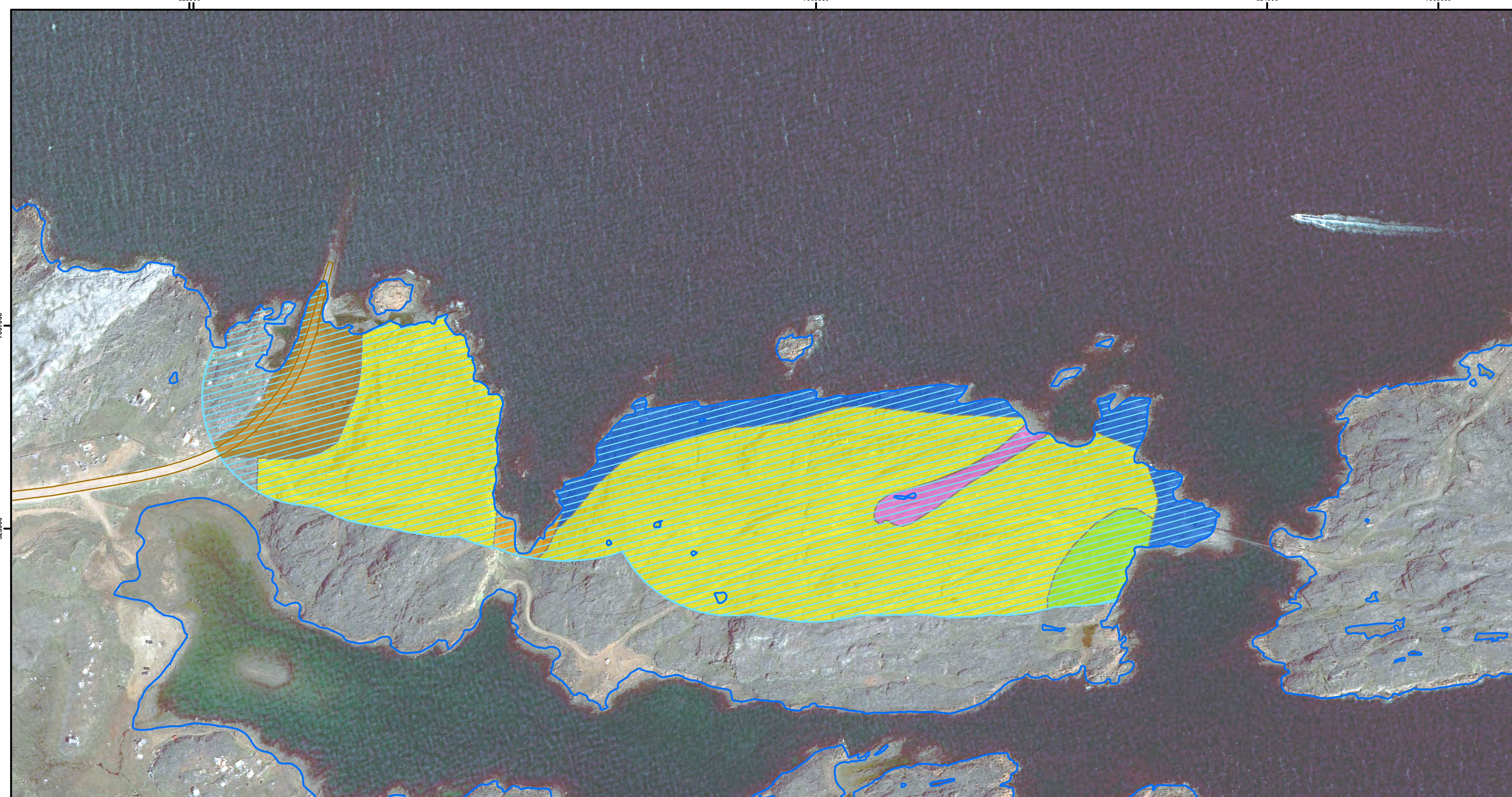
4.5.2 Fieldwork

4.5.2.1 Ecological Land Classification

A total of 12 ELC ground plots were surveyed in six unique vegetation communities within the Field Survey Area (Figure 4-1). The Vegetation communities identified include:

- Upland Bedrock Outcrop – Shallow Soils (UB-SS)
- Upland Shoreline Cliff (USC)
- Upland Shoreline (US)
- Upland Dwarf Shrub (UDS)
- Wetland Dwarf Shrub (WDS)
- Disturbed (DIS)

A species list for each of the identified vegetation communities is provided in Appendix 2. Detailed descriptions for each community are provided in the following sections. It should be noted that some sites were outside the final Field Survey Area but were retained as the species and community characterizations are representative of the Field Survey Area.



Legend

- Field Survey Area
- Major Shoreline
- Gravel Road

Vegetation Zones

- Disturbed
- Upland Bedrock - Shallow Soil
- Upland Dwarf Shrub
- Upland Shoreline
- Upland Shoreline Cliff
- Wetland Dwarf Shrub

0 25 50 100
Metres

Note:
- Coordinate System: NAD 1983 UTM Zone 19N
- Aerial Photo and Basedata from City of Iqaluit, 2016

B SHEET	
OneWay to zero harm	
DATE:	09/05/2017
DRAWN:	Y.M.
EDITED:	Y.M.
APPROVED:	M.M.

CUSTOMER: Nunavut

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IQALUIT MARINE INFRASTRUCTURE BASELINE REPORT
VEGETATION COMMUNITIES WITHIN THE FIELD SURVEY AREA

WORLEYPARSONS PROJECT No:	FIG No:	REV
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USER NAME: yao.mo
ISSUING OFFICE: BURNABY GIS

PLOT DATE & TIME: 09/05/2017 3:01:37 PM
SAVE DATE & TIME: 09/05/2017 3:01:37 PM

Service Layer Credits:

4.5.2.2 Upland Bedrock Outcrop – Shallow Soils

The UB-SS vegetation community is characterized as a mosaic of bedrock and vegetated areas. The vegetation community is dominated by bedrock outcrops with frequent vertical drops. The bedrock areas are vegetated exclusively by non-vascular lichen species. Small sheltered breaks in the bedrock and flatter areas where sands and gravels have accumulated are vegetated with vascular and non-vascular species. Sheltered areas are dominated by dwarf shrub species, including black crowberry (*Empetrum nigrum* L.) and bog blueberry (*Vaccinium uliginosum* L.). About 90% of the vegetation community is exposed bedrock, and 10% is sheltered and vegetated (Figure 4-2; Photo 4-1). Vegetation ground plots sampled in this community include IQ-16-GD02-05, IQ-16-GD07, and IQ-16-GD12). Slope and aspect is variable throughout this vegetation community.

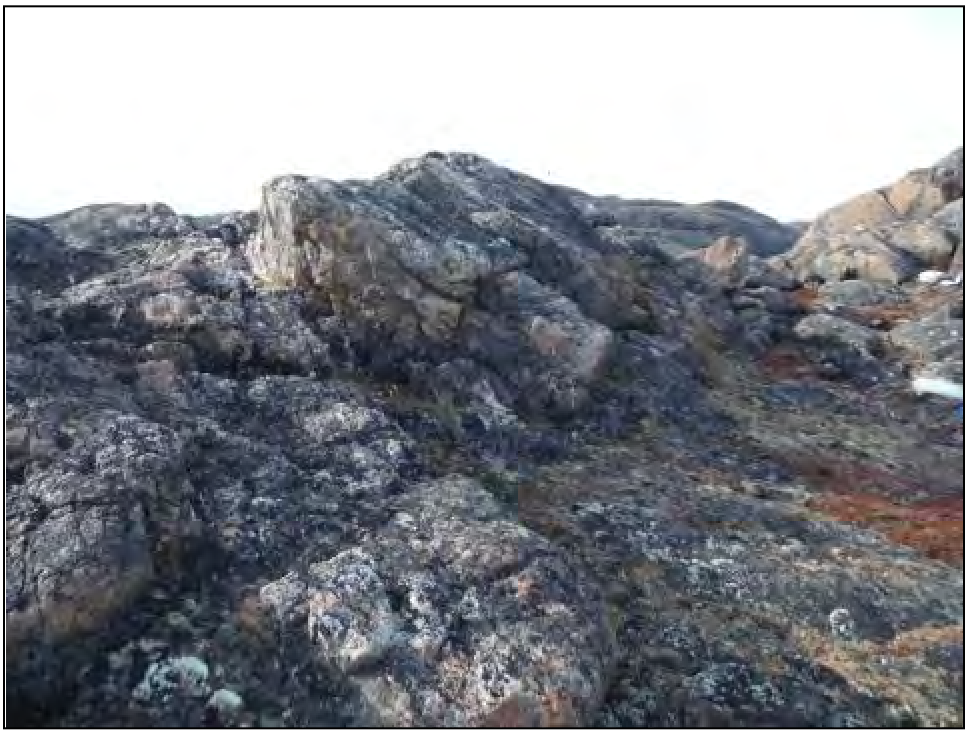


Photo 4-1 Upland Bedrock Outcrop – Shallow Soils Vegetation Community (Facing West from IQ-16-GD05)

4.5.2.3 Upland Shoreline Cliff

The USC was characterized by steep cliffs with small vegetated areas in breaks in the bedrock (Figure 4-2). Vegetation communities are influenced by the ocean moisture. Vegetated areas are dominated by glaucous bluegrass (*Poa glauca* Vahl), thrift seapink (*Armeria maritima* [Mill.] Willd.), and bryophyte (moss) species (Appendix 2). Vegetated areas have thin organic soils accumulated from vegetation litter and detritus from nesting birds along the cliff band. The exposed bedrock areas have a variety of non-vascular lichen species (Figure 4-2, Photo 4-2). A single vegetation ground plot (IQ-16-GD01) was sampled in this community.

Photo 4-2 Upland Shoreline Cliff Vegetation Community (Facing North from IQ-16-GD01)

4.5.2.4 Upland Shoreline

The US was located at and above the high water level, and was a mosaic of flatter graveled areas, and bedrock fingers alternating along the shoreline (Figure 4-2). The gravel flats were dominated by non-vascular species and shrub species including black crowberry and bog blueberry (Appendix 2). The bedrock outcrops were dominated by lichen species. The bedrock outcrops had frequent steep vertical steps, with occasional seepages hosting moisture loving species and denser vegetation than found in exposed areas. (Figure 4-2, Photo 4-3). Vegetation ground plots sampled in this community include IQ-16-GD09 and IQ-16-GD10.

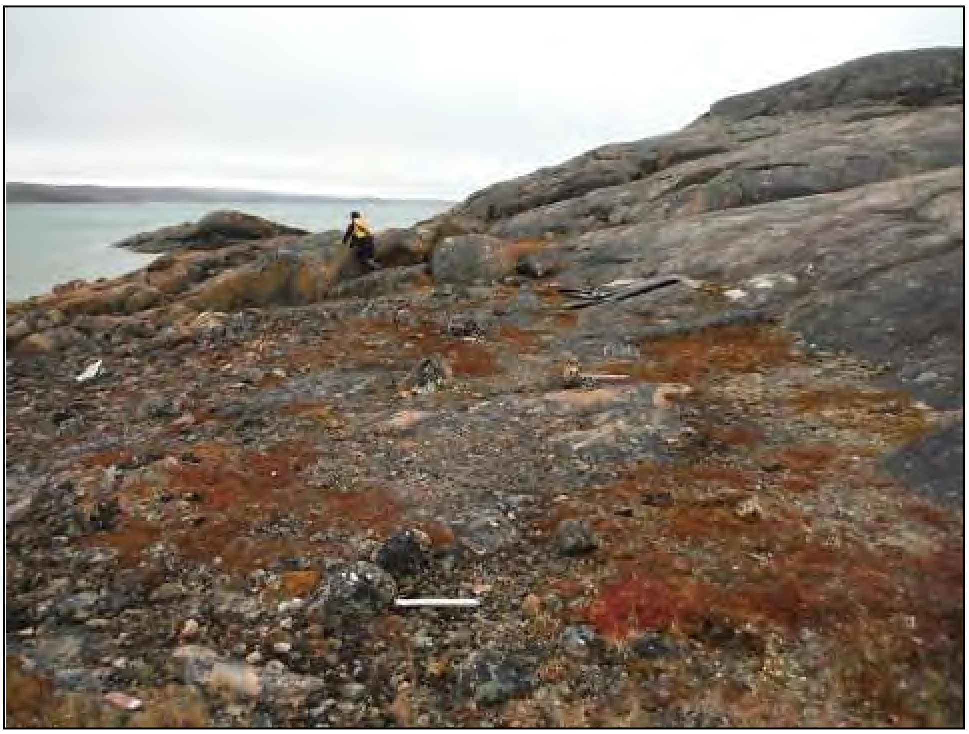


Photo 4-3 View of Upland Shoreline Vegetation Community (Facing South from IQ-16-GD09)

4.5.2.5 Upland Dwarf Shrub

The UDS vegetation community was a limited area of thicker sand and gravel soils, located in flat areas between bedrock outcrops (Figure 4-2). Soil depths were thicker in this vegetation community type than the surrounding bedrock mosaic types. The UDS vegetation community was dominated by non-vascular species and vascular shrub species including black crowberry and bog blueberry (Appendix 2; Figure 4-2, Photo 4-4). A single vegetation ground plot (IQ-16-GD11) was sampled in this community.

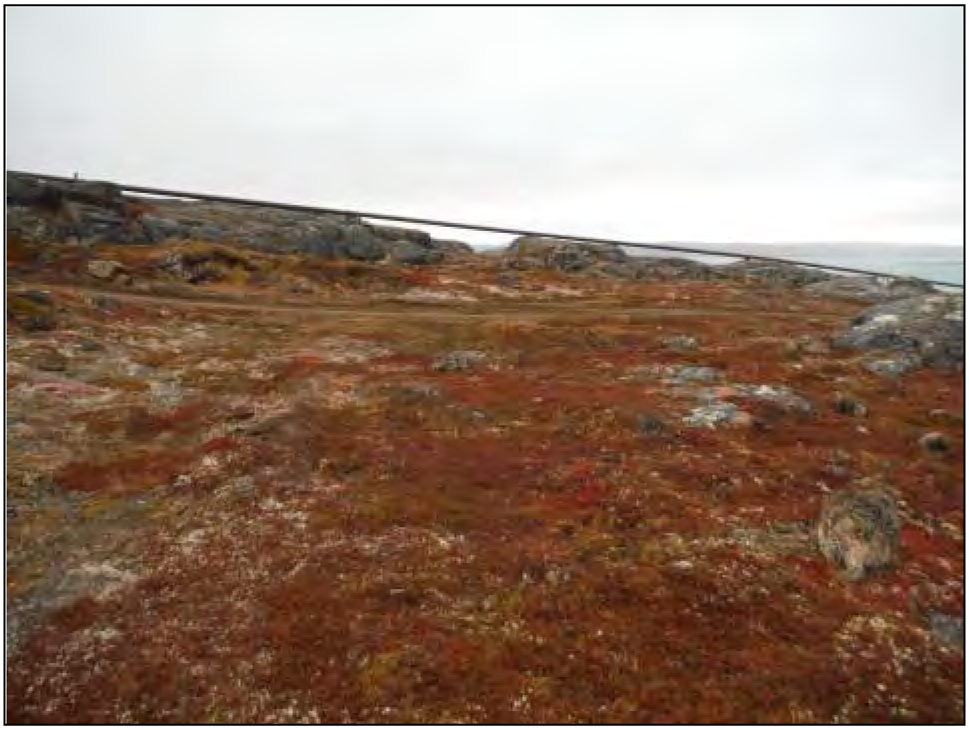


Photo 4-4 View of Upland Dwarf Shrub Vegetation Community (Facing East from IQ-16-GD11)

4.5.2.6 Wetland Dwarf Shrub

The WDS is a narrow riparian/wetland vegetation community situated in a linear break between exposed bedrock outcrops. Ephemeral wetlands are located at the north end of the community type, and evidence of an ephemeral drainage was observed draining towards the ocean (Figure 4-2). This community was consistently vegetated, with seepage areas having moisture loving vegetation. The vegetation was dominated by dwarf shrubs, including white arctic mountain heather (*Cassiope tetragona* [L.] D. Don), bog blueberry, and non-vascular lichen species (Appendix 2). Smaller micro-habitats of this vegetation community type were observed in other small seepage areas, which were too small to map (Appendix 2; Figure 4-2; Photo 4-5). A single vegetation ground plot (Plot IQ-16-GD06) was sampled in this community.

Photo 4-5 View of Wetland Dwarf Shrub Vegetation Community (Facing Northwest from IQ-16-GD06)

4.5.2.7 Disturbed

The DIS is an anthropogenic disturbed community type observed in the north area of the Field Survey Area. This area has been leveled and has imported gravel to create a parking area and boat launch, and has minimal vegetation present.

4.5.3 Vegetation Species at Risk

During the desktop assessment, a review of the Species at Risk Public Registry (Species at Risk Public Registry, 2016b) showed a total of two rare plants – including one vascular (i.e. trees, shrubs, herbs and graminoids) species and one non-vascular plant (i.e. moss, liverworts and lichens) species – with potential to occur in the Project area.

These included:

- Porsild's Bryum (*Haplodontium macrocarpum*), which was listed as Threatened under COSEWIC and Schedule 1 under the *Species at Risk Act* (SARA).
- Blanket-leaved willow (*Salix silicicola* Raup), which was listed as Special Concern under COSEWIC, Schedule 1 under SARA (Species at Risk Public Registry, 2016a).

Porsild's Bryum is a non-vascular bryophyte species. Porsild's Bryum has a broad, but disjunct distribution in Canada, including sites in Alberta, British Columbia, the island of Newfoundland, and Nunavut (specifically Ellesmere Island). This species has been designated as threatened since 2003, due to the fragmented distribution and limited confirmed population locations. There are 17 known populations in Canada, which accounts for about 70% of known global occurrences. Three of the Canadian populations are located in close proximity to each other within Quttinirpaaq National Park, Ellesmere Island, Nunavut (ECCC, 2016c).

Habitat requirements for Porsild's bryum in the Arctic are in treeless vegetation zones. Microhabitats for most populations are associated with waterfalls, and in sheltered calcareous rock crevices or rock faces with seepages. The specific habitat requirement of this species is considered to be a limiting factor for its establishment, and is therefore expected to not be found in other habitat types (ECCC, 2016c). No suitable habitat for this species was observed within the Field Survey Area (i.e. calcareous seepages), and therefore the Field Survey Area is not considered to have high potential for this rare non-vascular species.

Blanket-leaved willow is an erect shrub species, which is only found in two locations in Canada: the Athabasca Sand Dunes in Saskatchewan, and Pelly Lake at Pelly Lake, Nunavut, which is located on continental Nunavut. This species was designated as special concern in 2000 due to the restricted population extent.

The habitat required for the blanket-leaved willow population located in the Athabasca Sand Dunes is large, active sand dunes (Species at Risk Public Registry, 2016a). Little is known about the reported location in Nunavut, which was first observed in 1966. A limiting factor for this species is considered to be the limited spatial extent of their habitat (i.e. active sand dunes) (Environment Canada, 2013). As little is known about the habitat of the Nunavut population, habitat requirements can only be based on those for the Saskatchewan population. No suitable habitat for this species was observed within the Field Survey Area (i.e. active sand dunes), and therefore the Field Survey Area is not considered to have high potential for this rare shrub species.

No occurrences of either of Porsild's Bryum or blanket-leaved willow were observed during the field visit.

During the field assessment a total of 108 vegetation species were observed, including eight shrub, four graminoid, 20 forb and 76 non-vascular species. The most common species identified were black crowberry, willow species, dwarf fireweed and moss campion (*Silene acaulis* [L.] Jacq.). A list of the species identified is provided in Appendix 2.

4.5.4 Inuit Qaujimajatuqangit

During discussions with the HTA, there were no areas identified within the Field Survey Area which are used for traditional purposes. There was an area to the west, outside the Field Survey Area that is used for berry picking (Paul Kaludjak, personal communication 2016; Figure 2-1).

During the field survey, nine plants were identified as having traditional uses within the Iqaluit area by the Inuit Field Technicians. Uses for these species included food, medicine, tools, lamp wicks, and other items. Of these species, all were identified within the Field Survey Area during the field surveys. Additionally, five vegetation species observed within the Field Survey Area are noted to have traditional uses within the Nunivik region, as identified in the Atlas of Nunavik (Blondeau and Roy, 2004). Although the Field Survey Area is outside of the Nunavik region, it is assumed that traditional uses of these common species would be similar in Iqaluit Area. These species are detailed in Table 4-1.

Three species identified in the Field Survey Area were also identified in a study conducted on the medicinal use of plants by the Inuit on Baffin Island (Table 4-1) which included individuals interviewed in Iqaluit (Black et al., 2008).

Table 4-1 Traditional Species Identified during Field Surveys

Common Name	Latin Name and Authority
Shrubs	
Red fruit bearberry[X]	*Arctostaphylos rubra* (Rehder & Wilson) Fernald
White arctic mountain heather*	*Cassiope tetragona* (L.) D. Don
Black crowberry*	*Empetrum nigrum* L. ssp. *Nigrum*
Lapland rosebay*	*Rhododendron lapponicum* (L.) Wahlenb.
Willow species*	*Salix* spp.
lingonberry[X]	*Vaccinium vitis-idaea* L.
Bog blueberry*	*Vaccinium uliginosum* L.
Graminoids	
Tall cottongrass*	*Eriophorum angustifolium* Honck.
Forbs	
Alpine bistort*	*Bistorta viviparum* L.
Alpine bittercress*	*Cardamine bellidifolia* L.
Alpine clubmoss^	*Lycopodium alpinum* L.
Dwarf fireweed[X]	*Chamerion latifolium* L.
Alpine mountainsorrel*^	*Oxyria digyna* (L.) Hill
Three toothed saxifrage[X^]	*Saxifraga tricuspidata* Rottb.
Moss campion[X]	*Silene acaulis* (L.) Jacq.
Non-vascular	
Navel lichen[X]	*Umbilicaria* sp.
Orange wall lichen[X]	*Xanthoria elegans* (Link) Th. Fr.

Notes:

'*' denotes species was identified as having traditional use within the Iqaluit area by Inuit Technicians during the field assessment

'X' denotes species was identified as having traditional use according to the Atlas of Nunavik Blondeau and Roy (2004)

^ denotes species was identified as having medicinal use according to Black et al. (2008)

4.6 Discussion

The Vegetation study was undertaken to measure the current baseline conditions prior to Project development and will form the basis of determining the potential effects of the Project on vegetation resources.

The Project is located within the Tundra Biome and the Northern Arctic Ecozone. The vegetation communities identified during field studies were representative and typical of the Tundra and Northern Arctic Ecozone (Aarluk, 2012; ESWG, 1995). The Field Survey Area consisted primarily of exposed bedrock which is mostly vegetated with lichen species. Other communities identified (Upland Dwarf Shrub and Wetland Dwarf Shrub) occur within areas of the Field Survey Area that have accumulated soils and can support a vegetated cover dominated by black crowberry and bog blueberry.

No occurrences of either of Porsild's Bryum or blanket-leaved willow were observed during the field visit (ECCC, 2016c; Species at Risk Public Registry, 2016a). A total of 108 vegetation species were observed, most of which were lichen species. The relatively high diversity of lichen species was expected as much of the exposed bedrock in the Field Survey Area was vegetated with lichen cover. During field studies 76 species of lichen were identified and demonstrates the relative importance of non-vascular species to the flora of Nunavut (Aarluk, 2012). All vascular plants identified during the field survey are common in Nunavut (Page, 2000; Mallory and Aiken, 2012; Johnson, 1987). However, it should be noted that field studies occurred late in the season which can make plant identification difficult, due to the natural die back of plant material including the identifiable parts of the specimen. As a result, some species could not be identified or could only be identified to Genus and the species list for the Field Survey Area is incomplete. Despite this limitation, the collected data provided dominant species needed to characterize vegetation communities and was sufficient to support a conclusion that plant species at risk likely do not occur in the Field Survey Area. In addition, based on the habitat requirements known for the two listed vegetation species at risk for Nunavut, it is unlikely those species would occur within the Field Survey Area as there was no suitable habitat identified.

5 Terrestrial Wildlife

5.1 Program Objectives

The purpose of the Terrestrial Wildlife program was to determine the presence of terrestrial wildlife, important or critical habitats, and key features found in the Field Survey Area such that an effective effects assessment could be conducted and that Project planning can incorporate ecological information relevant to these species so potential negative effects can be avoided or mitigated.

The presence of terrestrial wildlife, important or critical habitats, and key features occur in the Field Survey Area were determined using historical information gathered as part of a desktop study, literature review and IQ gathering (see Section 2). To supplement the desktop study and literature review, field-based habitat assessment and wildlife reconnaissance survey were conducted in conjunction with the vegetation field program within the Field Survey Area. From the habitat assessment, vegetation survey results, and reconnaissance survey, a list of species likely to inhabit the Field Survey Area was generated.

Although they spend the majority of their life in marine environments on sea ice, for purposes of this Terrestrial Wildlife study, polar bears were considered to be terrestrial wildlife given that their maternal dens (a critical life-history stage) are constructed predominately in coastal terrestrial environments (COSEWIC 2008).

5.2 Desktop Study and Literature Review

The desktop study and literature review was conducted to determine species with historical occurrences near the Project. Furthermore, protected areas or known high value habitats (e.g. National Wildlife Areas, National or Territorial Parks) were identified. In addition to identifying historical occurrences, a list of species that could potentially occupy the Field Survey Area was generated. This list was determined by examining available habitat using aerial imagery (Google earth) and comparing it to habitat requirements for species whose ranges overlap with the Project. Range and habitat information was determined from the following data sources:

- Peer-reviewed literature and secondary literature:
  - A complete guide to Arctic wildlife (Sale, 2006)
  - Annales Zoologici Fennici (peer-reviewed journal)
  - Arctic (peer-reviewed journal)
  - ArcticWOLVES (Gauthier and Berteaux, 2011)
  - Canadian Field-Naturalist (peer-reviewed journal)
  - Canadian Journal of Zoology (peer-reviewed journal)
  - Journal of Wildlife Management (peer-reviewed journal)
  - Mammalian Species (peer-reviewed journal)
  - Oecologia (peer-reviewed journal)
  - Polar Biology (peer-reviewed journal)
- Territorial Government reports and databases:
  - Baffin Island Caribou Consultations (Jenkins and Goorts, 2013)
  - Draft Nunavut Land Use Plan (NPC, 2016a)
  - Estimating the Abundance of South Baffin Caribou (Jenkins et al., 2012)

  - Nunavut Wildlife Harvest Study (Priest and Usher, 2004)
- Federal government reports:
  - COSEWIC Assessments and Status Reports
- Environmental reports for other development projects:
  - Mary River Project Final Environmental Impact Statement (Baffinland Iron Mines Corporation, 2012a)
  - Nunavut Wildlife Resources and Habitat Values (Nunami Stantec, 2012)

5.2.1 Inuit Qaujimajatuqangit

IQ was incorporated into the Terrestrial Wildlife Program and was gathered from the following sources:

- Community Priorities and Values Interactive Map (NPC, 2016b).
- Conversations with Inuit Field Technicians during habitat assessment (see Section 5.3 below).
- Design workshops held with the local HTA (see Section 2 above).
- Government and scientific literature summarizing community consultations or IQ research:
  - Baffin Island Caribou Consultations (Jenkins and Goorts, 2013)
  - Nunavut Wildlife Harvest Study (Priest and Usher, 2004)
  - Nunavut Wildlife Resources and Habitat Values (Nunami Stantec, 2012)
- Summarization of data gathered during other community consultations:
  - Qulliq Energy Corporation Iqaluit Hydro-Electric Generation Sites (Knight Piésold, 2006)

5.3 Fieldwork Methods

The methodology used to collect habitat information is described in detail in the Vegetation baseline Section 4.4. In addition to collecting detailed data on vegetation diversity, composition, and structure, the vegetation ecologist also conducted a wildlife reconnaissance survey. During this reconnaissance survey, all wildlife species observed or detected by sign (scat, pellets, tracks, etc.) were identified (if possible), photographed, and georeferenced using a handheld GPS. In addition to individual wildlife, all wildlife features (e.g. burrows and dens) were similarly photographed and georeferenced. The information collected during the habitat assessment and wildlife reconnaissance survey was used to further refine the list of species with potential to inhabit the Field Survey Area.

