Fisheries and Oceans Canada | Pêches et Océans Canada

Clyde River Harbour Development

Environmental and Socio-Economic Baseline Survey

14 January 2020

307071-01306 – 00-EN-REP-0001

Advisian
Suite 500, 4321 Still Creek Drive
Burnaby, BC V5C 6S7 CANADA
Phone: +1 604 298 1616
Facsimile: +1 604 298 1625
www.advisian.com

Advisian
Worley Group

Project No. 307071-01306-00-EN-REP-0001 - Clyde River Harbour Development: Environmental and Socio-Economic Baseline Survey

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0	Issued for Use	V. Burdett-Coutts	M.E. Scott	H. Kullmann	20-Dec-19
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Any questions concerning the information or its interpretation should be directed to Victoria Burdett-Coutts, Author or Margaret Scott, Reviewer.

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Abbreviations and Acronyms

Term	Definition
AFA	Arctic Fishery Alliance
AIA	Archaeological Impact Assessment
AOPS	Arctic and Offshore Patrol Ships
BV	Bureau Veritas
CALA	Canadian Association for Laboratory Accreditation Inc.
CEAA	*Canadian Environmental Assessment Act*
CCME	Canadian Council of Ministers of the Environment
CEMP	Construction Environmental Management Plan
CIRNAC	Crown-Indigenous Relations and Northern Affairs Canada
CNWA	*Canadian Navigable Waters Act*
COC	Chain of Custody
COP	Conference of the Parties to the Convention on Biological Diversity
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
CRHDR	Clyde River Harbour Development Report
CSF	Coastal Shoreline and Flats
CTD	Conductivity, Temperature, and Depth
DAS	Disposal at Sea
DFO	Fisheries and Oceans Canada
DFO-FAA	DFO – Fisheries Act Authorization
DFO-FFHPP	DFO - Fish Habitat Protection Program
DFO-SCH	DFO - Small Craft Harbours
DHC	Disturbed Human-Caused
EBSAs	Ecologically and Biologically Significant Areas

Term	Definition
ECCC	Environment and Climate Change Canada
EEZ	Canada's Exclusive Economic Zone
EIA	Environmental Impact Assessment
ELC	Ecological Land Classification
EquIS	Environmental Quality Information System
ESES	Environmental and Socio-Economic Survey
ESWG	Ecological Stratification Working Group
FAA	Fisheries Act Authorization
FAO	Food and Agriculture Organization
GN	Government of Nunavut
GN-CGS	GN - Community and Government Services
GN-CH	GN - Department of Culture and Heritage
GN-DOE	GN - Department of Environment
GN-EDT	GN - Department of Economic Development & Transportation
GN-PPD	GN - Petroleum Products Division
GPS	Global Positioning System
HADD	Harmful Alteration Disruption or Destruction
HQR	Haul Road and Quarry Study Areas
HTO, HTA	Hunters and Trappers Organization/Hunters Trappers Association
HWM	High Water Mark
IAA	Impact Assessment Agency
IBAs	Important Bird Areas
ICSP	Integrated Community Infrastructure Sustainability Plan (for Hamlet of Clyde River)
IFMP	Integrated Fisheries Management Plan
IHT	Inuit Heritage Trust

Term	Definition
IIBA	Inuit Impact and Benefit Agreement
INAC	Indigenous and Northern Affairs Canada (now CIRNAC 2019)
IQ	Inuit Quajimajatuqanjit (Inuit Knowledge)
ISQG	Interim Sediment Quality Guideline
IUCN	International Union for Conservation of Nature
LoO	License of Occupation
LUP	Land Use Permit
LWM	Low Water Mark
MBS	Migratory Bird Sanctuaries
MMOs	Marine Mammal Observers
MPAs	Marine Protected Areas
MUN	Memorial University of Newfoundland
NAICS	North American Industry Classification System
NBRLUP	North Baffin Regional Land Use Plan
NCP	Northern Contaminants Program
NCRI	Nunavut Coastal Resource Inventory
NEAS	Nunavut Eastern Arctic Shipping Inc
NFA	Nunavut Fisheries Association
NGMP	Nunavut General Monitoring Plan
NIRB	Nunavut Impact Review Board
NMC	Nunavut Marine Council
NMCA	National Marine Conservation Area
NPC	Nunavut Planning Commission
NRCan	Natural Resources Canada
NRI	Nunavut Research Institute

Term	Definition
NSIDC	National Snow & Ice Data Center
NSSI	Nunavut Sealink and Supply Inc.
NTI	Nunavut Tunngavik Inc.
NuPPA	*Nunavut Planning and Project Assessment Act*
NWA	National Wildlife Area
NWB	Nunavut Water Board
NWHS	Nunavut Wildlife Harvest Study
NWMB	Nunavut Wildlife Management Board
NWNSRTA	*Nunavut Waters and Nunavut Surface Rights Tribunal Act*
OHWM/OLWM	Ordinary high water mark/Ordinary low water mark
OW	Open Water
PAHs	Polycyclic Aromatic Hydrocarbons
PCBs	Polychlorinated Biphenyls
PEL	Probable Effects Level
pH	Acidity
PSD	Particle Size Distribution
PSPC	Public Services and Procurement Canada
QA/QC	Quality Assurance/Quality Control
QEC	Qulliq Energy Corporation
QIA	Qikiqtani Inuit Association
QWB	Qikiqtaaluk Wildlife Board
RAs	Regulatory Authorities
RDL	Readable Detection Limits
ROV	Remote Operated Vehicle
RPD	Relative Percent Difference

Term	Definition
RWOs	Regional Wildlife Organizations
SAO	Senior Administrative Officer
SAP	Sampling and Analysis Plan
SAR	Species at Risk
SARA	*Species at Risk Act*
SCH	Small Craft Harbour
SDR	Screening Decision Report
SEC	Sediment and Erosion Control
SEC	Sediment and Erosion Control
TC	Transport Canada
TEL	Threshold Effects Level
TOC	Total organic carbon
TSS	Total suspended solids
UDS	Upland Dwarf Shrub
ULB	Upland Lichen Barren
VECs	Valued Ecosystem Components
WGD	Wetland Graminoid-Moss Drainage
WSP	Waste Stabilization Pond

Executive Summary

Advisian was retained by Fisheries and Oceans Canada-Small Craft Harbour (DFO-SCH) to undertake a Feasibility Assessment for the potential construction of small craft harbours (SCH) at four locations in Nunavut: Arctic Bay, Clyde River, Grise Fiord, and Resolute Bay. These harbours are part of the Inuit Impact and Benefit Agreement (IIBA) negotiated for the Tallurutiup Imanga (Lancaster Sound) National Marine Conservation Area (NMCA). The feasibility assessment scope is broad and considers design options, community engagement, geological, environmental and socio-economic scope. This report contributes the Environmental and Socio-Economic Survey (ESES) conducted to support the overall Feasibility Assessment for the Clyde River SCH. It further identifies the federal, territorial and municipal Regulatory Authorities (RAs) likely to be engaged through the planning, design, and construction phases of the Project. This ESES report is Appendix 7 of the Clyde River Harbour Development Report (Document No. 307071-01306-00-MA-REP-0001), hereafter referred to as the “main report” (Advisian, 2019).

Clyde River is located in Patricia Bay on the northeast coast of Baffin Island in Clyde Inlet. It is within the Qikiqtaaluk Region and the North Baffin Regional Land Use Plan (NBRLUP) Region. The environmental baseline studies include both the terrestrial and marine footprints for a quarry, haul road, SCH and potential disposal at sea (DAS) site. Study Areas were defined to include the footprint and a 100 m buffered area to include possible residual effects during construction, as defined in Section 1.3. The socio-economic baseline study incorporated information on the community from the Hamlet of Clyde River, the Nangmautag Hunters and Trappers Organization (HTO), and other Clyde River community leaders. The Socio-Economic Study Area included an area within the municipal borders of Clyde River and the marine environment where socio-economic effects of the proposed development are likely to occur. An archaeological Impact Assessment (AIA) was performed in junction with the August field survey in 2019, where there were no archaeological sites identified within the terrestrial portions of the Study Areas. The AIA is provided in Appendix 6 – Archaeological Assessment of the main report.

The ESES was undertaken using both desktop review and field survey means to understand the environmental and socio-economic conditions in Clyde River. Inuit Quajimajatuqanjit (IQ) was used through desktop review and project specific workshops with local knowledge holders to identify existing conditions of important environmental and socio-economic resources in and around Clyde River. Additionally, early engagement with the community allowed for a collaborative approach between the field team and community members during the field surveys with access to local resources for personnel and equipment, including boats. Integrating Inuit and scientific knowledge advances the understanding of the biological and socio-economic conditions providing a baseline that is not only scientifically sound but also connected to local values, needs, and priorities.

The environmental scope considered terrestrial vegetation, terrestrial wildlife, marine and migratory birds, fish and fish habitat, and marine mammals. These organism groups are important both ecologically and culturally in Nunavut. The habitat values within the Project Study Areas were generally low in the terrestrial portions and low to moderate in the marine portions of the Project. Details on the specific groups are provided in the relevant sections of this ESES report. Several Species at Risk (SAR) organisms do have the potential to be present in several Study Areas, but the Project footprint(s) and Study Areas do not provide critical habitat requirements for these species. Table 2-1 identifies potential SAR species and the likelihood of their presence in the relevant Study Areas. Under the assumption that the Project footprints do not change throughout the design phases, it is unlikely that subsequent field surveys would be required for the environmental scope. However, if additional surveys are required, these should be performed during the detailed design and permitting phase.

Early engagement with the Hamlet, the Nangmautaq HTO, and other key community leaders indicate a great deal of support for the Project and its benefits to the community. Hunters do not anticipate the construction of the Project to have significant impacts on wildlife or their ability to continue subsistence activities. Overall, the community is excited about the prospect of a long awaited SCH and to safer access and improved shelter for their boats. Further consultation with the community should be conducted during the detailed design and permitting phase to ensure that any potential impacts or risks to the community or harvesting rights during construction are properly mitigated.

The Nunavut Planning Commission (NPC) with the introduction of the *Nunavut Planning and Project Assessment Act* (NuPPAA) acts as a gate keeper in determining the referral process in Nunavut. It is expected that the Project will be referred to the Nunavut Impact and Review Board (NIRB) for review, and that the review would proceed as Part 4 Screening. Federal and territorial RAs likely to be engaged through Project planning, design, and construction phases in terms of permit acquisition includes but is not limited to; NIRB, Nunavut Water Board (NWB), Nunavut Research Institute (NRI), GN – Department of Culture and Heritage (GN-CH), Fisheries and Oceans Canada (DFO) Fish and Fish Habitat Protection Program (DFO-FFHPP), Environment and Climate Change Canada (ECCC), Transport Canada (TC), Crown-Indigenous Relations and Northern Affairs Canada (CIRNAC), Public Services and Procurement Canada (PSPC), and Natural Resources Canada (NRCan). However, further engagement should occur with additional organizations to confirm their interest, which includes but is not limited to: the Nunavut Marine Council (NMC), Nunavut Tunngavik Inc. (NTI), Qikiqtani Inuit Association (QIA), and the Qikiqtaaluk Wildlife Board (QWB). These groups will be engaged during the permitting process by NPC, NIRB and DFO – FFHPP, therefore their interest and awareness should be identified at an early stage.

1. Introduction

1.1 Project Overview

Advisian has been retained by Fisheries and Oceans Canada-Small Craft Harbour (DFO-SCH) to undertake a feasibility assessment for the potential construction of small craft harbours (SCH) at four locations in Nunavut: Arctic Bay, Clyde River, Grise Fiord, and Resolute Bay (Figure 1-1, Table 1-1) (hereafter referred to as Feasibility Assessment). These harbours are part of the Inuit Impact and Benefit Agreement (IBA) negotiated for the Tallurutiup Imanga (Lancaster Sound) National Marine Conservation Area (NMCA) (see Section 2.2.1.1). All locations are in the Qikiqtaaluk Region. Clyde River is located within the North Baffin Regional Land Use Plan (NBRLUP) Region (see Figure 1, Appendix 1)(NPC, 2000b).

This report summarizes the Environmental and Socio-Economic Survey (ESES) conducted to support the Feasibility Assessment for the Clyde River SCH.

Table 1-1 Field Survey Locations

Location	Location Description	Latitude	Longitude
Arctic Bay	the northwest coast of Baffin Island (Borden Peninsula), in Admiralty Inlet	73° 1.529'N	85° 7.203'W
Clyde River	located in Patricia Bay on the northeast coast of Baffin Island in Clyde Inlet	70° 28.189'N	68° 34.616'W
Grise Fiord	located on the southern shore of Ellesmere Island in Jones Sound	76° 25.001'N	82° 54.935'W
Resolute Bay	located on the south shore of Cornwallis Island in Parry Channel	74° 41.472'N	94° 51.549'W

1.2 Project Components

The Project components include footprints both in the marine and terrestrial environments, with a SCH and a potential disposal at sea (DAS) site in the marine environment, and a quarry and haul road in the terrestrial environment (Figure 1-2). Marine traffic, sealift operations and other ship operations are not considered in this ESES.

Further information on the quarry and haul road is presented in Appendix 5 – Geological Assessment of the main report.

1.2.1 Quarry

An existing quarry, approximately 5 km south east of the community, may be expanded to source rock for harbour construction.

Legend

SCH Footprint

- Option 1
- Option 2
- Option 3
- Site Location
- SCH Study Area

Aerial Image: GoogleEarth, July 2016
Locations approximate.

FISHERIES AND OCEANS CANADA
CLYDE RIVER HARBOUR DEVELOPMENT
ENVIRONMENTAL AND SOCIO-ECONOMIC BASELINE SURVEY

PROJECT LOCATION

Date: 18-DEC-19	Drawn by: KR	Edited by: KR	App'd by: VB

Fisheries and Oceans Canada

Advisian
Worley Group

Project No. 307071-01306

FIG No 1-1 | REV 0

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SAVE DATE & TIME: 2019-12-18 11:54:14 AM ISSUING OFFICE: BURNABY GIS

FILE LOCATION: U:\YVR\307071\01306_DFO_LanStHarSt\10_Eng\16_Geomatics\01_Mxd\ES_Baseline\ClydeRiver\Fig1-1_CR_Site_Location.mxd

1.2.2 Haul Road

The proposed haul road route starts from the active quarry and follows an existing gravel track for approximately 1.2 km before joining the main road to the community and the airport. The gravel track between the active quarry and the existing road is part of the track which leads to the original Clyde River settlement located on the shoreline west of the quarry. The gravel track is relatively flat and likely constructed from local sand and gravel borrow sources. Approximately midway between the quarry and the existing road, the gravel track crosses a bridge over the Clyde River. An alternate haul road route to by-pass the community runs parallel with the shoreline between the beach and houses (Figure 1-2).

1.2.3 Small Craft Harbour

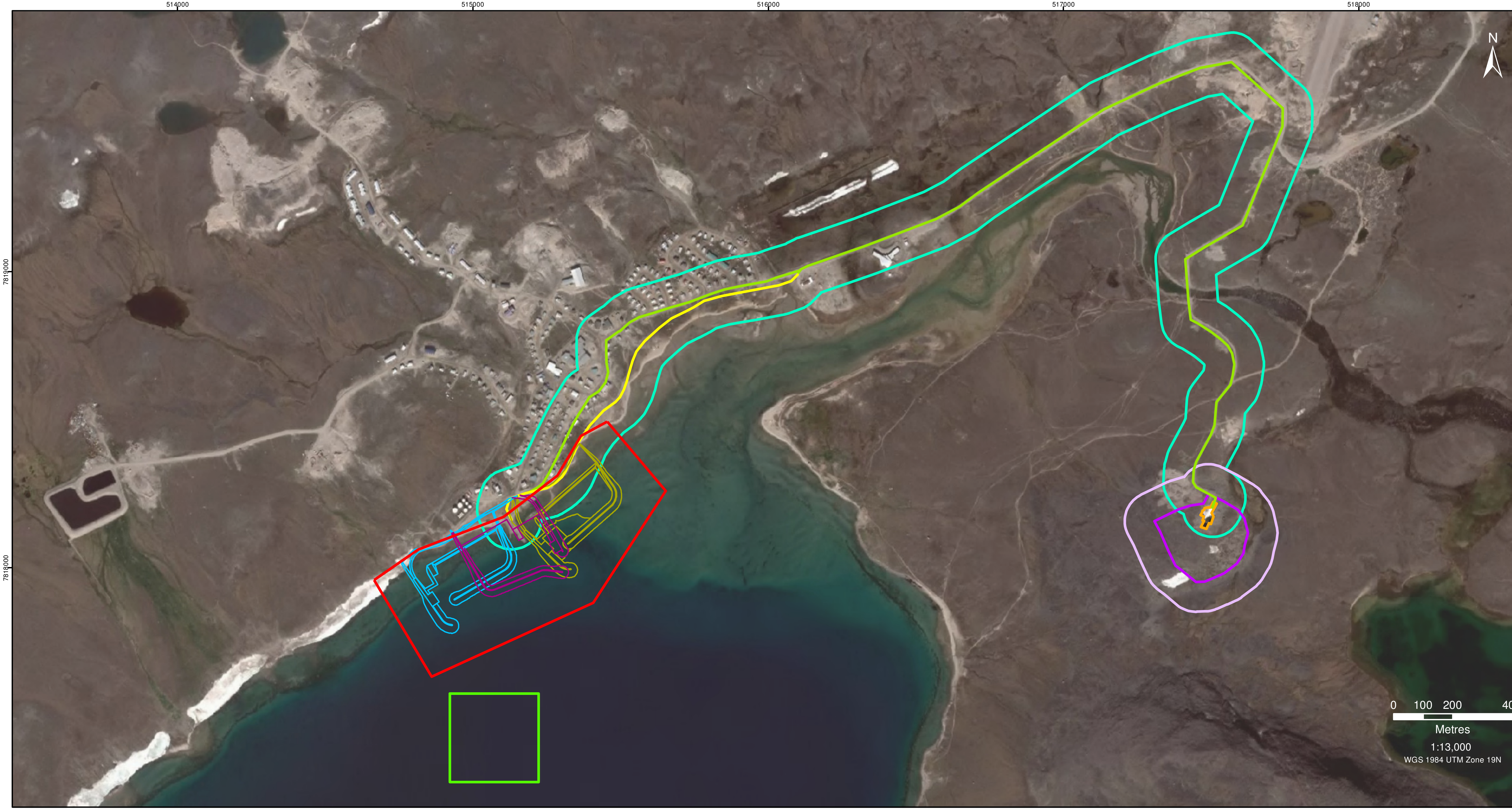
Three SCH options for Clyde River were conceptualized in collaboration with DFO-SCH in January 2019. These generalized arrangements form the basis of this study and were developed based on the local knowledge and feedback received during community consultations in November 2018. For all three options, the SCH is proposed at the location of the existing ramp and sealift area as shown in Figure 1-3. Preliminary design and description for the SCH options are provided in Appendix 1 - Drawings and Section 6 - Harbour Layout Concepts of the main report. A general arrangement of the SCH options is provided in Figure 1-4.

1.2.4 Disposal at Sea Location

Dredging is proposed for the three design options, where the priority for sediment disposal would be for use as infill or to be provided to the community for upland use. The Hamlet indicated that they can think of ways to use the dredge material if it is shown to be suitable for use on land (see Appendix 2 - Community Consultations of the main report). However, sediment DAS may be required and a potential DAS was identified based on technical feasibility, proximity to the dredge site, comparative water depth and through community consultation. The proposed DAS site is displayed in Figure 1-2.

1.3 Study Areas

Study Areas for each Project component were determined based on potential construction footprints and alignment with existing quarry, road, and shoreline access infrastructure (Figure 1-2). Land based construction areas will be required for a quarry to supply rock for construction, and a haul road to transport rock from the quarry to the SCH (Figure 1-2). The Study Areas for the quarry and haul road include the potential locations, either existing and new construction options, and a 100 m buffer. When referenced together, the quarry and haul road is referred collectively as the HRQ Study Area. The SCH Study Area was considered the total footprint of all three design options, plus the 100 m buffer The DAS site was just considered only as a Study Area as the footprint will be confirmed during the detailed design and permitting phase. The DAS Study Area is 200 m x 200 m. At times the Haul Road and Quarry Study Areas are discussed together, and so when relevant will collectively be referred to as the HRQ Study Areas. When all Study Areas are discussed, they will collectively be referred to as the Project Study Areas.



Legend

SCH Footprint	Potential Haul Road	Quarry	Study Area
Option 1	Existing Road/Track	Existing	SCH
Option 2	New Haul Road	Potential	DAS
Option 3			Haul Road
			Quarry

Imagery Source: GoogleEarth, July 2016
Locations approximate.

DEPARTMENT OF FISHERIES AND OCEANS
CLYDE RIVER HARBOUR DEVELOPMENT
ENVIRONMENTAL AND SOCIO-ECONOMIC BASELINE REPORT

PROJECT COMPONENTS AND STUDY AREAS (QUARRY, SMALL CRAFT HARBOUR, HAUL ROAD, DISPOSAL AT SEA SITE)

Date: 12-DEC-19	Drawn by: KR	Edited by: KR	App'd by: VB
Fisheries and Oceans Canada	Advisian Worley Group	Project No. 307071-01306	
		FIG No 1-2	REV 0

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Figure 1-3 Proposed Small Craft Harbour Location

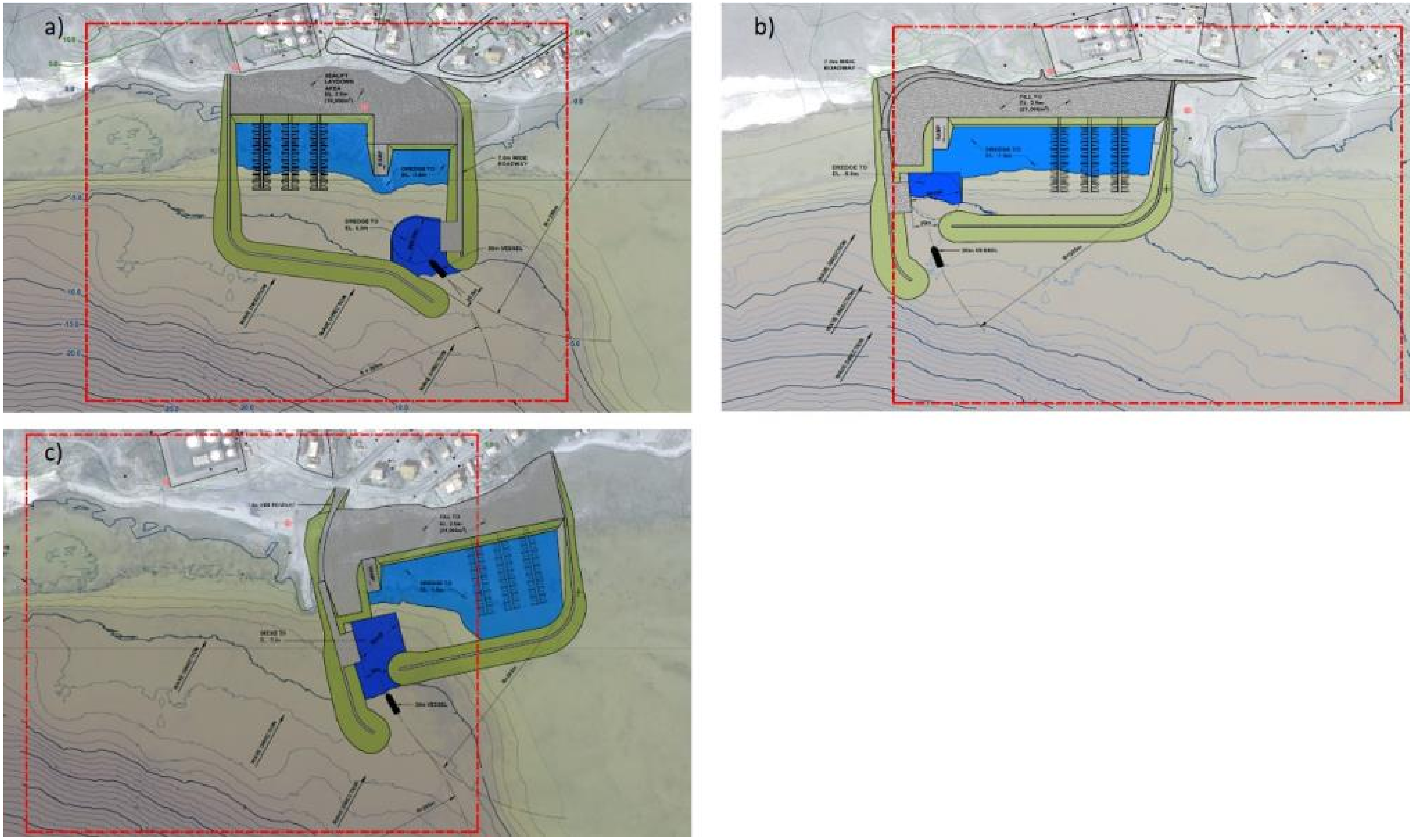

Figure 1-4 Clyde River Small Craft Harbour Design Options: a) Option 1; b) Option 2; and c) Option 3 (See Appendix 1 of Main Report for Drawings)

For many of the marine organisms discussed, they are mobile with migratory routes or ranges that extend beyond the SCH and DAS Study Areas. This is particularly true of marine mammals who will be discussed in the broader context of the marine corridors that connect Davis Strait, Baffin Bay and Lancaster Sound (Talluritiup Imanga). Further to this, there was no field survey conducted for the marine mammal discipline and desktop information is often general in nature. Broader marine water bodies discussed in this ESES are presented in Figure 1-5.

The Socio-Economic Study Area included an area within the municipal borders of Clyde River and the marine environment where socio-economic effects of the proposed development are likely to occur (see Figure 3-1).

1.4 Scope of Study

The study scope is intended to support the ESES Study included the list below:

- Water Quality
- Sediment Quality
- Terrestrial Vegetation (including rare plants)
- Terrestrial Wildlife
- Migratory and Marine Birds
- Fish and Fish Habitat
- Marine Mammals
- Socio-Economic Environment.

The objective of the ESES, conducted to inform the Feasibility Assessment is to summarize the physical, biological, or socio-economic environment as outlined in Table 1-2. Information was synthesized from a combination of desktop review, field surveys, and IQ. Desktop review and field survey methodologies are provided in the respective sections of this report. Methodology for the IQ Program for the Project is provided in Section 3. Results of the IQ Program are incorporated into the desktop review and discussion sections of each discipline.

A field survey was complete during the 2019 open-water season to conduct terrestrial vegetation, terrestrial wildlife, fish and fish habitat, marine water quality, marine sediment quality, geology, geophysics, and archaeological baseline studies within the Project Study Areas. Details on the Geological and Archaeological Assessments are available in Appendices 5 and 6of the main report.

Weather conditions and tides on the field survey dates is provided in Table 1-3.

1.5 Program Objectives

Program objectives for the different disciplines are detailed in Table 1-2.

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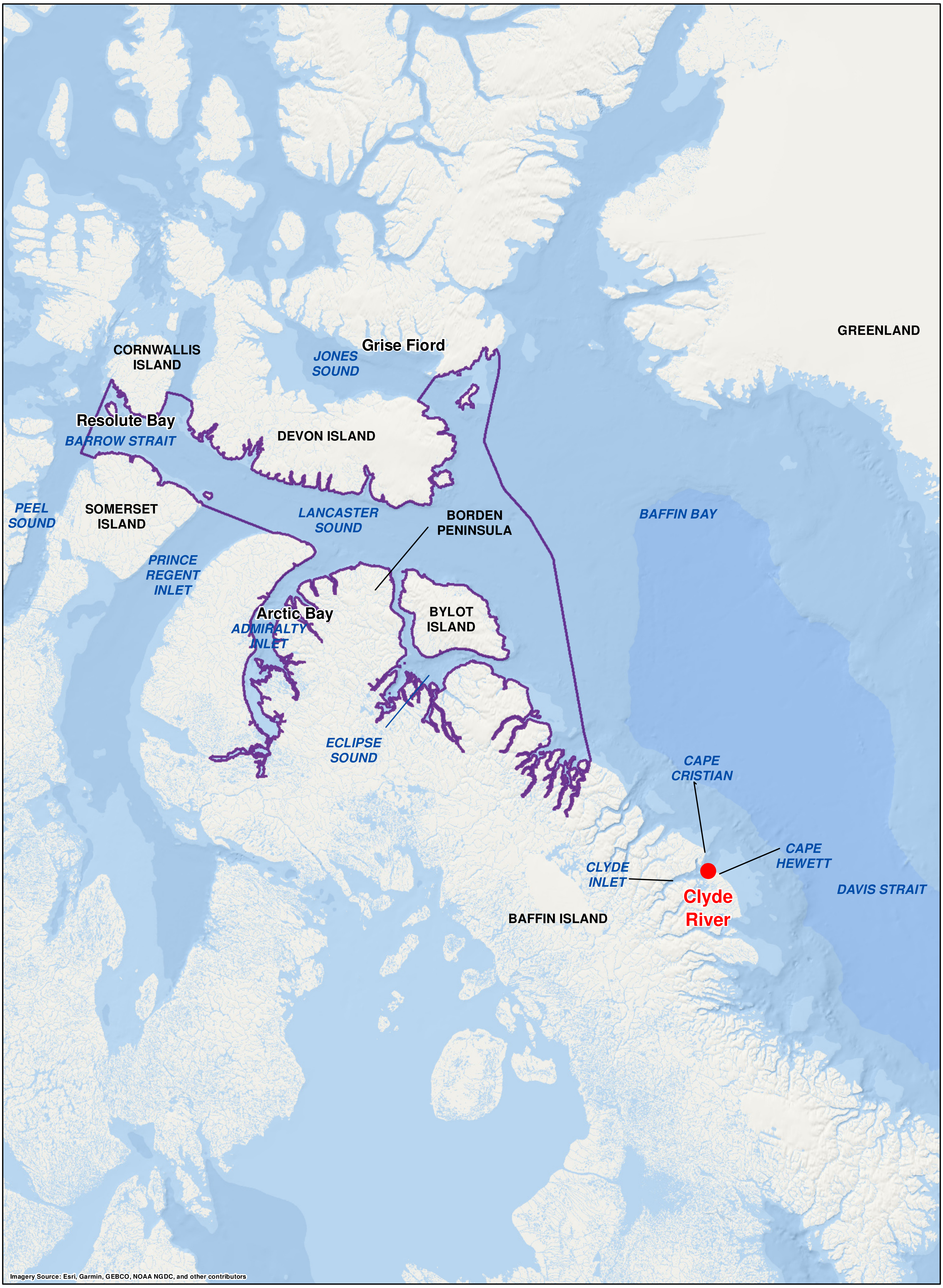

Legend

- Site Location
- Talluritiup Imanga NMCA

N

0 50 100 200
Kilometres
1:5,000,000
WGS 1984 Arctic Polar Stereographic

Location approximated.

FISHERIES AND OCEANS CANADA
CLYDE RIVER HARBOUR DEVELOPMENT
ENVIRONMENTAL AND SOCIO-ECONOMIC BASELINE SURVEY

PROJECT MARINE CORRIDORS

Fisheries and Oceans Canada

Advisian
Worley Group

Date: 18-DEC-19	Drawn by: JH	Edited by: KR	App'd by: VB
Project No. 307071-01306			
FIG No 1-5		REV 0	

Table 1-2 Environmental and Socio-Economic Program Elements for Lancaster Sound Project

Category	Relevant Study Areas	Program Objectives	Report Section
Inuit Qaujimajatuqangit (Inuit Knowledge or [IQ])	Project	▪ Land use in the Project Study Areas including fishing, hunting, trapping, plant harvesting and any other traditional or cultural uses as identified by local Inuit land users. ▪ Local Inuit knowledge of fish, marine and land mammals, migratory and marine birds. ▪ Marine access requirements for users during the open-water and iced-in season (i.e., skidoos). ▪ Harvesting of marine and terrestrial species – seasonal patterns, locations, and changes observed over time. ▪ Potential DAS sites within a feasible travel distance that have low biological biodiversity and are deemed acceptable to local harvesters. ▪ Input and feedback to harbour design such as wind direction and strength, currents, seasonal changes to ice, water and ice access, current boating practices, traffic, and community needs.	Section 3, IQ was incorporated within each discipline chapter. A discussion on local land and resource use can be found in Section 11.2.6.
Species at Risk (SAR)	Project	▪ Desktop review and field survey to determine potential SAR present in the Project Study Areas. ▪ SAR were those listed federally as Endangered, Threatened, or of Special Concern, and/or territorially as Critically Imperilled or Imperilled	Section 2
Marine Water Quality	SCH, DAS	▪ Desktop study to describe marine water and sediment quality characteristics of the SCH and DAS Study Areas ▪ Marine water and sediment quality field survey within the potential dredging (load) and disposal site (if relevant) ▪ Summarize filed survey results in reference to Canadian Council of Ministers of the Environment (CCME) guidelines.	Section 4
Marine Sediment Quality	SCH, DAS		Section 5

Category	Relevant Study Areas	Program Objectives	Report Section
Vegetation	HRQ	▪ Desktop review and a field survey to determine terrestrial plant species, plant communities, and SAR that occur within the Study Areas.	Section 6
Wildlife	HRQ	▪ Desktop review and field survey to determine the presence of terrestrial wildlife, including marine and migratory birds. Important habitats of these species will also be identified. ▪ Summarize habitat within the Study Areas to a level sufficient to support permitting requirements.	Section 7
Migratory and Marine Birds	Project		Section 8
Fish and Fish Habitat	SCH, DAS, HRQ (only if fish bearing water courses)	▪ Desktop review to identify fish and fish habitat that may be present in the Study Areas. ▪ Create a habitat map based on field data (intertidal, subtidal) within the SCH Study Area. ▪ Summarize habitat quality to a level that is sufficient to support permitting with territorial and federal regulators.	Section 9
Marine Mammals	SCH, DAS	▪ Identify key marine mammal species found in Clyde River, Lancaster Sound, Davis Strait and Baffin Bay (see Figure 1-5). ▪ Identify any marine mammal species of concern as identified by federal or territorial agencies, including any species listed under the *Species at Risk Act* (SARA), its critical habitat or the residences of individuals of the species. ▪ Provide baseline biological and ecological information for identified marine mammal species such that there can be effective effects assessment and mitigation planning, to be used during the detailed design and permitting phase	Section 10

Category	Relevant Study Areas	Program Objectives	Report Section
Socio-Economic	Project	Characterize the socio-economic conditions of the communities, including: ▪ population, education and labour force activity; ▪ infrastructure and services: health services, education, police, utilities and infrastructure including roads and land; ▪ resource use in the area, including subsistence harvesting, tourism, trapping and guiding operations (local and regional); ▪ traffic patterns; community health and wellness; and ▪ other valued socioeconomic components as determined through community consultation.	Section 11
Permitting Strategy	Project	▪ Identify permits likely to be required for the future construction of the SCH during the detailed design and permitting phase. The required permits will be documented along with the estimated timelines and key input factors that affect completion of the applications.	Section 12

Table 1-3 Survey Dates, Weather, and Environment for the Field Survey

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Precipitation: 0 mm
Temperature: 5-7° C
Wind: 1-10 km/h</td><td colspan="2">August 12</td></tr>
<tr><td>Time</td><td>Height (m)</td></tr>
<tr><td rowspan="4">Chart Datum (CD) Depth Surveyed (m)</td><td rowspan="4"><u>Project Footprint:</u>
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Maximum: 20.8 m
<u>DAS Study Area:</u>
Minimum: 37.4 m
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1.6 Field Permitting Requirements

The field survey was carried out with issuance of the permits outlined in Table 1-4, with the field survey conducted in accordance with the relevant permit conditions. The NRI and DFO require post field survey reporting which will be submitted by Advisian on behalf of DFO-SCH. The GN-CH requires both a technical report and a final AIA report to be submitted which will be managed by Lifeways of Canada (Lifeways), who performed the survey (see Appendix 6- Archaeological Assessment of the main report).

Table 1-4 Field Survey Permits

Regulatory Authority	Permit/File No.	Permit Type
NRI	02 058 19N-M	Research License (NRI, 2019)
NPC	149159	Conformity Determination (NPC, 2019b)
NIRB	19YN031	Screening Decision Report (NIRB, 2019)
GN-CH	No. 2019-54A	Class 2 Territory Archaeologist Permit (GN-CH, 2019)
DFO	S-19/20-1018-NU	License to Fish for Scientific Purposes (DFO, 2019a)

2. Species at Risk and Designated Areas

2.1 Species at Risk

Species discussed in this section have been assessed by international (International Union for Conservation of Nature [IUCN]), Federal (Committee on the Status of Endangered Wildlife in Canada (COSEWIC), SARA, territory agencies (GN Department of Environment [GN-DOE]), and the NBRLUP (NPC, 2000b). A list of the at-risk vegetation, wildlife, marine and migratory birds, marine fish and marine mammals that have potential to occur in the Project Study Areas and their likelihood of occurrence are listed in Table 2-1. Threatened or Endangered species may occur, but none were identified during field surveys (see applicable sections for more information).

DFO has generated an Aquatic species at risk map; however, at this time it does not include Clyde River (Government of Canada, 2019g).

2.2 Designated Areas

The United Nations *Convention on Biological Diversity* known as Aichi Target 11 (Convention on Biological Diversity, 2010), committed countries, including Canada to conserving 10% of coastal and marine areas by 2020. On August 1, 2019, Canada had met and exceeded this goal reaching 14% with recent Arctic designations (National Observer, 2019). The announcement of the Talluritiup Imanga NMCA contributed to this goal. NMCAs, Ecologically and Biologically Significant Areas (EBSAs), Important Bird Areas (IBAs), and Migratory Bird Sanctuaries (MBS) are all ultimately designed and designated for the protection or conservation of species and species habitat. Information on these designated areas as they relate to the Project are identified below.

Federally, marine habitat designations are managed by Parks Canada, DFO, and TC. These three federal bodies signed the IIBA(Government of Canada, 2019m) along with the QIA. The IIBA covers the requirements for any protected areas established within Canada’s High Arctic Basin (Tuvaijuittuq) (Atlas of Marine Protection, 2019).

The NBRLUP (NPC, 2000b) has also presented existing and proposed protected areas, some of which are included in the NMCA and Marine Protected Area (MPA) described in Section 2.2.1.

Table 2-1 Status of Flora and Fauna in the Terrestrial and Marine Environment with the Potential to be Present in the Project Study Areas

Species	Latin Name	Inukitut		IUCN Status	COSEWIC Status	SARA Status	Nunavut Rank	Study Area	Likelihood of Occurrence	Justification
		Syllabics	Transliteration							
Vegetation										
Porsild's Bryum	*Haplodintium macrocarpum*	ᐃᕝᕈᐃᔭᖅ	Ivruijak	No Status	Threatened	Threatened	S2	Quarry	Low	Known distribution only on Ellesmere Island in Nunavut but site environmental conditions are not inhibitive
Wildlife										
Barren-ground caribou (Baffin Island herd)	*Rangifer tarandus groenlandicus*	ᑐᒃᑐᖕᒋᑦ	Tuktuit	Vulnerable	Threatened	No Status	S4	Quarry	Unlikely	No historical harvest or IQ records near Project
Wolverine	*Gulo*	ᖃᕝᕕᒑᕐᔪᒃ	Qavvigaarjuk	Least Concern	Special Concern	Special Concern	S3	Quarry	Unlikely	Within mapped range, but observations are rare and not documented locally; species is wide-ranging, and any occurrence is likely to be transitory in nature
Migratory Birds										
Buff-breasted sandpiper	*Calidris subruficollis*	ᓴᑦᖃᕆᓪᓚᒃ	Satqarillak	Near Threatened	Special Concern	Special Concern	S3	Quarry/SCH	Possible	Outside mapped breeding range, so unlikely to breed near Project; however, possible during migration
Ivory gull	*Pagophila eburnean*	ᖃᑯᓪᓗᒃ	Qakulluk	Near Threatened	Endangered	Endangered	S1	Quarry/SCH	Possible	Near year-round mapped range, but outside breeding range and habitat not present; therefore, unlikely to breed near Project, but possible during staging
Peregrine falcon	*Falco peregrinus*	ᑭᒡᒐᕝᕕᐊᖅᔪᒃ	Kiggarviarjuk	Least Concern	Not at Risk	Special Concern	S4	Quarry/SCH	Low	Within mapped breeding range, but requires tall structures such as cliffs for breeding; therefore, probability of occurrence is low and nesting likelihood near the Project is unlikely
Red knot	*Calidris canutus*	ᓯᔾᔭᕆᐊᖅ	Sijjariaq	Near Threatened	Endangered	Endangered	S2	Quarry/SCH	Possible	Within mapped breeding range but limited habitat present; therefore, potential to breed near the project is moderate and it is also possible that the species could occur during migration and staging
Red-necked phalarope	*Phalaropus lobatus*	ᓴᐅᕐᕌᖅ	Saurraaq	Least Concern	Special Concern	Special Concern	S3	Quarry/SCH	Low	Habitat present but Project is at northern extent of mapped breeding range; therefore, potential to be present and breed near Project is low
Ross's gull	*Rhodostethia rosea*	ᓇᐅᔭᑦ	Naujat	Least Concern	Threatened	Threatened	S1	Quarry/SCH	Unlikely	Outside mapped breeding range and breeding habitat not present near Project

Species	Latin Name	Inukitut		IUCN Status	COSEWIC Status	SARA Status	Nunavut Rank	Study Area	Likelihood of Occurrence	Justification
		Syllabics	Transliteration							
Fish										
Lumpfish	*Cyclopterus lumpus*	ᓂᐱᓴ	Nipisa	Near Threatened	Threatened	No schedule, no status	NR	SCH/DAS	Unlikely	Are distributed throughout the North Atlantic Ocean, with occasional incidental catch up to 65° N in Davis Strait, but more common to the south with highest abundance around Newfoundland (COSEWIC, 2017b). They are primarily a demersal fish (bottom dwelling). Lumpfish prefer waters that are greater than 300 m, but do migrate to shallow coastal waters in the early summer (April, May) to spawn
Northern wolfish	*Anarhichas denticulatus*	ᓂᐱᓴ	Nipisa; Kerak; Qeraq	Endangered	Threatened	Threatened	NR	SCH/DAS	Unlikely	Canadian range includes Baffin Bay (south of 66° 36.603' N, 61° 18.638'W on the Baffin Island coast), Labrador, northeast Newfoundland Shelves, Grand Banks, Flemish Cap, the Gulf of Saint Lawrence and the Scotian Shelf. It is most common in deep waters of the continental shelf (500 to 1000 m), and only occasionally observed in Baffin Bay/Davis Strait. A biogeographic range map for the Northern wolfish is available in (Government of Canada, 2018e)
Spotted Wolffish	*Anarhichas minor*	ᑕᕐᓴᓕᒃ ᑲᓇᔪᖅ	Tarsalik Kanajuq	No Status	Threatened	Threatened	NR	SCH/DAS	Unlikely	The northwest Atlantic range of this species includes the Davis Strait (south of 68° 17.682'N, 66° 35.026'W on the Baffin Island coast), the Labrador Sea, the Gulf of St Lawrence, the east coast of Newfoundland, on the Grand Banks and on the Scotian Shelf. Preferred depths are between 200 and 750 m. A biogeographic range map for the Northern wolfish is available in (Government of Canada, 2018b)
Thorny Skate	*Amblyraja radiata*	ᐃᓴᕈᓖᑦ ᐃᖃᕐᒥᐅᑕᖅ	Isaruliit Iqarmiutaq	Vulnerable	Special Concern	No Status	NR	SCH/DAS	Unlikley	Distributed continuously from Baffin Bay (records are rare north of 68 ° latitude), Davis Strait, Labrador Shelf, Grand Banks, Gulf of St Lawrence, Scotian Shelf and Bay of Fundy to Georges Bank over a wide range of depths (18 m to 1200 m). Nunavut range not north of Baffin Island, depth range > 18 m. A distribution map is available in Figure 5a of COSEWIC (2012b)

Species	Latin Name	Inukitut		IUCN Status	COSEWIC Status	SARA Status	Nunavut Rank	Study Area	Likelihood of Occurrence	Justification
		Syllabics	Transliteration							
Marine Mammal										
Atlantic Walrus (Central/Low Arctic population)	*Odobenus rosmarus*	ᐊᑦᖠᑎ ᐊᐃᕖᑦ (ᖁᑦᑎᑐᒥ ᐊᐃᕖᑦ ᐅᓄᕐᑐᑦ ᑲᑎᖓᔪᑦ)	Atlaati Aiviit (Quttitumi Aiviit unurtut katingajut)		Special Concern	No Status	S3		Likely	Recorded in the area through the open water season
Bearded seal	*Erignathus barbatus*	ᐅᒡᔪᒃ	Ujjuk	Least Concern	Data Deficient	Not Applicable	NR	SCH/DAS	Likely	Within known open-water season distribution; reported in the area June—January
Beluga whale (Eastern High Arctic/Baffin Bay population)	*Delphinapterus leucas*	ᕿᓚᓗᒐ ᖃᑯᕐᑕᖅ (ᑲᓇᖕᓇᖕᒐᓂ ᖁᑎᒃᑐᖅ/ᓴᓐᓂᕈᑎᐅᑉ ᐃᒪᖕᒐᓄᑦ ᑲᑎᖓᔪᑦ)	Qilaluga qakurtaq (Kanangnangani Qutiktuq/Sannirut iup Imanganut katingajut)	Least concern	Special Concern	No Status	NR	SCH/DAS	Likely	Within known beluga range; recorded sightings especially in open-water season, including calving
Bowhead whale (Eastern Canada-West Greenland population)	*Balaena mysticetus*	ᐊᕐᕕᖅ	Arviq	Least Concern	Special Concern	No Status (under consideration)	NR	SCH/DAS	Likely	Recorded feeding in the area latter part of the open-water season—fall; harvest records
Harp seal	*Pagophilus groenlandicus*	ᖃᐃᕈᓕᒃ	Qairulik	Least Concern	Not Assessed	Not Applicable	NR	SCH/DAS	Likely	Within a known high density area; can be seen year-round
Hooded seal	*Cystophora cristata*	ᓇᑦᑎᕙᒃ	Nattivak	Vulnerable	Not At Risk	Not Applicable	NR	SCH/DAS	Possible	Within known range, can be seen in the area
Killer whale (Northwest Atlantic/Eastern Arctic population)	*Orcinus orca*	ᐋᕐᓗᒃ	Aarluk	Data Deficient	Special Concern	No Status (under consideration)	NR	SCH/DAS	Likely	Recorded in the are in the open-water season after break-up
Narwhal	*Monodon monoceros*	ᑐᒑᓕᒃ	Tuugaalik	Least Concern	Special Concern	No Status	NR	SCH/DAS	Likely	Within known range, from harvest records seen from late spring to fall
Polar bear	*Ursus maritimus*	ᓇᓄᖅ	Nanuq	Vulnerable	Special Concern	Special Concern	S3	Quarry/SCH/DAS	Likely	Within range of Baffin Bay population; reported in this area from observations and hunting records
Ringed seal	*Pusa hispida*	ᓇᑦᑎᖅ	Nattiq	Least Concern	Not At Risk	Not Applicable	NR	SCH/DAS	Likely	Recorded in the area year-round; within a known high-density area

Notes:
Sources for status: CESCC (2016); Government of Canada (2019q); IUCN (2019).
Sources for Inuktitut names: Translations provided by Parenty Reitmeier Translation Services

- <u>Terrestrial Vegetation</u>
  - Likelihood of occurrence within Project Study Areas was based upon a qualitative assessment of results of potential habitat. Other factors such as known locations were also incorporated.
    - Likely: Study Areas are located within areas that have known occurrence records and most of the area is habitat for the species;
    - Possible: Study Areas are located within areas that have known occurrence records and some habitat may be available for the species;
    - Low: Study Areas are located outside areas that have known occurrence records and habitat may be available for the species;
    - Unlikely: Study Areas are located outside areas that have known occurrence records and habitat is not identified.

- Wildlife and Migratory Birds Probability Description
    - Likelihood of occurrence within Project Study Areas was based upon a qualitative assessment of results of potential habitat. Similarly, other factors such as breeding range, location of known colonies, etc. were incorporated.
        - Likely: Study Areas are located within the mapped range and the majority of the area is available habitat;
        - Possible: Study Areas are located within the mapped range and some of the available habitats may provide suitable breeding or other life-stage requirements;
        - Low: Study Areas are located within the mapped range and some of the available habitat may provide marginal breeding or other life-stage requirements;
        - Unlikely: Study Areas are located outside of the mapped 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 the Hamlet), and available habitat is generally not present.
- Fish Probability Description
    - Possible: based on biogeographic range and literature may be in the SCH and DAS Study Areas
    - Unlikely: based on biogeographic range and desktop review is unlikely to be in the SCH and DAS Study Area (s)
- Marine Mammal Probability Description
    - Likely: based on biogeographic range, desktop review and IQ and may be in the proposed Study Area with regularity
    - Possible: based on biogeographic range and desktop review and IQ and may be in the proposed Study Area on an irregular basis
    - Unlikely: based on biogeographic range and desktop review and IQ, and is unlikely to be in the proposed Study Area

Nunavut Territorial Rank (CESCC, 2016): S1=critically imperilled, S2=imperilled, S3=Vulnerable, S4=apparently secure, NR = not ranked.

2.2.1 National Marine Conservation Areas and Marine Protected Areas

NMCAs and MPAs are managed by the federal government through Parks Canada, DFO and TC. The purpose of these designations is to protect and conserve representative marine habitat for the benefit, education and enjoyment of Canadians (Government of Canada, 2019l).

NMCAs are established to represent a marine region and include protection of the seabed, water column above it and may include wetlands, estuaries, islands, and other coastal lands (Parks Canada, 2017) They are protected from activities such as ocean dumping, undersea mining, and oil and gas exploration and development. Traditional fishing activities are permitted but must be managed with the conservation of the ecosystem as the main goal. Specifically, as defined by Parks Canada (2017), NMCAs are designed and designated to:

- represent oceanic and lake diversity
- maintain ecological processes and life support systems
- provide a model for sustainable use of marine species and ecosystems
- encourage marine research and ecological monitoring
- protect depleted, vulnerable, threatened or endangered marine species and their habitats
- provide for marine interpretation and recreation
- contribute to a growing worldwide network of marine protected areas

MPAs are designed for long-term conservation of ocean systems and environments (DFO, 2019b), though some activities are permitted depending on their impacts to the ecological features encompassed within MPAs. MPAs contribute to a healthy marine environment by protecting and conserving marine species and populations and the diversity of ecosystems that marine organisms depend on such as connected waterways, underwater canyons, and hydrothermal vents. In addition, MPAs are designed to support economic goals of society and contribute to Canadian culture by protecting areas with cultural heritage value (DFO, 2019b).

2.2.1.1 Talluritiup Imanga National Marine Conservation Area

The establishment of the Talluritiup Imanga NMCA (Government of Canada, 2019n; Inuit Tapiriit Kanatami, 2019) was announced on August 1, 2019. The new Talluritiup Imanga NMCA is approximately 108,000 km^2 and reaches 1.9% of Canada's 10% 2020 target (Government of Canada, 2019j)(see Figure 2, Appendix 1). In addition, the federal government announced infrastructure investments for communities in the Tallurtiup Imanga region (Justin Trudeau, 2019), which is the basis for the Feasibility Assessment.

As seen in Figure 2, Appendix 1, the Talluritiup Imanga NMCA is north of Clyde River.

2.2.1.2 Tuvaijuittuq Marine Protected Area

The Tuvaijuittuq MPA was designated on July 29, 2019 and reaches 5.6% of Canada's 10% target (Government of Canada, 2019h). Located off the coast of northwest Ellesmere Island, this MPA is approximately 319,411 km^2 and includes the marine waters off northern Ellesmere Island starting from the low water mark and extending to the outward boundary of Canada's Exclusive Economic Zone (EEZ) (Government of Canada, 2019i). This MPA is north of Clyde River (Figure 2 of Appendix 1).

2.2.2 National Wildlife Areas

National Wildlife Areas (NWAs) contain nationally significant terrestrial and/or marine habitats for animals or plants (Government of Canada, 2019c). Under the *Canada Wildlife Act* , NWAs are created and managed for the purposes of wildlife conservation, research, and interpretation. They are established through the Wildlife Area Regulations , and can only be designated on federally owned lands, however; partnerships can be created with territories, provinces, aboriginal groups, and private land owners to establish and cooperatively manage a wildlife area (Government of Canada, 2019c). Ninginganiq NWA is the nearest NWA and is the same area as described below in Isabella Bay EBSA.

2.2.3 Ecologically and Biologically Significant Areas

EBSAs are areas within Canada's oceans that have been identified through formal scientific assessments as having special biological or ecological significance when compared with the surrounding marine ecosystem (DFO, 2004b). The identification of EBSA's is a key component of basis for the development of federally designated areas (Cobb, 2011). EBSA's are designated by government using criteria set out by, and facilitated by, the Conference of the Parties to the Convention on Biological Diversity (COP) (Convention on Biological Diversity, 2019). This criteria includes:

- 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

The five Arctic marine biogeographic units for which EBSAs are being identified are the: Arctic Basin, Western Arctic, Arctic Archipelago, Eastern Arctic, and Hudson Bay Complex. Clyde River is within the Eastern Arctic ecoregion (Figure 3 of Appendix 1), ID 2.10: Baffin Island Coastline (DFO, 2011a, 2015d). The EBSAs are also demonstrated in the NBRLUP, Schedule B (see Figure 3 of Appendix 1).

The nearest EBSA is Isabella Bay which is located 80 kilometres southeast of the Project along the eastern coast of Baffin Island. Though it was identified primarily based on bowhead whale feeding aggregations, the location provides habitat for seabirds such as king eider (*Somateria spectabilis*), long-tailed duck (*Clangula hyemalis*), dovekies (*Alle alle*), and northern fulmar (*Fulmarus glacialis*) (DFO, 2015b). Further details on the importance of this EBSA to migratory birds and marine mammals is available in Sections 8.1.4 and 10.1.

2.2.4 Important Bird Areas

IBAs are sites that have been identified as internationally significant for the conservation of birds and biodiversity (Bird Studies Canada, 2019) IBAs support birds such as threatened species, large congregations of birds, and birds restricted in range or habitat. These IBAs are identified according to internationally agreed upon, standardized, quantitative, and scientifically defensible criteria. IBAs have been identified for their global and continental significance for species that congregate, and concentrations of waterfowl, and colonial waterbird and seabirds. Though IBAs are located outside the Project Study Areas, birds are highly mobile, and most are migratory. Consequently, there is potential for these species to occupy, stop-over, or pass through on their way to nearby IBAs. IBAs have also been identified as Key Bird and Habitat Sites and in some cases are also designated as EBSAs (DFO, 2015b; Oceans North Conservation Society, 2018a).

The nearest IBA is Scott Inlet which is located 105 km northwest of the Project along the eastern coast of Baffin Island. Steep and rugged cliffs are characteristic of the islands and adjacent mainland areas, and ice-capped areas and extensive snowfields are numerous.

Nunavut IBAs are provided in Figure 4, Appendix 1

Refer to Section 8 or Table 8-2 for further information relative to marine birds.

2.2.5 Migratory Bird Sanctuaries

Under the *Migratory Birds Convention Act*, ECCC through the Canadian Wildlife Service (CWS), can establish MBS's on federal, provincial/territorial, or private land to protect terrestrial and marine habitat and provide safe refuge for migratory birds (Government of Canada, 2017a). Once established, hunting of a listed species is not permitted, and rules and prohibitions are established with respect to taking, injuring, destruction, and molestation of migratory birds, their nests, or eggs. There are no migratory bird sanctuaries near the Project. MBS's in Nunavut are displayed in Figure 5 of Appendix 1.

Refer to Section 8 or Table 8-2 for further information relative to migratory and marine birds.

2.3 Polynyas

Sea ice is a fundamental component of Arctic environments that has a significant effect on the spatial and temporal distribution of marine life across all trophic levels. This influence subsequently has shaped socio-economic and cultural practices for the Inuit who depend on the harvest of these animals. Polynyas and ice edge habitat, characteristically areas of higher productivity, have a long history of cultural significance to the Inuit (NPC, 2000a). A polynya is an area of open-water that remains ice-free all year round (National Snow & Ice Data Center) (NSIDC, 2019). There are 23 polynyas in Canada's Arctic as displayed in Figure 6, Appendix 1. The closest polynya to the Project is the Bylot Island polynya which is about 300 km to the northwest (Canadian Geographic, 2019). The presence of polynyas has contributed to some of the EBSA designations described in Section 2.2.2. Canadian Geographic provides an interactive map which provides details on specific polynyas of interest (Canadian Geographic, 2019).

2.4 North Baffin Regional Land Use Plan

Existing and proposed protected areas are provided in the NBRLUP as shown in Figure 7, Appendix 1. The following interactive maps from 2014 and 2016 are available (NPC, 2019a):

2014 Interactive Maps

- Schedule A: Land Use Designations Interactive Map
- Schedule B: Direction to Regulators Interactive Map
- Community Priorities and Values Interactive Map

2016 Interactive Maps

- Schedule A: Designations
- Schedule B: Valued Ecosystem and Socio-Economic Components
- Schedule B1: Terrestrial Valued Components
- Schedule B2: Cariboo Ranges Valued Ecosystem Components
- Schedule B3: Marine Valued Components

2.5 National Parks

Nunavut has five national parks (Figure 8, Appendix 1), three of which are in the NBRLUP (Figure 1, Appendix 1).

2.5.1 Sirmilik National Park

Sirmilik National Park was established in 2001 (The Canadian Encyclopedia, 2019) and protects 22,252 km^2 of geological, natural history, and cultural values within the Eastern Arctic Lowlands and North Davis Natural Regions (Parks Canada, 2016). It is located on North Baffin Island, extending from the eastern entrance to Admiralty Inlet to west of the Hamlet of Pond Inlet (NPC, 2016b), approximately 480 km northwest of Clyde River. The park is divided into four parcels: Bylot Island, Borden Peninsula, Baillarge Bay, and Oliver Sound. With respect to wildlife, Sirmilik hosts the most diverse avian community in the high Arctic with more than 74 species of birds, of which 45 are confirmed breeders. Bylot Island in particular has up to 320,000 thick-billed murres and 50,000 black-legged kittiwakes. In addition to its avian diversity, 19 mammal species inhabit Bylot Island, of which, nine are terrestrial (Université of Laval, 2016).

2.5.2 Qausuittuq (Bathhurst Island) National Park

Qausuittuq National Park was established in 2015 and protects 11,000 km^2 of traditional hunting and fishing areas (Parks Canada, 2019; The Canadian Encyclopedia, 2019). It is located on northern Bathurst Island and smaller surrounding islands (The Canadian Encyclopedia, 2019), approximately 1,000 km northwest of Clyde River. It includes the waters of May Inlet and Young Inlet and is boarded to the south by Polar Bear Pass National Wildlife Area. Together these two areas protect a large, ecologically intact area in the Canadian Arctic Archipelago. Much of the landscape is tundra and also varies from wetlands and lowlands to plateaux, bluffs, and hills. Vegetation is sparse and found mostly on irregular surfaces of small hummocks. Terrestrial wildlife are not abundant and marine mammals inhabit the waters off Bathurst Island. The rich ocean life supports abundant seabirds and the wet sedge meadows support nesting grounds for geese and shorebirds (The Canadian Encyclopedia, 2019).

2.5.3 Quttinirpaaq National Park

Quttinirpaaq National Park was established in 1988 protects 37,775 km^2 of land with hundreds of archaeological sites (The Canadian Encyclopedia, 2019). It is located on northern Ellesmere Island, approximately 1,300 km north of Clyde River, and is Canada's second-largest and most northern national park. The landscape is dominated by hundreds of glaciers. Vegetation is sparse in upland areas and relatively lush in lowland areas. Few terrestrial wildlife species are present but species that are present can be abundant. About 30 species of birds nest in meadows of the park (The Canadian Encyclopedia, 2019).

2.6 Territorial Parks

The GN-DOE put out a call for people interested in participating in a joint planning and management committee for four territorial parks, which included Kinngaaluk Territorial Park near Sanikiluaq, Aguttinni Territorial Park near Clyde River, Napartulik Territorial Park near Grise Fiord and Kugluk Territorial Park near Kugluktuk. The Committees are composed of six people, based on interest, knowledge, Inuit culture and heritage. Community interest in the development of territorial parks is based on; Inuit rights to continue to use and enjoy parks; protecting culturally significant sites and important wildlife areas; promoting cultural and natural heritage; and developing economic and education benefits (Nunuvut News Online, 2019).

2.6.1 Agguttinni Territorial Park

The recently approved Agguttinni Territorial Park, became Nunavut's ninth (Government of Nunavut, 2019c) and largest territorial park (Environmental Journal, 2019), with support from the Government's of Nunavut and Canada, was announced on September 10 2019. It is located approximately 30 km west of Clyde River and is a joint GN and Inuit initiative. It includes a quarter of the Barnes Ice Cap which is a significant source of fresh water for Baffin Island (Nunatsiaq News, 2019a). The park was approved in September 2019 and has numerous cultural sites of importance for Inuit, as well as habitat for birds, poplar bears, and caribou (ECCC, 2019).

3. Inuit Quajimajatuqanjit – Traditional Knowledge Study

3.1 Program Objectives

IQ, although often translated as Inuit Traditional Knowledge, also includes important Inuit values, principles, cultural beliefs and behaviours. Its literal translation is, "that which has long been known by Inuit". There are many different definitions of IQ that aim to describe its holistic nature. The QIA has recently provided the following description that has guided our understanding of IQ (QIA, 2018b):

> *"Inuit Qaujimajatuqangit is a morality that is the base for Inuit existence. It is the belief system at the core of Inuit identity and governs Inuit society. It is born through a collective effort to survive in extreme conditions where no one else could and there is no other way to do so but together. Within this ideal lives a great life-affirming admiration to the land and animals. It is about living through helping each other. It is the Inuit way."*

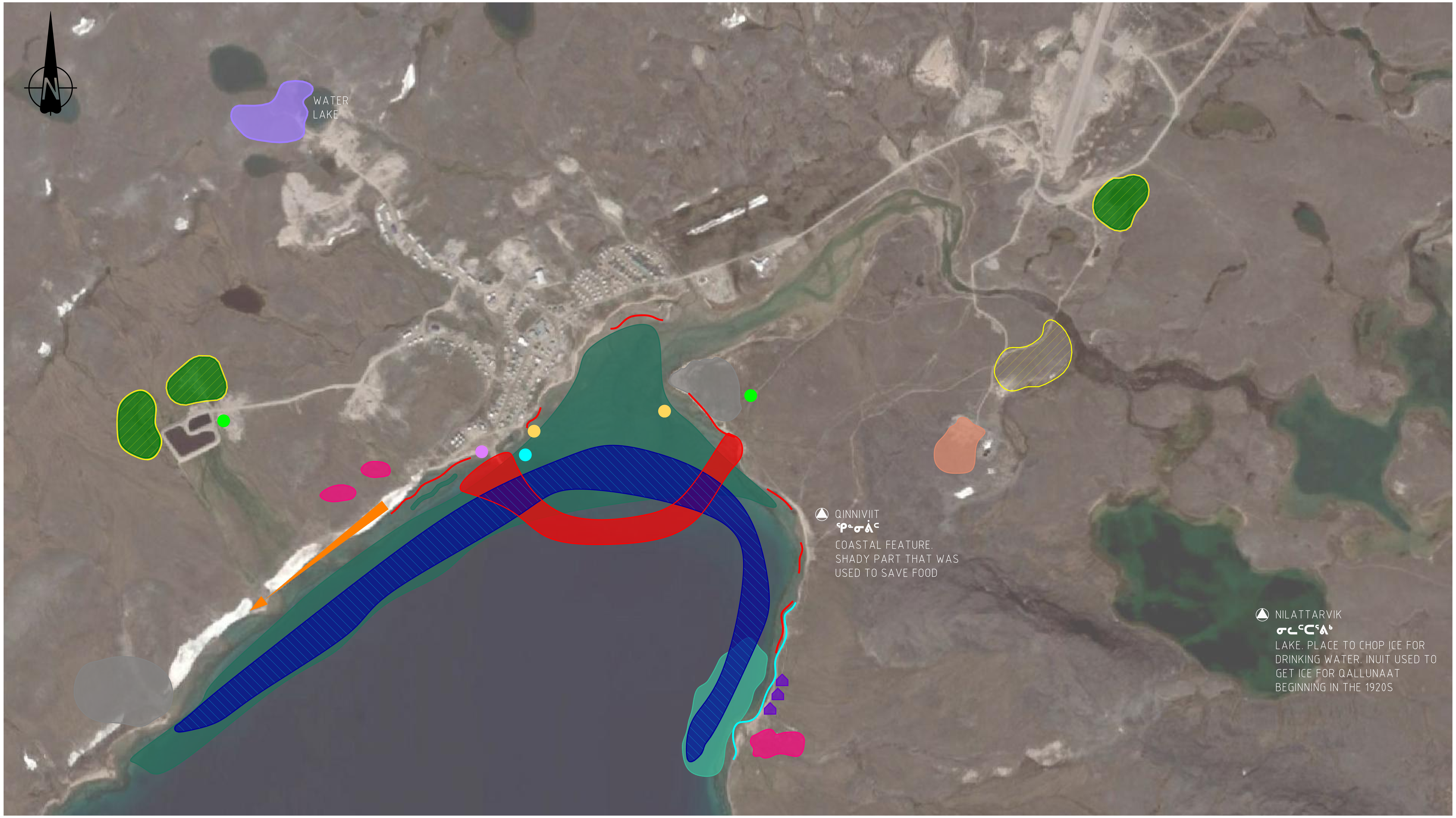
IQ, as we understand it, is not merely a collection of information about the land and wildlife, but an approach and set of principles to conducting research and project development that is based in respect and collaboration. The local knowledge holders we worked jointly with were also actively guiding decisions on the concept designs and early planning of the SCH for Clyde River. Our IQ program therefore aimed to gather 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: early Project decision-making and planning; and, to inform the environmental-screening process in the next phase.

We are grateful to the residents of Clyde River who graciously shared their time, knowledge and thoughtful feedback during our workshops.

Objectives for the IQ program are provided in Table 1-2.

3.2 Intellectual Property

The ESES was prepared with IQ gathered by Advisian and IQ reported in various regional studies. Advisian considers all IQ to be the intellectual property of the knowledge holders. The Land Use and Occupancy Map presented in Figure 3-1 was created jointly by Advisian and local knowledge holders to inform for the Feasibility Assessment for Clyde River. Any use of Figure 3-1, other than for the purpose stated, shall be done only with the express consent of DFO-SCH and the knowledge holders.



PLAN
1:10000

LEGEND:

- FISHING (CASTING / JIGGING)
- FISHING (NETS / CASTING)
- VARIOUS BIRDS (NESTING)
- CLAMS
- CLAMS (HARVESTING)
- SEAL / MARINE MAMMAL WAITING AREA
- VARIOUS SEALS
- RINGED SEALS (HARVESTED 2019)
- PTARMIGAN AND GEESE (HUNTING)
- POLAR BEAR (HARVESTED)
- NARWHAL AND VARIOUS SEALS (MAIN AREA OF SIGHTINGS)
- TENTS / CABINS
- BERRY HARVESTING
- SLED DOG AREAS
- CANADA GOOSE / SNOW GOOSE (HUNTING)
- SNOW GOOSE (HUNTING)
- BELUGA HARVESTED
- ICE ACCESS DURING SPRING BREAKUP (SNOWMOBILE)
- SOURCE INUIT HERITAGE TRUST: PLACE NAMES PROGRAM. INUIT HERITAGE TRUST INCORPORATED. JUNE, 2005

m 0 100 200 300 400 500m
1:10000

NOTES:

1. WATER DEPTHS WITHIN THE RED SURVEY BOUNDARY PROVIDED BY FISHERIES AND OCEANS CANADA. SURVEY WAS PERFORMED ON SEPTEMBER 14, 2018 BY AQUATICS-ESI, PROJECT NO. 18S022002, DRAWING NO. A1, REVISION 2, DATED 19/01/07

REV	DATE (DD-MMM-YY)	REVISION DESCRIPTION	DRAWN	DRAFT CHK	DESIGNED	ENG CHK	APPROVED	CUSTOMER	REF DRAWING No	REFERENCE DRAWING TITLE
D	20-DEC-19	ISSUED WITH FINAL REPORT	JLC	-	DP	-	HGK	-		
C	09-DEC-19	ISSUED FOR CLIENT REVIEW	JLC	-	DP	-	HGK	-		
B	27-NOV-19	ISSUED FOR INTERNAL REVIEW	JLC	-	DP	-	HGK	-		
A	25-OCT-19	FOR DISCUSSION	JLC	-	DP	-	HGK	-		

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CLYDE RIVER
LAND USE AND OCCUPANCY MAP
FIGURE 3-1

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3.3 Methodology

IQ was collected during:

- Two design workshops in November 2018 and May 2019 with members of the Nangmautaq HTO in Clyde River.
- One land use and wildlife focused workshop with four active Inuit hunters and fishers in May 2019.
- One verification workshop with the same four active Inuit hunters and fishers in November 2019.

The first design workshop in November 2018 concentrated on gaining an understanding from HTO members of the current conditions for accessing water and ice in Clyde River and the specific needs for a SCH. With the aid of an interpreter and aerial maps and photographs, an open dialogue between HTO members and the consultation team occurred allowing feedback and local knowledge from the most active users of the harbour to be obtained. IQ shared was noted and marked on maps during discussions by our Indigenous knowledge facilitator on topics such as: wind direction and strength, currents, seasonal changes to ice, water and ice access, DAS sites, and current boat traffic and ramp use. The workshop also provided an opportunity for the consultation team to advise the HTO of the field survey being planned for the open-water season (August) of 2019 and to describe the research activities expected to be conducted. Of interest to the HTO was the geophysics field survey (Appendix 5 – Geological Assessment of the main report) and the coordination of local support to the field team.

