REPORT

Mary River Project

Year 1 Freight Dock Offset Habitat Monitoring Report

Fisheries Act Authorization 18-HCAA-00160

Submitted to:

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Executive Summary

Baffinland Iron Mines Corporation (Baffinland, the Proponent) submitted an application for an authorization under paragraph 35(2)(b) of the *Fisheries Act* to Fisheries and Oceans Canada (DFO) for the installation of the Freight Dock, comprised of a permanent causeway and a seasonal floating barge. The construction of the Freight Dock resulted in unavoidable loss of fish habitat and serious harm to fish amounting to 26,449 m^2 (2,170 Habitat Equivalent Units; Baffinland 2019). To offset the loss of fish habitat, Baffinland Iron Mines Corporation (Baffinland) proposed to install coarse rock material around the perimeter of the Freight Dock to increase habitat complexity and hard substrate for attachment and growth of macroalgae and invertebrate taxa in 2019. Subsequently, DFO issued the *Fisheries Act* Authorization (FAA) #18-HCAA-00160, which included requirements for offsetting measures (FAA Section 4) as well as associated monitoring and reporting for the Freight Dock (FAA Section 5).

Field surveys were conduced on both Freight Dock offset habitat as well as a suitable Reference Area outside the area of Project influence, approximately 2.25 km northeast of the Freight Dock location; the Reference Area was selected for similarities in substrate, bathymetry, and habitat composition relative to the Freight Dock. Field surveys included the following components designed to achieve compliance with Section 5 of the FAA:

- A visual assessment at the Freight Dock during lowest low tide (0.4 m chart datum [CD] at 9:02am) to document intertidal offset habitat and inspect coarse substrate stability, where possible.
- Mapping of as-built Freight Dock offset habitat.
- Subtidal dive transect/quadrat surveys to quantitatively evaluate macroalgae, sessile and motile invertebrates and fish occurrence within both the Freight Dock offset habitat and Reference Area.
- Opportunistic observations of macroalgae, fish and motile/sessile invertebrates during mapping.
- Subtidal assessment of stability of the coarse substrate along the perimeter of the Freight Dock offset habitat.
- Mapping and reconnaissance of a nearby Reference Area for comparison with offset habitat.

Survey results indicate that macroalgae colonization was low-moderate at the Freight Dock offset habitat and, in general, the Reference Area showed relatively higher areal cover and taxa richness, as to be expected in Year 1 of a multi-year monitoring program. Taxa recorded in the Reference Area but not the Freight Dock include two species of brown-bladed understory kelp – sugar kelp (*Laminaria saccharina*) and sea colander (*Agarum clathratum*) – as well as a crustose coralline algae (Corallinales indet.). Turf macroalgae occurred in low cover at both the Freight Dock and Reference Area while an epilithic brown filamentous algae (*Pylaiella* spp.) was ubiquitous within both survey areas. Rockweed (*Fucus distichus*) was dominant within the Reference Area but not the Freight Dock, which instead was dominated by an unidentified fine green filamentous algae.

Sessile invertebrates were not observed at the Freight Dock offset habitat but were recorded in the Reference Area at low mean areal cover across the various tidal zones. In the intertidal, dominant species included wrinkled rock-borer *Hiatella arctica* and *Mya* spp. – both types of clam. In the upper subtidal and the shallow subtidal, dominant taxa were tunicate (Tunicata indet.) and clam (wrinkled rock-borer and *Mya* spp.). Motile invertebrates were not observed within intertidal or upper subtidal depth contours at either survey site; however, several taxa were recorded in the shallow subtidal zone, with the Reference Area supporting higher species richness than the

Freight Dock. The Freight Dock offset habitat had occurrence of low mean density including green urchin (*Strongylocentrotus droebachiensis*) and brittle star (Ophiuroidea indet.), while the Reference Area was dominated by shrimp. Mysids (opossum shrimp, Order Mysida) were abundant at both the Freight Dock offset habitat and Reference Area and density tended to increase with depth.

Fish density and taxa richness were comparable between the Freight Dock and the Reference Area with low overall occurrence. Sculpins (Family Cottidae) dominated observations, consisting of the species shorthorn sculpin (*Myoxocephalus scorpius*), fourhorn sculpin (*Myoxocephalus quadricornis*), as well as individuals that were too small to identify. One Greenland cod (*Gadus ogac*) was opportunistically observed during perimeter mapping of the Reference Area.

Overall, Year 1 monitoring indicates that the three-dimensional structure of the Freight Dock offset habitat provides a suitable and stable substrate for colonization and growth of marine organisms, as evidenced by the presence of macroalgae, motile invertebrate, and fish taxa. However, there are a few small and localised areas where the crushed rockfill foundation has become exposed; these exposed areas are vulnerable to erosion and may potentially be impacted further by seasonal abiotic processes (i.e., ice scour, wave action). The stability assessment planned for Year 2 (summer 2021) will provide additional information on the physical stability of these areas and whether remedial work may be considered.