5.4 Results

A total of 10 terrestrial wildlife species, ranging from lemmings to barren-ground caribou have historical occurrences or have the potential to occur within the Field Survey Area based on habitat and range (Table 5-1). Details on each species are provided in the following subsections.

Three of the mammals with potential to occur within the Study Area are species-at-risk: barren-ground caribou are listed as Threatened, polar bear and wolverine (*Gulo gulo*) are listed as Special Concern (COSEWIC, 2016).

5.4.1 Small Mammals (Rodents and Lagomorphs)

Small mammals are defined as those species belonging to the following mammalian orders: Rodentia (rodents) and Lagomorpha (hares and rabbits). Few small mammal inventories and studies have been undertaken near Iqaluit. Consequently, quantitative data and historical occurrence information is lacking. However, the 2004 Nunavut Wildlife Harvest Study (Priest and Usher, 2004) provides information on small game harvested by Iqaluit hunters. Location information from this database is lacking; thus, potential for these small game species and other small mammals to occupy the Field Survey Area were inferred from range maps, habitat requirements, and aerial imagery.

Arctic hare (*Lepus arcticus*) is the only small game species reported in the Nunavut Wildlife Harvest Study for Iqaluit and mean annual harvest is 79 individuals per year (Priest and Usher, 2004). Harvest of Arctic hare has ranged from 30 (in 1998/1999) to 148 (in 2000/2001). Much of the Meta Incognita Peninsula (located south of Iqaluit across Koojesse Inlet) has been identified as important hunting grounds, including for rabbit (sic: Arctic hare) (NPC, 2016b) (Figure 5-1).

In addition to Arctic hare, other small mammals that may inhabit the Field Survey Area include brown lemmings (*Lemmus trimucronatus*) and Perry land collared lemmings (*Dicrostonyx groenlandicus*).

Table 5-1 Terrestrial Wildlife that have Potential to Occur in within the Field Survey Area

Common Name	Scientific Name	Habitat[1]
Small Mammals (Rodents and Lagamorphs)		
Brown Lemming	*Lemmus trimucronatus*	▪ Damp (hydric) tundra dominated by grasses, sedges, and mosses ▪ Winter nests in areas of high micro-topography
Peary Land Collared Lemming	*Dicrostonyx groenlandicus*	▪ Dry (xeric), rocky tundra ▪ Winter nests in areas of high micro-topography
Arctic Hare	*Lepus arcticus*	▪ Typically willow-dominated tundra, but also rocks and broken terrain for cover
Medium Mammals (Canids and Mustelids)		
Arctic Fox	*Alopex lagopus*	▪ Likely determined more by prey availability (i.e. small mammals and geese) than vegetation ▪ Dens are large, complex burrow systems with multiple entrances
Red Fox	*Vulpes vulpes*	▪ Likely determined more by prey availability (i.e. small mammals and geese) than vegetation ▪ Uses pre-existing Arctic fox dens
Arctic Wolf	*Canis lupus arctos*	▪ Likely determined more by prey availability (i.e. caribou) than vegetation ▪ Dens along eskers
Ermine	*Mustela erminea*	▪ Habitat generalist, likely determined more by prey availability than vegetation ▪ Uses subnivean grass nests, rock piles and burrows often commandeered from prey
Wolverine[2]	*Gulo gulo*	▪ Wide-ranging species whose habitat is likely determined more by prey availability (i.e. carcasses and small mammals) than vegetation ▪ Dens within snow or under snow-covered rocks
Large Mammals		
Barren-ground Caribou[3]	*Rangifer tarandus groenlandicus*	▪ Mesic to xeric tundra with snow-free or shallow snow-covered ridges and other topographical features offering shelter

Common Name	Scientific Name	Habitat[1]
Polar Bear[4]	*Ursus maritimus*	▪ Wide ranging across sea-ice ▪ Constructs maternal snow dens along coast

Notes:

[1] Habitat information from: (Chesemore, 1969; Parker, 1977; Garrott et al., 1983; King, 1983; Gray, 1993; Klein and Bay, 1994; Sittler, 1995; McLoughlin et al., 2004; Sale, 2006; King and Powell, 2007; Duchesne et al., 2011; Gauthier and Berteaux, 2011; COSEWIC, 2003, 2004, 2008, 2011).

[2] Wolverine are listed by COSEWIC as Special Concern and are not listed under the *Species at Risk Act* (Species at Risk Public Registry, 2016b).

[3] Barren-ground caribou are listed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) as Threatened and are not presently listed under the *Species at Risk Act* (Species at Risk Public Registry, 2016b).

[4] Polar bear and wolverine are listed by COSEWIC as Special Concern and are listed on Schedule 1 as Special Concern under the *Species at Risk Act* (Species at Risk Public Registry, 2016b).

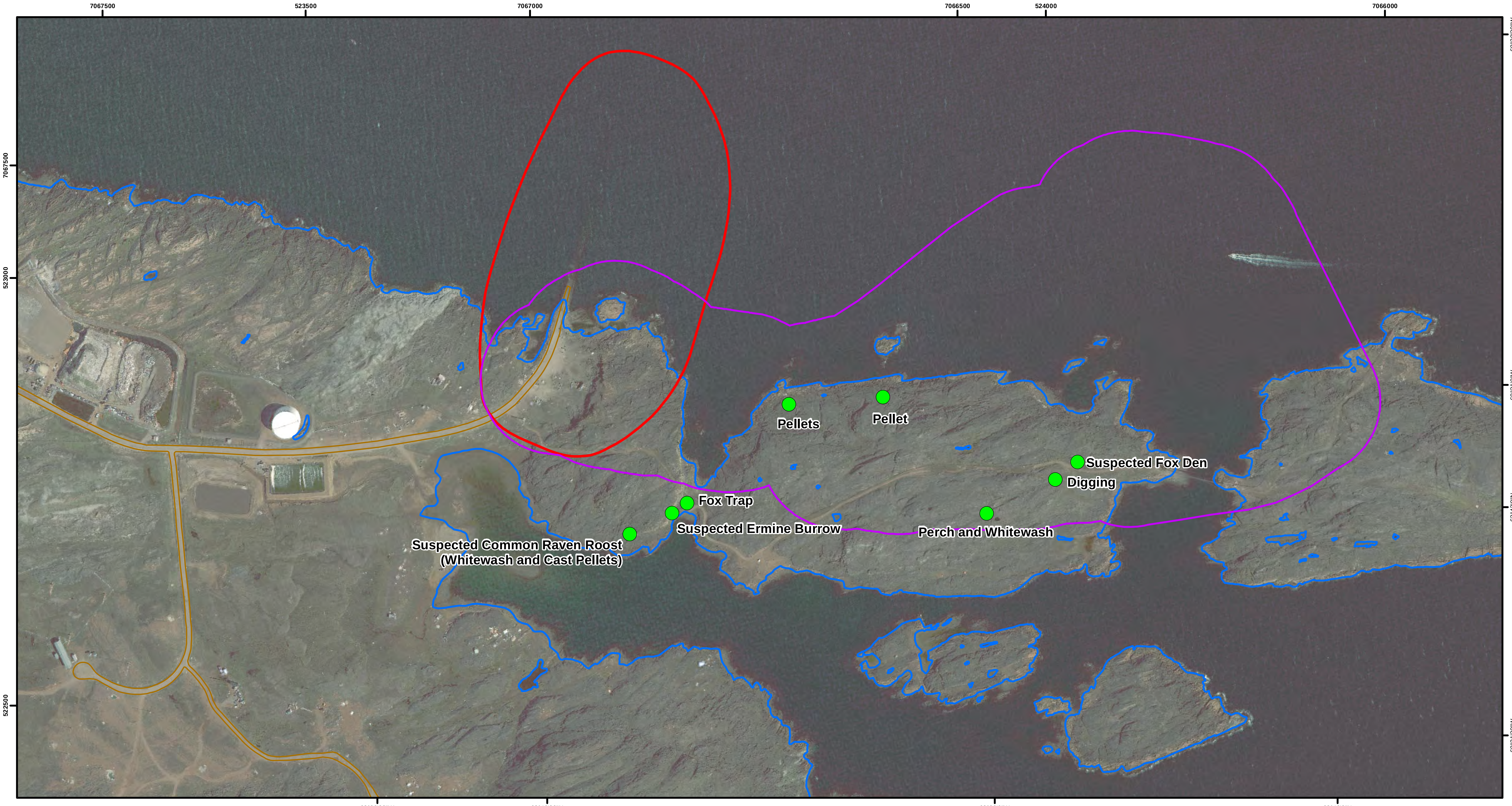
5.4.2 Medium Mammals (Canids and Mustelids)

For this Project, medium-sized mammals have been identified as those species belonging to the following mammalian orders: Canidae (dog family) and Mustelidae (weasel family). The Nunavut Wildlife Harvest Study (Priest and Usher, 2004) identified that Arctic wolf and both colour phases of Arctic fox have been harvested by Iqaluit hunters. However, location data for these species have not been collected. Therefore, it cannot be determined whether these species were distributed and harvested near the Field Survey Area. In addition to Arctic fox and wolves, the Field Survey Area has potential to provide habitat for red fox, ermine (*Mustela erminea*), and wolverine. Wolverines are federally-listed as Special Concern (COSEWIC, 2014).

During the wildlife reconnaissance survey, a small burrow with multiple entrances was observed near a craggy area at the base of a small cliff near the proposed DSP (Figure 5-1; Photo 5-1). Numerous pellets and animal remains were scattered at this site. Additionally, some pellets appeared to have been cached within the burrow. Given the size of the burrow entrances (<12 cm), it is suspected these are used by an ermine.

A short distance from the small burrows, a foot-hold trap was anchored into the rock, although it was not actively set (Figure 5-1; Photo 5-2). Inuit field technicians explained that this trap was for fox.

Further southeast, along the peninsula near the proposed DSP, was a vegetation community that contained deep, friable soil. A large, den complex was observed here along with diggings indicating possible foraging attempts (Figure 5-1; Photo 5-3). Based on the size of the entrance and the numerous entrances it was suspected it belongs to a fox (Arctic or red). Several seal carcasses (unidentified to species) had washed ashore within the inlet and nearby numerous bleached bones (presumed to be seal) had also been deposited on shore.



Legend

- Wildlife Point
- Deep Sea Port Study Area
- Causeway Study Area
- Major Shoreline
- Gravel Road

0 50 100 200
Metres

Note:
- Coordinate System: NAD 1983 UTM Zone 19N
- Aerial Photo and Basedata from City of Iqaluit, 2016

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IQALUIT MARINE INFRASTRUCTURE
BASELINE REPORT
WILDLIFE FEATURES AND SIGN OBSERVED DURING
THE WILDLIFE RECONNAISSANCE SURVEY
SEPTEMBER 19TH TO 21ST, 2016

WORLEYPARSONS PROJECT No:	FIG No:	REV
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Photo 5-1 A) Small Burrow Located within a Craggy Area, B) Additional Entrance with Pellet Remains Possibly Cached near Burrow Entrance

Photo 5-2 Foothold Trap (not set) Anchored to a Boulder

Photo 5-3 A) Large Den Complex with Considerable Soil Excavated Outside Main Entrance, B) Large Entrance Approximately 20 cm tall, C) Additional Entrances, D) Diggings Indicating Possible Foraging Attempts

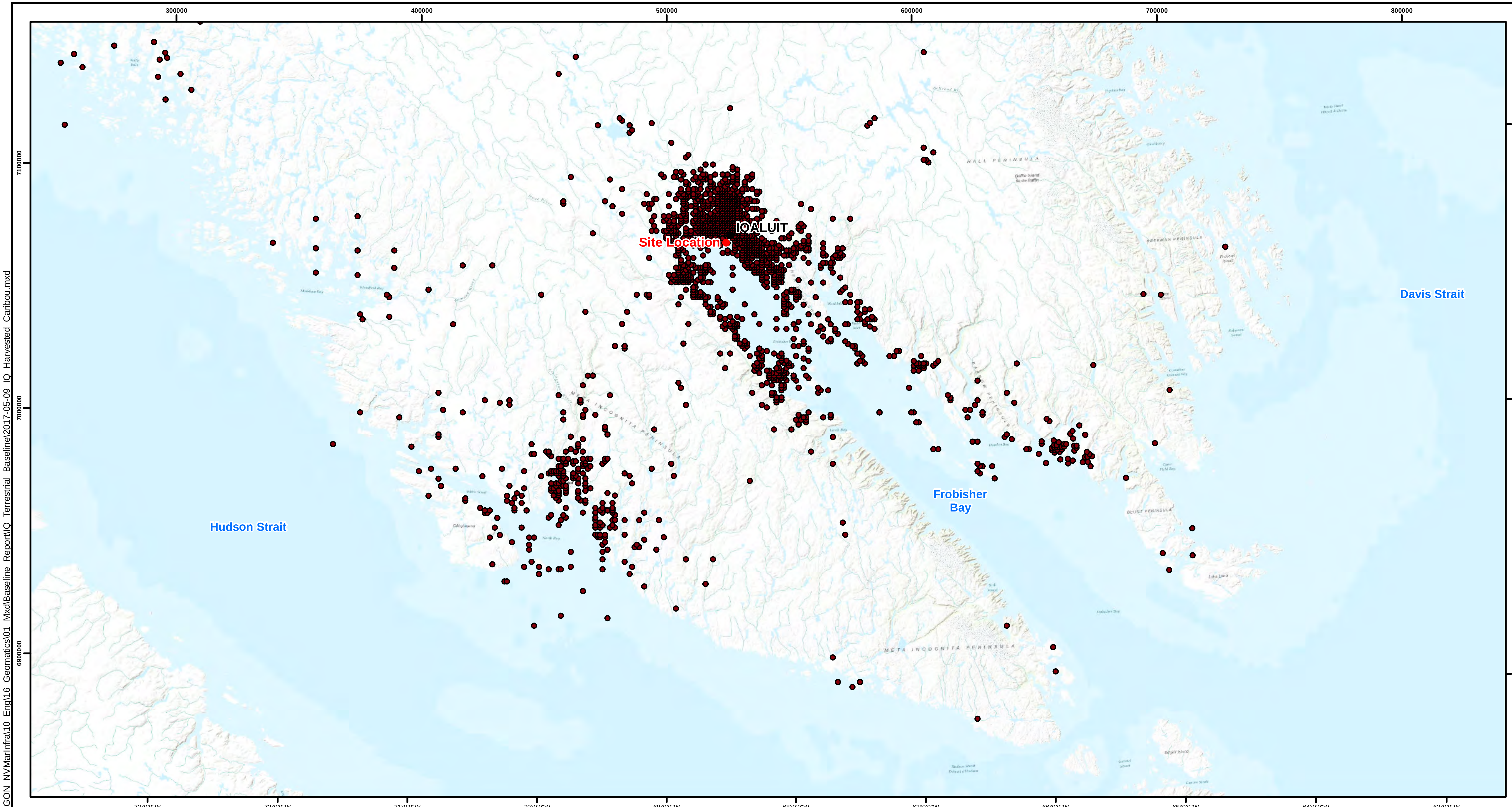
5.4.3 Large Mammals (Barren-Ground Caribou and Polar Bears)

Both barren-ground caribou and polar bears are harvested by hunters in Iqaluit (Priest and Usher, 2004). Caribou are the main source of country food, and between 1996 and 2011, the mean annual harvest of caribou was 1,834 individuals per year. Feedback regarding the result of the harvest survey revealed that community members felt the estimates were too low. However, caribou movement affects the harvest numbers. In some years, fewer caribou have come close to Iqaluit; thus, fewer are harvested (Priest and Usher, 2004). For polar bears, mean annual harvest was 16 individuals per year (Priest and Usher, 2004).

Location data collected as part of the survey revealed that caribou are hunted throughout Frobisher Bay and north to Anakudluk Lake (Sylvia Grinnell Lake; Figure 5-2) (Priest and Usher, 2004). In contrast, polar bears appear to be most often harvested farther southeast of Iqaluit past Pugh Island, with the majority of polar bears taken from the entrance to the bay (southeast of McLean Island; Figure 5-3) (Priest and Usher, 2004).

5.4.3.1 Designated Units – Polar Bear Maternal Denning

The polar bears whose range overlaps the Field Survey Area belong to the Davis Strait population (COSEWIC, 2008). Polar bears are known to use the tip of Meta Incognita Peninsula for maternity denning (Important Bird Areas, (IBA Canada, 2016)). In fact, several designated polar bear denning units have been identified as part of the Draft Nunavut Land Use Plan (NPC, 2016a). A designated polar bear denning unit extends from the entrance of Frobisher Bay near Barrow Peninsula to Hall Island (Figure 5-4). A second designated polar bear denning unit extends from the north short of Frobisher Bay north to Popham Bay (Figure 5-4). On the south shore of Frobisher Bay, a designated polar bear denning unit extends from Peters Point to Balcom Inlet, as well as a unit on Edge Island and Resolution Island (Figure 5-4). Each unit is over 100 km from the Field Survey Area.



Legend

- Harvested Caribou Location

0 12.5 25 50

Kilometres

N

Note:
Coordinate System: NAD 1983 UTM Zone 19N

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IQALUIT MARINE INFRASTRUCTURE
BASELINE REPORT
HARVESTED CARIBOU LOCATIONS (1998 - 2001)

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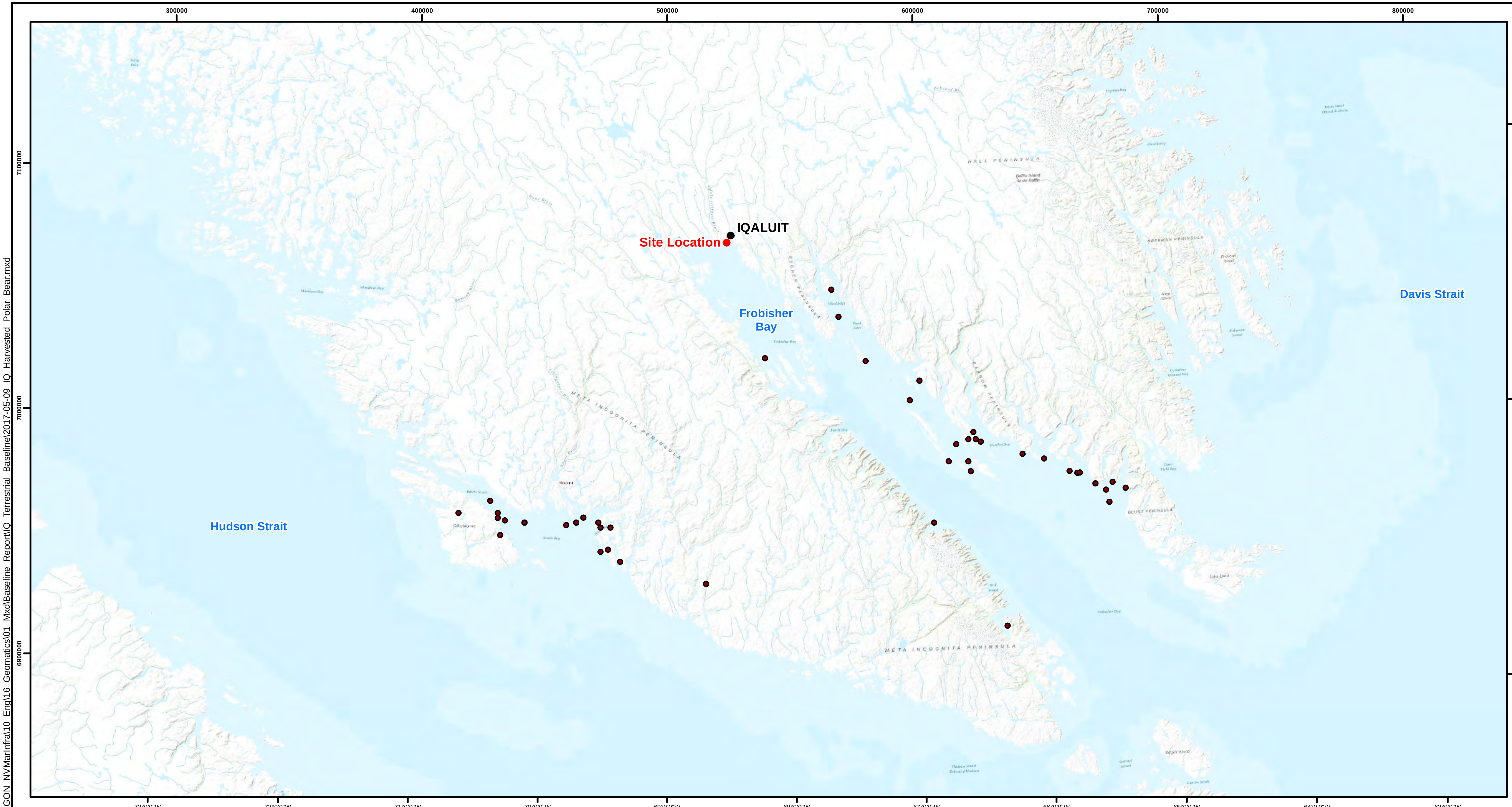

Legend

- Harvested Polar Bear Location

0 12.5 25 50
Kilometres

N

Note:
Coordinate System: NAD 1983 UTM Zone 19N

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IQALUIT MARINE INFRASTRUCTURE
BASELINE REPORT
HARVESTED POLAR BEAR LOCATIONS (1998 - 2001)

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Legend

Polar Bear Denning

0 12.5 25 50
Kilometres

N

Note:
Coordinate System: NAD 1983 UTM Zone 19N

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IQALUIT MARINE INFRASTRUCTURE
BASELINE REPORT
POLAR BEAR DENNING UNITS

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5.4.4 Inuit Qaujimajatuqangit

The information relayed during IQ interviews and design workshops included:

- Caribou have occurred all around the area, including in Iqaluit in 2004. However, since then, caribou are gone and are believed to have moved north.
- Polar bears have been observed in Iqaluit, including in 2016.

In addition to IQ interviews, Inuit Field Technicians informed the ecologist that caribou are not often seen near Iqaluit now and hunters have to travel much further to hunt.

Community consultations as part of the draft Nunavut Land Use Plan revealed a number of important areas for wildlife in the region, but none within the Field Survey Area (NPC, 2016a) (Figure 5-5).

A summary of harvest data described in the Nunavut Wildlife Harvest Study (Priest and Usher, 2004) is provided in Table 5-2. Community feedback regarding the results of the harvest study suggested that the estimate for caribou harvest was too low, particularly given this is the main source of country food; fewer caribou may be a result of changes in migration patterns (Priest and Usher, 2004) and a declining population (Jenkins et al., 2012). The polar bear harvest was not estimated but confirmed by records supplied by the Government of Nunavut. Finally, hunters reported that the wolf population appeared to be increasing (Priest and Usher, 2004).

Table 5-2 List of Species Harvested by Iqaluit Hunters and their Mean Number Harvested Per Year

Common Name	Scientific Name	Mean Number Harvested Per Year
Arctic hare	*Lepus arcticus*	79
Arctic wolf	*Canis lupus arctos*	14
Arctic fox	*Alopex lagopus*	25
Red fox	*Vulpes vulpes*	4
Barren-ground Caribou	*Rangifer tarandus groenlandicus*	1,834
Polar bear	*Ursus maritimus*	16
Moose[1]	*Alces americanus*	1

Source: Priest and Usher (2004)

Note:

[1] Moose were reported as harvested by Iqaluit hunters but given its range, this species is likely harvested elsewhere.

5.4.5 Habitat Value

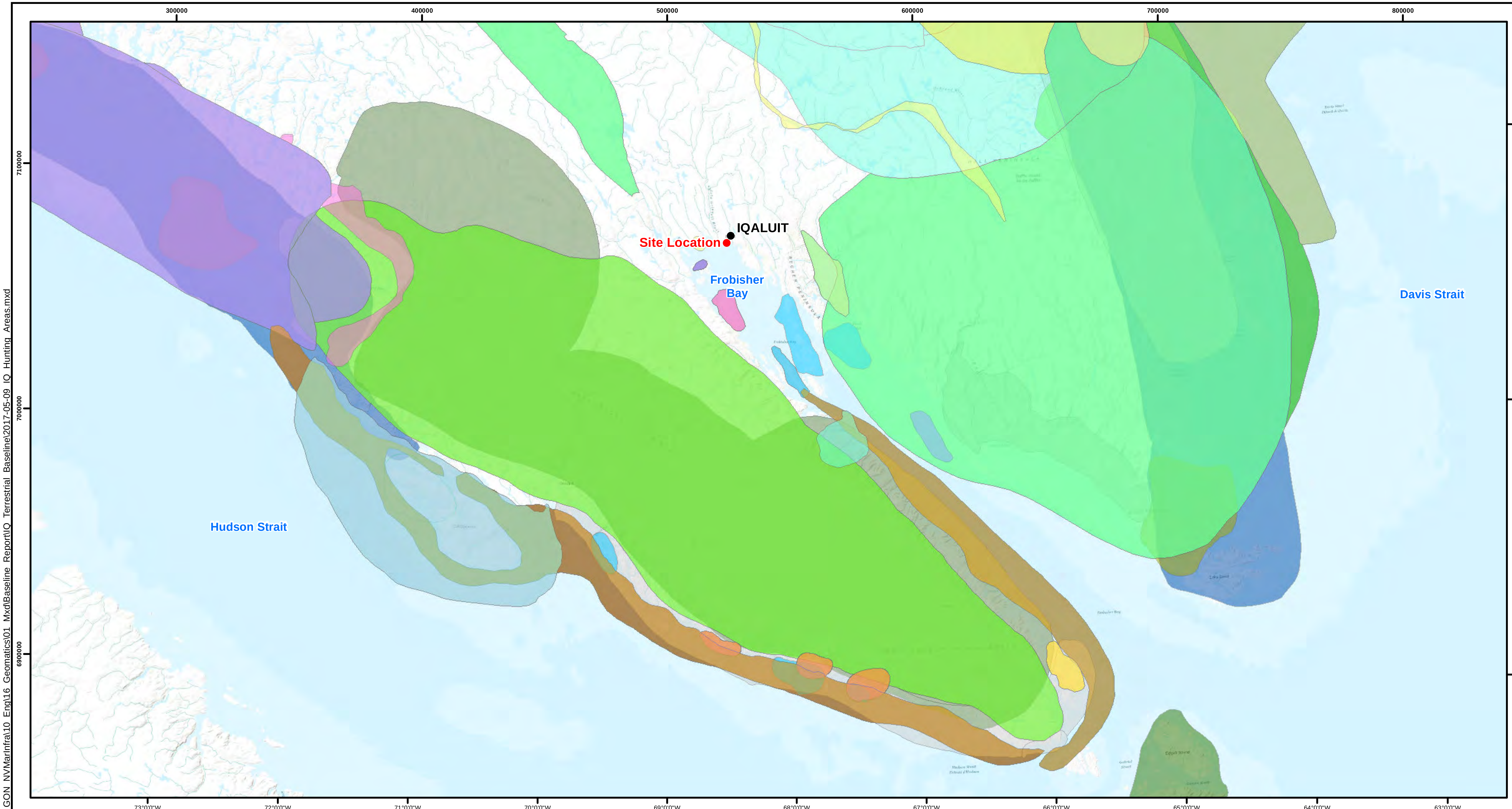
A full description of the vegetation communities is provided in Section 4.