The second design workshop, conducted in May 2019, presented concept designs that had been developed using the IQ information and feedback provided in the first workshop. With the aid of an interpreter, the workshop allowed HTO members to see how their suggestions and local knowledge had been directly considered in the design of the concept options and provide their feedback on any changes needed and any preferred options. IQ was noted during discussions by our Indigenous knowledge facilitator on topics such as: changes to ice once the harbour is built, seasonal access for hunters during construction, DAS sites, haul road and quarry options, and project schedule. The workshop also allowed the consultation team to provide further details to HTO members on the field survey being planned for August 2019.

A land use and wildlife focused workshop (IQ workshop) was conducted on May 25, 2019 with four currently active Inuit hunters and fishers (knowledge holders) (Mike Jaypoody, Leslie Ashevak, Isaac Tassugat, and Daniel Jaypoody). The knowledge holders were selected by the HTO for being especially knowledgeable of harvesting areas in and around Clyde River and for being currently quite active out on the land and water. With the aid of a local interpreter, knowledge holders were asked to read a project information sheet and consent form and then complete and sign the form before the start of the workshop. The consent form described the workshop's objectives, methods, and uses for the information, allowed the knowledge holder to specify where a copy of the transcript and map should be sent, and whether the knowledge holder wished to be acknowledged by name for their contribution. In an effort to better understand the potential interactions between harvesting rights and anticipated Project activities, discussions during the workshop focused on harvest locations, water and ice access, fishing, marine and land mammals, birds and other wildlife and the potential locations of the proposed small craft harbour, quarry and haul routes in relation to land use activities (e.g. fishing, hunting, gathering and trapping). A local interpreter supported the discussions when required. Land use and occupancy, and any culturally or ecologically valued areas were marked on maps and later digitized (see Figure 3-1). During discussions, a questionnaire was used as a checklist, for guidance only, so that information could flow in a manner that was natural for the participants and not restricted or bound to any strict process.

A verification workshop was held in November 2019 to ensure that the information gathered during the earlier IQ Workshop (May 2019) was not misinterpreted or presented in a manner unintended by the knowledge holders. All knowledge holders consented to their knowledge being shared with the team and for the purpose of informing the ESES, the archaeological assessment (Appendix 6 – Archaeological Assessment of the main report) and the overall Feasibility Assessment. Consent was also provided by the knowledge holders to have their knowledge presented as noted in the land use and occupancy map (Figure 3-1). We have attempted to join IQ with results from the field studies to allow the project team, in collaboration with community members, to make informed decisions on the design and construction planning of the small craft harbours that reflect local people's needs, priorities and values.

A review for existing and accessible IQ research relevant to the Project area was also conducted. The following sources were especially helpful in providing valuable regional context to this ESES:

- The Clyde River Knowledge Atlas (Clyde River Knowledge Atlas, 2019)
- Qikiqtaaluk Inuit Qaujimajatuqangit and Inuit Qaujimajangit Iliqqusingitigut for the Baffin Bay and Davis Strait Marine Environment. Qikiqtani Inuit Association (QIA, 2018c)
- The Nunavut Coastal Resource Inventory (NCRI) for Clyde River 2014 (Government of Nunavut, 2014)
- Tallurutiup Tariunga Inulik: Inuit Participation in Determining the Future of Lancaster Sound (QIA, 2012)
- Draft Nunavut Land Use Plan (NPC, 2016a)
- The Nunavut Wildlife Harvest Study (NWHS) (Priest & Usher, 2004)
- Inuit Heritage Trust (IHT): Place Names Program (IHT, 2007)
- NBRLUP (NPC, 2000a)

Where applicable, topic specific IQ information has been incorporated into this report. Additionally, a map of land use and occupancy information compiled during the HTO design workshops, IQ focused workshop and verification has been provided (see Figure 3-1). The map also includes place names in the area from the IHT database. A discussion on local land and resource use can be found in Section 11.2.6.

The IQ findings are based on a small number of 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 Project Study Areas or the surrounding region.

4. Marine Water Quality

Program objectives for water quality are provided in Section 1.6, Table 1-2.

4.1 Desktop Review

Water quality monitoring data for Nunavut is limited, particularly at the local scale. The Nunavut General Monitoring Plan (NGMP) classifies water quality monitoring into two categories: project monitoring (project specific within a local study area), and general monitoring (addresses information on the long-term state and health of aquatic ecosystems in the Nunavut territory) (NGMP, 2013). There is no established mechanism for the monitoring of marine water quality in the NGMP (NGMP, 2013). The lack marine water quality data for the Arctic is identified as knowledge gap by NPC due to its potential impact on marine mammals and seabirds (Government of Canada, 2018d). The Northern Contaminants Program is one organization that collects marine water quality information (Government of Canada, 2018a). Understanding marine water quality is important in Nunavut, particularly in the context of climate change, where changing conditions of sea ice and freshwater runoff are important drivers in Arctic water quality (Nummelin *et al.*, 2015). Understanding these variables provides a broader understanding of variable seasonal effects on coastal and offshore processes (Government of Canada, 2002)

Within communities, the influence of storm water runoff, the effectiveness of wastewater treatment, and localized spills can influence marine water quality. Storm water run-off in Clyde River is poorly understood, but its impact is likely at a localized level, since Clyde River is a relatively unimpacted area. Wastewater treatment in Clyde River is similar to most Nunavut communities and consists of passive systems such as waste stabilization ponds (WSPs) (Centre for Resource Studies, 2015; Schmidt *et al.*, 2016). The WSP system is located 1.3 km northwest of the existing breakwater. The effluent enters the marine environment after being discharged to a vegetated filter strip. The wastewater discharge site is 1.2 km southwest of the existing breakwater. There is limited information to confirm how the wastewater treatment system in Clyde River may influence localized marine water quality, however, Centre for Resource Studies (2015) indicated that a study is required in Clyde River to address improvements in the treatment of raw wastewater. Anthropogenic influence on marine water quality due to spills has not been studied in Nunavut, particularly at the local scale in communities such as Clyde River. No information on water quality was collected during the IQ Workshop (May 2019).

4.2 Field Survey

4.2.1 Methodology

4.2.1.1 Survey Location

Marine water quality in Clyde River was assessed over one sampling event on August 12, 2019 by an experienced marine scientist and a local Inuit assistant. Water samples were taken from four locations as shown in Figure 4-1. Sample locations were selected to give a broad overview of water quality in the vicinity of the SCH and DAS Study Areas. Survey locations and depth sampled are provided in Table 4-1.

Legend

SCH Footprint
- Option 1
- Option 2
- Option 3

Study Area
- SCH
- DAS

Water Quality Sampling Location

Imagery Source: CHS, July 2016

Locations approximate.

FISHERIES AND OCEANS CANADA
CLYDE RIVER HARBOUR DEVELOPMENT
ENVIRONMENTAL AND SOCIO-ECONOMIC BASELINE SURVEY

WATER QUALITY SAMPLING LOCATIONS

Fisheries and Oceans Canada

Date: 18-DEC-19	Drawn by: KR	Edited by: KR	App'd by: VB

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Table 4-1 Water Quality Sampling Locations (August 12, 2019)

Sample ID	Start		Time	Sample Depth Category	Depth (m)	Station Depth (m)	Tide Height (m)	Chart Datum Depth (m)
	Latitude	Longitude						
1	70° 27.898'N	68° 35.956'W	16:51	S	1	9.5	0.5	9.0
			16:55	D	8.5			
2	70° 27.914'N	68° 35.127'W	17:14	S	1	14	0.5	13.5
			17:21	D	13			
3	70° 28.049'N	68° 35.326'W	17:31	M	2	4.0	0.5	3.5
			17:34	M	2			
4	70° 27.748'N	68° 35.918'W	17:46	S	1	31.5	0.5	31.0
			17:50	D	30.5			

Notes: S = Shallow (1m below surface), D = Deep (1m above seabed), M = midwater

4.2.1.2 Field Survey Techniques

Samples for chemical analysis were collected from each sampling site using a 5.0 L Teflon lined Niskin bottle deployed from the vessel. When depths were greater than 8 m, two samples were taken from each site, one at the surface (1 m below surface) of the water column and one from the bottom of the water column (1 m above seabed). The Niskin was lowered over the side of the vessel to the required depth, a messenger was deployed and the Niskin retrieved to the surface with contained sample. Once at the surface, the water sample was decanted into specific containers, supplied by the laboratory, for the required analyses. Sample containers were appropriately labelled using indelible ink to write the sample location number, depth of sample and date and immediately stored in coolers. Samples remained in refrigerated condition until dispatched to the analytical testing laboratory, where they are maintained at four degrees Celsius (4°C).

All samples were retained at the analytical laboratory for three months from the date of submission for repeat/verification testing, if required.

Physicochemical analysis was planned, however, the SeaBird Conductivity, Temperature, and Depth (CTD) device was not taken due to weight limitations on the two charter flights into Grise Fiord from Clyde River and because such data, while nice to characterize background conditions for comparison during construction, this data is not required for the likely required permits or approvals. Consideration should be given to collect this data during future field surveys conducted during the detailed design and permitting phase.

4.2.1.3 Laboratory Analysis

Samples sent to the laboratory for chemical analysis were analyzed for the following:

- Nutrients (ammonia, nitrate, nitrite, phosphate, total organic carbon)
- Physical parameters (pH, total suspended solids)
- Total metals
- Dissolved metals

4.2.2 Data Analysis

Laboratory data were directly imported into the Environmental Quality Information System (EQuIS) 5.5.1 database (Earthsoft, Concord, MA). Quality control checks were conducted to confirm data are admissible for use. The results were compared to the CCME – Canadian Water Quality Guidelines for the Protection of Aquatic Life (CCME, 2003). These guidelines provide nationally endorsed, science-based goals for maintaining quality in aquatic ecosystems and are used for guidance to assess marine water quality. Water quality results were compared to long term guidelines.

4.2.3 Quality Assurance/Quality Control

4.2.3.1 Field QA/QC

The field Quality Assurance (QA)/Quality Control (QC) measures for the water quality field survey included procedures to reduce the risk of cross-contamination. The following QA/QC procedures were incorporated during sampling to ensure the highest quality results:

- Using qualified environmental staff experienced in marine water sampling and field supervision of local assistants.
- Decontaminating all water sampling equipment by washing with a phosphate-free detergent solution, followed by thorough rinsing with analyte-free (de-ionized) water, prior to collecting a sample at each location.
- Prevention of cross-contamination by wearing a new pair of nitrile gloves for each sampling location when handling samples and sampling equipment.
- Storing samples in the appropriately cleaned, pre-treated and labelled sample containers.
- 'Blind labelling' all field QA/QC duplicate samples in the field with QA/QC field numbers which do not relate to the sampling location names.
- Keeping water samples cool (4°C) after sampling and during transport.
- Avoiding headspace in the sample containers.
- Maintaining a clean and organized work area.

- A regimented process for sample documentation was used, including:
  - Labelling all field sample containers and field data sheets with pencil/indelible ink and waterproof labels.
  - Backing up electronic data (i.e. positional data from Global Positioning System [GPS], photographs), in duplicate, at the end of each field day and labelling electronic files.
  - Keeping thorough notes, including photographs, GPS coordinates, tidal/weather conditions, and recording potential confounding factors observed during field days and at sites.
- Transporting samples under Chain of Custody (COC) documentation.

4.2.3.2 Laboratory QA/QC

Laboratory analysis was conducted in accordance with professional standards using accepted testing methodologies, quality assurance, and quality control. The laboratory used for sediment sample analyses is a Canadian Association for Laboratory Accreditation Inc. (CALA) accredited for the methods used and is experienced in the analysis of marine sediments.

QA/QC procedures for contaminant assessment were used from sampling through to completion of laboratory analysis included:

- Chain of custody documentation
- Field and intra-laboratory QA/QC protocols

One field duplicate sample was collected in Clyde River and analyzed to determine the variability in analytical parameters.

Laboratory QA/QC included procedures to promote high quality laboratory results as well as measures to verify the results. These procedures included analysis of laboratory method blank, laboratory matrix spike, laboratory spiked blank, and laboratory duplicate.

A validation of the analytical data was undertaken to confirm that the data quality was suitable for undertaking an assessment to characterize water quality (see Section 4.2.5). This validation included a consideration of results for laboratory blanks, standards, spikes, and field and laboratory duplicate samples and is assessed against CCME (2016b).

4.2.4 Results

4.2.4.1 Chemical

The results for chemical analyses for water quality are summarized below and presented in Tables 1 (General water chemistry), Table 2 (Total Metals) and Table 3 (Dissolved Metals) in Appendix 2. Results are compared against the CCME (2003) long term marine water quality guideline for the protection of aquatic life.

Laboratory analytical results are available on request.

4.2.4.2 Major Ions, Nutrients and Physicochemical

Results of laboratory analysis for major ions, nutrients and physiochemical parameters are summarized as follows:

- pH was consistent across depth and sample location, ranging from 7.84 to 7.94.
- Nutrients analyzed were ammonia and total phosphorous. Phosphorous was consistent across all sampling locations, whereas ammonia was generally elevated at shallow depths (ranged from 0.5 mg/L to 1.3 mg/L) compared to deeper samples (ranged from 0.56 to 0.88 mg/L).
- Water hardness was consistent across sampling locations and was generally elevated at depth compared to surface samples. Total hardness (as $CaCO_3$) ranged from 4,720 mg/L to 6,170 mg/L.
- Total organic carbon (TOC) was consistent across sample location and depth, ranging from 80 mg/L to 97 mg/L.

4.2.4.3 Total Metals

Results of laboratory analysis for total metals are summarized as follows:

- Metals were below their respective CCME long term marine water quality guideline, where a guideline exists.
- Antimony, beryllium, bismuth, boron, lithium, cobalt, selenium, silicon, silver, thallium, tin, titanium, vanadium, and zirconium were below the RDL in all samples and therefore lower than the CCME long term marine water quality guideline, where a guideline exists.
- Aluminum, arsenic, barium, molybdenum, nickel, thallium, strontium, uranium, calcium, magnesium, potassium and sulphur were present above respective RDLs in all samples. Concentrations of all analytes were relatively consistent across depth and sample location.
- Cadmium was above RDL in two out of eight samples, both of which were in sample locations of deep water (CR-2 and CR-4). Cadmium ranged from 0.054 µg/L to 0.062 µg/L.
- Chromium was above RDL in five out of eight samples and ranged from 0.55 µg/L to 0.89 µg/L.
- Copper was above RDL in six out of eight samples and ranged from 0.51 µg/L to 2.00 µg/L.
- Iron was above the RDL in two samples, both shallow water samples (CR-2 and CR-4). There iron levels were both 11 µg/L. One sample (CR-1 shallow) was equal to the RDL (10 µg/L).
- Lead was above the RDL in four locations, all shallow water locations. Lead levels ranged from 0.14 µg/L to 1.14 µg/L.
- Manganese was above RDL in five locations, ranging from 0.65 µg/L 0.95 µg/L.
- Zinc was above RDL in three locations. Levels ranged from 5.2 µg/L to 6.6 µg/L.

4.2.4.4 Dissolved Metals

Results of laboratory analysis for dissolved metals are summarized as follows:

- Antimony, beryllium, bismuth, boron, lithium, cobalt, iron, selenium, silicon, silver, thallium, tin, titanium, vanadium and zirconium were below RDL in all samples.
- Aluminum, arsenic, barium, molybdenum, nickel, strontium, uranium, calcium, magnesium, potassium and sulphur were present above respective RDLs in all samples. Concentrations of all analytes were consistent across depth and sample location.
- Chromium was above RDL in all samples except one (CR-2 shallow).
- Copper was above RDL in three samples only, ranging from 0.56 µg/L to 0.95 µg/L.
- Lead was above RDL in 4 out of 8 samples, at concentrations ranging from 0.11 µg/L to 0.27 µg/L.
- Manganese was above RDL in five samples. Concentrations were relatively consistent across depths and locations and ranged from 0.56 µg/L 1.03 µg/L.
- Zinc was above RDL in only two locations, both shallow (CR-1; 7.8 µg/L and CR-4; 5.1 µg/L).

4.2.5 Data Validation

4.2.5.1 Laboratory Accuracy and Precision

Bureau Veritas (BV) incorporated a range of QA/QC methods to ensure accuracy and precision of data. The results of the QA/QC completed are detailed below.

Laboratory Method Blanks

An assessment of laboratory blank samples reported by BV demonstrates concentrations below the RDL for the majority of parameters, so cross-contamination of samples does not appear to have occurred.

Laboratory Duplicates

CCME (2016a) recommends that laboratory duplicate samples should be within a Relative Percent Difference (RPD) of ±20% for metals and nutrients and ±0.3 pH units or pH.

Review of BV QC results shows all RPDs to be within acceptable limits.

Matrix Spikes

To verify that the physical properties or characteristics of the matrix do not interfere with the analytical result, a known concentration of the chemical of interest is mixed into a sample of the required matrix. Matrix spikes measure the analytical methodology’s performance on a specific matrix type. CCME (2016a) states that recovery limits of 70% to 130% for metals are acceptable.

Review of BV QC results identified that all matrix spike recovery met the acceptability criteria for all metals except total molybdenum (126%), total tin (135%) and total ammonia (62%). Dissolved mercury also did not meet the acceptability criteria (78%).

4.2.5.2 Field Duplicate Analysis

Field duplicates are samples that are split from the original sample. These QC samples identify variation associated with sub-sample handling and repeatability of laboratory analysis. One field duplicate sample was collected for the program (collected at CR 3). The CCME (2016a) states that RPD for water quality field duplicates should be within ±40%.

Review of the field duplicate QC results showed all RPD's to be within acceptable limits.

4.2.5.3 Holding Times

All water samples that required refrigeration were stored in coolers and then transported to the laboratory chilled, where samples were stored under refrigeration until analyzed.

Samples did not meet their holding time requirements for all variables except total metals, as expedited shipping out of Nunavut was not possible. Standard methods for pH analysis state that pH should be analyzed within 15 minutes of sampling, and therefore, generally is measured in the field. Therefore, analysis of pH was completed outside of standard holding times. A summary is provided in Table 4-2.

Table 4-2 Clyde River Marine Water Quality Holding Times Reference Table

Parameter	Date			Number of Days Passed	Recommended Holding Time (days)
	Sample Taken	Sample Delivered	Sample Analyzed		
Mercury (dissolved)	12 August	3 September	12 September	31	28
Mercury (total)					28
TOC					28
Total Metals			11 September	30	180

4.3 Discussion

Marine water quality in Clyde River was consistent across sites and depth profiles.

Metal concentrations were all below respective CCME (2003) guidelines, and across all sample locations, dissolved metal concentrations were comparable to total concentrations, indicating that metals typically are not bound to solids. pH, hardness, alkalinity, TOC, total suspended solids (TSS), sulphur and metal concentrations were consistent across shallow and deep samples.

No IQ Assessment was completed at the site-specific level.

5. Sediment Quality

Program objectives for water quality are provided in Section 1.6, Table 1-2.

5.1 Desktop Review

Sediment quality in Nunavut, including Clyde River has not been widely studied. The collection of sediment quality data is generally driven by discreet project requirements, for which there have been few in the region requiring this level of detail.

In Clyde River, sediment quality has the potential to be influenced by stormwater draining from residential and industrial areas, effluent outfall from waste disposal, and spills from various shoreline activities. These variables are discussed in Section 4.1. Effluent quality monitoring at treatment plants is known to be a challenge for communities in Nunavut (Wooton *et al.*, 2008). As discussed in Section 4.1, WSPs are used for wastewater treatment in Clyde River. WSPs are an affordable option for Northern communities however, they do present a variety of challenges for monitoring such as limited resources, and difficulties in finding the outfall location. To date, it is unknown if effluent quality monitoring or reporting is undertaken in Clyde River. No information on sediment quality was collected during the IQ Workshop (May 2019).

5.2 Field Survey

5.2.1 Methodology

As dredging would likely be required for construction of the SCH, the sediment sampling program was developed to address the requirements of the ECCCs Disposal at Sea Regulations and associated ECCC guidance including: the Applicant's Guide to Applying for a DAS Permit (Government of Canada, 2019d), and Minimum Sample Collection Requirements (ECCC, 2018a). Due to potential DAS requirements, survey effort focused on the Project footprint (load site) and a potential DAS site (disposal site). Fifteen samples were planned for the load site, and 10 for the DAS site. The field survey was completed by an experienced marine scientist and a local Inuit assistant.

Sediment sample collection was designed to support a DAS permit application to ECCC with the number of samples at the load site based on the ECCC's 2018 Atlantic Guidance 'Characterization of Dredged Material for Open Water Disposal' (ECCC, 2018a) which were based on the size of the potential dredge footprint of the Option 1 design (approximately 15,000 m^2), where a minimum of eight samples are recommended. ECCC's guidance provides a range of recommended field samples based on a higher and lower certainty level, which is based on the confidence for the potential for contamination.

Given that Arctic environments are relatively pristine the sampling intensity (number of samples) was considered for the higher certainty recommendation. Typically, when planning for a DAS permit, a Sampling and Analysis Plan (SAP) to inform a DAS application will be obtained from ECCC prior to mobilization into the field. Permitting was not in the ESES scope, so assumptions were made based on ECCC (2018a) guidance.

5.2.1.1 Survey Location

Sediment quality in Clyde River was assessed over one sampling event on August 13, 2019. Sediment samples were taken from nine locations as shown in Figure 5-1. Logistical complications which impacted sediment collection are described in Section 5.2.1.2.

Sample locations were selected within the dredge footprints of design Option 1 and Option 2, thus samples outside of the dredge footprint of each design serve as a control for the other. Sediment sampling locations were placed randomly.

Table 5-1 Sediment Quality Sampling Locations (August 13, 2019)

Sample ID	Collection Method	Start		Time	Depth (m)	Tide Height (m)	Chart Datum Depth (m)
		Latitude	Longitude				
CR LS1	Ponar	70° 28.054'N	68° 35.737'W	8:55	5.0	0.4	4.6
CR LS2	Snorkel	70° 27.975'N	68° 36.075'W	16:45	2.5	0.5	2.0
CR LS3	Snorkel	70° 28.011'N	68° 35.983'W	16:54	3	0.5	2.5
CR LS4	Snorkel	70° 28.086'N	68° 35.565'W	17:36	0.5	0.5	0
CR LS5	Snorkel	70° 28.037'N	68° 35.842'W	17:05	2.5	0.5	2.0
CR LS6	Snorkel	70° 28.072'N	68° 35.782'W	17:10	1.5	0.5	1.0
CR LS7	Snorkel	70° 28.059'N	68° 35.709'W	17:17	2.0	0.5	1.5
CR LS8	Snorkel	70° 28.092'N	68° 35.706'W	17:25	1.5	0.5	1.0
Cr LS9	Snorkel	70° 28.062'N	68° 35.613'W	17:30	0.5	0.5	0

Legend

SCH Footprint	Dredge Area	Sediment Quality Sampling Locations	
Option 1	Option 1	Collected - Ponar	SCH Study Area
Option 2	Option 2	Collected - Hand	
Option 3	Option 3	Planned	

Imagery Source: CHS, July 2016

Locations approximate.

FISHERIES AND OCEANS CANADA
CLYDE RIVER HARBOUR DEVELOPMENT
ENVIRONMENTAL AND SOCIO-ECONOMIC BASELINE SURVEY

SEDIMENT SAMPLING LOCATIONS (PLANNED & COLLECTED) AT THE SMALL CRAFT HARBOUR

Fisheries and Oceans Canada

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Date: 18-DEC-19	Drawn by: KR	Edited by: JH	App'd by: VB
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5.2.1.2 Field Survey Techniques

5.2.1.3 Sample Collection Methods

The planned methodology had been to use a 0.0018 m^3 Ponar grab sampler (Ponar), deployed from a survey vessel, depending on location. Sample collection by Ponar was complicated in some of the survey sites due to the compact characteristics of the sand which did not enable the grab to successfully obtain sediment samples. Physical sediment characteristics can be confirmed from the geophysics field survey report (see Appendix 5 - Geological Assessment of the main report). When possible, some samples were collected by hand with snorkelling equipment. Sampling collection methodology for the two techniques is described below. Once at the surface samples were treated in the same manner, and logged and processed, as described in Section 5.2.1.4.

Figure 5-1 displays the planned versus collected sampling sites, as well as those collected by Ponar versus by hand. As a result of the compacted nature of sediments (see Section 5.3) no samples were collected in the DAS Study Area.

Ponar Grab Sampler

Samples were collected from each sampling location using a Ponar grab sampler deployed from the survey vessel. The Ponar was lowered manually over the side of the vessel to the seabed and then retrieved to the surface, with an intact sample. The Ponar collects a sample approximately 8 cm in depth over an area of 225 cm^2 (15 cm x 15 cm area).

Snorkel Collection

Samples were collected by an Advisian biologist in a dry suit. For safety reasons, the accessible depth was limited to 5 m. Samples were collected using a sterilized shovel and placed directly into a stainless steel mixing bowl. The sediments were collected over approximately the same area as the Ponar grab sample. The bowl was gently brought to the surface by the snorkeller and handed to the topside personnel.

5.2.1.4 Sample Processing

Sediment samples were logged and processed on board the survey vessel. At each sample site a sediment log of each sample was recorded on a field data sheet, providing a description of the composition of each sample, including the following information:

- Colour and evidence of staining
- Texture
- Odour
- Presence of debris and biological material
- Photograph of each sediment sample

Once samples were logged and photographed they were placed into large stainless-steel mixing bowls and homogenized using gloved hands (powderless nitrile gloves) and stainless steel sample scoop. Samples were stored in specific containers, supplied by the laboratory, for the required analyses. Sample containers were appropriately labelled using indelible ink to write the sample location number and date on both the label and the lid of the container and immediately stored in coolers. Samples remained in refrigerated condition until dispatched to the analytical testing laboratory, where they were maintained at four degrees Celsius (4°C).

All sample material held at the analytical laboratory is retained for three months from the date of submission for repeat/verification testing if required.

Raw data including sample photographs are provided in Appendix 3.

5.2.2 Laboratory Analysis

Based on a review of existing information in the area, known land uses within the catchment and the requirements of the Disposal at Sea Regulations and (Government of Canada, 2019d), sample analysis included:

- TOC
- Total metals (suite of 32)
- Polycyclic aromatic hydrocarbons (PAHs)
- Polychlorinated biphenyls (PCBs)
- Sediment grain size

5.2.3 Data Analysis

Laboratory data were directly imported into the EQuIS 5.5.1 database (Earthsoft, Concord, MA). Checks for data quality have been conducted to confirm data are admissible for use. The results were compared to the following guidelines:

- ECCC – criteria under Disposal at Sea Regulations
- CCME – Canadian Sediment Quality Guidelines for the Protection of Aquatic Life (CCME, 1999b). These guidelines provide nationally endorsed, science-based goals for maintaining quality in aquatic ecosystems and are used for guidance but not as strict criteria for DAS. Sediment quality data are compared to the following marine guidelines:
  - Interim Sediment Quality Guideline (ISQG), which is based on the Threshold Effects Level (TEL), or the concentration of an analyte below which adverse biological effects are rarely expected (less than 25% of the time).
  - Probable Effects Level (PEL) concentration, which is the level at which adverse biological effects occur more than 50% of the time.

5.2.4 Quality Assurance/Quality Control

5.2.4.1 Field QA/QC

The field QA and QC measures for the sediment sampling program included procedures to reduce the risk of cross-contamination. The following QA/QC procedures were incorporated during sampling to ensure the highest quality results:

- Using qualified environmental staff experienced in sediment sampling, field supervision and sediment logging.
- Using a survey vessel that was inspected and washed down.
- Decontaminating all sediment sampling equipment and associated utensils by scrubbing with a brush and phosphate-free detergent solution to remove excess sample material, followed by thorough rinsing with analyte-free (de-ionized) water.
- Prevention of cross-contamination by wearing a new pair of nitrile gloves for each sampling location when handling samples and sampling equipment.
- Storing samples in the appropriately cleaned, pre-treated and labelled sample containers.
- 'Blind labelling' all field QA/QC duplicate samples in the field with QA/QC field numbers which do not relate to the sampling location names.
- Keeping sediment samples cool (4°C) after sampling and during transport.
- Avoiding headspace in the sample jars.
- Maintaining a clean and organized work area.
- A regimented process for sample documentation was used, including:
  - Labelling all field sample jars and field data sheets with pencil/indelible ink and waterproof labels;
  - Backing up electronic data (i.e. positional data from GPS, photographs), in duplicate, at the end of each field day and labelling electronic files.
  - Keeping thorough notes, including photographs, GPS coordinates, tidal/weather conditions, and recording potential confounding factors observed during field days and at sites.
- Transportation of samples under COC as described in Section 4.2.3.2.

5.2.4.2 Laboratory QA/QC

Laboratory analysis was conducted in accordance with professional standards using accepted testing methodologies, quality assurance, and quality control. The laboratory used for sediment sample analyses is CALA accredited for the methods used and is experienced in the analysis of marine sediments.

QA/QC procedures for laboratory analysis included:

- COC documentation
- Field and intra-laboratory QA/QC protocols

Laboratory QA/QC included procedures to promote high quality laboratory results as well as measures to verify the results. These procedures included analysis of laboratory method blank, laboratory matrix spike, laboratory spiked blank, and laboratory duplicate (see Section 4.2.5).

A validation of the analytical data was undertaken to confirm that the data quality was suitable for undertaking an assessment to characterise material proposed for dredging and disposal. This validation included a consideration of results for laboratory blanks, standards, spikes, and field and laboratory duplicate samples and is assessed against CCME (2016b).

5.2.5 Results

5.2.5.1 Physical Characteristics

Within the SCH Study Area sediment Particle Size Distribution (PSD) is similar across most sample locations (refer to Figure 5-2), consisting predominantly of sands (average of 89%) and gravel (average of 9%), with minimal clay and silt. All sample locations have a similar total percentage of clay and silt. Notable exceptions are CR LS3, which consisted of 37% gravel; CR LS6, which consisted of 28% gravel; and CR LS9 which consisted of 22% gravel. (Figure 5-2).

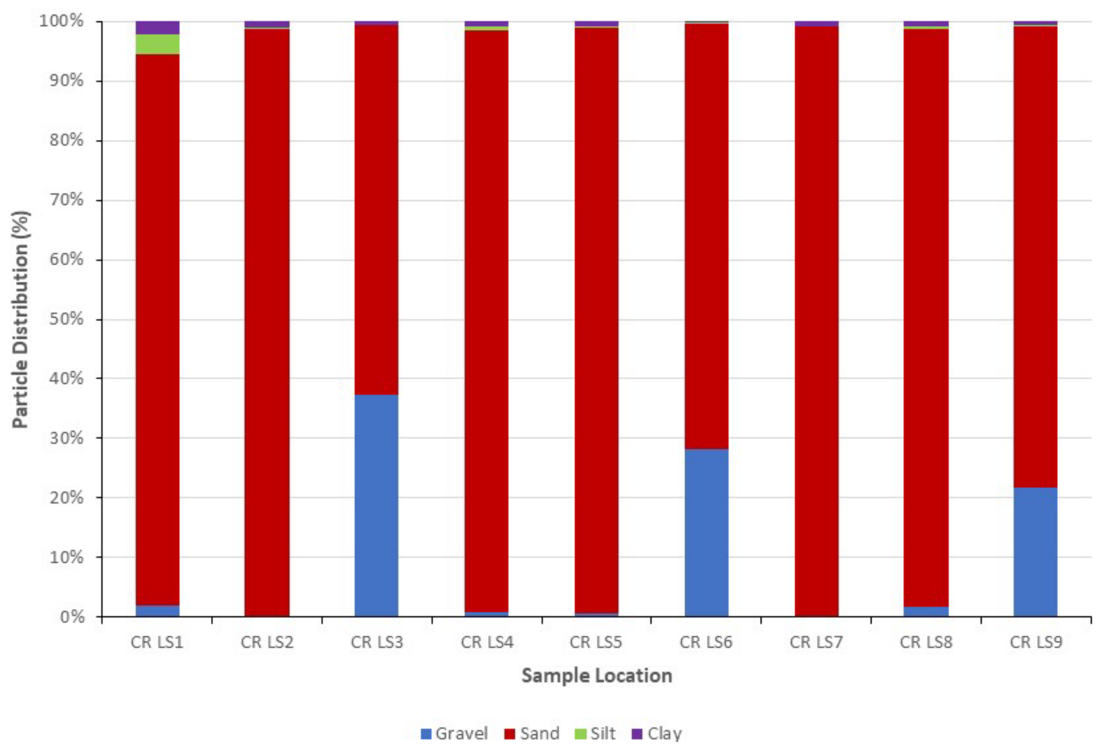


Figure 5-2 Mean Percentage of Particle Size Distribution of Sediments within the Small Craft Harbour Study Area

5.2.5.2 Chemical Characteristics

The results of chemical analyses for sediments within the SCH Study Area are summarized below and presented in Table 1 (Metals and Metalloids), Table 2 (PAHs), and Table 3 (PCBs) of Appendix 4.

Results are compared against the DAS Regulations and the CCME Sediment Quality Guidelines (CCME, 1999a).

Metals and Metalloids

Table 5-2 provides summary statistics for metals and metalloids for the SCH Study Area and Table 1, Appendix 4 provides a summary of the laboratory results for samples taken during this survey.

Table 5-2 Summary Statistics for Metals and Metalloids in the Small Craft Harbour Study Area

Metal/ Metalloid	Minimum (mg/kg)	Maximum (mg/kg)	Mean (mg/kg)	Median (mg/kg)	Standard Deviation (mg/kg)
Aluminum	643	11200	2130.78	1070	3412.60
Antimony*	0.05	0.55	0.11	0.05	0.17
Arsenic*	0.25	7.33	1.12	0.25	2.34
Barium	2.72	145	20	4.10	46.91
Beryllium*	0.10	0.36	0.13	0.10	0.09
Bismuth	N/A	N/A	N/A	N/A	N/A
Boron	1.20	5.50	1.97	1.50	1.36
Cadmium*	0.03	0.16	0.04	0.03	0.04
Calcium	1050	7100	2418.89	1940	1895.91
Chromium	2.10	17.20	6.19	4.70	4.48
Cobalt	0.39	9.27	1.70	0.85	2.85
Copper*	0.25	18.70	2.67	0.79	6.02
Iron	2520	27900	8494.44	5830	7654.45
Lead	0.57	10.10	2.20	1.29	3
Lithium*	2.50	9.00	3.22	2.50	2.17
Magnesium	513	6430	1424	802	1891.99
Manganese	17.60	666	101.01	34	212

Metal/ Metalloid	Minimum (mg/kg)	Maximum (mg/kg)	Mean (mg/kg)	Median (mg/kg)	Standard Deviation (mg/kg)
Mercury*	0.03	0.06	0.03	0.03	0.01
Molybdenum	0.10	0.66	0.22	0.17	0.17
Nickel*	0.40	18.30	3.09	1.31	5.72
Phosphorous	276	1000	623.22	672	274.11
Potassium	341	949	582.11	521	239.19
Selenium	N/A	N/A	N/A	N/A	N/A
Silver*	0.03	0.06	0.03	0.03	0.01
Sodium	241	1900	1035	981	437.02
Strontium	2.50	47.20	8.98	3.16	14.62
Thallium*	0.03	0.08	0.03	0.03	0.02
Tin	0.20	0.41	0.30	0.31	0.08
Titanium	198	538	329.78	326	111.96
Tungsten	N/A	N/A	N/A	N/A	N/A
Uranium	0.19	0.46	0.31	0.32	0.11
Vanadium	5.30	54.60	16.88	11.30	14.89
Zinc	2.70	74.10	12.32	4.90	23.22
Zirconium	0.63	5.28	1.68	1.30	1.42

Notes:
* Samples below laboratory RDL were set to one half RDL for purposes of completing summary statistics.
N/A All samples were below laboratory RDL. No summary statistics completed.
(yellow) Value exceeds CCME ISQG
(green) Value exceeds ECCC DAS Regulations and CCME PEL

Results of metals and metalloids analysis are summarized for the field survey:

- All metals and metalloids (cadmium, mercury, chromium, lead, zinc), except copper and arsenic, that have a regulated or guideline limit under the Disposal at Sea Regulations were below their respective limits at all sample locations. Mercury was below laboratory RDL in all samples except at CR LS9 (0.06 mg/kg).
  - Copper was met the CCME ISQG (18.7 mg/kg) at sampling location CR LS9.
  - Arsenic was above the CCME ISQG (7.24 mg/kg) at sampling locations CR LS9.

- Metals and metalloids were detected at all sample locations.
- The following were below laboratory RDL limits:
  - Antimony 8 of 9 samples
  - Arsenic 7 of 9 samples
  - Beryllium 8 of 9 samples
  - Cadmium 8 of 9 samples
  - Copper 2 of 9 samples
  - Lithium 8 of 9 samples
  - Mercury 8 of 9 samples
  - Nickel 1 of 9 samples
  - Silver 8 of 9 samples
  - Thallium 7 of 9 samples
- Bismuth, selenium, and tungsten were below laboratory RDL in all samples.

Polycyclic Aromatic Hydrocarbons

Table 2, Appendix 4 provides a summary of the laboratory results for samples taken during this survey.

Results of PAH analysis are summarized as follows:

- All individual PAHs were below their respective CCME ISQG
- Total PAHs were below the DAS Regulations (2.5 mg/kg) at all sample locations
- PAHs were detected at all sample locations
- With the exception of naphthalene, polycyclic aromatic hydrocarbons (light), and Total PAHs at sampling location CR LS 1, all PAHs were below laboratory RDL at all sample locations

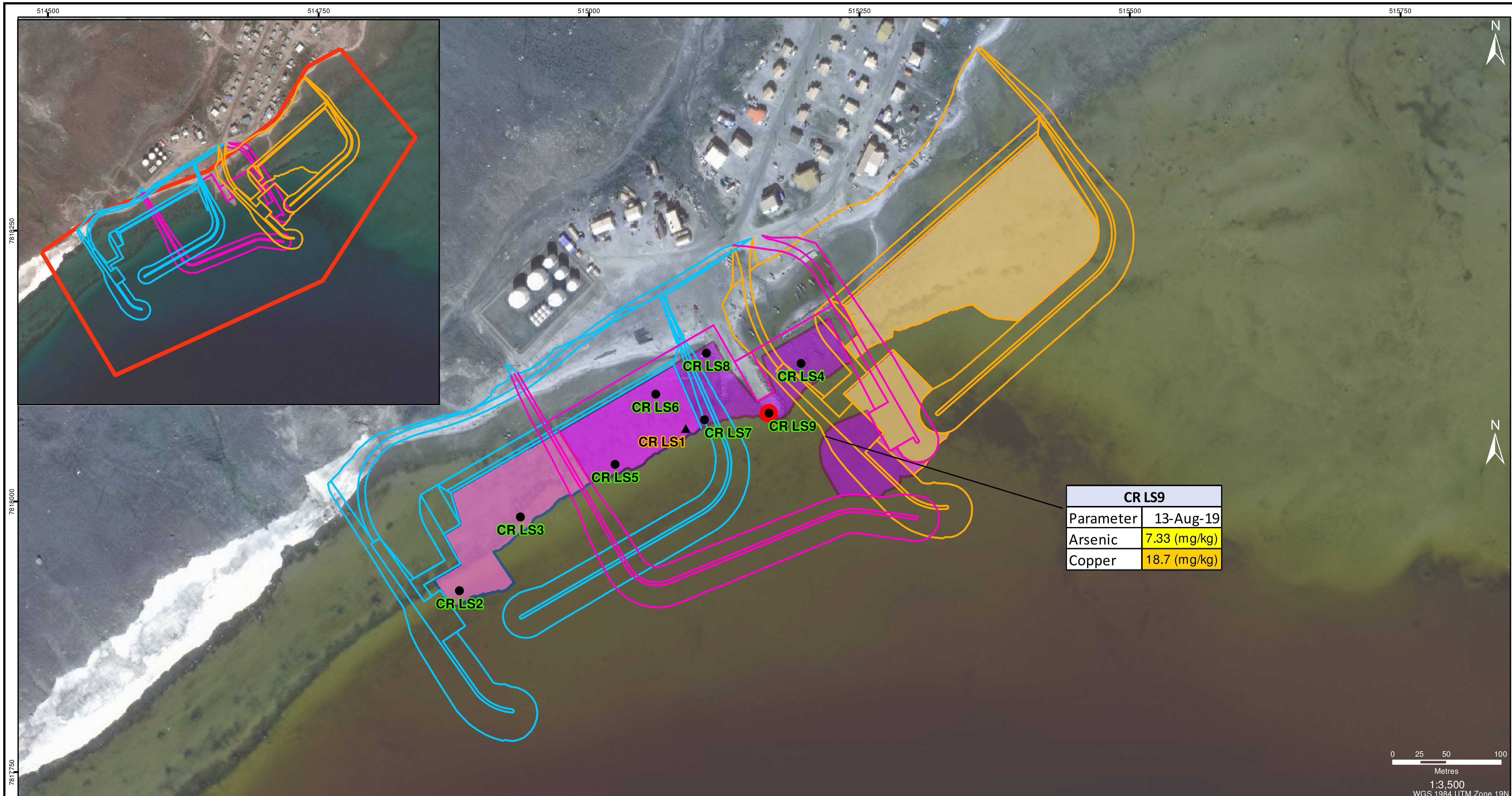
Polychlorinated Biphenyl

Table 3, Appendix 4 provides a summary of the laboratory results for samples taken during this survey.

Results of PCB analysis are summarized as follows:

- All individual PCBs were below their respective CCME ISQG
- Total PCBs were below the Disposal at Sea Regulations (0.1 µg/g) at all sample locations
- PCBs were detected at all sample locations

All PCBs were below laboratory RDL and the CCME ISQG and DAS Regulations at all sample locations in the SCH Study Area.



Legend

SCH Footprint	Dredge Area	Sediment Sampling Locations	
Option 1	Option 1	● Sediment Quality Collected - Hand	SCH Study Area
Option 2	Option 2	▲ Sediment Quality Collected - Ponar	
Option 3	Option 3	● Sediment Quality Exceed	

NOTE:

parameters at applied guideline/criteria

values exceeding (Canadian Environmnetal Quality Guildelines for Marine Sediment)

Imagery Source: CHS, July 2016

Locations approximate.

FISHERIES AND OCEANS CANADA
CLYDE RIVER HARBOUR DEVELOPMENT
ENVIRONMENTAL AND SOCIO-ECONOMIC BASELINE SURVEY

SEDIMENT SAMPLING EXCEEDANCES SUMMARY

Date: 18-DEC-19	Drawn by: KR	Edited by: JH	App'd by: VB

Fisheries and Oceans Canada

Advisian
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Project No. 307071-01306

FIG No 5-3 REV 0

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FILE LOCATION: U:\YVR\307071\01306_DFO_LanStHarSt\10_Eng\16_Geomatics\01_Mxd\ES_Baseline\ClydeRiver\Fig5-3_CR_SedimentQualityExceed.mxd

PLOT DATE & TIME: 2019-12-18 12:24:22 PM USER NAME: Jennifer.Huang
SAVE DATE & TIME: 2019-12-18 12:24:22 PM ISSUING OFFICE: BURNABY GIS

5.3 Discussion

Sediment sampling locations were comprised predominantly of sands (>90%), however CR LS3, CR LS6, and CR LS9 consisted of 20% to 40% sand. Sediment sample locations were placed randomly with the proposed dredge pocket and sampling depth varied from 0.5 m to 3m at these four sample locations. Therefore, the difference in particle size distribution is unlikely to be attributed to water depth and distance from shore.

CR LS1 had the greatest amount of silt and clay (5%) compared to the other sampling locations (<1.5%). This could be due to the difference in sampling method, as CR LS1 was the only sample collected by ponar, and the remaining samples by snorkel, where fines may be lost in underwater extraction. Physical characteristics of the beach can further be viewed from the intertidal survey which was conducted as component of the fish and fish habitat field study (see results in Section 9.2.3.1, Photo 9-1) and a site specific drone survey which was provided to Advisian by DFO-SCH (see Figure 9-4 for imagery) (Arctic UAV, 2019). Note that the drone survey was not a component of the field survey and was completed by a separate team (see Section 9.2.2 for description). The intertidal and shallow subtidal areas can be visually observed to be dominated by cobble, boulders and sand. The presence of cobble and boulders in the intertidal and shallow subtidal areas was not reflected in the sediment collection which targeted subsurface collections. The drone imagery shows the area to be scattered with cobble and boulders throughout the SCH Study Area which is valuable information to understand sediment dynamics in the area for the detailed design and permitting phase of the Project.

Sediment sampling complications occurred due to difficulty with the ponar which can be explained by the compacted nature of the sediments as determined by the geophysics field survey (see Appendix 5 - Geological Assessment of the main report). The surface materials along the shoreline are coarse grained ranging from medium to coarse grained sands to gravelly sands, sandy gravels, gravels with cobbles and boulders. Gravels and cobbles are typically sub-angular to sub-rounded and boulders range from angular to rounded. Intertidal sediments comprise predominantly gravelly sand with sporadic mounds of cobbles and occasional boulders. Ice rafted boulders ridges are also present parallel to the shoreline. In the intertidal to sub tidal zone the seabed is typically sand with sporadic gravel, cobbles and boulders. Results from sub-bottom profiling and seismic refraction indicate the surface layer comprising sands and gravels to be compact to dense and up to 33 m thick. The surface samples which were attempted to be collected with the ponar were without the aid of a winch or crane and a sampler that weighs approximately 6.8 kg. As the ponar is lowered and makes seabed contact, which activates the jaws of the ponar to close through activation of the self releasing pinch pin. Due to the compact to dense seabed materials, the sampler was unable to effectively penetrate the seabed and collect representative samples in some locations, including within the DAS Study Area.

Consideration for sampling techniques will be required during the detailed design and permitting phase to accommodate requirements for the DAS permit from ECCC. Nine samples were collected, where ECCC's guidance for an approximate dredge area of 15,000 m^2 (Option 1 Design) would require eight samples under the higher certainty category of ECCC (2018a). This assumes the entire dredge volume would be disposed at sea, which is very conservative as the first priority would be to use the dredged sediment for the project construction (e.g. infill) or provided the Hamlet for upland purposes. Due to sample collection issues noted above, no sediment samples were taken at the DAS site, which is expected to be a requirement for ECCC to issue a DAS permit to characterize physical, chemical and biological (infaunal) conditions.

Concentrations for all metals excluding phosphorous, potassium, sodium, tin, titanium, and uranium were higher at sample location CR LS9 than all other locations. Concentrations for bismuth, selenium, and tungsten were all below RDL for CR LS9. This was also the only sampling location in which exceedances occurred (arsenic and copper).

Concentrations of metals (and other contaminants) in sediments depends largely on regional and local geology and oceanography, particle size and proximity to contaminant sources (NGMP, 2013), and there is not enough information available in the literature to draw meaningful comparisons to sediment quality results in the SCH Study Area.

PCBs were below laboratory RDLs, CCME ISQG, and DAS Regulations across all sites. PAHs were below laboratory RDLs across all sites, except for naphthalene, light PAHs, and total PAHs at sampling location CR LS1, which may again be due to a localized impact from small scale anthropogenic influences.

There is limited information on the concentrations of PAHs and PCBs in marine sediments in Nunavut. Variations in sediment chemistry in foreshore areas fronting communities are more likely due to isolated and local anthropogenic influences, such as batteries, fuel, motor oil, engine coolant from small boats, ATVs, pick up trucks that are on the beach and on or over the water during the open-water and iced season.

6. Terrestrial Vegetation

Program objectives for vegetation are provided in Section 1.6, Table 1-2. Vegetation studies focused on the terrestrial environment, within the HRQ Study Areas (Figure 6-1).

6.1 Desktop Review

To support the field survey of the existing conditions of vegetation, a desktop review of existing literature and public databases was conducted to determine vegetation species with historical occurrences, or the potential to occur within the HRQ Study Areas. Desktop information including IQ knowledge (see Section 3.3 for methodology details) was used to inform the field survey, identify data deficiencies and focus the information required to complete a baseline study of plant species and communities, and species at risk. For pre-mapping, aerial imagery was reviewed to identify and delineate potential distinct vegetation communities to be confirmed in the field. Prior to field surveys, the Species at Risk Public Registry (Government of Canada, 2019q) was searched for rare vascular and non-vascular plants with geographic ranges that encompass the HRQ Study Areas. Available research on species distributions and habitats was evaluated to determine the likelihood of occurrence.

Most of Nunavut is located within the Tundra Biome and the Northern Arctic Ecozone (Ecological Stratification Working Group) (ESWG, 1995). However, the Project is located within the Arctic Cordillera Ecozone which occupies the northeastern fringe of Nunavut. This Ecozone is split into four Ecoregions With the extremely cold, desert-like climate, high winds and lack of soil cover in this Ecozone, the higher elevations are largely devoid of plant cover other than lichens and some mosses. The Project is located within Ecoregion 6 – Baffin Island Coastal Lowlands, which boarders on northeastern Baffin Island and has more herbaceous tundra communities than higher elevation Ecoregions within the Arctic Cordillera Ecozone. Specifically, the Baffin Coastal Lowlands has sparse vegetation cover of mixed low-growing herbs and shrubs, consisting of moss, purple mountain saxifrage (*Saxifraga oppositifolia* L.), avens (*Dryas* spp.), arctic willow (*Salix arctica* Pall.), bog sedges (*Kobresia* spp.), sedges (*Carex* spp.), and arctic poppy (*Papaver* spp.). Development of wet sites is typical with up to about 60% cover of wood rushes (*Luzula* spp.), wire rushes (*Juncus* spp.), and saxifrages (*Saxifraga* spp. and *Micranthes* spp.), along with nearly continuous cover of mosses (ESWG, 1995). Crustose lichens, cotton grasses (*Eriophorum* spp.), moss campion (*Silene acaulis* [L.] Jacq.), arctic white mountain heather (*Cassiope tetragona* [L.] D. Don), alpine mountain sorrel (*Oxyria digyna* [L.] Hill), bog blueberry (*Vaccinium uliginosum* L.) are other species that may be present in the Arctic Cordillera Ecozone (Aun *et al.*, 2002).

6.1.1 Vegetation Species at Risk

The review of the Species at Risk Public Registry (Government of Canada, 2019q) showed one rare plant species whose range overlaps the HRQ Study Areas:

- Porsild's bryum (*Haplodontium macrocarpum* [Hooker] Spence), listed as Threatened under COSEWIC and Schedule 1 under SARA

Porsild's bryum is a bryophyte species. It has a broad, but disjunct distribution in Canada, including sites in Alberta, BC, the island of Newfoundland, and Nunavut (specifically Ellesmere Island). This species has been designated as threatened since 2003, because of its fragmented distribution and few confirmed population locations. There are 19 known populations in Canada, which accounts for about 40% of known global occurrences. Three of the Canadian populations are located in proximity within Quttinirpaaq National Park, Ellesmere Island, Nunavut (ECCC, 2016b, 2016a), (see park description in Section 2.5.3) . Porsild's bryum are found in the high Arctic but also in other treeless vegetation zones such as the sub-alpine and along barren coastlines. Microhabitats for most populations are associated with waterfalls or sheltered calcareous rock crevices or faces near water seepages. Narrow substrate (calcareous rock) and habitat requirements (waterfalls and seepages) limit this species distribution (ECCC, 2016b, 2016a; Government of Canada, 2019p).

No historical occurrences of Porsild's bryum have been recorded in the HRQ Study Areas, and based on a review of aerial imagery, the HRQ Study Areas appears not to contain microhabitats that could support Porsild's bryum. Therefore, the HRQ Study Areas was predicted to have low potential to support populations of Porsild's bryum.

6.1.2 Traditionally-used Vegetation Species

Twenty plant species have been identified as having traditional uses in the high arctic ecoclimate (Baffinland Iron Mines Corporation, 2010a). Uses for these species include food, medicine, tools, and household items. These species along with their traditional use are identified in Table 6-1.

Berry picking areas have been identified east of the Hamlet and south of the proposed quarry area (IQ Workshop 2019 - Daniel Jaypoody; IQ Workshop 2019 - Issac Tassugat; IQ Workshop 2019 - Mike Jaypoody; IQ Workshop - Leslie Ashevak). All berry picking areas are outside the HRQ Study Areas (Figure 3-1).

Table 6-1 Traditionally-Used Vegetation Species

Latin Name and Authority	Common Name	Traditional Use
Shrubs		
Cassiope tetragona (L.) D. Don	white arctic mountain heather	mattresses, firewood
Empetrum nigrum L. ssp. *Nigrum*	black crowberry	edible
Ledum palustre L. ssp. *decumbens* (Aiton) Hultén	marsh Labrador tea	tea
Salix arctica Pall.	arctic willow	edible, firewood, tools
Salix richardsonii Hook.	Richardson's willow	edible
Saxifraga oppositifolia L.	purple mountain saxifrage	edible, tea
Saxifraga tricuspidata Rottb.	three toothed saxifrage	edible, tea
Vaccinium uliginosum L.	bog blueberry	edible

Latin Name and Authority	Common Name	Traditional Use
Graminoids		
Alopecurus alpinus Lam.	alpine meadow-foxtail	used to make whistling noises
Carex spp.	Sedges	not specified
Eriophorum spp.	arctic cotton grass	lamp wick
Forbs		
Chamerion latifolium (L.) Holub	dwarf fireweed	edible
Oxytropis maydelliana Traitv.	Maydell's oxytrope	edible
Oxyria digyna (L.) Hill	alpine mountain sorrel	edible
Pedicularis lanata Cham. & Schltdl.	woolly lousewort	edible
Pedicularis sudetica Wild.	sudetic lousewort	not specified
Polygonum viviparum L.	alpine bistort	edible
Pyrola grandiflora Radius	large-flowered wintergreen	tea
Silene uralensis (Rupr.) Bocquet ssp. *uralensis*	apetalous catchfly	not specified
Non-Vasculars		
Dicranum spp.	cushion mosses	used to treat pinworm infections
Racomitrium lanuginosum (Hedw.) Brid.	racomitrium moss	used to construct sleeping shelter

Source; IQ Workshop 2019 - Daniel Jaypoody ; IQ Workshop 2019 - Mike Jaypoody ; Baffinland Iron Mines Corporation (2010b)

6.2 Field Survey

6.2.1 Methodology

Field surveys were conducted from August 12 to 14, 2019, by an experienced vegetation ecologist and a local Inuit field assistant. An ecological land classification (ELC) survey was completed to identify the vegetation communities in the HRQ Study Areas. Field surveys also focussed on identifying each species encountered to collect an inventory for the area.

6.2.1.1 Ecological Land Classification

During the ELC survey, quantitative data on ecosystems were collected to assist in classification of vegetation communities throughout the HRQ Study Areas. As there is no official vegetation classification system used in Nunavut, vegetation communities were grouped based on similar characteristics such as species composition, topographical position, moisture regime, and percent cover of bedrock. Vegetation communities were identified using a combination of field verification and interpretation of desktop aerial imagery (Google Earth, 2019b).

Within the HRQ Study Areas, vegetation plots (0.5 x 0.5 m^2) were sited in each vegetation community identified during pre-mapping and in the field (Ground Plot; Figure 6-1). Plots were orientated to contain a homogeneous assemblage of plants representative of the typical vegetation community composition. Vegetation data collected at each plot included:

- General site characteristics such as slope, aspect, and surface substrate
- Vegetation species identification and canopy percent cover
- GPS coordinates
- Photographs

6.2.1.2 Terrestrial Vegetation Inventory and Rare Plant Assessment

A rare plant survey was completed within the HRQ Study Areas between August 12 to 14, 2019. Surveys were targeted in areas where desktop pre-mapping had identified potentially unique habitats or vegetation communities. Each area identified was surveyed using a random meander technique, and all vascular and non-vascular species encountered were inventoried (or collected for identification). Figure 6-1 displays the data points collected along the random meander coverage in and around the HRQ Study Areas (Rare Plant Search). Given that no standards exist for Nunavut, the Alberta Native Plant Council (2012) standards were used as a guideline for survey methodology. The standard states that if rare plants are identified, a 50 m diameter buffer from the plant location is to be investigated to determine the extent and size of the population. Detailed habitat and population information, photographs, and GPS coordinates are further documented, as per the standards, if rare plants are observed.

The following guidebooks were used to identify vegetation species:

- Common Plants of Nunavut (Mallory & Aiken, 2013)
- Macrolichens of the Pacific Northwest (McCune & Geiser, 2000)
- Mosses and Liverworts of Britain and Ireland a Field Guide (Atherton *et al.*, 2010)
- Mosses, Lichens and Ferns of Northwest North America (Vitt *et al.*, 1988)
- Mosses, Liverworts, and Hornworts, a Field Guide to Common Bryophytes of the Northeast (Pope, 2016)
- The Arctic Guide: Wildlife of the Far North (Chester, 2016)
- Vascular Plants of Continental Northwest Territories (Porsild & Cody, 1980)
- Non-native and invasive species were defined according to Government of Nunavut (2010a)

Legend

Vegetation Survey Location

- Ground Plot
- Rare Plant Search

Haul Road and Quarry (HRQ) Study Area

Location approximated.

FISHERIES AND OCEANS CANADA
CLYDE RIVER HARBOUR DEVELOPMENT
ENVIRONMENTAL AND SOCIO-ECONOMIC BASELINE SURVEY

VEGETATION STUDY AREA

Date:	16-JAN-20	Drawn by:	JH	Edited by:	KR	App'd by:	LP

Fisheries and Oceans Canada

Advisian
Worley Group

Project No. 307071-01306

FIG No 6-1

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If a species could not be identified in the field, a voucher sample was collected for identification by an expert. A total of nine bryophyte samples were collected and sent for identification to Terry McIntosh, Ph.D., and Steven Joya (bryologists) from the Department of Botany at the University of British Columbia. Nomenclature and authorities for each plant species recorded followed the United States Department of Agriculture Plants Database (USDA, 2019).

6.2.2 Field Results

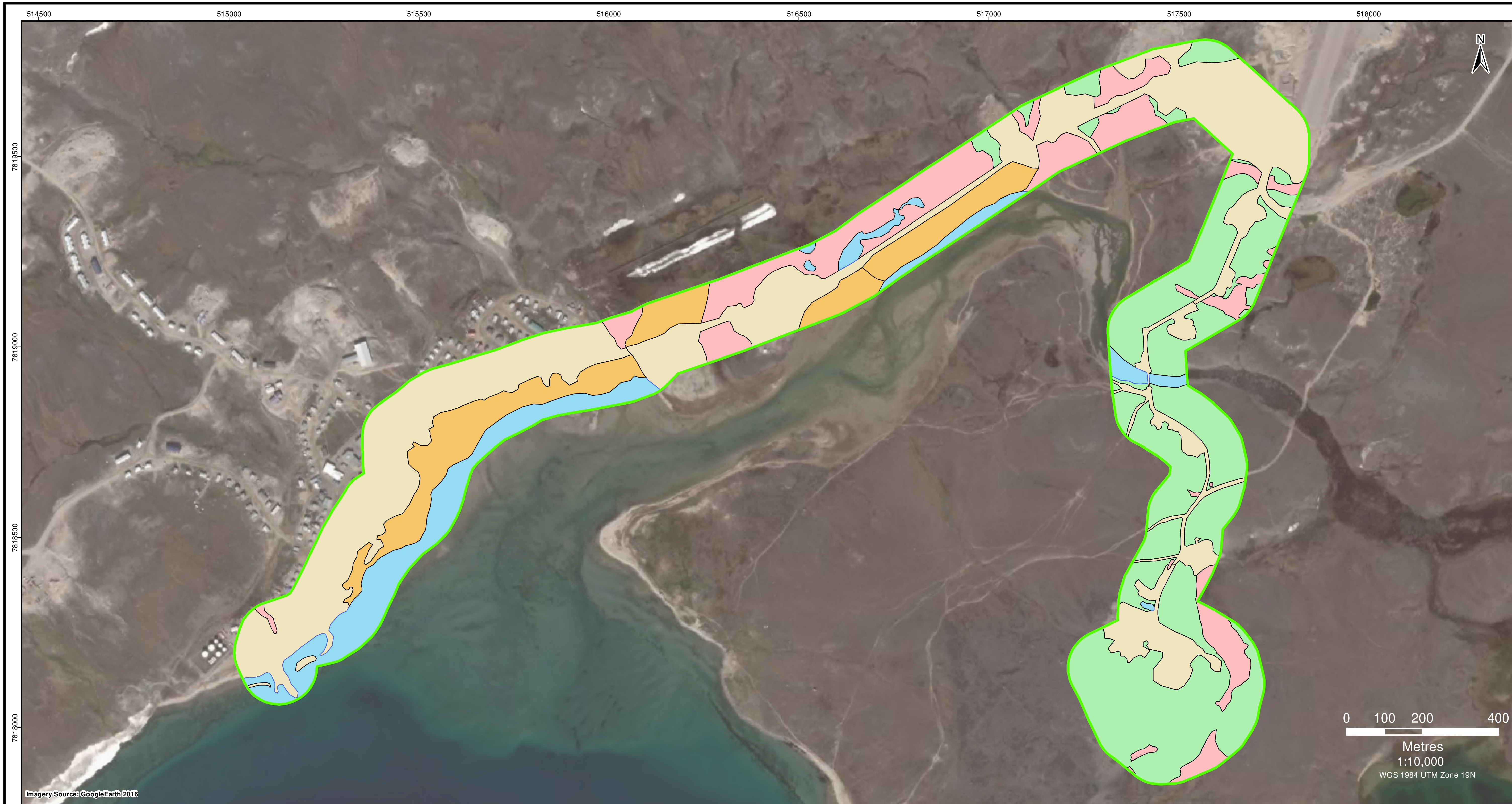
During the rare plant survey, 54 vegetation species were identified, including five shrub, 16 graminoid, 13 forb, 11 bryophyte, and nine lichen species. A total of 64 rare plant searches were conducted (Figure 6-1). A list of the species identified is provided in Table 6-2.

None of the species identified during the field survey are listed as species at risk or as invasive. All vegetation data collected in the field are provided in Appendix 5.

Five distinct vegetation communities were identified and mapped within the HRQ Study Areas (Figure 6-2) and five ELC ground plots were assessed to characterize these communities. Vegetation communities identified within the HRQ Study Areas included:

- Disturbed Human-Caused (DHC) – 45 ha (37% of the HRQ Study Area[s])
- Upland Dwarf Shrub (UDS) – 36 hectares (ha) (29% of the HRQ Study Area[s])
- Wetland Graminoid-Moss Drainage (WGD) – 16 ha (13% of the HRQ Study Area[s])
- Coastal Shoreline and Flats (CSF) – 13 ha (11% of the HRQ Study Area[s])
- Open Water (OW) – 11 ha (9% of the HRQ Study Area[s])

Other than the DHC community which consisted of road networks, existing quarries, and hamlet buildings, the HRQ Study Areas predominantly contains the UDS community. The UDS community was a rolling plateau of frost shattered rocky outcrops and dwarf shrubs. This plateau was interspersed with several drainages, which supports the WGD community. Overall, the area has a diverse bryophyte (moss) and lichen population, which are common on rock and soil substrates in the Arctic. Descriptions for each community is provided below. The Open Water area was not surveyed or described here as it is considered a marine environment (Figure 6-2).



Legend

Vegetation Mapping

- Coastal Shoreline and Flats
- Disturbed Human-Caused
- Open Water
- Upland Dwarf Shrub
- Wetland Graminoid-Moss Drainage

Haul Road and Quarry (HRQ) Study Area

Location approximated.

FISHERIES AND OCEANS CANADA
CLYDE RIVER HARBOUR DEVELOPMENT
ENVIRONMENTAL AND SOCIO-ECONOMIC BASELINE SURVEY

VEGETATION COMMUNITIES WITHIN THE HRQ STUDY AREA

Date: 18-DEC-19	Drawn by: JH	Edited by: KR	App'd by: LP

Fisheries and Oceans Canada

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Project No. 307071-01306

FIG No 6-2 | REV 0

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Upland Dwarf Shrub

The UDS community is characterized as a mosaic of vegetated and frost shattered rocky outcrop areas (Photo 6-1). Vegetated areas between rocks are dominated by dwarf shrub species, including white Arctic mountain heather (*Cassiope tetragona* [L.] D. Don), entireleaf mountain-avens (*Dryas integrifolia* Vahl), arctic willow (*Salix arctica* Pall.), snowbed willow (*Salix herbacea* L.), and bog blueberry (*Vaccinium uliginosum* L.) (Table 6-2). Forbs were sparse but included species such as alpine mountainsorrel (Oxyria digyna [L.] Hill), nodding saxifrage (*Saxifraga cernua* L.), and pygmy saxifrage (*Saxifraga hyperborea* R. Br.). Graminoids were also sparse and predominantly included alpine sweetgrass (*Anthoxanthum monticola* [Bigelow] Veldkamp) and northern white rush (Juncus albescens [Lange] Fernald). Bryophytes predominantly included racomitrium moss (*Racomitrium lanuginosum* [Hedw.] Brid.) and lichen cover predominantly consisted of witch's hair lichen (*Alectoria ochroleuca* [Hoffm.] A. Massal.) and snow lichens (*Flavocetraria* spp.) (Table 6-2 and Appendix 5).

Photo 6-1 Upland Dwarf Shrub Community at GD-06 (August 12, 2019)

Wetland Graminoid Drainage

The WSD community is characterized by saturated ground and vegetation dominated by wetland graminoid species (Photo 6-2). This community type was located in drainage draws and lowland areas. Vegetation was dominated by cotton grasses (*Eriophorum* spp.), short-leaved sedge (*Carex misandra* R. Br.) wideleaf polargrass (*Arctagrostis latifolia* [R. Br.] Griseb.), and bryophytes. Some forbs were present and commonly included high northern buttercup (*Ranunculus hyperboreus* Rottb.), and leafystem saxifrage (*Saxifraga foliolosa* R. Br.) (Table 6-2 and Appendix 5).

Photo 6-2 Wetland Graminoid Drainage Community at GD-08 (August 12, 2019)

Coastal Shoreline and Flats

The CSF community is characterized by a mostly flat shoreline leading to the ocean. Extensive, open, sediment deposit-flats and graminoid dominant areas were common (Photo 6-3). Vegetation was sporadic and species predominantly included saltmarsh starwort (*Stellaria humifusa* Rottb.), water sedge (*Carex aquatilis* Wahlenb.), icegrass (*Phippsia algida* [Sol.] R. Br.), false semaphoregrass (*Pleuropogon sabinei* R. Br.), glaucous bluegrass (*Poa glauca* Vahl), and creeping alkaligrass (*Puccinellia phryganodes* (Trin.) Scribn. & Merr.) (Table 6-2 and Appendix 5).

Photo 6-3 Coastal Shoreline and Flats Community at GD-10 (August 13, 2019)

Disturbed Human-Caused

The DHC community is characterized by levelled and graded areas mostly devoid of vegetation (Photo 6-4). DHC areas within the HRQ Study Areas consisted of road networks ditches, existing quarries, and hamlet buildings. Vegetation was sparse, but where present, predominantly included species such as alpine mountainsorrel, alpine meadow-foxtail (*Alopecurus magellanicus* Lam.), northern woodrush, and arctic bluegrass (*Poa arctica* R. Br.) (Table 6-2 and Appendix 5).

Photo 6-4 Disturbed Human-Caused Community at GD-07 (August 12, 2019)

Table 6-2 List of Vegetation Species Identified During Field Survey

Vegetation Species		Vegetation Community[1] Association and Richness			
Latin Name and Authority	**Common Name**	**CSF**	**DHC**	**UDS**	**WGD**
Shrubs		**1**	**0**	**5**	**0**
Cassiope tetragona (L.) D. Don *	white arctic mountain heather	---	---	Y	---
Dryas integrifolia Vahl	entireleaf mountain-avens	---	---	Y	---
Salix arctica Pall. *	arctic willow	Y	---	Y	---
Salix herbacea L.	snowbed willow	---	---	Y	---
Vaccinium uliginosum L. *	bog blueberry	---	---	Y	---
Forbs		**5**	**4**	**6**	**3**
Cerastium arcticum Lange	mouse-ear chickweed	Y	---	---	---
Oxyria digyna (L.) Hill *	alpine mountainsorrel	Y	Y	Y	---
Papaver labradoricum (Fedde) Solstad & Elven	Labrador poppy	---	---	Y	---
Pedicularis sp. *	Lousewort	---	Y	---	---
Polygonum viviparum L. *	alpine bistort	Y	---	Y	---
Potentilla nana Willd. ex Schltdl.	arctic cinquefoil	---	---	Y	---
Ranunculus hyperboreus Rottb.	high northern buttercup	---	---	---	Y
Saxifraga aizoides L.	yellow mountain saxifrage	---	Y	---	---
Saxifraga caespitosa L.	tufted alpine saxifrage	---	Y	---	---
Saxifraga cernua L.	nodding saxifrage	Y	---	Y	Y
Saxifraga foliolosa R. Br.	leafystem saxifrage	---	---	---	Y
Saxifraga hyperborea R. Br.	pygmy saxifrage	---	---	Y	---
Stellaria humifusa Rottb.	saltmarsh starwort	Y	---	---	---
Graminoids		**12**	**6**	**5**	**7**
Alopecurus magellanicus Lam. *	Alpine meadow-foxtail	Y	Y	Y	Y
Anthoxanthum monticola (Bigelow) Veldkamp	alpine sweetgrass	Y	---	Y	---
Arctagrostis latifolia (R. Br.) Griseb.	wideleaf polargrass	Y	Y	---	Y
Carex aquatilis Wahlenb. *	water sedge	Y	---	---	---
Carex misandra R. Br. *	shortleaved sedge	---	---	Y	---
Eriophorum angustifolium Honck. *	tall cottongrass	Y	---	---	Y
Eriophorum scheuchzeri Hoppe *	white cottongrass	Y	Y	---	Y
Festuca brachyphylla Schult. ex Schult. & Schult. f.	alpine fescue	---	Y	---	---
Juncus albescens (Lange) Fernald	northern white rush	---	---	---	Y
Luzula confusa Lindeberg	northern woodrush	Y	Y	Y	---
Phippsia algida (Sol.) R. Br.	Icegrass	Y	---	---	Y
Pleuropogon sabinei R. Br.	false semaphoregrass	Y	---	---	Y
Poa arctica R. Br.	arctic bluegrass	Y	Y	Y	---
Poa glauca Vahl	glaucous bluegrass	Y	---	---	---
Puccinellia phryganodes (Trin.) Scribn. & Merr.	creeping alkaligrass	Y	---	---	---
Bryophytes		**3**	**5**	**4**	**5**
Bryum pallens (Brid.) Sw.	bryum moss	Y	---	---	---
Cinclidium arcticum Bruch & Schimp.	arctic cinclidium moss	Y	---	---	Y
Ditrichum flexicaule (SchwÃ¤gr.) Hampe	ditrichum moss	---	---	---	Y

Vegetation Species		Vegetation Community[1] Association and Richness			
Latin Name and Authority	**Common Name**	**CSF**	**DHC**	**UDS**	**WGD**
Pogonatum urnigerum (Hedw.) P. Beauv.	pogonatum moss	---	Y	---	---
Polytrichum juniperinum Hedw.	juniper polytrichum moss	---	Y	Y	Y
Psilopilum cavifolium (Wilson) I. Hagen	psilopilum moss	---	---	Y	---
Psilopilum laevigatum (Wahlenb.) Lindb.	psilopilum moss	---	Y	Y	---
Racomitrium lanuginosum (Hedw.) Brid. *	racomitrium moss	---	Y	Y	---
Sphagnum arcticum Flatberg & Frisvoll	arctic sphagnum	---	---	---	Y
Tomentypnum nitens (Hedw.) Loeske	tomentypnum moss	---	---	---	Y
Trichostomum tenuirostre (Hook. & Taylor) Lindb.	narrow-fruited crisp-moss	---	Y	Y	---
Lichens		**0**	**1**	**8**	**0**
Alectoria ochroleuca (Hoffm.) A. Massal.	witch's hair lichen	---	---	Y	---
Cetraria ericetorum Opiz	cetraria lichen	---	---	Y	---
Flavocetraria cucullata (Bellardi) Karnefelt & A. Thell	snow lichen	---	---	Y	---
Flavocetraria nivalis (L.) Karnefelt & A. Thell	snow lichen	---	---	Y	---
Sphaerophorus fragilis (L.) Pers.	fragile ball lichen	---	---	Y	---
Stereocaulon alpinum Laurer ex Funck	alpine snow lichen	---	---	Y	---
Thamnolia subuliformis (Ehrh.) W.L. Culb.	whiteworm lichen	---	---	Y	---
Umbilicaria spp.	lichens	---	---	Y	---
Xanthoparmelia spp.	lichens	---	---	Y	---

Notes:
1 Vegetation communities included Coastal Shoreline and Flats (CSF), Disturbed Human Caused (DHC), Upland Dwarf Shrub (UDS), and Wetland Graminoid-Moss Drainage (WGD)
'Y' denotes species was identified within vegetation community
--- denotes species was not identified within vegetation community
* denotes species has been identified as traditionally used

6.3 Discussion

Vegetation communities identified during field studies (i.e. DHC [37%], UDS [29%], WGD [13%], and CSF [11%]) appear to be typical of the Baffin Island Coastal Lowland Ecoregion within the Arctic Cordillera Ecozone of the Tundra Biome (ESWG, 1995). Vegetation is overall sparse throughout the HRQ Study Areas and dwarfed due to harsh climate conditions, exposure to wind, and frost damage. The WGD community had the highest percent cover of vegetation and the least amount of exposed rock.