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ACRONYMS AND ABBREVIATIONS

Acronym or Abbreviations	Definition
Baffinland	Baffinland Iron Mines Corporation
CCA	Crustose coralline algae
CD	chart datum
DFO	Fisheries and Oceans Canada
ERP	Early Revenue Phase
FAA	*Fisheries Act* Authorization
GPS	Global Positioning System
Indet.	Indeterminate
LPL	lowest practical taxonomic level
m^2	square metres
MEEMP	Marine Environmental Effects Monitoring Program
MFEAP	Marine Foreshore Environmental Assessment Procedure
Mtpa	Million Tonnes per Annum
NIRB	Nunavut Impact Review Board
org.	organisms
QA/QC	quality assurance/quality control
sp.	Single species
spp.	Multiple species
The Project	Mary River Project
The Proponent	Baffinland Iron Mines Corporation
UTM	Universal Transverse Mercator
WAAS	Wide Area Augmentation System
%	Percent

1.0 INTRODUCTION

1.1 Project Background

1.1.1 Description of the Mary River Project

Baffinland Iron Mines Corporation (Baffinland, the Proponent) operates the Mary River Project (the Project), an iron ore mine located in the Qikiqtani Region of Nunavut, Canada. Project Certificate No. 005, amended by the Nunavut Impact Review Board (NIRB) on 18 June 2020 (Amendment No. 03), authorizes the Company to mine up to 22.2 million tonnes per annum (Mtpa) of iron ore from Deposit No. 1. Of the 22.2 Mtpa, Baffinland is authorized to transport 6.0 Mtpa of ore by truck to Milne Port for shipping through the Northern Shipping Route using chartered ore carrier vessels until December 31, 2021.

1.1.2 Freight Dock

Baffinland proposed to construct a Freight Dock at Milne Port to support the import of containerized supplies, break-bulk, and special cargos (Baffinland 2019). The Freight Dock, comprising a permanent causeway and seasonal floating spud barge, was a component of the Approved Project that was assessed previously by the NIRB (File No. 08MN053)[1]. The construction of the Freight Dock resulted in unavoidable loss of fish habitat and serious harm to fish amounting to 26,449 m^2 (2,170 Habitat Equivalent Units; Baffinland 2019), requiring an application for an authorization under paragraph 35(2)(b) of the *Fisheries Act*. To offset the loss of fish habitat, Baffinland proposed the addition of coarse rock material around the perimeter of the Freight Dock to increase habitat complexity and hard substrate for attachment and growth of macroalgae and invertebrate taxa. The construction of the Freight Dock and addition of coarse rock around its perimeter was completed in 2019 (Golder 2020b); however, additional habitat offsetting is also being considered for 2021. The Freight Dock location is shown on Figure 1.

1.1.2.1 FAA Monitoring Requirements

Fisheries and Oceans Canada (DFO) issued a *Fisheries Act* Authorization (FAA) for the Freight Dock on 21 March 2019 (#18-HCAA-00160, Appendix A) that included the following Conditions applicable to monitoring of the offset habitat:

4. Conditions that relate to the offsetting of the serious harm to fish likely to result from the authorized work, undertaking or activity:

4.1 Scale and description of offsetting measures:

4.1.1 Coarse rock substrate will be placed around the perimeter of the Freight Dock and moorings at Milne Inlet to provide 2729 HEUs of potential fish habitat

5. Conditions that relate to monitoring and reporting of implementation of offsetting measures (described above in section 4):

[1] The previous assessment is presented in Volume 3, Section 2.2.4 and Volume 8, Sections 3.4 and 4.5.2.1 of Baffinland's Final Environmental Impact Statement (FEIS, Baffinland, 2012).

5.1. The Proponent shall conduct monitoring of the implementation of offsetting measures according to the approved timeline and criteria in the Freight Dock Application, Section 9 in addition to an approved updated monitoring plan as follows:

5.1.1. The Proponent shall submit an updated offsetting monitoring plan for the proposed offsetting for review by DFO on or before May 31, 2019. The Monitoring plan must satisfy DFO's requirements to demonstrate through clear and measurable criteria, fisheries productivity changes as a result of the offsetting measures. To address uncertainty in the effectiveness of the proposed offsetting measures, the proposed monitoring must have sufficient statistical power to determine if changes to productivity are occurring as a result of the offsetting measures within a defined timeframe, and must employ the most up-to-date and proven methodologies demonstrated to be effective under Arctic conditions.

5.1.2. Monitoring of offsetting shall be conducted over ten years, with a five year monitoring program (years 1, 2, 5, 8, 10) as outlined in the Freight Dock Application, Section 8, or as outlined in an updated monitoring plan and/or subsequent versions and as approved by DFO.

5.1.3[2] In addition to the outlined criteria, a digital photographic record of pre-construction, during construction and post-construction conditions using the same vantage points and direction to show that the approved works have been completed in accordance with the Freight Dock Application and subsequent plans approved by DFO.

5.2. List of reports to be provided to DFO: The Proponent shall report to DFO on whether the offsetting measures were conducted according to the conditions of this authorization by providing the following:

5.2.2. Monitoring reports shall be submitted to the DFO-Yellowknife Office by March 31 following each monitoring year, as will be outlined in the approved monitoring plan.