5.4.5.1 Small Craft Harbour

In general, habitat near the proposed small craft harbour is of limited value for terrestrial wildlife. Given its location within Iqaluit, human development occurs to the edge of Koojesse Inlet. The beach is developed and has structures and boats along its length. The buildings and riprap along the breakwater may provide cover to small mammals and weasels. At low tide, the intertidal zone provides foraging opportunities. However, the value of these areas for habitat is low given the disturbance and human activity.

5.4.5.2 Deep Sea Port and Rock Cut Area

Habitat available for wildlife in proximity to the DSP is more natural and holds relatively more value than near the small craft harbour. Despite the fact that the rocky outcrop and cliff areas provide cover and the intertidal provides foraging opportunities, the majority of the terrain is comprised of bedrock; thus vegetation cover is sparse and low, reducing its attractiveness for foraging or cover habitat for species that depend on dense vegetation (e.g. small mammals).



Important Hunting Areas

- Wildlife
- Caribou
- Polar Bear
- Birds
- Nest
- Calving
- Hunting
- Wolves/Wolverine
- Rabbit/Hare
- Eggs
- Mammals
- Migration

0 12.5 25 50
Kilometres

N

Note:
Coordinate System: NAD 1983 UTM Zone 19N

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5.5 Discussion

Despite no confirmed observations of terrestrial wildlife within the Field Survey Area, habitat can support a number of terrestrial wildlife species. Still, the value of this habitat is likely lower than more inland areas.

5.5.1 Small Mammals (Rodents and Lagamorphs)

5.5.1.1 Arctic Hare Presence in the Field Survey Area

Arctic hare typically inhabit willow-dominated communities in winter and summer (Klein and Bay, 1994) where they typically forage on twigs, bark, and other plant material (Sale 2006) and willow, *Dryas integrifolia,* grasses, and forbs (Parker, 1977). Although willow-dominated communities are absent in the Field Survey Area, there are some dwarf shrub communities present which may provide some limited forage opportunities. Though Arctic hare may typically be found in willow-dominated communities, Parker (1977) found Arctic hares to commonly inhabit elevated, dry gravel slopes which support a sparse but diverse vegetation community. Moreover, Arctic hare commonly seek shelter behind rocks during winter (Gray, 1993). It is believed that this type of broken terrain provides appropriate escape cover and sheltering habitat. The majority of the Field Survey Area is comprised of upland bedrock outcrop communities, which would provide suitable escape cover.

5.5.1.2 Lemming Presence in the Field Survey Area

Brown lemmings occur on a variety of tundra types, but with greater abundance on damp tundra dominated by grasses, sedges and mosses (Sale, 2006). Some wetland dwarf shrub communities identified during the ecological land classification may be able to support this species. However, much of the Field Survey Area is comprised of bedrock. Perry land collared lemmings may be more likely to occupy these areas.

Collared lemmings occupy a variety of tundra types, but in contrast to brown lemmings, are more abundant on dry, rocky tundra (Sale, 2006). Both species however, nest in areas of high micro-topographic heterogeneity and abundance of deciduous shrubs and mosses, which provide opportunities for deep snow cover and thermal protection (Duchesne et al., 2011). This type of habitat was not present in the Field Survey Area.

5.5.2 Medium Mammals (Canids and Mustelids)

5.5.2.1 Ermine Presence in the Field Survey Area

Ermine are considered to be habitat generalists (King, 1983; King and Powell, 2007). Like many other mustelids, habitat is likely determined primarily by prey availability rather than vegetation associations (Klemola et al., 1999). In the Arctic, ermine primarily eat lemmings; when lemming populations are low, ermine use other food sources such as ptarmigan and eggs (King and Powell, 2007). Therefore, their likelihood of occurring in the Field Survey Area depends on the availability of prey. Ermine are known to occupy lemming nests during winter in tundra environments (Sittler, 1995); however, they also nest in rock piles and burrows (King, 1983). Based upon the size of the burrow found under the cliffs, it is likely used by ermine. Home ranges of ermine in the tundra and birch forests of Finland span from 35 to 66 ha for females and 121 to 207 ha for males (King and Powell, 2007). Consequently, only one pair (male and female) of weasels likely overlaps the Field Survey Area, if present at all.

5.5.2.2 Fox Presence in the Field Survey Area

Similar to weasels, Arctic fox appear to be less closely tied with vegetation associations as opposed to other factors such as prey availability. Cycles in Arctic fox populations are closely tied with lemming abundance (Gauthier and Berteaux, 2011). Moreover, Arctic fox home range and movement increase during periods (or in territories) of low food abundance (Gauthier and Berteaux, 2011). The widespread red fox which is highly adaptable and often associated with human developments and urban areas has been expanding their range into the Arctic during the 20th Century (Gauthier and Berteaux, 2011).

Arctic fox dens are generally large, complex burrow systems with multiple entrances (Garrott et al., 1983), averaging 18.7 cm in diameter and located in deep (>1 m soil) (Chesemore, 1969). Good drainage and ability to visualize predators are important characteristics (Gallant et al., 2012). Likewise, vegetation communities at these dens are characterized by grasses and forbs, which are often quite different than surrounding areas that are dominated by *Dryas* spp., lichens, and sedges (Garrott et al., 1983; Chesemore, 1969). Red fox are known to use pre-existing Arctic fox dens (Gallant et al., 2012). Given the size of the burrow entrance (~20 cm tall) found near the proposed the deep sea port, and the amount of soil excavated from the presumed main entrance, it is suspected this den belongs to a fox (Arctic or red). Given the occurrence of a large den complex and anchored fox traps, it is likely fox occur in the Field Survey Area and surrounding areas. The deep soil found in this small vegetation community clearly provides shelter and cover habitat, yet this type of denning habitat appears to be limited in the Field Survey Area. Given the numerous seal carcasses that have washed ashore, the area also provides valuable scavenging (foraging) opportunities for canids such as fox, but also others such as mustelids and polar bears. Based upon expected home range sizes, the Field Survey Area likely only supports one pair or family group of fox.

5.5.2.3 Arctic Wolf Presence in the Field Survey Area

Although it is possible that Arctic wolves could move through the Field Survey Area, it is unlikely. Arctic wolves have large home ranges and as with the other carnivores discussed, base their habitat utilisation upon their primary prey caribou, which are migratory (McLoughlin et al., 2004). It is suspected that wolves in southern Baffin Island follow caribou herds (Krizan, 2006). Nonetheless, at a home-range scale, wolves appear to select habitat based upon availability of den sites. Arctic wolves prefer esker habitat likely because granular and sandy composition soils can be easily excavated for dens, but is limiting in a landscape comprised primarily of bedrock, water and permafrost (McLoughlin et al., 2004).

5.5.2.4 Wolverine Presence in the Field Survey Area

Although federally-listed as Special Concern in Canada, wolverine populations appear to be increasing in Nunavut (COSEWIC, 2003). Much of the concern for this species is related to declines in the southern portion of its range (COSEWIC, 2003). Sensitive to disturbance, this species' habitat is becoming fragmented by industrial development and activity (particularly in southern areas).

Wolverines are a wide-ranging and species with home ranges of 230 to 1,580 km^2 for males and 50 to 400 km^2 for females (COSEWIC, 2003; Sale, 2006); as such densities are low (~5 to 10 individuals per 1,000 km^2; COSEWIC 2003). Despite relatively higher density in Nunavut compared to other locales (COSEWIC, 2003), no wolverines were harvested on Baffin Island (Priest and Usher, 2004) although tracks were reported near Clyde River, which is 750 km north of Iqaluit (COSEWIC, 2003). Generally nomadic, this species covers large ground as it searches for food. Although, in the Arctic wolverines occur in a variety of tundra communities, habitat is likely determined more by prey availability (e.g. rodents, hare, and ungulate carcasses) rather than vegetation (COSEWIC, 2003). Maternity dens usually occur under snow-covered rocks such as talus boulders and along eskers, caves, or snow tunnels (COSEWIC, 2003; Sale, 2006). Generally, these reproductive dens are isolated.

As such, although wolverines have potential to occur within the Field Survey Area, they likely only wander through and are unlikely to construct maternal dens given the proximity of the Project to Iqaluit and human activity.

5.5.3 Large Mammals

5.5.3.1 Barrenground Caribou Presence in the Field Survey Area

Barren-ground caribou have traditionally been commonly observed near Iqaluit (Priest and Usher, 2004); however, in recent years, caribou have declined (Jenkins et al., 2012). In the 1990's population estimates ranged between 60,000 and 180,000, but has since declined over 95% in 20 years to a recent estimate of between 1,065 and 2,097 (95% CI; Jenkins et al., 2012). The decline of caribou and low population has been corroborated by IQ, collected in ten communities on Baffin Island (Jenkins and Goorts, 2013; Jenkins et al., 2012). IQ interviews and discussions in this study have also corroborated this information. Additional IQ research has suggested that there may be two types of caribou (migratory and resident; Jenkins and Goorts, 2013). At low densities caribou may lose their migratory tendency (Jenkins and Goorts, 2013).

Despite the paucity of knowledge regarding caribou ecology on Baffin Island, caribou are known to feed on fruticose lichens, shrubs, and forbs (e.g. *Cassiopie tetragona* and *Dryas integrifolia*) (Ferguson and Gauthier, 2001).

Given the vegetation communities in the Field Survey Area are primarily bedrock and the fact that caribou have been absent from the Iqaluit area since the 1990's, and unlikely to be migrating through the area, the likelihood of caribou occupying the Study Area is low.

5.5.3.2 Polar Bear Presence in the Field Survey Area

Although polar bears have been observed in town as recently as summer 2015 and summer 2016 (both in Sylvia Grinnell Territorial Park near the Iqaluit airport, and at the end of Sinaa Street; CBC, 2015a, 2015b, 2015c, 2016), bear sightings appear to be infrequent, if not rare. Although one polar bear was observed near the breakwater and proposed small craft harbour, this sighting appears to be an unusual occurrence. Additionally, given the need to protect members of the community, polar bears are discouraged from entering Iqaluit and if necessary, culled.

Polar bears spend the majority of time on sea-ice hunting ringed seals (*Pusa hispida*), which is often associated with consolidated ice floes and pack-ice adjacent to pressure ridges (COSEWIC, 2008). Because of their reliance on sea-ice to access their main prey, polar bear distribution is tied to seasonal sea-ice extent (COSEWIC, 2008). For the Davis Strait population, loss of sea-ice in summer means polar bears must occupy summer retreats (COSEWIC, 2008). In summer retreats, polar bears may live off fat reserves, or have been observed feeding on berries (e.g. *Vaccinium uliginosum* and *Empetrum nigrum*), waterfowl nests and eggs, and even caribou. Garbage and food waste is known to attract bears at this time as well (COSEWIC, 2008).

During winter, female polar bears excavate maternal dens in snow-drifts in coastal areas. The areas at the mouth of Frobisher Bay are identified as important denning habitat (NPC, 2016a); however areas identified as important denning habitat are over 100 km from the Field Survey Area.

Given their dependence on sea-ice, for the majority of the year when present, polar bears are unlikely to occur near the Field Survey Area. During summer, there is potential for polar bears may wander through, depending on available food resources.

6 Migratory and Marine Birds

6.1 Program Objectives

The purpose of this Program was to identify the presence of migratory and marine birds, important or critical habitats, and key features found in the Study Area.

Presence of migratory and marine birds, important and critical habitats, and key features found within and around the Study Area were determined using historical information gathered as part of a desktop study, literature review, and IQ gathering (see Section 2). To supplement the desktop study and literature review, a field-based habitat assessment and wildlife reconnaissance survey was conducted in conjunction with the Vegetation field studies. From the habitat assessment and wildlife reconnaissance survey, a list of species likely to inhabit the Study Area was generated.

Although many marine birds are pelagic and spend the majority of their life at sea, for purposes of this Program, marine birds are considered together with migratory birds given that they nest (a critical life-history stage) on terrestrial environments.

6.2 Desktop Study and Literature Review

To support the assessment of the existing condition of migratory and marine birds, a species with historical occurrences in the Study Area were determined. Furthermore, protected areas or known high-value habitats (e.g. Migratory Bird Sanctuaries and Important Bird Areas) were identified. In addition to identifying historical occurrences, a list of species that could potentially occupy the Study Area was generated. This list was determined by examining available habitat using aerial imagery (Google earth) and comparing it to habitat requirements for species whose ranges overlaps with the Project. Range maps and habitat information was determined through the following data sources:

- Primary and secondary literature:
  - A Complete Guide to Arctic Wildlife (Sale, 2006)
  - Arctic (peer-reviewed journal)
  - Canadian Field-Naturalist (peer-reviewed journal)
  - The Birds of North America Online (Cornell Lab of Ornithology, 2016a), Waterbirds (peer-reviewed journal)

- Territorial Government reports and databases:
  - Draft Nunavut Land Use Plan (NPC, 2016a)
  - Nunavut Wildlife Harvest Study (Priest and Usher, 2004)
- Citizen Science Initiatives:
  - eBird (Cornell Lab of Ornithology, 2017b)
  - IBA Canada (2016)
- Federal government reports:
  - COSEWIC Assessments and Status Reports
  - Key Habitat Sites for Migratory Birds in the Nunavut Settlement Area (Environment Canada, 2014)
  - Key Marine Habitat Sites for Migratory Birds in the Nunavut and Northwest Territories (Mallory and Fontaine, 2004)
- Other environmental reports for other development projects:
  - Mary River Project Final Environmental Impact Statement (Baffinland Iron Mines Corporation, 2012a)
  - Nunavut Wildlife Resources and Habitat Values (Nunami Stantec, 2012)

6.2.1 Inuit Qaujimajatuqangit

IQ was incorporated into the terrestrial wildlife Program, and gathered from the following sources:

- Community Priorities and Values Interactive Map (NPC, 2016b).
- Conversations with Inuit Field Technicians during habitat assessment (see Section 6.3 below).
- Design workshops held with the local HTA (see Section 2 above).
- Government and scientific literature summarizing community consultations or IQ research:
  - Can Local Ecological Knowledge Contribute to Wildlife Management? Case Studies of Migratory Birds (Gilchrist et al., 2005)
  - Local Ecological Knowledge of Ivory Gull Declines in Arctic Canada (Mallory et al., 2003)
  - Nunavut Wildlife Harvest Study (Priest and Usher, 2004)
  - Nunavut Wildlife Resources and Habitat Values (Nunami Stantec, 2012)
- Summarization of data gathered during other community consultations:
  - Qulliq Energy Corporation Iqaluit Hydro-Electric Generation Sites (Knight Piésold, 2006)

6.3 Fieldwork Methods

Given fieldwork was conducted outside of the breeding season for migratory and marine birds (late-September 2016), the likelihood of gathering robust data on migratory and marine birds was considered very low. As such, fieldwork focused on gathering habitat data that could be used to generate a list of species with potential to inhabit the Study Area.

The methodology used to collect habitat information is described in detail in Section 4.4. In addition to collecting data on vegetation, including composition and structure, the vegetation ecologist conducted a general wildlife reconnaissance survey. During this reconnaissance survey, all birds observed and features that were detected (e.g. whitewash, pellets, nests, perches) were identified (if possible), photographed, and georeferenced using a handheld GPS.

6.4 Results

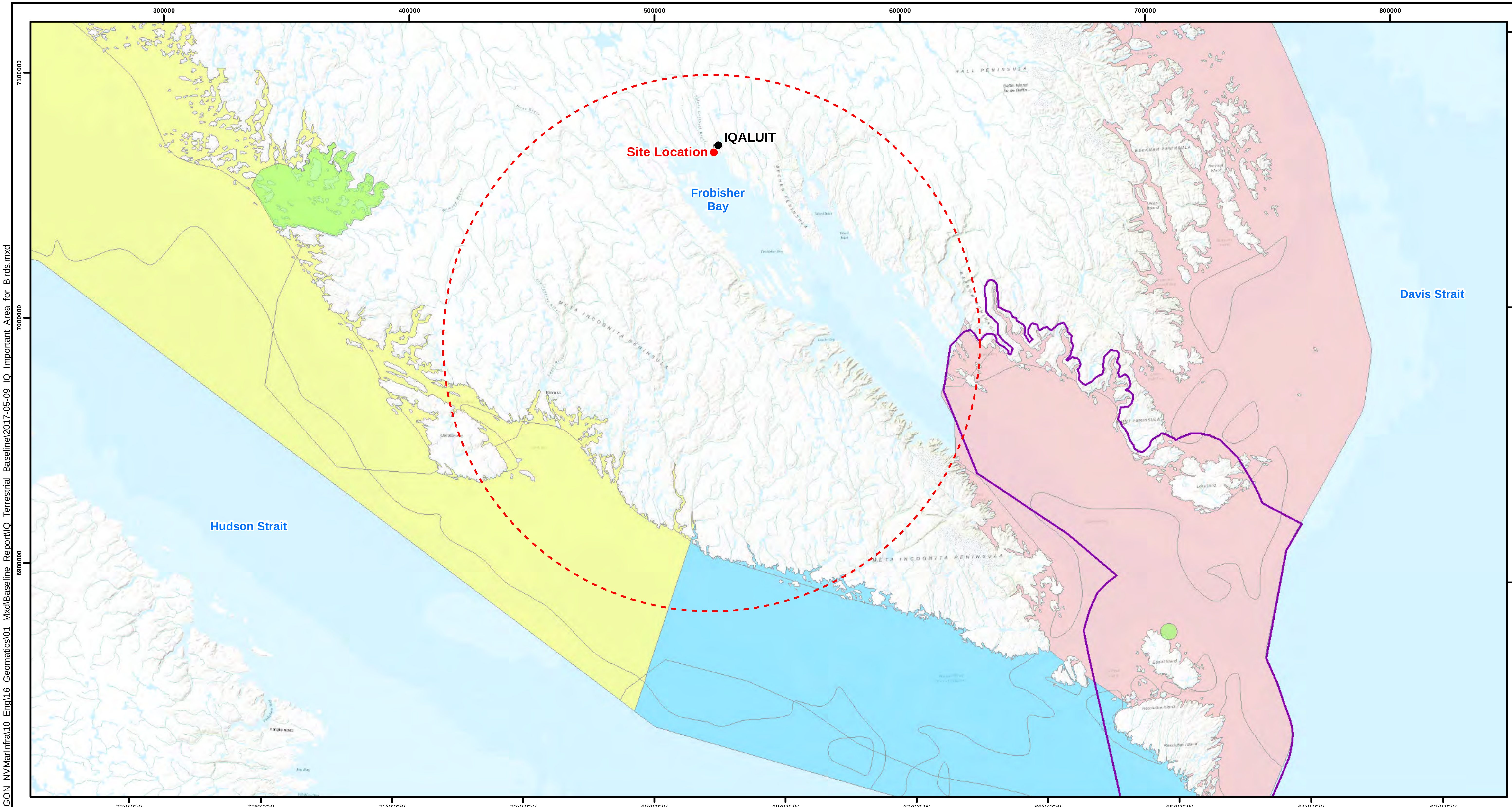
6.4.1 Important Bird Areas

Important Bird Areas (IBAs) are sites that have been identified as internationally significant for the conservation of birds and biodiversity. IBAs support birds such as threatened species, large congregations of birds, and birds restricted in range or habitat (IBA Canada 2016). These IBAs are identified according to internationally agreed upon, standardized, quantitative, and scientifically defensible criteria (IBA Canada, 2016).

No IBAs occur in the immediate vicinity of the Study Area, but two occur farther afield from Iqaluit: Hantzsch Island occurs at the mouth of Frobisher Bay and the Markham Bay Eider Colony which is located approximately 130 km west of Iqaluit on the southwest coast of Baffin Island (IBA Canada, 2016) (Figure 6-1). Although occurring a substantial distance from the Study Area, birds are highly mobile and in most cases migratory. Consequently, there is potential that for the species to occur, stop-over, or pass through the Study Area. As such these IBAs are discussed below.

Hantzsch Island is a small dome-shaped island with high, steep coastal cliffs and grassy slopes and is adjacent to a polynya just north of the Island (IBA Canada, 2016). The habitat at Hantsch Island supports many breeding seabird populations, including significant populations of thick-billed murres (~3% of national population) and black-legged kittiwakes (*Rissa tridactyla*) (~2% of national population) (IBA Canada, 2016). The Canadian Wildlife Service (CWS) has identified the site as a Key Habitat Site for migrating birds and it is classified as significant under the International Biological Programme (IBP).

Markham Bay Eider Colony provides valuable habitat for breeding common eiders (*Somateria mollissima*) which comprise ~2% of the *borealis* subspecies population (IBA Canada, 2016) It consists of gently rolling terrain with numerous freshwater ponds (IBA Canada, 2016). Other species which are known to breed in the area include long-tailed duck (*Clangula hyemalis*), king eider (*S. spectabilis*), glaucous gull (*Larus hyperboreus*), Thayer's gull (*L. thayeri*), black guillemot, and snow bunting (IBA Canada, 2016).



Legend

- WASI Site Gyrfalcon and Peregrine Falcon
- Important Birds Area
- Frobisher Bay Key Bird Habitat
- Western Hudson Strait EBSA
- Hatton Basin-Labrador Sea-Davis Strait EBSA
- Eastern Hudson Strait EBSA

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Note:
Coordinate System: NAD 1983 UTM Zone 19N

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EDITED:	Y.M.
APPROVED:	S.S.

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IQALUIT MARINE INFRASTRUCTURE
BASELINE REPORT
AREAS OF IMPORTANCE TO MIGRATORY AND MARINE BIRDS

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6.4.2 Key Bird and Habitat Sites

Over 100 migratory bird species nest in the Canadian Arctic and over 30% of these depend entirely on the Arctic (100% of nesting habitat occurs here) for producing young (Environment Canada, 2014).

Environment Canada prepared recommendations for Key Bird and Habitat Sites that should see reduced or mitigated human activities as part of the Draft Nunavut Land Use Plan (Environment Canada, 2014; NPC, 2016a). The areas, if adopted, were identified such that they could be a tool with legal force to ensure human activities do not risk the ecological function of these sites for migratory and marine birds and species at risk (Environment Canada, 2014).

No designated Key Bird Habitat Sites identified from the Nunavut Land Use Plan (NPC, 2016a) occur within the Study Area.

A Key Bird Habitat Site does occur at the entrance of Frobisher Bay (Figure 6-1). This unit extends from the entrance of Frobisher Bay near Hamlen Bay out to Queen Elizabeth Foreland and south to encompass Edgell Island and Resolution Island. Given this Key Bird and Habitat Site occurs at the entrance to Frobisher Bay, it can be expected that similar birds might be found in the Study Area; as such this Site is discussed below.

This Key Bird and Habitat Site is identified because expert-opinion and IQ indicates it is important for nesting sea-ducks, waterfowl, and seabirds (particularly thick-billed murres and common eiders; Table 6-1), and the polynyas and ice-floe edges are important for overwinter and migrating activities (Environment Canada, 2014). In addition, Loks Land supports Nunavut's largest colony of razorbills (*Alca torda*), and dovekies (*Alle alle*) congregate in large numbers at the south end of the bay in late summer (Environment Canada, 2014). Finally, this area provides habitat and harlequin ducks (*Histrionicus histrionicus*), a species at risk.

This Key Bird and Habitat Sites is over 100 km from the Project Area; moreover no polynyas or major nesting colonies are known to occur in the Study Area.

6.4.3 Wildlife Areas of Special Interest

The Meta Incognita Peninsula is an identified Wildlife Area of Special Interest (Nunami Stantec, 2012) (Figure 6-1). It is 32,914 km^2 in size and includes much of Frobisher Bay, Sylvia Grinnell Territorial Park, and Iqaluit. This Wildlife Area of Special Interest has been identified as an important nesting area for gyrfalcon (*Falco rusticolus*) and peregrine falcon (*F. peregrinus*).

Table 6-1 Marine Bird Community in the Frobisher Bay Key Bird and Habitat Site

Common Name	Scientific Name	Reason for Significance
Black Guillemots	*Cepphus grille*	Large numbers
Black-legged Kittiwake	*Rissa tridactyla*	Large congregations and breeding; 1% of population
Canada Geese	*Branta canadensis*	Common
Common Eider	*Somateria mollissima borealis*	Important nesting, feeding, and migration stopover; Large numbers
Dovekie	*Alle alle*	Large congregations
Glaucous Gulls	*Larus hyperboreus*	Breeding
Gull species	*Larus spp.*	Common
Harlequin Duck	*Histrionicus histrionicus*	Species at risk
Iceland Gulls	*Larus glaucoides*	Large congregations
Ivory Gull	*Pagophila eburnean*	Species at risk; Large groups
Long-tailed Duck	*Clangula hyemalis*	Common
Northern Fulmars	*Fulmarus glacialis*	Breeding and large congregations
Razorbills	*Alca torda*	Breeding Colony
Thick-billed Murres	*Uria lomvia*	Breeding Colony; 3% of population

Source: Mallory and Fontaine (2004)

6.4.4 Ecologically or Biologically Significant Marine Areas

Ecologically or Biologically Significant Marine Areas (EBSA) are areas designated by governments by criteria set out, and facilitated by, the Conference of the Parties to the Convention on Biological Diversity, CBD (2017). EBSAs support healthy, functioning oceans and are designated as such for their (CBD, 2017):

- Uniqueness or rarity
- Special importance for species' life history
- Important for at-risk species and habitats
- Vulnerability, fragility, sensitivity, or slow recovery
- Biological productivity and diversity
- Naturalness

No EBSAs near the Study Area are listed by the CBD (2017).

Fisheries and Oceans Canada is authorized to provide enhancement management to ecologically and biologically significant areas of oceans and coasts (DFO, 2004). In 2011, DFO identified a number of EBSAs that serve to develop an ecosystem-based management approach to managing the marine environment and establishment of marine-protected areas (MPA) under the *Oceans Act* (DFO, 2011). The EBSAs identified by DFO were based among a number of criteria, including productivity, ice and benthic features, haul-outs, migration routes, and seabird colony foraging radii (DFO, 2011).

The DFO EBSA nearest to Iqaluit is the Hatton Basin-Labrador Sea-Davis Strait EBSA, which extends from the entrance of Frobisher Bay southeast to Labrador off the coast of Torngat Mountains National Park and north past Cape Dyer (DFO, 2011, 2015) (Figure 6-1). Characteristics of this EBSA are listed in Table 6-2, but include important features such as mixing waters and polynyas, high productivity, feeding areas, breeding and migration corridors, seabird colonies, and presence of at-risk species (ivory gull [*Pagophila eburnean*] and harlequin duck) (DFO, 2011). In addition to the Hatton Basin-Labrador Sea-Davis Strait EBSA, the Western Hudson Strait and Eastern Hudson Strait EBSAs occur on the south side of the Meta Incognita Peninsula (DFO, 2011) (Figure 6-1). These EBSAs provide habitat for seabird and sea-duck nesting colonies as well as important foraging habitat. The Eastern Hudson Strait EBSA provides habitat for ivory gull (DFO, 2011).

None of the EBSAs identified by DFO overlap with the Study Area. The nearest EBSA is over 100 km from the Study Area.