Of the 20 traditionally used species identified during desktop review, 12 were identified within the HRQ Study Areas during the field surveys. These species include white arctic mountain heather, arctic willow, bog blueberry, alpine mountainsorrel, lousewort (*Pedicularis* sp.), alpine bistort (*Polygonum viviparum* L.), alpine meadow-foxtail, sedges (*Carex* spp.), cottongrasses (*Eriophorum* spp.), and racomitrium moss (Table 6-1 and Table 6-2). The UDS community contained the most traditionally used plants. Traditional use of these plants includes berry picking and edibles, lamp wicks, whistle construction, firewood, tool construction, mattress construction, and sleeping shelter construction. No traditional terrestrial plant use specific to the HRQ Study Areas was identified (IQ Workshop 2019 - Daniel Jaypoody; IQ Workshop 2019 - Mike Jaypoody). Any traditional plant use in the HRQ Study Areas would likely only be opportunistic and occur during travel and when hunting. No areas near the Project need to be avoided or protected for traditional use (IQ Workshop 2019 - Daniel Jaypoody; IQ Workshop 2019 - Issac Tassugat; IQ Workshop 2019 - Mike Jaypoody; IQ Workshop - Leslie Ashevak).

Based on the Species at Risk Public Registry (Government of Canada, 2019q), Porsild's bryum was assumed to be the only potential vegetation SAR within the HRQ Study Areas. However, no individuals or potential habitat (sheltered calcareous rock services or waterfall or water seepages) were identified during the field survey. As such, Porsild's bryum has a low probability of occurring within the HRQ Study Areas.

As with any species inventory, some less abundant species may have been missed during the vegetation field survey. However, all species observed are common in the Arctic Cordillera Ecozone and enabled the characterization of vegetation communities, identification of traditional use plants, and assessment of rare plant habitat potential.

Overall, the HRQ Study Areas were dominated by previously disturbed areas (DHC community), contains regionally common vegetation communities and plant species, and has low rare plant habitat potential. In addition, the potential quarry location is planned for an area dominated by the UDS and DHC communities, which both contain large areas of unvegetated rocky outcrops. These are the most common communities within the HRQ Study Areas. The potential haul road is also primarily sited along a pre-disturbed road within the DHC community. As a result, overall Project related disturbances to vegetation communities, traditionally-used plants, and species at risk are considered low.

7. Terrestrial Wildlife

Program objectives for terrestrial wildlife are provided in Section 1.5, Table 1-2. Migratory birds including marine birds are identified in Section 8. Considering polar bears spend most of their time on sea ice and rely heavily on marine habitats for food, the species is categorized under marine mammals in this document (Rode & Stirling, 2018). Therefore, polar bear is discussed in Section 10.2.7. Baseline information was determined through historical information gathered as part of a desktop review including a literature review and the IQ Workshop (May 2019, see Section 3.3 for methodology details). This desktop review was then validated through a field-based habitat assessment and wildlife reconnaissance survey (referred hereafter as the field survey) conducted in conjunction with the vegetation field survey. These results enabled refinement of a list of species likely to inhabit the HRQ Study Areas.

7.1 Desktop Review

The desktop review was conducted to determine species with historical occurrences near the Project. Furthermore, protected areas or known high value habitats (e.g. Wildlife Sanctuaries) were identified. In addition to identifying historical occurrences, a list of species that could potentially occupy the HRQ Study Areas were generated. This list was determined by examining available habitat using aerial imagery (Google Earth, 2019b) and comparing it to habitat requirements for species whose ranges overlap with the Project. Range maps and habitat information were determined by field guides, peer-reviewed literature, and other reference sources.

Terrestrial wildlife occurrences were primarily based on the NWHS (Priest & Usher, 2004). Species identified as having potential to inhabit in the HRQ Study Areas were further inferred from range maps, habitat requirements, aerial imagery, and IQ (IQ Workshop 2019 - Daniel Jaypoody; IQ Workshop 2019 - Issac Tassugat; IQ Workshop 2019 - Mike Jaypoody; IQ Workshop - Leslie Ashevak) and results of the vegetation review and community mapping.

There are nine terrestrial mammal species, ranging from lemmings (*Lemmus* sp. and *Dicrostonyx* sp.) to barren-ground caribou (*Rangifer tarandus groenlandicus*) that have historical occurrences or have the potential to occur within the HRQ Study Areas (Table 7-1). Details on each species are provided in the following subsections. Two of these species are listed as a species at risk: wolverine (*Gulo gulo*) and barren-ground caribou. Barren-ground caribou are federally-listed as Threatened, and wolverine are federally-listed as Special Concern (Government of Canada, 2019q).

Table 7-1 Terrestrial Wildlife that have Potential to Inhabit the HRQ Study Areas

Common Name	Scientific Name	Habitat[1]
Small Mammals (Rodents and Lagamorphs)		
Brown Lemming	*Lemmus trimucronatus*	▪ Damp (hydric) tundra dominated by grasses, sedges, and mosses
Peary Land Collared Lemming	*Dicrostonyx groenlandicus*	▪ Dry (xeric), rocky tundra

Common Name	Scientific Name	Habitat[1]
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*	▪ Likely determined more by prey availability (i.e. small mammals and geese) than vegetation ▪ Use pre-existing Arctic fox dens
Baffin Island wolf	*Canis lupus manningi*	▪ Likely determined more by prey availability (e.g. caribou) than vegetation ▪ Dens typically located along eskers
Wolverine[2]	*Gulo*	▪ Wide ranging species whose habitat is likely determined more by prey availability (i.e. carcasses and small mammals) than vegetation ▪ Den within snow or under snow-covered rocks
Ermine	*Mustela ermine*	▪ Habitat generalist likely determined more by prey availability than vegetation ▪ Uses subnivean grass nests, rock piles and burrows often commandeered from prey
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

Notes:

1 Habitat information from: (Chesemore, 1969; Parker, 1977; Garrott *et al.*, 1983; King, 1983; Gray, 1993; Klein & Bay, 1994; Sittler, 1995; McLoughlin *et al.*, 2004; Sale, 2006; King & Powell, 2007; COSEWIC, 2011; Duchesne *et al.*, 2011; Gauthier & Berteaux, 2011; COSEWIC, 2014a; Chester, 2016; COSEWIC, 2016a)

2 Wolverine are listed as Vulnerable by the Government of Nunavut, listed by COSEWIC as Special Concern, and are listed on Schedule 1 as Special Concern under the *Species at Risk Act* (SARA) Canadian Endangered Species Conservation Council (CESCC, 2016; Government of Canada, 2019q)

3 Barren-ground caribou are listed as Apparently Secure by the Government of Nunavut, are listed by the COSEWIC as Threatened but are not presently listed under the SARA (CESCC, 2016; Government of Canada, 2019q)

7.1.1 Small Mammals (Rodents and Lagomorphs)

Small mammals are defined in this report as those species belonging to the following mammalian orders: Rodentia (rodents) and Lagomorpha (hares and rabbits). A small-mammal survey was completed between 1990 and 1996 on Baffin Island where brown lemming (*Lemmus trimucronatus*) and Peary Land collared lemming (*Dicrostonyx groenlandicus*) were captured (Carrière, 1999). In earlier investigations in the 1950s, Peary Land collared lemmings apparently were more abundant than brown lemmings (Miller, 1955). However, the relative abundance of these two species can vary greatly in the same area from year to year (Watson, 1956).

According to the NWHS (Priest & Usher, 2004)., arctic hare (*Lepus arcticus*) is the only small mammal reported to be harvested by hunters from the Hamlet, and mean annual harvest was 55 individuals per year (Table 7-2).

7.1.2 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 NWHS (Priest & Usher, 2004) identified that Baffin Island wolf (*Canis lupus manningi*), red fox (*Vulpes vulpes*), and arctic fox (*Alopex lagopus*) have been harvested by hunters in the Hamlet. However, location data for these species have not been collected. Therefore, it cannot be determined whether these species were distributed and harvested near the HRQ Study Areas. On average, 36 arctic fox, three coloured (red) fox, and three wolves were harvested each year by hunters from the Hamlet (Table 7-2) (Priest & Usher, 2004).

In addition to foxes and wolves, ermine (*Mustela erminea*), and wolverine could potentially be present in or near the HRQ Study Areas. Foxes have been identified near the Hamlet tank farms and fox traps are commonly set in the region in unspecified areas (IQ Workshop - Leslie Ashevak). Although no surveys have been conducted near the Hamlet, ermine may be common in coastal lowlands (Miller, 1955). Though the mapped distribution for wolverine overlaps with the HRQ Study Areas, wolverine have a low probability of occurrence as observations are rare in the region and not documented locally (Mallory et al., 2001).

7.1.3 Large Mammals (Caribou)

Barren-ground caribou (*Rangifer tarandus groenlandicus*) are a main source of country food, and between 1996 and 2001, the mean annual harvest of caribou was 349 individuals per year (Table 7-2). Location data collected as part of the survey revealed that caribou were historically primarily hunted inland within the fjords; roughly over 60 km west of the Hamlet (Figure 9 of Appendix 1). This population of caribou was once recognized as the northeast Baffin Island population (Jenkins *et al.*, 2012), but the paucity of demographic and movement studies make divisions difficult to verify (Campbell *et al.*, 2015). Although historical barren-ground caribou range may have overlapped with the hamlet, current range of the barren-ground caribou does not overlap with the HRQ Study Areas, and in recent years, caribou on Baffin Island have declined (Jenkins *et al.*, 2012; Ringrose, 2018). Locals travel over 400 km from the Hamlet to hunt caribou (IQ Workshop - Leslie Ashevak). Moreover, recent studies of caribou density in the Hamlet area report a density of zero (Campbell *et al.*, 2015). A summary of harvest data described in the NWHS is provided in Table 7-2 (Priest & Usher, 2004).

Table 7-2 List of Species Harvested by Hunters from Clyde River and their Mean Number Harvested Per Year (1996 to 2001)

Common Name	Scientific Name	Mean Number Harvested per Year
Barren-ground caribou	*Rangifer tarandus groenlandicus*	349
Arctic hare	*Lepus arcticus*	55
Arctic fox	*Alopex lagopus*	36
Red fox (coloured fox)	*Vulpes*	3
Baffin Island wolf	*Canis lupus manningi*	3

Source: Priest and Usher (2004)

7.2 Field Survey

7.2.1 Methodology

A field survey was conducted in conjunction with the vegetation survey from August 12-14, 2019. All wildlife species observed or detected by sign (scat, pellets, tracks, etc.) were identified, photographed (if possible), and georeferenced using a handheld GPS. In addition to individual wildlife, all wildlife features (e.g. dens, burrows, diggings) were similarly photographed and georeferenced. The focus of the field survey included the proposed quarry and haul route plus a 100 m buffer, but incidental observations were also recorded outside this area because some terrestrial wildlife are migratory or nomadic and travel long distances and have large home ranges. Terrestrial wildlife can be cryptic and difficult to detect without repeat visits and targeted surveys. As such, a lack of observation does not preclude the potential for species occurrence within the Project Study Areas. Given logistical constraints, repeat visits and targeted surveys were not conducted. A general reconnaissance survey was the focus of the wildlife fieldwork and information collected during the vegetation survey were used to further refine the list of species with potential to inhabit the HRQ Study Areas. Weather conditions during the field surveys are provided in Section 1.6, Table 1-3.

7.2.2 Results

Terrestrial wildlife species identified or detected included lemming (unidentified species) and polar bear (*Ursus maritimus*). Lemmings detected were not identified to species level (as only a brief observation was noted) but they were suspected to be Peary Land collared lemming based on habitat (Figure 7-1). Polar bears are discussed in Section 10.2.7. All wildlife data collected, including coordinate locations are provided in Appendix 6. Wildlife species observed or detected are also shown in Figure 7-1.

Legend

- Haul Road and Quarry (HRQ) Study Area
- Incidental Wildlife Observation or Detection

Location approximated.

Imagery Source: Google Earth 2016

FISHERIES AND OCEANS CANADA
CLYDE RIVER HARBOUR DEVELOPMENT
ENVIRONMENTAL AND SOCIO-ECONOMIC BASELINE SURVEY

WILDLIFE AND WILDLIFE FEATURES OBSERVED OR DETECTED DURING FIELD SURVEY

Date: 18-DEC-19	Drawn by: JH	Edited by: KR	App'd by: LP

Fisheries and Oceans Canada

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7.3 Discussion

7.3.1 Habitat Value

In general, habitat near the SCH Study Area is of limited value for terrestrial wildlife. Human development in the Hamlet extends to the edge of the ocean. The beach is developed and has structures and boats along its length. The buildings along the beach may provide cover for small mammals and weasels. At low tide, the intertidal zone likely provides foraging opportunities. However, the value of these areas for habitat is low given the amount of disturbance and frequent human activity.

Habitat available for wildlife in proximity to the active and proposed quarry is similarly of low quality. Most of the terrain is comprised of rock and outcrop areas with sparse dwarf shrubs. Wetland and graminoid-moss dominant areas are also present. Therefore, security, escape, and thermal cover for some small mammals is present. More information about vegetation community descriptions and land cover types are provided in Section 6.

7.3.2 Small Mammals

7.3.2.1 Arctic Hare Presence in the HRQ Study Areas

Arctic hare typically inhabit willow-dominated communities in winter and summer (Klein & Bay, 1994) where they typically forage on twigs, bark, and other plant material (Sale, 2006) such as willow, avens, graminoids, and forbs (Parker, 1977). Willow-dominated communities were not identified in the HRQ Study Areas, although willows were present and may provide limited forage opportunities. Parker (1977) suggests that arctic hare also commonly inhabit elevated, dry gravel slopes, which support a sparse but diverse vegetation community. In addition, 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. Portions of the HRQ Study Areas, particularly around the proposed quarry location, would provide suitable escape cover for arctic hare. Despite the escape cover, it is unlikely that arctic hares occupy the HRQ Study Areas given lack of willow-dominated communities.

7.3.2.2 Lemming Presence in the HRQ Study Areas

Brown lemmings occupy a variety of tundra types, but with greater abundance on damp tundra dominated by grasses, sedges, and mosses (Sale, 2006). Some wetland graminoid areas identified during the ecological land classification may be able to support this species. However, much of the HRQ Study Areas is drier and composed of upland, open, and dwarf shrubs dominated areas. Therefore, Peary Land collared lemmings may be more likely to occupy the HRQ Study Areas. Peary Land 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 den in complex micro-habitat with an abundance of deciduous shrubs and mosses, which provide opportunities for deep snow cover and thermal protection (Duchesne *et al.*, 2011). Given that lemmings were identified during the field survey, they are likely to occur, and habitat is not limiting within the HRQ Study Areas.

7.3.3 Medium Mammals

7.3.3.1 Ermine Presence in the HRQ Study Areas

Ermine are considered to be habitat generalists (King, 1983; King & 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 eat primarily lemmings. When lemming populations are low, ermine use other food sources such as ptarmigan and eggs (King & Powell, 2007). Therefore, their likelihood of inhabiting the HRQ Study Areas depends on the availability of prey. Given lemming were identified within the HRQ Study Areas, it is expected that ermine may also be found. Ermine are known to occupy lemming nests during winter in tundra environments (Sittler, 1995), and they also nest in rock piles and burrows (King, 1983). Given the rock outcrops in the HRQ Study Areas, there may be suitable cover and escape habitat available. 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 & Powell, 2007). Consequently, at maximum, only one pair (male and female) of weasels are likely to inhabit the HRQ Study Areas as habitat and prey availability is unlikely to be limited.

7.3.3.2 Wolverine Presence in the HRQ Study Areas

Although federally-listed as Special Concern in Canada, wolverine populations appear to be increasing in Nunavut (COSEWIC, 2014b). No wolverines were reported to have been harvested on Baffin Island (Priest & Usher, 2004). Wolverine habitat use in the Arctic is likely determined more by prey availability (rodents, hare, and ungulate carcasses) rather than vegetation (COSEWIC, 2014b). Wolverines are a wide-ranging, generally nomadic species, found in low densities in remote areas away from human disturbance (Sale, 2006; COSEWIC, 2014b). As such, wolverine occurrence within the HRQ Study Areas is unlikely and would only be transient if present.

7.3.3.3 Fox Presence in the HRQ Study Areas

Similar to weasels, arctic fox appears to be less closely tied to vegetation associations than to other factors such as prey availability. Cycles in arctic fox populations are closely tied with lemming abundance (Gauthier & Berteaux, 2011). Arctic fox home range and movements also increase during periods (or in territories) of low food abundance (Gauthier & Berteaux, 2011). The widespread red fox, which is highly adaptable and often associated with human developments and urban areas, has recently been expanding into the arctic (Gauthier & Berteaux, 2011). There are likely few places for fox to den within the HRQ Study Areas, but abandoned or infrequently used buildings near the Hamlet could support denning habitat, such as those near the tank farm area at the west side of the Hamlet (IQ Workshop - Leslie Ashevak). The HRQ Study Areas may also provide foraging habitat given the presence of lemmings as a food source. Arctic fox home ranges are large and studies in other coastal areas indicated that they may be around 10 km^2 (males) and 4 km^2 (females) (Anthony, 1997). Red foxes are likely to have larger home range size than arctic fox because they require larger areas to meet basic metabolic needs (Harestad & Bunnell, 1979). As such, based upon expected home range sizes, the HRQ Study Areas might only partially support one pair or family group (of either species).

7.3.3.4 Wolf Presence in the HRQ Study Areas

Although it is possible that Baffin Island wolves could pass through the HRQ Study Areas, it is unlikely. Baffin Island wolves have large home ranges, and as is with the other carnivores discussed, base their habitat utilization upon prey availability. In the case of wolves on Baffin Island, their primary prey are caribou, which are migratory and have a current density of zero near the Hamlet (McLoughtin *et al*. 2004; Campbell *et al*. 2015). Given that it is expected that wolves follow caribou herds (Krizan, 2006), it is unlikely that wolves would frequent this area.

7.3.4 Large Mammals

7.3.4.1 Barren-ground Caribou Presence in the HRQ Study Areas

Given that caribou have declined in the Hamlet area since the late 1990s and more recently absent, caribou are not likely to occupy the HRQ Study Areas.

8. Migratory Birds (Including Marine Birds)

Program objectives for migratory and marine birds are provided in Section 1.6, Table 1-2. Although many marine birds are pelagic and spend most of their life at sea, for purposes of the ESES, marine birds are considered together with migratory birds given that they nest terrestrially (a critical life-history stage) and most are also migratory. The field survey focused on the SCH and HRQ Study Areas, but incidental observations were also recorded outside this area, such as those in the DAS Study Area.

8.1 Desktop Review

To support assessment of the existing condition of migratory and marine birds, existing literature and databases were reviewed to determine species with historical occurrences near the Project. Protected areas (e.g. MBSs) or known high-value habitats (e.g. IBAs) were identified (Sections 2.2.4 and 2.2.5). In addition to identifying historical occurrences, a list of species that could potentially occupy the Project Study Areas was generated. This list was determined by examining available habitat using aerial imagery (Google Earth, 2019b) and comparing it with habitat requirements for species whose ranges overlaps with the Project. Range maps and habitat information were determined by field guides, peer-reviewed literature, and other reference sources.

8.1.1 Migratory, Marine, and Other Birds Likely to be Present

A review of the NWHS (Priest & Usher, 2004), revealed that several bird species and their eggs are harvested by hunters in the Hamlet, confirming their presence and breeding in the surrounding area (Table 8-1). The species most harvested are ptarmigan (*Lagopus muta*), goose eggs, eider ducks (*Somateria* spp.), snow goose (*Chen caerulescens*), Canada goose (*Branta canadensis*), and gull eggs, respectively. Location data for harvested birds were not collected for most species. Hunters in the Hamlet hunt both common eiders (*S. mollissima*) and king eiders (*S. spectabilis*) and information on the locations of harvest for these species was collected. Although no bird harvests have been recorded within the Project Study Areas, much of Clyde Inlet and Patricia Bay are used for hunting eiders (Figure 10 of Appendix 1).

There are at least 56 bird species who have potential to be present in the region, but 36 were considered unlikely to nest within or near the HRQ and SCH Study Areas (Table 8-2). Eleven were considered likely to nest based on habitat, during the breeding season. These include: American pipit (*Anthus rubescens*), arctic tern (*Sterna paradisaea*), Baird's sandpiper (*Calidris bairdii*), common raven (*Corvus corax*), common redpoll (*Acanthis flammea*), hoary redpoll (*Acanthis hornemanni*), horned lark (*Eremophila alpestris*), northern wheatear (*Oenanthe oenanthe*), purple sandpiper (*Calidris maritim*), rock ptarmigan (*Lagopus muta*), and snow bunting (*Plectrophenax nivalis*) (Table 8-2).

IQ indicates that snow geese (*Chen caerulescens*) and Canada geese (*Branta Canadensis*) are hunted near the Hamlet (Figure 3-1) (IQ Workshop 2019 - Daniel Jaypoody). Ptarmigan and their eggs are also hunted near the hamlet in the early fall and winter, and low ptarmigan abundance in 2018 seemed to be related to high abundance of common ravens in the area (IQ Workshop - Leslie Ashevak). Gulls and ducks have also been identified to use the water within the SCH Study Area for foraging, and eider ducks (*Somateria* spp.) show up when the ice starts to break up in the spring (IQ Workshop 2019 - Daniel Jaypoody; IQ Workshop 2019 - Issac Tassugat).

Bird SAR that have potential to be present include ivory gull (*Pagophila eburnean*), buff-breasted sandpiper (*Tryngites subruficollis*), peregrine falcon (*Falco peregrinus*), red knot (*Calidris canutus*), red-necked phalarope (*Phalaropus lobatus*), and Ross's gull (*Rhodostethia rosea*) (Table 8-2). Ivory gull, buff-breasted sandpiper, and Ross's gull are not likely to nest within or near the Project Study Areas, and the potential for peregrine falcon and red-necked phalarope to nest in the area is low. The likelihood of red knot nesting in the Project Study Areas is moderate. The territorial and federal status of these SAR are provided in Table 8-2. These species are discussed further in Section 8.3.

Table 8-1 List of Species Harvested by Hunters from Clyde River and their Mean Number Harvested per Year (1996 to 2001)

Common Name	Scientific Name	Mean Number Harvested per Year
Ptarmigan	*Lagopus* spp.	1,214
Goose eggs	---	323
Eiders	*Somateria* spp.	133
Snow goose	*Chen caerulescens*	88
Canada goose	*Branta Canadensis*	39
Seagull eggs	---	33
Arctic tern eggs	*Sterna paradisaea*	9
Duck eggs	---	8
Red-throated loon	*Gavis stellate*	7
Thick-billed murre	*Uria lomvia*	1
Brant	*Branta bernicla*	1
Sandhill crane	*Antigone Canadensis*	<1
Common loon	*Gavia immer*	<1
Black guillemot	*Cepphus grille*	<1

Source: Priest and Usher (2004)

Table 8-2 List of Birds, their Federal and Territorial Statuses, their Preferred Foraging Strategy, and Potential to Nest (Based on Season-Use) Within or Near the SCH and HRQ Study Areas

Common Name	Scientific Name	COSEWIC Status	SARA Status	Territorial Status	Foraging Location	Period of Use	Nesting Resource Requirements	Nesting Likelihood
American golden plover	*Pluvialis dominica*	Not assessed	Not listed	S3	Shoreline	Breeding and Migration	Elevated on sparse, low vegetation, well-drained rocky slopes	Not Likely
American pipit	*Anthus rubescens*	Not assessed	Not listed	SU	Ground forager	Breeding and Migration	Mesic vegetation along streams, grassy meadows, and dry, dwarf shrub matts	Likely
Arctic tern	*Sterna paradisaea*	Not assessed	Not listed	S4	Nearshore	Breeding and Migration	Open country, close to water, no vegetation or low and sparse cover; rocky, gravelly islands, barrier beaches and spits, gravel moraines	Likely
Atlantic puffin	*Fratercula arctica*	Not assessed	Not listed	S3	Offshore	Breeding, Migration, and Overwinter	Burrows on rocky islands with short vegetation and on sea cliffs	Not Likely
Baird's sandpiper	*Calidris bairdii*	Not assessed	Not listed	S5	Shoreline	Breeding and Migration	Dry, well-drained coastal and upland exposed tundra. Beach ridges, terrace banks, bare soil with sparse vegetation	Likely
Black guillemot	*Cepphus grylle*	Not assessed	Not listed	S5	Nearshore	Breeding, Migration, and Overwinter	Colonies on rocky marine coasts of off-shore islands near shallow water	Not Likely
Black-bellied plover	*Pluvialis squatarola*	Not assessed	Not listed	S3	Shoreline	Breeding and Migration	Lowlands in coastal areas and on open, dry, heath tundra, dwarf shrub meadows, and dry exposed ridges, river banks, and beaches	Low
Black-legged kittiwake	*Rissa tridactyla*	Not assessed	Not listed	S5	Nearshore	Breeding and Migration	Colonies on cliff ledges of off-shore islands or inaccessible mainland	Not Likely
Brant	*Branta bernicla*	Not assessed	Not listed	S5	Coastal flats	Breeding and Migration	Colonial near salt marshes, estuaries, and deltas	Not Likely
Buff-breasted sandpiper	*Tryngites subruficollis*	Special Concern	Special Concern	S3	Ground forager	Breeding and Migration	Dry grassy tundra, shorelines, and rarely mudflats	Not Likely
Cackling goose	*Branta hutchinsii*	Not assessed	Not listed	S5	Ground forager	Breeding and Migration	Variety of low Arctic regions with open view and adjacent to permanent freshwater (ponds, lakes, streams, marshes, and muskeg)	Not Likely
Canada goose	*Branta canadensis*	Not assessed	Not listed	S5	Grassy flats	Breeding and Migration	Broad range of habitats but often adjacent to freshwater	Low
Common eider	*Somateria mollissima*	Not assessed	Not listed	S3	Nearshore	Breeding, Migration, Overwinter	Local colonies along marine coasts, islands, and islets	Not Likely
Common loon	*Gavia immer*	Not at Risk	Not listed	S5	Marine coast	Breeding and Migration	Large lakes	Not Likely
Common raven	*Corvus corax*	Not assessed	Not listed	S5	Ground forager	Breeding and Overwinter	Habitat generalist; often on cliffs, trees, and human structures	Likely
Common redpoll	*Acanthis flammea*	Not assessed	Not listed	SU	Foliage gleaner	Breeding and Migration	Dry, rocky or damp substrates on dry heaths or rocky slopes	Likely

Common Name	Scientific Name	COSEWIC Status	SARA Status	Territorial Status	Foraging Location	Period of Use	Nesting Resource Requirements	Nesting Likelihood
Dovekie	*Alle*	Not assessed	Not listed	S3	Offshore	Breeding, Migration, and Overwinter	Colonies on rocky marine coasts and cliffs	Not Likely
Glaucous gull	*Larus hyperboreus*	Not assessed	Not listed	S4	Nearshore	Breeding and Migration	Often in mixed colonies on marine and freshwater coasts, tundra, islands, cliffs, shorelines, and ice edges	Not Likely
Gyrfalcon	*Falco rusticolus*	Not at Risk	Not listed	S4	Open terrain	Breeding and Migration	Rocky outcrops, cliffs, and seacoasts	Not Likely
Hoary redpoll	*Acanthis hornemanni*	Not assessed	Not listed	S3	Foliage gleaner	Breeding and Migration	Similar to common redpoll, but near dwarf or creeping shrubs	Likely
Horned lark	*Eremophila alpestris*	Not assessed	Not listed	SU	Ground forager	Breeding and Migration	Open habitat on bare ground or short grasses	Likely
Iceland gull	*Larus glaucoides*	Not assessed	Not listed	S5	Nearshore	Migration	Colonies on rocky cliffs and fjords	Not Likely
Ivory gull	*Pagophila eburnea*	Endangered	Endangered	S1	Nearshore	Breeding, Migration, and Overwinter	Rocky islands and cliffs near pack ice	Not Likely
King eider	*Somateria spectabilis*	Not assessed	Not listed	S3	Nearshore	Breeding, Migration, Overwinter	Variety of tundra habitats, but often on dry and well-drained in vegetation adjacent to freshwater	Not Likely
Lapland longspur	*Calcarius lapponicus*	Not assessed	Not listed	S5	Ground forager	Breeding and Migration	Wet, hummocky meadows; avoids rocky and bare terrain	Low
Long-tailed duck	*Clangula hyemalis*	Not assessed	Not listed	S4	Nearshore	Breeding, Migration, Overwinter	Wetlands or offshore islands with freshwater	Not Likely
Long-tailed jaeger	*Stercorarius longicaudus*	Not assessed	Not listed	S5	Offshore	Migration and Overwinter	Tundra far from sea	Not Likely
Northern fulmar	*Fulmarus glacialis*	Not assessed	Not listed	S5	Offshore	Breeding, Migration, Overwinter	Steep sea-cliffs	Not Likely
Northern wheatear	*Oenanthe*	Not assessed	Not listed	SU	Ground forager	Breeding and Migration	Dry, elevated rubble, rocky fields, stony hilltops, and precipices of rocky coasts	Likely
Pacific loon	*Gavia pacifica*	Not assessed	Not listed	SU	Marine coast	Breeding and Migration	Freshwater lakes	Not Likely
Parasitic jaeger	*Stercorarius parasiticus*	Not assessed	Not listed	S4S5	Offshore	Migration and Overwinter	Pelagic bird that nests on low-lying marshy tundra and dry, tussock-heath	Low
Pectoral sandpiper	*Calidris melanotos*	Not assessed	Not listed	S4	Shoreline	Breeding and Migration	Flat, marshy tundra dominated by sedges and grasses	Not Likely
Peregrine falcon	*Falco peregrinus*	Not at Risk	Special Concern	S4	Open terrain	Breeding and Migration	Open landscapes with cliffs or tall human-made structures	Low
Pomarine jaeger	*Stercorarius pomarinus*	Not assessed	Not listed	S5	Offshore	Migration and Overwinter	Pelagic bird that nests irregularly in low-lying marshy tundra near small lakes	Not Likely

Common Name	Scientific Name	COSEWIC Status	SARA Status	Territorial Status	Foraging Location	Period of Use	Nesting Resource Requirements	Nesting Likelihood
Purple sandpiper	*Calidris maritima*	Not assessed	Not listed	S3	Shoreline	Breeding and Migration	Inland on mossy tundra, heath, and moorlands but also low tundra near shores on gravel-sand beaches along rivers	Likely
Red knot	*Calidris canutus*	Endangered	Endangered	S2	Shoreline	Breeding and Migration	Sparsely vegetated, dry, elevated tundra on ridges or slopes with low shrub cover	Moderate
Red phalarope	*Phalaropus fulicarius*	Not assessed	Not listed	S4	Nearshore	Breeding and Migration	Coastal, poorly-drained, hummocky, level terrain on tundra dominated by sedges	Not Likely
Red-breasted merganser	*Mergus serrator*	Not assessed	Not listed	S5	Pursuit Diver	Breeding and Migration	Coastal near fresh, brackish or saltwater wetlands in sheltered bays	Not Likely
Red-necked phalarope	*Phalaropus lobatus*	Special Concern	Special Concern	S3	Nearshore	Breeding and Migration	Mossy hummocks and sedges close to standing water	Low
Red-throated loon	*Gavia stellata*	Not assessed	Not listed	S4	Marine coast	Breeding and Migration	Wetlands and larger ponds, lakes	Not Likely
Rock ptarmigan	*Lagopus muta*	Not assessed	Not listed	S5	Ground forager	Breeding and Overwinter	Well-drained, hummocky tundra with rocky ridges; outcrops and mixed vegetation	Likely
Ross's gull	*Rhodostethia rosea*	Threatened	Threatened	S1	Nearshore	Breeding and Migration	Moist tundra and deltas with dwarf shrubs	Not Likely
Rough-legged hawk	*Buteo lagopus*	Not at Risk	Not listed	SU	Rolling, open terrain	Breeding and Migration	Open tundra including rocky outcrops, escarpments, and cliffs	Not Likely
Ruddy turnstone	*Arenaria interpres*	Not assessed	Not listed	S3	Shoreline	Breeding and Migration	Marshy slopes and flats near freshwater (marshes, streams, ponds) or tidal flats and beaches	Not Likely
Sabine's gull	*Xema sabini*	Not assessed	Not listed	S4S5	Nearshore	Breeding and Migration	Moist tundra near fresh water (ponds and lakes), low-lying sea coasts and coastal islands	Not Likely
Sanderling	*Calidris alba*	Not assessed	Not listed	S3	Shoreline	Breeding and Migration	Islands, peninsulas, and coastal tundra with well-vegetated moist to well-drained slopes, ridges, and alluvial plains	Not Likely
Sandhill crane	*Grus canadensis*	Not assessed	Not listed	S5	Ground forager	Breeding and Migration	Eskers dominated by lichens	Low
Snow bunting	*Plectrophenax nivalis*	Not assessed	Not listed	S3	Ground forager	Breeding and Migration	Rocky areas and boulder screes near vegetated tundra	Likely
Snow goose	*Chen caerulescens*	Not assessed	Not listed	S5	Coastal flats	Breeding and Migration	Colonial near freshwater (ponds, lakes, streams, and braided deltas) often in wet meadows but also undulating terrain, exposed slopes, or cliff edges	Not Likely
Snowy owl	*Bubo scandiacus*	Not assessed	Not listed	S4	Rolling, open terrain	Breeding and Migration	Variety of tundra environments on distinct promontories	Moderate
Thayer's gull	*Larus thayeri*	Not assessed	Not listed	S4S5	Marine coast	Breeding and Migration	Colonies on steep cliffs	Not Likely
Thick-billed murre	*Uria lomvia*	Not assessed	Not listed	S5	Offshore	Breeding, Migration, and Overwinter	Large colonies on cliff ledges near deep, offshore waters and land fast ice	Not Likely
Tundra swan	*Cygnus columbianus*	Not assessed	Not listed	S5	Coastal flats	Migration	Tundra lakes, ponds, and coastal deltas	Not Likely
White-rumped sandpiper	*Calidris fuscicollis*	Not assessed	Not listed	S5	Shoreline	Breeding and Migration	Well-vegetated, wet meadows and low-lying areas near water	Not Likely

Common Name	Scientific Name	COSEWIC Status	SARA Status	Territorial Status	Foraging Location	Period of Use	Nesting Resource Requirements	Nesting Likelihood
Willow ptarmigan	*Lagopus*	Not assessed	Not listed	S5	Foliage gleaner	Breeding and Overwinter	Abundant shrubby vegetation, flat terrain, and moist areas	Not Likely
Yellow-billed loon	*Gavia adamsii*	Not at Risk	Not listed	S4	Marine coast	Breeding and Migration	Near water on ground, partially hidden in tundra vegetation	Not Likely

Notes:

- Sources: (LePage et al., 1998; Mallory & Fontaine, 2004; Cornell Lab of Ornithology, 2015; CESCC, 2016; Cornell Lab of Ornithology, 2019; Government of Canada, 2019q)
- Likelihood of nesting within the Project Study Areas 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 Study Areas is located within the breeding range and the majority of available habitat provides preferred or suitable nesting habitat; Moderate: the Study Areas is located within the breeding range and some of the available habitat may provide suitable nesting habitat; Low: the Study Areas is located within the breeding range and some of the available habitat may provide marginal nesting habitat; Not Likely: the Study Areas 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 the Hamlet), and available habitat is generally not suitable for nesting.

Territorial Rank Descriptions

SX	Presumed Extirpated
SH	Possibly Extirpated
S1	Critically Imperiled
S2	Imperiled
S3	Vulnerable
S4	Apparently Secure
S5	Secure
SU	Unrankable
SNR	Unranked
SNA	Not Applicable

8.1.2 Important Bird Areas and Key Bird and Habitat Sites

IBAs are described in Section 2.2.4 with Scott Inlet being the closest to the Project site (Figure 4 of Appendix 1). An estimate of 10,000 pairs of predominately light-phase northern fulmars (*Fulmarus glacialis*) use Scott Inlet during the breeding season. This is about 3-5% of the Canadian population, and the light-phase colony is unusual for Canadian Eastern Arctic fulmar colonies (Mallory & Fontaine, 2004). Glaucous gulls (*Larus hyperboreus*) also used the Inlet and nests can be found scattered throughout the northern fulmar colony during the breeding season. There are approximately 100 nesting pairs of glaucous gulls that use the Inlet, which is about 1% of the Canadian population. The location is also used as a migration and staging site for ivory gull, black guillemot (*Cepphus grylle*), king eiders, common eiders, dovekies (*Alle alle*), and other various seabirds (Spencer *et al.*, 2014; Schimnowski *et al.*, 2018; Bird Studies Canada, 2019). Scott Inlet is also an International Biological Programme site which does not afford additional protections, but emphasizes the site's significance (Mallory & Fontaine, 2004; Birds Studies Canada, 2019).

8.1.3 Migratory Bird Sanctuaries

MBSs are described in Section 2.2.5.

8.1.4 Ecologically or Biologically Significant Marine Areas

EBSAs are described in Section 2.2.2.

8.2 Field Survey

8.2.1 Methodology

Fieldwork was conducted in conjunction with the vegetation survey from August 12-14, 2019. Given logistical constraints (i.e. ice break up), this timing was largely outside the breeding season for migratory and marine birds, which is from approximately June 5 to July 25 in the Arctic (ECCC, 2018b). Birds could nest past this period, up until around August 15 in the Arctic, although chances are lower (ECCC, 2018b). As such, fieldwork focused on gathering habitat data that could be used to generate a list of species with potential to breed within the Project Study Areas. All birds observed and features that were detected (e.g. whitewash, pellets, nests, perches) were identified, photographed, and georeferenced using a handheld GPS unit.

In addition, a visual survey with a series of five-minute point counts spaced approximately 400 m apart were conducted by following transects along the shoreline in the SCH Study Area (Figure 8-1). This distance spacing was used to minimize counting the same individual twice. This survey method followed a combination of the BC Coastal Waterbird Survey Protocol (Bird Studies Canada, 2013) and Alberta Sensitive Species Inventory Guidelines (Government of Alberta, 2013) because no government-recommended protocols exist in Nunavut for migratory or marine bird inventories. Each point count included a wait period of two minutes and listening and observing period of five minutes. Point counts were started no more than 30 minutes before sunrise and were completed before 10:00, when possible (in some cases this was not possible because of poor weather or logistical constraints). All birds observed or heard were identified and recorded. Weather conditions during the field surveys are provided in Section 1.6, Table 1-2.

8.2.2 Results

Twelve bird species were identified during the field survey from August 12-14, 2019 (Table 8-3). No nesting or breeding behaviour was identified. Considering the survey was conducted at the end of the breeding bird season, the lack of breeding behaviour does not preclude the potential for birds to nest in the area.

Flocks of Lapland longspurs (*Calcarius lapponicus*), glaucous gulls, and snow buntings (*Plectrophenax nivalis*) were observed (Figure 7-1; Appendix 6). In addition, a flock of black guillemots were observed approximately 500 m offshore from the SCH Study Area (Figure 7-1). Field-collected data for migratory and marine birds, are included in Appendix 6 with other wildlife observations and detections.

Table 8-3 Bird Species Observed during Point Counts and Field Survey

Bird Species	
Common Name	**Species Name**
Point Count Observations	
Common raven	*Corvus corax*
Glaucous gull	*Larus hyperboreus*
Iceland gull	*Larus glaucoides*
Snow bunting	*Plectrophenax nivalis*
Other Incidental Observations	
Baird's sandpiper	*Calidris bairdii*
Black guillemot	*Cepphus grille*
Goose species	*Chen* sp.
Lapland longspur	*Calcarius lapponicus*
Loon species	*Gavia* sp.
Northern fulmar	*Fulmarus glacialis*
Owl species	*Bubo* sp.
Ptarmigan species	*Lagopus* sp.

Legend

- Point Count Location
- SCH Study Area

Location approximated.

Imagery Source: GoogleEarth 2016

FISHERIES AND OCEANS CANADA
CLYDE RIVER HARBOUR DEVELOPMENT
ENVIRONMENTAL AND SOCIO-ECONOMIC BASELINE SURVEY

BIRD POINT COUNT LOCATIONS DURING FIELD SURVEY

Date: 18-DEC-19	Drawn by: JH	Edited by: KR	App'd by: LP

Fisheries and Oceans Canada

Advisian
Worley Group

Project No. 307071-01306

FIG No 8-1

REV 0

"This drawing is prepared solely for the use of our customers as specified in the accompanying report. Worley Canada Services Ltd. assumes no liability to any other party for any representations contained in this drawing."

PLOT DATE & TIME: 2019-12-18 1:03:28 PM USER NAME: Jennifer.Huang
SAVE DATE & TIME: 2019-12-18 1:03:21 PM ISSUING OFFICE: BURNABY GIS

FILE LOCATION: U:\YVR\307071\01306_DFO_LanStHarSt\10_Eng\16_Geomatics\01_Mxd\Wildlife_Mapping\ClydeRiver\Fig8-1_CR_BirdPointCount.mxd

8.3 Discussion

8.3.1 Habitat Value

In general, habitat in the SCH Study Area is of limited value to migratory and marine birds. Human development dominates the SCH Study Area with structures and boats along its length. Moreover, teams of dogs were tied up along its length. Species breeding in the SCH Study Area are likely those that nest on bare ground and gravelly areas (e.g. snow buntings) and are relatively tolerant of human disturbance (e.g. common raven). However, human use and dogs likely discourage birds from nesting. At low tide, the intertidal zone provides foraging opportunities, but only for those species tolerant of human activity (e.g. gulls and ravens). Consequently, the value of these habitats is considered low given disturbance and human activity. The HRQ Study Areas offers more natural habitat including wet, dry, barren, and vegetated areas; however, the quarry is actively used. Consequently, the HRQ Study Areas offers some value for nesting birds, but the presence of the active quarry reduced the value. There are no bird species that would nest in the DAS Study Area. More information about vegetation community descriptions and land cover types are provided in Section 6.

8.3.2 Migratory Birds

The upland dwarf shrub and wetland areas identified in the HRQ Study Areas (see Section 6) potentially offer nesting and foraging habitat for snow buntings, Lapland longspur, American pipit, common redpoll, hoary redpoll, horned lark, northern wheatear, and rock ptarmigan (Table 8-2). In addition, eider duck (Figure 10 of Appendix 1), snow goose (*Chen caerulescens*) and Canada goose (*Branta canadensis*) nesting areas have been documented near the hamlet by locals (Ittaq Heritage and Research Centre, 2015).

According to ECCC, the general nesting season for the region (N10: Arctic Plains and Mountains, Bird Conservation Region 3) is between late-May and mid-August, and the primary season (61-100% of birds nesting) is from early-June to late-July (ECCC, 2018b). 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. Timing could also vary according to micro-sites or factors such as early or late spring. 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 typically is initiated two weeks prior to the general nesting season (ECCC, 2018b).

8.3.3 Marine Birds

The majority of marine birds that have historical occurrences or whose range overlaps are unlikely to nest in terrestrial environments in the HRQ Study Areas (Table 8-2). Most of these birds nest in large colonies on remote, precipitous cliffs and remote islands that are inaccessible to predators (Cornell Lab of Ornithology, 2015, 2019). Although not breeding, 26 species of marine birds could potentially use inter-tidal, marine coast, and nearshore habitats in the SCH Study Area, Clyde Inlet, and Patricia Bay for foraging and staging (Table 8-2). The use of this habitat likely peaks between mid-July and October during ice free periods at the Hamlet (Mallory & Fontaine, 2004).

8.3.4 Species at Risk

8.3.4.1 Ivory Gull

Ivory gulls breed where the ocean is free (or partly free) of ice in late-May and early-June: the Project Study Areas do not support breeding and nesting habitat (COSEWIC, 2006b). However, given the proximity to ice edge and availability of food for scavenging, including historical observations, it is likely ivory gulls forage near the Hamlet, particularly in the fall during migration.

8.3.4.2 Buff-breasted Sandpiper

Buff-breasted sandpiper occur in tundra regions, primarily in wet/lowland habitat, often near a wetland, pond, or lake with sedge-dominated vegetation (COSEWIC, 2012a). Habitat use varies depending on breeding stage. In spring, males often display on barren ridges, but as the snow melts, they may display in moister areas. Nests have been documented on the drier parts of the tundra, including slopes with sedge tussocks and moss-willow-varied grass areas, and in sedge-graminoid meadows close to streams or open-water wetlands (COSEWIC, 2012a). Although this community type was present within the HRQ Study Areas, the Project is outside the mapped breeding range of this species. Buff-breasted sandpipers are unlikely to nest near the Project Study Areas.

8.3.4.3 Peregrine Falcon

The likelihood of peregrine falcon being within the Project Study Areas is low. Although they breed in a wide variety of habitats and use coastal areas for hunting avian prey, natural nesting structures capable of supporting this species (cliffs with open gulfs of air) are not present within the Project Study Areas. Peregrine falcons have also been known to nest on human-made structures such as buildings, bridges, and other tall structures, but prefer nesting on cliffs between 50 and 200 m (Cornell Lab of Ornithology 2015, 2019; COSEWIC 2017c).

8.3.4.4 Red Knot

Three subspecies of red knot (*Calidris canutus*) are considered to be at-risk in Canada: *rufa* (Endangered), *roselaari* (Threatened), and *islandica* (Special Concern). The *rufa* subspecies is the most likely to overlap the Project Study Areas (ECCC, 2016c). Red knots breed on windswept ridges, slopes, and plateaus with sparse (<5%) vegetation cover, often on south-facing sites in proximity to freshwater such as wetlands and lakes (COSEWIC, 2007a). Although much of the HRQ and SCH Study Areas are disturbed, the vegetation communities identified could support breeding habitat for this species. Therefore, the likelihood of this species nesting in the HRQ and SCH Study Areas was considered moderate.

8.3.4.5 Red-necked Phalarope

Red-necked phalarope typically breed in low-Arctic tundra near freshwater (e.g. ponds, lakes, and streams) in vegetation dominated by graminoids (COSEWIC, 2014c). Nesting habitat within the HRQ and SCH Study Areas may be present, particularly in the wetland and graminoid areas identified in Section 6. However, this species is considered an accidental visitor to the region (LePage *et al.*, 1998) and the Hamlet is at the margins of the breeding range for this species. Consequently, the likelihood of red-necked phalarope being present is low.

8.3.4.6 Ross's Gull

Ross's gulls are distributed across the Arctic, but breed primarily in Siberia and overwinter in the Bering Sea (COSEWIC, 2007b). They may nest in a wide variety of habitats including marshy tundra and gravel reefs, but always close to water. The Project Study Areas do not support their preferred nesting habitat, and it is unlikely that this species would be present.

9. Fish and Fish Habitat

Program objectives for fish and fish habitat are provided in Section 1.6, Table 1-2.

9.1 Desktop

Canada's Arctic region is characterized by dramatic shifts in light, temperature and frozen versus open-water states of the ocean (Carmack *et al.*, 2006). Variations in the seasonal or permanent extent of sea ice in the Arctic have a fundamental influence on Arctic ecosystems (Oceans North Conservation Society, 2018b) and the Inuit (Ford, 2009) who harvest marine life.

The coastal marine environment of the Arctic ocean surrounding Nunavut represents an important ecosystem for fish and fish habitat. Intertidal areas are inaccessible throughout periods of the year when the ocean is frozen and when marine vegetation has limited periods of time to facilitate growth due to limited light regimes. These variables have led to uniquely adapted species that have tolerance for extreme climatic regimes (Lindgren *et al.*, 2016). It also represents an important socio-economic function for the people of Nunavut who are dependent on fish and marine mammals for subsistence harvesting.

Information used to summarize desktop information for Nunavut is best managed through a combined approach of available scientific literature and IQ. Clyde River has recently launched an interactive online map (the Clyde River Knowledge Atlas (Clyde River Knowledge Atlas, 2019; Nunatsiaq News, 2019b) based on the data collected for the Clyde River NCRI which will presents a platform for the development of multi-disciplinary data integration.

9.1.1 Benthic Habitat

Arctic benthic flora and fauna have adapted to be resilient due to extreme fluctuations in temperature, salinity, light availability, and ice scouring (Conlan & Kvitek, 2005; Wiencke *et al.*, 2007; Brown *et al.*, 2011; Kupper *et al.*, 2016), which varies with depth. For these reasons, vertical zonation is one of the most important variables shaping intertidal and shallow subtidal benthic communities. Disturbance from ice scouring is believed to be the most important 'architect' of Arctic biodiversity (Conlan & Kvitek, 2005) in intertidal and shallow subtidal waters. There is limited published information available on the marine benthic habitat of Clyde River. Substrate of Arctic shorelines is predominantly sand intermixed with small rocks and gravel (Greenwood, 2016) and a barren high intertidal (Ellis, 1955). Seaward of the ice extent (controlled by tide height, slope and ice thickness) subtidal marine vegetation is controlled by availability of hard substrates (e.g. cobble, boulder) for attachment.

Marine vegetation has a large influence on biomass and biodiversity of marine species in temperate and tropical environments (Cristie *et al.*, 2003; Wikstrom & Kautsky, 2007; Warfe *et al.*, 2008; Brown *et al.*, 2011), typically because it provides three-dimensional habitat that can provide a survival function (e.g. habitat, food) for multiple life history stages of marine fish and invertebrates (Radio Canada International, 2019). The extent to which seaweed provides three dimensional habitat for marine organisms has not been well studied in the Arctic. Włodarska-Kowalczuk *et al.* (2009) hypothesize that holdfasts of larger kelps provide refuge for organisms such as amphipods, as they offer protection from ice scour events. It is likely that established seaweed beds are important for a variety of life stages of marine species occurring in the coastal waters of Arctic environments. Furthermore, they are primary producers, and thus play an important role in broader ecosystem productivity during a relatively short open-water season (Glud *et al.*, 2002). How subtidal kelp species that exist below the crush zone (area where ice impact destroys marine life annually) survive is not well understood. It is believed that some kelp species may continue to grow or survive during the iced season (CBC, 2019). There are limited site specific studies that exist to document subtidal kelp populations in the region and those that are known have focused in and around northern Baffin Island (Cape Hatt in Eclipse Sound, Kupper *et al.* (2016), and Pond Inlet [Phillipe Archambault unpublished]).

There is interest in documenting the biomass and biodiversity of Arctic seaweed communities, given that the sea ice season continues to shorten, where it is predicted that the extent and range of seaweeds will change (CBC, 2019). Increases in the extent of rockweed have been predicted (Jueterbock *et al.*, 2016) and observed (Greenland, Weslawski *et al.*, 2010; Norway, Kortsch *et al.*, 2012) in the Arctic. The extent to which seaweed extent has changed in Clyde Inlet has not been studied.

A variety of kelp species (bladder wrack, edible kelp, hollow stemmed kelp, sea colander) are documented as 'areas of occupation' in and around Clyde River, Clyde Inlet, Cape Hewett and Cape Cristian (see Figure 11 Appendix 1, see Figure 1-5 for locations) How these names correlate to common or scientific names was not provided in the document . Seaweed is harvested by community members, but not in the area (IQ Workshop 2019 - Issac Tassugat). Although if seaweed washes up on the shore, some people (mostly elders) will harvest it (IQ Workshop 2019 - Issac Tassugat). There are two types of 'kelp' in Clyde River (IQ Workshop 2019 - Daniel Jaypoody), and rockweed grows everywhere along the coast (IQ Workshop - Leslie Ashevak). QIA (2018c) states that edible kelp (kuanniq) and hollow stemmed kelp (qiqquaq), dulse and other seaweeds are important foods to communities for flavour and salt (QIA, 2018c). In Clyde River, people like to dip seaweed into seal broth which turns the plants a nice green (IQ Workshop 2019 - Daniel Jaypoody).

9.1.2 Anadromous River Systems

The Clyde River Estuary is immediately east of the existing breakwater, and approximately 800 m east of the river mouth (Figure 9-1), and established as an anadromous river for Arctic char. Other anadromous rivers, where Arctic char are harvested, in proximity to Clyde River that have been documented through IQ include Kuuktannaq River (80 km southeast of Clyde River) and Kogalu River (30 km northwest of Clyde River) (Read, 2000). Clyde River is listed as one of the top 11 rivers for accessing Arctic char in reference to tourism opportunities (Outdoor Canada, 2019).

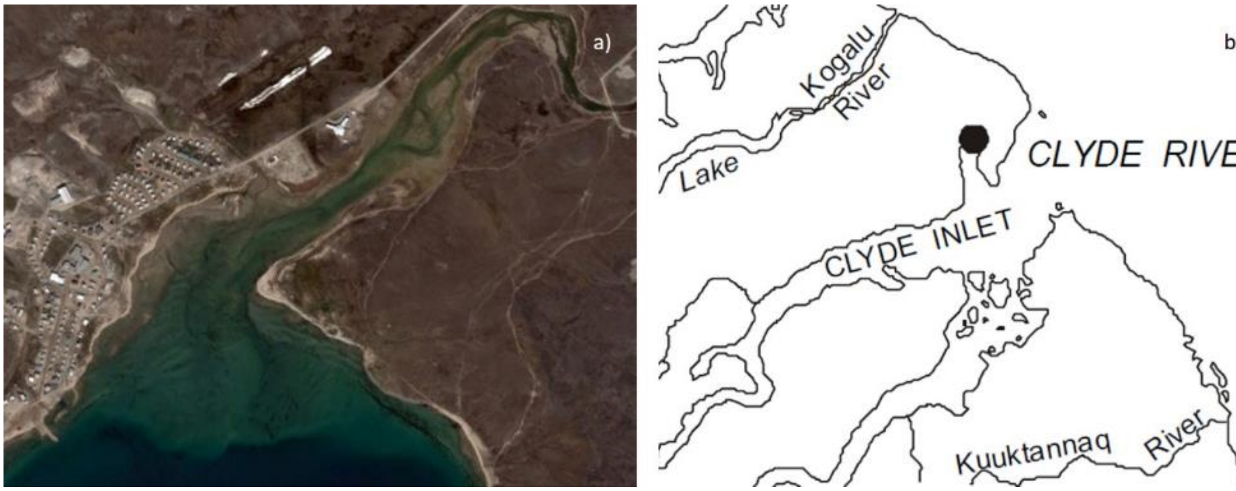

Figure 9-1 Anadromous River Systems in Proximity to Clyde River a) Clyde River Estuary and Existing Breakwater, b) Kogalu and Kuuktannaq Rivers

Source: Read (2000); Google Earth (2019a)

9.1.3 Focal Fish Species

Focal fish species were selected based those that are important to the Inuit for harvesting as identified through the Project specific IQ (see Section 3.3 for methodology, Section 9.2.3 for results), online IQ, and online and published literature. Species identified as important were Arctic char (*Salvelinus alpinus*), Arctic cod (*Boreogadus saida*), sculpin and the truncate soft shell clam (*Mya truncata*).

9.1.3.1 Arctic char

Arctic char are the northernmost freshwater fish species (Brunner *et al.*, 2001; Evans *et al.*, 2015; Oceans North Conservation Society, 2018b) with a circumpolar distribution north of 75 °N (DFO, 2018) (Figure 12, Appendix 1). Typical of salmonid species, Arctic char are ecologically and socio-economically important in Canada's Arctic. Arctic char represent the second-most widely consumed country food (Hurubise, 2016).

Figure 12, Appendix 1 is not necessarily indicative of Arctic char density as more northern areas may be less studied. However, despite limited available information, Clyde River is documented as a higher of high concentration for Arctic char (Oceans North Conservation Society, 2018b), with observations in Patricia Bay and Clyde Inlet (see Figure 13, Panel A, Appendix 1).

Arctic char exist in both anadromous (referred to as sea run char in IQ) and lacustrine (land locked) forms, however, the focus of this desktop review is on the anadromous form as the proposed project occurs in the marine environment. Anadromous (sea run) char are not considered to be common in the high Arctic, but they sometimes occur where outflows are substantial enough to ensure a return migration in August (Government of Nunavut, 2014) The primary purpose of the seaward migration is to increase energy reserves, at which time they may double their body mass (Jørgensen *et al.*, 1997) over a relatively short summer migration (~20 to 45 days) (Bégout Anras *et al.*, 1999; Klemetsen *et al.*, 2003). The Clyde River NCRI document shows anadromous Arctic char being harvested from July through September (Government of Nunavut, 2014). Clyde River char, Arctic char are in the area in mid July when the river starts breaking up the ice (IQ Workshop 2019 - Daniel Jaypoody) and return by mid August (IQ Workshop - Leslie Ashevak), however larger Arctic char come from further away and remain for much longer, sometimes until freeze up (IQ Workshop - Leslie Ashevak).There is minimal documented information on the migratory patterns of Arctic char in and around Clyde River to confirm if they are migrating from the nearby Clyde River or other near by rivers (e.g. as detailed in Section 9.1.2). Ocean Network Canada (OCN) conducted Arctic char tagging studies in Clyde River in the open-water season of 2013 (Nunatsiaq News, 2013), but data and findings are not published. Acoustic telemetry technology has facilitated the ability to understand habitat use and migratory routes of anadromous species (Drenner *et al.*, 2012), although there are limited acoustic telemetry studies to date to monitor marine migrations of in and around Clyde Inlet Arctic char. The extent to which Arctic char migrate, and where in the marine environment they select to be is poorly understood. From other studies in Nunavut, Arctic char prefer migrating along coastlines as opposed to across water bodies (Moore, 1975; Moore *et al.* 2016), and are typically found within 30 km of their natal rivers (Bégout Anras *et al.*, 1999). Harris *et al.* (2014) found that coastline distance was the closest genetic link between fish in Cambridge Bay. Therefore, links are closer along coastlines, as opposed to across a bay for example, even if the coastline distance is farther. However, recently in a Cambridge Bay DFO study that has been underway since 2013, a recently harvested char, had migrated nearly 80 km from its 2013 tagging location (Nunatsiaq News, 2019c). Typically, Arctic char return to their natal rivers (Kristofferson *et al.*, 1984; Harris *et al.*, 2014) although some straying does occur. QIA (2018c) indicate that Arctic char are found in the inlets and fiords that connect anadromous rivers lakes, Typically, Arctic char return to their natal rivers (Kristofferson *et al.*, 1984; Harris *et al.*, 2014) although some straying does occur.

Despite the primary reason for marine migration to be driven by dietary requirements, very little is known about the diet of anadromous Arctic char, particularly at the local level. Arctic char are likely opportunistic predators, feeding on fish (capelin, northern sand lance), crustaceans (mysids, amphipods, decapods), polychaetes, and insects (Moore & More, 1974; Johnson, 1989; Rikardsen & Elliot 2000; Guiger *et al.* 2002). The preferred prey likely varies between systems depending on availability. There have been no directed studies on the feeding preferences of Clyde River Arctic char. Arctic char return to freshwater, regardless of their sexual maturity, likely an adaptation to avoid harsh environmental variables (e.g. freezing temperatures) (Klemetsen *et al.*, 2003). Arctic char in Clyde River eat krill for the first month and then transition to baby sculpin/cod and then 'snails with wings' (IQ Workshop - Leslie Ashevak). Snails with wings are most likely the pteropod *(Limacina* sp), which were observed in the water column during the remote operated vehicle (ROV) survey (pers. obs. Victoria Burdett-Coutts).

Arctic char spawn in freshwater in September and October over gravel, where eggs incubate under the ice for approximately six months and spend their early life history in freshwater (DFO, 2013). Spawning season in the fall and spring migrations are key life history behaviours of anadromous Arctic char (QIA, 2018c). The first migration to the sea occurs at approximately four to five years when they are 150 to 200 mm in length, but this size range likely differs depending on river systems. It is believed that Arctic char do not make their seaward migration the summer before they spawn, indicating this species needs to maintain significant energy reserves during their fecund period. This, in addition to a short period of energy accumulation during the short summer season, means that Arctic char typically do not spawn in consecutive years (Duitil, 1986).

9.1.3.2 Arctic Cod

Arctic cod (*Boreogadus saida*) are a pelagic marine species believed to be the single most important species in the trophic link between plankton, and marine birds and mammals in the Arctic ecosystem (Welch *et al.*, 1992). This species is considered to be inferior to Arctic char in terms of a harvestable species, "*The cods poor diet and high water content leads to poorer tasting meat and shorter preservation*," (Hurubise, 2016; p43, pers comm July 13 2015). However, while they are less important than Arctic char in regard to human consumption, they are more important in consideration of the food chain of marine birds and mammals (Sekerak, 1982). Arctic cod are a semelparous (single reproductive episode) highly fecund, fast-growing, short-lived fish species highly specialized to living in cold Arctic waters that are partially frozen for portions of the year (Lawson *et al.*, 1998; DFO, 2016). Hatching season for this species depends on the bloom of ice microalgae (January to July, peaks April to May) (Bouchard & Fortier, 2011).

Migratory patterns of Arctic cod are not fully understood, with the exception of a pre-spawning late-summer migration to coastal waters (FAO, 2017). The floe edge is an important ecological niche for Arctic cod, likely because they are feeding on the abundant sea ice zooplankton (Bradstreet, 1982). At the floe edge, Arctic cod are predated on by numerous marine mammal and marine bird species. Arctic cod are known to form large schools in bays and inlets (Hop *et al.*, 1992; Crawford & Jorgensen, 1993), with approximate densities of 80 fish/m^3 and surface areas up to 4.6 hectares (Crawford & Jorgensen, 1996). Cod at the floe edge is an essential to the Arctic food web in the spring migration (QIA, 2018c). Arctic cod, Atlantic cod and Greenland cod are all present in Baffin Bay and Davis Strait but Arctic cod are the most common (QIA, 2018c).

Given their importance to the diet of marine mammals such as narwhals, who are known to be present in the fiords around Clyde River in the open-water season (mid-June to end of July (QIA, 2018c), and given their abundance in nearby Lancaster Sound (Bradstreet, 1982), it is probable they are present in the open-water season. IQ interviews confirmed that Arctic cod are present in Clyde River (Government of Nunavut, 2014), which was further confirmed during the IQ Workshop with a lot of cod being caught (IQ Workshop 2019 - Issac Tassugat; IQ Workshop - Leslie Ashevak). Cod presence in Clyde River is confirmed in Government of Nunavut (2014) (see Figure 13, Panel B, Appendix 1).

9.1.3.3 Arctic Sculpin

Sculpins are generally solitary, benthic marine fishes belonging to the family Cottidae. Distinguished by a large broad head with a body that tapers toward the tail, large mouths with small teeth, two dorsal fins, large pectoral fins and one anal fin (University of Guelph, 2019). There are five genera (*Artediellus*, *Gymnocanthus*, *Icelus*, *Myoxocephalus*, *Triglops*) and 14 species of sculpin that occur in the Canadian Arctic, the largest of which, those of the genus *Myoxocephalus*, can reach up to 60 cm in length, although most are much smaller (Alfonso *et al.*, 2018).

Sculpins are ubiquitous in the Canadian Arctic and generally inhabit shallow coastal water, however, some are known to range as deep as 2,000 m (Mecklenburg *et al.*, 2016). The Shorthorn sculpin (*Myoxocephalus scorpius*) and Arctic staghorn sculpin (*Gymnocanthus tricuspis*) were the species most commonly observed in Government of Nunavut (2014) and so will be the focus of this desktop review (see Figure 13, Panel C, Appendix 1). The shorthorn and Arctic staghorn and sculpin distributions in Nunavut are shown in Figures 14 and 15, Appendix 1 (Alfonso *et al.*, 2018). Sculpins are found on all types of substrate, including underneath fronds of large-bladed kelp species (Moeller, 2018). To date, no studies have been conducting observing the movement patterns of sculpins in Clyde River. However (Government of Nunavut, 2014) confirmed the presence of sculpins in Clyde River during IQ interviews, and sculpin are listed as one of the key species in Government of Nunavut (2014). The presence of sculpins was further confirmed during the IQ Workshop where it was acknowledged that there are five species of sculpin in Clyde River (IQ Workshop 2019 - Issac Tassugat; IQ Workshop - Leslie Ashevak).

Sculpins lay demersal eggs and the larvae become planktonic after hatching. These larvae are sometimes guarded by the male (Landry *et al.*, 2018). There is limited information on the feeding habits of sculpins but they tend to be associated with generalist feeding behaviours, preying on larger invertebrates as well as small fish (Landry *et al.*, 2018) Sculpin diet includes benthic molluscs, small fishes, crustaceans and worms. Due to very limited studies regarding sculpin feeding behaviour, there is a lack of quantitative, localized diet information available for Clyde River. Sculpins also serve as an important forage fish for larger organisms and are found in the stomachs of narwhal, belugas, bowheads and seals (Government of Nunavut, 2010b; QIA, 2018c).

9.1.3.4 Truncate Soft Shell Clam

The truncate soft shell clam (*Mya truncata*) is an important infaunal species in the Arctic. The distribution is largely influenced by ice scour events, either by direct mechanical interference, or modification of seafloor topography (Conlan & Kvitek, 2005). This clam species is important to Arctic ecosystems for its role in carbon cycling and providing prey for many species of marine mammals. Given their sedentary adult life stage, they are a predictable food source for higher trophic level species (Highsmith & Coyle, 1990). As is characteristic of other Arctic bivalves, the truncate soft shell clam has a long life span and low annual growth, which is influenced largely by the length of the open-water season (Piepenburg *et al.*, 2011). Habitat preferences of this particular species have not been studied extensively, but a similar sub-arctic species (*M. arenaria*) showed higher densities in eddies, estuaries, and in slack water adjacent to swift currents (Cristian *et al.*, 2010).

It appears clams are documented as present throughout the spring to fall (April to October), with higher abundances noted during open-water season (July, August) (Government of Nunavut, 2014). There are no details to describe how clams are accessed during the time the ocean is frozen. There are no white papers to document the abundance of clams in and around Clyde River, however, through available IQ resources (Priest & Usher, 2004; Government of Nunavut, 2014) and the IQ Workshop, clams are harvested in the area (see Section 9.1.4.4, Figure 3-1), which is indicative of course of their presence (see Figure 13, Panel D, Appendix 1).

9.1.4 Fishery Resource

Fisheries in Nunavut occur as traditional food (subsistence), commercial (inshore traditional and offshore non-traditional), and recreational fisheries (Boudreau & Fanning, 2016; Nunatsiaq News, 2018). Commercial fisheries are managed collaboratively under the Nunavut Agreement (Kristofferson & Berkes, 2005; Boudreau & Fanning, 2016). Management of commercial fisheries by the Nunavut Agreement, is accomplished with a co-management approach that includes: the Nunavut Wildlife Management Board (NWMB), Nunavut Tunngavik Inc. (NTI), The GN, DFO, Regional Wildlife Organizations (RWOs), Hunters and Trappers Organizations (HTOs, HTAs) (GN EFS, 2016). Commercial fisheries in Nunavut are considered as offshore and inshore fisheries, with offshore targeting Greenland halibut and northern shrimp, and the inshore targeting Arctic char and Greenland halibut. The potential for clams, scallops and crab are being explored (Nunavut Marine Council, 2019). The Nunavut Fisheries Association (NFA) was developed in 2012, and is composed of the four Inuit owned companies which own all of the offshore shrimp and turbot allocations (Arctic Fishery Alliance [AFA], Baffin Fisheries, Pangnirtung Fisheries, Qikiqtaaluk Corporation) (Qikiqtaaluk Corporation, 2018). The Hamlet of Clyde River is a co-owner of Baffin Fisheries (NFA, 2018), and has been instrumental in exploring opportunities to expand the offshore Greenland halibut fishery to be an inshore fishery since 2001 (DFO, 2008b). The AFA have a vessel (Kiviuq 1) used for exploratory fisheries (AFA, 2018) which in recent years has regularly been in the high Arctic Waters, including Clyde Inlet seeking opportunities for commercial harvests for Greenland halibut and shrimp (Navigator, 2015). The AFA works with Memorial University of Newfoundland (MUN) on this endeavour. An exploratory license was first requested from DFO in 2008 by the HTOs of Grise Fiord, Arctic Bay and Resolute for inshore fishing in Jones Sound, Admiralty Inlet, and Parry Sound, respectively (DFO, 2008a). There was a Greenland halibut exploratory fishery the week prior to the IQ Workshop, which was 50 km to 100 km north of Clyde River. It is thought that the waters around Clyde River may not be deep enough, as some people have tried but not been successful to harvest Greenland halibut (IQ Workshop 2019 - Issac Tassugat).

Although the Nunavut Agreement came into effect in 1993 and Nunavut was established in 1999, Nunavut fisheries are still managed under the Northwest Territories Fishery Regulations (Government of Canada, 2019k, 2019g). Nunavut Fishery Regulations are being developed cooperatively between DFO, NTI, NWMB, GN and the Makivik Corporation. A consultation period was run from February 11, 2018 to July 31, 2019 (Government of Canada, 2019b).

9.1.4.1 Arctic char

Arctic char is a highly valued fish species to the people of Nunavut for subsistence, and also for commercial fisheries primarily in Cambridge Bay and Cumberland Sound (DFO, 2014a). An Integrated Fisheries Management Plan (IFMP) has been developed for the Cambridge Bay fishery (DFO, 2014a), and are not developed for subsistence fisheries in the territory. However, there is growing interest in developing commercial fisheries in the territory. There are currently no exploratory fisheries for Arctic char occurring in Clyde River. The Clyde River population is considered by DFO to be a vulnerable but sustainable fishery (DFO, 2004a). This assessment requires more detailed information on local stocks to confirm DFO's understanding, as many of the category ratings are due to a lack of data. There are currently several collaborative research projects occurring throughout Nunavut between DFO and the relevant HTOs/HTAs to fill these information gaps. Subsistence fisheries are an important component of the diets of the people of Nunavut, who depend on these fisheries for their livelihood. QIA (2018a) converted country foods into a monetary value, where the value of Arctic char country foods fishery for a study which involved six communities (Grise Fiord, Arctic Bay, Pond Inlet, Clyde River, Qikiqtaarjuak, Pangnirtung), provided a substitution value of $1,120,755.

Arctic char fisheries are managed by DFO on the assumption that each river system supports a discrete fish stock (Kristofferson *et al.*, 1984), leading DFO to conclude there are vulnerabilities in assessing the sustainability of Arctic char in the Clyde Inlet region, as these stocks have not been defined. The Arctic char fisheries to date in close proximity to the SCH Study Area are mainly harvested for subsistence purposes as informed through community consultation (Section 3) and desktop review.

Commercially, Arctic char are harvested using gillnets (DFO, 2013), and in some locations subsistence fisheries also use angling and snagging (Vangerwen-Toyne *et al.*, 2013). In Clyde River, Arctic char are harvested using gillnets and by hook-and-line fisheries (see Figure 3-1), and only for subsistence and recreational purposes. Arctic char is an important subsistence fishery, during the NWHS five-year study period (1996-2001) a total of 174 fishers harvested clams (see Table 9-1 from Priest & Usher (2004).

At the territorial level, efforts are underway to determine the efficacy of expanding the commercial Arctic char fleet, which in 2012 had a landed value of $186,000 (DFO, 2014a). Government of Nunavut & Nunavut Tunngavik Incorporated (2005) is keen to develop the recreational fishery, which typically has a greater value per fish.

9.1.4.2 Arctic Cod

As indicated earlier in this section, Arctic cod are not considered as valuable as Arctic char, and thus are not a primary subsistence fishery in Nunavut. There is interest in commercial fisheries for this species (CBC, 2015; Nunatsiaq Online, 2016). However, there are currently no commercial fisheries or exploratory fishery licenses for fishing Arctic cod in or around Clyde River and viability is affected by the lack of local fuelling facilities for large commercial vessels. Possibly due to their abundance in the area, Arctic cod are harvested by the residents of Clyde River (IQ Workshop - Leslie Ashevak; Priest & Usher, 2004; Government of Nunavut, 2014). During the NWHS five year study period (1996 to 2001), a total of 59 harvesters fished for Arctic cod in Clyde River

9.1.4.3 Arctic Sculpins

There are no commercial fisheries for Arctic sculpins in Nunavut, however, it is considered an important subsistence fishery species (Government of Nunavut, 2014; QIA, 2018c). Sculpins are often by-catch to other targeted fisheries, used as bait, or caught for scientific research (Department of Fisheries and Aquaculture, 2019).

Although the third most commonly hunted marine species by the Inuit (Hurubise, 2016). sculpins are not the primary targets for subsistence fishing and are often caught on accident or recreationally (Priest & Usher, 2004). However, (QIA, 2018c) list them as one of the most important subsistence fisheries. During the NWHS five year study period (1996 to 2001), a total of 38 harvesters fished for Sculpin in Clyde River (see Table 9-1 from Priest & Usher (2004)). In Clyde River, older women jig for edible sculpin (IQ Workshop 2019 - Daniel Jaypoody), and are caught frequently (IQ Workshop 2019 - Issac Tassugat; IQ Workshop - Leslie Ashevak).

9.1.4.4 Clams

There is no commercial fishery for benthic species, including clams in Clyde River, and this species is not currently harvested for subsistence purposes. Clams are included in the category of sea floor dwellers in QIA (2018c) and are considered to be critical for food chain dynamics of larger predators such as marine mammals, fish and marine birds.

There is interest in expanding commercially exploited fisheries in Nunavut, some of which include soft shell clam, soft corals, amphipods, brittle stars, and brown sea cucumber (*Cucumaria frondosa*) (Boudreau & Fanning, 2016). However, at this time there are no known exploratory fisheries occurring in the vicinity of Clyde River.

As a subsistence fishery, the truncate soft shell clam is known to be present in Clyde River (Government of Nunavut, 2014). Through IQ, clams are documented as occurring in Clyde River and in Clyde Inlet with a Probability of Occurrence being between one to five of the interviewees, and a total of 77 fishers harvesting clams during the NWHS study period (1996-2001) (see Table 9-1 in Priest & Usher (2004)). (Government of Nunavut, 2014). Clam harvesting areas were identified during the IQ Workshop, which are seaward of the existing breakwater (see Figure 3-1). Some people use 30 ft. poles to harvest clams on the other side in the spring and fall as there are more clams in that area (IQ Workshop 2019 - Mike Jaypoody). Sometimes the storms push clams in to shore but otherwise they are too deep in the SCH Study Area to harvest (IQ Workshop 2019 - Mike Jaypoody).

Table 9-1 Number of Hunters Harvesting Each Species in Clyde River (June 1996 to May 2001)

Species	Year					Total
	Y1 (June 1996 – May 1997)	Y2 (June 1997 – May 1998)	Y3 (June 1998 – May 1999)	Y4 (June 1999 – May 2000)	Y5 (June 2000 – May 2001)	
Arctic char	112	89	96	105	82	484
Cod	9	12	16	19	26	82
Sculpin	31	33	52	40	37	193
Clams	23	14	14	20	6	77

Source: Table 78 from Priest and Usher (2004)

9.2 Field Survey – SCH Study Area

Quantitative surveys were undertaken on August 12 and 13, 2019 to characterize the seabed conditions of the intertidal and subtidal areas of the SCH and DAS (subtidal only) Study Areas in Clyde River.

9.2.1 Methodology

Habitat was characterized in the Study Areas (SCH, DAS) using a combination of intertidal and subtidal habitat survey techniques. The survey zones are defined as follows:

- Intertidal: High water mark (HWM) to the low water mark (LWM)
- Subtidal: All water below LWM

9.2.1.1 Survey Location

Surveys were focused within the SCH and DAS Study Areas (see Table 9-2, Figure 9-2, Figure 9-3).

Table 9-2 Marine Field Studies Fish and Fish Habitat Surveys

Survey Type	Study Area	Date
Intertidal (quadrat)	SCH	14 August 2019
Subtidal (ROV)	SCH, DAS	12, 13 August 2019

9.2.1.2 Field Survey Techniques

Intertidal (SCH Study Area) and subtidal (SCH, DAS Study Areas) transects were conducted to determine habitat characteristics along the foreshore of the Study Areas and reference areas (see Section 1.4 for Study Area definitions). Tidal conditions on the date of the surveys is provided in Table 1-3. The tide height on the date of the survey provided in Table 9-2. Transect locations for the field surveys is provided in Table 9-3 and Table 9-4 for intertidal and subtidal surveys respectively. Photographs and video recordings from the field surveys were later analyzed by the enumeration techniques described in Table 9-6 for substrate and Table 9-7 for categorizations of marine fauna/flora. Habitat observed was categorized by the quality definitions provided in Table 9-8. Sessile and motile fauna observed abundance estimates are counts, percent cover, or relative estimates, depending on the particular organism being assessed. Marine vegetation is assessed through a percent cover estimate, sessile invertebrates were assessed through a combination of counts and aerial coverage (m^2), depending on their abundance. Mobile organisms were assessed with a count.

Intertidal Habitat

Transects were established perpendicular to the shoreline at regular intervals from the HWM to the water line, both within and adjacent to the SCH Study Area. Perpendicular transects facilitate the identification of transitions between habitat types, as zonation is a strong feature of intertidal communities for both rocky and sandy communities. A total of six transects were set in the intertidal for the SCH (Figure 9-2). Transect start and stop points and habitat band transitions were delineated with a GPS. A habitat band was defined as an observable differentiation on biophysical features (substrate, fauna, flora) composition on a vertical gradient.

Photographs were taken of each habitat band within each transect, and individual photographs were taken of identified taxa. Observed flora and fauna were identified to the lowest possible taxonomic level.

Legend

SCH Footprint
- Option 1
- Option 2
- Option 3

Transects
- Start
- End
- Intertidal
- Subtidal

SCH Study Area

Imagery Source: CHS, July 2016

Locations approximate.

FISHERIES AND OCEANS CANADA
CLYDE RIVER HARBOUR DEVELOPMENT
ENVIRONMENTAL AND SOCIO-ECONOMIC BASELINE SURVEY

SMALL CRAFT HARBOUR INTERTIDAL AND SUBTIDAL TRANSECT SURVEYS

Fisheries and Oceans Canada

Advisian
Worley Group

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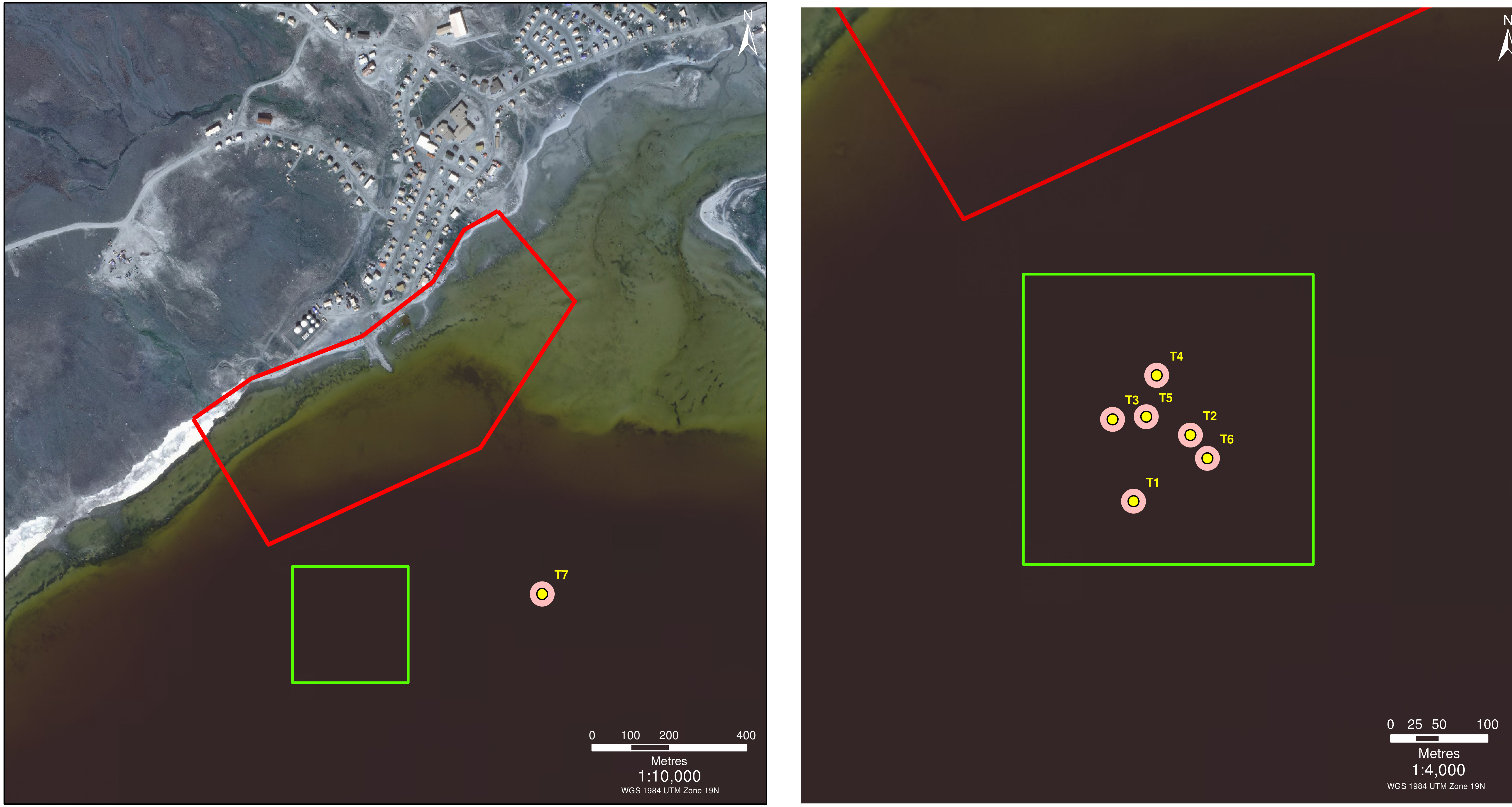

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Study Area

- SCH
- DAS
- ROV Start Location
- ROV Observation Area

Imagery Source: CHS 2016

Locations approximate.

FISHERIES AND OCEANS CANADA
CLYDE RIVER HARBOUR DEVELOPMENT
ENVIRONMENTAL AND SOCIO-ECONOMIC BASELINE SURVEY

DISPOSAL AT SEA SUBTIDAL TRANSECT SURVEYS

Fisheries and Oceans Canada

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Table 9-3 Information on Intertidal Transects Conducted at the Small Craft Harbour Study Area

Transect No.	Start		Stop		Transect Length (m)	Number of Quadrats	Quadrat Spacing (m)	Distance from Previous Transect (m)
	Latitude	Longitude	Latitude	Longitude				
Transect 1	70° 28.019'N	68° 36.248'W	70° 28.016'N	68° 36.245'W	4	3	2	
Transect 2	70° 28.069'N	68° 36.010'W	70° 28.067'N	68° 36.008'W	4	6	2	170
Transect 3	70° 28.119'N	68° 35.639'W	70° 28.116'N	68° 35.632'W	4	7	2	245
Transect 4	70° 28.164'N	68° 35.452'W	70° 28.162'N	68° 35.450'W	7.5	4	2	140
Transect 5	70° 28.205'N	68° 35.336'W	70° 28.202'N	68° 35.331'W	8	5	2	110
Transect 6	70° 28.263'N	68° 35.211'W	70° 28.261'N	68° 35.210'W	6.5	3	2	130

Subtidal Habitat

Subtidal habitat transects were conducted using a VideoRay Pro 4 remotely operated vehicle (ROV). Survey methodology varied between the SCH and DAS Study Area due to depths as the ROV is more difficult to manoeuvre in deeper waters. The number of transects conducted at each site and other descriptive characteristics are provided in Table 9-4.

Within the SCH Study Area, parallel (east-west) and perpendicular (north-south) to shore transects were conducted. Parallel to shore transects were initiated on the eastern or western side of the SCH Study Area, depending on currents and wind direction. The boat was anchored at the start position, and the ROV travelled for 50 m to 70 m in a parallel to shore direction, the distance of which was estimated by the length of tether that had been run out. A GPS position was taken at the start position, and the end position was estimated using the AvenaPDF measuring application. Perpendicular to shore transects where either initiated from shore, or from the seaward extent on a boat. The perpendicular to shore transects were conducted in the same manner as parallel to shore transects, and varied in length from 30 m to 55 m. The SCH Study Area ROV survey targeted Option 1 and 2 designs, were the transects conducted outside of the footprint for one design will serve as a control for the other. A total of 21 parallel and perpendicular to shore transects were conducted in the Option 1 Study Area are and 11 were conducted in the Option 2 Study Area.

Within the DAS Study Area, the ROV was deployed on auto depth to a setting that was 2 m above the seabed, as determined by the use of a Lowrance depth sounder. Once on the bottom, the ROV travelled in a 10 m circumference. Six transects were conducted in the DAS Study Area and one control transect was conducted at a nearby reference location.

Video recordings were later analyzed by the enumeration techniques as described in Section 9.2.1.3. A subset of images was analyzed which were considered representative of the relevant transect. Images were taken during the survey, as the ROV can record and photograph simultaneously. Additional images were taken as video snapshots using the program Adobe Premiere Pro CC 2019. Where possible, exact counts were provided, but were otherwise in relative abundance. When there was uncertainly in the species identification, an indication of 'possible' (poss) or 'probable' (prob) is provided.

Table 9-4 Information on Subtidal Transects Conducted at the SCH Study Area

Transect No.	Start		Stop		Time	Tide Height (m)	Depth (m)		Length (m)
	Latitude (N)	Longitude (W)	Latitude	Longitude	Start		Sounder	CD	
Small Craft Harbour – Parallel to Shore 12/08/2019									
T1	70° 27.879'N	68° 36.082'W	70° 27.897'N	68° 35.998'W	09:26	0.5	11.3	10.8	54
T2	70° 27.917'N	68° 36.058'W	70° 27.914'N	68° 35.950'W	09:41	0.5	7.6	7.1	56
T3	70° 27.908'N	68° 36.160'W	70° 27.921'N	68° 36.068'W	09:55	0.5	8.0	7.5	62
T4	70° 27.941'N	68° 36.220'W	70° 27.950'N	68° 36.127'W	10:05	0.6	2.6	2.0	60
T5	70° 27.923'N	68° 35.868'W	70° 27.930'N	68° 35.760'W	10:18	0.6	7.7	7.1	70
T6	70° 27.944'N	68° 35.910'W	70° 27.950'N	68° 35.800'W	10:33	0.6	6.6	6.0	68
T7	70° 27.962'N	68° 35.987'W	70° 27.966'N	68° 35.878'W	10:42	0.6	6.0	5.4	65
T8	70° 27.993'N	68° 36.033'W	70° 27.999'N	68° 35.935'W	10:51	0.6	1.8	1.2	62
T9	70° 27.983'N	68° 35.934'W	70° 27.990'N	68° 35.829'W	11:00	0.6	5.2	4.6	65
T10	70° 28.024'N	68° 35.887'W	70° 28.031'N	68° 35.783'W	11:10	0.6	1.7	1.1	65
T11	70° 28.014'N	68° 35.757'W	70° 28.021'N	68° 35.653'W	11:25	0.6	4.8	4.2	65
T12	70° 27.983'N	68° 35.681'W	70° 27.990'N	68° 35.577'W	11:33	0.6	6.4	3.8	65
T13	70° 28.049'N	68° 35.695'W	70° 28.042'N	68° 35.758'W	11:41	0.6	3.1	2.5	40
T14	70° 27.994'N	68° 35.481'W	70° 27.981'N	68° 35.556'W	13:18	0.6	6.0	5.4	50

Transect No.	Start		Stop		Time	Tide Height (m)	Depth (m)		Length (m)
	Latitude (N)	Longitude (W)	Latitude	Longitude	Start		Sounder	CD	
T15	70° 28.032'N	68° 35.247'W	70° 28.029'N	68° 35.327'W	13:39	0.6	6.1	5.5	50
T16	70° 28.073'N	68° 35.290'W	70° 28.070'N	68° 35.380'W	13:53	0.6	4.4	3.8	55
T17	70° 28.049'N	68° 35.363'W	70° 28.049'N	68° 35.466'W	14:01	0.5	5.0	4.5	60
T18	70° 28.036'N	68° 35.598'W	70° 28.039'N	68° 35.502'W	14:17	0.5	4.3	3.8	60
T19	70° 28.107'N	68° 35.362'W	70° 28.105'N	68° 35.459'W	14:27	0.5	2.1	1.6	60
T20	70° 28.082'N	68° 35.462'W	70° 28.066'N	68° 35.593'W	14:36	0.5	1.7	1.2	85
Small Craft Harbour – Perpendicular to Shore – 13/08/2019									
T21	70° 28.121'N	68° 35.333'W	70° 28.130'N	68° 35.382'W	13:09	0.6	1.5	0.9	35
T22	70° 28.097'N	68° 35.396'W	70° 28.122'N	68° 35.399'W	13:19	0.6	3.0	2.4	45
T23	70° 28.079'N	68° 35.464'W	70° 28.094'N	68° 35.466'W	13:32	0.6	2.5	1.9	30
T24	70° 28.064'N	68° 35.555'W	70° 28.088'N	68° 35.515'W	13:44	0.6	2.3	1.7	50
T25	70° 28.053'N	68° 35.579'W	70° 28.077'N	68° 35.614'W	13:55	0.6	3.8	3.2	40
T26	70° 28.053'N	68° 35.579'W	70° 28.074'N	68° 35.644'W	14:10	0.6	3.8	3.2	40
T27	70° 28.045'N	68° 35.661'W	70° 28.071'N	68° 35.668'W	14:21	0.6	3.4	2.8	40
728	70° 28.035'N	68° 35.778'W	70° 28.065'N	68° 35.779'W	14:33	0.6	4.1	3.5	55
T29	70° 28.007'N	68° 35.965'W	70° 28.041'N	68° 35.963'W	15:16	0.5	2.2	1.7	60

Transect No.	Start		Stop		Time	Tide Height (m)	Depth (m)		Length (m)
	Latitude (N)	Longitude (W)	Latitude	Longitude	Start		Sounder	CD	
T30	70° 27.993'N	68° 36.105'W	70° 28.025'N	68° 36.080'W	15:30	0.5	1.5	1.0	60
T31	70° 27.971'N	68° 36.161'W	70° 27.998'N	68° 36.160'W	15:45	0.5	1.0	0.5	50
T32	70° 27.949'N	68° 36.238'W	70° 27.984'N	68° 36.246'W	15:59	0.5	1.0	0.5	60

Table 9-5 Information on Subtidal Transects Conducted at the DAS Study Area, August 12, 2019

Transect No.	Start		Time	Tide Height (m)	Depth (m)	
	Latitude (N)	Longitude (W)	Start		Sounder (m)	CD
T1	70° 27.664'N	68° 35.831'W	12:13	0.6	40.6	40.0
T2	70° 27.700'N	68° 35.735'W	12:21	0.6	38.7	38.1
T3	70° 27.709'N	68° 35.864'W	12:34	0.6	38.0	37.4
T4	70° 27.733'N	68° 35.790'W	12:42	0.6	39.0	38.4
T5	70° 27.711'N	68° 35.808'W	12:50	0.6	38.0	37.4
T6	70° 27.687'N	68° 35.707'W	12:58	0.6	40.0	39.4
T7	70° 27.750'N	68° 34.972'W	11:56	0.6	43.6	43.0

9.2.1.3 Habitat Characterization

Substrate categories for both surveys were as defined by DFO (1990) (see Table 9-6). Marine plant observations were recorded as a percent areal cover (DFO 1990, addition of 'infrequent' category specific to this program). Sessile and motile fauna observed abundance estimates are counts, percent cover, or relative estimates, depending on the particular organism being assessed. When using relative estimates, the categories defined in Table 9-7 are used.

Table 9-6 Substrate Categories for the Marine Fish and Fish Habitat Field Assessment

Substrate	Definition	Size (mm)
Silt, clay, mud	Loose sedimentary deposit	<0.0625
Sand	Loose granular material	0.0625 – 2
Gravel	Loose fragments of rock	2 – 64
Cobble	Loose stone larger than gravel, smaller than a boulder	64 – 256
Boulder	Detached mass of rock	>256
Bedrock	Solid rock underlying unconsolidated surface material	
Shell hash	Shell fragments of various organisms	

Source: DFO (1990)

Table 9-7 Categorizations of Marine Fauna when Enumerated with Estimates

Category	Definition
Abundant	▪ Organisms distributed as the primary flora or fauna ▪ Distribution that covered an area >60% of available suitable habitat
Moderate	▪ Organisms either clustered in groups or sporadic within the habitat zone ▪ Distribution covering 25% to 50% of available habitat
Infrequent	▪ Combination of moderate and trace, patchy and ephemeral in nature, occurring in more frequent clusters than trace
Trace	▪ Relatively small cluster of colonizing organisms (<10% to 25%) of assessed area.

Source: DFO (1990), exception is 'Infrequent' this was specific to this survey

Table 9-8 Habitat Categories

Category	Description
High	High value habitat that contribute to a critical life stage or function (e.g. feeding, nursery, reproductive, migratory route) of a marine species, or that are of high social or cultural significance. Additionally, loss of the habitat in question is limited or could result in decreased connectivity of a marine species or population.
Moderate	Habitat that may contribute to critical life stages or function of a marine species but is not limited.
Low	Habitat does not contribute to life stages and functions of marine species and is not limited. Habitat may be used as, or is likely to be used for migratory purposes of marine species, but alternative migratory routes are available.

9.2.1.4 Quality Assurance/Quality Control

Subtidal ROV Survey

- Intertidal photographs and subtidal ROV footage (video, photographs) were recorded and backed up on field laptops, providing a copy both to the Advisian network and a back up drive of the data for review at a later date.
- The video feed was monitored throughout the survey to verify the camera was not obstructed and that the recording was of sufficient quality for later analysis.

9.2.2 Drone Survey

A drone survey was conducted by ArcticUAV on August 23 on the Clyde River foreshore area during a separate field survey. The purpose of the survey was to support the feasibility phase of the Project and was commissioned by DFO-SCH. The imagery was provided to Advisian to support the fish and fish habitat program. Georeferencing information was not available at the time of this report, and the spatial coverage was not sufficient to encompass the SCH Study Area, so this map was not used to support habitat mapping. It does however, provide demonstrative habitat of the intertidal and shallow subtidal characteristics. Since the drone survey was not in the scope of Advisian, it will not be discussed in the results section but will be used as reference material in the discussion.

9.2.3 Results

Details from the intertidal survey are provided in Table 1 and Photos 1 to 6 of Appendix 7 with representative photos provided in Photo 9-1. Details from the SCH Study Area subtidal survey are provided in Table 1, Appendix 8. Two photo panels of the parallel and perpendicular to shore transects, broken down by transect number are also provided in Appendix 8. A representative photo of the SCH Study Area subtidal zone is provided in Photo 9-2. Details from the DAS Study Area subtidal survey are provided in Table 1 and a photo panel are provided in Appendix 9 with representative photos provided in Photo 9-3.

9.2.3.1 Intertidal

The intertidal shoreline observed in Clyde River was a largely sandy substrate with infrequent to moderate distribution of boulders. Amphipods were observed in infrequent to moderate densities in the lower intertidal areas, and their presence was often associated with sand depressions that remained moist or when boulders were present. Abundance and distribution of marine vegetation was trace, for when it was attached the patches were relatively small. There was loose (detached) rockweed throughout the intertidal beach. There were no observations of marine fish.

Photo 9-1 Clyde River Intertidal Foreshore

9.2.3.2 Subtidal

9.2.3.3 SCH Study Area

Substrates observed within the SCH Study Area were primarily soft substrates (sand) with occasional boulder, which were at times in clusters. When hard substrates were present, higher densities of marine vegetation were observed. The marine vegetation that was most abundant was rockweed (*Fucus sp*), which had higher densities in the western portion (30% to 70%) than the eastern portion (<40%) of the SCH Study Area. Rockweed was typically in less than 5 m CD depth. Other types of marine vegetation observed included occasional patches of kelp (sugar wrack kelp, *Saccharina latissima*, ~10% in clusters and sea colander, *Agarum clathratum*, 40 to 90% on occasional boulder). When observed, kelp species were between 2 m to 7 m CD depth. A brown filamentous algae, which is possibly thread brown algae (*Chordaria sp*.), was observed throughout the site as a thin layer on both hard (boulders) and soft substrates (sand).

The most abundant marine invertebrate was the truncate soft shell clam (*Mya truncata*) occurring in densities which ranged from 20/m^2 to upwards of 50/m^2. The categorization range of the truncate soft shell clam (see Table 9-7) ranged from infrequent to moderate (observed on 26 of 32 transects). Other marine invertebrates observed included; green sea urchins (*Strongylocentrotus drobachiensis*, when present 5 to 10 per transect, trace to infrequent, observed on 12 of 32 transects), tube dwelling anemones (*Pachycerianthus borealis*, <5/m^2, trace, observed on 1 of 32 transects), buccinum snail egg casings (1 to 2, trace, observed on 2 of 32 transects), pipe cleaner hydroid (*Lafoeina maxima*, 6, trace, observed on 1 of 32 transects).

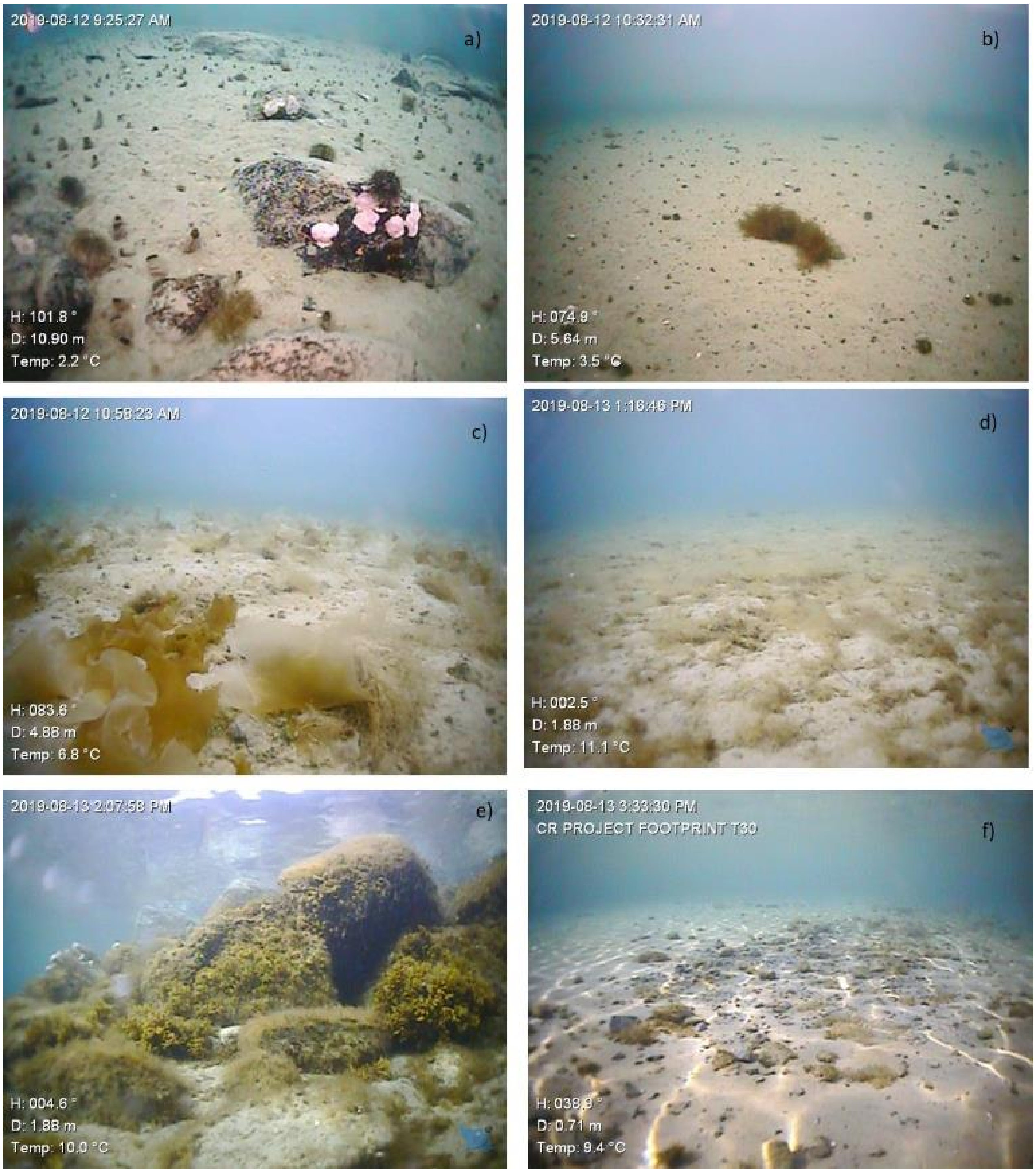


Photo 9-2 Clyde River Project Footprint Subtidal Overview: a) T1, Truncate Soft Shell Clam, Sea Urchins; b) T6, Threaded Brown Algae; c) T9, Sugar Wrack Kelp; d) T22, Overview; e) T25, Rockweed and Boulders; and f) T30, Overview

9.2.3.4 DAS Study Area

Substrates observed within the DAS Study Area were primarily soft substrates (sand) with occasional boulder, which were at times in clusters. When hard substrates were present, higher densities of marine sessile marine invertebrates were observed. Detached rockweed (*Fucus* sp.) was observed throughout the site.

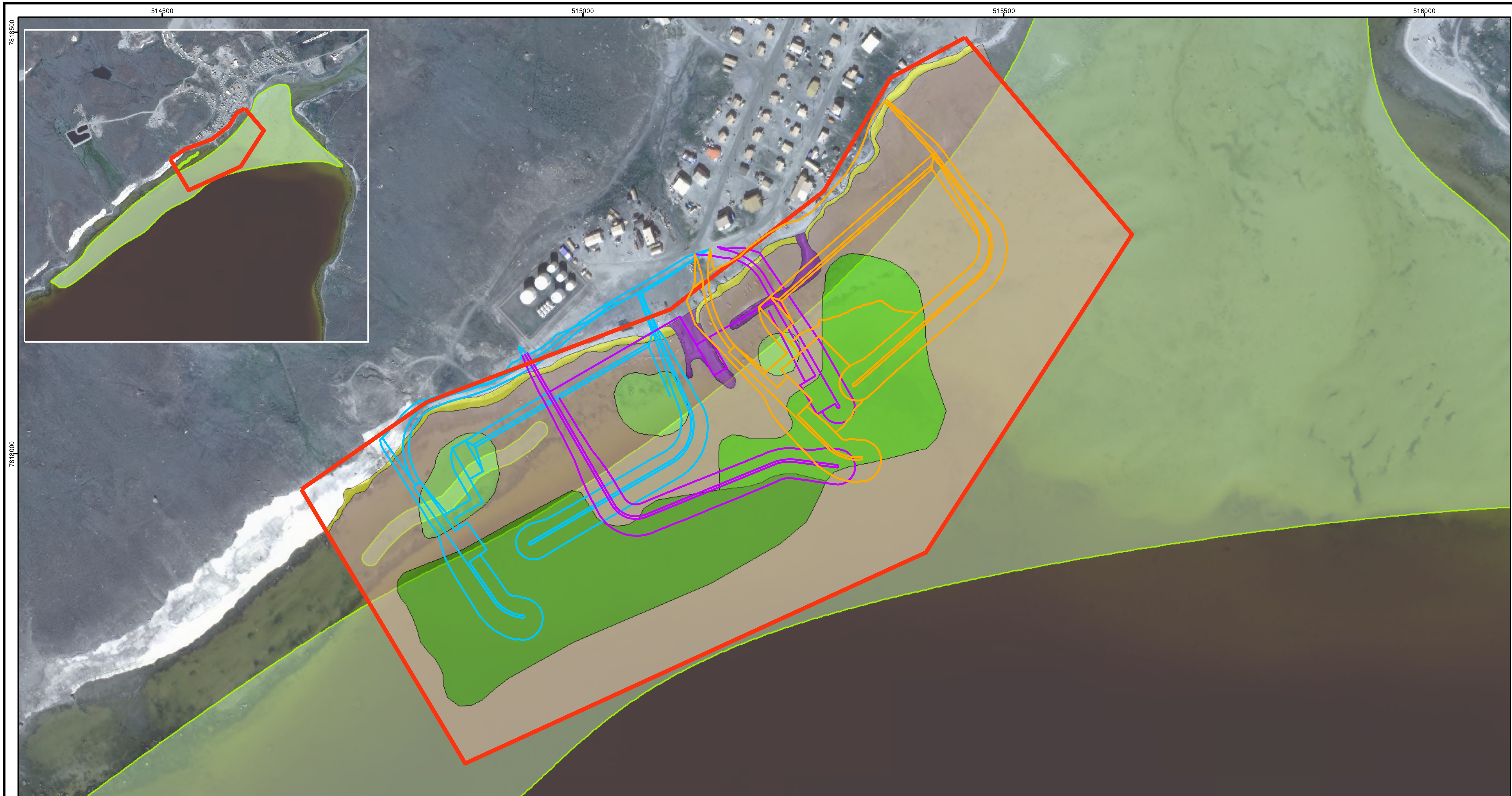
The most abundant marine invertebrates were brittle stars which occurred in very high densities throughout the DAS Study Area (*Ophiocten* or *Ophiura* sp, 30 to 60/m^2 when observed). The categorization range of the brittle stars (see Table 9-7) ranged from moderate to abundant (observed on seven of seven transects). Other marine invertebrates observed included:

- Green sea urchins (*Strongylocentrotus drobachiensis*, when present 3 to 10 per transect, trace to infrequent, observed on four of seven transects)
- Sun stars (*Solaster sp.*, when present two per transect, trace, observed on two of seven transects)
- Burrowing sea cucumber (*Psolus sp.*, one, trace, observed on one of seven transects
- Buccinum snail egg casings (one observed, trace, observed on one of seven transects)
- Barnacle (Balanus sp., one observed on one transect, trace, observed on one of seven transects)
- Snails (Buccinum sp, when observed one per transect, trace, observed on two of seven transects)
- Calcareous tube worm (unidentified species, when observed were two to ten per transect, trace observed on three of seven transects)
- Sponge (unidentified species, one observed on one transect, trace)
- Soft coral (*Alcyonium sp*, six observed on one transect, trace)

Photo 9-3 Representative Photo Panel for the DAS Study Area a) T2, Crinoid, b) T3, Truncate Soft Shell Clam and Overview, c) T4, Brittle Stars and Overview, d) T4, Sun Star, e) T5, Soft Coral, f) T6 Clam Siphons, Brittle Stars and Overview

9.2.3.5 Drone Survey

Figure 9-4 Clyde River Drone Survey (August 23, 2019)



Legend

SCH Footprint	Habitat	Clam Habitat
Option 1	Existing Breakwater	Low Density - 5-10 per square metre
Option 2	Sand Trace Boulder	Moderate Density - 10-20 per square metre
Option 3	Intertidal - Sand with Intermittent Cobble	High Density - 20-40 per square metre
		Clam Bed - as confirmed from IQ Workshop

N

0 50 100 200

Metres

1:4,500

WGS 1984 UTM Zone 19N

Locations approximate.

Imagery Source: CHS, July 2016

FISHERIES AND OCEANS CANADA
CLYDE RIVER HARBOUR DEVELOPMENT
ENVIRONMENTAL AND SOCIO-ECONOMIC BASELINE SURVEY

CLYDE RIVER SMALL CRAFT HARBOUR STUDY AREA HABITAT MAP

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Fisheries and Oceans Canada

Advisian
Worley Group

Project No. 307071-01306

FIG No 9-5

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9.3 Field Survey – Fresh Water Crossings

9.3.1 Methodology

Fresh water crossings for the potential Haul Road Study Area were observed qualitatively by the field team. Photographs and GPS positions were documented.

9.3.2 Results

9.3.2.1 Haul Road Study Area

There are two creek crossings (Photo 9-4) which both run approximately north to south and include culverts beneath the existing road travelling from the community to the airport. The rivers were not field assessed for whether not they could be fish bearing.

Photo 9-4 Haul Road Fresh Water Courses

9.3.2.2 SCH Study Area

There are four minor creeks which drain into foreshore fronting Clyde River, one of which is within the SCH Study Area. These creeks are draining small thermokarst lakes located north of the community. Creek 3, which is within the SCH Study Area was followed to a nearby road crossing with a culvert installation (70° 28.287'N, 68° 35.651'W, see Photo 9-5). Creek 3 was not field assessed for whether not it could be fish bearing.

Table 9-9 Freshwater Creeks

Creek Number	Location		Distance from Breakwater (m)
	Latitude	Longitude	
1	70° 28.532'N	68° 34.181'W	70 m NW
2	70° 28.476'N	68° 34.631'W	810 m NW
3	70° 28.435'N	68° 34.809'W	950 m NW
4	70° 28.127'N	68° 35.612'W	1.2 km NW

Legend

SCH Footprint

- Option 1
- Option 2
- Option 3
- SCH Study Area
- Fresh Water Creek

Imagery Source: Google Earth, 2016

Locations approximate.

FISHERIES AND OCEANS
CLYDE RIVER HARBOUR DEVELOPMENT
ENVIRONMENTAL AND SOCIO-ECONOMIC BASELINE SURVEY

FRESH WATER CREEKS ALONG THE CLYDE RIVER FORESHORE

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Fisheries and Oceans Canada	Advisian Worley Group	Project No. 307071-01306	
		FIG No 9-6	REV 0

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Photo 9-5 Creek 3 Photo Panel: a) Culvert, b) South of Culvert, c) North of Culvert

9.4 Discussion

The depth range of the area observed during the subtidal Field Survey ranged from 0.5 m to 10.8 m CD, with a tidal range of 2.0 m (see Section 4.4.3 - Tides of main report). Habitat quality within the SCH Study Area is considered low quality in the intertidal area and low quality to moderate quality within the subtidal zone. There were little to no observations of marine vegetation within the intertidal zone, however, amphipods were observed and typically associated with boulder habitat or in sandy depressions which remain inundated at low tide (pers. obs. Victoria Burdett-Coutts). This is similar to others Arctic areas where an intertidal zone is present. Characteristics of the intertidal habitat as low quality are supported by the drone imagery taken in August 2019 (see Figure 9-4). Amphipods are considered an important diet item of Arctic char and have been documented as diet in studies conducted in Iqaluit (O'Connor unpublished data). In Clyde River, Arctic char are considered to be eating 'krill' for the first month of the open-water season (IQ Workshop 2019 - Daniel Jaypoody), which is possibly an amphipod. How Arctic char utilize marine habitats during their ocean migration is not known, however, given the close proximity of the Clyde River Estuary, Arctic char would certainly be passing through the SCH Study Area. As summarized in Section 9.1.4.1 Arctic char are utilizing the foreshore waters of Clyde River with a presence extending from mid-July (start of open-water) (IQ Workshop 2019 - Daniel Jaypoody) to mid-August (IQ Workshop - Leslie Ashevak). However, Arctic char that migrate back up the Clyde River are migrating earlier than fish that are believed to be travelling from further away (IQ Workshop - Leslie Ashevak).

Rockweed occurred in moderate to abundant densities and was more prevalent in the western part of the SCH Study Area than the eastern. The majority of the SCH Study Area is likely within the crush zone during the iced season which may partially explain the relatively low diversity, other than the abundance of soft truncate shell clams. Drift algae (kelps, filamentous seaweeds) was observed along several transects, where it has been noted that in areas of low currents a layer of dead algae can be observed overtop a layer of live filamentous algae (Kupper *et al.*, 2016). Rockweed and other seaweeds are known to be present in Clyde River (IQ Workshop - Leslie Ashevak; Government of Nunavut, 2014).

Boulder habitat was scattered throughout the SCH Study Area, and when present was typically related to higher species biodiversity. The truncate soft shell clam's presence was not related to boulder or other hard substrates, as it is a soft substrate organism. These clams were observed in moderate to abundant densities in and were the most frequently observed marine invertebrate throughout the subtidal ROV survey. There is currently no harvesting of these bivalves by residents of Clyde River, however, the abundance of this organism eludes to the area representing ideal habitat for this species. There was not a predictable pattern to attribute to the densities of clams throughout the site. It is not known how these densities compare to nearby areas, although the SCH Study Area does not appear to be unique in comparison other foreshore areas in Patricia Bay.

Species diversity within the DAS Study Area was considered moderate based on the descriptions given in Table 9-7, but not dissimilar from nearby areas for that depth. The depths ranged from 36 m to 40 m. Species diversity and biomass along Transect 7 (control) was similar to the habitat observed along Transects 1 to 6.

There were no designated species observed during the field survey.

As there are no known published surveys for benthic habitat within or in close proximity to Clyde River, comparisons with desktop literature is not possible.

Several small creeks were observed along the Clyde River Foreshore, and were within the SCH and Haul Road Study Areas. These creeks were not assessed in the field but Google Earth imagery of Creeks 1, 2, and 4 show they are drainage and do not lead to larger freshwater courses (Figure 9-6). Creek 3 is a shallow creek which is likely dry at times and so is unlikely to be providing valuable fish habitat.

10. Marine Mammals

Program objectives for marine mammals are provided in Section 1.6, Table 1-2.

Baffin Bay and Davis Strait, and when possible the waters of Clyde Inlet and the Hamlet of Clyde River (see Figure 1-5). Marine mammals are an integral component of the Canadian Arctic and hold ecological, socio-economic, and cultural importance. Lancaster Sound and Davis Strait are important migratory pathways for marine mammals (Parks Canada, 2017). Lancaster Sound is recognized for its importance as a migratory corridor for beluga, narwhal, bowhead, walrus, harp seals and polar bears, which contributes to its designations as both an EBSA (DFO, 2015b, 2015a) and an NMCA (QIA, 2012) (see Section 2.2.2).

Marine mammals are considered in a broader context than the SCH and DAS Study Areas defined in Section 1.3 as no directed project-specific studies were conducted and desktop information is often general in nature. Further to this, marine mammals are highly mobile and are generally not restricted to small geographical areas. Marine corridors that connect Lancaster Sound, Baffin Bay and Davies Strait which are available to marine mammal species seasonally throughout the year, depending primarily on sea ice conditions. The IQ workshop (see Section 3) provided valuable insight and local knowledge into the seasonality, distributions and habitat use of marine mammals in Clyde River. Species specific habitat preferences were taken into account, so that information presented is as focussed as possible to the waters of Clyde River. For reference, the commonly referred to place names are identified in Figure 1-5.

10.1 Desktop Review Methodology

The desktop review was initiated with a review of the IUCN website for global species ranges, conservation statuses and general risk factors. From this, a candidate species list was compiled, and then filtered for those with a coastal distribution, or those that are known to move into coastal waters for part of their life history, with special emphasis on High Arctic waters. Scientific, government, natural history and IQ sources were then reviewed to refine the species-specific information. Information relevant to Canadian populations was taken from the COSEWIC and SARA websites, including conservation statuses, Species Status Reports and other information. Local information was obtained from online resources related to Arctic marine mammals, the marine wildlife of Nunavut and IQ websites and documents. Social media posts were also evaluated for community specific information.

10.1.1 Species Spatial Categories

From a broad review of marine mammals, ten were identified with Arctic ranges that included Clyde River (Table 2-1) and were categorized as either Arctic Residents or Seasonal Visitors, as defined below:

- Arctic Resident: species that resides in the Arctic year-round
- Seasonal Visitor: species that predictably resides within the Arctic region for a portion of the year, which most typically is the open-water season

Many of the marine mammal species ranges are international, and therefore can have different global (i.e., IUCN) and Canadian conservation statuses (i.e., SARA and COSEWIC).

10.2 Arctic Residents

Seven species of marine mammals can be found in Artic waters year-round, however their presence in Clyde River may be seasonal as they migrate or disperse to other Arctic areas.

10.2.1 Beluga

Beluga whales (*Delphinapterus leucas*) are circumpolar in distribution, and can be found throughout Arctic and Subarctic waters, as far south as the Gulf of Saint Lawrence (COSEWIC, 2004a; Lowry *et al.* 2017). Their range includes Canada, Greenland, the Russian Federation, Svalbard and Jan Mayen, and the United States (i.e. Alaska), though occasional sightings have been reported in areas like Japan, New Jersey, Scotland and France, among others (Jefferson *et al.*, 2012a). Globally, there is only one species of beluga whale and it is listed by the IUCN as *Least Concern* (Lowry *et al.* 2017), however under the SARA registry there are several populations with a COSEWIC status of Special Concern that are not listed under SARA (Government of Canada, 2019q).

In Canada, there are seven identified populations by COSEWIC (COSEWIC, 2004a). The Eastern High Arctic/Baffin Bay population is found from the eastern Canadian Arctic to Greenland (COSEWIC, 2004a). (COSEWIC, 2004a; Jefferson *et al.*, 2012a), where the animals summer around Somerset Island in Barrow Strait, Lancaster Sound, Prince Regent Inlet and Peel Sound, and winter in northern Baffin Bay and off Greenland (COSEWIC, 2004a; DFO, 2015c; Lowry, 2016; Weber Arctic, 2019). This population is listed as *Special Concern* by COSEWIC in Canada (COSEWIC, 2004a), and may actually consist of two separate populations: the North Water population numbering around 15,000, and the West Greenland population of around 5,000 (COSEWIC, 2004a). Innes *et al.* (2002) found an estimated 21,123 whales during an aerial survey of the Canadian High Arctic. The Talluritiup Imanga NMCA region provides essential habitat for up to 20% of the Canadian beluga population (Government of Canada, 2019o). The Eastern High Arctic/Baffin Bay population winters in north Baffin Bay amongst the heavy pack ice and in the North Water Polynya, and summers in the Lancaster Sound area including Peel Sound, Barrow Strait, Prince Regent Inlet and Lancaster Sound (COSEWIC, 2004a) (see locations on Figure 1-5).

As the sea ice breaks up in the late spring, beluga whales follow leads in the ice to river estuaries. They are found throughout the summer in the coastal shallows and at glacier fronts (COSEWIC, 2004a). In mid-August they move away from land to deeper waters then overwinter in areas with loose pack ice or polynyas (COSEWIC, 2004a). These seasonal movements are heavily influenced by both prey species availability and ice cover (COSEWIC, 2004a). Clyde River is within range of beluga whale known distribution (Stephenson & Hartwig, 2010), and within identified beluga range (NPC, 2008c). They can be seen near Clyde River (Canadian Northern Economic Development Agency, 2019), especially during the summer months of July and August (Dietz *et al.*, 2001; Government of Nunavut, 2014). Belugas are seen less frequently around Baffin Island as the ice forms and return in the spring as the fast ice breaks up (COSEWIC, 2004a), with calving occurring in July and August (Higdon, 2017).

The beluga whale diet is diverse (Ellis, 1994), and includes a variety of benthic and pelagic prey species including fish, squid, octopus, crustaceans, molluscs, and polychaete worms (Bluhm & Gradinger, 2008, in Vard Marine Ltd., 2016). Beluga habitat use is likely related to prey species distribution. Their close association with the ice floe edges may be related to the presence of Arctic cod, which is an important prey species (Kilabuk, 1998). Little is known of their mating behaviour, but it is thought to occur during late-winter to early-spring (Kleinenberg *et al.*, 1964; Brodie *et al.*, 1981), with the peak before mid-April (Burns & Seaman, 1985). Beluga whales are believed to calve offshore, and coastal habitats are understood to be important for rearing and nursing (Higdon, 2017). Calves are born between June and September, with the peak from mid-June to early-July (Stewart *et al.*, 1995; Higdon, 2017). Belugas have been reported to calve near Clyde River in July and August (Higdon, 2017). Lancaster Sound is likely a calf rearing habitat as females have been observed returning in the summer with calves, rather than having their calves there (Higdon, 2017). Beluga whales particularly use the waters near Devon, Cornwallis and Somerset islands (Higdon, 2017). The importance of these high arctic waters for beluga whale survival was recognised in the formation of Talluritiup Imanga NMCA which includes essential habitat for beluga whales (Office of the Auditor General of Canada, 2013; Government of Canada, 2019o).Beluga whales are a social and highly vocal species that makes a wide range of underwater calls and echolocation clicks (Ellis, 1994). The frequency range is broad for this species, ranging from 0.1 – 120 kHz (Todd *et al.*, 2015), and they have been called the “sea canaries” because of their frequent use of underwater acoustics (Ellis, 1994). This species can remain submerged for up to about 15 minutes (Ridgeway *et al.*, 1984), and can make forays under ice. Beluga whales often use the same coastal habitats from year to year and have long been targeted by hunters throughout their distribution.

Beluga whale harvesting is reported to occur throughout Nunavut, but only one kill was reported in Clyde River in a 5-year study, indicating that they are only occasionally harvested there (Priest & Usher, 2004). This is confirmed through the IQ Workshop, where belugas are observed in the bay *“maybe one every ten years”* (IQ Workshop 2019 - Daniel Jaypoody; IQ Workshop 2019 - Issac Tassugat; IQ Workshop 2019 - Mike Jaypoody; IQ Workshop - Leslie Ashevak). The locations belugas have been most recently harvested are shown in Figure 3-1. IQ reports indicate that beluga whales are rare in the fiords and inlets near Clyde River, traveling northwards along the floe edge from April to June, and generally remaining in the open waters until the ice breaks-up (QIA, 2018b). In Clyde River, beluga harvesting is not actively pursued due the conditions of the sea ice in the spring when it is buckled by the tide, and it is too difficult to travel to the floe edge during *Upirngasaaq* (mid-March through end of May) (QIA, 2018b). There have been some concerns that beluga whales are disturbed by shipping and have moved off their migratory path, sometimes closer to Clyde River (QIA, 2018b). Beluga whales are not present in Clyde River from *Ukiaq* (mid-October to beginning of November) through *Ukiuq* (November to mid-March) (QIA, 2018b).

Based on this species’ life history, ecology, habitat use, IQ, and hunt reports, beluga whales could occur in the waters of Clyde River during the open-water season. Presence in Clyde River is determined by the ice extent, and likely mediated by food chain interactions, or avoidance of killer whales.

Threats include harvesting (less than 100 animals per year in the High Arctic), climate change (loss of sea ice), human activities (oil and gas development, shipping) (DFO, 2014b), pollution and disease (COSEWIC 2004a; Lowry *et al.* 2017).The Eastern High Arctic/Baffin Bay population is also heavily harvested in west Greenland (COSEWIC, 2004a). Natural predators include killer whales and polar bears (COSEWIC, 2004a).

10.2.2 Narwhal

Narwhal (*Monodon monoceros*) are the most northerly of all cetaceans (Ellis, 1994), and occur in Arctic waters throughout Canada, Greenland, Russian Federation, and Svalbard and Jan Mayen (Jefferson *et al.*, 2012b). Only one species of narwhal has been identified globally, though 12 sub-populations exist (Jefferson *et al.*, 2012b). Narwhal are globally listed by the IUCN as *Least Concern* (Lowry *et al.* 2017). Narwhals summering in the Eastern Arctic are listed as *Special Concern* by COSEWIC (COSEWIC, 2004c), and no status under SARA (Government of Canada, 2019q). Between 45,000–50,000 narwhals from the Baffin Bay population are estimated to summer in Canadian waters of the High Arctic (COSEWIC, 2004c) . This population consists of five summering stocks including East Baffin Island, which is likely to be seen around Clyde River (DFO, 2010b; Watt *et al.*, 2012). The waters of the Talluritiup Imanga NMCA provides essential habitat for up to 75% of the global narwhal population during the open-water season (Government of Canada, 2019o).

Clyde River is located within known narwhal range (NPC, 2008c). They can be seen around this area during the late spring/summer/early fall months (QIA, 2018b) coming into the fiords as the ice breaks up, and are harvested during this time (COSEWIC, 2004b; Priest & Usher, 2004; Government of Nunavut, 2014; Ittaq Heritage and Research Centre, 2015; IHT, 2017). The timing of the spring return of the narwhal to the Clyde River area is related to the timing of the break-up, and the group sizes are reported as being relatively small at less than seven animals (Bradstreet, 1982). There is great variability in the size of narwhal from year to year (IQ Workshop 2019 - Daniel Jaypoody; IQ Workshop - Leslie Ashevak), where in the last couple of years there have been very few and other years up to 100 sometimes (IQ Workshop 2019 - Daniel Jaypoody), but there were more observed in the open-water season of 2019 than in the past couple of years (IQ Workshop 2019 - Daniel Jaypoody; IQ Workshop 2019 - Issac Tassugat; IQ Workshop 2019 - Mike Jaypoody; IQ Workshop - Leslie Ashevak).

The fiords around Clyde River provide habitat for calving and nursing calves (Hidgon, 2017; Clyde River Knowledge Atlas, 2019). In the fall, narwhals that spent the summer in Lancaster and Jones Sounds migrate back through the area (Government of Nunavut, 2014). Several hundred of these whales can be found around Clyde Inlet-Inugsuin Fiord in the late summer and fall (Government of Nunavut, 2014). They winter amongst the offshore pack ice in southern Baffin Bay and northern Davis Strait (Nunavut Department of Environment, 2014). Narwhal are not present in Clyde River during the winter, with IQ indicating that this species stays offshore in southern Baffin Bay and northern Davis Strait until the ice break up in the spring when they move into the fiords and inlets (QIA, 2018b).

The deep diving narwhal has a broad diet that includes benthic and pelagic fish, squid, and crustaceans (Bluhm & Gradinger, 2008), where diet varies seasonally with a winter emphasis on benthic prey (Jefferson *et al.*, 2012b). Narwhals likely target ice edges for foraging, based on comparison of stomach samples taken at the ice edge or from ice cracks, compared with those from open-water (Bradstreet, 1982; COSEWIC, 2004c). Narwhal are a social and vocal species with a diversity of calls and clicks (Ellis, 1994). The frequency range is broad, ranging from 0.3 to 48 kHz (Todd *et al.*, 2015). DFO has expressed concerns about potential masking of shipping sounds and the effect that would have on narwhal in the area, especially in narrow bodies of water (DFO, 2014b). Narwhal can remain submerged for up to about 15 minutes (Martin *et al.*, 1994), and can make forays under the ice. Killer whales are known to avoid areas with ice, thus IQ studies indicate narwhals may congregate in these areas to avoid being hunted (Ferguson *et al.*, 2012; Science, 2012). Marcoux *et al.* (2009) also suggest summering grounds of narwhals may be related to avoidance of killer whales.

Narwhal are currently harvested by some indigenous communities in Canada and Greenland (NWMB, 2012; Lowry *et al.* 2017), including in Nunavut (QIA, 2018b). Harvests for narwhal have been reported in May, and from July to November, with inter-annual variation in the timing and numbers taken (Priest & Usher, 2004). IQ informs that narwhal remain in the Clyde River area until the late summer and fall and that they give birth in the fiords during the summer (QIA, 2018b). Narwhal are not present in Clyde River from *Ukiaq* (December) through *Ukiuq* (December to mid-March) (QIA, 2018b).

Based on this species' life history, ecology, IQ, habitat designations, and monthly harvest reports, narwhal can be spotted near Clyde River during the open-water season. The harvest data indicate that this species is accessible in the late spring, late summer and early fall.

Threats include hunting, climate change (both loss and timing of sea ice), human activities (oil and gas development, commercial shipping, commercial fishing), pollution, and disease (Lowry *et al.* 2017).

10.2.3 Bowhead Whales

Bowhead whales (*Balaena mysticetus*) inhabit the Arctic and subarctic waters of Canada, Greenland, and the United States (i.e. Alaska) (Reilly *et al.*, 2012). There is only one species of bowhead whale, listed globally as *Least Concern* (Reilly *et al.*, 2012) by IUCN. Of the four recognized sub-populations, two are located in Canada; the Eastern Canada-West Greenland population is relevant to Lancaster Sound (termed the Eastern Arctic population and the Eastern Canada-West Greenland Population) (COSEWIC, 2009b; Cooke & Reeves, 2018). The Eastern Arctic population has no status under either COSEWIC or the SARA registry and the Eastern Canada-West Greenland population has Special Status under COSEWIC and is not listed under the SARA Registry, but is under consideration for addition to Schedule 1. The seasonal migration path follows the eastern shore of Baffin Island, into and out of Lancaster Sound and Admiralty and Prince Regent Inlets (COSEWIC, 2009b). They may be seen in the Lancaster Sound area in late spring, summer and early fall (COSEWIC, 2009a; Thomas *et al.*, 2016).

The Eastern Canada–West Greenland subpopulation was heavily harvested from the 1500s until the early 1900s. The population is thought to be over 4,000 animals (COSEWIC, 2009b, estimates 6,000 animals) and is increasing but still well below pre-whaling levels of over 25,000 (Cooke & Reeves, 2018). This population summers in western Baffin Bay, northwestern Hudson Bay, Foxe Basin, and the Lancaster Sound region, and winters in Davis Strait and Hudson Strait (COSEWIC, 2009b; Cooke & Reeves, 2018). Bowhead whales are reported in the Clyde River area close to shore, feeding in the late summer and fall (Hidgon, 2017; Government of Nunavut, 2014).

Bowhead whales are known to occur throughout the region during the summer and have been observed in northern Hudson Bay and Foxe Basin, along the eastern coast of Baffin Island, and south of Lancaster Sound in Pond Inlet, Eclipse Sound, Navy Board Inlet, Admiralty Inlet, Prince Regent Inlet, and the Gulf of Boothia (QIA, 2012). Clyde River is located just to the south of bowhead critical habitat and range (NPC, 2008c), although bowhead whales are common in the area (IQ Workshop 2019 - Daniel Jaypoody; IQ Workshop 2019 - Issac Tassugat; IQ Workshop 2019 - Mike Jaypoody; IQ Workshop - Leslie Ashevak). Prince Regent Inlet, specifically south of Creswell Bay, is thought to be a highly utilized area by bowhead in the summer season (Dueck & Ferguson, 2008), as is Isabella Bay on the east coast of Baffin Island (Finley, 1990). Thomas *et al.* (2016) observed variability in densities of bowhead whales during the 2015 aerial surveys for the Baffinland project.

IQ informs that bowhead whales occur at the floe edge in the *Upirngasaaq* (early spring), then then move into deeper waters before entering inlets during the *Upirngaaq* (late spring), and are found feeding in Isabella Bay during the *Aujaq* (summer) before moving southwards (QIA, 2018b). Bowhead whales are not present in Clyde River during the *Ukiassaaq* (early fall), *Ukiaq* (fall/early winter) or *Ukiuq* (winter) (QIA, 2018b).

Bowhead whales forage during the open-water season, taking advantage of the productive arctic waters. The main prey are pelagic zooplankton (Ellis, 1994; Bluhm & Gradinger, 2008; Reilly *et al*., 2012) Bowhead whales can remain submerged for up to an hour and will swim under ice (Ellis, 1994; Krutzikowski & Mate, 2000). Bowhead whales are capable of breaking through ice that is several inches thick due to their large skulls and powerful bodies (WWF, 2019). Bowhead whales can communicate over large distances and use a frequency range from 0.02 to 5 kHz (Todd *et al*., 2015). Seasonal distribution over the years is dependent upon timing and distribution of sea ice (Cooke & Reeves, 2018).

According to elders in Clyde River, sightings of bowhead whales were rarer during their childhoods but increased considerably from the 1960s onwards (NWMB, 2000), and they are now common in Clyde River (Canadian Northern Economic Development Agency, 2019). There was a bowhead whale harvested by the Clyde River community in 2014, which was a first for the community (IQ Workshop 2019 - Mike Jaypoody).

Large numbers of bowheads are reported in the summer in Admiralty Inlet and migrating south/feeding off Clyde River in the late summer/fall, with cow-calf pairs occasionally reported in the area in late summer (NWMB, 2000; Clyde River Knowledge Atlas, 2019). There is evidence of killer whale predation on bowheads in the area (NWMB, 2000), and this is likely to increase as more ice-free areas become available (DFO, 2010a). Located 120 km to the south of Clyde River in Isabella Bay is the Ninginganiq National Wildlife Area (NWA) (Government of Canada, 2017b; Clyde River Knowledge Atlas, 2019). Bowheads are very likely to be seen in this area (Innuit Heritage Trust, 2016; QIA, 2018c; Innuit Places, 2019), which is part of the important summer range for the bowheads that remain off the Baffin Island coast throughout the summer and fall (Canadian Northern Economic Development Agency, 2019).

Based on this species' life history, ecology, habitat use, and IQ, bowhead whales can be expected at the floe edge in the spring, and with large numbers during the open-water season, and will leave the in the early fall. Threats to bowhead whale conservation include increased human activity, vessel strikes, pollution, and climate change (COSEWIC, 2009b).

10.2.4 Ringed Seal

Ringed seals (*Pusa hispida*), the most common seal in the Arctic, have a circumpolar distribution (Kingsley, 1989; Goodwin, 1990). Native to Canada, Estonia, Finland, Greenland, Japan, Latvia, Norway, Russian Federation, Svalbard and Jan Mayen, Sweden, and the United States, these are the smallest pinnipeds in the world (Kingsley, 1989; Lowry, 2016). The five recognized subspecies of ringed seal have been assessed individually by the IUCN, with a global listing of *Least Concern* (Lowry, 2016). The Arctic ringed seal subspecies (*P. h. hispida*) (Lowry, 2016) can be spotted near every community in Nunavut in the spring (Canadian Northern Economic Development Agency, 2019). Ringed seals are listed as *Not at Risk* under COSEWIC, with no status under SARA (Government of Canada, 2019q). A 2016 IUCN Red List assessment found 1,450,000 mature individuals in the Arctic population, with a likely total population greater than three million animals (L. Lowry, 2016).

Ringed seals are a non-migratory species that remain in Arctic waters year-round and can be found throughout Lancaster Sound and the contiguous waterways, including Clyde River (Kingsley, 1989; Goodwin, 1990; Natures Edge, 2015). IQ informs that ringed seals occur throughout the Lancaster Sound region, including Baffin Bay and Davis Strait and at Clyde River (QIA, 2018b). IQ informs that ringed seals have been observed from Clyde River in all months of the year (QIA, 2018b). Ringed seal are one of the preferred species for harvesting (IQ Workshop 2019 - Daniel Jaypoody; IQ Workshop 2019 - Issac Tassugat; IQ Workshop 2019 - Mike Jaypoody; IQ Workshop - Leslie Ashevak).

Ringed seals are known to use a variety of habitats including pack ice and will forage in shallow coastal waters, as well as offshore waters as deep as 150 m (McLaren, 1958). Ringed seals eat a variety of fish and invertebrates, and planktonic, nektonic, and benthic prey (McLaren, 1958; Goodwin, 1990; Bluhm & Gradinger, 2008).

The seasonal distribution of this species indicates that the local distribution is highly influenced by the ice. In *Ukiuq* (end of December to end of March) ringed seals are found at breathing holes; in *Upirngasaaq* (April to beginning of June) ringed seals are found at breathing holes and in birthing lairs where they begin having pups; in *Upirngaaq* (mid-June to end of July) they are found at breathing holes, at the floe edge, and in birthing lairs (QIA, 2018b). From Aujaq (August to mid-October) through *Ukiassaaq* (mid-October to November) they use the open waters, and for the remainder of the year, this species is found at the floe edge (QIA, 2018b).

They remain in fast ice year-round, maintaining breathing holes in the winter (Kingsley, 1989) and can also be found in multiyear ice (Government of Nunavut, 2010b). Clyde River is located within a ringed seal high density area (NPC, 2008c) with the species present year-round in Clyde River and the surrounding area, especially at the mouth of the River (Government of Nunavut, 2014). They can also be found 120 km to the south in the Ninginganiq NWA (Isabella Bay) (Innuit Heritage Trust, 2016; Government of Canada, 2017b; Clyde River Knowledge Atlas, 2019; Innuit Places, 2019). There are multiple pupping areas around the inlets and fiords, and ringed seals can be seen on land in the summer (Government of Nunavut, 2014; Clyde River Knowledge Atlas, 2019).

In mid-May, ringed seals haul out to moult, fasting during this time (McLaren, 1958). Most mating occurs in April shortly after pups are born (Goodwin, 1990). Pups are born in lairs on fast ice around April and are nursed for 30 days, and parental care lasts until break-up (McLaren, 1958; Kingsley, 1989). Bradstreet (1982) observed in Lancaster Sound that seals were in noticeably higher densities within 24 km of the ice edge than farther away.

The ringed seal produces sounds that range from 0.4 to 16 kHz (Todd *et al.*, 2015), with vocalizations consisting of barks and yelps heard during the breeding season, but the species is relatively silent otherwise (Kingsley, 1989). This species can remain submerged for up to 17 minutes (Lydersen, 1991).

An average of about 2000 ringed seals are harvested year round in Clyde River with variation in the monthly effort and numbers taken; significantly more are harvested in the summer (June/July) (Priest & Usher, 2004). Natural predators include killer whales, walrus, polar bears and Arctic foxes, and predation on pups by birds such as gulls and ravens has been observed (Kingsley, 1989). Threats include pollution, climate change (habitat loss with reduced sea ice and snow cover), and anthropogenic disturbance (Lowry, 2016).

Based on this species' life history, ecology, habitat use, IQ, and harvest reports ringed seals can be expected year-round in the Clyde River Region.

10.2.5 Bearded Seal

Greenland, Iceland, Norway, Russian Federation, Svalbard and Jan Mayen, and the United States (COSEWIC, 2007d; Kovacs, 2016b). Two separate subspecies, the Atlantic and the Pacific, can be found in the Canadian Arctic (Kovacs, 2015). The Atlantic bearded seal (*E. b. barbatus*) is present in the eastern Arctic and is listed by the IUCN as *Least Concern* (Kovacs, 2016a). Bearded seals are the largest of the Arctic seals (Goodwin, 1990; Natures Edge, 2015). This species is listed as *Data Deficient* in Canada, (COSEWIC, 2007d).