6.4.5 Marine Protected Areas and National Marine Conservation Areas

Under the *Ocean's Act*, DFO is committed (both nationally and internationally) to protect marine environments (DFO, 2016b). Marine Protected Areas (MPAs) are located on the coast or seaward of the coastline, situated partly or wholly in a marine environment (including intertidal and subtidal ocean, saltmarsh, estuaries, or the Great Lakes) and consistent with the International Union for the Conservation of Nature (IUCN) definition: "*a clearly defined geographical space, recognized, dedicated, and managed through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural value,*" (DFO, 2016b). These MPAs allow for a variety of protective and management measures (DFO, 2016b); the focus of which is to conserve and protect marine species, habitats and ecosystems (DFO, 2016a).

No MPAs occur in proximity to the Study Area (ECCC, 2016d).

Similar to MPAs, Parks Canada has a mandate to establish National Marine Conservation Areas, which are MPAs that protect and conserve representative natural and cultural marine heritage, yet provide opportunities for public education and enjoyment (ECCC, 2016b).

No National Marine Conservation Areas occur in proximity to the Study Area (ECCC, 2016d).

6.4.6 Inuit Qaujimajatuqangit

The information relating to migratory and marine birds that was relayed during IQ interviews and design workshops included:

- Snow buntings are observed and known to inhabit the Study Area in March and April.
- Eggs of marine birds such as eiders, geese and gulls are collected from Long Island across from the DSP Study Area.
- A colony of common ravens is present on the cliffs in and around the DSP and Causeway Study Area.

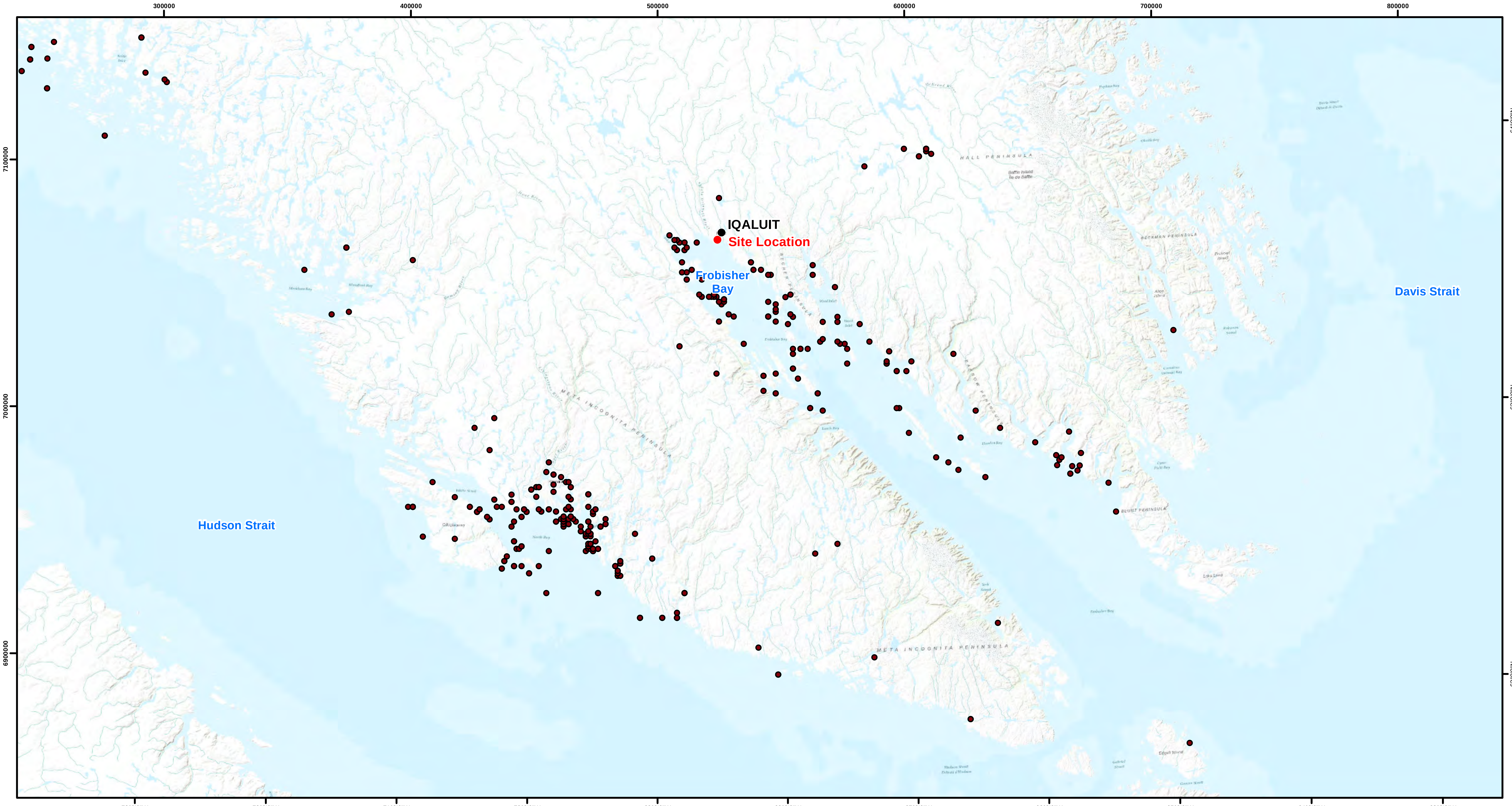
Community consultations as part of the draft Nunavut Land Use Plan revealed a number of important areas in the region for birds, but none within the Field Survey Area (NPC, 2016a) (Figure 5-5).

A review of the Nunavut Hunter Study (Priest and Usher, 2004), revealed that several bird species and their eggs are harvested by hunters in Iqaluit (Table 6-2). The species most harvested are ptarmigan, duck eggs, eiders, Canada geese and their eggs. Community discussion and feedback on the result of the hunter survey revealed that the number of Canada geese and duck eggs appeared to be correct; in contrast, the number of harvested goose eggs appeared low (Priest and Usher, 2004). Location data for harvested birds were not collected for most species; however, information on the location of harvested common eider and king eiders was collected. Although no birds or eggs were taken near the Study Area, much of Frobisher Bay is used for hunting (Figure 6-2).

Table 6-2 List of Species Harvested by Iqaluit Hunters and their Mean Number Harvested Per Year

Common Name	Scientific Name	Mean Number Harvested Per Year
Snow goose	*Chen caerulescens*	16
Canada goose	*Branta Canadensis*	127
Goose eggs	-	1
Duck eggs	-	1,294
Eiders	*Somateria spp.*	271
Eider down	*Somateria spp.*	60
Red-breasted merganser	*Mergus serrator*	1
Black Guillemot	*Cepphus grille*	9
Thick-billed murre	*Uria lomvia*	2
Ptarmigan	*Lagopus spp.*	2,960

Source: Priest and Usher (2004)



Legend

- Harvested Eider or Eider Egg Location

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IQALUIT MARINE INFRASTRUCTURE
BASELINE REPORT
HARVESTED EIDER LOCATIONS (1998 - 2001)

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6.4.7 Habitat Value within Study Area

A full description of the vegetation communities is provided in Section 4.

6.4.7.1 Small-Craft Harbour

In general, habitat within the SCH study area is of limited value to migratory and marine birds; given its location within Iqaluit. The beach is developed and has structures and boats along its length. For species that nest on bare ground and gravelly areas (e.g. snow buntings) or are relatively tolerant of human disturbance (e.g. common raven), there may be limited nesting habitat. However, human use and presence of dogs likely discourage birds from nesting. At low tide, the intertidal zone provides foraging opportunities; likewise only for those species tolerant of human activity. Consequently, the value of these habitats is low given the disturbance and human activity.

6.4.7.2 Deep-Sea Port

Habitat available for migratory and marine birds in the DSP Study Area is more natural and holds relatively more value than at the SCH. This upper shoreline cliff community likely holds the highest value in terms of nesting habitat, evidenced by the numerous pellets, whitewash, and animal remains indicating the presence of a falcon eyrie or common raven roost. The remaining terrain is predominately comprised of bedrock; thus vegetation cover is sparse and low, reducing its attractiveness for nesting and cover habitat for species that depend on dense vegetation.

Given the large congregations of marine birds that were observed during the reconnaissance survey in September, it is clear this nearshore environment offers valuable foraging habitat. Open water at ice edges is a critical foraging habitat for marine birds. Not only are ice edges rich and abundant with food resources, but the open water allows access to food, particularly in winter (Gilchrist and Robertson, 2000). At floe edges and polynyas, common and king eiders, and long-tailed ducks occur in large numbers, as do other marine birds such as mergansers, black guillemot, and glaucous gull (Gilchrist and Robertson, 2000) Moreover, birds not typically associated with the marine environment such as common raven and snowy owls can often be observed along land-fast ice edges (Gilchrist and Robertson, 2000).

6.4.8 Migratory and Marine Birds

Thirty-eight bird species have historical occurrences housed within the Iqaluit Town and Sylvia Grinnell Territorial Park Hotspot (Cornell Lab of Ornithology, 2017b) (Table 6-3). Moreover, new breeding records for savannah sparrow (*Passerculus sandwichensis*) and dark-eyed junco (*Junco hyemalis*) have recently been reported (Hussell et al., 2012). Although not included in historical occurrences (hot spot checklists), fifteen additional bird species have ranges that overlap the Study Area (Table 6-3): snow goose (*Chen caerulescens*), Ross' goose (*C. rossii*), tundra swan (*Cygnus columbianus*), red-breasted merganser, American golden plover (*Pluvialis dominica*), ruddy turnstone (*Arenaria interpres*), purple sandpiper (*Calidris maritima*), least sandpiper (*C. minutilla*), red phalarope (*Phalaropus fulicarius*), pomarine jaeger (*Stercorarius pomarinus*), parasitic jaeger (*S. parasiticus*), long-tailed jaeger (*S. longicaudus*), Arctic tern (*Sterna paradisaea*), and peregrine falcon. Both the harlequin duck and the peregrine falcon are federally-listed as Special Concern (COSEWIC, 2016).

Of the 55 species that have historical occurrences or range overlaps with the Study Areas, 14 have some likelihood of nesting (four likely) because of the habitat available (Table 6-3). In addition to the species that have potential to nest, a number of marine birds that may normally nest elsewhere, may use the DSP Study Area for foraging in nearshore or tidal environments during breeding, migration, or overwintering (Table 6-4). Species considered to be pelagic (those that forage offshore) were not included.

Bird presence was sparse during the vegetation mapping and habitat assessment; however, given the assessment occurred in late-September, it was at a time when most birds have initiated migration (Cornell Lab of Ornithology, 2016a). Common ravens and unidentified gulls were observed during vegetation surveys. The upper shoreline cliff community contained numerous instances of whitewash, abundant pellets and animal remains (Figure 5-1), suggesting the possibility of a falcon eyrie (Booms et al., 2008; White et al., 2002) or common raven roost (Boarman and Heinrich, 1999).

Although few birds were observed within the terrestrial portion of the DSP Study Area, several large congregations (each >500 individuals) of marine birds were observed approximately 1 km from shore in Frobisher Bay. These birds were congregated around some rocky islands at low tide and Inuit field technicians informed the ecologist they were foraging on sculpin (Family: Cottoidea).

Table 6-3 List of Bird Occurrences Housed in the eBird, Iqaluit Town and Sylvia Grinnell Territorial Park Hotspots, their breeding habitat and likelihood of nesting in the Project Area

Common name	Scientific Name	Breeding Habitat[1]	Nesting Likelihood[2]
Snow Goose[3]	*Chen caerulescens*	Colonial near freshwater (ponds, lakes, streams, and braided deltas) often in wet meadows but also undulating terrain, exposed slopes, or cliff edges.	Not Likely
Ross' Goose[3]	*Chen rossii*	Colonial with snow geese and in open areas on lake islands and adjacent mainland.	Not Likely
Tundra Swan[3]	Cygnus *columbianus*	Tundra lakes, ponds, and coastal deltas.	Not Likely
Canada Goose	*Branta canadensis*	Nests on dry, elevated sites with short vegetation, in a variety of open habitats near fresh water.	Not Likely
Northern Pintail	*Anas acuta*	Open country with shallow, seasonal wetlands and low vegetation.	Not Likely
King Eider	*Somateria spectabilis*	Variety of tundra habitats but often on dry and well-drained in vegetation adjacent to freshwater.	Not Likely
Common Eider	*Somateria mollissima*	Local colonies along marine coasts, islands, and islets.	Not Likely
Harlequin Duck[6]	*Histrionicus histrionicus*	Fast flowing streams.	Not Likely
Long-tailed Duck	*Clangula hyemalis*	Wetlands or offshore islands with freshwater.	Not Likely
Red-breasted Merganser[3]	*Mergus serrator*	Coastal near fresh, brackish or saltwater wetlands in sheltered bays.	Not Likely
Rock Ptarmigan	***Lagopus muta***	**Well-drained, hummocky tundra with rocky ridges; outcrops and mixed vegetation.**	**Low**
Red-throated Loon	*Gavia stellata*	Wetlands.	Not Likely
Pacific Loon	*Gavia pacifica*	Freshwater lakes.	Not Likely

Common name	Scientific Name	Breeding Habitat[1]	Nesting Likelihood[2]
Common Loon[4]	*Gavia immer*	Large lakes.	Not Likely
Northern Fulmar	*Fulmarus glacialis*	Precipitous cliffs on islands.	Not Likely
Rough-legged Hawk[4]	***Buteo lagopus***	**Open tundra including rocky outcrops, escarpments, and cliffs.**	**Low[7]**
American Golden Plover[3]	***Pluvialis dominica***	**Elevated on sparse, low vegetation, well-drained rocky slopes.**	**Low**
Common Ringed Plover	*Charadrius hiaticula*	Accidental to area, breeds in Arctic Eurasia.	Not Likely
Semipalmated Plover	***Charadrius semipalmatus***	**Well-drained, sandy or gravelly areas including shale.**	**Low**
Ruddy Turnstone[3]	*Arenaria interpres*	Marshy slopes and flats near freshwater (marshes, streams, ponds) or tidal flats and beaches.	Not Likely
Purple Sandpiper[3]	*Calidris maritima*	Often far inland but sometimes on low tundra near shore and on coarse gravel-sand beaches along rivers.	Not Likely
Baird's Sandpiper	*Calidris bairdii*	Dry, well-drained coastal and upland exposed tundra. Beach ridges, terrace banks, bare soil with sparse vegetation.	Not Likely
Least Sandpiper[3]	*Calidris minutilla*	Wet bogs, near ponds and mudflats; coastal islands with sand dunes and bogs around lagoons.	Not Likely
White-rumped Sandpiper	*Calidris fuscicollis*	Well-vegetated, wet, meadows and low-lying areas near water.	Not Likely
Pectoral Sandpiper	*Calidris melanotos*	Flat, marshy tundra dominated by sedges and grasses.	Not Likely
Red-necked Phalarope[5]	*Phalaropus lobatus*	Tundra on mossy tussocks near freshwater.	Not Likely
Red Phalarope[3]	*Phalaropus fulicarius*	Coastal, poorly-drained, hummocky, level terrain on tundra dominated by sedges.	Not Likely
Pomarine Jaeger[3]	*Stercorarius pomarinus*	Pelagic bird that nests irregularly in low-lying marshy tundra near small lakes.	Not Likely
Parasitic Jaeger[3]	*Stercorarius parasiticus*	Pelagic bird that nests on low-lying marshy tundra and dry, tussock-heath.	Not Likely

Common name	Scientific Name	Breeding Habitat[1]	Nesting Likelihood[2]
Long-tailed Jaeger[3]	*Stercorarius longicaudus*	Tundra far from sea.	Not Likely
Dovekie	*Alle alle*	Large colonies among colluvium of talus slopes at foot of cliffs.	Not Likely
Thick-billed Murre	*Uria lomvia*	Large colonies on cliff ledges near deep, offshore waters and land fast ice.	Not Likely
Black Guillemot	*Cepphus grille*	Colonies on rocky marine coasts of off-shore islands near shallow water.	Not Likely
Black-legged Kittiwake	*Rissa tridactyla*	Colonies on cliff ledges of off-shore islands or inaccessible mainland.	Not Likely
Herring Hull	*Larus argentatus*	Well-drained substrate on islands, islets, marshy hummocks and barrier beaches.	Not Likely
Thayer's Gull	*Larus thayeri*	Colonies on steep cliffs.	Not Likely
Iceland Gull	*Larus glacucoides*	Colonies on steep cliffs.	Not Likely
Glaucous Gull	*Larus hyperboreus*	Often in mixed colonies on marine and freshwater coasts, tundra, islands, cliffs, shorelines, and ice edges.	Not Likely
Great Black-backed Gull	*Larus marinus*	Temperate and Boreal Latitudes.	Not Likely
Arctic Tern[3]	***Sterna paradisaea***	**Open country, close to water, no vegetation or low and sparse cover; rocky, gravelly islands, barrier beaches and spits, gravel moraines.**	**Low**
Snowy Owl[4]	*Bubo scandiacus*	Variety of tundra environments on distinct promontories.	Not Likely
Gyrfalcon[4]	***Falco rusticolus***	**Rocky outcrops, cliffs, and seacoasts.**	**Low[7]**
Peregrine Falcon[3,6]	***Falco peregrinus***	**Cliffs and buildings**	**Low[7]**
Common Raven	***Corvus corax***	**Habitat generalist; often on cliffs, trees, and human structures.**	**Likely**
Horned Lark	***Eremophila alpestris***	**Open habitat on bare ground or short grasses.**	**Likely**
Northern Wheatear	***Oenanthe oenanthe***	**Dry, elevated rubble, rocky fields, stony hilltops, and precipices of rocky coasts.**	**Likely**

Common name	Scientific Name	Breeding Habitat[1]	Nesting Likelihood[2]
American Pipit	*Anthus rubescens*	Mesic vegetation along streams, grassy meadows, and dry, dwarf shrub matts.	Not Likely
Lapland Longspur	*Calcarius lapponicus*	Wet, hummocky meadows; avoids rocky and bare terrain.	Not Likely
Snow Bunting	***Plectrophenax nivalis***	**Rocky areas and boulder screes near vegetated tundra.**	**Likely**
Dark-eyed Junco[3]	*Junco hyemalis*	Variety of habitats such as exposed rocky slopes but generally in forests with dense understory and ground cover.	Not Likely
White-crowned Sparrow	***Zonotrichia leucophrys***	**Matrix of grassy and bare areas with dense shrubs.**	**Low**
Savannah Sparrow[3]	*Passerculus sandwichensis*	Open country such as grassy meadows, roadsides, tundra.	Not Likely
Common Redpoll	***Acanthis flammea***	**Dry, rocky or damp substrates on dry heaths or rocky slopes.**	**Moderate**
Hoary Redpoll	***Acanthis hornemanni***	**Similar to common redpoll but near dwarf or creeping shrubs.**	**Moderate**

Notes:

Species in **bold** are more likely to nest in the Study Area

[1] Breeding habitat and nesting information from Birds of North America. (P.G. Rodewald, Ed.). Ithaca: (Cornell Lab of Ornithology, 2016a).

[2] Likelihood of nesting within Project footprint was based upon a qualitative assessment of results of the ecological land classification and habitat assessment and potential for the habitat to provide suitable nesting requirements. Similarly, other factors such as breeding range, location of known colonies, etc. were incorporated. **Likely**: the Project is located within the breeding range and the majority of available habitat provides preferred or suitable nesting habitat; **Moderate**: the Project is located within the breeding range and some of the available habitat may provide suitable nesting habitat; **Low:** the Project is located within the breeding range and some of the available habitat may provide marginal nesting habitat; **Not Likely**: the Project is located outside of the breeding range or outside of known colonies (or the species is colonial and such a colony would likely be known to locals given its proximity to Iqaluit), and available habitat is generally not suitable for nesting.

[3] Species not identified in Cornell Lab of Ornithology (2017a) checklists but with potential to occur in Project Area (migration, foraging, etc.)

[4] Species are listed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) as Not at Risk (COSEWIC, 2016) and are not listed under the *Species at Risk Act* (Species at Risk Public Registry, 2016b).

[5] Species is listed by COSEWIC (2016) as Special Concern but are not listed under the *Species at Risk Act* (Species at Risk Public Registry, 2016b).

[6] Species is listed by COSEWIC (2016) as Special Concern and listed under Schedule 1 of the *Species at Risk Act* (Species at Risk Public Registry, 2016b).

[7] Although this type of habitat is available in the Study Area in the upper shoreline cliff community, IQ from interviews revealed this to be inhabited by a colony of common ravens (*Corvus corax*); thus the likelihood of a rough-legged hawk, gyrfalcon, or peregrine falcon inhabiting these cliffs is lower.

Table 6-4 List of Marine Birds with their preferred foraging strategy and habitat with Potential to Occupy (based on season use) Marine Habitats near the Proposed Deep-Sea Port and Small-Craft Harbour

Common name	Scientific Name	Foraging Method	Foraging Habitat	Period of Use
Snow Goose[1]	*Chen caerulescens*	Herbivore	Coastal Flats	Migration
Ross' Goose	*Chen rossii*	Herbivore	Coastal Flats	Breeding and Migration
Brant	*Branta bernicla*	Herbivore	Coastal Flats	Migration
Canada Goose	*Branta canadensis*	Herbivore	Grassy flats	Breeding and Migration
Tundra Swan	*Cygnus columbianus*	Herbivore	Coastal flats	Breeding and Migration
King Eider	*Somateria spectabilis*	Molluscivore	Nearshore	Breeding, Migration, Overwinter
Common Eider	*Somateria mollissima*	Molluscivore	Nearshore	Breeding, Migration, Overwinter
Harlequin Duck	*Histrionicus histrionicus*	Insectivore	Nearshore	Migration
Long-tailed Duck	*Clangula hyemalis*	Crustaceavore	Nearshore	Breeding, Migration, Overwinter
Red-breasted Merganser	*Mergus serrator*	Piscivore	Pursuit Diver	Breeding and Migration
Red-throated Loon	*Gavia stellata*	Piscivore	Marine Coast	Breeding and Migration
Pacific Loon	*Gavia pacifica*	Piscivore	Marine Coast	Breeding and Migration
Common Loon	*Gavia immer*	Piscivore	Marine Coast	Breeding and Migration
Red-necked Phalarope	*Phalaropus lobatus*	Crustaceavore	Nearshore	Breeding and Migration
Red Phalarope[1]	*Phalaropus fulicarius*	Crustaceavore	Nearshore	Breeding and Migration
Black Guillemot	*Cepphus grille*	Piscivore	Nearshore	Breeding, Migration, and Overwinter
Black-legged Kittiwake	*Rissa tridactyla*	General Predator	Nearshore	Breeding and Migration

Common name	Scientific Name	Foraging Method	Foraging Habitat	Period of Use
Herring Hull	*Larus argentatus*	General Predator	Nearshore	Breeding and Migration
Iceland Gull	*Larus glacucoides*	General Predator	Nearshore	Migration
Glaucous Gull	*Larus hyperboreus*	General Predator	Nearshore	Breeding and Migration
Arctic Tern	*Sterna paradisaea*	Piscivore	Nearshore	Breeding and Migration

Source: Mallory and Fontaine (2004); Cornell Lab of Ornithology (2017b).

Note: Pelagic birds such as jaegers, murres, and dovekie that are strongly tied to offshore habitat are not included as they are unlikely to occur near Study Area.

[1] Species not identified in Cornell Lab of Ornithology (2017b) checklists but with potential to occur in Project Area (migration, foraging, etc.).

6.5 Discussion

6.5.1 Migratory Birds

Relatively few (four) of the 52 species that have historical occurrences or whose range overlaps the Project are likely to nest in the Field Survey Area. Given the sparse vegetation community and the preponderance of bedrock, species likely to nest are those that nest on the ground with very little vegetation cover. Consequently, the species likely to nest here include: common raven, horned lark, northern wheatear (*Oenanthe oenanthes*) and snow bunting.

Another 10 species of birds could potentially nest in the Field Survey Area, but the likelihood is considered lower. For example, rough-legged hawk (*Buteo lagopus*), gyrfalcon, and peregrine falcon all nest on cliffs such as the one at the upper shoreline cliff community near the DSP. Likewise, the area around Iqaluit has been previously identified as a Wildlife Area of Special interest for gyrfalcons and peregrine falcons (see Section 6.4.3). However, the presence of a raven colony in this area, based on IQ knowledge, reduces the nesting potential for other bird species. Common ravens are known to gather in 'crowds' when feeding and roost together for protection. The evidence of numerous pellets (unidentified to species) provides evidence of the importance of this area. Ravens are known to show interspecific aggression to other predatory birds (Boarman and Heinrich, 1999). Consequently, it is believed this cliff is a raven roost and nesting by falcons is unlikely here given the potential for interspecific aggression.

According to ECCC, the nesting season for Iqaluit (N10: Arctic Plains and Mountains, Bird Conservation Region 3) is between late-May and mid-August (ECCC, 2016a). It should be noted these are estimated breeding dates and that the exact timing can vary according to the species occurrence, climate, elevation, and habitat type; similarly nesting could vary according to micro-sites or factors such as early or late spring (ECCC, 2016a). Because of natural variability in nesting, the timing could vary by up to ten days; moreover, the period above does not include a nest building phase which generally occurs two weeks prior (ECCC, 2016a).

6.5.2 Marine Birds

The majority of marine birds that have historical occurrences or whose range overlaps are unlikely to nest in the Field Survey Area. Most of these birds nest in large colonies on remote, precipitous cliffs and remote islands that are inaccessible to predators (Cornell Lab of Ornithology, 2016b, 2016a). Although not breeding, 21 species of marine birds could potentially use inter-tidal and nearshore habitats of the Study Area for foraging. The use of this habitat may occur during migration on-route from breeding areas or during the breeding season when adults are brooding young. For example, common eider adult females will lead recently hatched, precocious chicks to water and travel from nesting island to feed along intertidal flats and pools along mainland coasts (Goudie et al., 2000). Consequently, such species are likely to breed elsewhere. However, given they use marine environments to forage and are migratory, it is expected most will only use this area to forage following breeding and on-route during migration. Thus, the period that these species may be foraging in the Field Survey Area is relatively short (e.g. several weeks).

King eider, common eider, long-tailed duck, and black guillemot have potential to forage in nearshore environments over-winter. However, these species are dependent on ice-free areas to access food; thus occur at the floe-edge (Gilchrist and Robertson, 2000). Given that freeze-up near Iqaluit is generally complete by November and lasts until break-up at the start of June (Marine Baseline Report: Advisian, 2017), the over-wintering species that forage in nearshore environments are unlikely to occur at this time in Koojesse Inlet. As such, it is expected these species will forage in polynyas and ice-free areas at the entrance to Frobisher Bay.