There are few data for bearded seals, but Clyde River and adjacent waters are within the known summer distribution (Government of Nunavut, 2014). Bearded seals winter in Lancaster Sound and Davis Strait (COSEWIC, 2007d), and where they occur year-round (DFO, 2015c). They show a preference for open water less than 200 m deep with broken ice (COSEWIC, 2007c), and their seasonal movements depend upon prey availability and ice distribution (Kovacs, 2015).

IQ informs that bearded seals have been observed from Clyde River June through January (QIA, 2018b). The seasonal distribution of this species is highly influenced by the ice and return to the area in *Upirngaaq* (mid-June to end of July). They are found in the open waters from *Aujaq* (August to mid-October) through *Ukiassaaq* (mid-October to November) (QIA, 2018b). Bearded seals move out of the area following the open water in *Ukiaq* (December), and do not return until the following year (QIA, 2018b). Bearded seal are one of the preferred species for harvesting (IQ Workshop 2019 - Daniel Jaypoody; IQ Workshop 2019 - Issac Tassugat; IQ Workshop 2019 - Mike Jaypoody; IQ Workshop - Leslie Ashevak).

Bearded seals are primarily benthic feeders but have a varied diet which includes pelagic fishes, crustaceans and molluscs (COSEWIC, 2007c). When not feeding, they will haul out on the ice, and they are one of the few species to use pack ice for resting, pupping, and moulting (COSEWIC, 2007d). Bearded seals are reported to be closely associated with drifting ice floes and shallower waters that provide feeding opportunities (Government of Nunavut, 2010b). Large aggregations of bearded seals are not often encountered (Goodwin, 1990).

Pups are born in the spring (April–May), and are nursed for around 24 days, maintaining a close bond with their mothers even after weaning (COSEWIC, 2007c). Mating occurs in the water following weaning, followed by a period of moulting (Goodwin, 1990; COSEWIC, 2007d). Bearded seals also are known to use waters northwest from Bylot Island in Lancaster Sound, with pupping sites identified along north and east coasts of Bylot Island (Baffinland Iron Mines Corporation, 2012).

This species may be present in and near Clyde River year-round but occurs more frequently during the open-water season. They are not as plentiful as ringed seals in this area (Clyde River Knowledge Atlas, 2019). Some of the highest densities of bearded seals are found west of Clyde River in Eclipse Sound, Oliver Sound and Milne Inlet (Koski & Davis, 1980). Their vocalizations range from 0.02 to 11 kHz (Todd *et al.*, 2015). In the spring, the calls of bearded seals can be audible under the water for up to 25 km likely as part of courtship behaviours (COSEWIC, 2007d). Dives are usually a few minutes in length and to depths shallower than 100 m, but they have been recorded longer than 20 minutes and up to 450 m (COSEWIC, 2007c).

Bearded seals are hunted year-round in Nunavut where they are available, with the majority killed June–October (COSEWIC, 2007c). Around 20 animals are killed annually from Clyde River from May to January, with the majority taken in August and September (Priest & Usher, 2004).

Based on this species' life history, ecology, habitat use, IQ, and harvesting reports, bearded seals can be expected May through January. Natural predators include polar bears and walrus (COSEWIC, 2007c). Threats include harvesting, climate change (reduction of sea ice), anthropogenic disturbance, entanglement in fisheries gear, and pollution (contaminants and spills) (COSEWIC, 2007c; Kovacs, 2015).

10.2.6 Walrus

Walrus (*Odobenus rosmarus*) can be found in Arctic and sub-Arctic waters, usually around the shallow continental shelf (Lowry, 2016). They are native to Canada, Greenland, Russian Federation, Svalbard and Jan Mayen, and the United States (i.e. Alaska) (Lowry, 2016). Based on the SARA registry there are two populations of walrus that occur in the Canadian Arctic (i.e., Central Low Arctic Population, High Arctic population). The Central/Low Arctic population can be found in Foxe Basin, Hudson Bay, south and east Baffin, southern Hudson Strait-Ungava Bay-Labrador Bay, and James Bay (COSEWIC, 2017a). The High Arctic population is further away from Clyde River and can be found in Penny Strait-Lancaster Sound, western Jones Sound, and Baffin Bay (COSEWIC, 2017a). This species is globally listed as *Vulnerable* by the IUCN, as Special Concern by COSEWIC and is not listed under SARA (Government of Canada, 2019q). However, the Central Low Arctic and High Arctic populations are under consideration for addition to Schedule 1 (Government of Canada, 2019q). A 2009 survey resulted in an estimate of 2,481 animals I the High Arctic population (COSEWIC, 2006a), and a minimum of 18,900 animals in the Central/Low Arctic population, though survey coverage is incomplete in the latter case, and trends are unknown (COSEWIC, 2017a; Government of Canada, 2019q).

Walrus are year-round residents in the Arctic, though seasonal changes in distribution are noted in relation to ice cover (COSEWIC, 2006a). Walrus spend about two-thirds of their lives at-sea, with the rest of their time hauled out on drifting pack ice or land to rest, pup, or moult (Goodwin, 1990).

Walrus can be found in the vicinity of Clyde River, mostly just offshore, and are more common between the months of May and August (Government of Nunavut, 2014; Clyde River Knowledge Atlas, 2019). They are not often hunted there; only one was reported killed during a 5-year study (Priest & Usher, 2004). There is no identified concentration of walrus around Clyde River (NPC, 2008b). IQ informs that walrus have been observed from Clyde River May through October, but can be found in Davis Strait and Baffin Bay year-round where the third largest concentration (after Southampton Island and Foxe Basin), can be found along the east side of Ellesmere Island in Baffin Bay (QIA, 2018b). Walrus are less abundant than they used to be in the Clyde River vicinity (IQ Workshop 2019 - Issac Tassugat).

The seasonal distribution of walrus is influenced by the ice. The species is not present in *Ukiaq* (fall and early winter) or in *Ukiuq* (winter), and start to arrive in the *Upirngasaaq* (early spring) as female walrus arrive with pups south of Clyde Inlet and at the floe edge, they remain at the floe edge through *Upirngaaq* (late spring), and move in to the open waters, inlets and fiords during *Augaq* (summer) (QIA, 2018b). During this season they can also be found hauled out in Isabella Bay, before departing for the wintering grounds in *Ukiassaaq* (early fall) (QIA, 2018b).

Walrus are known to winter in several locations in Lancaster Sound (DFO, 2015d), including Jones Sound, Devon Island, the floe edge of Lancaster and Jones Sounds, and the North Water polynya (Born et al. 1995 cited in QIA, 2012). Wintering habitats in the Lancaster region include the east and west ends of Jones Sound (Cardigan Strait-Fram Sound and around Dundas Island), the west end of Devon Island (south of Grinnell Peninsula), the floe edge of Lancaster and Jones and Sounds, and the North Water polynya (Born *et al.*, 1995).

Walrus typically prefer near-shore areas during the open-water season that provide haul out locations and shallow water (less than 100 m) suitable for providing access to prey (Outridge et al. 2003 cited in QIA, 2012).This species requires shallow, coastal, ice-free waters with significant bivalve growth as well as haul out sites nearby (Lowry, 2016). Walrus devote a large proportion of the day (8 to 12 hours) foraging (Goodwin, 1990), and can remain submerged for nearly half an hour (COSEWIC, 2006a). Though walrus have a diverse diet ranging from clams and worms, to fish, squid, sea birds, and occasionally seals, they are primarily benthic feeders and use soft substrate coastal waters that range from 10 to 80 m in depth (COSEWIC, 2006a; Bluhm & Gradinger, 2008; Lowry, 2016). The 'flesh eating' walrus are found in Clyde River, with a diet that consists of seals not clams (IQ Workshop 2019 - Issac Tassugat).

A gregarious species, walrus are often found in groups (Lowry, 2016).. Males establish territories in winter during the mating season, with pups born in May the following year (Lowry, 2016) with an extended pup weaning period of about two years (Goodwin, 1990).

Walrus have been historically used for food, hides, ivory and bones by Indigenous communities, but the commercial hunts of the 1700s to the mid-1800s depleted the population significantly (Lowry, 2016). Walrus are harvested in Nunavut, and only occasionally harvested in Clyde River, with sporadic harvests recorded to occur in most months from March to October, with inter-annual variation in the numbers taken and the months harvested (Priest & Usher, 2004). A concern with increased shipping is disturbance to walrus causing them to move further away from hunting communities, as happened in Resolute in the 1990s (AMSA, 2009).

Based on this species' life history, ecology, habitat use, IQ, and harvest reports walrus are likely to occur during the spring and summer months. Predators include polar bears and killer whales (Lowry, 2016).. Threats include harvesting, degradation of feeding areas (e.g. disturbance by benthic trawl fisheries, industrial development), anthropogenic disturbance (including vessel and aircraft traffic), oil and gas exploration, and climate change (and effects on ice conditions) (COSEWIC, 2006a).

10.2.7 Polar Bear

Polar bears (*Ursus maritimus*) are circumpolar and can be found throughout the Arctic, with a preference for shallow, ice-covered areas of productive upwelling (Wiig *et al.*, 2015). Habitat selection is most closely related to sea ice concentration. Polar bears are native to Canada, Greenland, Norway, the Russian Federation, Svalbard and Jan Mayen, and the United States (Alaska), and are occasionally also spotted in Iceland (Wiig *et al.*, 2015). Globally classified as *Vulnerable* under the IUCN, there are 19 recognized subpopulations of polar bears (Wiig *et al.*, 2015), 14 of which can be found in Canada (COSEWIC, 2018; Government of Canada, 2018c) (See Figure 16, Appendix 1). The Baffin Bay population, which is likely stable (Wiig *et al.*, 2015), overlaps with Clyde River (Obbard *et al.*, 2010). Polar bears are listed as *Special Concern* under COSEWIC (COSEWIC, 2018) and *Special Concern* on Schedule 1 of SARA (Government of Canada, 2019q). They are not listed under any territorial act in Nunavut.

Polar bears are found throughout the High Arctic and can be found along the entire Baffin, Devon, and Ellesmere islands coastlines (QIA, 2018b). IQ indicates that polar bear summer habitats include the south and east coasts of Devon Island, the east side of the Brodeur Peninsula, Borden Peninsula, and Bylot Island. (QIA, 2012, 2018c). High densities of polar bears can be seen in central and eastern Lancaster Sound National Marine Conservation Area which overlaps with the Baffin Bay population, and these animals spend the summers to the west where they can find multi-year pack ice (McLoughlin *et al.*, 2007). Recent estimates of bears in the Baffin Bay Management Unit suggest a population of between 2,001-3,000 adults (Government of Canada, 2018c). Polar bears with cubs are present in the Clyde River region during the summer (IQ Workshop 2019 - Daniel Jaypoody). The Lancaster Sound National Marine Conservation Area provides essential habitat for polar bears in Canada (Government of Canada, 2019o).

Polar bears occur at low densities and have a very low reproductive rate, with mating occurring in the spring and implantation delayed until autumn (Wiig *et al.*, 2015). The females move into dens in late autumn and cubs, usually twins, are born in December or January, leaving the den in early spring (Wiig *et al.*, 2015). The preferred diet consists of ringed seals, as well as bearded, harp and hooded seals, walrus, narwhal and beluga (Wiig *et al.*, 2015; COSEWIC, 2018). The life history of polar bears is closely tied to that of the ringed seal (their primary prey species) (QIA, 2018b). Polar bears have their cubs in dens before ringed seals give birth. And hunt ringed seal pups in their lairs, or out on open ice (QIA, 2018b).

Polar bears show site fidelity to feeding and denning areas, based on sea-ice concentration, type, bathymetry, distance to edge, and distance to land (COSEWIC, 2018). Bear migration patterns show deliberate movements on drifting ice to stay within productive habitats (Vard Marine Inc., 2016). The Baffin Bay region has seen significant decline in sea-ice habitat and the polar bears have shifted northward and landward. Polar bear denning sites are known to occur along the shorelines in nearby Lancaster Sound and along the shores of Baffin and Devon islands (NPC, 2017b).

The Baffin Bay population is managed with Greenland; allowable harvest in July 2018 was 65 bears from Canada and 67 from Greenland (COSEWIC, 2018). An increased report of human-bear conflict has been reported in Clyde River, though whether this is due to increase in bear population or movement due to change in sea ice and prey availability is undetermined (COSEWIC, 2018); residents report an increase in bears seen on land (McLoughlin *et al.*, 2007).

In Nunavut, only Inuit (or an assignee) can harvest polar bears (based on set restrictions), and they can only otherwise be killed in defense of human life or property (COSEWIC, 2018). Areas throughout Admiralty Inlet, Prince Regent Inlet, Lancaster Sound and northern Baffin Bay have been noted as among the high value polar bear harvesting grounds for Inuit communities (QIA, 2012). Records from Clyde River show that polar bears have been harvested in March, April, May, October, December and January (Priest & Usher, 2004). An average of nine animals are harvested annually in Clyde River (Priest & Usher, 2004). Polar bears are found throughout the Clyde River area and are very common, especially during ice forming (IQ Workshop 2019 - Daniel Jaypoody; IQ Workshop 2019 - Issac Tassugat; IQ Workshop 2019 - Mike Jaypoody; IQ Workshop - Leslie Ashevak; QIA, 2018b). Near Clyde River, they are attracted to whale carcases and food processing areas (IQ Workshop 2019 - Daniel Jaypoody; IQ Workshop 2019 - Issac Tassugat; IQ Workshop 2019 - Mike Jaypoody; IQ Workshop - Leslie Ashevak). During the terrestrial wildlife field survey (Section 7), a polar bear was observed feeding on a whale carcase near the shoreline, approximately 2 km south of the proposed quarry (Figure 7-1). Hunt sites are located along the shores of eastern Baffin Island, near Clyde River, as well as throughout the contiguous waterways of the high Arctic both north and south of this area (QIA, 2018b).

Based on this species' life history, ecology, habitat use, IQ, and harvest reports, polar bears can occur in this region year-round. Threats to polar bear survival include loss of sea ice due to climate change, human-caused mortality, pollution, oil development (pollution as well as human interactions), and shipping (Wiig *et al.*, 2015; COSEWIC, 2018).

10.3 Arctic Seasonal Visitors

Three species of marine mammals are considered to be seasonal visitors, moving northwards into Arctic waters during the open-water season.

10.3.1 Killer Whales

Killer whales (*Orcinus orca*) are a cosmopolitan species found throughout the world's oceans, and are known to be native to more than 150 countries (Reeves *et al.*, 2017). Globally listed as *Data Deficient* by the IUCN (Reeves *et al.*, 2017), the species consists of many distinct populations or ecotypes which do not interbreed. It is important to note, that taxonomic complexity exists, and the classification of this species may be refined as research continues (Taylor *et al.*, 2013). As the taxonomic uncertainties are resolved, global conservation statuses may change accordingly.

Five separate killer whale populations are recognized in Canada, with four occurring in the Pacific off British Columbia. The fifth, the Northwest Atlantic/Eastern Arctic population, which is likely to be found around Lancaster Sound, is listed as *Special Concern* (COSEWIC, 2008; NPC, 2017a), with no listing under SARA (considered *Data Deficient*) (COSEWIC, 2008; Government of Canada, 2019q). The small size of this population (fewer than 1000, and likely less than 250 mature individuals), as well as their susceptibility to disturbance, contributes to their COSEWIC to their designation. Relatively little is known about the range and distribution of the Northwestern Atlantic/Eastern Arctic killer whales, and there is no population estimate available (COSEWIC, 2008).

Killer whales are reported near Clyde River during the summer months when the ice breaks up, with most sightings occurring between April and October (Government of Nunavut, 2014; Clyde River Knowledge Atlas, 2019). Clyde River is within killer whale range according to NPC (2008c). Killer whales are becoming increasingly more common, with six to 15 whales in a pod (IQ Workshop 2019 - Daniel Jaypoody; IQ Workshop 2019 - Issac Tassugat; IQ Workshop 2019 - Mike Jaypoody; IQ Workshop - Leslie Ashevak).

Given their predatory nature, there is interest in determining killer whale abundance and distribution in the Arctic. Ferguson *et al.* (2012) conducted a series of IQ interviews, and it is believed that these killer whales are predators primarily of marine mammals, as no interviewees have observed them eating fish. The results of this survey state that killer whales are predators of narwhal, beluga whales, bowhead whales, and ringed and bearded seals as well as immature walrus (Government of Nunavut, 2010b). Reported predation events on narwhal and beluga whales far outnumber those on bowhead whales or pinnipeds, with the majority reported in Lancaster Sound. Bowhead predation is more frequently reported in Davis Strait-Baffin Bay, and most sightings of killer whales occur in the late spring, summer and early fall (Higdon *et al.*, 2012), often near groups of marine mammals (Laidre *et al.*, 2006). Killer whale sightings from the Davis Strait-Baffin Bay represent 7.3% of all reported sightings in the Canadian Arctic (Higdon *et al.*, 2012). Killer whales have recently had an increased presence and range expansion in the Arctic, likely as the climate changes and sea ice declines, making new areas available to them (Ferguson *et al.*, 2010; Higdon *et al.*, 2012; Reeves *et al.*, 2017). This may also influence the distribution of other marine mammals.

Killer whales are social animals capable of communicating over large distances underwater, using a variety of clicks and whistles. The frequency range is broad, ranging from 0.5 to 75 kHz (Todd *et al.*, 2015). Killer whales that eat marine mammals have relatively short dive times of less than about 15 minutes (Morton, 1990).

Killer whales arrive in Clyde River in *Upirngaaq* (late spring – arriving in July), are present in *Aujaq* (summer) but leave by September (QIA, 2018b). This species is not present in Clyde River during *Ukiassaaq* (early fall), Ukiaq (fall/early winter), *Ukiuq* (winter) and *Upirngasaaq* (early spring) (QIA, 2018b). The residents of Clyde River do not harvest killer whales 'it's not our known meat, we don't know these animals or their behaviours' (IQ Workshop 2019 - Mike Jaypoody)Based on this species' life history, ecology, habitat use, and IQ, killer whales can occur in this region from the late spring through the summer months. Threats include hunting (in Greenland), anthropogenic disturbance (acoustic and physical), prey depletion, vessel strikes, interaction with commercial fisheries, and contaminants (COSEWIC, 2008).

10.3.2 Harp Seal

Harp seals (*Pagophilus groenlandicus*) can be found in the North Atlantic and Arctic oceans, and are native to Canada, Greenland, Iceland, Norway, Russian Federation, and Svalbard and Jan Mayen (Kovacs, 2015). Globally, harp seals are listed as *Least Concern* by the IUCN, with the stipulation that climate change could seriously affect this species and it should be reassessed within a decade (Kovacs, 2015). While they are considered a single species, there is some taxonomic uncertainty related to breeding populations (Kovacs, 2015). Harp seals have not yet been assessed by COSEWIC.

The most abundant pinniped in the northern hemisphere, the Northwest Atlantic population is stable at around 7.5 million animals (Kovacs, 2015). Commercial hunting for oil and later pelts drastically reduced the numbers and led to a low of 1.8 million in the early 1970s, but the population has since recovered (Kovacs, 2015). Yearly quotas are set at 400,000 however only half of this number is actually killed in Greenland and Canada combined (Kovacs, 2015). Currently, harp seals can be killed in subsistence harvests without permit by Indigenous people as well as anyone living north of 53 degrees' latitude (Kovacs, 2015).

This is a truly marine seal, as they live their entire lives (approximately 30 years) at sea – never touching land (Goodwin, 1990). Harp seals are highly migratory, traveling about 4,800 km per year – one of the longest known animal migrations (Goodwin, 1990). This species travels to the Arctic during the open-water season to access feeding grounds each year, and returns south to the Gulf of St. Lawrence, southern Labrador and northern Newfoundland for the winter (Goodwin, 1990; DFO, 2012; Kovacs, 2015). Their annual movements appear to follow fluctuations of the ice pack, as they forage at the ice edge during the year (Stenson, 2015). Their diet consists of pelagic and benthic invertebrates and fish (Bluhm & Gradinger, 2008).

Harp seals are the most abundant marine mammal species in the North Atlantic (Stenson, 2015), and Clyde River is located within a harp seal high density area (NPC, 2008a). Harp seals can be seen year-round in this vicinity but are more common in the fiords in the summer and fall, as they migrate through the area during their return trip from their summering areas in Lancaster and Jones Sounds (Government of Nunavut, 2014; Clyde River Knowledge Atlas, 2019). High density areas are known to be in Jones Sound, Lancaster Sound, Navy Board, Eclipse and Pond Inlets, and down the east coast of Baffin Island (NPC, 2017a).

Harp seals are a gregarious species, with the exception of the first year of life, when the pups must migrate alone (Goodwin, 1990). Pups are born from late-February to early-March on the pack ice in their southern wintering grounds (Goodwin, 1990; DFO, 2012; Stenson, 2015). Pupping is followed by the annual moult, which occurs from April to May (DFO, 2012). Coastal locations of Bylot Island in Lancaster Sound and Baffin Bay have been identified by Inuit as harp seal pupping sites (Baffinland Iron Mines Corporation, 2012).

This species is in numerous places throughout Nunavut, including in Lancaster Sound along the coast of Devon Island (Indigenous and Northern Affairs Canada (INAC, 1983 cited in QIA, 2012)). It is possible that seasonal presence of harp seals in Clyde River changes from year to year and depends on a number of environmental factors given this species large annual habitat range. The seasonal distribution based on IQ of this species indicates that the local distribution is highly influenced by the ice. This species can be seen at the floe edge but are not common by *Upirngasaaq* (April to beginning of June), and continue to pass by the area in *Upirngaaq* (mid-June to end of July), and are only present in the open water in *Aujaq* (August to mid-October) (QIA, 2018b). This species is not present for the remainder of the year (QIA, 2018b). Harp seals are observed in Clyde River in the fall, with observations occurring from July through November (IQ Workshop 2019 - Issac Tassugat).

Harp seals have a variety of calls including growls, grunts, squeaks and knocks in a frequency range <16 kHz (Todd *et al.*, 2015). The dive times are relatively short for this species at less than 15 minutes (Lydersen & Kovacs, 1993).

Harp seals are harvested in Nunavut, with harvests occurring out of Clyde River in April and from July to January, with variation in the monthly timing and numbers taken (Priest & Usher, 2004). An average of 13 animals are killed annually in Clyde River (Priest & Usher, 2004). Harp seals are typically not actively harvested (IQ Workshop - Leslie Ashevak), and are only used for their skins and as dog food (IQ Workshop 2019 - Daniel Jaypoody; IQ Workshop 2019 - Issac Tassugat; IQ Workshop 2019 - Mike Jaypoody; IQ Workshop - Leslie Ashevak).

Based on this species' life history, ecology, habitat use, IQ, and hunt reports harp seals occur in this region mostly during the summer and fall months. Predators include polar bears, killer whales and Greenland sharks (Kovacs, 2015). Threats include reduction of prey availability, entanglement, oil spills, vessel traffic, contamination, and climate change.

10.3.3 Hooded Seal

Hooded seals (*Cystophora cristata*) can be found in the North Atlantic and seasonally in the Arctic ocean, and are native to the waters of Canada, Greenland, Iceland, and Norway (Kovacs, 2016a). Globally, hooded seals are listed as *Vulnerable* by the IUCN (Kovacs, 2016a), due in part to changing sea ice conditions, and are recommended for re-evaluation once new data become available. Three separate breeding populations are recognized; Lancaster Sound is within range of the Davis Strait population (Campbell, 1986; Kovacs, 2016a). Last assessed in Canada in 1986 and determined to be *Not At Risk* (Campbell, 1986), hooded seals have recently been identified by COSEWIC as a Candidate Priority Species to be scientifically re-assessed (COSEWIC, 2016b). The global population is thought to be in the hundreds of thousands, though no recent estimate is available, and the population is likely declining due to reduction in pack ice required for breeding (Kovacs, 2016a). One of four main pupping areas is located in central Davis Strait, and was assessed in 1984 at 19,000 pupas and again in 2005 at 3,346 indicating a significant decline (Kovacs, 2016a).

Hooded seals were heavily targeted for commercial trade in the 1800s and 1900s (Campbell, 1986; Kovacs, 2016a). Total allowable catch in the Northwest Atlantic is 8,200 animals yearly in Canada, and a few thousand animals per year are also killed in Greenland (some of which are likely from the Davis Strait population) (Kovacs, 2016a). Hooded seal are one of the preferred species for harvesting (IQ Workshop 2019 - Daniel Jaypoody; IQ Workshop 2019 - Issac Tassugat; IQ Workshop 2019 - Mike Jaypoody; IQ Workshop - Leslie Ashevak).

Hooded seals distribution is influenced by sea ice availability and they tend to move south in winter and north in summer (RCampbell, 1986; Kovacs, 2016a).They are sometimes seen in around Clyde River in the summer, but are less common than the other seals in the area (Government of Nunavut, 2014).

Hooded seals have a preference for drifting on ice floes and deep water and are solitary animals outside the breeding season (Goodwin, 1990). In February, mature individuals congregate near the ice prior to pupping and mating (Campbell, 1986). Pups are born on pack ice (in Davis Strait) in the late spring, when break-up has begun (Campbell, 1986; Goodwin, 1990; Kovacs, 2016a). Pups nurse for only four days—the shortest lactation period of any mammal—before transitioning to an adult diet (Goodwin, 1990). This is followed by a compressed breeding season lasting only about 2.5 weeks, with mating occurring in the water (Campbell, 1986; Kovacs, 2016a). Animals move northward after the mating season (Campbell, 1986), congregating again for the summer moult (Campbell, 1986; Goodwin, 1990; Kovacs, 2016a). These seals can remain submerged for up to 30 minutes, though longer dives have been recorded (Kovacs, 2016a). Hooded seals are generalists and eat a diverse range of prey that includes zooplankton, benthic and pelagic fish, crustaceans, molluscs, and squid (Kovacs, 2016a). The vocal frequency range for this species is <6 kHz (Todd *et al.*, 2015).

Hooded seals are a harvested species in Nunavut but are not commonly harvested in Clyde River; only one was reported harvested in this area in a 5-year study 1996-2001 (Priest & Usher, 2004). They are not regular visitors to the area but are more likely to be seen in the spring and fall (Clyde River Knowledge Atlas, 2019).

Natural predators include polar bears, killer whales and Greenland sharks (Kovacs, 2016a). Threats include harvesting, by-catch/entanglement, competition for food with local fisheries, pollution, and climate change and associated reduced pack ice habitat required for pupping and molting (Kovacs, 2016a).

10.4 Discussion

The desktop review for marine mammals identified ten marine mammal species that could occur differentially throughout the year in Clyde River. All of which have also been identified as Valued Ecosystem Components (VECs) in Nunavut (Nunavut General Monitoring Plan (NGMP, 2012)). These marine mammal VECs include: beluga whale, narwhal, bowhead whales, killer whales, walrus, and ringed, bearded, harp, and hooded seals and polar bears (NGMP, 2012). In addition to the Arctic residents and seasonal visitors, IQ informs that on occasions other species of marine mammal may also be present in the Clyde River area on an infrequent or rare basis. This additional diversity includes the common minke whale (*Balaenoptera acutorostrata acutorostrata*), harbour seal (*Phoca vitulina concolor*), finned pilot whale (*Globicephala* spp.), harbour porpoise (*Phocoena phocoena*), northern bottlenose whale (*Hyperoodon ampullatus*), and sperm whale (*Physeter macrocephalus*) (IQ Workshop 2019 - Issac Tassugat; QIA, 2018b). Occurrence of these species would. be considered to be an uncommon or rare event, and IQ informs that harbour seals are considered rare, but if they are present observations occur in *Upirngaaq* and *Aujaq* (July to October) (QIA, 2018b). These additional species are not considered to be either Arctic Residents or Seasonal Visitors due to the rarity of the occurrences.

The arctic ecosystem of Lancaster Sound and Baffin Bay is particularly important to marine mammals during the open-water season. During this time period, beluga whales, narwhal, bowhead whales, killer whales, ringed, harp, hooded and bearded seals, walrus and polar bears use the area for a variety of fundamental life functions. The importance of this regions' biodiversity is evident through the information provided by the IQ and through the diversity of marine mammal species that reside or seasonally visit the region. Further to this, the ecological importance is recognized as Clyde River is located within the Baffin Island Coastline EBSA which contains important marine mammal migration pathways (DFO, 2011b). The arctic ecosystem is integrally linked between the predators and the prey species. Marine mammal predators (e.g., ringed seal, bearded seal, harp seal, walrus, narwhal and beluga) congregate where the Arctic char are in abundance, and there is no region along the east coast of Baffin Island that does not have this combination of animals (QIA, 2018b). Seals are also drawn to aggregations of Greenland halibut (QIA, 2018b). Similarly, the capelin migration northward on the east side of Baffin Island in the spring, signals the return of whales (QIA, 2018b).

Of the identified 10 species, most are likely to occur differentially in the study area throughout the year. The occurrence of killer whales is unpredictable and the presence of hooded seals appears to be relatively uncommon. IQ provided regionally specific details for the is clear that the waters of Clyde River are seasonally important to marine mammals and the Inuit who live near them. IQ informed about the inter-annual variability which has been noted for some species such as narwhal which have fluctuated in numbers in recent years, walrus that are being seen less frequently, and bowhead whales which are becoming more common in the region.

The importance of marine mammals for Inuit harvesting was also evident for all of the identified species except killer whales. IQ provided information on harvest species preferences, such as ringed, hooded and bearded seals, as well as of the recent event of a bowhead whale harvest. Details of some of the uses of marine mammals was enhanced through IQ, such as the harp seals being used for their skins and for dog food. In addition, at this community, harvesting of beluga whale and walrus were less common events than in some other Arctic communities. The direct connections between the marine mammals of the Arctic and the Inuit who call this region home is clear through the details provided by the IQ. The culmination of the all the data sources relevant to the marine mammals at Clyde River and in the surrounding areas indicates that there is an ecological richness that changes according to the ice, and over time.

11. Socio-Economic Environment

This survey provides an overview of the existing socio-economic environment of the Hamlet of Clyde River including demographics; labour force and economic activity; housing and accommodation; community infrastructure and services; local businesses; and land and resource use. Its main objective is to describe the socio-economic conditions that may interact with the construction of the proposed SCH. Program objectives for the Socio-Economic survey are outlined in Section 1.6, Table 1-2. The Socio-Economic Study Area for Clyde River is described in Section 1.4.

11.1 Methodology

Data collection for the baseline study were obtained through a combination of field research (primary data) and desktop research (secondary data). Field research involved interviews and meetings with community leaders and key stakeholders including mayor and council, the local Senior Administrative Officer (SAO), Economic Development Officer (EDO), Finance Director, Fire Chief, business owners, RCMP, and health centre personnel. Local interpreters were hired to facilitate discussions as required.

Desktop research consisted of reviewing and analyzing data provided by relevant government and industry reports and websites including but not limited to:

- Statistics Canada (Statistics Canada, 2019)
- Nunavut Bureau of Statistics (Government of Nunavut, 2019b)
- The Hamlet of Clyde River Integrated Community Infrastructure Sustainability Plan (ICSP) Vol.1 and Vol. 2 (Government of Nunavut, 2011)
- The Hamlet of Clyde River 2019/2020 Infrastructure Plan
- Baffinland Iron Mines Corporation's Socio-Economic Baseline Study, Mary River Project (Baffinland Iron Mines Corporation, 2012) and Socio-Economic Monitoring reports (Baffinland, 2017)
- Nunavut Adult Learning Strategy (Government of Nunavut & Nunavut Tunngavik Incorporated, 2006);
- The Nunavut Planning Commission's Summary of Community Meetings on the Draft Nunavut Land Use plan, Clyde River (NPC, 2012)
- Nunavut Tourism (Government of Nunavut, 2019d)
- GN EDT and GN CGS Clyde River community profiles (Government of Nunavut, 2018a)
- Nunavut Housing Corporation's annual report 2017-2018 (NHC, 2018).

11.2 Socio-Economic Profile

The Hamlet of Clyde River is known locally as Kangirqtugaapik which means *"a nice little inlet"* in Inuktitut. The community is located on the shore of Patricia Bay, off the coast of Admiralty Inlet on the east coast of northern Baffin Island. It lies in the Baffin Mountains, which in turn form part of the Arctic Cordillera mountain range. Clyde River is located on a flood plain, surrounded by fiords that reach all the way into the Barnes Ice cap. The nearest communities are Pond Inlet, Arctic Bay and Qikiqtarjuaq.

11.2.1 Demographics

11.2.1.1 Population

According to Statistics Canada 2016 census data, the total population of Clyde River is 1,053 representing an increase of 12.7% since 2011 (Statistics Canada, 2017b) . The population is young with children aged 0–14 years representing over a third of the total population (35.2% or 370 individuals) and a median age of 22 years old for the total population (Statistics Canada, 2017a). A breakdown of key population statistics provided by Statistics Canada for Clyde River is presented in Table 11-1 below. The Nunavut Bureau of Statistics estimated the population of Clyde River as of July 1, 2018 to be 1,149. (Nunavut Bureau of Statistics, 2019).

11.2.1.2 Aboriginal Identity

The total self-declared Inuit population is 1,020 or 96.9% of the total population according to Statistics Canada 2016 census data (Table 11-1).

11.2.1.3 Educational Attainment and Language

Table 11-1 shows that in 2016, of the total population 15 years old and over in Clyde River: 15.3% (105 individuals) held a secondary school diploma (or equivalent) as their highest educational attainment and 20.4% (140 individuals) held a postsecondary certificate, diploma or degree. Of the 140 individuals with postsecondary accreditations, 14.3% (20 individuals) held apprenticeship or trades certificates; and 14.3% (20 individuals) graduated from a University with a bachelor level degree or higher. In the census results 435 individuals (63.5%) held no certificate, diploma or degree.

Lack of basic literacy and numeracy present a challenge to labour force development in Clyde River and across Nunavut (Government of Nunavut & Nunavut Tunngavik Incorporated, 2006). Individuals with low levels of literacy are prevented from gaining meaningful employment, *"while others are dead-ended in positions from which they can't progress without additional education and training"* (Government of Nunavut and Nunavut Tunngavik Incorporated 2006). Often, the lack of child care in town also becomes an impediment to employment (Local business owner, pers. comm. May 2019) (Government of Nunavut & Nunavut Tunngavik Incorporated, 2006).

Inuktitut is the prevalent language in Clyde River reported as the mother tongue for 96% of residents. Additionally, nearly 80% of employed residents in Clyde River work in settings where Inuktitut is the language most often used at work (Statistics Canada, 2017b). In addition, a majority of people speak English in Clyde River – 835 residents or approximately 82% of the population (Statistics Canada, 2017b).

11.2.2 Housing and Accommodation

The 2016 census reports Clyde River having a total of 288 private dwellings, of which 250 were occupied by their usual residents. Of the 250 occupied dwellings, 84% (210) were rented. Of the 210 rented dwellings, over 90% were public (subsidized) housing. Nearly one in three occupied dwellings were also in need of major repairs.

Additionally, according to the Nunavut Housing Needs Survey, over half (51%) of occupied dwellings in Clyde River at the time were classified as crowded based on the lack of enough bedrooms (Government of Nunavut 2011). In over half of the crowded dwellings, respondents indicated that they regularly used the living room for sleeping because there was no other place to sleep (Government of Nunavut, 2011). The Nunavut Housing Corporation's annual report for 2017-2018 listed Clyde River's housing stock at 31% indicating a serious need for housing (NHC, 2018).

Accommodation in Clyde River is limited and is currently provided by the Naujaaraaluit hotel with eight rooms (one bed in each room) and capacity for ten guests and the Qammaq hotel with six rooms (two single beds in each) with capacity for 12 guests (Diane Jaypoody, hotel manager. pers. comm. Nov 2019).

11.2.3 Labour Force and Economic Activity

Table 11-1 presents the participation, employment and unemployment rates in Clyde River according to the 2016 Census. Clyde River experiences lower participation rates and higher unemployment rates compared to Baffin region as a whole. Of the population 15 years old and over (685), 410 people or 59.9% participate in the labour force. The unemployment rate was reported as 40.2% in Clyde River compared to 17.3% for Baffin (Statistics Canada, 2017b). According to Nunavut's Bureau of Statistics' Annual Labour Force Update, Inuit employment in Nunavut decreased between 2017 and 2018 while non-Inuit employment increased. 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. This disparity is also represented with an employment rate of 44.8% for Inuit compared to 90.7% for non-Inuit (Nunavut Bureau of Statistics 2019).

According to 2016 census data, median income reported for recipients 15 years and over with income was $20,320 in 2015 with 21.6% of total income attributed to Government Transfers.

The economy of Clyde River is characterized by traditional subsistence activities (hunting, fishing, trapping and gathering) mixed with wage-based activities. Many residents continue to rely heavily on fish, seal and whale hunting, both for subsistence and as a cultural activity, including customary resource sharing practices.

The Ilisaqsivik Society is the largest employer in Clyde River and employs over 20% of the local Inuit labour force (Ilisaqsivik Society, 2019). Ilisaqsivik Society is a non-profit, community initiated and community-based Inuit organization in Clyde River dedicated to promoting community wellness. It offers approximately 120 full, part-time and casual employment to its Inuit staff throughout the year. Ilisaqsivik Society often provides the first paid job opportunity for many Inuit workers in Clyde River. The Society offers the skills necessary for their employees to move on to different work opportunities for the health centre, schools, hamlet, government, and other jobs (Ilisaqsivik Society, 2019).

A breakdown of how the current labour force in Clyde River is allocated across various industries is provided in Table 11-2. Three industries, educational services, public administration, and health care, collectively occupied over half (55%) of the total labour force activity in Clyde River (Statistics Canada, 2017b).

More recently, Baffinland's Mary River iron ore mining project has had an impact on the local economy. According to Baffinland's 2017 Socio-Economic Report for the Mary River Project, an average of 30 local Inuit residents and two local non-Inuit residents were employed by either the Baffinland corporation or its contractors at the Mary River mine site over the course of 2017 (Baffinland, 2017). More recently, Baffinland reported 58 Inuit employees from Clyde River employed for the mine (Baffinland, 2019).

Table 11-1 Clyde River Demographics

Characteristics: 2016 Census Data	Total
Population	
Population in 2016	1053
Population in 2011	934
Median age of the population	22.0
% of the population < 15 years of age	35.2
Percent population change (from 2011)	12.7
Aboriginal Population	
Inuit - single response	1020
Non-Aboriginal identity population	30
Highest Educational Attainment	
Total population 15 years and over	680
No certificate, diploma or degree	435
Secondary (high) school diploma or equivalency certificate	105
Postsecondary certificate, diploma or degree	140
Apprenticeship or trades certificate or diploma	20
College; CEGEP or other non-university certificate or diploma	105
University certificate or diploma below the bachelor level	10
University certificate or degree at bachelor level or above	20
Labour force activity	
Total population 15 years and over	685
In the labour force	410
Employed	245
Unemployed	165
Not in the labour force	270

Characteristics: 2016 Census Data	Total
Participation rate %	59.9
Employment rate %	35.8
Unemployment rate %	40.2
Income in 2015	
Median income ($) for total population 15 years and over with income	20,320
Composition of total income (100%)	
Earnings - As a % of total income	100
Government transfers - As a % of total income	21.6
Market Income - As a % of total income	78.1

Source: Statistics Canada (2017b)

Table 11-2 Total Labour Force Population Aged 15 Years and Over by Industry - North American Industry Classification System (NAICS) 2012

NAICS Category	Total
21 Mining, quarrying, and oil and gas extraction	25
23 Construction	15
44-45 Retail trade	40
48-49 Transportation and warehousing	15
53 Real estate and rental and leasing	10
56 Administrative and support, waste management and remediation services	10
61 Educational services	70
62 Health care and social assistance	50
72 Accommodation and food services	10
81 Other services (except public administration)	10
91 Public administration	60

Source: Statistics Canada (2017b)

11.2.4 Community Infrastructure and Services

11.2.4.1 Hamlet-owned Infrastructure

According to the GN-CGS, the Hamlet of Clyde River currently owns the following infrastructure:

- Hamlet Office
- Community Hall and Arena
- Fire Hall, two-bay
- Hamlet Marine Dock
- Arena
- Two-bay maintenance garage
- Three-Bay Garage #1
- Three-Bay Garage #2
- Water fill and test cabin
- Workshop

11.2.4.2 Hamlet Equipment and Vehicle Inventory

The following equipment and vehicles are currently owned by the Hamlet (Marcel Holder Robinson, Finance Director. pers. comm. Nov 2019).

Table 11-3 2019 Hamlet Equipment and Vehicle Inventory

Year	Model	Type
2001	Caterpillar	IT38G
2007	Volvo	L90F
2009	Komatsu	D61EX-15EO
1998	GMC	C7500
2010	Ford	Ranger
2010	Ford	Escape
2010	Ford	Ranger
2011	Ford	F150
2013	Ford	Explorer

Year	Model	Type
2002	GMC	C7H042
2009	Sterling	Acterra
2009	Sterling	Acterra
2010	Freightliner	M2 106
2011	Ford	F550
2012	Peterbilt	348
2013	Freightliner	1085D
2013	Freightliner	1085D
2016	Western Star	4700 SB
2006	International	7600
2007	JCB	215
2018	Ford	F150
2019	Freightliner	M2106
2019	Freightliner	M2106
2013	Ford	Escape
2014	Ford	F150
2014	Ford	F150
2019	Cat Loader	938M
2012	Chev ETV	Ambulance

Source: The Hamlet of Clyde River (Marcel Holder Robinson, Finance Director. pers. comm. Nov 2019)

11.2.4.3 Utilities and Communications

The Hamlet of Clyde River is responsible for water, sewage and solid waste collection. Water is collected from Water Lake located approximately 1.5 km from town. Water lake is fed by melt water and is the only potable water source. The Hamlet recently applied for renewal of their Nunavut Water Board (NWB) water licence requesting water withdrawal of 146.85 cubic metres per day or 53,600 cubic metres annually based on an estimated population of 1,163 in 2029 (Hamlet of Clyde River, 2019a). Water is treated with chlorine at the truck fill station and loaded into trucks for distribution to holding tanks in each building and dwelling. The community reports that there are no issues with water quality (Marcel Holder Robinson, Director of Finance. pers. comm. Nov 2019) (Hamlet of Clyde River, 2019a).

Currently, there are two water trucks that deliver water daily to residences and commercial operations. Each truck makes approximately 40–60 deliveries per day (James Arreak, SAO pers. comm. Nov 2019). According to Clyde River's infrastructure plan for 2019/2020, a third water truck is needed as the two water trucks are continually needing to be replaced and usually cannot fulfil daily schedules. The water truck fill station is expected to be replaced in next three to five years.

Sewage and municipal wastewater are collected by two trucks daily. The water and sewage trucks follow the same routes and use the same roads. The Community has a single cell sewage lagoon which receives trucked sewage from holding tanks for each building. The sewage lagoon is located within the waste disposal zone approximately 2 km from the centre of the Hamlet. The sewage is naturally treated there before disposal to the wetland then discharged to sea (Hamlet of Clyde River, 2019b).

The municipal waste facility includes domestic wastes, construction wastes, metal wastes and hazardous goods. The landfill does not have berms, gate, lights or designated areas for different wastes. Current fencing is not high enough and is considered inadequate to keep the solid waste inside the fenced in area. Waste is strewn all over and blows into the community and into the water source. The average waste generation rate is considered is 0.015 m^3/person/day and for an estimated population of 1,031 in 2019, a total of 5,645 cubic meters of waste is expected annually. The size of the existing landfill site is too small and has a capacity issue (Hamlet of Clyde River, 2019b).

The bulky metals site is located next to the landfill site separated by an access road. This site receives all the metal wastes without any segregation. Dump truck or low bed is used to transport bulky metals from the community to this site. A hazardous waste management cell was not built within the bulky metals site and as a result hazardous wastes are mixed with other materials.

A new fenced facility with gate to control and manage wastes is anticipated in three to four years (Hamlet of Clyde River, 2019b). Stantec is conducting a feasibility study to select a new site for this new facility that will accommodate all types of wastes in one compound.

The Hamlet operates one garbage truck five days a week for collection of solid waste within the community and transfer to the solid waste facility. A front-end loader is used to haul metal objects such as old automobiles and fridges to the metal dump. An access road from the community connects the landfill site, bulky metal site and the truck sewage disposal point.

Electricity through diesel generators is provided by the Qulliq Energy Corporation (QEC), a territorial corporation 100% owned by the GN. 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.

The GN Petroleum Products Division (PPD) is responsible for the import, storage and distribution of Nunavut's fuel products. Fuel levels are monitored monthly and reported to PPD. Fuel is stored at a tank farm located near the SCH Study Area, with some volumes stored in tanks at airports for Jet fuel. Although the community has never completely run out of fuel, in recent years it has run low and the resupply tanker had to come in early once (James Arreak, SAO. pers. comm. Nov 2019). The total fuel storage capacity for Clyde River is provided in Table 11-4.

Table 11-4 Bulk Fuel Storage Capacity for Clyde River

Total Diesel	Total Gasoline	Total Jet A-1
5,035,437 L	1,115,311 L	360,000 L

Landline and mobile phone services are provided by NorthwesTel/Bell Mobility while internet service has been provided by Qiniq. However, as of 2019, a new open-access network by Northwestel and Bell called Tamarmik Nunaliit now delivers 15 megabits per second (Mbps) Internet and LTE wireless service to Clyde River and all Nunavut communities. Operating on Telesat ka-Band satellite technology, the network provides up to 20 times more Internet capacity than previously available, making high-speed Internet and wireless service possible in the community.

The local community Akunnirmiut Radio Station broadcasts daily in Inuktitut and English. There is also a Post Office located in the Northern Store.

11.2.4.4 Education Services

A strong component of the Clyde River's community vision is education and training in a healthy, vibrant and proactive Hamlet. The Hamlet is home to various education services:

- Qululaq Elementary and High School (K to 12)
- Piqqusilirivvik Inuit Cultural Learning Centre (a division of Nunavut Arctic College)
- Community library
- The Ilisaqsivik Society

11.2.4.5 Transportation

Clyde River is serviced daily (except for Saturdays) by scheduled commercial flights provided by Canadian North through Iqaluit. The Naujaaraaluit Hotel offers free airport shuttle service and can arrange for vehicle rentals.

The roads in Clyde River are gravel surface with no walkways. Pedestrians, all-terrain vehicles, snow machines, cars, and trucks all share the road. Although dust control on roads is provided by the Hamlet, dust in the community is a concern. Investments in dust suppressant and equipment was among the top priorities listed for the community in their ICSP (Government of Nunavut, 2011).

Sealift is a vital link for all communities in Nunavut that supply residents their annual cargo of goods and materials needed for 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. The current providers of sealift carriage and associated services are Nunavut Sealink and Supply Inc. (NSSI) and Nunavut Eastern Arctic Shipping Inc. Sealift ships usually arrive in Clyde River towards the end of August, with the last boat of the year leaving sometime around middle to late September. Sealift companies report the need for security in the off-loading areas, such as a fenced staging area, to protect the safety of residents (especially children) during off loading, and to provide for more onshore storage during sealift activities (Government of Nunavut, 2011).

11.2.4.6 Emergency and Protection Services

Fire protection is the responsibility of the Hamlet and currently relies on 19 volunteer firefighters, led by a paid full time Fire Chief. On average, the department will respond to approximately ten minor fires a year, but major fires do happen occasionally. Firefighting equipment is becoming old and worn and advanced first aid training is required for most of the fire fighters (Nick Illauq, Fire Chief. Nov 2019). The community's ambulance is also lacking in the equipment and materials needed to supply proper care to patients (Nick Illauq, Fire Chief. Nov 2019).

The RCMP detachment office, located near the proposed harbour area, has a staff of two full time officers.

11.2.4.7 Public Health

Health services are provided at the local health centre that was built in 1996 and offers 24-hour on-call emergency service. A non-emergency sick clinic is open Monday to Friday from 9:00-12:00 am. The health centre is understaffed with a supervisor and two full time support nurses (Anastazia Jurkova, Supervisor. pers. comm. Nov 2019). Occasionally, staff is limited to just the two nurses or only the supervisor which leads to reduced service available for emergency and public health program delivery – it is understaffed at the best of times (Anastazia Jurkova, Supervisor. pers. comm. Nov 2019). 2016 was the most recent year that data on the per capita number of health centre visits were made available from the Government of Nunavut (2018b) (Department of Health). In that year, Clyde River had 9.6 per capita health centre visits or 10,847 total visits (Government of Nunavut, 2018b). The health centre is clearly under resourced (Government of Nunavut, 2018b).

There are specialist services that visit Clyde River periodically including: a pediatrician; a general practitioner; an ear, nose, and throat specialist; a physiotherapist; a speech-language pathologist; an occupational therapist; and an audiologist. A dentist usually visits Clyde River every two or three months (Anastazia Jurkova, Supervisor. pers. comm. Nov 2019).

Community wellness programs and services are also provided by the Ilisaqsivik Society. Ilisaqsivik provides space, resources, and programming such as: Inuit to Inuit counselling services; Inuktitut language classes; Inuit youth summer work experience programs; and land based IQ programs.

11.2.5 Local Businesses

The following businesses are registered with the Hamlet for the current financial year (Marcel Holder Robinson. Finance Director. pers. comm. Nov 2019).

Table 11-5 Registered Business for Current Financial Year

Business	Owner	Type
The Northwest Company LP	Alan Cook	Retail Outlet
The Northwest Company LP	Alan Cook	Restaurant
Naujaaraaluit Hotel	Diane Jaypoody	Hotel
Ilisaqsivik Society	Malcolm Ranta	Retail Outlet
Nangmautaq HTO	Gary Aipellee	Retail Outlet
Akuniq Enterprises Inc.	Johnathan Palluq	Fuel Distribution
Palituq Outfitting	Levi Palituq	Outfitting
Akuniq Enterprises Inc.	Johnathan Palluq	Retail Outlet
Bradley Air Services Ltd. o/a First Air	Lianna McQuirter	Air Transportation of passengers and cargo on scheduled and chartered services
TAPS Snacks	Tapeesa & Shawn Wilton	Retail Confectionary
Baffin General Store Corporation	Martin Kigutaq	Retail Outlet
Munch Time	Paulo & Sarahme Pinto	Retail Outlet
Qimiqpik Niuvirbik	Lizzie Palituq	Retail Outlet

11.2.6 Land and Resource Use

11.2.6.1 Harvesting and Food Security

Food security is a problem in Inuit communities throughout northern Canada but especially in Nunavut. Food security, as defined by the United Nation's Food and Agriculture Organization (FAO), exists *"when all people, at all times, have physical, social and economic access to sufficient, safe, and nutritious food that meets their dietary needs and food preferences for an active and healthy life"* (FAO, 2002). Nearly half (46.8%) of Nunavut households were reported to be food insecure in 2014 compared with 12 per cent of households across Canada (Tarasuk *et al.*, 2016). Additionally, results from the 2007/2008 International Polar Year Inuit Health Survey indicated that 70% of Inuit preschoolers in Nunavut resided in food insecure households (Egeland *et al.*, 2010) and that the Inuit in Nunavut had the highest documented food insecurity rate for any Indigenous population in a developed country (FAO, 2002; Egeland *et al.*, 2010; Egeland, 2011).

The availability of traditionally harvested foods (country food) is therefore crucial because it lowers the demand for imported food which is very costly and most often less nutritious. Additionally, the harvesting, preparation, and sharing of meat and skins offers important opportunities to maintain and enhance Inuit culture.

Residents in Clyde River obtain food resources from harvesting, purchasing at stores, and through sealift. Harvesting remains essential to life in Clyde River. The harvesting of ringed seal, Arctic char, narwhal, and caribou are of particular importance (HTO member, pers. comm. May 2019). A new three module community freezer managed by the HTO arrived in Clyde River this past summer. One module is the freezer, a second module will be used for fish and meat processing (country food) and the third module will hold an office, washroom and mechanical room (Gary Aipellee. HTO manager. pers. comm. Nov 2019).

Harvesting locations (fishing, hunting, and berry picking) identified during the IQ workshop have been provided in the Land Use and Occupancy map (Figure 3-1).

Fishing (nets and casting/jigging) occurs in the harbour area, all along the shoreline, and in Patricia Bay as marked. Some people use 30-ft poles to harvest clams in the spring and fall on the other side of the bay near the old community site where the clams are most abundant (Figure 3-1). In the summer and early fall, storms will push clams in to the shore near the existing breakwater where they are gathered by a few individuals *"otherwise it's just too deep around this area and there aren't enough of them to really harvest"* (IQ Workshop 2019 - Daniel Jaypoody).

Although berry harvesting sites are located near the proposed harbour area, elders and active hunters remarked during the IQ and verification workshops that there are no important areas for plants or berries that should be avoided or protected.

> *"I don't see any concern for plant harvesting, nobody really picks in and around town because it's too dusty"* (IQ Workshop 2019 - Mike Jaypoody).

Ptarmigan are hunted starting in the early fall and all winter long. Their eggs are also harvested. Although Ptarmigan are around all year, *"their diet changes which affects their taste, so we only hunt in early fall and winter"* (IQ Workshop - Leslie Ashevak). Snow geese and Canada geese are most often hunted in the low-lying "wet tundra" areas found near the existing quarry (Figure 3-1).

Although fox trapping is relatively common once the season opens in October, trap lines were not marked because "people set trap lines but it's not an issue, they are set all over. People have their own favourite areas to trap. Fox seem to like the tank farm area" (IQ Workshop - Leslie Ashevak).

The knowledge holders stated that there was no sense in marking polar bear sightings in the area because they can be almost anywhere where there's food, or where marine mammals have been processed. They are also attracted to food caches and the sled dog areas. Areas where polar bears have more recently been harvested (one near the landfill and one near the sled dogs) were marked on the map (Figure 3-1). Polar bears are very commonly observed closer to the community when the ice is forming and are often sighted sleeping out on the ice in Patricia Bay (IQ workshop 2019).

There were no culturally important areas identified by the knowledge holders during the IQ workshop or by HTO members during any of the design workshops.

11.2.6.2 Travel Routes and Access

The existing harbour site includes the main sealift ramp, which is also used for launching boats. During the open-water season, most residents' boats are either anchored in the water or pulled up on the beach adjacent the ramp. There are several small breakwaters adjacent the ramp. The breakwaters are rudimentary and attempt to create a protected harbour for vessels. However due to strong winds and currents the area experiences sediment accumulation and frequent washouts, and in some cases, limited benefit from the breakwaters against strong southerly wind waves. The community currently uses a backhoe to repair the deteriorated infrastructure and remove sand build up. The existing configuration of the site is small, limiting the size and number of vessels, also exposing them to harsh conditions and susceptible to damages. This causes the community to anchor their boats at the tide line for protection. During the winter months, boats are stored along the shoreline and at the ramp.

Dry cargo from the sealift is lightered to shore in the conventional manner using small tugs and barges that are carried on board the arriving ship. The barges are brought into the ramp that is also used for launching boats from trailers. The majority of the upland area at the ramp is used for dry cargo storage temporarily until it is delivered into the community. Congestion and conflicts with boating exist until the cargo is cleared several days after the delivery. Concerns over safety have been expressed by the community over the interference between public boating access and sealift operations that use large front-end loaders and trucks especially considering that many children enjoy playing on the beach and around the coast line at all times of the day.

During the winter, ice access is considered very good as stated by HTO members and knowledge holders during the design and IQ workshops.

> "*Getting on the ice is super easy, we can get on anywhere. We adapt and just keep traveling south down the shore during ice break up to access hunting grounds*" (IQ Workshop - Leslie Ashevak).

According to Clyde River's 2019/2020 Infrastructure plan, the community would like to establish access to the old community site and cemetery and build a new road from the community hall to the airport road minimizing traffic on the main road. Additionally, the community is requesting that a new bridge over the river to access the quarry be designed and built to withstand a gross weight of 64,000 kg. The existing bridge is designed for only a maximum gross weight of 27,000 kg.

11.2.6.3 Recreation and Tourism

The Hamlet manages community recreational facilities throughout the year comprised of the following:

- Community Hall
- Ice arena
- Baseball diamond
- Community library

The Hamlet Recreation Department hosts weekly and annual events. Weekly events include bingo games. Special events include:

- Hamlet Day
- Nunavut Day
- Canada Day
- Halloween
- Christmas
- New Years

The Recreation Department also assists community youth and athletes by paying for their sports registration fees. Residents have expressed the need for a swimming pool and youth centre for their children (Community Wellness Plan For Clyde River, 2016).

In addition, Clyde River has the Ittaq Heritage and Research Centre. Ittaq works closely with Ilisaqsivik Society to support educational, cultural, language, land-based, and wellness projects and programs. One of its main programs is film making. Illisaqsivik organizes local and regional media training workshops almost every year with the aim to support Clyde River residents to gain more media skills.

The stunning mountains, icebergs and glaciers that surround Clyde River attract tourists and extreme sports adventurers from around the world. The vistas are spectacular and the high mountain range offer a high-adrenaline challenge to mountaineers, ice climbers and base cliff jumpers. The remote landscape is home to unique wildlife including seals, Narwhals, Bowhead whales, and polar bears. The Hamlet provides access to the Isabella Bay which is a Biosphere Reserve and NWA and the Ninginganiq NWA, a Bowhead Whale Sanctuary. Clyde River is the contact point of travel into Sam Ford Fiord and other deep fiords in Central Baffin.

In September 11, 2019, the Nunavut and Canada announced the creation of Agguttinni Territorial Park, a collaborative venture between the Nunavut government and the Hamlet of Clyde River (see description in Section 2.6.1).

Some residents of Clyde River believe that tourism presents an opportunity to demonstrate the vibrancy of their culture and create new economic activities, but this area of economic development is still fledgling and has not been fully explored. Cruise ships to Clyde River are minimal, with no more than three landings each season over the past five years. According to Nunavut's Master Cruise Ship Itinerary for 2019, only one ship from the World/Eyos Expeditions (with an estimated 200 passengers) was scheduled to visit Clyde River this past season (Government of Nunavut, 2019a). Increasing high-end sailboats and yacht visits have been observed in recent years in the community (HTO member. pers. comm. June 2019).

The Nangmautaq HTO and Levi Palituq of Palituq Outfitting Services are the currently operating outfitters in the community. They can arrange tours and Inuit guides for a wide range of experiences, including dog sledding, floe edge trips, kayaking, fishing, whale watching, bird watching, and camping.

12. Permitting Summary

Program objectives that should be considered during the SCH detailed design and permitting phase are provided in Table 1-2.

12.1 Key Contributions to Regulatory Permitting

Construction and operation of a SCH in Clyde River will require securing federal, territorial, and municipal permits and approvals. For efficient acquisition of these permits and approvals, a regulatory roadmap identifying the federal, territorial, and municipal Regulatory Authorities (RAs) and the permitting schedule should be developed. Table 12-1 summarizes the likely federal and territorial RAs, legislative requirements, and expected acquisition of permit timelines for the construction and operation of a SCH in Clyde River. Permit acquisition vary from two months to two years as a result of the RAs mandate and consultation requirements. At this time, no permits are expected from municipal RAs, but continued engagement and collaboration with the community will be essential during the detailed design and permitting phase, to confirm an SCH that reflects the priorities and needs of the community.

The territorial and federal permitting processes that govern environmental effects permitting in Nunavut are closely intertwined. The NPC is essentially the 'gate keeper' of the system where a Conformity Determination is made, with the decision taken to refer the project to the NIRB. In this case, a referral is highly probable, where the predicted outcome would be that the Project would proceed as a Screening Decision with conditions. NPC will take the decision for referral and include pertinent Federal and Territorial regulators, most of whom are encompassed in Table 12-1. NIRB will not initiate a review until they have received a referral from NPC, and often NWB (if a water license is required) is required to wait for a NIRB decision prior to issuing a permit. Federal regulators will also be engaged through the territorial process, and will not issue federal permits until the NIRB process is complete. NPC and NIRB will both expect to be provided with a list of expected permits required for the Project to assist them in confirming the scope of the Project is understood and interpreted during their respective processes.

Early engagement with all RAs is recommended so that the expectations of information provided are clearly understood to ensure a complete application is submitted. Most regulatory processes have defined legislative processes; however, these timelines may reset or restart if information requests are received on the application. The most expedient approach to the regulatory permitting process is prepare the regulatory roadmap early during project planning, incorporate the permitting schedule in the overall project schedule, and engage early with RAs to understand expectations for complete applications and efficiently manage information requests to avoid delays during the legislated review period.

Table 12-1 Summary of Federal, Territorial, and Municipal Permitting Requirements

Legislation	Regulatory Authority	Construction Activity	Required Authorization/Permit/Approval	Additional Details	Recommended Permit Timelines	Key Inputs
Territorial						
The mandate of the NPC is to establish, implement, and monitor land use plans under the *Nunavut Land Claims Agreement Act* (Nunavut Agreement, or NA) Article 11 The NPC's regulatory powers are defined within the *Nunavut Planning and Project Assessment Act* (NuPPA), the *Nunavut Waters and Nunavut Surface Rights Tribunal Act* (NWNSRTA), and the Nunavut Water Regulations. https://laws-lois.justice.gc.ca/eng/acts/N-28.75/page-2.html#h-370569	NPC	Development of land and water resources within Nunavut	Conformity Determination. (Determination of the need for referral to NIRB)	A conformity determination is a review of a project description to determine whether it complies with all the terms and conditions of the applicable land use plan, if one exists. Clyde River is within the NBRLUP (NPC, 2000b). Following the issuance of a conformity determination letter (NPC has 45 days to review), the NPC will then refer the project proposal to the Nunavut Impact Review Board (NIRB) for screening and notify other pertinent regulatory agencies.	3 months	▪ Effects assessment ▪ CEMP ▪ Indigenous consultation and IQ to confirm baseline conditions, potential effects and offset ideas
Nunavut Planning and Project Assessment Act https://laws-lois.justice.gc.ca/eng/acts/N-28.75/page-2.html#h-370569	Nunavut Impact Review Board (NIRB)	Any development of land and water resources within Nunavut as determined by NPC's conformity determination	Screening decision report (SDR) with terms and conditions	The Project(s) will likely require a screening under NA Part 4 by the NIRB (Screening). Screenings are conducted over 45 to 60 days and includes a 21-day consultation period. Consultation includes a public comment period via the registry, and a NIRB determined distribution list which includes pertinent RAs, hamlets/municipalities, HTOs/HTAs, regional Inuit associations and non-government organizations. Once NIRB issues an SDR, the Minister will issue a decision based on NIRB's report, and will accept NIRB's determination to proceed or reject it based on concerns for National Interest, inappropriate conditions, or for further review. The Minister has 15 days to agree or reject the NIRB determination, with a process that can be extended up to 120 days if necessary (NIRB, 2018)	4 to 6 months. While the legislated timeline is 45 days, additional information can be requested at any time. Each time this occurs, the 45 day clock is reset upon receipt of the new information. This timeline assumes a screening decision is sufficient and that that no environmental assessment (Part 5) is required.	
*Nunavut Waters and Nunavut Surface Rights Tribunal Act (*NWNSRTA), Nunavut Water Regulations https://www.canlii.org/en/ca/laws/regu/sor-2013-69/latest/sor-2013-69.html	NWB	Potential for withdrawal of freshwater or the need to cross freshwater crossings for haul road construction	Water Licence, likely Type B	Will likely be required but would be the responsibility of the contractor.	1 to 2 months	
		Potential for diversion of small creeks within SCH footprint		NIRB and NWB provide guidance on a Detailed Coordination Process Framework to minimize redundancy and expedite the permitting process, when there is the need for permitting consideration from both Institutions of Public Government. Typically, this coordinated process is only required when it determined that an Environmental Impact Statement is required from NIRB. This is unlikely to be the case for the Project, where it is expected to proceed through NIRB via an SDR.		

Legislation	Regulatory Authority	Construction Activity	Required Authorization/Permit/Approval	Additional Details	Recommended Permit Timelines	Key Inputs
Nunavut Act Section 51 and the Nunavut Archaeological and Paleontological Sites Regulation.	GN-CH	Potential for archaeological features to be in the Project footprint	Class 2 Nunavut Territory Archaeologist Permit	An AIA was completed in August 2019 under Class 2 Archaeologist Permit 19-054A. The AIA resulted in recording two archaeological sites, OcDn-8 and OcDn-9. The newly recorded archaeological sites are outside of the SCH and Haul Road Study Areas (see Appendix 6 – Archaeological Assessment of the main report) and therefore no further work was recommended.	3 months	
Land Use Territorial Regulations, *Territorial Lands Act*	GN	See CIRNAC and PSPC below for associated construction activity.	Land use Permit (CIRNAC) or License of Occupation (PWGS)	Confirm land ownership early to identify relevant parties and the requirement for a temporary LUP or LoO, and to support CIRNAC or PWGS with the preparation of documents required for the transfer of administrative control of the water parcel for the SCH construction and operation.	2 to 4 months	▪ See CIRNAC description
Federal						
Fisheries Act https://laws-lois.justice.gc.ca/PDF/F-14.pdf	DFO	In water works associated with the construction of the SCH that have the ability to result in the harmful alteration, disruption or destruction to fish or fish habitat, as defined under the *Fisheries Act*.	Section 35(2) FAA	Potential environmental effects may be considered mitigatable, with the exception of the seabed footprint of the SCH and possibly the DAS. A FAA will be required for this seabed footprint. An important component of an FAA is the development of an Offset Plan. A Harmful Alteration Disruption or Destruction (HADD) footprint will be determined, based on the Project footprint and an agreed determination of habitat value. Offsetting is likely to be a combination of physical works (e.g. restoration, shoreline protection of the SCH) and complementary measures (e.g. research) as there are limited opportunities for restoration works in unmodified environments such as Clyde River. Engagement with the community and the Nangmautaq HTO should be conducted to confirm any offsetting opportunities and research interests in Clyde River.	Legislative timelines are 60 and 90 days. The Minister has 60 days from the date of submission of an application to confirm the application is complete and 90 days to issue the FAA (Government of Canada, 2019f) However 18 to 24 months are recommended as FFHPP will stop the clock as required to request response to fill information gaps.	▪ Effects assessment ▪ Construction Environmental Management Plan (CEMP) ▪ Description of HADD footprint ▪ Indigenous consultation and IQ to confirm baseline conditions, potential effects and offset ideas ▪ Offset Plan
Canada Environmental Protection Act: Disposal at Sea Regulations http://laws-lois.justice.gc.ca/eng/acts/c-15.31/ http://laws-lois.justice.gc.ca/eng/regulations/SOR-2001-275/	ECCC	Disposal of dredged material at sea at an approved location.	DAS Permit	The DAS Permit application will require the development of a dredge management and monitoring plan. This plan will be developed in consultation with the community and the Nangmautaq HTO.	ECCC states a minimum of 90 days to complete the assessment of an application (Government of Canada, 2019e). However a minimum 12 months in advance of construction is recommended as additional sediment sampling may be required	▪ SAP which details the collection methodology for sediment quality analysis at load site ▪ Sediment transport modelling report ▪ CEMP

Legislation	Regulatory Authority	Construction Activity	Required Authorization/Permit/Approval	Additional Details	Recommended Permit Timelines	Key Inputs
Canadian Navigable Waters Act http://laws-lois.justice.gc.ca/PDF/N-22.pdf	Transport Canada (TC)	In-water works associated with the construction and operations of the SCH that have the potential to interfere with navigation.	Notice of Works Application for Approval	Communications with TC should initiate early to confirm if the proposed construction would be considered major works and would require an Approval. Based on project experience, an approval is likely required. TC will require specific advertising and consultation requirements regarding navigational effects. In addition, recent changes to the *Canadian Navigable Waters Act* (CNWA) have resulted in an online registry of projects and approvals.	6 to 12 months	▪ Details surrounding potential navigational interferences due to construction/operation ▪ CEMP
Territorial Land Use Regulations https://laws-lois.justice.gc.ca/eng/Regulations/C.R.C.,_c._1524/index.html	Crown-Indigenous Relations and Northern Affairs Canada (CIRNAC)	In-water works relative to the use of the seabed (areas below the OHWM)	Land Use Permit	Confirmation of land ownership and whether federal, territorial or municipal governments need to be involved for administrative control of the land transfer will be an important part of the permitting scope. Typically in Nunavut, a LUP is required from CIRNAC. CIRNAC's mandate includes the seabed between the ordinary high water mark (OHWM) and the ordinary low water mark (OLWM). Confirmation will further need to be made to determine if CIRNAC has administrative rights to lands above the OHWM through the "jaws of the land" legal description.	LUP and LoO can be processed in two to four months. Applications can be processed in shorter periods of time, but in the event there is confusion on land ownership, CIRNAC and/or PSPC should be engaged early in the permitting process. The transfer of land title from Crown to Commissioner is driven by CIRNAC or PWGS and through an Order in Council.	▪ Details surrounding ownership of land above and below the HWL of the Project footprint
	Public Services and Procurement Canada (PSPC)		License, Land transfer	PSPC may need to be engaged for the works below the OLWM where the "jaws of land" principle does not apply This typically occurs through either a License of Occupation (LoO) for the time required to transfer of care and control of the seabed from the Crown to Commissioner		
Explosives Act (Section 7): Explosives Regulations (2013) http://laws-lois.justice.gc.ca/PDF/E-17.pdf (Act) http://laws.justice.gc.ca/PDF/SOR-2013-211.pdf (Regulation)	Natural Resources Canada (NRCan)	Blasting – For any industrial explosive that is to be imported into or manufactured, transported, possessed or used in Canada. Transport, storage and acquisition of explosives.	Authorization of Explosives Magazine Licence Application	Acquisition of this permit is typically the responsibility of the contractor subsequent to construction contract award.	3 months	▪ To be obtained by contractor
Impact Assessment Act *https://laws-lois.justice.gc.ca/eng/acts/I-2.75/index.html*	Impact Assessment Agency (IAA)	In 2008, Article 12 of the Nunavut Agreement was formally amended to remove the application of the *Canadian Environmental Assessment Act* (CEAA) in the Nunavut Settlement Area (NSA). This eliminated potential for duplication in the impact assessment process applicable within the NSA and leaves the NIRB the sole agency responsible for conducting impact assessment in Nunavut (NIRB, 2018). The IAA replaced CEAA through Bill C 69 which came into force on August 28, 2019 (Government of Canada, 2019a). It is not expected that a review by the IAA will be required, as the effects of the project are also anticipated to be considered a Part 4 Screening by the NIRB and the community is in support of the project.				

Important documents that will be required for permitting may include, but is not limited to the following:

- Documentation of consultation and IQ to confirm community knowledge of baseline environmental conditions, potential project environmental effects, and specific to the DFO FAA, ideas for a fish habitat offset plan.
- Environmental Impact Assessment (EIA) that outlines potential residual effects on the environment due to the construction and operation of the SCH.
- Construction Environmental Management Plan (CEMP) that outlines the effects considered in the EIA and provides industry standard mitigation and monitoring measures to minimize negative effects on the environment.

13. Closure

We trust that this report satisfies your current requirements and provides suitable documentation for your records. A number of authors collaborated on this survey, as listed by section below. If you have any questions or require further details, please contact the undersigned at any time.

Inuit Quajimajatuqanjit and Socio-Economic Content

Prepared by:

Diane Pinto, B.Sc., M.Sc.
Senior Community Engagement
and Indigenous Knowledge Consultant

Reviewed by:

Susan Ferner, M.A.
Senior Engagement Specialist, Social Impact Analyst

Water Quality, and Sediment Quality Content

Prepared by:

Niamh Ryan, M.Sc.
Marine Scientist

Reviewed by:

Janine Beckett, MSc., R.P.Bio.
Consulting Manager, Marine Science

Fish and Fish Habitat, and Permitting Summary Content

Prepared by:

Victoria Burdett-Coutts, MSc., R.P.Bio.
Marine Scientist

Reviewed by:

Janine Beckett, MSc., R.P.Bio.
Consulting Manager, Marine Science

Vegetation Content

Prepared by:

Lucas Pittman, B.Sc., P.Biol.
Ecologist

Reviewed by:

Andrea Borkenhagen, Ph.D.
Senior Wetland and Vegetation Ecologist

Wildlife and Migratory Birds Content

Prepared by:

Lucas Pittman, B.Sc., P.Biol.
Ecologist

Reviewed by:

Stephen Symes, M.Sc., P.Biol., R.P.Bio.
Senior Wildlife Ecologist

Marine Mammals Content

Prepared by:

Anna Hall, Ph.D.
Zoologist

Reviewed by:

Janine Beckett, MSc., R.P.Bio.
Consulting Manager, Marine Science

Environment & Society
Advisian, Americas

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Appendices

Appendix 1 Supporting Figures

Appendix 1 Supporting Figures

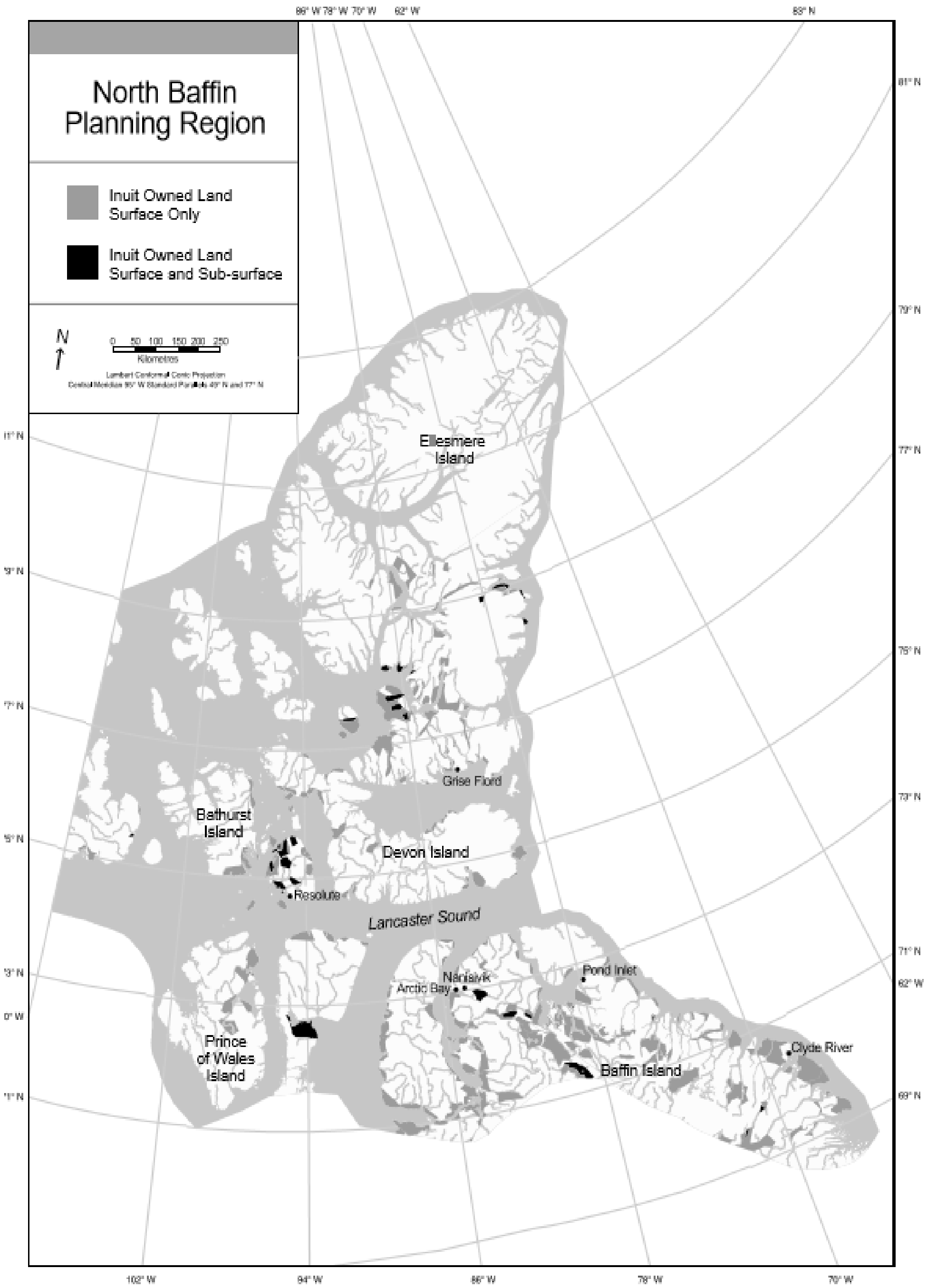

Figure 1 North Baffin Land Use Planning Region

Source: (NPC, 2000b)

DEPARTMENT OF FISHERIES AND OCEANS
CLYDE RIVER HARBOUR DEVELOPMENT
ENVIRONMENTAL AND SOCIO-ECONOMIC BASELINE SURVEY

TALLURUTIUP IMANGA NATIONAL MARINE CONSERVATION AREA AND TUVAIJUITTUQ MARINE PROTECTED AREA

Date: 12-DEC-19	Drawn by: KR	Edited by: KR	App'd by: VB
Fisheries and Oceans Canada	Advisian Worley Group	Project No. 307071-01306	
		FIG No 2	REV 0

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Data Sources:
Tallurutiup Imanga (Lancaster Sound) NMCA from Protected Planet
(provided by Environment Canada)
Tuvaijuittuq MPA from DFO

Imagery Source: NOAA National Centers for Environmental Information (NCEI); International Bathymetric Chart of the Arctic Ocean (IBCAO); General Bathymetric Chart of the Oceans (GEBCO)

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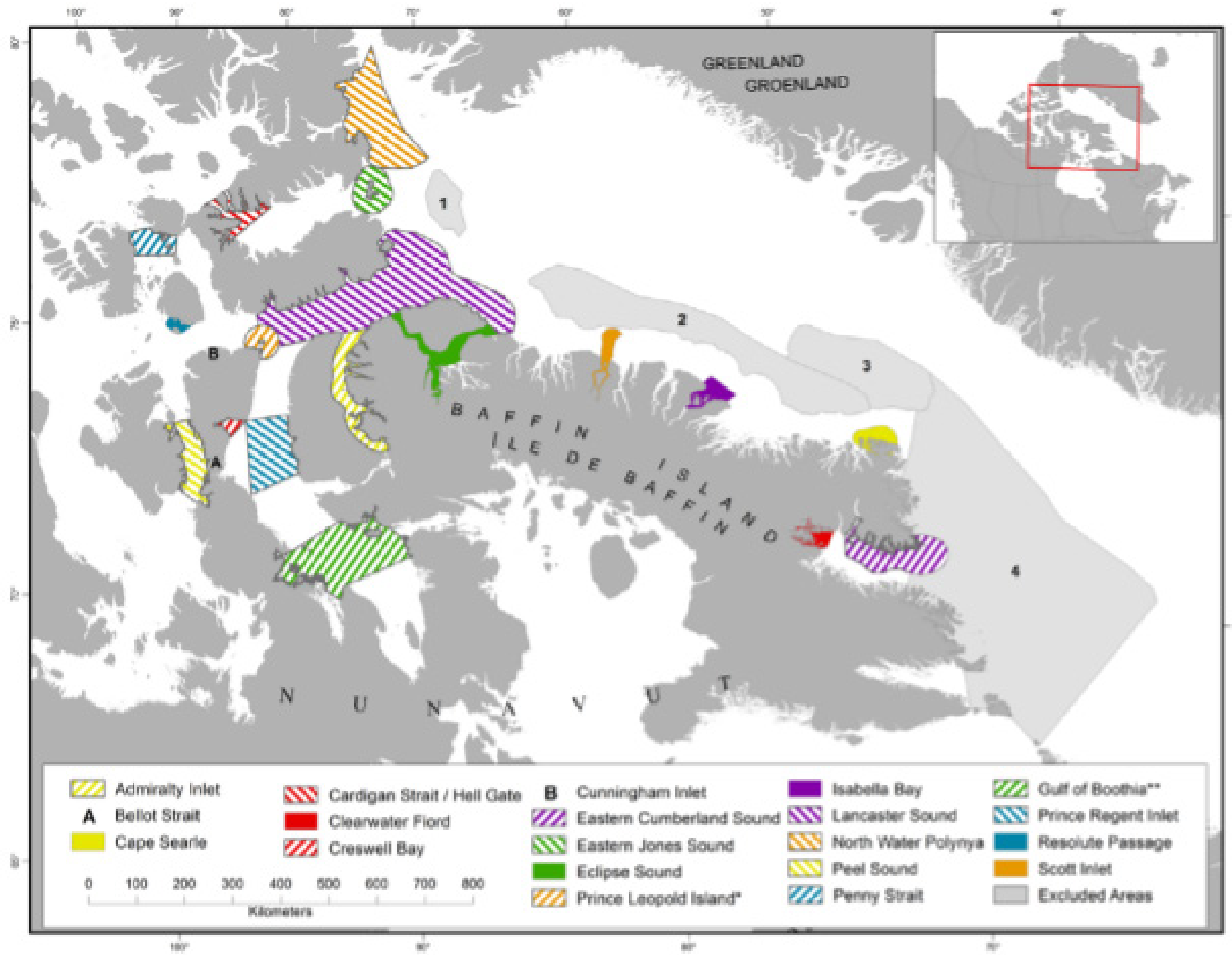

Figure 3 EBSAs in the Eastern Arctic Biogeographic Region

Source: (DFO, 2015c); Schimnowski *et al.* (2018)

Legend

- Site Location
- Important Bird Areas

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FISHERIES AND OCEANS CANADA
CLYDE RIVER HARBOUR DEVELOPMENT
ENVIRONMENTAL AND SOCIO-ECONOMIC BASELINE SURVEY

IMPORTANT BIRD AREAS IN NUNAVUT

Date: 18-DEC-19	Drawn by: JH	Edited by: JH	App'd by: VB
Fisheries and Oceans Canada	Advisian Worley Group	Project No. 307071-01306	
		FIG No 4	REV 0

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PLOT DATE & TIME: 2019-12-18 10:17:43 AM USER NAME: Jennifer.Huang
SAVE DATE & TIME: 2019-12-18 10:17:33 AM ISSUING OFFICE: BURNABY GIS

Imagery Source: NOAA National Centers for Environmental Information (NCEI); International Bathymetric Chart of the Arctic Ocean (IBCAO); General Bathymetric Chart of the Oceans (GEBCO)

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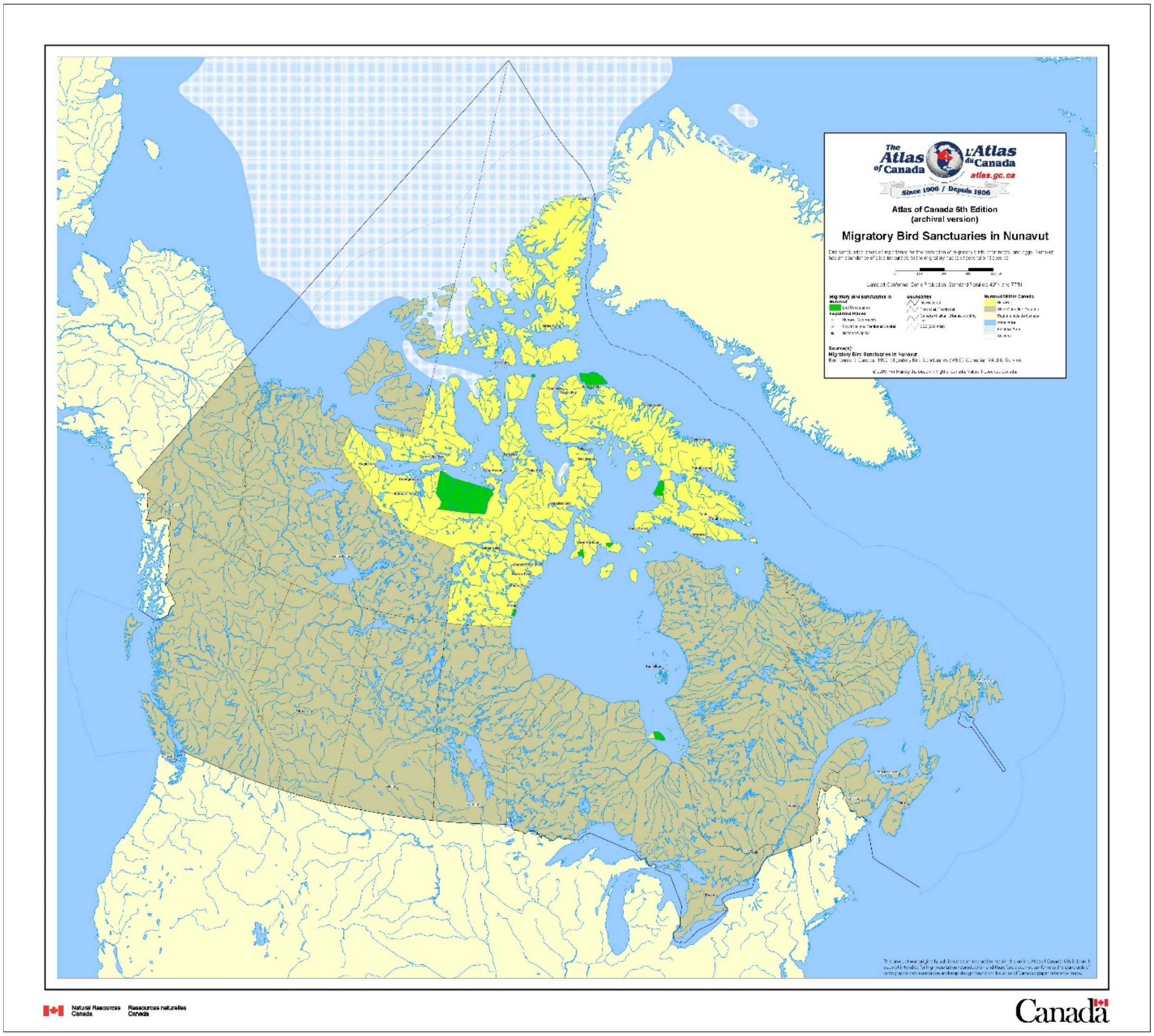
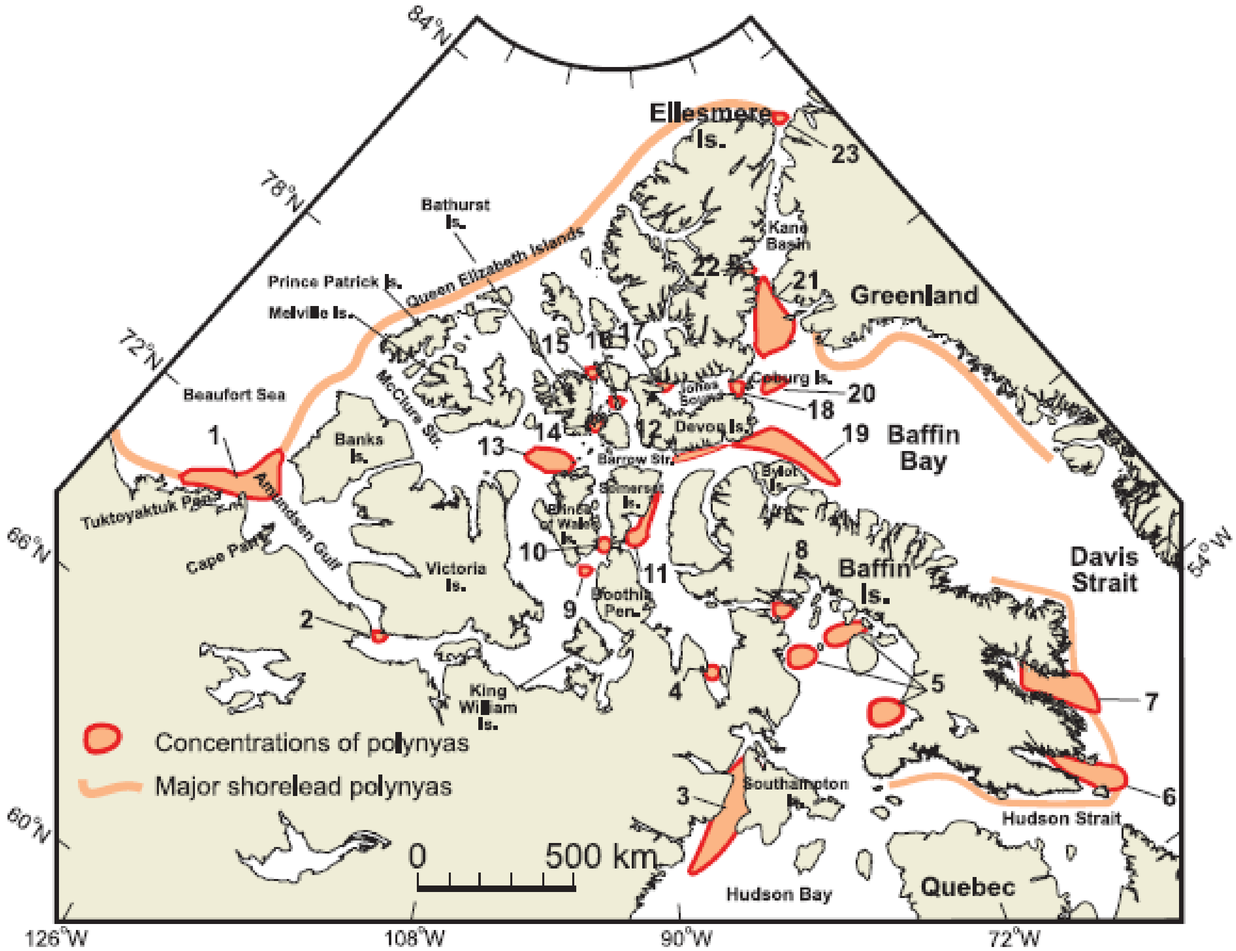


Figure 5 Migratory Bird Sanctuaries in Nunavut

Source: Government of Canada (2019)



1 Cape Bathurst
2 Lambert Channel
3 Roes Welcome Sound
4 Committee Bay
5 Foxe Basin
6 Frobisher Bay
7 Cumberland Sound
8 Fury and Hecla Strait
9 Franklin Strait
10 Bellot Strait
11 Prince Regent Inlet
12 Lancaster Sound
13 Viscount Melville Sound
14 Karluk Brooman
15 Queens Channel and Penny Strait
16 Dundas Island
17 Hell Gate – Cardigan Strait
18 Lady Ann Strait
19 Bylot Island
20 Coburg Island
21 North Water (NOW)
22 Flagler Bay
23 Lincoln Sea

Figure 6 Known Polynyas in the Canadian Arctic

Source: Figure 1 in Hannah et al (2009).

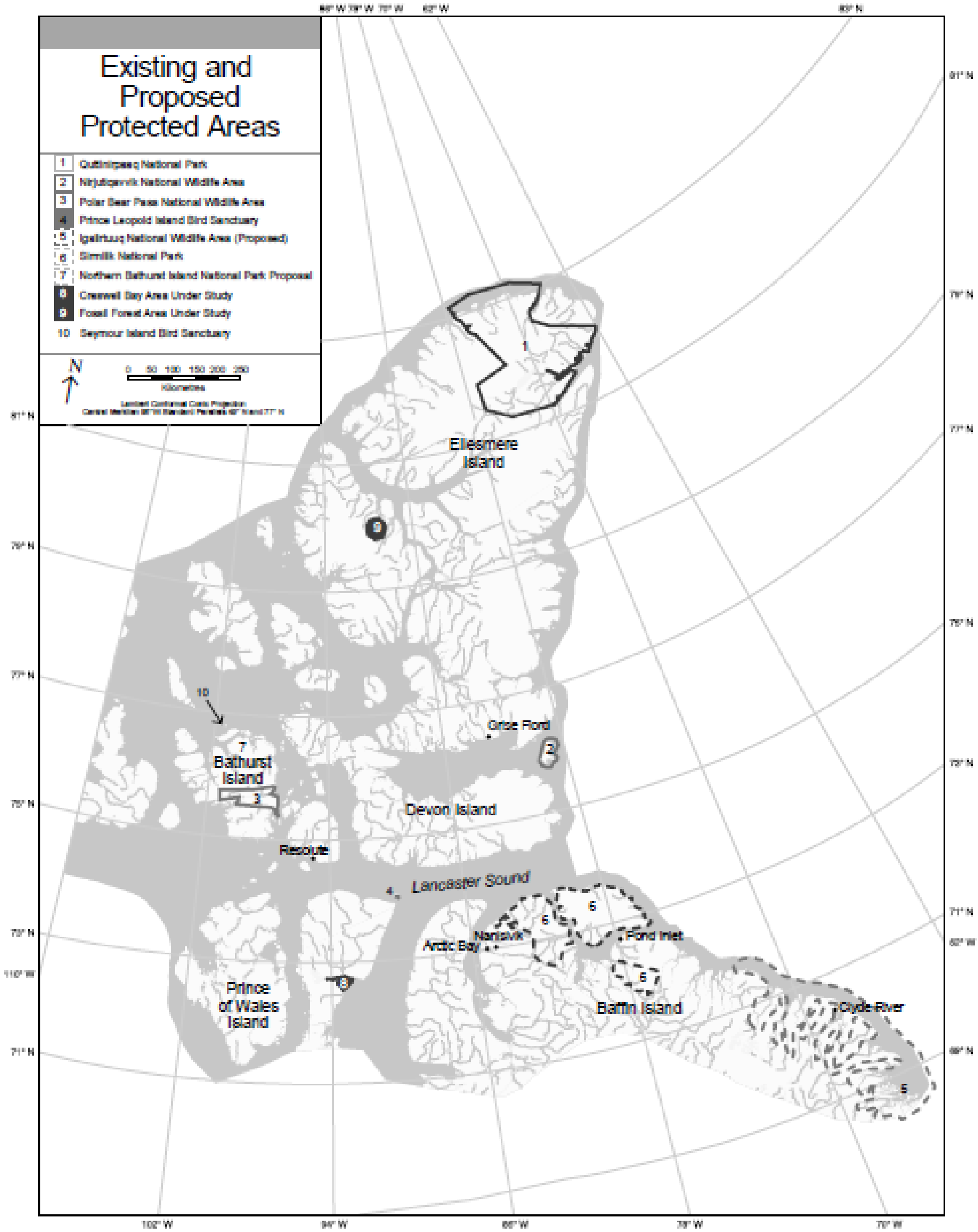
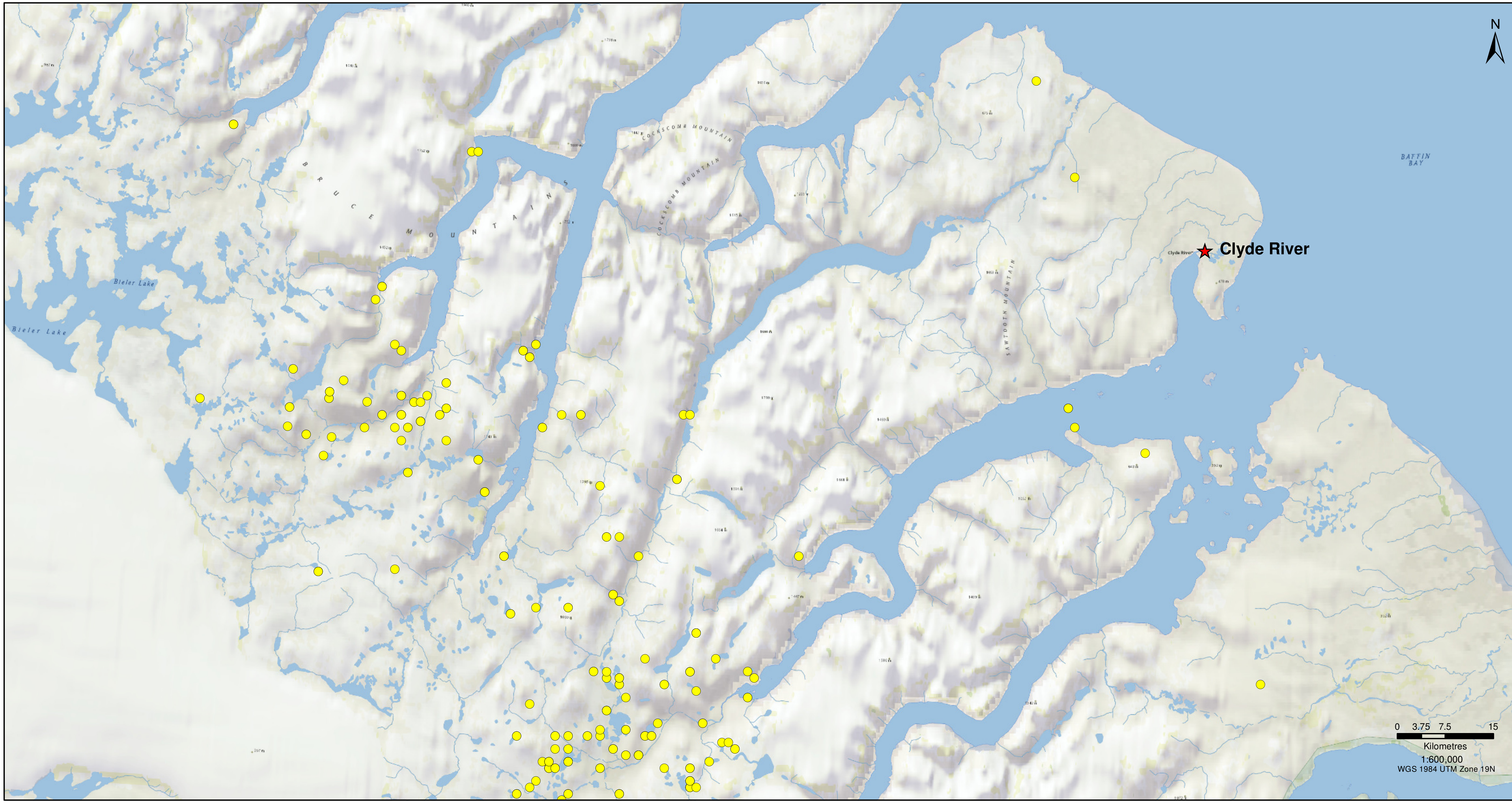


Figure 7 Existing and Proposed Protected Areas in the North Baffin Region

Source: (NPC, 2000)

Figure 8 Locations of Canada's National Parks

Source: Parks Canada, 2018)



Legend

Animal Species

- Barren-ground Caribou

Location approximated.

Imagery Source: National Geographic, Esri, Garmin, HERE, UNEP-WCMC, USGS, NASA, ESA, METI, NRCAN, GEBCO, NOAA, increment P Corp.

FISHERIES AND OCEANS CANADA
CLYDE RIVER HARBOUR DEVELOPMENT
ENVIRONMENTAL AND SOCIO-ECONOMIC BASELINE SURVEY

NWHS HARVESTED CARIBOU LOCATIONS IN CLYDE RIVER (1996-2001)

Date: 18-DEC-19	Drawn by: JH	Edited by: KR	App'd by: LP
Fisheries and Oceans Canada	Advisian Worley Group	Project No. 307071-01306	
		FIG No 9	REV 0

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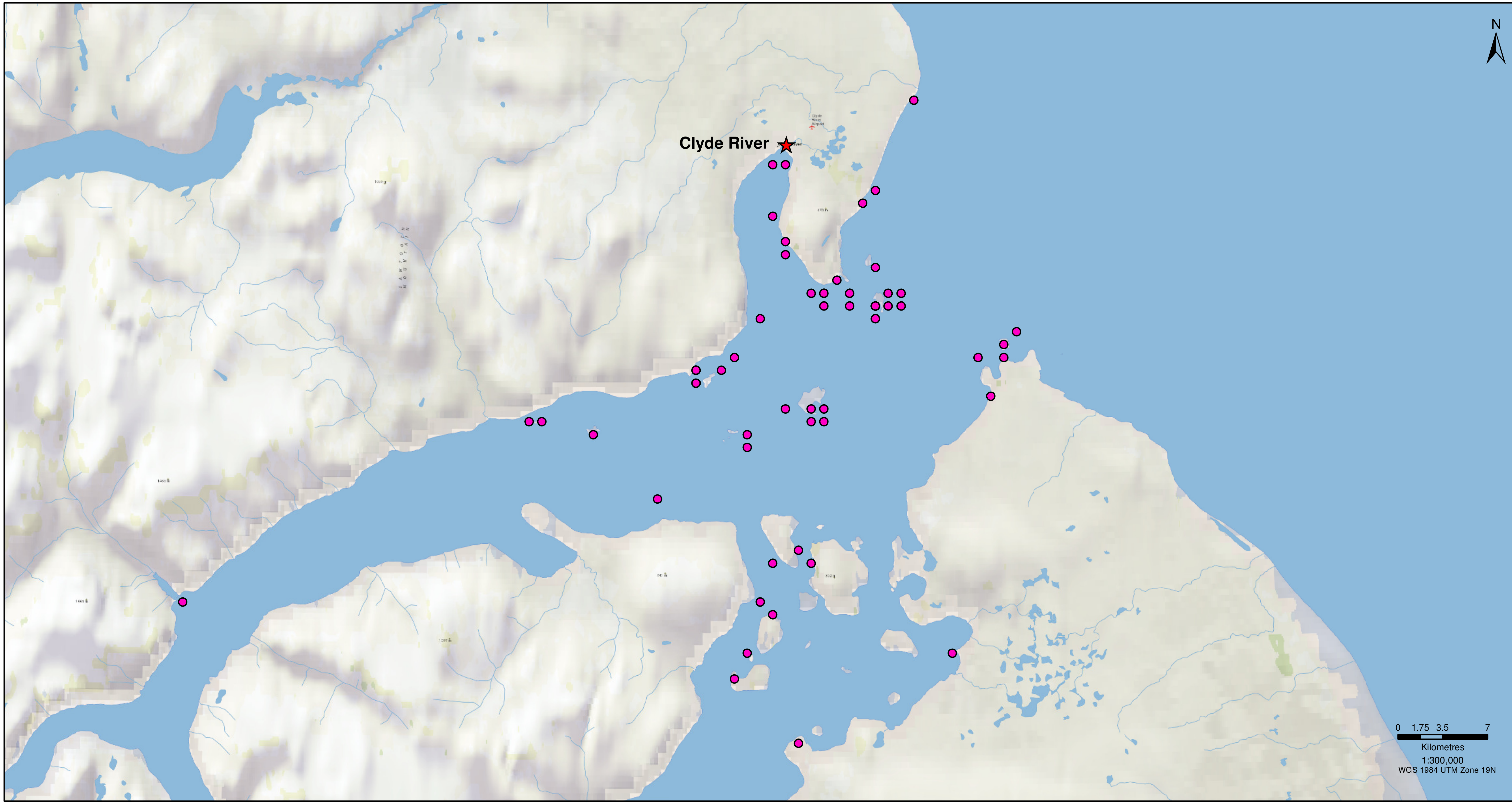


Legend

Animal Species

- Common Eider

Location approximated.

Imagery Source: National Geographic, Esri, Garmin, HERE, UNEP-WCMC, USGS, NASA, ESA, METI, NRCAN, GEBCO, NOAA, increment P Corp.

FISHERIES AND OCEANS CANADA
CLYDE RIVER HARBOUR DEVELOPMENT
ENVIRONMENTAL AND SOCIO-ECONOMIC BASELINE SURVEY

NWHS HARVESTED COMMON EIDER DUCK AND EGG LOCATIONS IN CLYDE RIVER (1996-2001)

Date: 18-DEC-19	Drawn by: JH	Edited by: KR	App'd by: LP
Fisheries and Oceans Canada	Advisian Worley Group	Project No. 307071-01306	
		FIG No 10	REV 0

PLOT DATE & TIME: 2019-12-18 1:15:04 PM USER NAME: Jennifer Huang
SAVE DATE & TIME: 2019-12-18 1:14:58 PM ISSUING OFFICE: BURNABY GIS

FILE LOCATION: U:\YVR\307071\01306_DFO_LanStHarSt\10_Eng\16_Geomatics\01_Mxd\Wildlife_Mapping\ClydeRiver\Fig10_CR_HarvestedEiderDuck.mxd

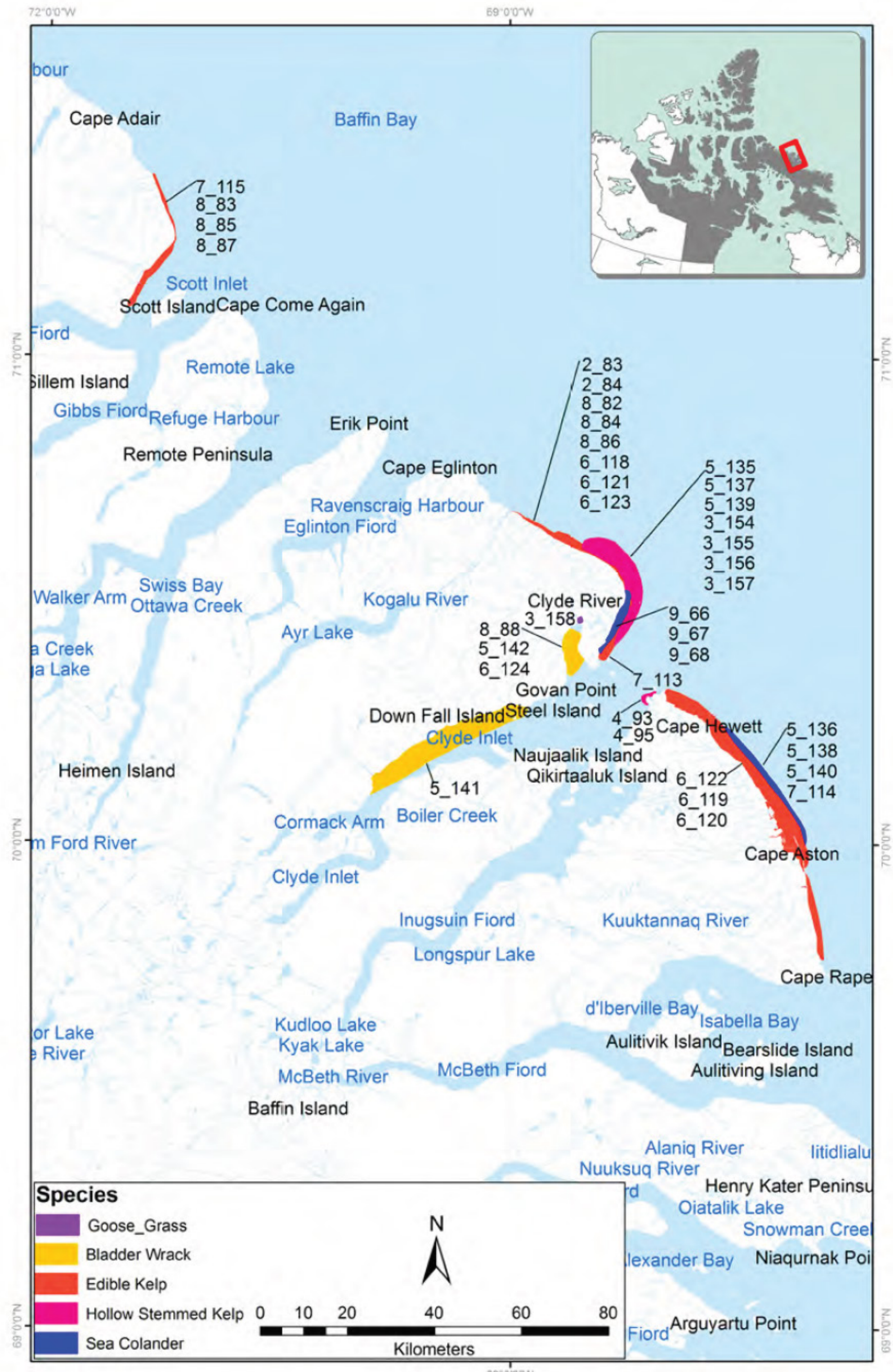
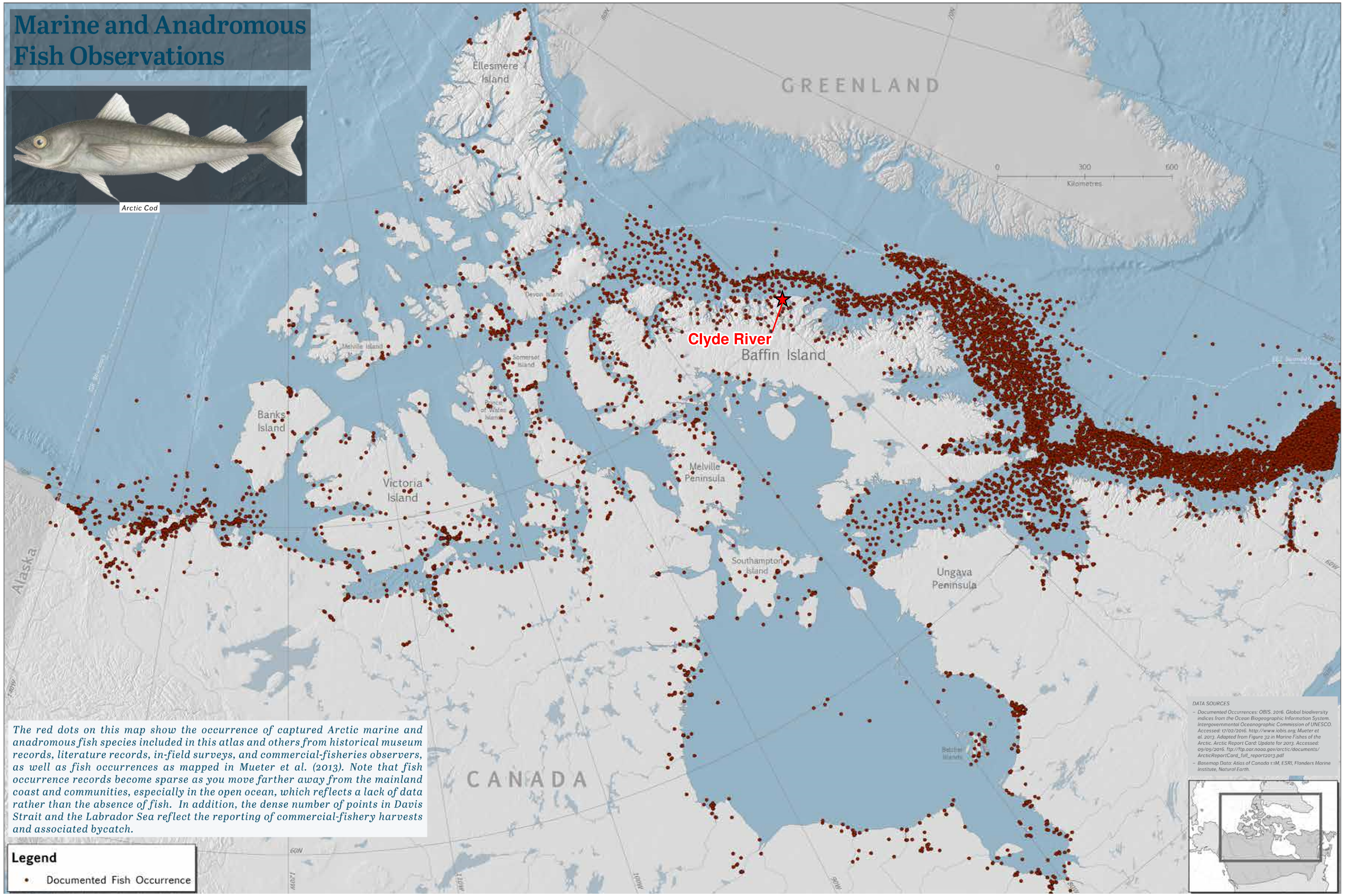


Figure 11 NCRI Clyde River IQ Data for Seaweed Distribution



Location approximated.

FISHERIES AND OCEANS CANADA
CLYDE RIVER HARBOUR DEVELOPMENT
ENVIRONMENTAL AND SOCIO-ECONOMIC BASELINE SURVEY

ANADROMOUS FISH DISTRIBUTION IN CANADA

Fisheries and Oceans Canada	Date:	18-DEC-19	Drawn by:	KR	Edited by:	KR	App'd by: VB
Advisian Worley Group					Project No.	307071-01306	
					FIG No	12	REV 0

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PLOT DATE & TIME: 2019-12-18 12:41:27 PM USER NAME: Jennifer.Huang
SAVE DATE & TIME: 2019-12-18 12:41:22 PM ISSUING OFFICE: BURNABY GIS

FILE LOCATION: U:\YVR\307071\01306_DFO_LanStHarSt\10_Eng\16_Geomatics\01_Mxd\ES_Baseline\ClydeRiver\Fig12_CR_AnadromousFish.mxd

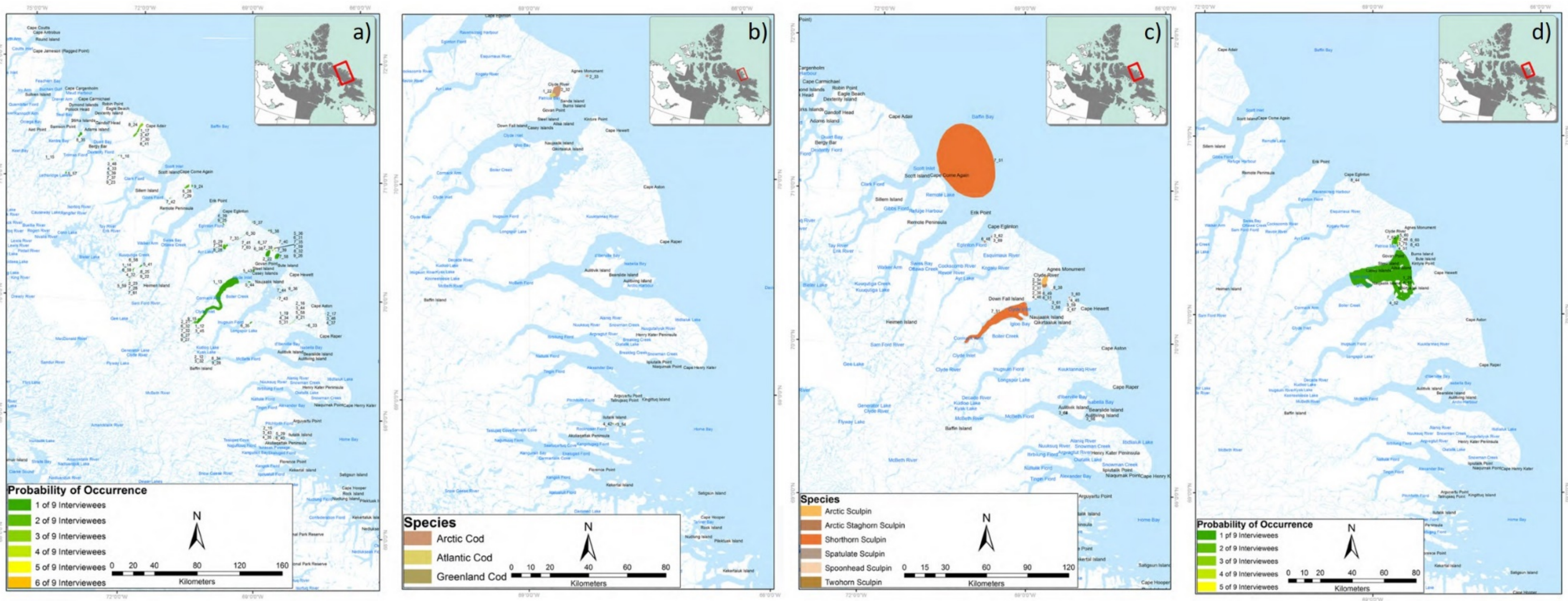

Figure 13 NCRI Clyde River IQ Data for a) Arctic Char, b) Arctic cod, c) Sculpin and d) Clam Distribution

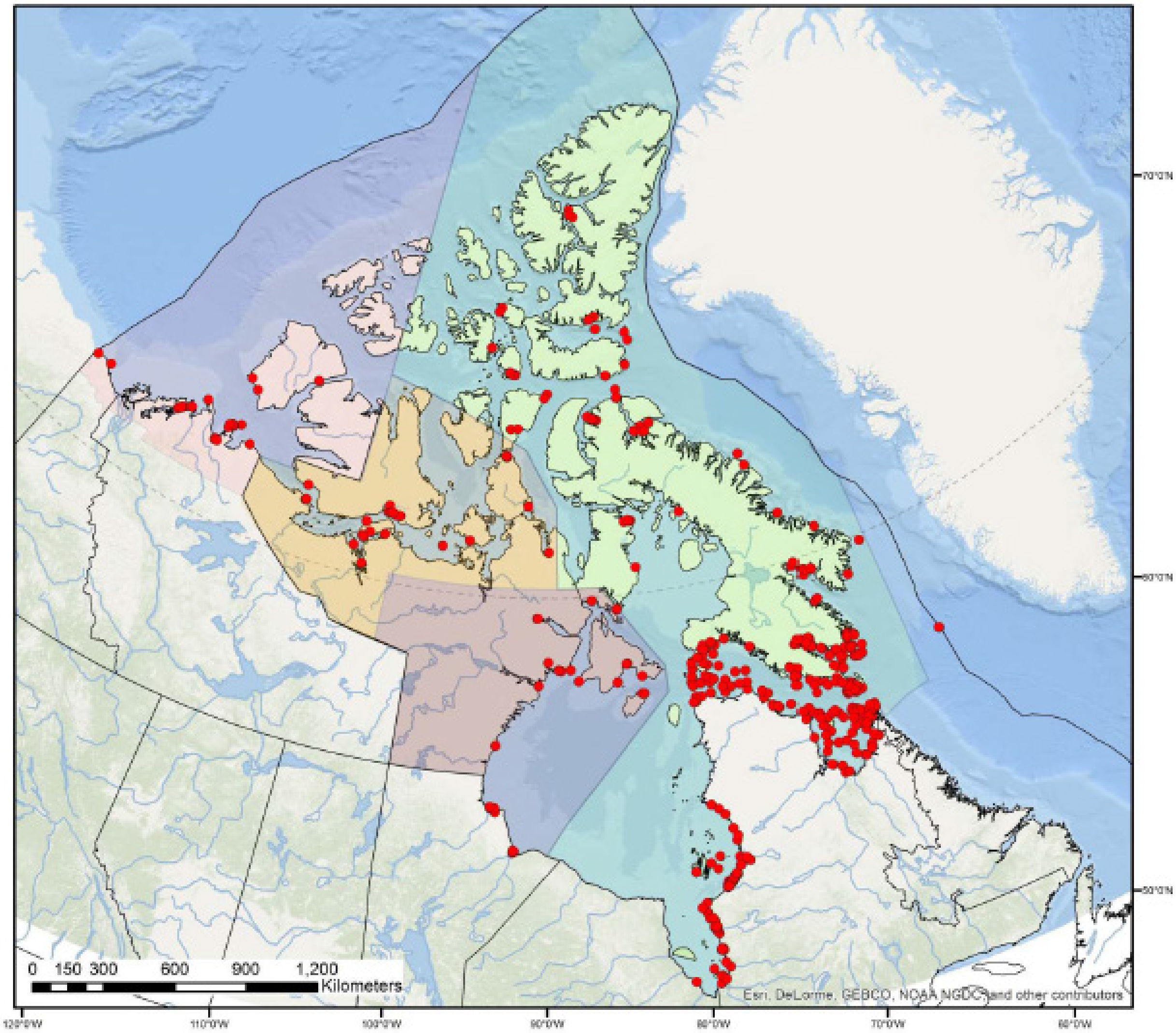

Figure 14 Records of Myoxocephalus scorpius (Shorthorn sculpin) in the Marine Fishes of Canada data base

Source: Figure 157 of Alfonso et al (2018)

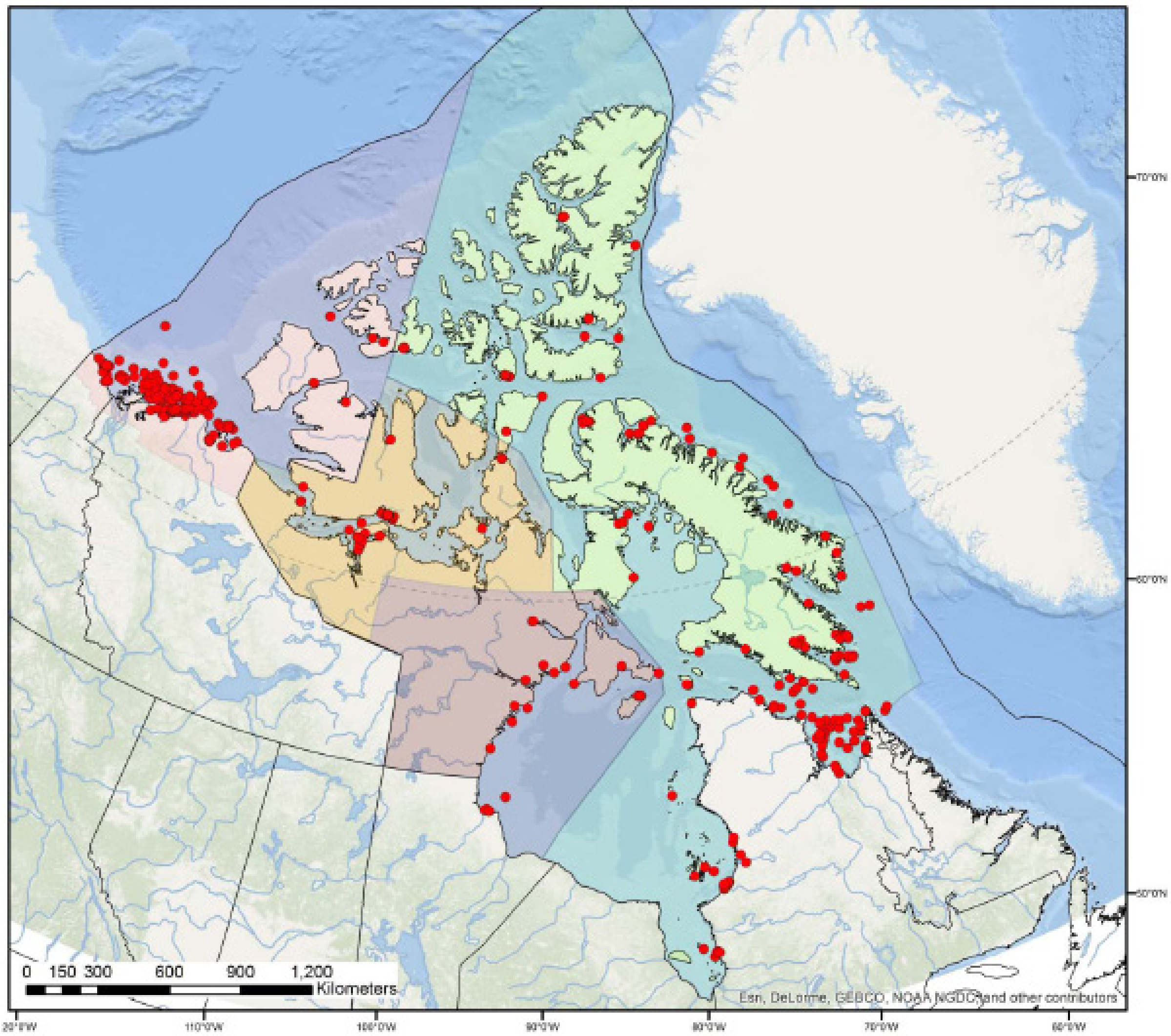

Figure 15 **Records of Gymnocanthus tricuspis (Arctic Staghorn sculpin) in the Marine Fishes of Canada data base.**

Source: Figure 9 of Alfonso et al (2018)

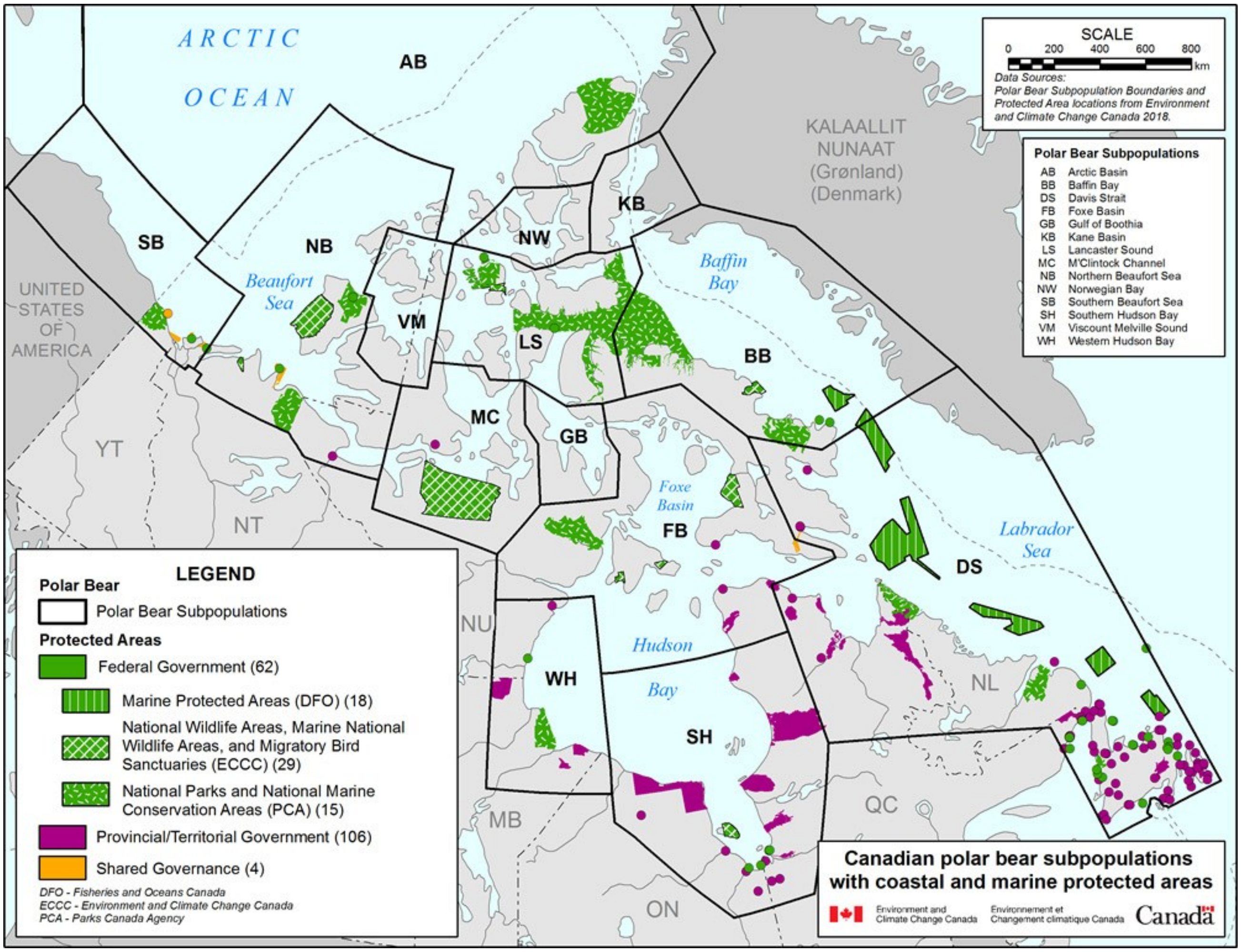

Figure 16 Map of subpopulation of polar bears and protected areas

Source: Government of Canada, 2019

Appendix 2 Water Quality Summary of Analytical Results

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Table 1

Water Quality Results: General and Salinity Parameters

PROJECT No.: 307071-01306

Monitoring Station	Date (dd-mmm-yyyy)	pH (pH units)	Hardness (as CaCO3) - Total Calculated (mg/L)	Hardness (as CaCO3) - Dissolved (mg/L)	Total Organic Carbon (mg/L)	Total Suspended Solids (mg/L)	Nitrate as N (mg/L)	Nitrate plus nitrite as N (mg/L)	Nitrite as N (mg/L)	Ammonia as N (mg/L)	Filter and HNO3 Preservation (none)	Sulphur - Dissolved (mg/L)	Sulphur - Total (mg/L)	Orthophosphate (mg/L)	Total Phosphorus (mg/L)
CCME Marinewater Aquatic Life, 2007 [#1]		**(7 - 8.7)**	**---**	**---**	**---**	**---**	**3.6**	**---**	**---**	**---**	**---**	**---**	**---**	**---**	**---**
Clyde River															
CR 1 DEEP	12-Aug-2019	7.93	5780	5770	97 [#2]	< 4.0	---	---	---	0.88	FIELD	878	874	0.016	0.017 [#3]
CR 1 SHALLOW	12-Aug-2019	7.86	4720	5210	82 [#2]	9.2	---	---	---	1.3	FIELD	800	715	0.0095	0.011 [#3]
CR 2 DEEP	12-Aug-2019	7.90	6030	5780	98 [#2]	7.6	---	---	---	0.56	FIELD	878	912	0.016	0.017 [#3]
CR 2 SHALLOW	12-Aug-2019	7.94	5100	4970	84 [#2]	7.6	---	---	---	1.3	FIELD	762	768	0.0083	0.011 [#3]
CR 3 DEEP	12-Aug-2019	7.90	4950	4980	80 [#2]	< 4.0	---	---	---	0.61	FIELD	755	753	0.0090	0.012 [#3]
CR 3 SHALLOW	12-Aug-2019	7.93	4910	5100	79 [#2]	11.2	---	---	---	0.65	FIELD	776	750	0.0090	0.011 [#3]
RPD		0.003790272	0.008	-0.024	#####	#####	######	#VALUE!	#VALUE!	0.063492	#######	-0.027	0.004	0	#VALUE!
CR 4 DEEP	12-Aug-2019	7.84	6170	5880	96 [#2]	< 4.0	---	---	---	0.57	FIELD	895	923	0.022	0.028 [#3]
CR 4 SHALLOW	12-Aug-2019	7.91	4990	5030	86 [#2]	< 4.0	---	---	---	1.0	FIELD	760	755	0.0087	0.012 [#3]
Arctic Bay															
ABS 1 DEEP	10-Aug-2019	7.92	5440	5240	63 [#2]	7.2	< 0.020	< 0.020 [#5]	< 0.0050 [#5]	0.60 [#4]	FIELD	777	830	0.022	0.10 [#6]
ABS 1 SHALLOW	10-Aug-2019	7.99	4180	4200	44 [#2]	6.6	< 0.020	< 0.020	< 0.0050	0.45 [#4]	FIELD	630	636	0.0072	< 0.030 [#6]
ABS 2 DEEP	10-Aug-2019	7.98	5310	5140	65 [#2]	2.7	< 0.020	< 0.020	< 0.0050	0.78 [#4]	FIELD	770	803	0.020	0.039 [#6]
ABS 2 SHALLOW	10-Aug-2019	8.00	4340	4290	47 [#2]	4.3	< 0.020	< 0.020	< 0.0050	0.28 [#4]	FIELD	648	661	0.0073	< 0.030 [#6]
ABS 3 DEEP	10-Aug-2019	8.00	5070	5100	62 [#2]	3.0	< 0.020	< 0.020	< 0.0050	0.11 [#4]	FIELD	776	771	0.020	0.035 [#6]
ABS 3 SHALLOW	10-Aug-2019	8.00	4430	4280	50 [#2]	1.7	< 0.020	< 0.020	< 0.0050	0.54 [#4]	FIELD	669	669	0.0079	< 0.030 [#6]
ABS 4 SHALLOW	10-Aug-2019	8.02	4270	4390	54 [#2]	1.3	< 0.020	< 0.020	< 0.0050	0.67 [#4]	FIELD	667	652	0.0081	0.025 [#6]
ABS 5 SHALLOW	10-Aug-2019	7.98	4130	4160	51 [#2]	2.2	< 0.020	< 0.020	< 0.0050	< 0.010 [#4]	FIELD	617	633	0.0073	0.079 [#6]
Grise Fiord															
GF 1 DEEP	16-Aug-2019	7.89	5630	5910	93 [#2]	7.6	---	---	---	0.85	FIELD	919	847	0.021	0.024
GF 1 SHALLOW	16-Aug-2019	7.98	4530	4510	73 [#2]	6.8	---	---	---	0.85	FIELD	687	678	0.0086	0.011
GF 2 DEEP	16-Aug-2019	7.99	4480	4620	75 [#2]	9.2	---	---	---	1.0	FIELD	737	667	0.0085	0.011
GF 3 DEEP	16-Aug-2019	7.83	5790	5950	100 [#2]	12.4	---	---	---	0.58 [#7]	FIELD	939	872	0.024	0.027
GF 3 SHALLOW	16-Aug-2019	8.00	4430	4660	70 [#2]	12.4	---	---	---	0.86	FIELD	740	668	0.0075	0.011
GF 4 DEEP	16-Aug-2019	**4.96 [#1]**	< 0.50	< 0.50	< 10 [#2]	< 4.0	---	---	---	< 0.015	FIELD	< 20	< 20	< 0.0030	< 0.0030
GF 5 SHALLOW	16-Aug-2019	7.96	4780	4970	86 [#2]	6.4	---	---	---	0.70	FIELD	785	718	0.0087	0.012
GF 6 SHALLOW	16-Aug-2019	8.00	4910	4940	84 [#2]	5.2	---	---	---	0.83	FIELD	749	734	0.0084	0.011
Resolute Bay															
RB 1 DEEP	18-Aug-2019	7.95	5560	5780	93 [#2]	10.4	---	---	---	1.3	FIELD	860	831	0.019	0.023
RB 1 SHALLOW	18-Aug-2019	7.88	4650	5000	85 [#2]	6.8	---	---	---	0.68	FIELD	747	691	0.011	0.030
RB 2 DEEP	18-Aug-2019	7.96	5430	5700	100 [#2]	9.2	---	---	---	1.1	FIELD	872	811	0.019	0.022
RB 2 SHALLOW	18-Aug-2019	7.89	4680	4790	81 [#2]	8.0	---	---	---	1.4	FIELD	721	700	0.0099	0.014
RB 3 DEEP	18-Aug-2019	7.92	4800	245	87 [#2]	< 4.0	---	---	---	0.75	FIELD	37	717	0.012	0.012
RB 3 SHALLOW	18-Aug-2019	7.92	4710	4910	84 [#2]	6.4	---	---	---	0.82	FIELD	754	704	0.011	0.012
RB 4 DEEP	18-Aug-2019	7.96	6870	276	94 [#2]	14.0	---	---	---	0.61	FIELD	41	951	0.013	0.015
RB 4 SHALLOW	18-Aug-2019	7.89	6420	244	83 [#2]	< 4.0	---	---	---	0.82	FIELD	37	869	0.013	0.012

NOTES:

1. --- in guideline row(s) denotes no criteria for that parameter.
2. --- in detail data row(s) denotes parameter not analyzed.
3. Highlighting indicates parameters above applied guideline/criteria.
4. Highlighting indicates non-detect parameters above applied guideline/criteria.
5. Highlighting indicates parameters at applied guideline/criteria.
6. Superscript [#1] denotes values exceeding
   (Canadian Environmental Quality Guidelines for the Protection of Aquatic Life (CCME, 1999 and Updates, last update v7 2007))
   Nitrate as N:
   Guideline for NO3 as N, for reporting as just "NO3", the guideline is 3.6 mg/L
7. Superscript [#2] - Detection limits raised due to sample matrix.
8. Superscript [#3] - Sample analyzed past hold time.
9. Superscript [#4] - Detection limits raised due to dilution to bring analyte within the calibrated range.
10. Superscript [#5] - Matrix spike exceeds acceptance limits due to suspected matrix interference.
11. Superscript [#6] - Due to the sample matrix, sample required dilution. Detection limit was adjusted accordingly.
12. Superscript [#7] - Matrix spike exceeds acceptance limits due to probable matrix interference.