6.5.3 Migratory and Marine Birds Species at Risk

Despite the fact that breeding range for harlequin ducks overlaps with Iqaluit, this species breeds in shallow, fast-flowing streams and rivers that have large concentrations of aquatic prey and adjacent shelter for nesting (Robertson and Goudie, 1999). Nests are typically located on the ground near water on stream islands, 100 m from river edges, and up to 30 to 40 m above water at the mouths of gorges and ravines (Robertson and Goudie, 1999). This type of habitat does not exist in proximity to the Field Survey Area and the mouth of the nearest river (Sylvia Grinnell River) is approximately 3 km away. Consequently, the likelihood of this species occurring near the Field Survey Area during the summer breeding season is low; however, it is possible this species could occur in nearshore habit in proximity to the deep-sea port and small craft harbour Study Areas following breeding and some females are known to abandon broods before moving to the coast (Robertson and Goudie, 1999). Focused surveys in July and August along the coastline of southern Baffin Island and along the northern shore of Frobisher Bay by the CWS resulted in only three harlequin duck observations near Iqaluit between 1998 and 2002 (Mallory et al., 2008). In addition, a female with brood was observed in Ward Inlet (~14 km from Project Area) in 2004 (Mallory et al., 2008). It has been estimated there are <100 pairs of breeding harlequin ducks in southern Baffin Island (COSEWIC, 2012) with the majority located near Kimmirut (Mallory et al., 2008). Harlequin ducks are a short- to medium-distance migrant. The nearest overwintering areas are in Greenland and Labrador and this species will stage and travel along the coast. They are not known to overwinter in Nunavut and moulting locations for this species are unknown (Mallory et al., 2008). As such, the most likely period when this species may be encountered near the Study Area is before (spring) or after (autumn) they breed in streams and rivers; which was confirmed by previously conducted IQ interviews (Mallory et al., 2008). In the spring, these individuals are likely to use the floe edge and in the fall, fresh-saltwater interfaces (Robertson and Goudie, 1999).

Although considered a species at risk, peregrine falcons have shown continuing recovery of their population since the 1970's and are near historical numbers (COSEWIC, 2007). This success has been attributed to the ban on organochlorine pesticides, such as dichlorodiphenyltrichlorethane (DDT) (COSEWIC, 2007). Habitat capable of supporting this species (cliffs with open gulfs of air) occurs within the Field Survey Area. Although the upper shoreline cliff community near the proposed rock cut area supports an apparent common raven roost, it is possible this habitat could support a nesting peregrine falcon. Whether currently occupying the Field Survey Area or not, given that this species will nest on artificial buildings and nest boxes (COSEWIC, 2007), it is possible peregrine falcons could move (either into or within the Field Survey Area) to occupy the DSP infrastructure if provided sufficient nesting platforms. Peregrine falcons have adapted to urban environments and rarely experience enough disturbances to cause breeding failure (COSEWIC, 2007); though nest disturbance has been reported during construction and maintenance activities, excessive visitation and flare firing (COSEWIC, 2007).

The timing of breeding is related to latitude but most pairs at the most northern localities have been observed to remain at eyries in January if sufficient prey occurs (White et al., 2002). In Alaska, eggs are laid around the end of May and in Greenland have been noted in the last week of June (White et al., 2002). In Nunavut, eggs hatch early-July; parents brood the young for 10 days and then gradually decrease feeding until 20 days after hatching (White et al., 2002). Young are generally fledged at the end of August or early September (White et al., 2002).

7 Archaeology

7.1 Program Objectives

The objective of the archaeological study was to inventory archaeological sites within the terrestrial portion of the Study Area and to assess the potential impact of the various Project components on the archaeological resources. Palaeontological sites are also included in this section as they are governed and managed under the same legislation.

7.2 Desktop Study and Literature Review

To support the assessment of the existing condition of archaeology, a desktop review of existing archaeological resource knowledge and available IQ to assess landforms for their heritage resource potential was undertaken. A Nunavut Archaeological Site Data Licence Request was submitted on September 26, 2016 to the Department of Culture and Heritage, Government of Nunavut for information on previously recorded sites within 10 km of the Project sites. Available relevant archaeological reports and studies and published academic articles were also reviewed.

IQ is being collected as part of the public consultation for the Project and is ongoing. Preliminary results have included the importance of archaeological sites to the community, function of site types, and features that have been recorded and the importance of having Elders and/or knowledgeable land users involved in archaeological field studies.

The data collected during the desktop study and literature review was used to inform the field studies completed for the Project.

7.3 Inuit Qaujimajatuqangit

The incorporation of IQ into the Archaeology Program for the Project is ongoing. Results from the Project public consultation program have been incorporated into the field programs and reporting. Fieldwork for the Project also included Iqaluit community members who acted as field assistants and participated in the identification and recording of archaeological sites. The results of the Project archaeology program are being presented to the community for comment as part of the consultation program.

7.4 Fieldwork Methods

All archaeological fieldwork requires a valid Class I or Class II Nunavut Archaeologist Permit issued by Department of Culture and Heritage, Government of Nunavut. The Archaeological field program consists of the assessment of all areas of elevated archaeological potential within the Project footprint and a 30 m buffer.

The purpose of a field investigation is to identify archaeological materials, document location and content, and provide data to be used in the development of recommendations for mitigation or avoidance. Inventory and assessment techniques followed established practices and consisted of the following:

- Visual examination of the Project area to determine the presence of surficial features such as stone cache pits, house or tent rings, standing or collapsed buildings, and exposed Pre-contact cultural materials such as stone tool making debris and tools.
- Visual examination of bedrock exposures or gravels for Pre-contact quarrying activity.

- Excavation of shovel tests (ca. 40 x 40 cm) to varying depths to determine the potential for subsurface Pre-contact cultural remains if deposition is present.
- Documentation of the location (GPS coordinates), nature, size, and complexity of each identified site.
- Documentation of individual site features to record content, context, potential identity, and to provide information required to develop a mitigation program.

All sites and related features that are recorded or revisited are evaluated based on perceived heritage resource value and community cultural value. Community input plays an important role in the evaluation of site value, and the inclusion of members of the local community on a field crew aided in the in-field discussions regarding site significance.

These results, along with updates and mitigation recommendations will be included in written submissions to the Department of Culture and Heritage as required by the Permit to conduct the fieldwork, and discussed with the Territorial Archaeologist of Nunavut.

All fieldwork was completed by two Lifeways of Canada Limited archaeologists on behalf of Advisian with assistance from three Iqaluit community members.

7.4.1 Study Area

The Archaeology Program was focussed on the Project footprint as any direct or indirect Project effects on archaeology will result from ground disturbance. The Archaeology Program also considered the type, amount, and significance of heritage resource sites specific to the region, and therefore an area extending 10 km from the Project footprint was also considered.

7.5 Results

The Archaeological Impact Assessment (AIA) for the Project was initiated following a chance find of potential heritage sites during the geotechnical reconnaissance and vegetation survey for the DSP conducted between September 19 and 21, 2016. The AIA was conducted between September 28 and October 1, 2016 under Nunavut Archaeology Class II Permit 2016-038A as per the Nunavut Archaeological and Palaeontological Sites Regulations establish pursuant to Section 51 of the *Nunavut Act*. The field survey included all the lands that may be affected onshore and resulted in 12 sites being recorded. These include three stone features sites, (KkDn-44, -45 and -52) with multiple features (including stone circles, caches, and cairns), four stone cache sites (KkDn-46, -47, -48 and -49), two stone circle sites (KkDn-51 and -53), one lithic scatter (KkDn-50), and two modern land use sites.

7.5.1 Palaeontology

A review of the database of significant palaeontological sites that the Canadian Museum of Nature maintains on behalf of the Territory of Nunavut did not result in any previously identified palaeontological sites in conflict with the proposed Project. Based on a review of the geology of the Project area unrecorded significant paleontological sites is not anticipated.

7.6 Discussion

The conclusion of the desktop study was that the Project area had potential to contain yet unrecorded archaeological resource sites. Based on this result and following a chance find of potential heritage features during geotechnical and vegetation field studies, a field survey was conducted in the fall of 2016 resulting in 12 archaeological sites being newly recorded. Discussions on the results of the Archaeology program will be continued with the Department of Culture and Heritage throughout the Project development.

8 Socio-Economic Environment

8.1 Program Objectives

This socio-economic baseline provides an overview of the existing socio-economic environment of the city of Iqaluit including the following topics: demographics; education; health and social services; community infrastructure; workforce and economic activity; transportation and land and resource use. Its main objective is to focus on and describe the community's socio-economic conditions that may interact with the Project.

Consultation on the project is ongoing and further socio-economic information may be obtained that is not included in this baseline report. That information will still be used to inform the design and planning for the Project and will be considered within the Part 4 Screening and environmental permitting by regulatory agencies.

8.2 Study Sources

Information for the baseline study was obtained from:

- Statistics Canada, 2011 Census of Population (Statistics Canada, 2012).
- Nunavut Bureau of Statistics (2016).
- The City of Iqaluit 2015-2019 Community Economic Development Plan (City of Iqaluit, 2015).
- The Qikiqtaaluk Socio-Economic Monitoring Committee Spring 2015 and 2016 Annual Meeting Reports (Government of Nunavut, 2015a, 2016b).
- Iqaluit Sustainable Community Development Plan (City of Iqaluit, 2014).
- Existing and relevant government and industry reports and websites for the area such as: Baffinland Iron Mines Corporation's Socio-Economic Baseline Study, Mary River Project (Baffinland Iron Mines Corporation, 2012b); Nunavut Adult Learning Strategy (Government of Nunavut & Nunavut Tunngavik Incorporated, 2006); Strategic Plan for the Iqaluit Deepwater Port Project, (Aarluk, 2005); Nunavut tourism, etc.
- Semi-structured interviews with the City of Iqaluit Economic Development Officer (EDO), City of Iqaluit Planning and Development, Baffin Regional Chamber of Commerce, Iqaluit Chamber of Commerce, fire marshal, building inspector, Coast Guard, outfitters and business owners (conducted in November 2016).
- Project update meeting and design workshop with the Amaruq HTA (conducted in September and November 2016, and March 2017).
- Informal discussions with the Sinaakuut Support Group (conducted in September and November 2016).
- Group meetings with INAC, land, water and field inspection personnel.
- The ILMP website (Ford, 2017).

8.3 Results: Socio-Economic Profile

The City of Iqaluit is the capital city of Nunavut and is located in the South Baffin region. Iqaluit was previously called Frobisher Bay after Martin Frobisher who, in 1576, was the first non-Inuit to document the body of water in Iqaluit which he called Frobisher Straight (City of Iqaluit, 2016b). In 1861 another non-Inuit, Charles Hall, explored the area searching for Franklin's lost expedition and noted that the body of water was a bay and called it Koojesse Bay after his Inuit guide (City of Iqaluit, 2016b). Up until the early 1900's the whaling trade brought non-Inuit to the area until the industry crashed amidst a growing fur trade. The Hudson Bay

Company set up a trading post approximately 64 km from Iqaluit in 1914 in Ward Inlet. The trading post was relocated to Apex, following the establishment of the US air force military base at Frobisher Bay. In 1987 Frobisher Bay was renamed to Iqaluit, the original Inuktitut name for the area meaning "place of many fish" (City of Iqaluit, 2016b). Iqaluit became a city in 2001 following the establishment of Nunavut as a Territory. Iqaluit is located at 63°44'N and 68° 31' W (Figure 1-1). The nearest communities with greater than 1,000 people are Cape Dorset to the northwest and Pangnirtung to the northeast.

8.3.1 Demographics

8.3.1.1 Population

According to 2011 census data from Statistics Canada, the total population of Iqaluit was 6,700 (comprising 3,400 males and 3,300 females), representing an increase in population of 8.3% from 2006. The population was young, with a median age of 30.1 and with children aged 0 to 14 years representing nearly a quarter of the total population (23.9% or 1,600 individuals) (City of Iqaluit, 2016c; Statistics Canada, 2012). A breakdown of key population statistics provided by the 2011 census is presented in Table 8-1.

Nunavut Bureau of Statistics (2011) estimated the population of Iqaluit as of July 1, 2016 to be 7,590.

8.3.1.2 Aboriginal Identity

The total aboriginal population was 4,110 individuals, including 3,895 Inuit (58.1% of the total population) according to 2011 census (Table 8-1). The Inuit population of Iqaluit is characterized by a younger population than the average across Canada, but is not nearly as different compared to remote communities across North Baffin.

8.3.1.3 Educational Attainment and Language

According to the 2011 National Housing Survey, of the total population 15 years and over, 17.0% (865 individuals) were high school graduates (or equivalents) but only 6.9% (315 individuals) held apprenticeship or trades certificates. Iqaluit far exceeds the territorial average for post-secondary attainment, with 20.4% (1,040 individuals) of those 15 years and over having graduated from a University with a bachelor level degree or higher (Statistics Canada, 2013).

The City of Iqaluit's most recent economic development plan highlighted that delivering education in Nunavut is complicated by factors such as: a shortage of housing (resulting in overcrowding and limited space for study and sleep); household food insecurity; and social problems, such as higher rates of teenage pregnancy and substance abuse (City of Iqaluit, 2015).

Inuktitut and English are the most prevalent languages in Iqaluit with 3,005 individuals (44.9%) and 2,915 individuals (43.5%) reporting them, respectively, as their mother tongue. However, seven in 10 respondents reported English being the most often language spoke at home, and only one in 10 Inuit reported Inuktitut being the language most often spoken at work (Statistics Canada, 2012), indicating a threat to Inuktitut.

8.3.2 Housing and Accommodation

In 2011, Iqaluit was reported as having a total of 2,370 private dwellings, of which nearly one in five were in need of major repairs (Statistics Canada, 2012). More recently, the City of Iqaluit reports that the number of dwellings has now reached 2,900 (City of Iqaluit, 2016c). Additionally, the 2009/2010 Nunavut Housing Needs Survey reported that 30% of occupied dwellings in Iqaluit were below housing standards, meaning they were either crowded or in need of major repairs or a combination of both. Public housing had the highest proportion of dwellings below housing standards (52%) compared with other types of housing such as owner-occupied dwellings, staff housing or other rental housing (Statistics Canada, 2013).

According to the Nunavut Housing Corporation's Annual Report for 2015-2016, Iqaluit's current housing stock is at 35 to 40%, indicating a critical need for housing (Nunavut Housing Corporation, 2016). A severe lack of adequate housing is often reported as a fundamental issue affecting any progress on social development in Iqaluit. Additionally, the serious overcrowding problem in homes, leads to greater spread of diseases and infections and poor sleeping conditions (City of Iqaluit, 2015).

8.3.3 Labour Force and Economic Activity

Table 8-1 presents the participation, employment and unemployment rates of the total population in Iqaluit according to the 2011 Census. The unemployment rate was reported as 9.2%. According to Statistics Canada's 2015 Annual Labour Force Update for Nunavut, although Inuit accounted for about 80% of the working-age population in Nunavut, on average they accounted for only 68% of the total employed individuals in the Territory that year. Inuit were less likely than non-Inuit to be in the labour force, with an employment rate of 44.9% for Inuit compared to 86.0% for non-Inuit (Statistics Canada, 2016).

Median income reported for the total population 15 years and over with income in Iqaluit was $60,688 in 2010, with only 5.4% of total income attributed to Government Transfers (Statistics Canada, 2013). However, the reported median income for the aboriginal population 15 years and over in 2010 was only $34,013 (Statistics Canada, 2013).

An understanding of how the current labour force in Iqaluit is allocated across various occupations and industries can be gained from census data (Table 8-2). With the exception of public administration, each industry sector accounts for less than 8% of total labour force allocation, indicating a fairly diverse economy. However, as the government centre and territorial capital of Nunavut, government is the dominant industry and public administration jobs occupy the efforts of nearly half (43.5%) the workforce in Iqaluit (Table 8-2; Statistics Canada 2013).

The traditional subsistence economy (includes hunting, fishing, trapping and gathering) remains important in Iqaluit, albeit less so when compared to the smaller, more northern communities on Baffin, (Baffinland Iron Mines Corporation, 2012b) with many households still engaging in subsistence activities at least part time (City of Iqaluit, 2015).

Table 8-1 City of Iqaluit Statistics

Characteristic	Total
Population	
Population in 2011	6,700
Population in 2006	6,184
Median age of the population	30.1
Percent of the population <15 year of age	23.9
Percent of the population >15 year of age	76.1
Total population 15 years and over	5,100
Percent Population Change (from 2006)	8.3

Characteristic	Total
Aboriginal Population	
Total Aboriginal identify population	4,110
Inuit – single response	3,895
Non-Aboriginal identity population	2,659
Educational Attainment	
Total population 15 years and over	5,100
High school certificate or equivalent	865
Apprenticeship or trades certificate or diploma	315
College; CEGEP or other non-university certificate or diploma	970
University certificate or diploma below the bachelor level	130
University certificate or degree	1,040
Labour force activity	
Total population 15 years and over in the labour force:	3,920
Employed	3,560
Unemployed	360
Total population 15 years and over not in the labour force	1,060
Participation rate	78.7%
Employment Rate	71.5%
Unemployment Rate	9.2%
Income in 2010	
Median Income ($) for total population 15 years and over with income	$60,688
Composition of total income (100%)	
▪ Earnings – as a% of total income	100%
▪ Government transfers – as a% of total income	5.4%
▪ Market Income – as a% of total income	94.6%

Source: Statistics Canada (2012); Nunavut Bureau of Statistics (2016)

Table 8-2 Total Labour Force by Occupation

National Occupation Classification (NOC) 2011	Total
0 Management occupations	580
1 Business; finance and administration occupations	775
2 Natural and applied sciences and related occupations	205
3 Health occupations	160
4 Occupations in education; law/social; community and government services	800
5 Occupations in art; culture; recreation and sport	165
6 Sales and service occupations	665
7 Trades; transport and equipment operators and related occupations	445
8 Natural resources; agriculture and related production occupations	15
9 Occupations in manufacturing and utilities	30
Total labour force population aged 15 years and over by industry North American Industry Classification System (NAICS) 2007	
Agriculture, forestry, fishing and hunting	10
Mining, quarrying, and oil and gas extraction	0
Utilities	70
Construction	175
Manufacturing	20
Wholesale trade	40
Retail trade	255
Transportation and warehousing	220
Information and cultural industries	100
Finance and insurance	50
Real estate and rental and leasing	85
Professional, scientific and technical services	100
Management of companies and enterprises	0
Administrative and support, waste management and remediation services	125
Educational services	255
Health care and social assistance	290

National Occupation Classification (NOC) 2011	Total
Arts, entertainment and recreation	75
Accommodation and food services	165
Other services (except public administration)	145
Public administration	1,670

Source: Statistics Canada (2012)

8.3.4 Community Infrastructure and Services

8.3.4.1 Utilities and Communications

The City of Iqaluit's Department of Public Works is responsible for water and sewer services, road maintenance, garbage and waste collection.

Municipal services for water and sewage are provided by either the utilidor system or trucked service.

The municipal water source is Lake Geraldine which is located approximately 1.5 km northeast from the downtown. The dam outlet on the lake was raised in 2006 to increase the capacity of the reservoir to an overwintering supply for a population of approximately 12,800 (City of Iqaluit, 2014). Given that the Lake Geraldine watershed has an estimated volume of water to support a population of 8,300 people, the City identified Niaqunguk River as a supplementary source and subsequently commissioned studies to confirm the suitability and necessary infrastructure (City of Iqaluit, 2014). Construction of the Niaqunguk River intake was proposed to begin in 2014 however; planning is ongoing as of a January 15, 2015 presentation to Council which indicated that further work was required to collect and analyze water quality samples taken in October 2014 and undertake regulatory approvals and preliminary design. To protect the community water sources, the City of Iqaluit designated Lake Geraldine and Niaqunguk River watersheds as Watershed Protection Areas (City of Iqaluit, 2014).

The City's sewage treatment facility and back up sewage lagoon are located at the end of the airport strip along West 40 approximately 0.6 km from downtown (Figure 2-1). The treatment facility provides primary treatment utilizing screens and filters to remove solids, before the water is released into Koojesse Inlet (City of Iqaluit, 2014). An INAC inspection on July 1, 2010 noted that the discharge quality from the sewage treatment system was unacceptable however, the dams/dykes, erosion, seepages and operation and maintenance plan were acceptable. The inspection noted an effluent discharge rate of two megalitres per day and separated solids are transported every two days to the Municipal landfill (INAC, 2010).

The City is in the process of upgrading the primary wastewater treatment facilities to secondary treatment, which is required in the City's water licence. A moving bed biological reactor system is planned (Craig Kelman & Associates Ltd., 2016).

As the City of Iqaluit grows, it has been recognized that the utilidor pipes need replacement to reduce leaks and breakage. Further, the City recognized that trucked services may pose an increased health and safety risk due to potential spills; however, conversion to piped services is deemed cost prohibitive (City of Iqaluit, 2014). Those residences that do not have piped services are also responsible for their own water tank maintenance and cleaning.

The City's solid waste landfill is located approximately 2.5 km from downtown at the West 40 Landfill. Solid waste from residential and commercial locations is picked up several times a week and transported to the landfill. Sewage sludge from the wastewater treatment plant is also transported to the landfill. The landfill receives and separates metal, wood, electronic, household hazardous waste, tires and mattresses. The landfill does not accept contaminated soil, asbestos or industrial hazardous waste, however, there are private businesses in Iqaluit that do accept these wastes (City of Iqaluit, 2014). The landfill uses berms to manage onsite runoff and collects runoff in on-site detention ponds which are pump discharged across the road to an off-site detention pond. The runoff is retained in off-site detention ponds for several months before being filtered and discharged to the environment through a geotube. The INAC 2010 inspection found that the landfill was nearing capacity. It was noted that the City does not burn wastes but rather shreds material and layers it over the ground surface causing mounds to be in excess of 25 m at that time of inspection. During the inspection, water management was noted as a continual concern (INAC, 2010).

In 2010, a fire broke out at the West 40 Landfill that took over five weeks to extinguish. Since 2010, there have been five other fires (January 2013, December 2013, January 2014, March 2014 and May 20, 2014). The fire was extinguished on September 16, 2014 with City of Iqaluit and Government of Nunavut resources. The landfill was found to not meet best management practices whereby the slopes were too steep, there was inadequate or no cover and there was no cleanup or re-compaction following the previous fires. Further fires at the landfill have occurred in June and August 2016 but were extinguished by the Iqaluit fire department (City of Iqaluit, 2016a).

In January of 2014, the City Council adopted a Solid Waste Management Plan that included a new solid waste management site and program. The program is a landfill with a compost program, bulk recycling, end of life vehicle program, reuse centre, hazardous waste management program, and a public education program (City of Iqaluit, 2015). In 2014, the landfill was noted as at capacity however, it continues to operate and the Sustainable Community Plan indicates that historic waste sites located in the community need remediation (City of Iqaluit, 2014).

Electricity in the city is provided through diesel generators by the Qulliq Energy Corporation (QEC), a territorial corporation 100% owned by the Government of Nunavut. QEC is the only generator, transmitter and distributor of electrical energy in Nunavut. All electricity needs in Nunavut are met by imported fossil fuel supplies.

Energy in Iqaluit is produced by the two diesel power plants, the primary plant is located near Lake Geraldine and the secondary plant is located on Federal road. The diesel tank farm is on West 40. All fuel comes up on the sea lift and is transferred by pipeline along the causeway to the power plants and then stored in the tank farm. There are also a number of fuel trucks serving as backup delivery and power lines to transport energy from the plants to the community (City of Iqaluit, 2015).

Heating fuel for homes and buildings is the responsibility of Petroleum Products Division of Community and Government Services, with the distribution and inventory management outsourced to Uqsuq Corporation.

The City of Iqaluit has recently been looking at making energy production more sustainable. Innovative small scale projects are currently being researched or implemented across the city. For example, waste heat from the power plant is used to heat the hospital and a small scale photovoltaic (solar energy) system has been running at the Nunavut Arctic College's main Nunatta Campus since 1995. This system has provided on average 2,000 kWh of electricity on an annual basis without interruption (City of Iqaluit, 2015).

There are a variety of providers offering television, radio, Internet and phone services. The local newspaper is Nunatsiaq News.

8.3.4.2 Transportation

Iqaluit is seen as a transportation and resource distribution hub that provides access to smaller communities through the connection of the International airport and the sealift delivery services (Chris West pers. comm. November 2016). Further, Iqaluit offers an opportunity for tourism access to the Territory by international travelers as a Canadian Customs point of entry into Canada. The airport is also utilized by the Canadian military and international aircraft manufactures as a Forward Operating Location and an aircraft cold-weather testing site, respectively.

The Iqaluit International Airport owned by the Government of Nunavut is currently undergoing major improvements including the construction of a new terminal building.

First Air operates daily flights from Ottawa and Montreal to Iqaluit. Canadian North also operates a daily flight from Ottawa to Iqaluit. Both airlines also offer service from Yellowknife to Iqaluit, via Rankin Inlet.

Iqaluit currently has four primary marine facilities, the existing Causeway located across the harbour from the town site, the Municipal Wharf centrally located at the town site, the sealift beach adjacent the south end of the airport runway, and the Fuel Resupply facilities at Innuit Head.

Sealift is a vital link for all communities in Nunavut allowing residents to obtain their annual re-supply of goods and materials needed throughout the year. Sealift ships travel from several southern Canadian Ports with a variety of goods ranging from housewares, non-perishable items, construction materials, vehicles, and heavy equipment. Current providers of sealift carriage and associated services include: Nunavut Sealink & Supply (NSSI), Nunavut Eastern Arctic Shipping Inc. (NEAS) and Northern Transportation Company Limited (NTCL). In 2016 there were 13 ship calls by two dry cargo carriers. These ranged from two to 10 days in duration, for a total of 72 ship days (Jean-Pierre Lehnert pers. comm. November 2016).

Currently, dry cargo shipped into Iqaluit is generally conducted by barge lightering operations from ships anchored offshore in the upper reaches of Frobisher Bay, south of Koojesse Inlet. The ships generally provide their own barges and tugs to support lightering. However, some shipping lines leave one or two barges in Iqaluit for the duration of the shipping season. Cargo barges are landed at the landing beach adjacent to the airport runway where shipping companies offload cargo at the high watermark. A local contractor is responsible for storing the cargo within the beach laydown area and distributing the cargo within the townsite. The Canadian Coast Guard's (CCG) Superintendent of Arctic Field Operations (Beachmaster) is responsible for coordination of the activities at the landing beach and laydown yard. The landing beach consists of approximately 2.5 ha of open storage space available for sealift storage, a portion of which is contained within the CCG's 1 ha secured (fenced) compound. The CCG reported that the laydown area is presently utilized to its limit and if significant cargo cannot be delivered to the end user, for whatever reason, before the next significant cargo arrives, the laydown area quickly overflows.

At the start of each sealift season, the tidal portion of the beach must be cleared of boulders and cobbles deposited by the shifting ice floes during the breakup period. Some years, the beach is reportedly so severely choked with ice that barge lightering is not possible and vessels are turned back causing delays of essential cargo (HTA Member pers. comm. November 2016). In 2009, a structural steel beam was reported to have accidentally been dropped into the sea during a lightering operation. This caused a delay in construction of a building in Iqaluit until the following year, when the component could be replaced. In the fall of 2015, construction of the $40 million Aquatic Centre in Iqaluit was delayed by three weeks after heavy ice in Frobisher Bay slowed down sealift delivery resulting in crews working overtime past the November 6 construction season deadline (Northern News Services, 2016).

Fuel is supplied by coastal tanker under contract to Woodward Oil, which transfers fuel by floating hoses deployed by the ship's crew after the ship has been secured and once weather conditions are favourable.

The City of Iqaluit Public Works department is responsible for road maintenance including street signs, culverts, and walkways. The majority of roads in Iqaluit are paved with secondary roads constructed of gravel. Roads accommodate two lanes of traffic and typically do not have sidewalks or pathways. Iqaluit currently has no public transportation, although there is taxi service widely available throughout the city.

Small craft access to Koojesse Inlet is predominately from the Municipal Wharf and Causeway. The access to the municipal wharf is within a residential neighbourhood and is accessed by both motorized and non-motorized boat users for traditional harvesting, outfitting and recreational activities. The road to the Municipal Wharf provides access to residential homes and can become extremely congested during boat launching and take-out times (Photo 8-1). The road lacks sufficient parking areas and cars can line the shoulder of the road blocking access to residential houses (SSG pers. comm. November 2016), when waiting for access to the launching ramp. The congestion at the Municipal Wharf is caused by the fact that people launch and return at the same time due to factors such as tides/winds, daylight hours, working hours and days of the week, in particular on Sunday (SSG pers. comm. November 2016).