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Table 2

Water Quality Results: Dissolved Metals and Trace Elements

PROJECT No.: 307071-01306

Monitoring Station	Date (dd-mmm-yyyy)	pH (pH units)	Aluminum (ug/L)	Antimony (ug/L)	Arsenic (ug/L)	Barium (ug/L)	Beryllium (ug/L)	Bismuth (ug/L)	Boron (ug/L)	Cadmium (ug/L)	Calcium (mg/L)	Chromium (ug/L)	Cobalt (ug/L)	Copper (ug/L)	Iron (ug/L)	Lead (ug/L)	Lithium (ug/L)	Magnesium (mg/L)	Manganese (ug/L)	Mercury (ug/L)	Molybdenum (ug/L)	Nickel (ug/L)	Phosphorus (ug/L)	Potassium (mg/L)	Selenium (ug/L)	Silicon (ug/L)	Silver (ug/L)	Sodium (mg/L)	Strontium (ug/L)	Thallium (ug/L)	Tin (ug/L)	Titanium (ug/L)	Uranium (ug/L)	Vanadium (ug/L)	Zinc (ug/L)	Zirconium (ug/L)
CCME Marinewater Aquatic Life, 2007 [#1]		**(7 - 8.7)**	---	---	**12.5**	---	---	---	---	**0.12**	---	**1.5**	---	---	---	---	---	---	---	**0.016**	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Clyde River																																				
CR 1 DEEP	12-Aug-2019	7.93	15	< 0.50	2.75	8.6	< 1.0	< 1.0	4030	< 0.050	374	0.68	< 0.10	< 0.50	< 10	< 0.10	159	1170	< 0.50	< 0.0020 [#2]	10.2	0.57	---	352	< 0.50	< 1000	< 0.050	---	7800	< 0.10	< 1.0	< 10	2.89	< 10	< 5.0	< 10
CR 1 SHALLOW	12-Aug-2019	7.86	32	< 0.50	1.99	7.9	< 1.0	< 1.0	3630	< 0.050	340	0.54	< 0.10	0.95	< 10	0.27	142	1060	1.03	< 0.0020	9.4	0.63	---	316	< 0.50	< 1000	< 0.050	---	7120	< 0.10	< 1.0 [#3]	< 10	2.78	< 10	7.8	< 10
CR 2 DEEP	12-Aug-2019	7.90	14	< 0.50	2.68	8.6	< 1.0	< 1.0	4250	< 0.050	378	0.66	< 0.10	< 0.50	< 10	< 0.10	166	1170	< 0.50	< 0.0020	10.4	0.52	---	352	< 0.50	< 1000	< 0.050	---	7990	< 0.10	< 1.0	< 10	2.93	< 10	< 5.0	< 10
CR 2 SHALLOW	12-Aug-2019	7.94	16	< 0.50	2.46	7.3	< 1.0	< 1.0	3590	< 0.050	323	< 0.50	< 0.10	< 0.50	< 10	0.11	142	1010	0.65	< 0.0020	9.0	0.70	---	305	< 0.50	< 1000	< 0.050	---	6950	< 0.10	< 1.0	< 10	2.60	< 10	< 5.0	< 10
CR 3 DEEP	12-Aug-2019	7.90	16	< 0.50	2.63	7.2	< 1.0	< 1.0	3540	< 0.050	319	0.63	< 0.10	< 0.50	< 10	< 0.10	146	1020	0.56	< 0.0020	8.9	0.56	---	303	< 0.50	< 1000	< 0.050	---	6700	< 0.10	< 1.0	< 10	2.54	< 10	< 5.0	< 10
CR 3 SHALLOW DUPE	12-Aug-2019	7.93	16	< 0.50	2.46	7.5	< 1.0	< 1.0	3610	< 0.050	328	0.67	< 0.10	< 0.50	< 10	< 0.10	144	1040	0.68	< 0.0020	9.0	0.64	---	311	< 0.50	< 1000	< 0.050	---	6860	< 0.10	< 1.0	< 10	2.59	< 10	< 5.0	< 10
RDP		0.00379	0	#####	0.067	0.041	#####	#####	0.02	######	0.028	0.062	#####	#####	#####	#####	0.014	0.019	0.194	#VALUE!	0.011	0.133	#####	0.026	#####	######	######	#####	0.024	#####	######	#####	0.0195	#####	#####	#####
CR 4 DEEP	12-Aug-2019	7.84	18	< 0.50	2.95	8.3	< 1.0	< 1.0	4200	0.064	380	0.95	< 0.10	0.63	< 10	0.13	171	1200	< 0.50	< 0.0020	10.5	0.73	---	357	< 0.50	< 1000	< 0.050	---	8130	< 0.10	< 1.0	< 10	3.00	< 10	11.6	< 10
CR 4 SHALLOW	12-Aug-2019	7.91	16	< 0.50	2.66	7.2	< 1.0	< 1.0	3570	< 0.050	325	0.76	< 0.10	0.56	< 10	0.11	149	1020	0.67	< 0.0020	8.7	0.57	---	306	< 0.50	< 1000	< 0.050	---	6820	< 0.10	< 1.0	< 10	2.60	< 10	5.1	< 10
Arctic Bay																																				
ABS 1 DEEP	10-Aug-2019	7.92	13	< 0.50	2.89	8.3	< 1.0	< 1.0	3780	< 0.050	346	< 0.50	< 0.10	< 0.50	< 10	< 0.10	156	1060	< 0.50	< 0.0020	9.8	0.98	< 50	328	< 0.50	< 1000	< 0.050	9190	7130	< 0.10	< 1.0	< 10	2.82	< 10	< 5.0	---
ABS 1 SHALLOW	10-Aug-2019	7.99	28	< 0.50	2.50	4.2	< 1.0	< 1.0	2930	< 0.050	283	< 0.50	0.11	0.92	< 10	0.22	123	849	0.69	< 0.0020	8.0	0.94	< 50	262	< 0.50	< 1000	< 0.050	7260	5570	< 0.10	< 1.0	< 10	2.17	< 10	30.0	---
ABS 2 DEEP	10-Aug-2019	7.98	20	< 0.50	2.60	7.8	< 1.0	< 1.0	3790	< 0.050	340	< 0.50	0.12	< 0.50	< 10	< 0.10	154	1040	< 0.50	< 0.0020	9.7	0.86	< 50	322	< 0.50	< 1000	< 0.050	8790	6750	< 0.10	< 1.0	< 10	2.70	< 10	< 5.0	---
ABS 2 SHALLOW	10-Aug-2019	8.00	18	< 0.50	2.14	4.2	< 1.0	< 1.0	3110	< 0.050	284	< 0.50	< 0.10	< 0.50	21	< 0.10	129	869	0.75	< 0.0020	8.2	1.13	< 50	267	< 0.50	< 1000	< 0.050	7490	5710	< 0.10	< 1.0	< 10	2.21	< 10	< 5.0	---
ABS 3 DEEP	10-Aug-2019	8.00	22	< 0.50	2.59	8.2	< 1.0	< 1.0	3820	< 0.050	331	< 0.50	0.12	< 0.50	< 10	< 0.10	154	1040	< 0.50	< 0.0020	9.3	0.72	< 50	315	< 0.50	< 1000	< 0.050	8880	6860	< 0.10	< 1.0	< 10	2.67	< 10	< 5.0	---
ABS 3 SHALLOW	10-Aug-2019	8.00	22	< 0.50	2.34	5.6	< 1.0	< 1.0	3150	< 0.050	283	< 0.50	0.10	< 0.50	10	< 0.10	131	868	1.39	< 0.0020	8.0	0.61	< 50	267	< 0.50	< 1000	< 0.050	7450	5660	< 0.10	< 1.0	< 10	2.18	< 10	< 5.0	---
ABS 4 SHALLOW	10-Aug-2019	8.02	18	< 0.50	2.25	4.7	< 1.0	< 1.0	3190	< 0.050	288	0.59	0.10	< 0.50	< 10	< 0.10	130	891	2.28	< 0.0020	8.0	0.68	< 50	272	< 0.50	< 1000	< 0.050	7560	5810	< 0.10	< 1.0	< 10	2.29	< 10	< 5.0	---
ABS 5 SHALLOW	10-Aug-2019	7.98	19	< 0.50	2.56	5.1	< 1.0	< 1.0	3070	< 0.050	279	< 0.50	< 0.10	< 0.50	< 10	< 0.10	125	842	1.91	< 0.0020	7.8	0.93	< 50	260	< 0.50	< 1000	< 0.050	7070	5570	< 0.10	< 1.0	< 10	2.09	< 10	< 5.0	---
Grise Fiord																																				
GF 1 DEEP	16-Aug-2019	7.89	11	< 0.50	3.19	9.6	< 1.0	< 1.0	4070	< 0.050	410	< 0.50	< 0.10	< 0.50	< 10	< 0.10	169	1190	< 0.50	< 0.0020	10.8	0.28	---	357	< 0.50	< 1000	< 0.050	---	7950	< 0.10	1.7	< 10	2.93	< 10	< 5.0	< 10
GF 1 SHALLOW	16-Aug-2019	7.98	27	< 0.50	2.98	9.5	< 1.0	< 1.0	3210	< 0.050	297	0.82	0.13	0.61	< 10	0.36	132	914	2.32	< 0.0020	8.1	0.45	---	274	< 0.50	< 1000	< 0.050	---	6140	< 0.10	< 1.0	< 10	2.38	10	9.7	< 10
GF 2 DEEP	16-Aug-2019	7.99	14	< 0.50	2.63	11.8	< 1.0	< 1.0	3180	0.084	334	< 0.50	< 0.10	< 0.50	< 10	< 0.10	131	920	1.02	< 0.0020	8.5	1.00 [#4]	---	278	< 0.50	< 1000	< 0.050	---	6250	< 0.10	< 1.0	< 10	2.37	10	< 5.0	< 10
GF 3 DEEP	16-Aug-2019	7.83	11	< 0.50	3.30	11.2	< 1.0	< 1.0	4030	**0.129 [#1]**	428	< 0.50	< 0.10	< 0.50	< 10	< 0.10	164	1180	< 0.50	< 0.0020	10.8	0.59	---	358	< 0.50	< 1000	< 0.050	---	7870	< 0.10	< 1.0	< 10	3.01	< 10	< 5.0	< 10
GF 3 SHALLOW	16-Aug-2019	8.00	13	< 0.50	2.73	12.0	< 1.0	< 1.0	3190	0.066	335	< 0.50	< 0.10	< 0.50	< 10	< 0.10	129	928	1.07	< 0.0020	8.5	0.65	---	276	< 0.50	< 1000	< 0.050	---	6230	< 0.10	< 1.0	< 10	2.40	10	< 5.0	< 10
GF 4 DEEP	16-Aug-2019	**4.96 [#1]**	18	< 0.50	1.01	< 1.0	< 1.0	< 1.0	< 50	< 0.050	< 1.0	1.09	< 0.10	1.24	16	< 0.10	< 20	< 1.0	< 0.50	< 0.0020	< 1.0	< 0.20	---	< 1.0	< 0.50	< 1000	< 0.050	---	< 10	< 0.10	1.2	< 10	< 0.050	17	< 5.0	< 10
GF 5 SHALLOW	16-Aug-2019	7.96	13	< 0.50	3.08	7.7	< 1.0	< 1.0	3450	0.085	356	< 0.50	< 0.10	< 0.50	41	< 0.10	139	992	1.20	< 0.0020	9.1	1.64 [#4]	---	300	< 0.50	< 1000	< 0.050	---	6630	< 0.10	< 1.0	< 10	2.54	< 10	< 5.0	< 10
GF 6 SHALLOW	16-Aug-2019	8.00	16	< 0.50	2.67	8.2	< 1.0	< 1.0	3490	< 0.050	319	0.51	< 0.10	< 0.50	< 10	< 0.10	140	1010	0.66	< 0.0020	8.9	0.48	---	301	< 0.50	< 1000	< 0.050	---	6770	< 0.10	< 1.0	< 10	2.52	10	6.0	< 10
Resolute Bay																																				
RB 1 DEEP	18-Aug-2019	7.95	20	< 0.50	2.72	9.0	< 1.0	< 1.0	4080	0.066	373	1.13	< 0.10	0.90	14	< 0.10	164	1180	2.24	< 0.0020	10.3	0.55	---	351	< 0.50	< 1000	< 0.050	---	7790	< 0.10	< 1.0	< 10	2.86	11	< 5.0	< 10
RB 1 SHALLOW	18-Aug-2019	7.88	20	< 0.50	2.91	7.9	< 1.0	< 1.0	3410	0.056	321	1.30	< 0.10	0.92	24	< 0.10	143	1020	0.68	< 0.0020	8.7	0.97	---	297	< 0.50	< 1000	< 0.050	---	6680	< 0.10	1.3	< 10	2.55	11	6.1	< 10
RB 2 DEEP	18-Aug-2019	7.96	35	< 0.50	2.96	9.4	< 1.0	< 1.0	3970	0.080	382	< 0.50	< 0.10	0.81	15	< 0.10	162	1150	1.51	< 0.0020	10.6	0.60	---	347	< 0.50	< 1000	< 0.050	---	7570	< 0.10	< 1.0	< 10	2.84	< 10	< 5.0	< 10
RB 2 SHALLOW	18-Aug-2019	7.89	31	< 0.50	2.52	8.2	< 1.0	< 1.0	3460	< 0.050	322	1.15	0.20	< 0.50	14	0.24	140	969	< 0.50	< 0.0020	8.7	0.50	---	288	< 0.50	< 1000	< 0.050	---	6560	< 0.10	1.0	< 10	2.45	10	< 5.0	< 10
RB 3 DEEP	18-Aug-2019	7.92	< 10	< 0.50	< 0.50	< 1.0	< 1.0	< 1.0	174	< 0.050	15.7	< 0.50	< 0.10	< 0.50	< 10	< 0.10	< 20	50.0	< 0.50	< 0.0020	< 1.0	< 0.20	---	15.0	< 0.50	< 1000	< 0.050	---	325	< 0.10	< 1.0	< 10	0.122	< 10	< 5.0	< 10
RB 3 SHALLOW	18-Aug-2019	7.92	49	< 0.50	2.33	8.9	< 1.0	< 1.0	3360	0.057	339	**1.58 [#1]**	< 0.10	0.56	22	< 0.10	140	987	< 0.50	< 0.0020	9.1	0.74	---	293	< 0.50	< 1000	< 0.050	---	6460	< 0.10	1.1	< 10	2.52	< 10	< 5.0	< 10
RB 4 DEEP	18-Aug-2019	7.96	< 10	< 0.50	< 0.50	< 1.0	< 1.0	< 1.0	194	< 0.050	17.6	< 0.50	< 0.10	< 0.50	< 10	< 0.10	< 20	56.4	< 0.50	< 0.0020	< 1.0	< 0.20	---	16.7	< 0.50	< 1000	< 0.050	---	367	< 0.10	< 1.0	< 10	0.140	< 10	< 5.0	< 10
RB 4 SHALLOW	18-Aug-2019	7.89	< 10	< 0.50	< 0.50	< 1.0	< 1.0	< 1.0	168	< 0.050	16.1	< 0.50	< 0.10	< 0.50	< 10	< 0.10	< 20	49.6	< 0.50	< 0.0020	< 1.0	< 0.20	---	14.8	< 0.50	< 1000	< 0.050	---	323	< 0.10	< 1.0	< 10	0.125	< 10	< 5.0	< 10

NOTES:

1. --- in guideline row(s) denotes no criteria for that parameter.
2. --- in detail data row(s) denotes parameter not analyzed.
3. Highlighting indicates parameters above applied guideline/criteria.
4. Highlighting indicates non-detect parameters above applied guideline/criteria.
5. Highlighting indicates parameters at applied guideline/criteria.
6. Superscript [#1] denotes values exceeding
   (Canadian Environmental Quality Guidelines for the Protection of Aquatic Life (CCME, 1999 and Updates, last update v7 2007))
   Chromium:
   Standard is for Chromium VI as it is the most conservative value.
7. Superscript [#2] - Matrix spike exceeds acceptance limits due to probable matrix interference.
8. Superscript [#3] - Matrix Spike outside acceptance criteria due to sample matrix interference.
9. Superscript [#4] - Dissolved greater than total. Reanalysis yields similar results.

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Table 3

Water Quality Results: Total Metals and Trace Elements

PROJECT No.: 307071-01306

Monitoring Station	Date (dd-mmm-yyyy)	pH (pH units)	Aluminum (ug/L)	Antimony (ug/L)	Arsenic (ug/L)	Barium (ug/L)	Beryllium (ug/L)	Bismuth (ug/L)	Boron (ug/L)	Cadmium (ug/L)	Calcium (mg/L)	Chromium (ug/L)	Cobalt (ug/L)	Copper (ug/L)	Iron (ug/L)	Lead (ug/L)	Lithium (ug/L)	Magnesium (mg/L)	Manganese (ug/L)	Mercury (ug/L)	Molybdenum (ug/L)	Nickel (ug/L)	Phosphorus (ug/L)	Potassium (mg/L)	Selenium (ug/L)	Silicon (ug/L)	Silver (ug/L)	Sodium (mg/L)	Strontium (ug/L)	Thallium (ug/L)	Tin (ug/L)	Titanium (ug/L)	Uranium (ug/L)	Vanadium (ug/L)	Zinc (ug/L)	Zirconium (ug/L)
CCME Marinewater Aquatic Life, 2007		(7 - 8.7)	---	---	12.5	---	---	---	---	0.12	---	1.5	---	---	---	---	---	---	---	0.016	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Clyde River																																				
CR 1 DEEP	12-Aug-2019	7.93	37	< 0.50	2.25	8.6	< 1.0	< 1.0	3930	< 0.050	372	< 0.50	< 0.10	0.59	< 10	< 0.10	165	1180	< 0.50	< 0.0020	10.6	0.50	---	352	< 0.50	< 1000	< 0.050	---	7900	< 0.10	< 1.0	< 10	2.82	< 10	5.2	< 10
CR 1 SHALLOW	12-Aug-2019	7.86	37	< 0.50	2.28	7.3	< 1.0	< 1.0	3290	< 0.050	308	0.55	< 0.10	2.00	10	1.14	139	961	0.95	< 0.0020	8.8 [#3]	0.67	---	289	< 0.50	< 1000	< 0.050	---	6490	< 0.10	< 1.0 [#3]	< 10	2.48	< 10	6.6	< 10
CR 2 DEEP	12-Aug-2019	7.90	33	< 0.50	2.60	9.3	< 1.0	< 1.0	4010	0.062	389	0.57	< 0.10	< 0.50	< 10	< 0.10	168	1230	< 0.50	< 0.0020	10.9	0.57	---	365	< 0.50	< 1000	< 0.050	---	8410	< 0.10	< 1.0	< 10	3.00	< 10	< 5.0	< 10
CR 2 SHALLOW	12-Aug-2019	7.94	37	< 0.50	2.47	7.8	< 1.0	< 1.0	3440	< 0.050	327	0.84	< 0.10	1.02	11	0.31	145	1040	0.83	< 0.0020	9.1	0.73	---	310	< 0.50	< 1000	< 0.050	---	6930	< 0.10	< 1.0	< 10	2.59	< 10	5.2	< 10
CR 3 DEEP (dup)	12-Aug-2019	7.90	37	< 0.50	2.36	7.5	< 1.0	< 1.0	3340	< 0.050	319	0.54	< 0.10	0.51	< 10	< 0.10	137	1010	0.65	< 0.0020	9.2	0.72	---	305	< 0.50	< 1000	< 0.050	---	6760	< 0.10	< 1.0	< 10	2.50	< 10	< 5.0	< 10
RPD		0.005051	0	#VALUE!	0.046	0.039	#VALUE!	#VALUE!	0.029	#VALUE!	0.0248	0.435	#VALUE!	0.667	#VALUE!	#VALUE!	0.057	0.0293	0.243	#VALUE!	0.011	0.014		0.0163	#VALUE!	#VALUE!	#VALUE!		0.025	#VALUE!	#VALUE!	#VALUE!	0.0354	#VALUE!	#VALUE!	#VALUE!
CR 3 SHALLOW	12-Aug-2019	7.93	38	< 0.50	1.91	7.6	< 1.0	< 1.0	3330	< 0.050	316	< 0.50	< 0.10	< 0.50	< 10	0.14	137	1000	0.68	< 0.0020	9.2	0.60	---	304	< 0.50	< 1000	< 0.050	---	6800	< 0.10	< 1.0	< 10	2.49	< 10	< 5.0	< 10
CR 4 DEEP	12-Aug-2019	7.84	32	< 0.50	2.51	8.9	< 1.0	< 1.0	4170	0.054	405	< 0.50	< 0.10	0.54	< 10	< 0.10	172	1250	< 0.50	< 0.0020	11.0	0.40	---	376	< 0.50	< 1000	< 0.050	---	8620	< 0.10	< 1.0	< 10	3.08	< 10	< 5.0	< 10
CR 4 SHALLOW	12-Aug-2019	7.91	37	< 0.50	1.74	7.6	< 1.0	< 1.0	3350	< 0.050	321	0.89	< 0.10	0.78	11	0.36	138	1020	0.72	< 0.0020	9.0	0.55	---	305	< 0.50	< 1000	< 0.050	---	6810	< 0.10	< 1.0	< 10	2.51	< 10	< 5.0	< 10
Arctic Bay																																				
ABS 1 DEEP	10-Aug-2019	7.92	59	< 0.50	2.01	9.1	< 1.0	< 1.0	3730	< 0.050	352	< 0.50	0.16	0.61	26	< 0.10	162	1110	0.86	< 0.0020	10.1	1.26	< 50	335	0.52	< 1000	< 0.050	9810	7310	< 0.10	< 1.0	< 10	2.99	< 10	7.7	---
ABS 1 SHALLOW	10-Aug-2019	7.99	66	< 0.50	0.75	4.7	< 1.0	< 1.0	2850	< 0.050	277	< 0.50	0.12	1.22	29	0.41	123	846	1.31	< 0.0020	7.9	1.05	< 50	260	< 0.50	< 1000	< 0.050	7620	5590	< 0.10	< 1.0	< 10	2.30	< 10	33.4	---
ABS 2 DEEP	10-Aug-2019	7.98	34	< 0.50	1.60	9.4	< 1.0	< 1.0	3650	< 0.050	348	< 0.50	0.14	< 0.50	15	< 0.10	157	1080	< 0.50	< 0.0020	10.0	1.07	< 50	329	< 0.50	< 1000	< 0.050	9470	7040	< 0.10	< 1.0	< 10	2.82	< 10	6.0	---
ABS 2 SHALLOW	10-Aug-2019	8.00	46	< 0.50	0.89	4.7	< 1.0	< 1.0	3000	< 0.050	285	< 0.50	0.10	0.71	30	0.12	130	882	1.21	< 0.0020	8.0	1.10	< 50	268	< 0.50	< 1000	< 0.050	7740	5660	< 0.10	< 1.0	< 10	2.30	< 10	6.7	---
ABS 3 DEEP	10-Aug-2019	8.00	34	< 0.50	1.65	10.0	< 1.0	< 1.0	3590	< 0.050	335	< 0.50	0.13	< 0.50	18	< 0.10	155	1030	0.75	< 0.0020	9.6	1.27	< 50	318	< 0.50	< 1000	< 0.050	8960	6820	< 0.10	< 1.0	< 10	2.78	< 10	< 5.0	---
ABS 3 SHALLOW	10-Aug-2019	8.00	38	< 0.50	1.41	5.0	< 1.0	< 1.0	3090	< 0.050	291	< 0.50	0.13	0.68	25	< 0.10	134	900	1.62	< 0.0020	8.4	1.03	< 50	275	< 0.50	< 1000	< 0.050	7720	5780	< 0.10	< 1.0	< 10	2.35	< 10	5.6	---
ABS 4 SHALLOW	10-Aug-2019	8.02	38	< 0.50	1.20	5.6	< 1.0	< 1.0	3020	< 0.050	284	< 0.50	0.14	< 0.50	25	< 0.10	128	865	2.73	< 0.0020	8.2	1.40	< 50	272	< 0.50	< 1000	< 0.050	7730	5650	< 0.10	< 1.0	< 10	2.27	< 10	6.2	---
ABS 5 SHALLOW	10-Aug-2019	7.98	49	< 0.50	1.20	5.4	< 1.0	< 1.0	2880	< 0.050	275	< 0.50	0.12	0.92	27	< 0.10	124	837	2.10	< 0.0020	7.8	1.07	< 50	258	< 0.50	< 1000	< 0.050	7490	5460	< 0.10	< 1.0	< 10	2.23	< 10	6.8	---
Grise Fiord																																				
GF 1 DEEP	16-Aug-2019	7.89	33	< 0.50	2.85	8.1	< 1.0	< 1.0	3810	< 0.050	371	< 0.50	< 0.10	< 0.50	< 10	< 0.10	159	1140	< 0.50	< 0.0020	10.4	0.32	---	347	< 0.50	< 1000	< 0.050	---	7790	< 0.10	< 1.0	< 10	2.80	< 10	< 5.0	< 10
GF 1 SHALLOW	16-Aug-2019	7.98	57	< 0.50	2.18	9.2	< 1.0	< 1.0	3010	< 0.050	293	0.66	< 0.10	1.27	25	1.36	125	922	1.53	< 0.0020	8.1	0.30	---	274	< 0.50	< 1000	< 0.050	---	6200	< 0.10	< 1.0	< 10	2.33	< 10	12.6	< 10
GF 2 DEEP	16-Aug-2019	7.99	47	< 0.50	2.16	9.0	< 1.0	< 1.0	3120	< 0.050	291	< 0.50	< 0.10	< 0.50	16	0.19	129	912	1.30	< 0.0020	7.7	0.53	---	272	< 0.50	< 1000	< 0.050	---	6150	< 0.10	< 1.0	< 10	2.39	< 10	< 5.0	< 10
GF 3 DEEP	16-Aug-2019	7.83	34	< 0.50	2.63	8.6	< 1.0	< 1.0	3910	0.060	376	0.62	< 0.10	< 0.50	< 10	< 0.10	163	1180	< 0.50	< 0.0020	10.4	0.56	---	353	< 0.50	< 1000	< 0.050	---	7890	< 0.10	< 1.0	< 10	3.00	< 10	< 5.0	< 10
GF 3 SHALLOW	16-Aug-2019	8.00	45	< 0.50	1.80	9.0	< 1.0	< 1.0	2990	< 0.050	287	< 0.50	< 0.10	1.00	15	0.11	128	902	1.12	< 0.0020	7.9	0.32	---	274	< 0.50	< 1000	< 0.050	---	6050	< 0.10	< 1.0	< 10	2.31	< 10	< 5.0	< 10
GF 4 DEEP	16-Aug-2019	4.96 [#1]	31	< 0.50	< 0.50	< 1.0	< 1.0	< 1.0	< 50	< 0.050	< 1.0	< 0.50	< 0.10	< 0.50	< 10	< 0.10	< 20	< 1.0	< 0.50	< 0.0020	< 1.0	< 0.20	---	< 1.0	< 0.50	< 1000	< 0.050	---	< 10	< 0.10	< 1.0	< 10	< 0.050	13	< 5.0	< 10
GF 5 SHALLOW	16-Aug-2019	7.96	43	< 0.50	2.10	8.5	< 1.0	< 1.0	3280	< 0.050	313	< 0.50	< 0.10	< 0.50	48	< 0.10	136	971	1.30	< 0.0020	8.7	0.37	---	291	< 0.50	< 1000	< 0.050	---	6540	< 0.10	< 1.0	< 10	2.53	< 10	< 5.0	< 10
GF 6 SHALLOW	16-Aug-2019	8.00	41	< 0.50	1.81	8.5	< 1.0	< 1.0	3310	< 0.050	316	< 0.50	< 0.10	1.66	14	0.14	139	1000	0.77	< 0.0020	8.8	0.32	---	297	< 0.50	< 1000	< 0.050	---	6700	< 0.10	< 1.0	< 10	2.54	< 10	< 5.0	< 10
Resolute Bay																																				
RB 1 DEEP	18-Aug-2019	7.95	47	< 0.50	2.49	9.2	< 1.0	< 1.0	3780	0.062	360	< 0.50	< 0.10	< 0.50	17	< 0.10	155	1130	1.96	< 0.0020	9.8	0.50	---	336	< 0.50	< 1000	< 0.050	---	7600	< 0.10	< 1.0	< 10	2.76	< 10	< 5.0	< 10
RB 1 SHALLOW	18-Aug-2019	7.88	32	< 0.50	2.15	7.8	< 1.0	< 1.0	3160	< 0.050	299	0.79	< 0.10	0.57	< 10	< 0.10	135	948	< 0.50	< 0.0020	8.2	0.60	---	281	< 0.50	< 1000	< 0.050	---	6250	< 0.10	< 1.0	< 10	2.31	< 10	7.0	< 10
RB 2 DEEP	18-Aug-2019	7.96	35	< 0.50	2.08	8.5	< 1.0	< 1.0	3580	0.051	353	< 0.50	< 0.10	< 0.50	10	< 0.10	152	1100	1.57	< 0.0020	9.8 [#3]	0.54	---	330	< 0.50	< 1000	< 0.050	---	7400	< 0.10	< 1.0 [#3]	< 10	2.75	< 10	< 5.0	< 10
RB 2 SHALLOW	18-Aug-2019	7.89	33	< 0.50	2.06	7.7	< 1.0	< 1.0	3190	< 0.050	298	< 0.50	< 0.10	0.57	< 10	< 0.10	131	956	< 0.50	< 0.0020	8.6	0.44	---	285	< 0.50	< 1000	< 0.050	---	6250	< 0.10	< 1.0	< 10	2.32	< 10	< 5.0	< 10
RB 3 DEEP	18-Aug-2019	7.92	35	< 0.50	1.82	8.0	< 1.0	< 1.0	3220	< 0.050	314	< 0.50	< 0.10	< 0.50	< 10	< 0.10	135	975	< 0.50	< 0.0020	8.8	0.49	---	296	< 0.50	< 1000	< 0.050	---	6650	< 0.10	< 1.0	< 10	2.42	< 10	< 5.0	< 10
RB 3 SHALLOW	18-Aug-2019	7.92	32	< 0.50	2.11	7.6	< 1.0	< 1.0	3130	< 0.050	307	0.73	< 0.10	< 0.50	< 10	< 0.10	132	957	< 0.50	< 0.0020	8.4	0.46	---	290	< 0.50	< 1000	< 0.050	---	6490	< 0.10	< 1.0	< 10	2.37	< 10	< 5.0	< 10
RB 4 DEEP	18-Aug-2019	7.96	222	3.72	2.91	17.8	< 1.0	< 1.0	3680	0.289 [#1]	957	3.97 [#1]	5.33	80.0	147	2.74	149	1090	105	< 0.0020	10.4	18.1	---	331	< 0.50	< 1000	0.111	---	8340	0.11	1.9	< 10	3.06	< 10	12300	< 10
RB 4 SHALLOW	18-Aug-2019	7.89	215	3.51	2.47	17.6	< 1.0	< 1.0	3230	0.220 [#1]	913	4.03 [#1]	5.35	80.4	139	2.67	136	1010	105	< 0.0020	9.3	17.7	---	299	< 0.50	< 1000	0.086	---	7530	< 0.10	2.8	< 10	2.73	< 10	12400	< 10

NOTES:

1. --- in guideline row(s) denotes no criteria for that parameter.
2. --- in detail data row(s) denotes parameter not analyzed.
3. Highlighting indicates parameters above applied guideline/criteria.
4. Highlighting indicates non-detect parameters above applied guideline/criteria.
5. Highlighting indicates parameters at applied guideline/criteria.
6. Superscript [#1] denotes values exceeding
   (Canadian Environmental Quality Guidelines for the Protection of Aquatic Life (CCME, 1999 and Updates, last update v7 2007))
   Chromium:
   Standard is for Chromium VI as it is the most conservative value.
7. Superscript [#2] - Matrix spike exceeds acceptance limits due to probable matrix interference.
8. Superscript [#3] - Matrix Spike outside acceptance criteria due to sample matrix interference.
9. Superscript [#4] - Dissolved greater than total. Reanalysis yields similar results.

Appendix 3 Sediment Quality Photo Panels and Field Data

Appendix 3 – Clyde River Sediment Sample Photographs

CR LS1

CR LS2

CR LS3

CR LS4

CR LS5

CR LS7

CR LS8

CR LS9

Appendix 4 Sediment Quality Chemical Results Data

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Table 1

Sediment Analytical Results: Metals and Trace Elements

PROJECT No.: 307071-01306

Sampling Location	Date (dd-mmm-yyyy)	pH (pH units)	Aluminum (mg/kg)	Antimony (mg/kg)	Arsenic (mg/kg)	Barium (mg/kg)	Beryllium (mg/kg)	Bismuth (mg/kg)	Boron (mg/kg)	Cadmium (mg/kg)	Calcium (mg/kg)	Chromium (mg/kg)	Cobalt (mg/kg)	Copper (mg/kg)	Iron (mg/kg)	Lead (mg/kg)	Lithium (mg/kg)	Magnesium (mg/kg)	Manganese (mg/kg)	Mercury (mg/kg)	Molybdenum (mg/kg)	Nickel (mg/kg)	Phosphorus (mg/kg)	Potassium (mg/kg)	Selenium (mg/kg)	Silver (mg/kg)	Sodium (mg/kg)	Strontium (mg/kg)	Thallium (mg/kg)	Tin (mg/kg)	Titanium (mg/kg)	Tungsten (mg/kg)	Uranium (mg/kg)	Vanadium (mg/kg)	Zinc (mg/kg)	Zirconium (mg/kg)
CCME Marine Sediment, 1999		---	---	---	**7.24**	---	---	---	---	**0.7**	---	**52.3**	---	**18.7**	---	**30.2**	---	---	---	**0.13**	---	---	---	---	---	---	---	---	---	---	---	---	---	---	**124**	---
BC-Environment Canada Disposal at S		---	---	---	---	---	---	---	---	**0.6**	---	---	---	---	---	---	---	---	---	**0.75**	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
UNSPECIFIED																																				
AB LS1	10-Aug-2019	7.75	16800	0.23	5.12	96.7	1.01	0.25	19.5	0.155	1860	28.7	13.1	**37.4**	33500	21.8	---	7290	231	< 0.050	2.06	27.4	353	2400	< 0.50	0.070	4330	20.4	0.140	1.06	105	< 0.50	---	40.9	77.0	12.4
AB LS2	10-Aug-2019	8.34	16200	0.15	3.59	306	0.81	0.16	30.9	0.100	4850	36.9	15.2	**44.3**	33400	12.7	---	9970	276	< 0.050	1.44	34.1	369	3440	< 0.50	< 0.050	6320	29.0	0.125	0.60	177	< 0.50	---	54.7	51.6	17.6
CR LS1	13-Aug-2019	7.76	1360	< 0.10	0.98	6.24	< 0.20	< 0.10	5.5	< 0.050	2820	4.1	0.88	0.79	4800	1.45	< 5.0	1130	36.7	< 0.050	0.24	1.73	900	923	< 0.50	< 0.050	1900	11.7	< 0.050	0.39	421	< 0.50	0.396	9.8	6.0	1.84
CR LS2	13-Aug-2019	8.42	888	< 0.10	< 0.50	3.73	< 0.20	< 0.10	2.2	< 0.050	2930	7.4	0.85	0.51	9370	1.26	< 5.0	802	34.0	< 0.050	0.17	1.31	1000	455	< 0.50	< 0.050	1280	4.20	< 0.050	0.41	390	< 0.50	0.398	19.0	4.0	1.76
CR LS3	13-Aug-2019	8.34	656	< 0.10	< 0.50	2.72	< 0.20	< 0.10	1.4	< 0.050	1090	4.5	0.54	< 0.50	5450	0.57	< 5.0	552	21.7	< 0.050	0.10	0.85	295	341	< 0.50	< 0.050	1040	2.58	< 0.050	0.20	198	< 0.50	0.186	10.9	2.8	0.77
CR LS4	13-Aug-2019	7.35	1110	< 0.10	< 0.50	4.47	< 0.20	< 0.10	1.2	< 0.050	1050	4.8	0.84	0.88	5830	2.04	< 5.0	837	31.0	< 0.050	0.17	1.29	328	544	< 0.50	< 0.050	804	2.61	< 0.050	0.23	230	< 0.50	0.210	11.3	5.6	0.86
CR LS5	13-Aug-2019	8.59	643	< 0.10	< 0.50	2.76	< 0.20	< 0.10	1.3	< 0.050	1060	2.1	0.39	< 0.50	2520	0.64	< 5.0	513	17.6	< 0.050	0.13	< 0.80	276	344	< 0.50	< 0.050	956	2.50	< 0.050	0.21	210	< 0.50	0.189	5.3	2.7	0.63
CR LS6	13-Aug-2019	8.20	1070	< 0.10	< 0.50	4.10	< 0.20	< 0.10	1.6	< 0.050	2160	7.5	0.90	0.84	10200	1.49	< 5.0	751	36.2	< 0.050	0.21	1.51	741	521	< 0.50	< 0.050	1170	3.75	< 0.050	0.31	326	< 0.50	0.459	20.0	4.9	1.61
CR LS7	13-Aug-2019	7.95	810	< 0.10	< 0.50	2.95	< 0.20	< 0.10	1.3	< 0.050	1940	4.7	0.64	0.55	5870	0.96	< 5.0	611	25.8	< 0.050	0.18	0.96	672	393	< 0.50	< 0.050	981	3.16	< 0.050	0.27	287	< 0.50	0.322	12.1	3.5	1.10
CR LS8	13-Aug-2019	7.41	1440	< 0.10	< 0.50	8.00	< 0.20	< 0.10	1.5	< 0.050	1620	3.4	0.98	1.23	4510	1.29	< 5.0	1190	40.1	< 0.050	0.14	1.48	558	949	< 0.50	< 0.050	943	3.15	0.059	0.36	368	< 0.50	0.247	8.9	7.3	1.30
CR LS9	13-Aug-2019	7.55	11200	0.55	**7.33**	145	0.36	< 0.10	1.7	0.159	7100	17.2	9.27	18.7	27900	10.1	9.0	6430	666	0.060	0.66	18.3	839	769	< 0.50	0.060	241	47.2	0.080	0.35	538	< 0.50	0.403	54.6	74.1	5.28
GS LS6	16-Aug-2019	8.89	4490	< 0.10	1.59	21.1	0.25	< 0.10	12.5	< 0.050	77700	9.6	3.39	6.05	10500	2.23	26.6	28800	128	< 0.050	0.41	6.54	438	1570	< 0.50	< 0.050	2160	64.5	0.073	0.27	350	< 0.50	0.375	21.9	18.4	4.41
GS LS7	13-Aug-2019	8.83	4790	< 0.10	1.55	18.4	0.26	< 0.10	11.8	< 0.050	75900	12.9	3.50	6.79	12700	2.70	30.3	30400	116	< 0.050	0.45	7.13	573	1560	< 0.50	< 0.050	2080	61.8	0.070	0.24	372	< 0.50	0.447	34.4	18.3	5.22
GS LS8	16-Aug-2019	8.81	4240	< 0.10	1.53	15.3	0.23	< 0.10	10.9	< 0.050	66500	10.8	3.39	6.47	11500	2.39	24.2	23400	114	< 0.050	0.38	6.78	522	1460	< 0.50	< 0.050	2090	54.6	< 0.050	0.23	364	< 0.50	0.363	27.9	17.7	4.83
GS LS10	16-Aug-2019	9.18	3120	< 0.10	1.39	19.2	0.20	< 0.10	6.5	< 0.050	90200	7.6	2.74	4.46	10300	1.57	15.1	19100	96.0	< 0.050	0.28	4.76	359	931	< 0.50	< 0.050	545	70.3	< 0.050	0.21	312	< 0.50	0.292	22.5	14.8	3.44

NOTES:

1. --- in guideline row(s) denotes no criteria for that parameter.
2. --- in detail data row(s) denotes parameter not analyzed.
3. Highlighting indicates non-detect parameters above applied guideline/criteria.
4. Highlighting indicates parameters at applied guideline/criteria.
5. Denotes values exceeding
   (Canadian Environmental Quality Guidelines for Marine Sediment (ISQGs), (CCME, 1999))
6. Denotes values exceeding
   (BC-Environment Canada Disposal at Sea Regulations)

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Table 2

Sediment Analytical Results: Polycyclic Aromatic Hydrocarbons (PAHs)

PROJECT No.: 307071-01306

Sampling Location	Date (dd-mmm-yyyy)	2-Methylnaphthalene (mg/kg)	Acenaphthene (mg/kg)	Acenaphthylene (mg/kg)	Anthracene (mg/kg)	Benzo[a]anthracene (mg/kg)	Benzo[a]pyrene (mg/kg)	Benzo[a]pyrene Total Potency Equivalent (mg/kg)	Benzo[b&j]fluoranthene (mg/kg)	Benzo[b]fluoranthene (mg/kg)	Benzo[g,h,i]perylene (mg/kg)	Benzo[k]fluoranthene (mg/kg)	Chrysene (mg/kg)	Dibenzo[a,h]anthracene (mg/kg)	Fluoranthene (mg/kg)	Fluorene (mg/kg)	Indeno[1,2,3-cd]pyrene (mg/kg)	Indexed Value of Additive Cancer Risk (IACR) (none)	Naphthalene (mg/kg)	Phenanthrene (mg/kg)	Polycyclic Aromatic Hydrocarbons (heavy) (mg/kg)	Polycyclic Aromatic Hydrocarbons (light) (mg/kg)	Pyrene (mg/kg)	Total PAHs (mg/kg)
CCME Marine Sediment, 1999		**0.0202**	**0.00671**	**0.00587**	**0.0469**	**0.0748**	**0.0888**	**---**	**---**	**---**	**---**	**---**	**0.108**	**0.00622**	**0.113**	**0.0212**	**---**	**---**	**0.0346**	**0.0867**	**---**	**---**	**0.153**	**---**
BC-Environment Canada Disposal at S		**---**	**---**	**---**	**---**	**---**	**---**	**---**	**---**	**---**	**---**	**---**	**---**	**---**	**---**	**---**	**---**	**---**	**---**	**---**	**---**	**---**	**---**	**2.5**
UNSPECIFIED																								
AB LS1	10-Aug-2019	**0.051**	< 0.00050	0.00095	0.0018	0.0012	< 0.0010	< 0.010	0.0019	---	0.0022	< 0.0010	0.0039	< 0.00050	0.0050	0.0054	< 0.0020	< 0.10	0.026	0.012	0.016	0.098	0.0061	0.11
AB LS2	10-Aug-2019	0.0077	< 0.00050	< 0.00050	< 0.0010	< 0.0010	< 0.0010	< 0.010	0.0014	---	< 0.0020	< 0.0010	0.0038	< 0.00050	0.0018	0.0019	< 0.0020	< 0.10	0.0036	0.0082	0.0095	0.021	0.0038	0.031
CR LS1	13-Aug-2019	< 0.0010	< 0.00050	< 0.00050	< 0.0010	< 0.0010	< 0.0010	< 0.010	< 0.0010	< 0.0010	< 0.0020	< 0.0010	< 0.0010	< 0.00050	< 0.0010	< 0.0010	< 0.0020	< 0.10	0.0016	< 0.0010	< 0.0010	0.0016	< 0.0010	0.0016
CR LS2	13-Aug-2019	< 0.0010	< 0.00050	< 0.00050	< 0.0010	< 0.0010	< 0.0010	< 0.010	< 0.0010	< 0.0010	< 0.0020	< 0.0010	< 0.0010	< 0.00050	< 0.0010	< 0.0010	< 0.0020	< 0.10	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010
CR LS3	13-Aug-2019	< 0.0010	< 0.00050	< 0.00050	< 0.0010	< 0.0010	< 0.0010	< 0.010	< 0.0010	< 0.0010	< 0.0020	< 0.0010	< 0.0010	< 0.00050	< 0.0010	< 0.0010	< 0.0020	< 0.10	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010
CR LS4	13-Aug-2019	< 0.0010	< 0.00050	< 0.00050	< 0.0010	< 0.0010	< 0.0010	< 0.010	< 0.0010	< 0.0010	< 0.0020	< 0.0010	< 0.0010	< 0.00050	< 0.0010	< 0.0010	< 0.0020	< 0.10	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010
CR LS5	13-Aug-2019	< 0.0010	< 0.00050	< 0.00050	< 0.0010	< 0.0010	< 0.0010	< 0.010	< 0.0010	< 0.0010	< 0.0020	< 0.0010	< 0.0010	< 0.00050	< 0.0010	< 0.0010	< 0.0020	< 0.10	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010
CR LS6	13-Aug-2019	< 0.0010	< 0.00050	< 0.00050	< 0.0010	< 0.0010	< 0.0010	< 0.010	< 0.0010	< 0.0010	< 0.0020	< 0.0010	< 0.0010	< 0.00050	< 0.0010	< 0.0010	< 0.0020	< 0.10	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010
CR LS7	13-Aug-2019	< 0.0010	< 0.00050	< 0.00050	< 0.0010	< 0.0010	< 0.0010	< 0.010	< 0.0010	< 0.0010	< 0.0020	< 0.0010	< 0.0010	< 0.00050	< 0.0010	< 0.0010	< 0.0020	< 0.10	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010
CR LS8	13-Aug-2019	< 0.0010	< 0.00050	< 0.00050	< 0.0010	< 0.0010	< 0.0010	< 0.010	< 0.0010	< 0.0010	< 0.0020	< 0.0010	< 0.0010	< 0.00050	< 0.0010	< 0.0010	< 0.0020	< 0.10	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010
CR LS9	13-Aug-2019	< 0.0010	< 0.00050	< 0.00050	< 0.0010	< 0.0010	< 0.0010	< 0.010	< 0.0010	< 0.0010	< 0.0020	< 0.0010	< 0.0010	< 0.00050	< 0.0010	< 0.0010	< 0.0020	< 0.10	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010
GS LS6	16-Aug-2019	0.0022	< 0.00050	0.00073	0.018	0.0032	0.0015 [#1]	< 0.010	0.0051	0.0035	< 0.0020	0.0016	0.0073	< 0.00050	0.021	0.019	< 0.0020	< 0.10	0.0060	0.049	0.044	0.096	0.011	0.14
GS LS7	13-Aug-2019	< 0.0010	< 0.00050	< 0.00050	< 0.0010	< 0.0010	< 0.0010	< 0.010	0.0015	0.0015	< 0.0020	< 0.0010	0.0037	< 0.00050	0.0063	< 0.0010	< 0.0020	< 0.10	0.0019	0.0029	0.013	0.0048	0.0034	0.018
GS LS8	16-Aug-2019	< 0.0010	0.00062	< 0.00050	0.0020	0.0015	< 0.0010	< 0.010	0.0028	0.0028	< 0.0020	0.0011	0.0064	< 0.00050	0.017	0.0036	< 0.0020	< 0.10	0.0017	0.011	0.033	0.019	0.0085	0.052
GS LS10	16-Aug-2019	< 0.0010	< 0.00050	< 0.00050	< 0.0010	< 0.0010	< 0.0010	< 0.010	< 0.0010	< 0.0010	< 0.0020	< 0.0010	0.0035	< 0.00050	0.0035	< 0.0010	< 0.0020	< 0.10	< 0.0010	0.0023	0.0090	0.0023	0.0020	0.011

NOTES:

1. --- in guideline row(s) denotes no criteria for that parameter.
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4. Highlighting indicates parameters at applied guideline/criteria.
5. Denotes values exceeding
   (Canadian Environmental Quality Guidelines for Marine Sediment (ISQGs), (CCME, 1999))
6. Denotes values exceeding
   (BC-Environment Canada Disposal at Sea Regulations)
7. Superscript [#1] - Tentatively identified result and may be potentially biased high due to matrix interference.

Table 3

Sedment Analytical Results: General and Particle size Parameters

PROJECT No.: 307071-01306

Sampling Location	Date (dd-mmm-yyyy)	% Moisture (%)	pH (pH units)	Clay (%)	Gravel (%)	Sand (%)	Silt (%)	< -1 Phi (2 mm) (%)	< 0 Phi (1 mm) (%)	< +1 Phi (0.5 mm) (%)	< +2 Phi (0.25 mm) (%)	< +3 Phi (0.12 mm) (%)	< +4 Phi (0.062 mm) (%)	< +5 Phi (0.031 mm) (%)	< +6 Phi (0.016 mm) (%)	< +7 Phi (0.0078 mm) (%)	< +8 Phi (0.0039 mm) (%)	< +9 Phi (0.0020 mm) (%)	Total Organic Carbon (mg/kg)
UNSPECIFIED																			
AB G5	10-Aug-2019	---	---	8.2	0.38	64	27	100 #1	100 #1	99	99	88	35	19	13	8.9	8.2	7.0	---
AB LS1	10-Aug-2019	31□ 26	7.75	11	4.0	58	27	96	95	94	90	64	38	26	19	12	11	8.8	5200
AB LS2	10-Aug-2019	32□ 27	8.34	41	11	21	27	89	87	85	82	77	68	60	54	44	41	36	8000
CR GS1	13-Sep-2019	---	---	0.21	64	36	0.28	36	16	6.1	2.7	1.1	0.49	0.31	0.23	0.22	0.21	0.23	---
CR GS3	13-Sep-2019	---	---	1.1	0.49	98	0.82	100	98	85	32	5.4	1.9	1.4	1.2	1.1	1.1	1.0	---
CR GS4	13-Sep-2019	---	---	1.2	2.3	91	5.7	98 #2	96	91	80	44	6.9	2.7	1.6	1.3	1.2	1.2	---
CR GS5	13-Sep-2019	---	---	2.6	2.5	90	4.5	98 #2	97 #2	93	76	41	7.1	4.1	3.3	2.6	2.6	2.5	---
CR GS7	13-Sep-2019	---	---	0.95	2.8	96	0.54	97	93	80	42	4.1	1.5	1.2	1.1	0.95	0.95	0.95	---
CR GS8	13-Sep-2019	---	---	2.6	< 0.10	87	10	100 #2	99 #2	96	80	52	13	4.9	3.4	2.7	2.6	2.6	---
CR GS11	13-Sep-2019	---	---	1.9	< 0.10	94	4.1	100	99	97	84	35	6.0	3.6	2.5	1.9	1.9	1.9	---
CR LS1	13-Aug-2019	17□ 22	7.76	2.1	1.9	93	3.3	98 #3	96	85	48	16	5.4	3.2	2.5	2.1	2.1	2.1	970
CR LS2	13-Aug-2019	20□ 20	8.42	1.0	< 0.10	99	0.29	100 #4	100	94	34	3.3	1.3	1.3	1.1	1.0	1.0	1.1	590
CR LS3	13-Aug-2019	19□ 18	8.34	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	< 500
	16-Aug-2019	---	---	0.53	37	62	0.19	63	59	38	5.6	1.1	0.72	0.65	0.58	0.56	0.53	0.53	---
CR LS4	13-Aug-2019	18□ 17	7.35	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	< 500
	16-Aug-2019	---	---	0.80	0.90	98	0.64	99	94	55	12	2.8	1.4	1.1	0.90	0.83	0.80	0.77	---
CR LS5	13-Aug-2019	18□ 19	8.59	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	< 500
	16-Aug-2019	---	---	0.80	0.59	98	0.19	99	98	78	13	1.4	0.99	0.93	0.80	0.43	0.80	0.81	---
CR LS6	13-Aug-2019	16□ 16	8.20	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	< 500
	16-Aug-2019	---	---	0.25	28	71	0.21	72	67	45	15	2.2	0.46	0.36	0.29	0.28	0.25	0.24	---
CR LS7	13-Aug-2019	18□ 20	7.95	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	< 500
	16-Aug-2019	---	---	0.80	< 0.10	99	0.14	100	99	83	20	2.8	0.95	0.86	0.80	0.78	0.80	0.75	---
CR LS8	13-Aug-2019	19□ 18	7.41	0.90	1.8	97	0.37	98	96	92	76	8.9	1.3	1.1	0.98	0.93	0.90	0.89	< 500
CR LS9	13-Aug-2019	16□ 18	7.55	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	< 500
	16-Aug-2019	---	---	0.47	22	78	0.27	78	72	57	24	3.7	0.73	0.58	0.47	0.47	0.47	0.45	---
CR SAMPLE 2	13-Sep-2019	---	---	0.67	42	57	0.49	58	43	32	18	2.9	1.2	0.96	0.79	0.62	0.67	0.61	---
CR SAMPLE 6	13-Sep-2019	---	---	0.85	39	59	1.8	61	44	30	18	8.5	2.6	1.3	0.97	0.82	0.85	0.80	---
GS LS6	16-Aug-2019	22□ 18	8.89	2.7	39	41	17	61	57	54	50	37	20	10	6.3	3.3	2.7	1.8	18000
GS LS7	13-Aug-2019	18□ 16	8.83	4.3	24	50	21	76	73	71	68	51	26	15	9.1	5.1	4.3	3.3	16000
GS LS8	16-Aug-2019	16□ 19	8.81	2.5	4.9	81	11	95	93	91	82	35	14	7.7	4.9	3.0	2.5	1.9	8900
GS LS10	16-Aug-2019	15□ 8.6	9.18	0.96	65	30	4.2	35	26	21	18	9.6	5.1	2.9	1.8	1.1	0.96	0.77	9700

NOTES:

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2. --- in detail data row(s) denotes parameter not analyzed.
3. Highlighting indicates non-detect parameters above applied guideline/criteria.
4. Highlighting indicates parameters at applied guideline/criteria.
5. Superscript #1 - PSA sample observation comment: Fraction contained shells.
6. Superscript #2 - PSA sample observation comment: Fraction contained shells
7. Superscript #3 - PSA sample observation comment: Fraction contained shells and fibers
8. Superscript #4 - PSA sample observation comment: Fraction contained fibers

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Table 4

Sedment Analytical Results: Polychlorinated Biphenyl

PROJECT No.: 307071-01306

Sampling Location	Date (dd-mmm-yyyy)	Aroclor 1016 (ug/g)	Aroclor 1221 (ug/g)	Aroclor 1232 (ug/g)	Aroclor 1242 (ug/g)	Aroclor 1248 (ug/g)	Aroclor 1254 (ug/g)	Aroclor 1260 (ug/g)	Aroclor 1262 (ug/g)	Aroclor 1268 (ug/g)	PCBs-TOTAL (ug/g)
CCME Marine Sediment, 1999		---	---	---	---	---	**0.0633**	---	---	---	**0.0215**
BC-Environment Canada Disposal at Sea Regula		---	---	---	---	---	---	---	---	---	**0.1**
UNSPECIFIED											
AB LS1	10-Aug-2019	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020
AB LS2	10-Aug-2019	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020
CR LS1	13-Aug-2019	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
CR LS2	13-Aug-2019	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
CR LS3	13-Aug-2019	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
CR LS4	13-Aug-2019	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
CR LS5	13-Aug-2019	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
CR LS6	13-Aug-2019	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
CR LS7	13-Aug-2019	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
CR LS8	13-Aug-2019	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
CR LS9	13-Aug-2019	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
GS LS6	16-Aug-2019	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
GS LS7	13-Aug-2019	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
GS LS8	16-Aug-2019	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
GS LS10	16-Aug-2019	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010

NOTES:

1. --- in guideline row(s) denotes no criteria for that parameter.
2. --- in detail data row(s) denotes parameter not analyzed.
3. Highlighting indicates non-detect parameters above applied guideline/criteria.
4. Highlighting indicates parameters at applied guideline/criteria.
5. Denotes values exceeding
   (Canadian Environmental Quality Guidelines for Marine Sediment (ISQGs), (CCME,
6. Denotes values exceeding
   (BC-Environment Canada Disposal at Sea Regulations)

Appendix 5 Vegetation Field Data

Appendix 5 – Vegetation Field Data

Table A5-1 Abiotic Data Collected During Ecological Land Classification

Date	Plot	Biome	Ecozone	Ecoregion	Community Type	Slope	Aspect	Soil Moisture Regime	Soil Nutrient Regime	Meso Slope Position	Exposure Type	Drainage	Mineral Soil Texture	Organic Soil Texture	Humus Form	Surface Shape	Coarse Fragment Content	Surficial Material
12-Aug-19	GD-06	Tundra	Arctic Cordillera	Baffin Island Coastal Lowlands	Upland Dwarf Shrub	0->5%	Rolling, mostly level	Xeric	Poor	Upper Slope	Wind, Frost, Cold Air Drainage	Imperfectly	DNC	Fibric	Mor	Convex, Straight	>70%	Till Veneer
12-Aug-19	GD-07	Tundra	Arctic Cordillera	Baffin Island Coastal Lowlands	Disturbed Human-Caused	0->5%	Mostly level though variable	Very Xeric	Very Poor	Level	Wind, Frost, Cold Air Drainage	Moderately Well	DNC	NA	NA	Straight	>70%	Till Veneer
12-Aug-19	GD-08, GD-09	Tundra	Arctic Cordillera	Baffin Island Coastal Lowlands	Wetland Graminoid-Moss Drainage	0-2%	Mostly level	Hydric	Poor	Middle Slope, Lower Slope	Wind, Frost, Cold Air Drainage	Poorly	DNC	Fibric	Mor	Concave, Straight	20-35%	Till Veneer
13-Aug-19	GD-10	Tundra	Arctic Cordillera	Baffin Island Coastal Lowlands	Coastal Shoreline and Flats	0-2%	Southerly	Subhydric	Poor	Middle Slope	Wind, Frost, Cold Air Drainage	Moderately Well, Imperfectly	Sandy	Fibric	Mor	Straight	< 20%	Offshore sediments

Notes:

NA – means not applicable
DNC – means did not collect
Categories for abiotic conditions that were considered included the following:

- Slope: 0%, 1%, 2%, 2-5%, >5%
- Aspect: level, mostly level, rolling, variable, northernly, southerly, easterly, westerly
- Soil Moisture Regime: very xeric, xeric, subxeric, submesic, mesic, subhygric, hygric, subhydric, hydric
- Soil Nutrient Regime: very poor, poor, medium, rich, very rich
- Meso Slope Position: crest, upper slope, middle slope, lower slope, toe, depression, level
- Exposure Type: wind, insolation, frost, cold air drainage, toxicity (atmospheric or soil), not applicable
- Drainage: very rapidly, rapidly, well, moderately well, imperfectly, poorly, very poorly
- Mineral Soil Texture: sandy, loamy, silty, clayey
- Organic Soil Texture: fibric, mesic, humic
- Humus Form: mor, moder, mull
- Surface Shape: concave, convex, straight
- Coarse Fragment Content: <20%, 20-35%, 35-70%, >70%

Table A5-2 Vegetation Ground Plot Data

Date	Plot	Community Type	Total Tree Layer %	Total Shrub Layer %	Total Forb Layer %	Total Graminoid Layer %	Total Non-vascular Layer %	Litter %	Water %	Mineral Soil %	Rock %	Species Name and Author	Common Name	% Foliar Cover
12-Aug-19	GD-06	Upland Dwarf Shrub	0	30	0	2	30	20	0	0	10	*Alectoria ochroleuca* (Hoffm.) A. Massal.	witch's hair lichen	10
												Cassiope tetragona (L.) D. Don	white arctic mountain heather	30
												Cladina rangiferina (L.) Nyl.	greygreen reindeer lichen	2
												Flavocetraria cucullata (Bellardi) Karnefelt & A. Thell	snow lichen	1
												Flavocetraria nivalis (L.) Karnefelt & A. Thell	snow lichen	3
												Luzula confusa Lindeberg	northern woodrush	2
												Polytrichum juniperinum Hedw.	juniper polytrichum moss	1
												Racomitrium lanuginosum (Hedw.) Brid.	racomitrium moss	20
12-Aug-19	GD-07	Disturbed Human-Caused	0	0	1	5	2	2	0	10	90	*Alopecurus magellanicus* Lam.	Alpine Meadow-Foxtail	2
												Luzula confusa Lindeberg	northern woodrush	5
												Psilopilum cavifolium (Wilson) I. Hagen	psilopilum moss	2
												Oxyria digyna (L.) Hill	alpine mountainsorrel	0.5
												Poa arctica R. Br.	arctic bluegrass	1
												Polytrichum juniperinum Hedw.	juniper polytrichum moss	0.5
12-Aug-19	GD-08	Wetland Graminoid-Moss Drainage	0	0	1	30	80	10	2	0	0	*Kobresia* sp.	bog sedge	15
												Eriophorum angustifolium Honck.	tall cottongrass	5
												Eriophorum scheuchzeri Hoppe	white cottongrass	10
												Mosses	Moss	80
												Polytrichum juniperinum Hedw.	*juniper polytrichum moss*	2
												Saxifraga cernua L.	nodding saxifrage	1
												Saxifraga foliolosa R. Br.	leafystem saxifrage	1
12-Aug-19	GD-09	Wetland Graminoid-Moss Drainage	0	1	40	80	15	40	0	0	0	*Arctagrostis latifolia* (R. Br.) Griseb.	wideleaf polargrass	2
												Aulacomnium turgidum (Wahlenb.) SchwÃ¤gr.	turgid aulacomnium moss	1
												Carex misandra R. Br.	shortleaved sedge	5
												Cladina rangiferina (L.) Nyl.	greygreen reindeer lichen	2
												Eriophorum angustifolium Honck.	tall cottongrass	1
												Eriophorum scheuchzeri Hoppe	white cottongrass	20

Date	Plot	Community Type	Total Tree Layer %	Total Shrub Layer %	Total Forb Layer %	Total Graminoid Layer %	Total Non-vascular Layer %	Litter %	Water %	Mineral Soil %	Rock %	Species Name and Author	Common Name	% Foliar Cover
												Luzula confusa Lindeberg	northern woodrush	20
												Racomitrium lanuginosum (Hedw.) Brid.	racomitrium moss	10
												Salix herbacea L.	snowbed willow	1
												Sphagnum arcticum Flatberg & Frisvoll	arctic sphagnum	1
13-Aug-19	GD-10	Coastal Shoreline and Flats	0	0	10	50	0	5	1	30	0	*Eriophorum scheuchzeri* Hoppe	white cottongrass	1
												Luzula confusa Lindeberg	northern woodrush	1
												Cinclidium arcticum Bruch & Schimp.	arctic cinclidium moss	1
												Puccinellia phryganodes (Trin.) Scribn. & Merr.	creeping alkaligrass	50
												Stellaria humifusa Rottb.	saltmarsh starwort	10

Table A5-3 Vegetation Rare Plant Survey Data

Date	Community Type	Strata	Species Name and Authority	Common Name
12-Aug-19	Disturbed Human-Caused	Forbs	*Oxyria digyna* (L.) Hill	alpine mountainsorrel
12-Aug-19	Disturbed Human-Caused	Forbs	*Pedicularis* sp.	lousewort
12-Aug-19	Disturbed Human-Caused	Forbs	*Saxifraga aizoides* L.	yellow mountain saxifrage
12-Aug-19	Disturbed Human-Caused	Forbs	*Saxifraga caespitosa* L.	tufted alpine saxifrage
12-Aug-19	Disturbed Human-Caused	Graminoids	*Alopecurus magellanicus* Lam.	Alpine Meadow-Foxtail
12-Aug-19	Disturbed Human-Caused	Graminoids	*Arctagrostis latifolia* (R. Br.) Griseb.	wideleaf polargrass
12-Aug-19	Disturbed Human-Caused	Graminoids	*Eriophorum scheuchzeri* Hoppe	white cottongrass
12-Aug-19	Disturbed Human-Caused	Graminoids	*Festuca brachyphylla* Schult. ex Schult. & Schult. f.	alpine fescue
12-Aug-19	Disturbed Human-Caused	Graminoids	*Luzula confusa* Lindeberg	northern woodrush
12-Aug-19	Disturbed Human-Caused	Graminoids	*Poa arctica* R. Br.	arctic bluegrass
12-Aug-19	Disturbed Human-Caused	Bryophytes	*Polytrichum juniperinum* Hedw.	juniper polytrichum moss
12-Aug-19	Disturbed Human-Caused	Bryophytes	*Psilopilum laevigatum* (Wahlenb.) Lindb.	psilopilum moss
12-Aug-19	Disturbed Human-Caused	Bryophytes	*Pogonatum urnigerum* (Hedw.) P. Beauv.	pogonatum moss
12-Aug-19	Disturbed Human-Caused	Bryophytes	*Trichostomum tenuirostre* (Hook. & Taylor) Lindb.	narrow-fruited crisp-moss
12-Aug-19	Disturbed Human-Caused	Bryophytes	*Racomitrium lanuginosum* (Hedw.) Brid.	racomitrium moss
12-Aug-19	Upland Dwarf Shrub	Shrubs	*Cassiope tetragona* (L.) D. Don	white arctic mountain heather
12-Aug-19	Upland Dwarf Shrub	Shrubs	*Dryas integrifolia* Vahl	entireleaf mountain-avens
12-Aug-19	Upland Dwarf Shrub	Shrubs	*Salix arctica* Pall.	arctic willow
12-Aug-19	Upland Dwarf Shrub	Shrubs	*Salix herbacea* L.	snowbed willow
12-Aug-19	Upland Dwarf Shrub	Shrubs	*Vaccinium uliginosum* L.	bog blueberry
12-Aug-19	Upland Dwarf Shrub	Forbs	*Oxyria digyna* (L.) Hill	alpine mountainsorrel
12-Aug-19	Upland Dwarf Shrub	Forbs	*Papaver labradoricum* (Fedde) Solstad & Elven	Labrador poppy
12-Aug-19	Upland Dwarf Shrub	Forbs	*Polygonum viviparum* L.	alpine bistort
12-Aug-19	Upland Dwarf Shrub	Forbs	*Potentilla nana* Willd. ex Schltdl.	arctic cinquefoil
12-Aug-19	Upland Dwarf Shrub	Forbs	*Saxifraga cernua* L.	nodding saxifrage
12-Aug-19	Upland Dwarf Shrub	Forbs	*Saxifraga hyperborea* R. Br.	pygmy saxifrage
12-Aug-19	Upland Dwarf Shrub	Graminoids	*Alopecurus magellanicus* Lam.	Alpine Meadow-Foxtail
12-Aug-19	Upland Dwarf Shrub	Graminoids	*Anthoxanthum monticola* (Bigelow) Veldkamp	alpine sweetgrass
12-Aug-19	Upland Dwarf Shrub	Graminoids	*Carex misandra* R. Br.	shortleaved sedge
12-Aug-19	Upland Dwarf Shrub	Graminoids	*Luzula confusa* Lindeberg	northern woodrush
12-Aug-19	Upland Dwarf Shrub	Graminoids	*Poa arctica* R. Br.	arctic bluegrass
12-Aug-19	Upland Dwarf Shrub	Bryophytes	*Polytrichum juniperinum* Hedw.	juniper polytrichum moss
12-Aug-19	Upland Dwarf Shrub	Bryophytes	*Psilopilum cavifolium* (Wilson) I. Hagen	psilopilum moss

Date	Community Type	Strata	Species Name and Authority	Common Name
12-Aug-19	Upland Dwarf Shrub	Bryophytes	*Psilopilum laevigatum* (Wahlenb.) Lindb.	psilopilum moss
12-Aug-19	Upland Dwarf Shrub	Bryophytes	*Trichostomum tenuirostre* (Hook. & Taylor) Lindb.	narrow-fruited crisp-moss
12-Aug-19	Upland Dwarf Shrub	Bryophytes	*Racomitrium lanuginosum* (Hedw.) Brid.	racomitrium moss
12-Aug-19	Upland Dwarf Shrub	Lichens	*Alectoria ochroleuca* (Hoffm.) A. Massal.	witch's hair lichen
12-Aug-19	Upland Dwarf Shrub	Lichens	*Cetraria ericetorum* Opiz	cetraria lichen
12-Aug-19	Upland Dwarf Shrub	Lichens	*Flavocetraria cucullata* (Bellardi) Karnefelt & A. Thell	snow lichen
12-Aug-19	Upland Dwarf Shrub	Lichens	*Flavocetraria nivalis* (L.) Karnefelt & A. Thell	snow lichen
12-Aug-19	Upland Dwarf Shrub	Lichens	*Umbilicaria* spp.	lichens
12-Aug-19	Upland Dwarf Shrub	Lichens	*Xanthoparmelia* spp.	lichens
12-Aug-19	Upland Dwarf Shrub	Lichens	*Sphaerophorus fragilis* (L.) Pers.	fragile ball lichen
12-Aug-19	Upland Dwarf Shrub	Lichens	*Stereocaulon alpinum* Laurer ex Funck	alpine snow lichen
12-Aug-19	Upland Dwarf Shrub	Lichens	*Thamnolia subuliformis* (Ehrh.) W.L. Culb.	whiteworm lichen
12-Aug-19	Wetland Graminoid-Moss Drainage	Forbs	*Ranunculus hyperboreus* Rottb.	high northern buttercup
12-Aug-19	Wetland Graminoid-Moss Drainage	Forbs	*Saxifraga cernua* L.	nodding saxifrage
12-Aug-19	Wetland Graminoid-Moss Drainage	Forbs	*Saxifraga foliolosa* R. Br.	leafystem saxifrage
12-Aug-19	Wetland Graminoid-Moss Drainage	Graminoids	*Alopecurus magellanicus* Lam.	Alpine Meadow-Foxtail
12-Aug-19	Wetland Graminoid-Moss Drainage	Graminoids	*Arctagrostis latifolia* (R. Br.) Griseb.	wideleaf polargrass
12-Aug-19	Wetland Graminoid-Moss Drainage	Graminoids	*Eriophorum angustifolium* Honck.	tall cottongrass
12-Aug-19	Wetland Graminoid-Moss Drainage	Graminoids	*Eriophorum scheuchzeri* Hoppe	white cottongrass
12-Aug-19	Wetland Graminoid-Moss Drainage	Graminoids	*Juncus albescens* (Lange) Fernald	northern white rush
12-Aug-19	Wetland Graminoid-Moss Drainage	Graminoids	*Kobresia* sp.	bog sedge
12-Aug-19	Wetland Graminoid-Moss Drainage	Graminoids	*Phippsia algida* (Sol.) R. Br.	icegrass
12-Aug-19	Wetland Graminoid-Moss Drainage	Graminoids	*Pleuropogon sabinei* R. Br.	false semaphoregrass
12-Aug-19	Wetland Graminoid-Moss Drainage	Bryophytes	*Cinclidium arcticum* Bruch & Schimp.	arctic cinclidium moss
12-Aug-19	Wetland Graminoid-Moss Drainage	Bryophytes	*Ditrichum flexicaule* (SchwÃ¤gr.) Hampe	ditrichum moss
12-Aug-19	Wetland Graminoid-Moss Drainage	Bryophytes	*Polytrichum juniperinum* Hedw.	juniper polytrichum moss
12-Aug-19	Wetland Graminoid-Moss Drainage	Bryophytes	*Sphagnum arcticum* Flatberg & Frisvoll	arctic sphagnum
12-Aug-19	Wetland Graminoid-Moss Drainage	Bryophytes	*Tomentypnum nitens* (Hedw.) Loeske	tomentypnum moss
13-Aug-19	Coastal Shoreline and Flats	Shrubs	*Salix arctica* Pall.	arctic willow
13-Aug-19	Coastal Shoreline and Flats	Forbs	*Cerastium arcticum* Lange	mouse-ear chickweed
13-Aug-19	Coastal Shoreline and Flats	Forbs	*Oxyria digyna* (L.) Hill	alpine mountainsorrel
13-Aug-19	Coastal Shoreline and Flats	Forbs	*Polygonum viviparum* L.	alpine bistort
13-Aug-19	Coastal Shoreline and Flats	Forbs	*Saxifraga cernua* L.	nodding saxifrage
13-Aug-19	Coastal Shoreline and Flats	Forbs	*Stellaria humifusa* Rottb.	saltmarsh starwort

Date	Community Type	Strata	Species Name and Authority	Common Name
13-Aug-19	Coastal Shoreline and Flats	Graminoids	*Alopecurus magellanicus* Lam.	Alpine Meadow-Foxtail
13-Aug-19	Coastal Shoreline and Flats	Graminoids	*Anthoxanthum monticola (*Bigelow) Veldkamp	alpine sweetgrass
13-Aug-19	Coastal Shoreline and Flats	Graminoids	*Arctagrostis latifolia* (R. Br.) Griseb.	wideleaf polargrass
13-Aug-19	Coastal Shoreline and Flats	Graminoids	*Carex aquatilis* Wahlenb.	water sedge
13-Aug-19	Coastal Shoreline and Flats	Graminoids	*Eriophorum angustifolium* Honck.	tall cottongrass
13-Aug-19	Coastal Shoreline and Flats	Graminoids	*Eriophorum scheuchzeri* Hoppe	white cottongrass
13-Aug-19	Coastal Shoreline and Flats	Graminoids	*Kobresia* sp.	bog sedge
13-Aug-19	Coastal Shoreline and Flats	Graminoids	*Luzula confusa* Lindeberg	northern woodrush
13-Aug-19	Coastal Shoreline and Flats	Graminoids	*Phippsia algida* (Sol.) R. Br.	icegrass
13-Aug-19	Coastal Shoreline and Flats	Graminoids	*Pleuropogon sabinei* R. Br.	false semaphoregrass
13-Aug-19	Coastal Shoreline and Flats	Graminoids	*Poa arctica* R. Br.	arctic bluegrass
13-Aug-19	Coastal Shoreline and Flats	Graminoids	*Poa glauca* Vahl	glaucous bluegrass
13-Aug-19	Coastal Shoreline and Flats	Graminoids	*Puccinellia phryganodes* (Trin.) Scribn. & Merr.	creeping alkaligrass
13-Aug-19	Coastal Shoreline and Flats	Bryophytes	*Bryum pallens* (Brid.) Sw.	bryum moss
13-Aug-19	Coastal Shoreline and Flats	Bryophytes	*Cinclidium arcticum* Bruch & Schimp.	arctic cinclidium moss

Appendix 6 Wildlife and Migratory Bird Field Data

Appendix 6 – Wildlife and Migratory Bird Field Data

Table A6-1 Incidental Wildlife Species Observed for Detected during Field Survey

Date	Species Code	Species Name	Common Name	Count	Type	Easting	Northing	Coordinate System	Zone
12-Aug-19	OWSP	*Bubo* sp.	owl species	1	pellet	517062	7818196	UTM NAD83	19W
12-Aug-19	LALS	*Calcarius lapponicus*	Lapland longspur	3	flock	517305	7818185	UTM NAD83	19W
12-Aug-19	BASA	*Calidris bairdii*	Baird's sandpiper	1	foraging	516571	7817111	UTM NAD83	19W
12-Aug-19	BLGU	*Cepphus grylle*	black guillemot	8	flock circling offshore	515227	7818265	UTM NAD83	19W
12-Aug-19	GOSP	*Chen* sp.	goose species	3	scat	517366	7818335	UTM NAD83	19W
12-Aug-19	LESP	*Dicrostonyx* spp.	lemming species	2	dashed under rock	517260	7817817	UTM NAD83	19W
12-Aug-19	NOFU	*Fulmarus glacialis*	northern fulmar	1	flyover	517366	7818335	UTM NAD83	19W
12-Aug-19	LOSP	*Gavia* sp.	loon species	1	flyover	515251	7818198	UTM NAD83	19W
12-Aug-19	PTSP	*Lagopus* sp.	ptarmigan species	1	scat	517305	7818185	UTM NAD83	19W
12-Aug-19	ICGU	*Larus glaucoides*	Iceland gull	1	flyover	515251	7818198	UTM NAD83	19W
12-Aug-19	GLGU	*Larus hyperboreus*	glaucous gull	10	flyover	515251	7818198	UTM NAD83	19W
12-Aug-19	SNBU	*Plectrophenax nivalis*	snow bunting	20	flock	517463	7819073	UTM NAD83	19W
12-Aug-19	SNBU	*Plectrophenax nivalis*	snow bunting	1	foraging	517568	7818216	UTM NAD83	19W
12-Aug-19	POBE	*Ursus maritimus*	polar bear	1	scavenging	516571	7817110	UTM NAD83	19W

Table A6-2 Bird Species Observed or Detected during Field Migratory Bird Point Count Survey

Point Count Name	Date	Time start (5 min)	Wind (km/hour)	Cloud Cover (%)	Temp (°C)	Precipitation (mm)	Species Name	Common Name	Count	Easting	Northing	Coordinate System	Zone
CR-PC-06	12-Aug-19	8:25	3	100	7	0	*Corvus corax*	common raven	1	515131	7818124	UTM NAD83	19W
CR-PC-06	12-Aug-19	8:25	3	100	7	0	*Larus hyperboreus*	glaucous gull	1	515131	7818124	UTM NAD83	19W
CR-PC-06	12-Aug-19	8:25	3	100	7	0	*Larus glaucoides*	Iceland gull	1	515131	7818124	UTM NAD83	19W
CR-PC-07	13-Aug-19	7:45	1	100	5	0	*Corvus corax*	common raven	3	515681	7818813	UTM NAD83	19W
CR-PC-07	13-Aug-19	7:45	1	100	5	0	*Larus hyperboreus*	glaucous gull	3	515681	7818813	UTM NAD83	19W
CR-PC-08	13-Aug-19	8:13	1	100	5	0	*Corvus corax*	common raven	3	515365	7818442	UTM NAD83	19W
CR-PC-08	13-Aug-19	8:13	1	100	5	0	*Larus hyperboreus*	glaucous gull	1	515365	7818442	UTM NAD83	19W
CR-PC-09	13-Aug-19	8:45	10	100	5	0	*Corvus corax*	common raven	2	515060	7818162	UTM NAD83	19W
CR-PC-09	13-Aug-19	8:45	10	100	5	0	*Larus hyperboreus*	glaucous gull	3	515060	7818162	UTM NAD83	19W
CR-PC-10	13-Aug-19	9:10	3	100	7	0	*Corvus corax*	common raven	2	514686	7817988	UTM NAD83	19W
CR-PC-10	13-Aug-19	9:10	3	100	7	0	*Plectrophenax nivalis*	snow bunting	2	514686	7817988	UTM NAD83	19W

Appendix 7 Fish and Fish Habitat (Intertidal)

Appendix 7 - Intertidal Transect Photos

Photo 1 – Overview and Quadrats

Transect 1	
Seaward Overview	**Landward Overview**
	

Quadrats		
Quadrat 1	**Quadrat 2**	**Quadrat 3**
		

No further photos

Photo 2 – Overview and Quadrats

Transect 2

Seaward Overview

Landward Overview

Quadrats

Quadrat 1

Quadrat 2

Quadrat 3

Quadrat 4

No further photos

Photo 3 – Overview and Quadrats

Transect 3	
Seaward Overview	**Landward Overview**
	

Quadrats		
Quadrat 1	**Quadrat 2**	**Quadrat 3**
		

No further photos

Photo 4 – Overview and Quadrats

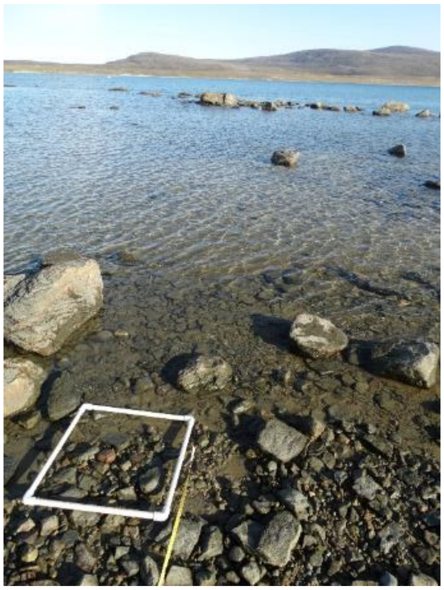
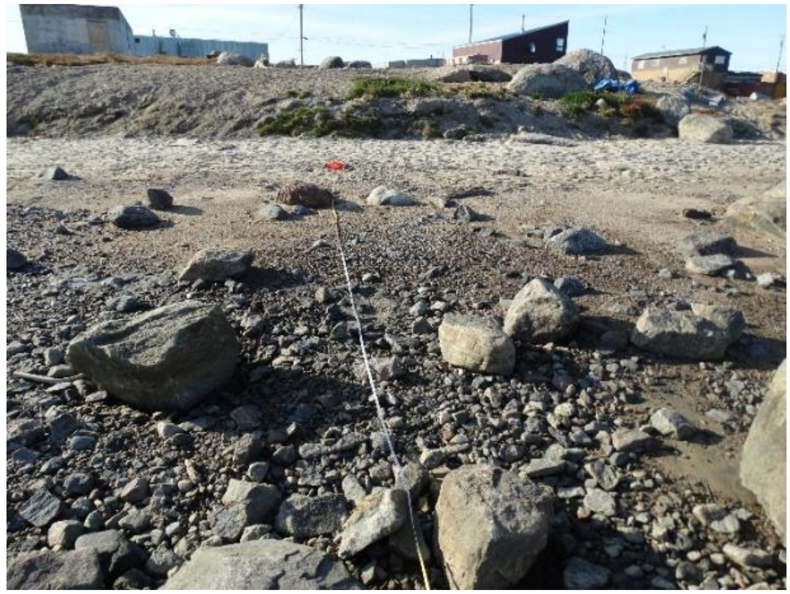
Transect 4

Seaward Overview	Landward Overview
	

Quadrats

Quadrat 1	Quadrat 2	Quadrat 3
		
Quadrat 4		
	No further photos	

Photo 5 – Overview and Quadrats

Transect 5	
Seaward Overview	**Landward Overview**
	

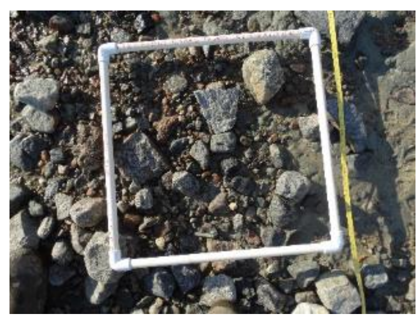
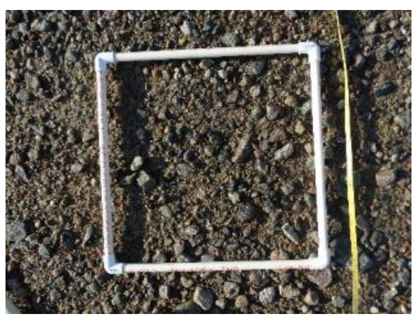
Quadrats		
Quadrat 1	**Quadrat 2**	**Quadrat 3**
		
Quadrat 4	**Quadrat 5**	
		No further photos

Photo 6 – Overview and Quadrats

Transect 6	
Seaward Overview	**Landward Overview**
	

Quadrats		
Quadrat 1	**Quadrat 2**	**Quadrat 3**
		
Quadrat 4		
	No further photos	

Appendix 8 Fish and Fish Habitat (Subtidal SCH Study Area)

Advisian

Appendix 8 - Table 1
Clyde River Subtidal ROV data

Survey Time	Transect No	ROV Depth (m)		Sounder Depth (m)	Tide Height (m)	Chart Datum (CD, m) (sounder	Temperature (° C)	Substrate		Vegetation (%)					Invertebrates					Fish (n)			
		Minimum	Maximum					Type	Percent	Species Name		Abundance	Cateogorization Range (Table 9-7)	ID Confidence	Species Name		Abundance	Measure	Cateogorization Range (Table 9-6)	Species Name		Abundance (count)	Cateogorization Range (Table 9-6)
										Common	Latin				Common	Latin				Common	Latin		
Parallel to Shore																							
9:26	1	8	10	11.3	0.5	10.8	6.3	sand	90 to 100	sea collander	*Agarum clathratum*	<5%	trace	probable	truncate soft shell clam	*Mya truncata*	20-40/m2	density	moderate				
								boulder	<10	encrusting coralline agae	Corallina sp.	<5%	trace	probable	green sea urchin	*Strongylocentrotus drobachiensis*	5	count	trace				
9:41	2	4	6	7.6	0.5	7.1	9	sand	90 to 100	thread brown algae	*Chordaria sp.*	<5%	trace	possible	truncate soft shell clam	*Mya truncata*	20-40/m2	density	moderate	Shorthorn sculpin	*Myoxocephalus sp (prob)*	1	trace
								boulder	<10						tube-dwelling anemone	*Pachycerianthus borealis*	1	count	trace				
															green sea urchin	*Strongylocentrotus drobachiensis*	3	count	trace				
9:55	3	6.5	8	8	0.5	7.5	7.4	sand	90 to 100						truncate soft shell clam	*Mya truncata*	20-40/m2	density	moderate				
								boulder	<10						green sea urchin	*Strongylocentrotus drobachiensis*	10	count	trace				
10:05	4	1	2	2.6	0.6	2	8.6	sand	90 to 100	thread brown algae	*Chordaria sp.*	40-90 %	abundant	possible	truncate soft shell clam	*Mya truncata*	10-20/m2	density	infrequent				
								boulder	<10						Buccinum snail egg mass		1	count	trace				
10:18	5	5	7	7.7	0.6	7.1	5.2	sand	90 to 100	sea collander	*Agarum clathratum*	<5%	trace	probable	truncate soft shell clam	*Mya truncata*	10-20/m2	density					
								boulder	<10						green sea urchin	*Strongylocentrotus drobachiensis*	10	count	trace				
10:33	6	4.5	6	6.6	0.6	6	8.4	sand	90 to 100						truncate soft shell clam	*Mya truncata*	10-20/m2	density	infrequent				
								boulder	<10						green sea urchin	*Strongylocentrotus drobachiensis*	5	count	trace				
10:42	7	5	6	6	0.6	5.4	3.7	sand	90 to 100						truncate soft shell clam	*Mya truncata*	10-20/m2	density	infrequent				
								boulder	<10						green sea urchin	*Strongylocentrotus drobachiensis*	5	count	trace				
10:51	8	0.5	2	1.8	0.6	1.2	8.5	sand	90 to 100	thread brown algae	*Chordaria sp.*	40-90 %	abundant	possible	truncate soft shell clam	*Mya truncata*	20-40/m2	density	moderate				
								boulder	<10														
11:00	9	1.5	5	5.2	0.6	4.6	9.6	sand	90 to 100	thread brown algae	*Chordaria sp.*	40-90 %	abundant	possible	truncate soft shell clam	*Mya truncata*	5-10/m2	density	infrequent				
								boulder	<10	sugarwrack kelp	*Saccharina latissima*	20-50%	infrequent	probable									
										sea lettuce		30-50%											
11:10	10	0.4	1.2	1.7	0.6	1.1	9.2	sand	90 to 100	rockweed	*Fucus sp.*	10-30%	moderate	probable									
								boulder	<10	thread brown algae	*Chordaria sp.*	40-90 %	abundant	possible									
										sugarwrack kelp	*Saccharina latissima*	20-50%	infrequent	possible									
11:25	11	1.5	3.5	4.8	0.6	4.2	10.1	sand	90 to 100	thread brown algae	*Chordaria sp.*	40-90 %	abundant	possible									
								boulder	10 to 20	sugarwrack kelp	*Saccharina latissima*	10%	trace	probable									
11:33	12	5.5	6.5	6.4	0.6	5.8	5	sand	90 to 100						truncate soft shell clam	*Mya truncata*	5-10/m2	density	infrequent				
								boulder	10 to 20						green sea urchin	*Strongylocentrotus drobachiensis*	5	count	trace				
11:41	13	2.5	3	3.1	0.6	2.5	8.7	sand	90 to 100	thread brown algae	*Chordaria sp.*	30 to 50%	abundant	possible	truncate soft shell clam	*Mya truncata*	5-10/m2	density	infrequent				
								boulder	10 to 20	sea lettuce		<10%											
										sugarwrack kelp	*Saccharina latissima*	<10%	trace	probable									
13:18	14	5.5	6.5	6	0.6	5.4	2.7	sand	90 to 100						truncate soft shell clam	*Mya truncata*	10-20/m2	density	infrequent				
								boulder	<10						green sea urchin	*Strongylocentrotus drobachiensis*	1	count	trace				
13:39	15	5.5	6.5	6.1	0.6	5.5	5	sand	90 to 100						truncate soft shell clam	*Mya truncata*	5-10/m2	density	infrequent				
								boulder	<10						green sea urchin	*Strongylocentrotus drobachiensis*	5	count	trace				
13:53	16	4.5	5.5	4.4	0.6	5.5	6.5	sand	90 to 100	thread brown algae	*Chordaria sp.*	40-90 %	abundant	possible	truncate soft shell clam	*Mya truncata*	10-20/m2	density	infrequent				
								boulder	<10	sea lettuce		30-50%											
										rockweed	*Fucus sp.*	10-20%	infrequent	probable									
14:01	17	3.5	4.5	5	0.5	4.5	8.5	sand	90 to 100	thread brown algae	*Chordaria sp.*	40-90 %	abundant	possible	truncate soft shell clam	*Mya truncata*	10-20/m2	density	infrequent				
								boulder	<10	sea lettuce		30-50%											
14:17	18	3.5	4.5	4.3	0.5	3.8	8.5	sand	90 to 100	thread brown algae	*Chordaria sp.*	40-90 %	abundant	possible	truncate soft shell clam	*Mya truncata*	10-20/m2	density	infrequent				
								boulder	<10	sea lettuce		30-50%											
14:27	19	0.5	1.8	2.1	0.5	1.6	10	sand	90 to 100	thread brown algae	*Chordaria sp.*	40-90 %	abundant	possible	truncate soft shell clam	*Mya truncata*	10-20/m2	density	infrequent				
								boulder	<10	sea lettuce		30-50%											
14:36	20	1.5	2.5	1.7	0.5	1.2	10	sand	90 to 100	thread brown algae	*Chordaria sp.*	40-90 %	abundant	possible									
								boulder	<10	sea lettuce		30-50%			truncate soft shell clam	*Mya truncata*	20-40/m2	density	moderate				
Perpendicular to Shore																							
13:09	21	0.4	1.5	1.5	0.6	0.9	10	sand	80	thread brown algae	*Chordaria sp.*	40-90 %	abundant	possible						Shorthorn sculpin	*Myoxocephalus sp (prob)*	1	trace
								cobble	<10	sea lettuce		30-50%											
								boulder	<10	rockweed	*Fucus sp.*	10-20%	infrequent										
13:19	22	0.5	2.2	3	0.6	2.4	9.5	sand	70 to 80	thread brown algae	*Chordaria sp.*	40-90 %	abundant	possible	truncate soft shell clam	*Mya truncata*	10-20/m2	density	infrequent				
								boulder	10 to 20	sea lettuce		30-50%											
										rockweed	*Fucus sp.*	10-20%	infrequent	probable									
13:32	23	1.7	2.5	2.5	0.6	1.9	9	sand	60 to 70	thread brown algae	*Chordaria sp.*	40-90 %	abundant	possible	truncate soft shell clam	*Mya truncata*	10-20/m2	density	infrequent				
								bedrock	30 to 40	sea lettuce		30-50%											
13:44	24	0.5	2.5	2.3	0.6	1.7	9.5	sand	70 to 80	thread brown algae	*Chordaria sp.*	40-90 %	abundant	possible	truncate soft shell clam	*Mya truncata*	5-10/m2	density	trace				
								boulder	20 to 30	sea lettuce		30-50%											
13:55	25	0.1	2.4	3.8	0.6	3.2	9.5	sand	60 to 70	thread brown algae	*Chordaria sp.*	40-60%	abundant	possible									
								boulder	30 to 40	rockweed	*Fucus sp.*	40-60%	abundant	probable									
14:10	26	0.1	2.4	3.8	0.6	3.2	9.5	sand	60 to 70	thread brown algae	*Chordaria sp.*	40-60%	abundant	possible									
								boulder	30 to 40	rockweed	*Fucus sp.*	40-60%	abundant	probable									
14:21	27	1.4	2.9	3.4	0.6	2.8	9	sand	90 to 100	thread brown algae	*Chordaria sp.*	40-90 %	abundant	possible	truncate soft shell clam	*Mya truncata*	5-10/m2	density	trace				
								boulder	<10	sea lettuce		30-50%			green sea urchin	*Strongylocentrotus drobachiensis*	1	count	trace				
14:33	28	0.3	1.9	4.1	0.6	3.5	9.2	sand	50	thread brown algae	*Chordaria sp.*	40-90 %	abundant	possible	truncate soft shell clam	*Mya truncata*	5-10/m2	density	trace				
								boulder	10 to 20	sea lettuce		30-50%			green sea urchin	*Strongylocentrotus drobachiensis*	1	count	trace				
								cobble	20 to 30														
15:16	29	0.3	1.4	2.2	0.5	1.7	9.4	sand	50	thread brown algae	*Chordaria sp.*	40-90 %	abundant	possible									
								boulder	20 to 30	sea lettuce		30-50%											
								cobble	20 to 30	rockweed	*Fucus sp.*	10-20%	infrequent	probable									
15:30	30	0.1	1	1.5	0.5	1	10	sand	90 to 100						pipe cleaner hydroid (possible)	Lafoeina maxima	6	count	trace				
								boulder	<10						truncate soft shell clam	*Mya truncata*	5-10/m2	density	trace				
15:45	31	0.4	1	1	0.5	0.5	9.6	sand	50	thread brown algae	*Chordaria sp.*	40-60%	abundant	possible	truncate soft shell clam	*Mya truncata*	5-10/m2	density	trace				
								boulder	20 to 30	rockweed	*Fucus sp.*	40-60%	abundant	probable									
								cobble	20 to 30														
15:59	32	0.1	1.3	1	0.5	0.5	10.2	sand	90 to 100	thread brown algae	*Chordaria sp.*	40-90 %	abundant	possible	truncate soft shell clam	*Mya truncata*	5-10/m2	density	trace				
								boulder	<10	rockweed	*Fucus sp.*	30-50%	moderate	probable									
										sea lettuce		10-20%											

Appendix 8 – Clyde River ROV Transects – Parallel to Shore

Transect 1 – Photo 1 - Overview

Transect 1 – Photo 2 (clam siphons)

Transect 1 – Photo 3 - Overview

Transect 1 – Photo 4 (clam siphons)

Transect 2 – Photo 1 (sculpin)

Transect 2 – Photo 2 (overview)

Transect 2 – Photo 3 – Anthropogenic debris

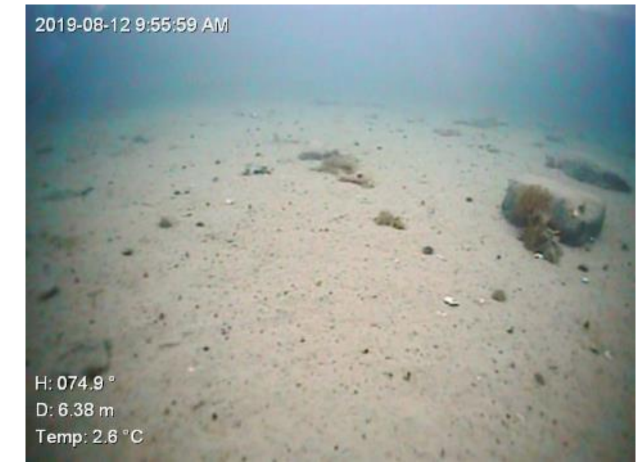
Transect 2 – Photo 4 – tube dwelling anemone

Transect 3 – Photo 1 - overview

Transect 3 – Photo 2 (thread brown algae)

Transect 3 – Photo 3 (sea urchin)

Transect 3 – Photo 4 - overview

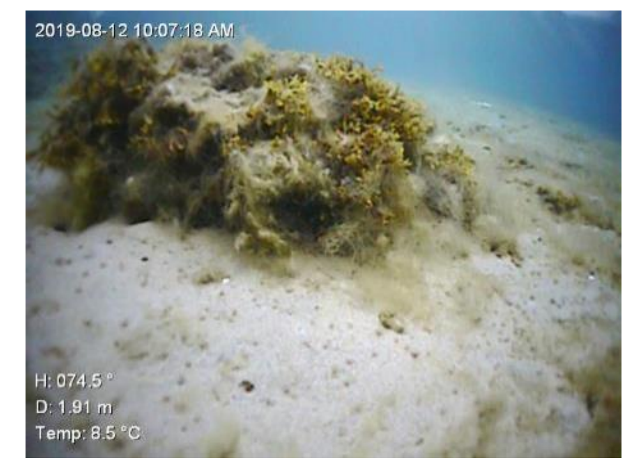


Transect 4 – Photo 1 – Overview (sea colander)

Transect 4 – Photo 2 (Buccinum snail egg

Transect 4 – Photo 3 - Overview

Transect 4 – Photo 4 – rockweed



Transect 5 – Photo 1 - Overview

Transect 5 – Photo 2 (clam siphons)

Transect 4 – Photo 1 - overview

Transect 5 – Photo 4 - Overview

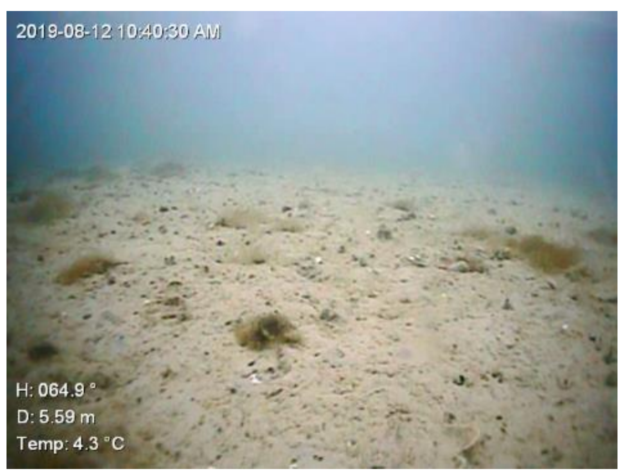
Transect 6 – Photo 1 - Overview

Transect 6 – Photo 2 (green sea urchin)

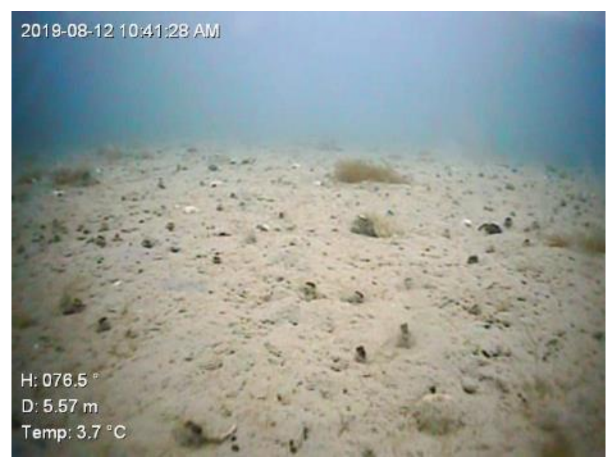
Transect 6 – Photo 3 - Overview

Transect 6 – Photo 4 - overview

Transect 7 – Photo 1 - Overview

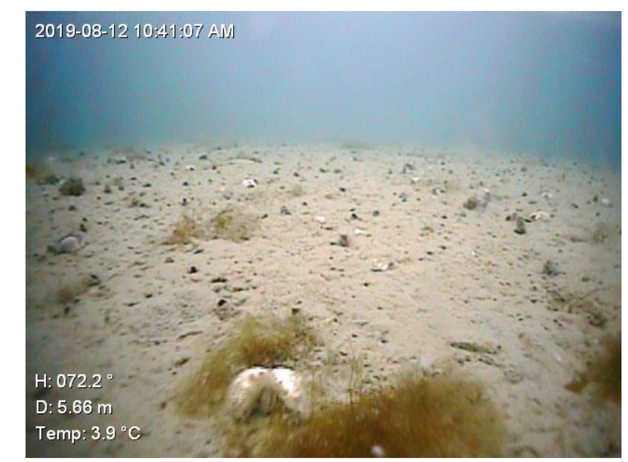


Transect 7 – Photo 2 - Overview



Transect 7 – Photo 3 (clam siphons)

Transect 7 – Photo 4 (clam siphons)



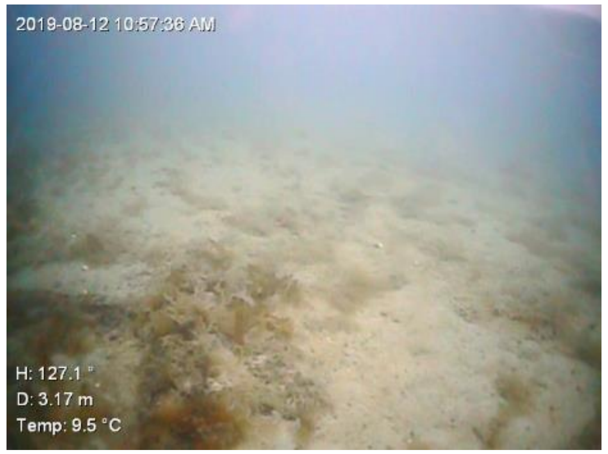
Transect 8 – Photo 1 – boulder cluster

Transect 8 – Photo 2 – overview

Transect 8 – Photo 3 – overview

Transect 8 – Photo 4 – rockweed

Transcept 9 – Photo 1 - overview



Transect 9 – Photo 2 (sea collander)

Transect 9 – Photo 3 - overview

Transect 9 – Photo 4 - overview

Transect 10 – Photo 1 – overview

Transect 10 – Photo 2 – overview

Transect 10 – Photo 3 – overview

Transect 10 – Photo 4 – overview

Transect 11 – Photo 1 – overview

Transect 11 – Photo 2 – overview

Transect 11 – Photo 3 – overview

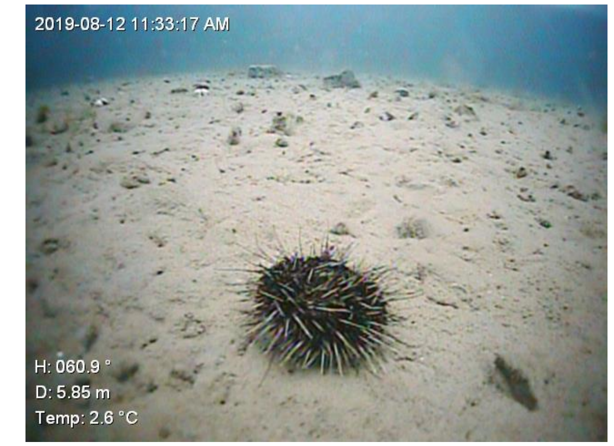
Transect 11 – Photo 4 – sea colander

Transect 12 – Photo 1 – overview

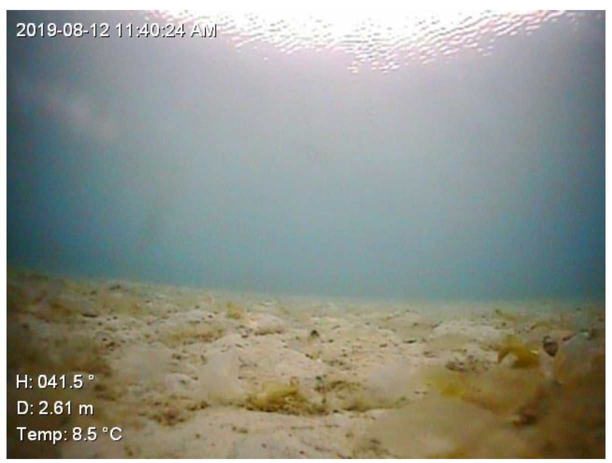
Transect 12 – Photo 2 – overview

Transect 12 – Photo 3 – overview

Transect 12 – Photo 4 – sea urchin



Transect 13 – Photo 1 – overview



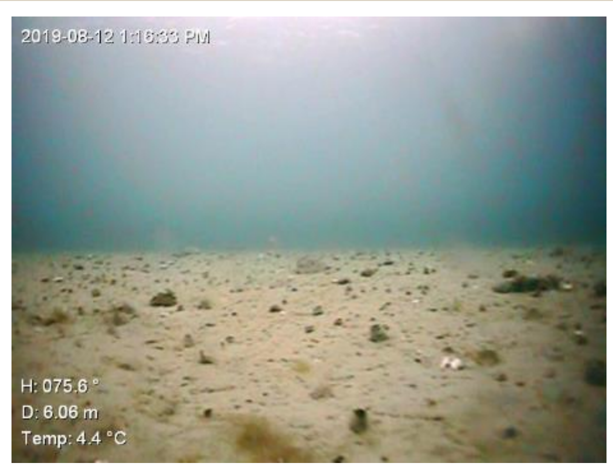
Transect 13 – Photo 2 – overview

Transect 13 – Photo 3 – overview

Transect 13 – Photo 4 – overview

Transect 14 – Photo 1 – overview

Transect 14 – Photo 2 – overview

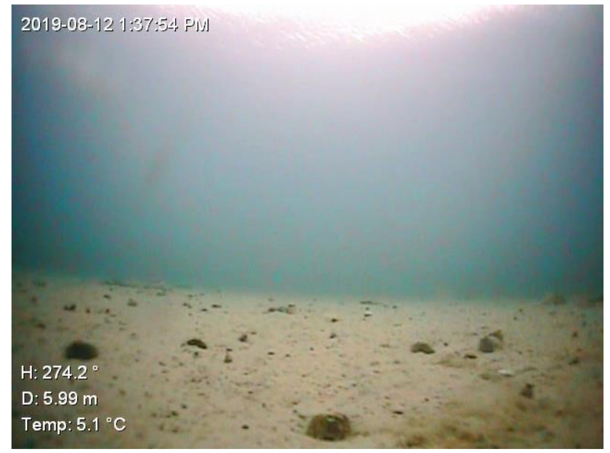


Transect 14 – Photo 3 – overview

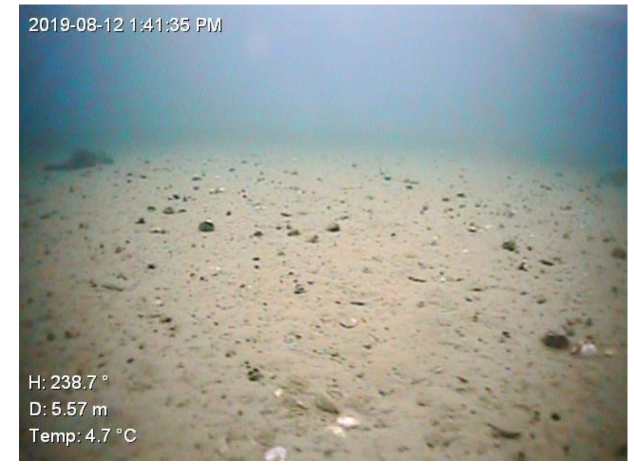
Transect 14 – Photo 4 – clam siphons

Transcript 15 – Photo 1 – overview

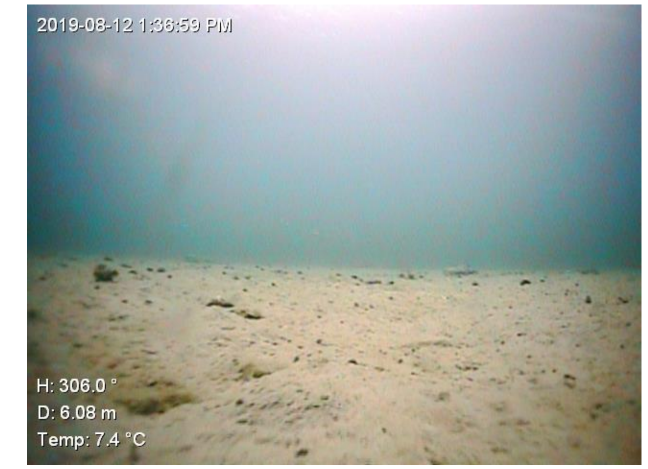
Transect 15 – Photo 2 – sea urchins



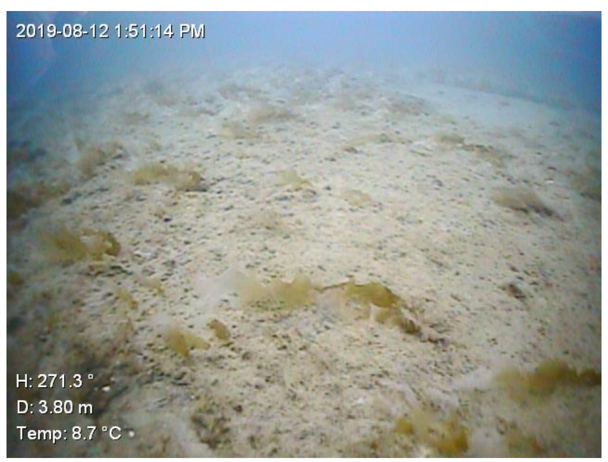
Transect 15 – Photo 3 – overview



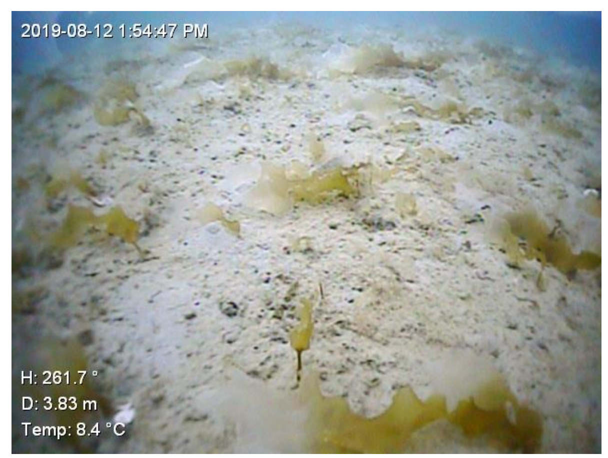
Transect 15 – Photo 4 – overview



Transect 16 – Photo 1 – overview

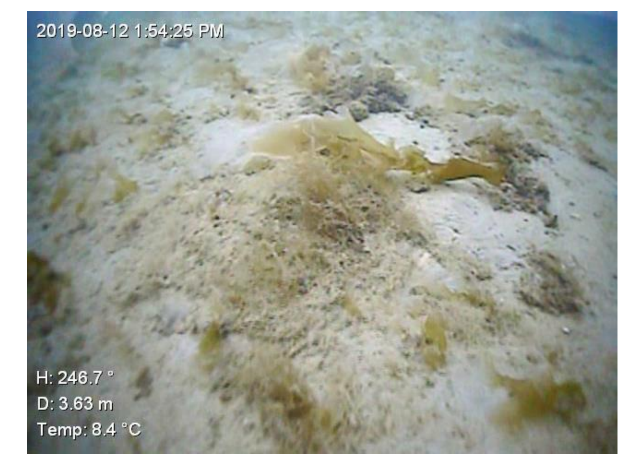


Transect 16 – Photo 2 – overview



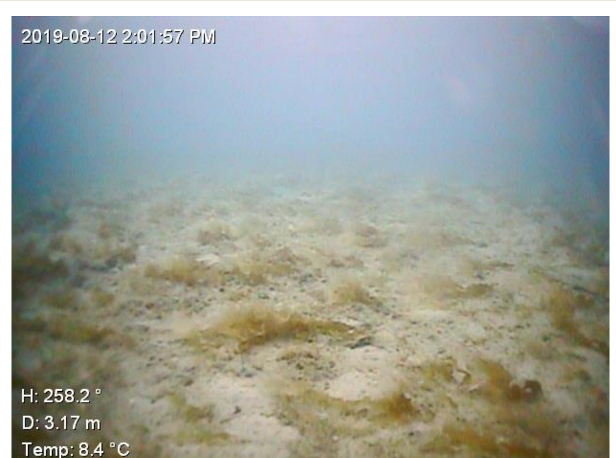
Transect 16 – Photo 3 – sea colander

Transect 16 – Photo 4 - overview

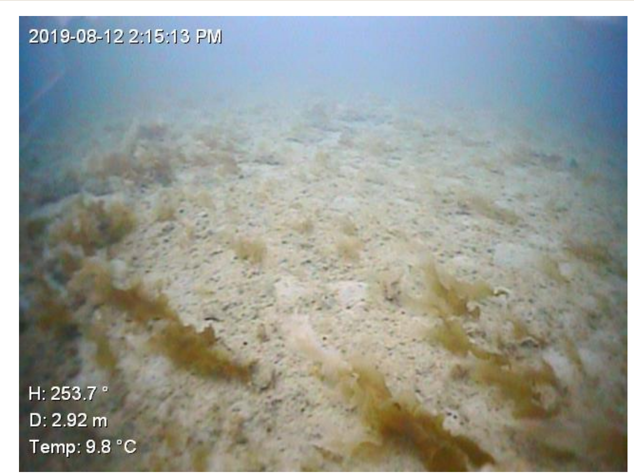


Transect 17 – Photo 1 – Overview

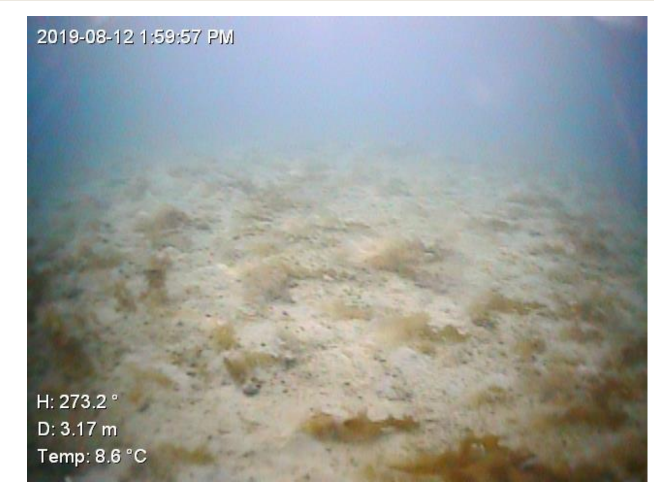
Transect 17 – Photo 2 – Overview



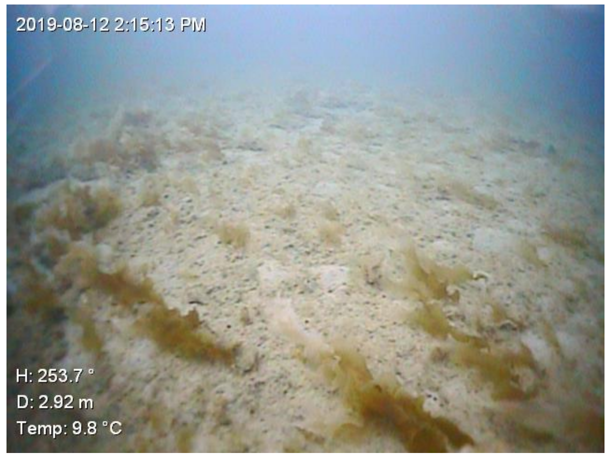
Transect 17 – Photo 3 – Overview



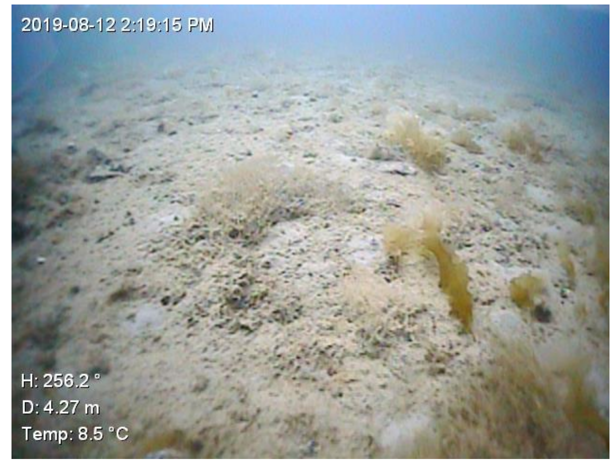
Transect 17 – Photo 4 – Overview



Transect 18 – Photo 1 – Overview



Transect 18 – Photo 2 – Overview

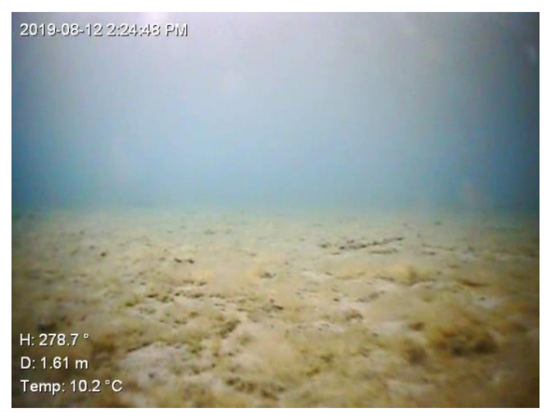


Transect 18 – Photo 3 – Overview

Transect 18 – Photo 4 – Overview

Transect 19 – Photo 1 – Overview

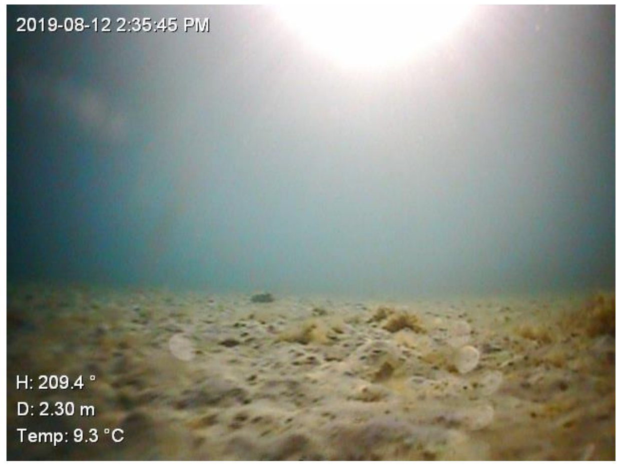
Transect 19 – Photo 2 – Overview



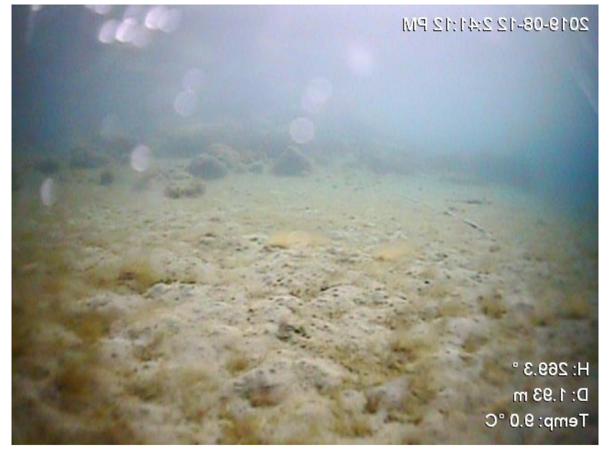
Transect 19 – Photo 3 – Boulder

Transect 19 – Photo 4 – Overview

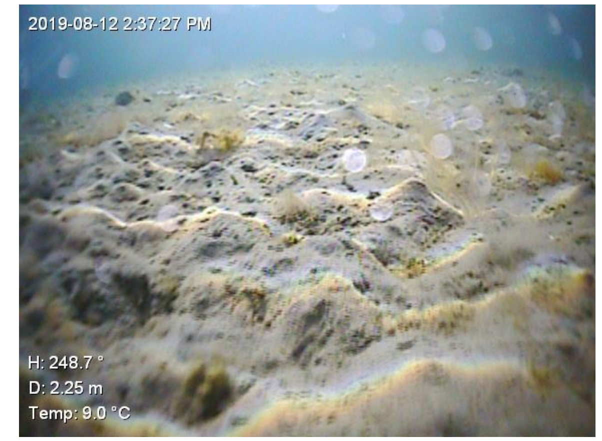
Transcect 20 – Photo 1 – Overview



Transect 20 – Photo 2 – Overview



Transect 20 – Photo 3 – Overview



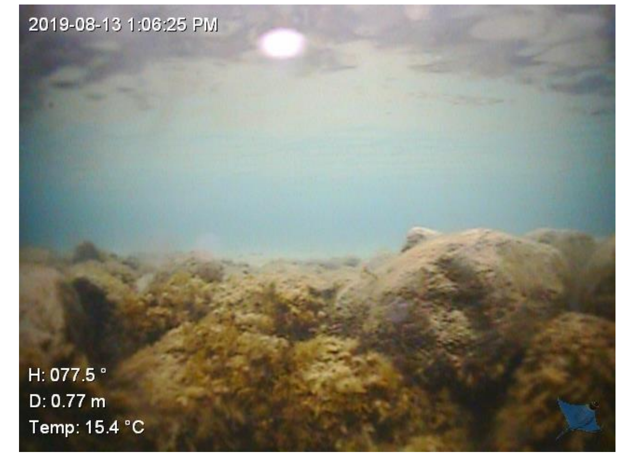
Transect 20 – Photo 4 – Breakwater

Clyde River ROV Transects – Perpendicular to Shore

Transect 21 – Photo 1 - Overview

Transect 21 – Photo 2 - Rockweed

Transect 21 – Photo 3 - Overview



Transect 21 – Photo 4 - Overview

Transect 22 – Photo 1 (thread brown algae)

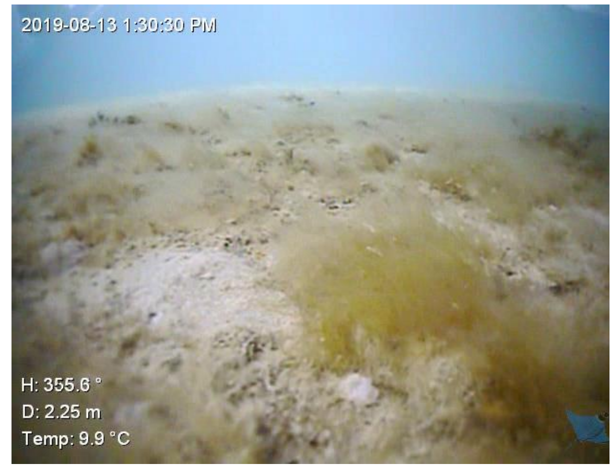
Transect 22 – Photo 2 - Overview

Transect 22 – Photo 3 – Rockweed

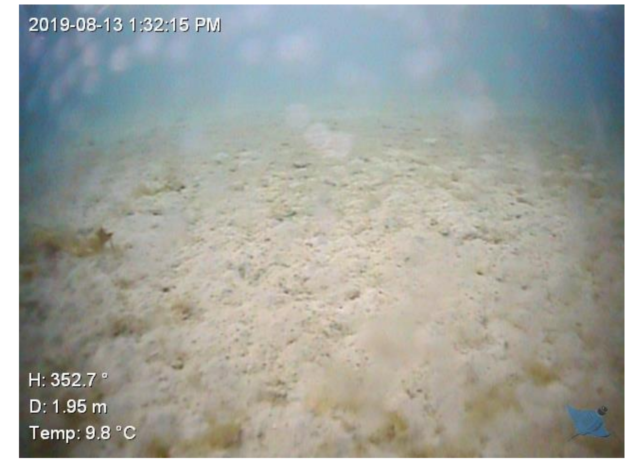
Transect 22 – Photo 4 – Overview

Transect 23 – Photo 1 - Overview

Transect 23 – Photo 2 (thread brown algae)



Transect 23 – Photo 3 - Overview



Transect 23 – Photo 4 - Overview

Transect 24 – Photo 1 – Overview

Transect 24 – Photo 2 - Rockweed

Transect 24 – Photo 3 - Overview

Transect 24 – Photo 4 – rockweed

Transect 25 – Photo 1 - Rockweed

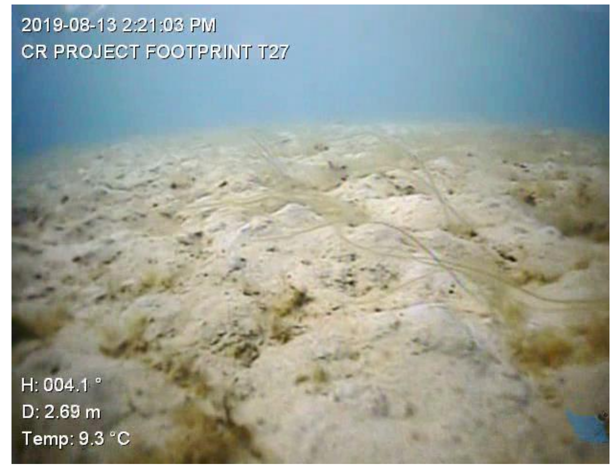
Transect 25 – Photo 2 – Boulder cluster

Transect 25 – Photo 3 – Thread brown algae

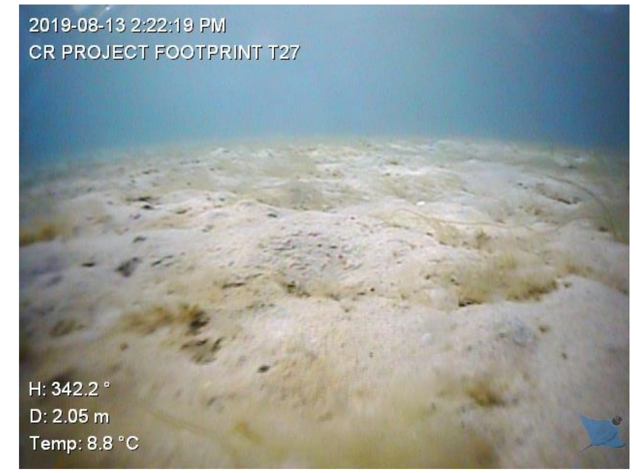
Transect 5 – Photo 4 - Overview

Transect 27 – Photo 1 – Thread brown algae

Transect 27 – Photo 2 - Overview



Transect 27 – Photo 3 – Overview



Transect 27 – Photo 4 - Overview

Transect 28 – Photo 1 – Thread brown algae

Transect 28 – Photo 2 – Overview

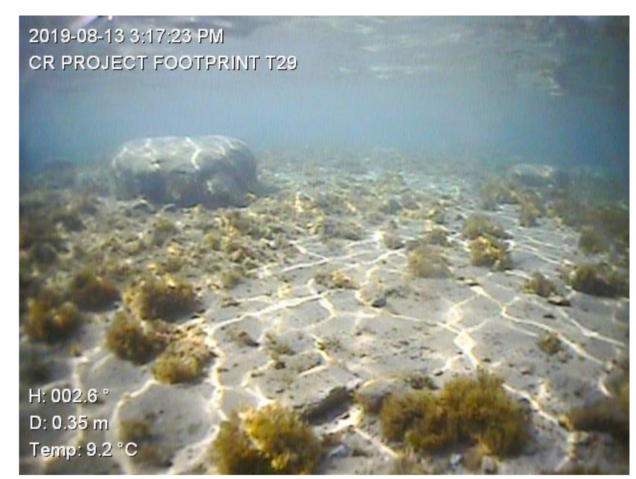
Transect 28 – Photo 3 – Overview

Transect 28 – Photo 4 – Overview

Transect 29 – Photo 1 – Thread brown algae

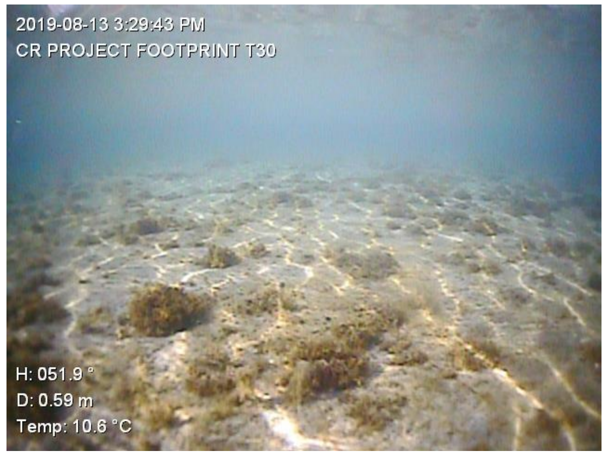
Transect 29 – Photo 2 - Rockweed

Transect 29 – Photo 3 – Overview

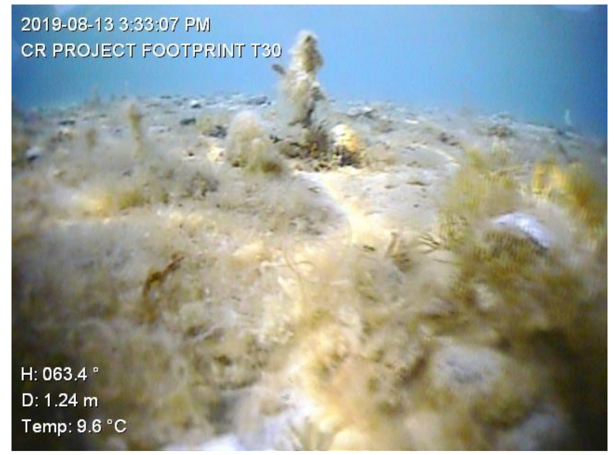


Transect 29 – Photo 4 - Overview

Transect 30 – Photo 1 – Overview



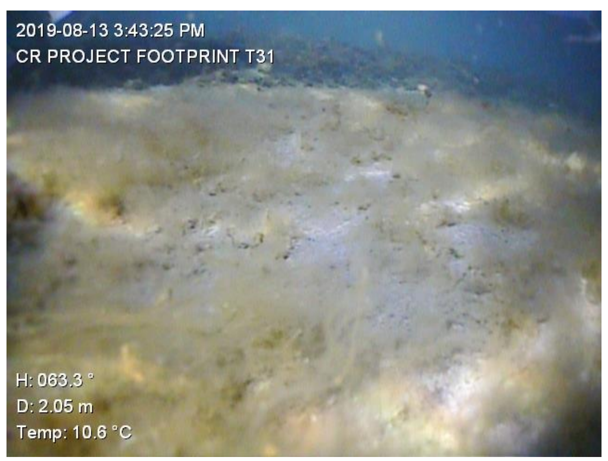
Transect 30 – Photo 2 – Thread brown algae



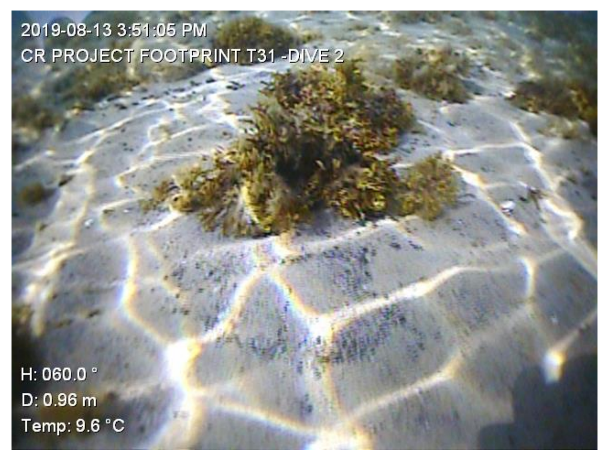
Transect 30 – Photo 3 – Overview

Transect 30 – Photo 4 – Rockweed

Transect 31 – Photo 1 – Thread brown algae



Transect 31 – Photo 2 – Rockweed



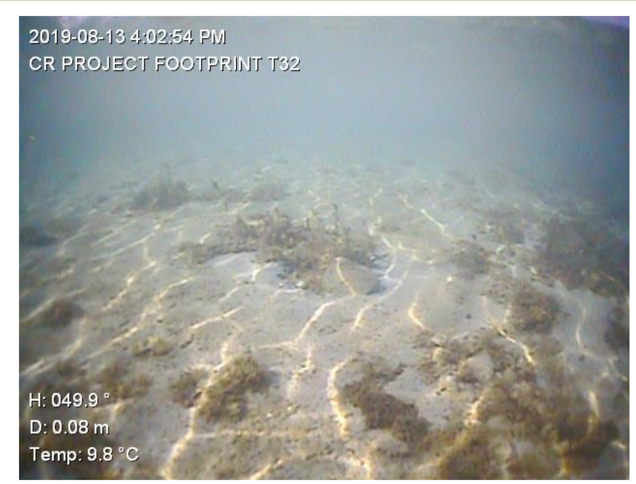
Transect 31 – Photo 3 – Overview

Transect 31 – Photo 4 – Overview

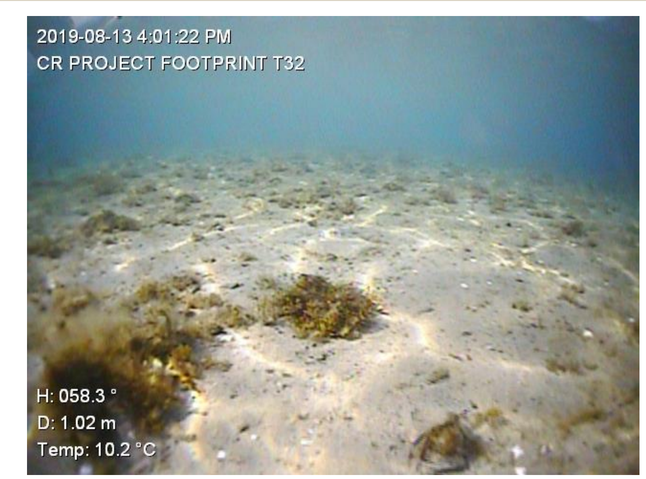
Transect 32 – Photo 1 – Overview

Transect 32 – Photo 2 – Overview

Transect 32 – Photo 3 – Overview



Transect 32 – Photo 4 – Rockweed



Appendix 9 Fish and Fish Habitat (Subtidal DAS Study Area)

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Appendix 9 - Table 1
Clyde River Subtidal DAS data

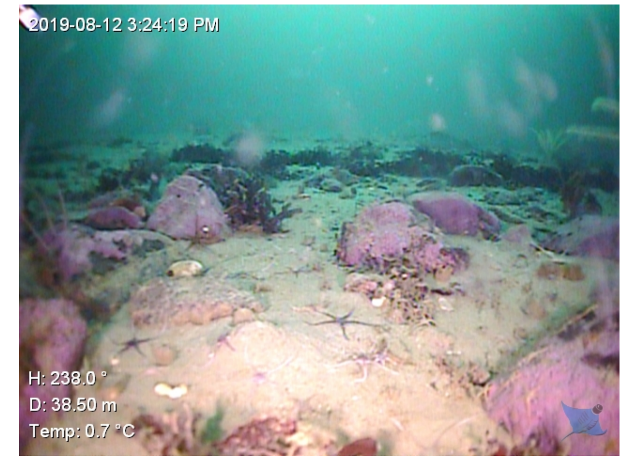
Survey Time	Transect No	ROV Depth (m)		Sounder Depth (m)	Tide Height (m)	Depth Chart Datum (m)	Temperature (° C)	Substrate		Vegetation (%)				Invertebrates					Fish (n)			
		Minimum	Maximum					Type	Percent	Species Name		Abundance	Cateogorization Range (Table 9-7)	Species Name		Abundance	Measure	Cateogorization Range (Table 9-6)	Species Name		Abundance (count)	Cateogorization Range (Table 9-6)
										Common	Latin			Common	Latin				Common	Latin		
								sand	80	rockweed (loose)	*Fucus sp.*	<5%	trace	brittle star	*Ophiocten or Ophiura sp*	30 to 60 /m2	density	abundant				
								boulder	<10	encrusting coralline agae	*Corallina sp.*	<5%	trace	calcareous tube worm	UNID	10	count	trace				
12:13	1	37.4	41.2	40.6	0.6	40	0.6	cobble	<10					crinoid	*Heliometra glacialis (poss)*	10		infrequent				
								sand	70	rockweed (loose)	*Fucus sp.*	<5%	trace	brittle star	*Ophiocten or Ophiura sp*	30 to 60 /m2	density	abundant				
								boulder	<10	encrusting coralline agae	*Corallina sp.*	<5%	trace	green sea urchin	*Strongylocentrotus drobachiensis*	3	count	trace				
								cobble	20					truncate soft shell clam	*Mya truncata*	1	count	trace				
														crinoid	*Heliometra glacialis (poss)*	10	count	trace				
														snail	*Buccinum sp.*	1	count	trace				
12:21	2	36.9	38.5	38.7	0.6	38.1	0.4							scallop	UNID	1	count	trace				
								sand	70	rockweed (loose)	*Fucus sp.*	<5%	trace	brittle star	*Ophiocten or Ophiura sp*	50 to 70 /m2	density	abundant				
								boulder	<10	encrusting coralline agae	*Corallina sp.*	<5%	trace	green sea urchin	*Strongylocentrotus drobachiensis*	3	count	trace				
								cobble	20					truncate soft shell clam	*Mya truncata*	2	count	trace				
														calcareous tube worm	UNID	2	count	trace				
														crinoid	*Heliometra glacialis (poss)*	10	count	infrequent				
12:34	3	35.4	37.3	38	0.6	37.4	0.6							burrowing sea cucumber	*Psolus sp. (poss)*	2	count	trace				
								sand	80	rockweed (loose)	*Fucus sp.*	<5%	trace	brittle star	*Ophiocten or Ophiura sp*	50 to 70 /m2	density	abundant	fish		1	
								boulder	<10	encrusting coralline agae	*Corallina sp.*	<5%	trace	green sea urchin	*Strongylocentrotus drobachiensis*	10	count	trace to infrequent				
								cobble	<10					sun star	*Solaster sp.*	4	count	trace				
														snail	*Buccinum sp.*	2	count	trace				
														tunicate	*Halocynthia sp. (poss)*	1	count	trace				
														crinoid	*Heliometra glacialis (poss)*	20	count	infrequent				
														hedgehog amphipod	*Paramphitoe sp.*	1	count	trace				
12:42	4	37.2	38	39	0.6	38.4	0.7							sponge	*UNID*	3	count	trace				
								sand	80	rockweed (loose)	*Fucus sp.*	<5%	trace	limpet	*Tectura sp. (prob)*	3	count	trace				
								boulder	<10	encrusting coralline agae	*Corallina sp.*	<5%	trace	crinoid	*Heliometra glacialis (poss)*	10	count	infrequent				
								cobble	<10					soft coral	*Alcyonium sp.*	6	count	trace				
12:50	5	37	38	39	0.6	38.4	1.2															
								sand	60	rockweed (loose)	*Fucus sp.*	<5%	trace	brittle star	*Ophiocten or Ophiura sp*	50 to 70 /m2	density	abundant				
								boulder	30					crinoid	*Heliometra glacialis (poss)*	25	count	infrequent				
								cobble	10					sun star	Solaster sp.	1	count	trace				
12:58	6	37.3	39.4	40	0.6	39.4	0.8															
								sand	90 to 100	rockweed (loose)	*Fucus sp.*	<5%	trace	brittle star	*Ophiocten or Ophiura sp*	50 to 70 /m2	density	abundant				
								boulder	<10					green sea urchin	*Strongylocentrotus drobachiensis*	7	count	trace				
														snail	*Buccinum sp.*	1	count	trace				
														calcareous tube worm	UNID	2	count	trace				
														truncate soft shell clam	*Mya truncata*	2 to 5 /m2	density	trace				
														crinoid	*Heliometra glacialis (poss)*	25	count	infrequent				
														burrowing sea cucumber	*Psolus sp.*	1	count	trace				
														barnacle	*Balanus sp.*	1	count	trace				
12:56	7	42.7	43.2	43.6	0.6	43	0.7							Buccinum snail eggs		1	count	trace				

Appendix 9 – Clyde River ROV Transects – Disposal at Sea Study Area

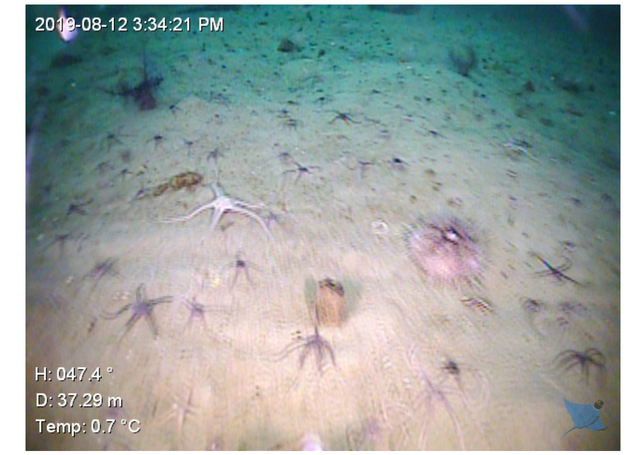
Transect 1 – Photo 1 - Overview

Transect 2 – Photo 1 - Crinoid

Transect 2 – Photo 2 - Overview

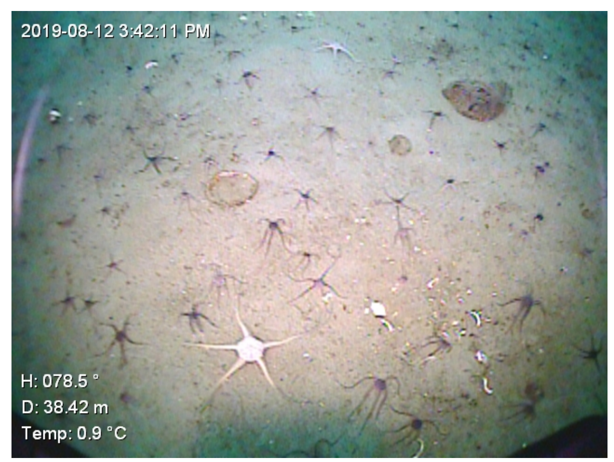


Transect 3 – Photo 1 - Overview

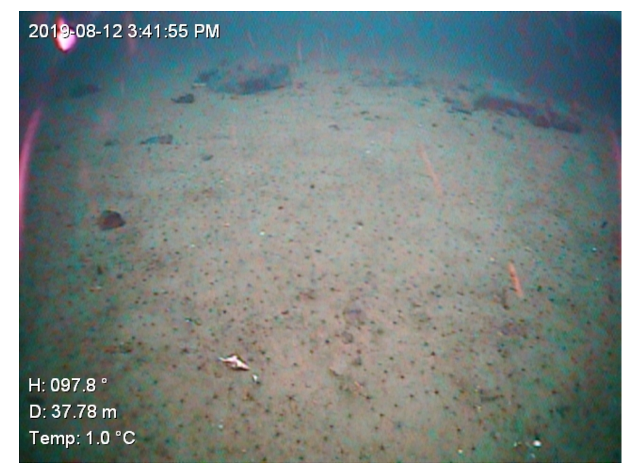


Transect 3 – Photo 2 - Truncate softshell clam

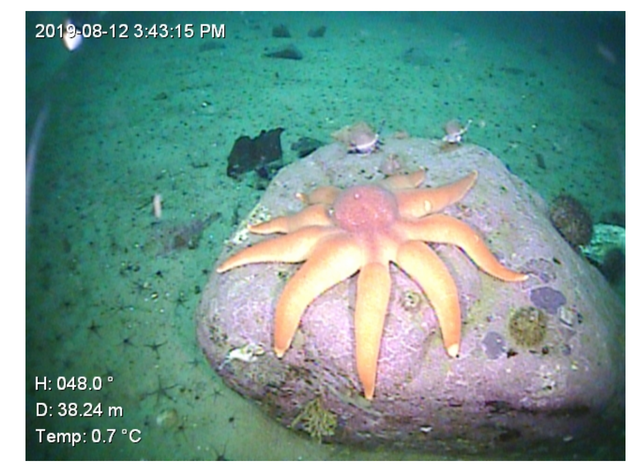
Transect 4 – Photo 1 - Brittle stars



Transect 4 – Photo 2 – Overview

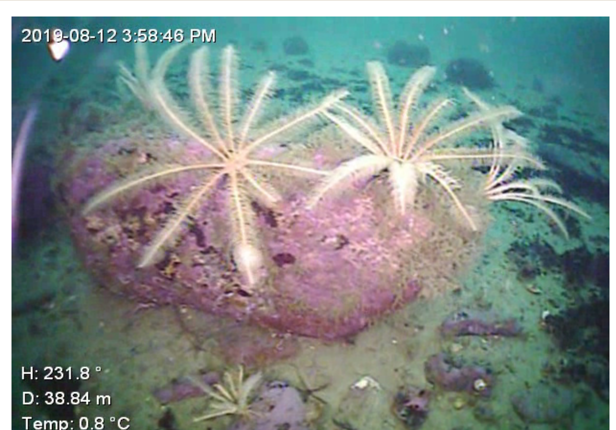


Transect 4 – Photo 3 – Sun star

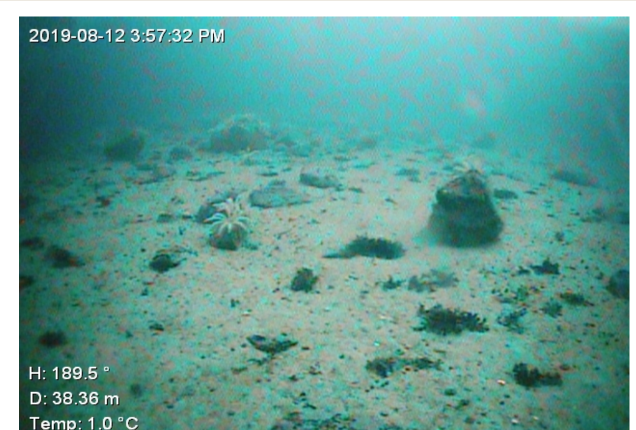


Transect 5 – Photo 1 – Soft coral

Transect 6 – Photo 1 - Crinoid



Transect 6 – Photo 2 - Overview



Transect 7 – Photo 1 - Overview