The Causeway is used as an alternative launching and take-out area and provides some parking space for trucks with boat trailers (SSG pers. comm. November 2016). The road to the Causeway, however, is unpaved and is in disrepair in numerous places which can prevent access by cars with trailers (SSG pers. comm. September 2016; SSG pers. comm. November 2016).

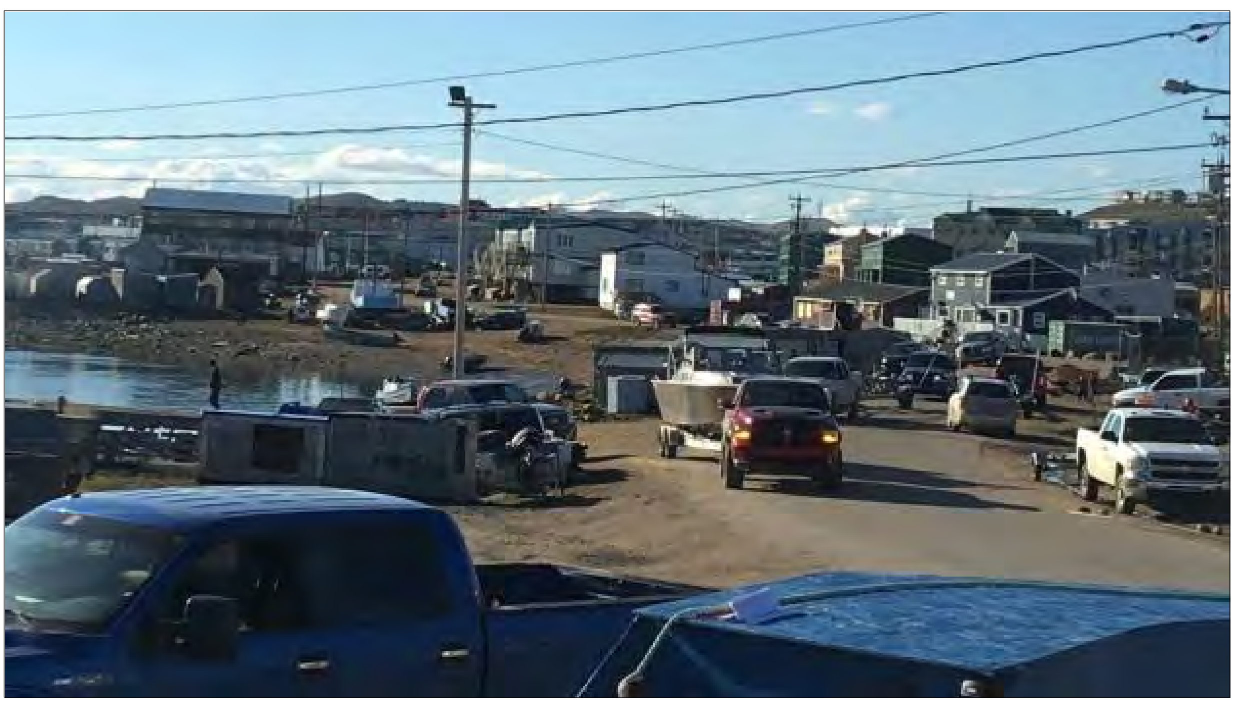


Photo Credit: Sinaakuut Support Group

Photo 8-1 Typical Parking and Traffic Congestion at Municipal Wharf

8.3.4.3 Emergency and Protection Services

The Department of Emergency and Protective Services includes fire protection, ambulance service and communication / dispatch units. Services are provided by a mix of fulltime and volunteer staff. The department has 18 full time firefighters / emergency medical responders, six dispatchers and 15 volunteer firefighters and is led by a chief and deputy chief (City of Iqaluit, 2017).

It has been reported in the local news media, that Iqaluit firefighters are overworked and working an estimated 300 hours of overtime on a yearly basis (Ducharme, 2016). The City of Iqaluit website explains that fire calls have been increasing, resulting in the need for the City to recently advertise and attempt to attract further volunteer firefighters (City of Iqaluit, 2017). However, it also explains that ambulance calls have been decreasing since 2008.

The RCMP provides services including crime protection and public safety, emergency preparedness, and policing services. According to a City Councillors' briefing, provided by Sergeant Dave Combden on July 26, 2016, the Iqaluit detachment would benefit from more officers to deal with increased needs in the City. According to the Sergeant, the Iqaluit RCMP officers responded to 3,084 calls for service over the first quarter of that year, which represented 114 more calls compared to the same period of the previous year.

8.3.4.4 Public Health

The Governments of Nunavut and Canada have a shared responsibility for health care services in Nunavut. Health Canada provides funding for insured hospital services in Nunavut. Iqaluit is the only community with a general hospital, public health facility, family practice clinic and non-contracted rehabilitative treatment, provided through the Timimut Ikajuksivik Centre.

More than one third of the Department's total operational budget is spent on costs associated with medical travel ($64,686,706) and physician and hospital services ($57,140,612) outside the Territory. Due to the Territory's very low population density and limited health infrastructure (i.e. diagnostic equipment and health human resources) access to a range of hospital and specialist services often requires residents to travel outside the Territory (Government of Nunavut, 2015b).

The Qikiqtani General Hospital is currently the only acute care facility in Nunavut providing a range of in-and out-patient hospital services including 24-hour emergency services, in-patient care (including obstetrics, pediatrics and palliative care), surgical services, laboratory services, diagnostic imaging, and respiratory therapy.

According to City of Iqaluit "2012 What We Have: Our Community Assets" report, health facilities and services include two dental clinics, two pharmacies, an Adult Group Home, Akausisarvik mental health facility, chiropractic/ acupuncture services, Elders home/care facility, massage therapy services, medical emergency travel (Medivac/Nunavut Lifeline), Nunavut Kamatsiaqtut Help Line, an optometrist, personal trainers (Atii Fitness), physiotherapy services, psychiatric services, public health clinic, Qikiqtani General Hospital (emergency room and hospital services) and Tammaativvik Boarding Home (City of Iqaluit, 2012).

The community does struggle with acute social issues such as mental illness, addiction, abuse, suicide, low educational achievement, unemployment, housing shortages, cultural erosion, and disengagement (City of Iqaluit, 2014).

8.3.5 Land and Resource use

8.3.5.1 Harvesting and Food Security

The Nunavut Food Security Coalition defines food security as, "…physical and economic access to sufficient, safe, and nutritious food to meet their dietary needs and food preferences for an active and healthy life," (https://www.nunavutfoodsecurity.ca/, accessed January 15, 2017). The Coalition estimates that nearly 70% of homes in Nunavut are food insecure. However, in September 2012, a study conducted over one year by researchers at McGill University found that 28.7% of the surveyed households in Iqaluit were food insecure. While this rate is below the territorial average found by the Nunavut Food Security Coalition, it is still three times higher than the national average (Guo et al., 2015).

The community obtains food resources from hunting and harvesting, purchasing at stores or through the sealift and air cargo and by growing (City of Iqaluit, 2014). Food is available for purchase at grocery and convenience stores, restaurants, cafes and coffee shops and Country Food markets. The community also has school-based breakfast programs for all kids, the Qayuqtuvik Soup Kitchen which is open daily and the Iqaluit Food Bank which is open every two weeks (City of Iqaluit, 2014, 2015). The community can access Country Food through hunters, feasts, markets and stores and there is an active Iqaluit Greenhouse Society (City of Iqaluit, 2014).

As stated in Section 8.3.3, traditional subsistence economy is important in Iqaluit. This includes hunting, fishing, trapping and gathering. Information obtained from the HTA indicated that subsistence harvesting occurring within the City is limited and mainly involves fishing along the shoreline (Figure 2-1). Arctic char is an important species for subsistence and commercial fishing in Iqaluit. The HTA stated that typically hunters do not harvest in Koojesse Inlet because they are concerned about contamination from the wastewater treatment plant discharge and it would be a rare occurrence to see anyone harvesting clams in the area anymore (HTA Member pers. comm. March 2017).

Food security is a challenge for many in Iqaluit and to address this, the City of Iqaluit provides funding for food security programs through the Government of Nunavut's Community Cluster Funding program. There is also a community freezer purchased in November 2016 by the HTA that provides hunters free storage for their harvests. To address the issue at a territorial level, in May of 2014, the Nunavut Food Security Coalition released the Nunavut Food Security Strategy and Action Plan 2014-16 structured around six key themes: 1) Country Food; 2) Store-Bought Food; 3) Local Food Production; 4) Life Skills; 5) Programs; and 6) Community Initiative, as well as Policy and Legislation. The availability of traditionally harvested foods (country food) is crucial in that it lowers the demand for imported food which is very costly and typically less nutritious. Additionally, the harvesting, preparation, and distribution of meat and skins provide important opportunities to maintain and enhance Inuit culture.

8.3.5.2 Access

Information from the HTA and BWG workshops and discussions with elders concerning winter and open water access in and around the proposed project development areas has been provided in Figure 2-1.

Small craft access to Koojesse Inlet is predominately from the municipal breakwater and existing Causeway. The access to the municipal breakwater is within a residential neighbourhood and is accessed by both motorized and non-motorized boat users for traditional harvesting, outfitting and recreational activities. According to the HTA and local outfitters, approximately 60 to 70% of users have boat trailers. A recent informal boat count by a local outfitter noted that of 231 boats counted, 191 (or 83%) were on trailers. It would appear that in the summer a "*majority of these boats are launched just prior to being used and are taken* *back out of the water upon returning to the community,*" (Local Outfitter: May 2017, 2017). Local hunters without boat trailers depend on the tides to access the water. During discussions with HTA members, one such hunter indicated, "*I have to follow the tides. If I leave at 3:00 am then I have to come back at 3:00 pm. I'm envious of people with trailers, make it [the port] useful for people who don't have trailers also,*" (HTA Member pers. comm. November 2016).

For boat owners with trailers, the existing Causeway (Photo 8-2) is used as an alternative to the municipal breakwater for launching and take-out and provides some parking space for trucks with boat trailers (SSG pers. comm. November 2016). However, as stated in Section 8.3.4.2, the road to the existing Causeway is unpaved and is in disrepair in numerous places which can, at times, prevent access by vehicles with trailers. As a hunter remarked, "*If we don't have a trailer to get to the Causeway, we wait for the tide, or we get a friend to take us or we go to Apex. We're hunters. This isn't 9-5, we always find a way to get out if we need to,*" (BWG Workshop: April 2017).

Photo 8-2 Existing Causeway

Additionally, access to boats frequently requires a perilous scramble down the slippery riprap slope with cargo and/or gasoline jerry cans at either the Municipal Breakwater or the existing Causeway (HTA Member pers. comm. November 2016). This is especially dangerous for elderly tourists wishing to go out on boat tours with local outfitters (Outfitter Focus Group: November 2016).

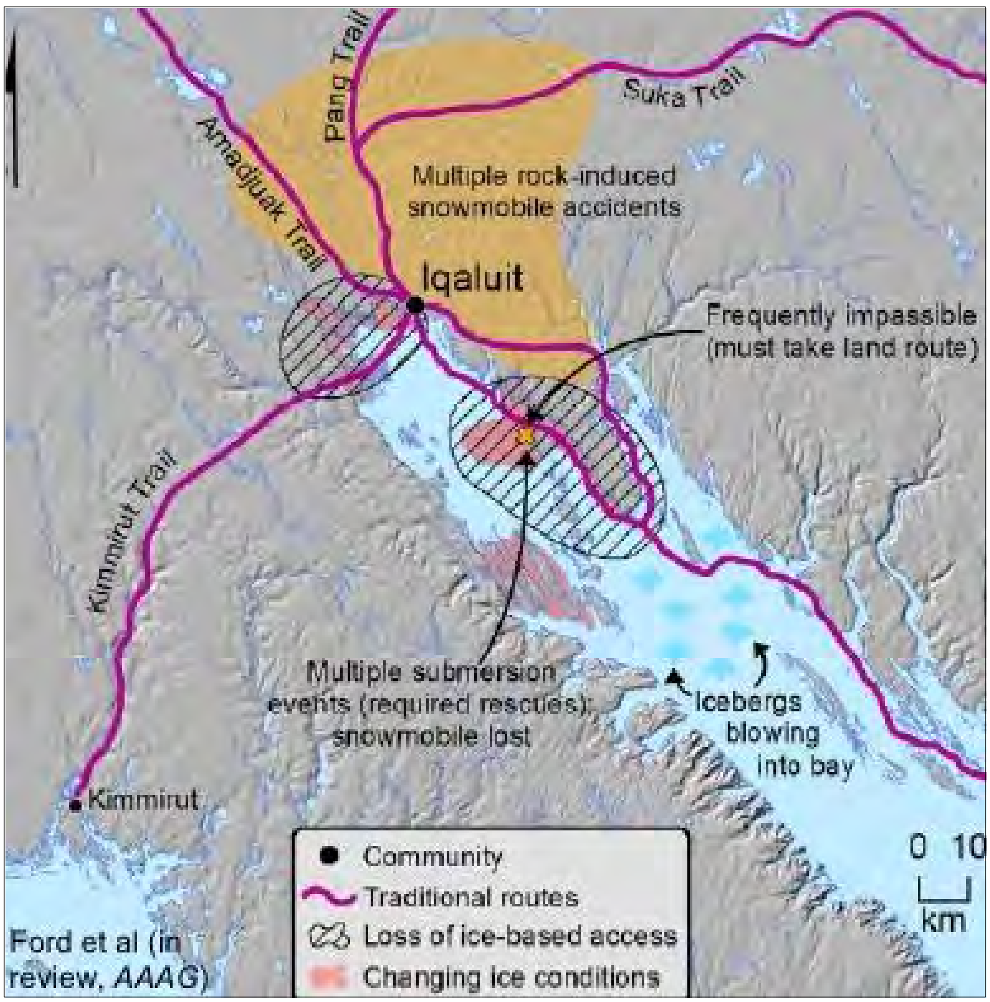
Accessing the ice in Iqaluit is, at times, considered challenging by local hunters who have to adapt their routes and access due to changing ice conditions. Winter and spring access routes at the municipal breakwater and the existing Causeway are provided in Figure 2-1. The existing Causeway is a busy access point with an estimated 200 snowmobiles accessing from there some days in a typical season (HTA Member pers. comm. November 2016). During early summer it is very busy at the Causeway because of the overlap of spring to summer access (qamutik, snowmobiles, and boats) (HTA Member pers. comm. November 2016; BWG Workshop: April 2017).

Feedback received from elders and HTA members indicates that although ice access can be challenging at times in Iqaluit, they manage: "*We are hunters. We adapt to changes. Every year we have to find access routes to the ice. Ensure that our access at the causeway and the municipal breakwater is maintained. If you do that, we have no concerns,*" (HTO Member Design Workshop, 2016).

8.3.5.3 Travel Routes

The Iqaluit Land Use Mapping Project is currently producing a series of land-use maps (Figure 8-1 and Figure 8-2, for examples) documenting the changes that hunters are making in the way they use the land in and around Iqaluit due to an increasing occurrence of land-use hazards (such as unstable ice, thin snow, whiteouts) caused by climate change (Ford, 2017).

According to a presentation by an ILMP researcher, Dr. James Ford, data obtained from 2008 to 2010, by equipping two full-time hunters with GPS, indicate that over 21,000 km was travelled, with 70% of that distance being covered by snowmobile. The other 30% was done by boat. The average trip by snowmobile was 107 km compared to an average of 99 km being traveled by boat (Ford, 2017).



Source: Ford (2017)

Figure 8-1 Image presented by Dr. James Ford at the IPY 2012 Conference in Montreal, given on April 24, 2012

Source: Ford (2017)

Figure 8-2 Image presented by Dr. James Ford at the IPY 2012 Conference in Montreal, given on April 24, 2012

8.3.5.4 Beach Shacks – Municipal Wharf Area

There are a variety of shacks, storage containers, boats and snowmobile which are built or parked at the Municipal Wharf shoreline. The shacks and storage containers are not authorized land uses by the City of Iqaluit and it is unknown who owns them (Melodie Simard pers. comm. November 2016). Information obtained during discussions with a local community group and residents along the shoreline indicated that the shacks are used for storage of hunting and boating equipment, fuel, and tools used for cleaning and preparing harvest catch such as seal and fish (SSG pers. comm. September 2016). It is suspected that a resident does live in one of the sea containers on site and sometimes lives on a boat along the shoreline (Jack Anawak pers. comm. November 2016). As there is a lack of parking area at the Municipal Wharf, the parking area at the Causeway is an important community area and often residents will leave snowmobiles there for extended periods of time (Melodie Simard pers. comm. November 2016).

8.3.5.5 Recreation and Tourism

A variety of tourist and recreational facilities are available for visitors and residents of Iqaluit throughout the year, including the Unikkaarvik Visitors' Centre, the Nunatta Sunakkutaangit Museum Arctic, the Arctic Winter Games Complex, the Arnaitok Arena, and a brand new aquatic centre.

There are several outfitting companies operating out of Iqaluit that offer boating, snowmobiling, kite skiing, hunting, dog sledding and river raft trips at the Katannilik Park (situated between Iqaluit and Kimmirut).

In the summertime there are many scenic places to go hiking, fishing, camping and berry picking, such as Sylvia Grinnell Park, the Road to Nowhere, and the seaside trail to Apex. The Qaummaarviit Territorial Historic Park offers a unique opportunity to see archaeological artifacts and learn about Thule culture.

Iqaluit's Spring Festival, Toonik Tyme, is held every April and showcases traditional Inuit games and activities such as iglu building and seal skinning combined with musical performances, scavenger hunts, ice golf, and snowmobile races (Figure 2-1). The Alianait Arts Festival showcases music, theatre, circus acts, and visual art from Nunavut and around the world under a big top tent that dominates downtown Iqaluit every year from the end of June to early July. According to the City of Iqaluit (2015) , almost 10,000 visitors pass through the doors of the Iqaluit Unikkaarvik Visitors Centre on a yearly basis.

Despite increased traffic of tourist cruise ships in the region around Baffin Island, there were only a handful of cruise ships that visited Iqaluit in 2016. Table 8-3 provides the itinerary for the ships that were expected in Iqaluit over the 2016 cruising season.

Table 8-3 Master Nunavut Cruise Ship Itinerary 2016

Ship/Company	Estimated Arrival	Estimated Number of Passengers
Akademik Ioffe / One Ocean Expeditions	August 1 (embark) September 9 (disembark)	96
Akademik Sergey Vavilov/One Ocean Expeditions	August 2 (embark)	92
Le Boreal / Compagnie du Ponant	September 11 (call)	264
Silver Explorer / Silversea Cruises	September 13 (call)	119
Sea Adventurer / Quark Expeditions	September 23 (disembark)	100

Source: Government of Nunavut (2016a)

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Appendix 1 Laboratory Results

QUANTITATIVE PHASE ANALYSIS OF THREE POWDER SAMPLES USING THE RIETVELD METHOD AND X-RAY POWDER DIFFRACTION DATA.

Project: WorleyParsons B702697

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January 27, 2017

EXPERIMENTAL METHOD

The three samples of **Project: Worley Parsons B702697** were reduced to the optimum grain-size range for quantitative X-ray analysis (<10 μm) by grinding under ethanol in a vibratory McCrone Micronizing Mill for 10 minutes. Step-scan X-ray powder-diffraction data were collected over a range 3-80°2θ with CoKα radiation on a Bruker D8 Focus Bragg-Brentano diffractometer equipped with an Fe monochromator foil, 0.6 mm (0.3°) divergence slit, incident- and diffracted-beam Soller slits and a LynxEye-XE detector. The long fine-focus Co X-ray tube was operated at 35 kV and 40 mA, using a take-off angle of 6°.

RESULTS

The X-ray diffractograms were analyzed using the International Centre for Diffraction Database PDF-4 using Search-Match software by Bruker. X-ray powder-diffraction data of the samples were refined with Rietveld program Topas 4.2 (Bruker AXS). The results of quantitative phase analysis by Rietveld refinements are given in Table 1. These amounts represent the relative amounts of crystalline phases normalized to 100%. The Rietveld refinement plots are shown in Figures 1 – 3.

Table 1. Results of quantitative phase analysis (wt.%)

Mineral	**Ideal Formula**	**2: QJ7744 QA16-06**	**3: QJ7745 QA16-08**	**5: QJ7747 QA16-13**
Ankerite – Dolomite	$Ca(Fe^{2+},Mg,Mn)(CO_3)_2 – CaMg(CO_3)_2$		0.7	
Biotite	$K(Mg,Fe)_3(AlSi_3O_{10})(OH)_2$	1.3	2.0	3.6
Calcite	$CaCO_3$	1.2	0.9	0.4
Clinochlore	$(Fe^{2+},Mg)_5Al(AlSi_3O_{10})(OH)_8$	2.4	2.7	2.6
Illite-Muscovite 1M	$\sim K_{0.65}Al_{2.0}(Al_{0.65}Si_{3.35}O_{10})(OH)_2/KAl_2(AlSi_3O_{10})(OH)_2$	2.5		
Ilmenite	$Fe^{2+}TiO_3$			0.3
Kaolinite	$Al_2Si_2O_5(OH)_4$			2.6
K-Feldspar	$KAlSi_3O_8$	22.1	31.9	34.9
Magnetite	$Fe^{2+}Fe^{3+}{}_2O_4$	2.4	1.3	1.1
Plagioclase	$NaAlSi_3O_8 – CaAl_2Si_2O_8$	26.8	23.1	17.4
Quartz	SiO_2	41.3	37.4	37.0
Total		100.0	100.0	100.0

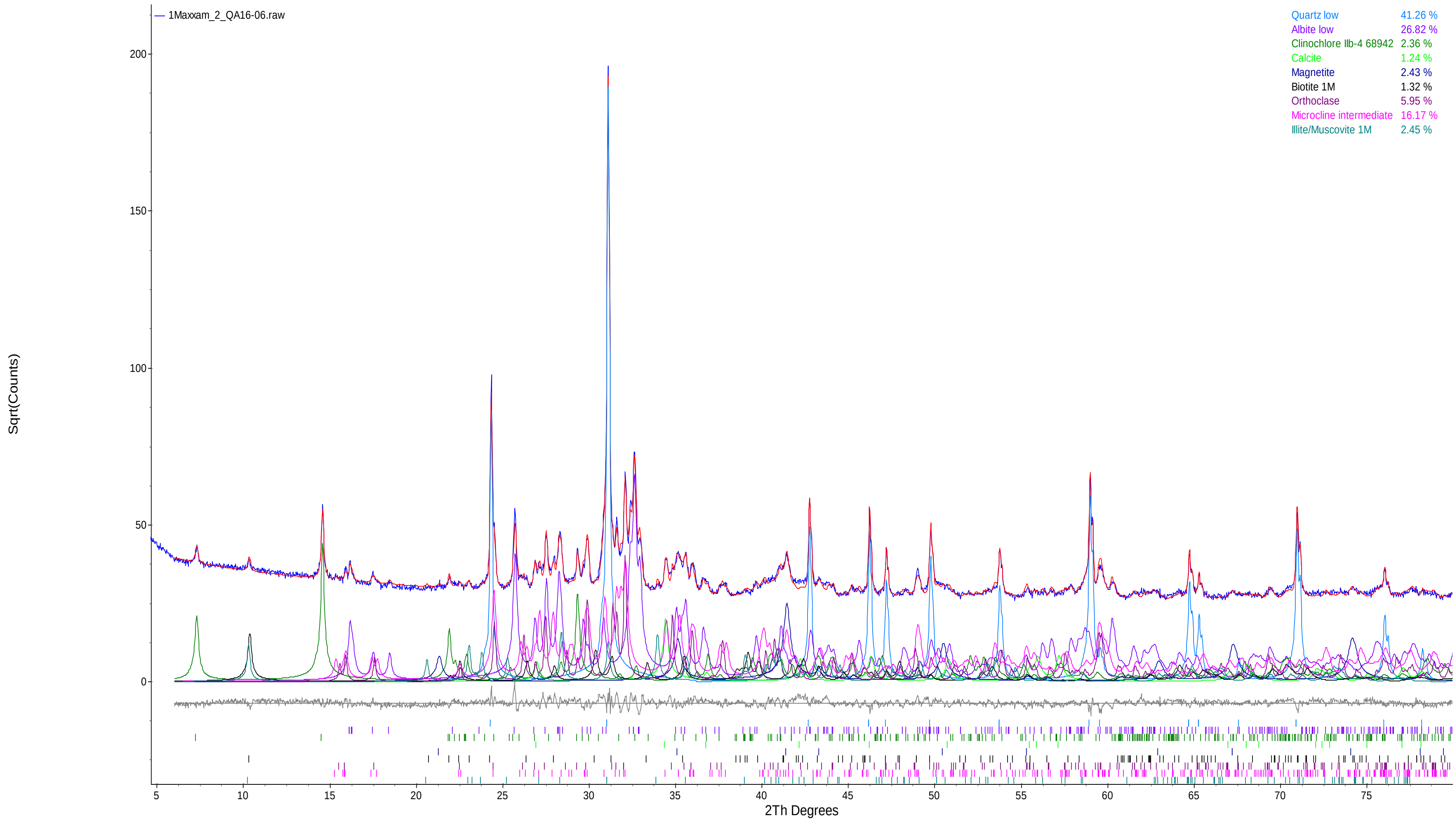

Figure 1. Rietveld refinement plot of sample **Maxxam Analytics "2: QJ7744 QA16-06"** (blue line - observed intensity at each step; red line - calculated pattern; solid grey line below - difference between observed and calculated intensities; vertical bars - positions of all Bragg reflections). Coloured lines are individual diffraction patterns of all phases.

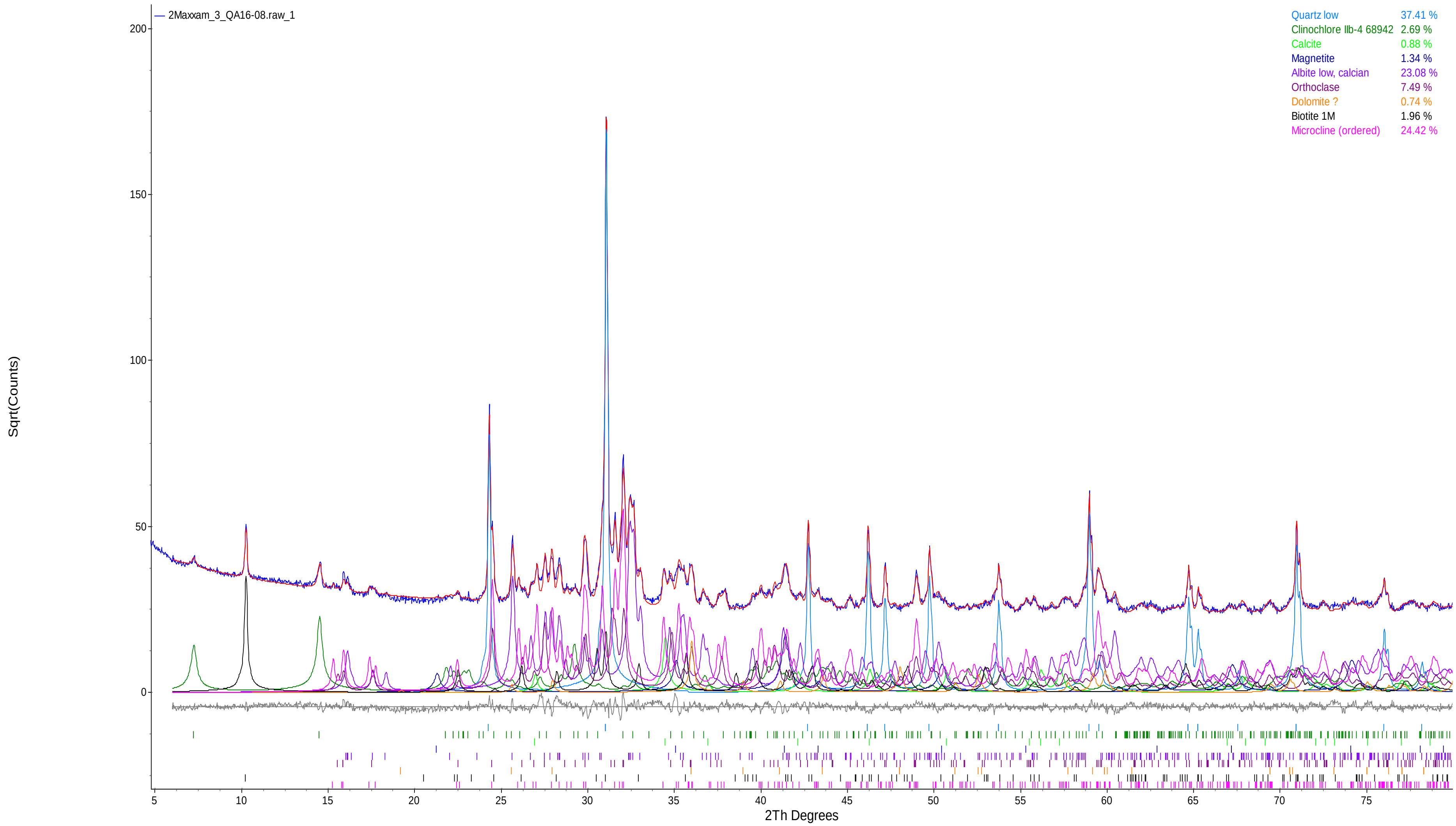

Figure 2. Rietveld refinement plot of sample **Maxxam Analytics "3: QJ7745 QA16-08"** (blue line - observed intensity at each step; red line - calculated pattern; solid grey line below - difference between observed and calculated intensities; vertical bars - positions of all Bragg reflections). Coloured lines are individual diffraction patterns of all phases.

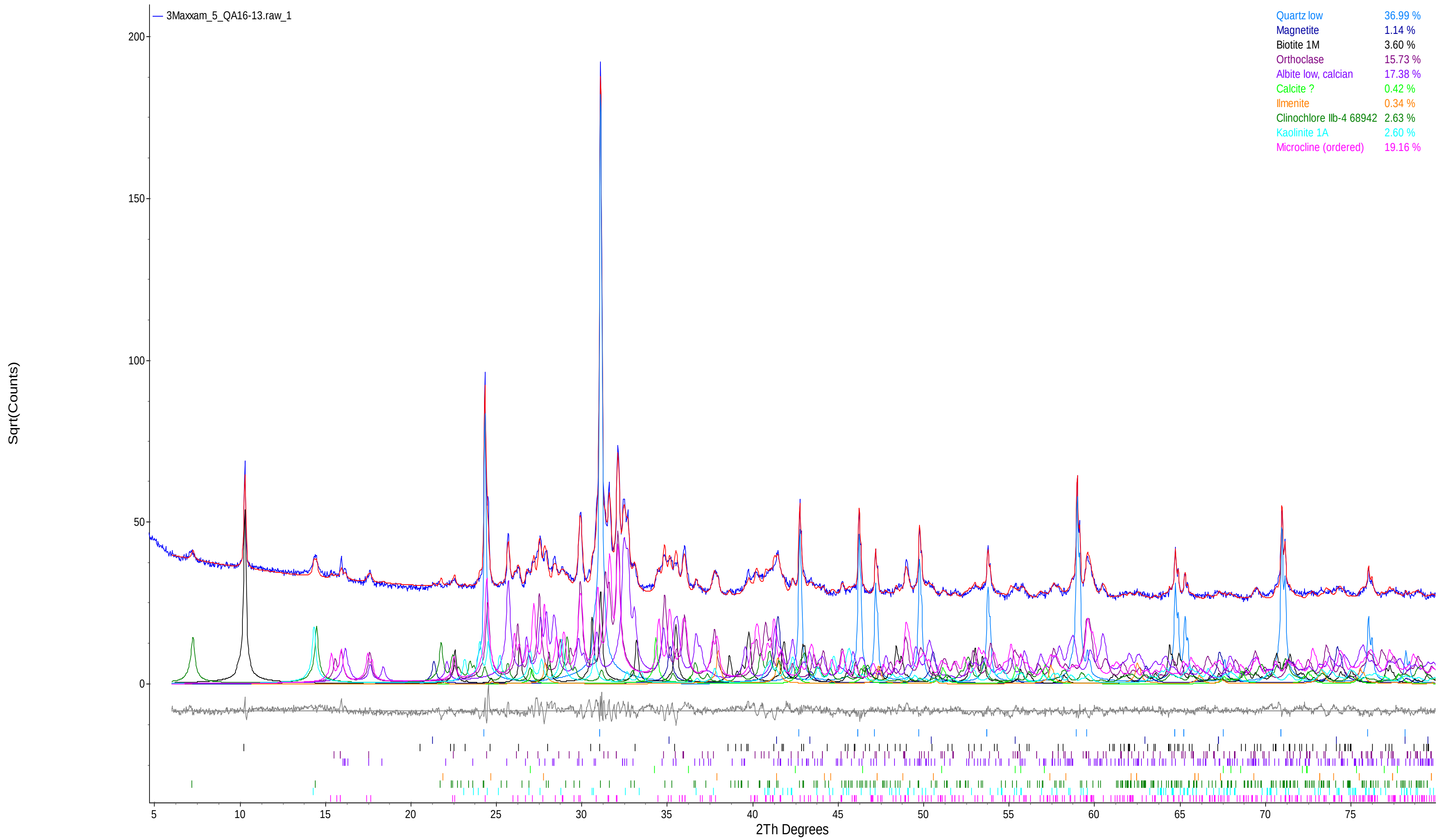

Figure 3. Rietveld refinement plot of sample **Maxxam Analytics "5: QJ7747 QA16-13"** (blue line - observed intensity at each step; red line - calculated pattern; solid grey line below - difference between observed and calculated intensities; vertical bars - positions of all Bragg reflections). Coloured lines are individual diffraction patterns of all phases.

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Client: WORLEYPARSONS CANADA SERVICES

Table 1: ABA Test Results for project Iqaluit Marine Infrastructure

Maxxam Sample No	Sample ID	Paste pH	Paste EC	Rinse pH (on <2mm)	Rinse EC (on <2mm)	CO2	CaCO3 Equiv.	Total S	HCl Extractable Sulphur	HNO3 Extractable Sulphur	Non Extractable Sulphur (by diff.)	Acid Generation Potential	Mod. ABA Neutralization Potential	Fizz Rating	Net Neutralization Potential	Neutralization Potential Ratio
	Units	pH Units	uS/cm	pH Units	uS/cm	wt%	Kg CaCO3/T	wt%	wt%	wt%	wt%	Kg CaCO3/T	Kg CaCO3/T	N/A	Kg CaCO3/T	N/A
QJ7743	QA16-03	9.16	156	9.54	111	0.18	4.1	<0.02	0.01	0.01	<0.02	0.3	11.3	SLIGHT	11.0	37.7
QJ7744	QA16-06	8.96	201	9.58	130	0.34	7.7	<0.02	0.01	0.01	<0.02	0.3	13.3	SLIGHT	13.0	44.3
QJ7745	QA16-08	9.17	169	9.64	131	0.25	5.7	<0.02	0.01	0.01	<0.02	0.3	13.0	SLIGHT	12.7	43.3
QJ7746	QA16-12	9.20	231	9.69	135	0.09	2.1	<0.02	<0.01	0.01	<0.02	0.3	8.5	NONE	8.20	28.3
QJ7747	QA16-13	8.97	132	9.52	102	0.04	0.9	0.03	<0.01	0.02	<0.02	0.6	10.0	NONE	9.40	16.7
QJ7748	QB16-02	8.84	493	9.45	364	0.28	6.4	<0.02	0.01	0.01	<0.02	0.3	13.5	SLIGHT	13.2	45.0
QJ7749	QB16-05	9.83	396	10.0	284	0.21	4.8	<0.02	<0.01	0.01	<0.02	0.3	13.8	SLIGHT	13.5	46.0
QJ7750	QB16-11	9.75	445	9.90	359	0.11	2.5	<0.02	0.01	0.01	<0.02	0.3	14.0	SLIGHT	13.7	46.7
QJ7751	IQI16-02	9.08	104	9.41	68.7	0.02	<0.5	<0.02	<0.01	0.01	<0.02	0.3	5.3	NONE	5.00	17.7
QJ7752	IQI16-03	9.17	106	9.50	101	0.44	10.0	0.12	0.01	0.04	0.07	1.3	12.8	SLIGHT	11.5	9.8
Detection Limits		*N/A*	*1*	*N/A*	*0.5*	*0.02*	*0.5*	*0.02*	*0.01*	*0.01*	*0.02*	*0.3*	*0.1*	*N/A*	*0.1*	*0.1*
Maxxam SOP #		*Y0SOP-00*	*Y0SOP-00*	*BBY0SOP-00012*	*BBY0SOP-00029*	*LECO*	*BBY WI-00033*	*LECO*	*BBY0SOP-00010*	*BBY0SOP-00010*	*BBY WI-00033*	*BBY WI-00033*	*BBY0SOP-00020*	*BY0SOP-0002*	*BBY WI-00033*	*BBY WI-00033*

Notes:

Lawrence, R.W. 1991. Acid Rock Drainage Prediction Manual

References:

Acid Generation Potential = HNO3 Extractable Sulphide Sulphur*31.25

CaCO3 Equivalency = Carbonate Carbon (CO2)*(100/44)*10

Carbonate carbon (CO2; HCl direct method) by Leco.

Fizz Rating - Reference method used is based on NP method.

Non Extractable Sulphur = (Total Sulphur)-(HCl Extractable Sulphate Sulphur)-(HNO3 Extractable Sulphide Sulphur)

Net Neutralization Potential = (Modified ABA Neutralization Potential)-(Acid Generation Potential (HNO3 Extr))

Mod. ABA Neutralization Potential - MEND Acid Rock Drainage Prediction Manual, MEND Project 1.16.1b (pages 6.2-11 to 17), March 1991.

Neutralization Potential Ratio = (Neutralization Potential)/(Acid Generation Potential)

Paste EC - based on Field and Laboratory Methods Applicable to Overburdens and Minesoils, (EPA 600 / 2-78-054, March 1978).

Paste pH - Field and Laboratory Methods Applicable to Overburdens and Minesoils, (EPA 600 / 2-78-054, March 1978).

Rinse EC (on <2mm) - Based on Rince pH Procedure, MEND PREDICTION MANUAL, (MEND Report 1.20.1, December 2009).

Rinse pH (on <2mm) - MEND PREDICTION MANUAL, (MEND Report 1.20.1, December 2009).

HCl Extractable Sulphur is based on a modified version of ASTM Method D 2492-02

HCl Extractable Sulphur and HNO3 Extractable Sulphur is based on a modified version of ASTM Method D 2492-02

Total sulphur, total carbon & carbonate carbon (CO2; HCl direct method) by Leco.

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Table 2: ABA QAQC Test Results for project Iqaluit Marine Infrastructure

Duplicate QC

Maxxam Sample No	Sample ID	Paste pH Reported	Paste pH Dup	Rinse pH (on <2mm) Reported	Rinse pH (on <2mm) Dup	CO2 Reported	CO2 Dup	Total S Reported	Total S Dup	HCl Extractable Sulphur Reported	HCl Extractable Sulphur Dup	HNO3 Extractable Sulphur Reported	HNO3 Extractable Sulphur Dup	Mod. ABA Neutralization Potential Reported	Mod. ABA Neutralization Potential Reported Dup	Fizz Rating Reported	Fizz Rating Dup
	Units	pH Units	pH Units	pH Units	pH Units	wt%	wt%	wt%	wt%	wt%	wt%	wt%	wt%	Kg CaCO3/T	Kg CaCO3/T	N/A	N/A
QJ7747 Dup	QA16-13					0.04	0.04										
QJ7750 Dup	QB16-11							<0.02	<0.02								
QJ7752 Dup	IQI16-03	9.17	9.16	9.50	9.49					0.01	0.01	0.04	0.03	12.8	12.0	SLIGHT	SLIGHT

Reference Material QC

	Paste pH	CO2	Total S	HCl Extractable Sulphur	HNO3 Extractable Sulphur	Mod. ABA Neutralization Potential Reported
Units	pH Units	wt%	wt%	wt%	wt%	Kg CaCO3/T
Reference Material						
ARD REF MAT GS311-1 (8537105) (2.32 wt%)			2.34			
ARD Spike C02 (8537132) (1.55 wt%)		1.46				
ARD-Paste pH 8.29 (8539266) (8.29 pH Units)	8.37					
KZK-1ModS Slight (8539269) (58.9 Kg CaCO3/T)						58.3
ARD SPIKE GS910-4 CS (8537105) (8.27 wt%)			7.99			
RS10 STD (0.06 % S)				0.05		
ARD Ref Mat DBOHC (0.27 wt%)				0.26		
ARD Ref Mat S-S (0.36 wt%)					0.36	
ARD Ref Mat DBOHN (0.26 wt%)					0.30	

Blank QC

	Paste pH	CO2	Total S	HCl Extractable Sulphur	HNO3 Extractable Sulphur	Mod. ABA Neutralization Potential Reported
Method Blank			<0.02			
Method Blank		<0.02				
Method Blank				<0.01	<0.01	0.0

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Table 3: Ultratrace Metals Test Results for project Iqaluit Marine Infrastructure

Maxxam Sample No	Sample ID	Mo	Cu	Pb	Zn	Ag	Ni	Co	Mn	Fe	As	U	Au	Th	Sr	Cd	Sb	Bi	V
	Units	ppm	ppm	ppm	ppm	ppb	ppm	ppm	ppm	%	ppm	ppm	ppb	ppm	ppm	ppm	ppm	ppm	ppm
QJ7743	QA16-03	1.71	2.50	3.54	33.1	15	2.5	1.5	87	1.99	<0.1	0.4	2.5	26.4	8.6	0.03	0.05	<0.02	5
QJ7744	QA16-06	1.95	3.32	2.22	45.5	7	2.2	2.1	278	3.38	<0.1	1.0	0.9	21.7	7.9	0.02	0.02	<0.02	3
QJ7745	QA16-08	1.23	2.41	2.17	38.0	10	2.1	2.3	230	2.48	<0.1	0.4	0.5	17.8	6.7	0.02	<0.02	<0.02	3
QJ7746	QA16-12	0.76	2.22	2.22	33.0	22	2.4	2.4	206	3.44	<0.1	0.9	<0.2	16.0	4.7	0.01	<0.02	<0.02	3
QJ7747	QA16-13	1.45	9.74	2.30	46.6	23	2.6	2.9	196	3.32	0.4	0.3	<0.2	11.8	3.8	0.14	0.02	0.02	3
QJ7748	QB16-02	0.93	6.10	0.93	81.9	11	3.5	4.3	298	3.10	0.1	0.1	0.3	1.4	5.0	0.02	<0.02	<0.02	14
QJ7749	QB16-05	0.82	5.57	0.83	12.6	12	2.8	2.9	108	2.08	<0.1	0.5	0.3	2.2	4.6	0.01	<0.02	<0.02	6
QJ7750	QB16-11	1.96	3.65	0.76	40.7	10	4.1	3.3	159	3.29	<0.1	0.1	0.3	0.5	6.0	0.02	<0.02	<0.02	14
QJ7751	IQI16-02	2.77	7.33	1.14	40.6	19	2.1	1.3	87	1.79	<0.1	0.2	0.9	2.5	3.3	0.06	<0.02	<0.02	3
QJ7752	IQI16-03	0.26	38.2	0.46	28.4	27	16.5	14.4	211	2.69	<0.1	<0.1	0.4	<0.1	13.1	0.02	<0.02	<0.02	189
QAQC																			
Duplicates																			
QJ7744 Dup	QA16-06	1.91	3.34	2.41	45.8	6	2.5	2.3	293	3.43	<0.1	1.0	0.9	22.7	8.3	0.01	0.03	<0.02	3
Blanks																			
Method Blank		<0.01	<0.01	<0.01	<0.1		<0.1	<0.1	<1		<0.1	<0.05		<0.1	<0.5	<0.01	<0.02	<0.002	<2
Method Blank						<2							<0.2						
Method Blank										<0.01									
Reference Material																			
DS10 ppm (8537352)		1.71	675.47	15.52	35		379.9	53	421		10.9	1.9		10.8	4	0.04	0.24	0.27	296
True Values DS10 ppm		**14.69**	**154.61**	**150.55**	**370**		**74.6**	**12.9**	**875**		**43.7**	**2.59**		**7.5**	**67.1**	**2.49**	**8.23**	**11.65**	**43**
Percent Difference (8537352)		-88.4	336.9	-89.7	-90.5		409.2	310.9	-51.9		-75.1	-26.6		44.0	-94.0	-98.4	-97.1	-97.7	588.4
Reference Material																			
REF OREAS45EA PPB (8537418)						272							56.3						
True Values REF OREAS45EA PPB						**260**							**53**						
Percent Difference (8537418)						4.6							6.2						
Reference Material																			
REF OREAS45EA (%) (8537424)										21.99									
True Values REF OREAS45EA										**23.51**									
Percent Difference (8537424)										-6.5									
Reference Material																			
DS10 ppm (8537352)		13.71	161.79	141.69	349.5		76.1	13.1	841		44.9	2.8		7.6	64.8	2.6	6.99	11.67	44
True Values DS10 ppm		**14.69**	**154.61**	**150.55**	**370**		**74.6**	**12.9**	**875**		**43.7**	**2.59**		**7.5**	**67.1**	**2.49**	**8.23**	**11.65**	**43**
Percent Difference (8537352)		-6.7	4.6	-5.9	-5.5		2.0	1.6	-3.9		2.7	8.1		1.3	-3.4	4.4	-15.1	0.2	2.3
Reference Material																			
DS10 ppb (8537418)						1859							44.7						
True Values DS10 ppb						**2020**							**91.9**						
Percent Difference (8537418)						-8.0							-51.4						
Reference Material																			
DS10 % (8537424)										2.72									
True Values DS10 %										**2.719**									
Percent Difference (8537424)										0.0									
Detection Limits		0.01	0.01	0.01	0.1	2	0.1	0.1	1	0.01	0.1	0.05	0.2	0.1	0.5	0.01	0.02	0.002	2
Maxxam SOP #		1F-MS	1F-MS	1F-MS	1F-MS	1F-MS	1F-MS	1F-MS	1F-MS	1F-MS	1F-MS	1F-MS	1F-MS	1F-MS	1F-MS	1F-MS	1F-MS	1F-MS	1F-MS

Maxxam Sample No	Sample ID	Ca	P	La	Cr	Mg	Ba	Ti	B	Al	Na	K	W	Sc	Tl	Hg	Se	Te	Ga	S
	Units	%	%	ppm	ppm	%	ppm	%	ppm	%	%	%	ppm	ppm	ppm	ppb	ppm	ppm	ppm	%
QJ7743	QA16-03	0.34	0.012	53.4	50.8	0.22	36.6	0.068	<20	0.30	0.027	0.16	<0.1	4.1	0.04	<5	<0.1	<0.02	4.8	<0.02
QJ7744	QA16-06	0.52	0.018	57.7	58.3	0.39	10.2	0.009	<20	0.79	0.022	0.05	<0.1	8.2	<0.02	<5	<0.1	<0.02	9.0	<0.02
QJ7745	QA16-08	0.35	0.016	46.3	55.4	0.50	42.4	0.073	<20	0.55	0.026	0.20	<0.1	9.7	0.06	<5	<0.1	<0.02	5.1	<0.02
QJ7746	QA16-12	0.15	0.011	47.9	69.5	0.90	75.3	0.141	<20	1.15	0.027	0.38	<0.1	12.1	0.08	<5	<0.1	<0.02	9.6	<0.02
QJ7747	QA16-13	0.09	0.006	32.2	78.2	0.80	77.4	0.153	<20	0.83	0.025	0.40	<0.1	11.4	0.12	<5	<0.1	<0.02	7.6	0.03
QJ7748	QB16-02	0.50	0.039	20.8	62.5	0.45	19.5	0.015	<20	0.84	0.030	0.07	<0.1	3.8	<0.02	<5	<0.1	<0.02	6.0	<0.02
QJ7749	QB16-05	0.59	0.044	20.3	72.9	0.29	6.6	0.088	<20	0.43	0.087	0.03	<0.1	4.4	<0.02	<5	<0.1	<0.02	4.2	<0.02
QJ7750	QB16-11	0.38	0.057	31.9	78.4	0.24	20.3	0.036	<20	0.38	0.072	0.08	<0.1	4.6	<0.02	<5	<0.1	<0.02	5.6	<0.02
QJ7751	IQI16-02	0.11	0.023	19.3	65.7	0.24	37.7	0.069	<20	0.28	0.025	0.17	<0.1	5.3	0.04	<5	<0.1	<0.02	4.2	<0.02
QJ7752	IQI16-03	0.90	0.066	5.8	73.9	0.35	29.7	0.091	<20	0.60	0.115	0.09	<0.1	7.5	<0.02	<5	<0.1	<0.02	3.8	0.10
QAQC																				
Duplicates																				
QJ7744 Dup	QA16-06	0.53	0.017	60.3	61.9	0.39	10.9	0.009	<20	0.80	0.022	0.05	<0.1	8.3	<0.02	<5	<0.1	<0.02	9.5	<0.02
Blanks																				
Method Blank				<0.5	<0.5		<0.5		<20				<0.05	<0.1	<0.02		<0.1	<0.02	<0.1	
Method Blank																<5				
Method Blank		<0.01	<0.001			<0.01		<0.001		<0.01	<0.001	<0.01								<0.02
Reference Material																				
DS10 ppm (8537352)				7.8	926.7		153.2						<0.05	76.8	0.06		0.7	0.07	13.2	
True Values DS10 ppm				**17.5**	**54.6**		**359**						**3.32**	**2.8**	**5.1**		**2.3**	**5.01**	**4.3**	
Percent Difference (8537352)				-55.4	1597.3		-57.3						-100.0	2642.9	-98.8		-69.6	-98.6	207.0	
Reference Material																				
REF OREAS45EA PPB (8537418)																10				
True Values REF OREAS45EA PPB																**10**				
Percent Difference (8537418)																0.0				
Reference Material																				
REF OREAS45EA (%) (8537424)		0.03	0.027			0.09		0.103		3.25	0.024	0.05								0.04
True Values REF OREAS45EA		**0.036**	**0.029**			**0.095**		**0.106**		**3.32**	**0.02**	**0.053**								**0.036**
Percent Difference (8537424)		-16.7	-6.9			-5.3		-2.8		-2.1	20.0	-5.7								11.1
Reference Material																				
DS10 ppm (8537352)				17	53.7		387.1						2.9	2.6	4.78		1.9	4.64	4.2	
True Values DS10 ppm				**17.5**	**54.6**		**359**						**3.32**	**2.8**	**5.1**		**2.3**	**5.01**	**4.3**	
Percent Difference (8537352)				-2.9	-1.6		7.8						-12.7	-7.1	-6.3		-17.4	-7.4	-2.3	
Reference Material																				
DS10 ppb (8537418)																281				
True Values DS10 ppb																**300**				
Percent Difference (8537418)																-6.3				
Reference Material																				
DS10 % (8537424)		1.06	0.074			0.79		0.08		1.04	0.072	0.34								0.28
True Values DS10 %		**1.09**	**0.079**			**0.81**		**0.077**		**1.06**	**0.066**	**0.35**								**0.3**
Percent Difference (8537424)		-2.8	-6.3			-2.5		3.9		-1.9	9.1	-2.9								-6.7
Detection Limits		0.01	0.001	0.5	0.5	0.01	0.5	0.001	20	0.01	0.001	0.01	0.05	0.1	0.02	5	0.1	0.02	0.1	0.02
Maxxam SOP #		1F-MS	1F-MS	1F-MS	1F-MS	1F-MS	1F-MS	1F-MS	1F-MS	1F-MS	1F-MS	1F-MS	1F-MS	1F-MS	1F-MS	1F-MS	1F-MS	1F-MS	1F-MS	1F-MS

Maxxam

Maxxam Analytics 4606 Canada Way, Burnaby, BC Canada V5G 1K5 Tel: 604 734 7276 Fax: 604 731 2386 www.maxxam.ca

Client: WORLEYPARSONS CANADA SERVICES

Table 4: MEND SFE Test Results for project Iqaluit Marine Infrastructure

Maxxam Sample No	Sample ID	Sample Weight	Volume Used	pH	EC	ORP	SO4	Acidity to pH4.5	Acidity to pH8.3	Total Alkalinity	Bicarbonate	Carbonate	Hydroxide
	Units	g	ml	pH Units	uS/cm	mV	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
QJ7744	QA16-06	250	750	9.42	53.2	120	1.0	<0.5	<0.5	17	21	<0.5	<0.5
QJ7745	QA16-08	250	750	9.35	69.2	120	0.6	<0.5	<0.5	23	28	<0.5	<0.5
QJ7747	QA16-13	250	750	9.31	48.5	160	0.5	<0.5	<0.5	17	20	<0.5	<0.5
QAQC													
Duplicates													
QJ7744 Dup	QA16-06						0.6	<0.5	<0.5	17	21	<0.5	<0.5
QJ7747 Dup	QA16-13						<0.5						
QK7791	QA16-08 SFE SPLIT DUP	250	750	9.45	65.9	120	0.8	<0.5	<0.5	25	31	<0.5	<0.5
Blanks													
Method Blank		0	750	5.74	1.1	360	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Method Blank													
Method Blank										<0.5	<0.5	<0.5	<0.5
Method Blank										<0.5	<0.5	<0.5	<0.5
Method Blank								<0.5	<0.5				
Method Blank													
Method Blank													
Method Blank							0.6						
Method Blank													
Reference Material													
Alkalinity W Soln' B (8538176) % Recovery										96.76471			
Alkalinity W Soln' B (8538180) % Recovery										101.63866			
True Values Alkalinity W Soln' B										**47.6**			
Reference Material													
Acidity 8.3 W-Van (8538628) % Recovery									101.71053				
True Values Acidity 8.3 W-Van									**100**				
Reference Material													
CRC ICPMS H2O 10 ppb (8538835) % Recovery													
True Values CRC ICPMS H2O 10 ppb													
Reference Material													
Chloride W K-Van (8540070) % Recovery													
True Values Chloride W K-Van													
Percent Difference (8540070)													
Reference Material													
Sulphate W K-Van (8540071) % Recovery							91.06000						
True Values Sulphate W K-Van							**20**						
Reference Material													
Fluoride water (8540554) % Recovery													
True Values Fluoride water													
Detection Limits				*N/A*	*0.5*		*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*
Maxxam SOP #		*BBY0SOP-00*	*Y0SOP-000*	*Y0SOP-000*	*BBY0SOP-00006*	*Y0SOP-00*	*Y6SOP-000*	*BY6SOP-0003*	*BBY6SOP-00037*	*BBY6SOP-00026*	*BY6SOP-0002*	*BY6SOP-0002*	*BY6SOP-0002*

References:
Hardness = (Calcium*2.497) + (Magnesium*4.118)

Standard Methods for the Examination of Water and Wastewater, 22nd Edition, 2012, Oxidation-Reduction Potential measurement in Clean Water, 2580 B

Table 4: MEND SFE Test Results for project Iqaluit Marine Infrastructure

Maxxam Sample No	Sample ID	Fluoride	Dissolved Chloride	Hardness CaCO3	Dissolved Aluminum (Al)	Dissolved Antimony (Sb)	Dissolved Arsenic (As)	Dissolved Barium (Ba)	Dissolved Beryllium (Be)	Dissolved Bismuth (Bi)	Dissolved Boron (B)	Dissolved Cesium (Cs)	Dissolved Cadmium (Cd)	Dissolved Calcium (Ca)
	Units	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
QJ7744	QA16-06	0.04	2.9	13.8	0.454	0.000298	0.000349	0.00156	<0.000010	<0.0000050	<0.050	<0.000050	<0.0000050	4.93
QJ7745	QA16-08	0.10	2.4	12.0	0.383	0.000113	0.000298	0.00216	<0.000010	<0.0000050	<0.050	<0.000050	<0.0000050	3.47
QJ7747	QA16-13	0.09	1.4	11.8	0.442	0.000081	0.000206	0.00200	<0.000010	<0.0000050	<0.050	<0.000050	<0.0000050	3.57
QAQC														
Duplicates														
QJ7744 Dup	QA16-06	0.03	2.8											
QJ7747 Dup	QA16-13		1.5											
QK7791	QA16-08 SFE SPLIT DUP	0.09	2.2	11.2	0.436	0.000075	0.000172	0.00247	<0.000010	<0.0000050	<0.050	<0.000050	<0.0000050	3.17
Blanks														
Method Blank		<0.01	<0.5	<0.50	<0.00050	<0.000020	<0.000020	<0.000020	<0.000010	<0.0000050	<0.050	<0.000050	<0.0000050	<0.050
Method Blank					<0.00050	<0.000020	<0.000020	<0.000020	<0.000010	<0.0000050	<0.050	<0.000050	<0.0000050	<0.050
Method Blank														
Method Blank														
Method Blank														
Method Blank					<0.00050	<0.000020	<0.000020	<0.000020	<0.000010	<0.0000050	<0.050	<0.000050	<0.0000050	<0.050
Method Blank			<0.5											
Method Blank														
Method Blank		<0.01												
Reference Material														
Alkalinity W Soln' B (8538176) % Recovery														
Alkalinity W Soln' B (8538180) % Recovery														
True Values Alkalinity W Soln' B														
Reference Material														
Acidity 8.3 W-Van (8538628) % Recovery														
True Values Acidity 8.3 W-Van														
Reference Material														
CRC ICPMS H2O 10 ppb (8538835) % Recovery					112.13700	104.90000	102.61000	106.29000	111.00000	95.20000	111.38400	96.70000	100.18000	
True Values CRC ICPMS H2O 10 ppb					**100**	**1**	**10**	**10**	**10**	**1**	**100**	**1**	**10**	
Reference Material														
Chloride W K-Van (8540070) % Recovery			92.65000											
True Values Chloride W K-Van			**20**											
Percent Difference (8540070)			363.3											
Reference Material														
Sulphate W K-Van (8540071) % Recovery														
True Values Sulphate W K-Van														
Reference Material														
Fluoride water (8540554) % Recovery		98.0												
True Values Fluoride water		**0.5**												
Detection Limits		*0.01*	*0.5*	*0.50*	*0.00050*	*0.000020*	*0.000020*	*0.000020*	*0.000010*	*0.0000050*	*0.050*	*0.000050*	*0.0000050*	*0.050*
Maxxam SOP #	*BB*	*BBY6SOP-0004*	*BY6SOP-0001*	*BBY WI-00033*	*BY7SOP-0000*	*BY7SOP-0000*	*Y7SOP-000*	*BY7SOP-0000*	*BY7SOP-0000*	*Y7SOP-000*	*BY7SOP-0000*	*BY7SOP-0000*	*BY7SOP-0000*	*BY7SOP-0000*

References:

Hardness = (Calcium*2.497) + (Magnesium*4.118)

Standard Methods for the Examination of Water and Wastewater, 22nd Edition, 2012, Oxidatior

Table 4: MEND SFE Test Results for project Iqaluit Marine Infrastructure

Maxxam Sample No	Sample ID	Dissolved Chromium (Cr)	Dissolved Cobalt (Co)	Dissolved Copper (Cu)	Dissolved Lanthanum (La)	Dissolved Iron (Fe)	Dissolved Lead (Pb)	Dissolved Lithium (Li)	Dissolved Magnesium (Mg)	Dissolved Manganese (Mn)	Dissolved Phosphorus (P)	Dissolved Molybdenum (Mo)	Dissolved Nickel (Ni)	Dissolved Potassium (K)
	Units	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
QJ7744	QA16-06	<0.00010	<0.0000050	0.00378	<0.000050	0.0080	0.0000260	0.00091	0.357	0.00189	0.0113	0.000937	0.000051	1.58
QJ7745	QA16-08	<0.00010	0.0000070	0.000220	<0.000050	0.0298	0.0000260	0.00172	0.813	0.00252	0.0090	0.000499	0.000050	2.67
QJ7747	QA16-13	<0.00010	0.0000050	0.000290	<0.000050	0.0281	0.0000230	0.00143	0.701	0.00221	0.0077	0.000738	<0.000020	2.40
QAQC														
Duplicates														
QJ7744 Dup	QA16-06													
QJ7747 Dup	QA16-13													
QK7791	QA16-08 SFE SPLIT DUP	<0.00010	0.0000060	0.000254	<0.000050	0.0506	0.0000320	0.00149	0.808	0.00316	0.0098	0.000399	0.000042	2.51
Blanks														
Method Blank		<0.00010	<0.0000050	<0.000050	<0.000050	<0.0010	<0.0000050	<0.00050	<0.050	<0.000050	0.0048	<0.000050	<0.000020	<0.050
Method Blank		<0.00010	<0.0000050	<0.000050	<0.000050	<0.0010	<0.0000050	<0.00050	<0.050	<0.000050	0.0034	<0.000050	<0.000020	<0.050
Method Blank														
Method Blank														
Method Blank														
Method Blank		<0.00010	<0.0000050	<0.000050	<0.000050	<0.0010	<0.0000050	<0.00050	<0.050	0.000087	0.0028	<0.000050	0.000027	<0.050
Method Blank														
Method Blank														
Method Blank														
Reference Material														
Alkalinity W Soln' B (8538176) % Recovery														
Alkalinity W Soln' B (8538180) % Recovery														
True Values Alkalinity W Soln' B														
Reference Material														
Acidity 8.3 W-Van (8538628) % Recovery														
True Values Acidity 8.3 W-Van														
Reference Material														
CRC ICPMS H2O 10 ppb (8538835) % Recovery		104.12000	107.02000	104.66000	97.90000	105.62500	99.22000	117.39000		102.74000		105.90000	108.13000	
True Values CRC ICPMS H2O 10 ppb		**10**	**10**	**10**	**1**	**100**	**10**	**10**		**10**		**1**	**10**	
Reference Material														
Chloride W K-Van (8540070) % Recovery														
True Values Chloride W K-Van														
Percent Difference (8540070)														
Reference Material														
Sulphate W K-Van (8540071) % Recovery														
True Values Sulphate W K-Van														
Reference Material														
Fluoride water (8540554) % Recovery														
True Values Fluoride water														
Detection Limits		*0.00010*	*0.0000050*	*0.000050*	*0.000050*	*0.0010*	*0.0000050*	*0.00050*	*0.050*	*0.000050*	*0.0020*	*0.000050*	*0.000020*	*0.050*
Maxxam SOP #	*BB*	*BBY7SOP-00002*	*BBY7SOP-00002*	*BY7SOP-0000*	*BY7SOP-0000*	*BY7SOP-0000*	*BY7SOP-0000*	*BY7SOP-0000*	*BY7SOP-0000*	*BY7SOP-0000*	*BY7SOP-0000*	*BY7SOP-0000*	*BY7SOP-0000*	*BY7SOP-0000*

References:

Hardness = (Calcium*2.497) + (Magnesium*4.118)

Standard Methods for the Examination of Water and Wastewater, 22nd Edition, 2012, Oxidatior

Table 4: MEND SFE Test Results for project Iqaluit Marine Infrastructure

Maxxam Sample No	Sample ID	Dissolved Rubidium (Rb)	Dissolved Selenium (Se)	Dissolved Silicon (Si)	Dissolved Silver (Ag)	Dissolved Sodium (Na)	Dissolved Strontium (Sr)	Dissolved Sulphur (S)	Dissolved Tellurium (Te)	Dissolved Thallium (Tl)	Dissolved Thorium (Th)	Dissolved Tin (Sn)	Dissolved Titanium (Ti)	Dissolved Tungsten (W)
	Units	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
QJ7744	QA16-06	0.00229	<0.000040	1.65	<0.0000050	2.07	0.0121	<10	0.000065	0.0000030	<0.0000050	<0.00020	<0.00050	0.000139
QJ7745	QA16-08	0.00248	<0.000040	2.52	<0.0000050	5.09	0.00974	<10	0.000054	0.0000020	0.0000050	<0.00020	0.00083	0.000029
QJ7747	QA16-13	0.00353	<0.000040	1.70	<0.0000050	1.62	0.00739	<10	0.000046	0.0000030	<0.0000050	<0.00020	0.00133	0.000020
QAQC														
Duplicates														
QJ7744 Dup	QA16-06													
QJ7747 Dup	QA16-13													
QK7791	QA16-08 SFE SPLIT DUP	0.00230	<0.000040	2.70	<0.0000050	5.70	0.00930	<10	0.000028	0.0000020	0.0000150	<0.00020	0.00107	0.000021
Blanks														
Method Blank		<0.000050	<0.000040	<0.10	<0.0000050	<0.050	<0.000050	<10	0.000083	<0.0000020	<0.0000050	<0.00020	<0.00050	<0.000010
Method Blank		<0.000050	<0.000040	<0.10	<0.0000050	<0.050	<0.000050	<10	0.000058	<0.0000020	<0.0000050	<0.00020	<0.00050	<0.000010
Method Blank														
Method Blank														
Method Blank														
Method Blank		<0.000050	<0.000040	<0.10	<0.0000050	<0.050	<0.000050	<10	<0.000020	<0.0000020	<0.0000050	<0.00020	<0.00050	<0.000010
Method Blank														
Method Blank														
Method Blank														
Reference Material														
Alkalinity W Soln' B (8538176) % Recovery														
Alkalinity W Soln' B (8538180) % Recovery														
True Values Alkalinity W Soln' B														
Reference Material														
Acidity 8.3 W-Van (8538628) % Recovery														
True Values Acidity 8.3 W-Van														
Reference Material														
CRC ICPMS H2O 10 ppb (8538835) % Recovery			106.33000		102.70000		99.38000		118.70000	98.80000		104.50000	95.00000	
True Values CRC ICPMS H2O 10 ppb			**10**		**1**		**10**		**1**	**1**		**1**	**10**	
Reference Material														
Chloride W K-Van (8540070) % Recovery														
True Values Chloride W K-Van														
Percent Difference (8540070)														
Reference Material														
Sulphate W K-Van (8540071) % Recovery														
True Values Sulphate W K-Van														
Reference Material														
Fluoride water (8540554) % Recovery														
True Values Fluoride water														
Detection Limits		*0.000050*	*0.000040*	*0.10*	*0.0000050*	*0.050*	*0.000050*	*10*	*0.000020*	*0.0000020*	*0.0000050*	*0.00020*	*0.00050*	*0.000010*
Maxxam SOP #	*BB'*	*BY7SOP-0000*	*BY7SOP-0000*	*BY7SOP-0000*	*BY7SOP-0000*	*BY7SOP-0000*	*Y7SOP-000*	*Y7SOP-000*	*BY7SOP-0000*	*BY7SOP-0000*	*BY7SOP-0000*	*BY7SOP-0000*	*BY7SOP-0000*	*BY7SOP-0000*

References:
Hardness = (Calcium*2.497) + (Magnesium*4.118)

Standard Methods for the Examination of Water and Wastewater, 22nd Edition, 2012, Oxidatior

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Table 4: MEND SFE Test Results for project Iqaluit Marine Infrastructure

Maxxam Sample No	Sample ID	Dissolved Uranium (U)	Dissolved Vanadium (V)	Dissolved Zinc (Zn)	Dissolved Zirconium (Zr)	Anion Sum	Cation Sum	Balance %
	Units	mg/L	mg/L	mg/L	mg/L	N/A	N/A	N/A
QJ7744	QA16-06	0.0000420	0.00021	0.00026	<0.00010	0.449	0.456	-0.800
QJ7745	QA16-08	0.0000530	0.00020	0.00011	<0.00010	0.543	0.573	-2.70
QJ7747	QA16-13	0.0000140	<0.00020	0.00015	<0.00010	0.389	0.418	-3.60
QAQC								
Duplicates								
QJ7744 Dup	QA16-06							
QJ7747 Dup	QA16-13							
QK7791	QA16-08 SFE SPLIT DUP	0.0000470	0.00023	0.00029	<0.00010	0.582	0.587	-0.400
Blanks								
Method Blank		<0.0000020	<0.00020	0.00021	<0.00010			
Method Blank		<0.0000020	<0.00020	0.00022	<0.00010			
Method Blank								
Method Blank								
Method Blank								
Method Blank		<0.0000020	<0.00020	<0.00010	<0.00010			
Method Blank								
Method Blank								
Method Blank								
Reference Material								
Alkalinity W Soln' B (8538176) % Recovery								
Alkalinity W Soln' B (8538180) % Recovery								
True Values Alkalinity W Soln' B								
Reference Material								
Acidity 8.3 W-Van (8538628) % Recovery								
True Values Acidity 8.3 W-Van								
Reference Material								
CRC ICPMS H2O 10 ppb (8538835) % Recovery		104.18000	103.51000	105.36000				
True Values CRC ICPMS H2O 10 ppb		**10**	**10**	**10**				
Reference Material								
Chloride W K-Van (8540070) % Recovery								
True Values Chloride W K-Van								
Percent Difference (8540070)								
Reference Material								
Sulphate W K-Van (8540071) % Recovery								
True Values Sulphate W K-Van								
Reference Material								
Fluoride water (8540554) % Recovery								
True Values Fluoride water								
Detection Limits		*0.0000020*	*0.00020*	*0.00010*	*0.00010*			
Maxxam SOP #		*BBY7SOP-0000*	*BY7SOP-0000*	*BY7SOP-0000*	*BY7SOP-00002*	*BBY WI-00033*	*BBY WI-00033*	*BBY WI-00033*

References:

Hardness = (Calcium*2.497) + (Magnesium*4.118)

Standard Methods for the Examination of Water and Wastewater, 22nd Edition, 2012, Oxidatior

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Client: WORLEYPARSONS CANADA SERVICES

Table 5: Sample List for project Iqaluit Marine Infrastructure

Maxxam Sample ID	Client Sample ID	Sample Form	Dry Weight Received (kg)
QJ7743	QA16-03	Dry Coarse Rock	1.877
QJ7744	QA16-06	Dry Coarse Rock	1.132
QJ7745	QA16-08	Dry Coarse Rock	1.800
QJ7746	QA16-12	Dry Coarse Rock	1.397
QJ7747	QA16-13	Dry Coarse Rock	1.592
QJ7748	QB16-02	Dry Coarse Rock	1.609
QJ7749	QB16-05	Dry Coarse Rock	0.704
QJ7750	QB16-11	Dry Coarse Rock	1.292
QJ7751	IQI16-02	Dry Coarse Rock	0.974
QJ7752	IQI16-03	Dry Coarse Rock	1.878
		Total Weight	14.26
		Total Samples Received	10

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Table 6: Sample Summary for project STILL CREEK

WORLEYPARSONS CANADA SERVICES , 4321 STILL CREEK BURNABY

Date Samples Rec'd by Maxxam:	12 sample were rec'd on 13-Jan-2017.
Sample Prep Conducted by Maxxam:	YES
Date of Analysis:	January 2017

Client:	WORLEYPARSONS CANADA SERVICES
Client Project Name:	STILL CREEK
Client Project No:	
ARD Project #:	
Maxxam Job No:	B702697
Contact Person:	Jeff Gibson, Cheibany Ould Elemine
E-mail Address:	**jeffrey.gibson@advisian.com; cheibany.elemine@advisian.com**

Data Validated by:	SAID ZEINAB
Position:	Senior Manager, Acid Rock Drainage

Sample Storage

Sample rejects (and selected test residues where applicable) have been archived
Standard archive protocol is archiving for samples for 3 months after testing is complete.
If archiving is required past 3 months a fee will be required.

Appendix 2 Vegetation Species List

Appendix 2 – Vegetation Species List

Table 1 List of Vegetation Species in the Iqaluit Study Area

Vegetation Species		Vegetation Community				
Latin Name and Authority	**Common Name**	**UB-SS**	**USC**	**US**	**UDS**	**WDS**
Shrubs						
Arctostaphylos rubra (Rehder & Wilson) Fernald	red fruit bearberry	Y	---	Y	---	---
Cassiope tetragona (L.) D. Don	white arctic mountain heather	Y	---	Y	Y	---
Dryas integrifolia Vahl	entire leaf mountain-avens	Y	---	Y	Y	---
Empetrum nigrum L.	black crowberry	D	Y	D	D	---
Rhododendron lapponicum (L.) Wahlenb.	Lapland rosebay	Y	---	---	---	---
Salix spp.[1]	willow species	Y	Y	Y	Y	---
Vaccinium vitis-idaea L.	lingonberry	Y	Y	---	Y	---
Vaccinium uliginosum L.	bog blueberry	D	---	D	D	---
Graminoids		---	---	---	---	---
Carex spp.	sedge species	---	---	Y	Y	---
Eriophorum angustifolium Honck.	tall cottongrass	Y	---	---	---	---
Graminoid spp.	grass species	Y	---	D	Y	---
Poa glauca Vahl	glaucous bluegrass	---	D	---	---	---
Forbs						
Armeria maritima (Mill.) Willd.	thrift seapink	Y	D	---	---	---
Astragalus spp.	milkvetch species	---	---	---	Y	---
Bistorta viviparum L.	alpine bistort	Y	Y	Y	---	---
Cardamine bellidifolia L.	alpine bittercress	---	---	---	---	---
Cerastium arcticum Lange	mouse-ear chickweed	---	Y	---	Y	---
Chamerion latifolium L.	dwarf fireweed	Y	Y	Y	Y	---
Cochlearia groenlandica L.	Danish scurvygrass	---	Y	---	---	---
fern col.		---	Y	---	---	---
Hieracium alpinum L.	alpine hawkweed	---	---	---	Y	---
Lycopodium alpinum L.	alpine clubmoss	Y	---	Y	---	---
Oxyria digyna (L.) Hill	alpine mountainsorrel	Y	---	---	---	---
Pedicularis spp.	lousewort species	Y	---	---	Y	---
Potentilla nana Willd. ex Schlecht.	arctic cinquefoil	Y	Y	---	---	---
Silene acaulis (L.) Jacq.	moss campion	Y	Y	Y	Y	---

Vegetation Species		Vegetation Community				
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Silene involucrata (Cham. & Schlecht.) Bocquet	arctic catchfly	Y	---	---	---	---
Saxifraga cernua L.	nodding saxifrage	Y	Y	---	Y	---
Saxifraga rivularis L. var. *hyperborea* (R. Br.) Dorn	pygmy saxifrage	---	---	---	---	---
Saxifraga tricuspidata Rottb.	three toothed saxifrage	Y	---	---	---	---
Stellaria spp.	chickweed species	Y	---	---	---	---
Pyrola grandiflora Radius	largeflowered wintergreen	Y	---	---	Y	---
Non-vasculars						
Alectoria ochroleuca (Hoffm.) A. Massal.	witch's hair lichen	Y	---	Y	---	---
Allantoparmelia almquistii (Vain.) Essl.	Almquist's allantoparmelia lichen	---	---	Y	---	---
Arctocetraria nigricascens (Nyl.) Karnefelt & A. Thell	lichen	Y	---	Y	---	---
Arctoparmelia centrifuga (L.) Hale	arctoparmelia lichen	Y	---	---	---	---
Arctoparmelia incurva (Pers.) Hale	arctoparmelia lichen	Y	Y	Y	---	---
Arctoparmelia separata (Th. Fr.) Hale	arctoparmelia lichen	Y	---	---	---	Y
Asahinea chrysantha (Tuck.) W.L. Culb. & C.F. Culb.	golden asahinea lichen	---	---	Y	---	---
Aulacomnium palustre (Hedw.) Schwaegr.	aulacomnium moss	Y	---	Y	Y	---
Bryocaulon divergens (Ach.) Karnefelt	bryocaulon lichen	Y	---	---	---	---
Bryophyte spp.	moss	Y	D	---	---	---
Bryoria nitidula (Th. Fr.) Brodo & D. Hawksw.	horsehair lichen	Y	---	---	---	---
Candelariella terrigina Räsänen	lichen	---	---	---	---	---
Cetraria ericetorum Opiz	certarian lichen	Y	Y	---	Y	---
Cetraria islandica (L.) Ach.	island cetraria lichen	Y	---	---	---	---
Cladina spp.	lichen	Y	---	---	---	---
Cladonia arbuscula (Wallr.) Flotow ssp. *mitis* (Sandst.) Ruoss	reindeer lichen	---	---	---	---	---
Cladonia borealis S. Stenroos	boreal cup lichen	Y	---	Y	---	---
Cladonia chlorophaea (Flörke ex Sommerf.) Spreng.	cup lichen	---	---	Y	---	---
Cladonia coccifera (L.) Willd.	cup lichen	---	Y	Y	---	---
Cladonia deformis (L.) Hoffm.	deformed cup lichen	Y	---	---	---	---
Cladonia gracilis (L.) Willd.	cup lichen	Y	Y	Y	---	---
Cladonia macrophylla (Schaerer) Stenh.	largeleaf cup lichen	Y	---	---	---	---

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Cladonia pleurota (Flörke) Schaerer	cup lichen	Y	---	---	---	---
Cladonia pocillum (Ach.) Grognot	cup lichen	---	Y	Y	---	---
Cladonia pyxidata (L.) Hoffm.	cup lichen	Y	Y	---	---	---
Cladonia spp.	cup lichen	Y	Y	---	---	---
Dactylina arctica (Richardson) Nyl.	arctic dactylina lichen	Y	---	---	Y	---
Dicranum spp.	dicranum moss	Y	---	Y	Y	---
Flavocetraria cucullata (Bellardi) Karnefelt & A. Thell	lichen	---	---	Y	---	---
Flavocetraria nivalis (L.) Karnefelt & A. Thell	lichen	Y	Y	Y	---	---
Hylocomium splendens (Hedw.) Schimp. in B.S.G.	splendid feather moss	Y	---	---	---	---
Hypogymnia subobscura (Vain.) Poelt	tube lichen	Y	---	---	---	---
Lecanora cenisia Ach.	rim lichen	Y	---	---	---	---
Lecidella euphorea (Flörke) Hertel	lecidella lichen	Y	---	---	---	---
Lichen crustose black	crustose lichen	D	---	D	---	D
Lichen crustose white	crustose lichen	Y	---	---	---	---
Lichen crustose gray	crustose lichen	D	---	D	---	Y
Megaspora verrucosa (Ach.) Hafellner & V. Wirth	megaspora lichen	Y	---	---	---	---
Ochrolechia frigida (Sw.) Lynge	cold crabseye lichen	---	Y	---	---	---
Ochrolechia upsaliensis (L.) A. Massal.	Upsala crabseye lichen	---	---	---	---	---
Pannaria pezizoides (Weber) Trevis.	matted lichen	---	---	---	Y	---
Parmelia omphalodes (L.) Ach.	shield lichen	Y	---	Y	---	---
Parmelia saxatilis (L.) Ach.	shield lichen	Y	---	---	---	---
Peltigera aphthosa (L.) Willd.	felt lichen	---	---	---	Y	---
Peltigera leucophlebia (Nyl.) Gyel	felt lichen	Y	---	---	Y	---
Pertusaria dactylina (Ach.) Nyl.	pore lichen	---	---	---	---	---
Phylliscum demangeoni (Moug. & Mont.) Nyl.	Demangeon's phylliscum lichen	Y	---	---	---	---
Physcia caesia (Hoffm.) Furnr.	rosette lichen	---	Y	---	---	---
Physcia dubia (Hoffm.) Lettau	rosette lichen	---	Y	---	---	---
Pleurozium schreberi (Brid.) Mitt.	Schreber's big red stem moss	y	---	---	---	---
Pohlia wahlenbergii (F. Weber & D. Mohr) Andrews	Wahlenberg's pohlia moss	D	---	Y	Y	---
Polytrichnum spp.	hair-cap moss	Y	---	Y	Y	---

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Protoparmelia badia (Hoffm.) Hafellner	protoparmelia lichen	Y	---	Y	---	---
Pertusaria dactylina (Ach.) Nyl.	pore lichen	---	---	---	---	Y
Pseudephebe minuscula (Nyl. ex Arnold) Brodo & D. Hawksw.	blackcurly lichen	Y	---	---	---	---
Pseudephebe pubescens (L.) M. Choisy	blackcurly lichen	Y	---	---	---	---
Ptilium spp.	moss	Y	---	Y	Y	---
Rhizocarpon geographicum (L.) DC.	world map lichen	Y	---	Y	---	Y
Sphaerophorus fragilis (L.) Pers.	fragile ball lichen	Y	---	Y	---	---
Sphaerophorus globosus (Huds.) Vain.	globe ball lichen	Y	Y	Y	---	---
Stereocaulon alpinum Laurer ex Funck	alpine snow lichen	---	---	---	D	---
Stereocaulon rivulorum H. Magn.	snow lichen	---	Y	---	---	---
Stereocaulon sp	lichen	---	---	Y	---	Y
Teloschistes flavicans (Sw.) Norman	teloschistes lichen	---	---	---	---	---
Thamnolia subuliformis (Ehrh.) W.L. Culb.	whiteworm lichen	---	---	---	Y	---
Thamnolia vermicularis (Sw.) Ach. ex Schaerer	whiteworm lichen	Y	D	---	---	---
Umbilicaria arctica (Ach.) Nyl.	arctic navel lichen	---	---	Y	---	---
Umbilicaria cylindrica (L.) Delise ex Duby	cylindric navel lichen	Y	---	Y	---	---
Umbilicaria deusta (L.) Baumg.	navel lichen	---	---	---	---	---
Umbilicaria havaasii Llano	Havaas' navel lichen	Y	---	Y	---	---
Umbilicaria hyperborea (Ach.) Hoffm.	navel lichen	Y	---	Y	---	Y
Umbilicaria mammulata (Ach.) Tuck.	navel lichen	Y	---	---	---	---
Umbilicaria proboscidea (L.) Schrad.	navel lichen	Y	---	---	---	Y
Umbilicaria torrefacta (Lightf.) Schrad.	navel lichen	Y	---	---	---	---
Umbilicaria virginis Schaerer	navel lichen	Y	Y	---	---	Y
Xanthoria elegans (Link) Th. Fr.	elegant orange wall lichen	Y	Y	---	---	---

Notes:

1 Willow species were examined for specific characteristics that would indicate they could be the rare species.

'Y' denotes species present within vegetation community

'D' denotes species is dominant within vegetation community

-- denotes species is not present within vegetation community