[2] Condition 5.1.3. was met with submission of the *Environmental Monitoring Completion Report: Milne Port Freight Dock Construction Project* (Golder 2020b).

LEGEND

REFERENCE AREA

0 250 500

1:15,000 METRES

REFERENCE(S)

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PROJECTION: UTM ZONE 17 DATUM: NAD 83

CLIENT
BAFFINLAND IRON MINES CORPORATION

PROJECT
MARY RIVER PROJECT – YEAR 1 FREIGHT DOCK MONITORING

TITLE
FREIGHT DOCK AND REFERENCE AREA LOCATION

CONSULTANT

GOLDER

YYYY-MM-DD	2021-03-03
DESIGNED	EG
PREPARED	AJA
REVIEWED	MW
APPROVED	DK

PROJECT NO.	CONTROL	REV.	FIGURE
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1.2 Objectives

In accordance with the Conditions outlined in the FAA, this report summarizes methods and results for the Year 1 offset habitat monitoring undertaken in August 2020 to satisfy DFO's requirements *to demonstrate through clear and measurable criteria, fisheries productivity changes as a result of the offsetting measures* (Condition 5.1.1). To this end, a Monitoring Plan ("Revised Effectiveness Monitoring Plan for Coarse Rock Offsetting Habitat as a Condition of the *Fisheries Act* Authorization"; hereafter referred to as "The Monitoring Plan") was developed and submitted to DFO (Golder 2019a; Appendix B).

As outlined in the Monitoring Plan, the following objectives are used to evaluate the Freight Dock offset habitat:

- Document the offset habitat using repeatable photographs and videos taken annually along established transects at a range of depths to demonstrate extent of community establishment compared to similar coarse rock habitat (i.e., similar depth and habitat features) near Milne Port
- Assess abundance[3], density[4] and diversity for taxa and functional groups
- Assess presence and habitat usage by fish and motile invertebrates
- Delineate the offset habitat to confirm the coarse rock habitat has been constructed as designed and assess stability over the 10-year monitoring period
- Assess the functionality of the coarse rock, identify any structural failures or problems with the offset habitat, and implement actions to remediate problems

1.2.1 Indicators and Metrics

To address the objectives and evaluate the functionality of the offset habitat, effectiveness monitoring includes the evaluation of the following indicators:

- Primary producers - diatoms, seaweed propagules, perennial/ephemeral macroalgae species, canopy/non-canopy forming bladed kelps
- Sessile colonizers - bryozoans, polychaetes, spirorbids, barnacles, anemones, sponges and corallines, trophic level, biological traits, habitat influence
- Fish and motile invertebrate use
- Arctic char (*Salvelinus alpinus*) prey species e.g., krill, mysid shrimp, other fish species
- Physical stability of coarse rock habitat

Table 1 identifies the indicators and metrics that were implemented to address the FAA Conditions and identified in Golder 2019a.

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[3] Abundance refers to a quantity/ amount of the taxa/functional group.

[4] Density refers to a quantity of a taxa/functional group in a given area.

Table 1: Summary of Fish Habitat Offset Monitoring Activities

Indicators - Metrics	FAA Condition/ The Monitoring Plan (Golder 2019a)	Monitoring Event				
		Year 1	Year 2	Year 5	Year 8	Year 10
Structural integrity: visual assessment	FAA Condition 5.1.1/ Section 2.3.4	√				
Macroalgae: percent (%) cover, diversity	FAA Condition 5.1.1/ Section 2.3	√				
Sessile invertebrates: % cover, diversity	FAA Condition 5.1.1/ Section 2.3	√				
Motile invertebrates: density, diversity	FAA Condition 5.1.1/ Section 2.3	√				
Fish: density, diversity	FAA Condition 5.1.1/ Section 2.3	√				
Arctic char prey species: density, diversity	FAA Condition 5.1.1/ Section 2.3	√				

2.0 METHODS

2.1 Survey Areas

Surveys were conducted within the intertidal and subtidal footprint of the Freight Dock, and a suitable Reference Area within south Milne Inlet (Figure 2).

- **Freight Dock**: The perimeter of the offset habitat was mapped and 11 shore-perpendicular transects were established with two to seven quadrats per transect surveyed depending on the length of the transect.
- **Reference Area**: The Reference Area, located approximately 2.25 km northeast of the Freight Dock location, included four shore-perpendicular transects with six to nine quadrats per transect surveyed depending on the length of the transect.

2.2 Selection of Reference Area

Criteria used to guide selection of a suitable reference area included:

- Outside zone of influence of Port operations
- Similar substrate and bathymetry to Milne Port
- Similar habitat composition

The first step in selecting a suitable reference area was to conduct a desktop review of available bathymetric data for southern Milne Inlet, including Milne Port. The bathymetry in these areas was then compared to that surrounding the Freight Dock to identify the potential occurrence of coarse substrate at similar depth contours. In general, assessment of bathymetry in south Milne Inlet was challenging as it is a steep-sided inlet with soft substrates below intertidal (+2.3 to 0 m CD) and upper subtidal (0 to -3 m CD) zones. An area along the south shoreline of South Milne Inlet was identified as a potential location (Boxed area on Figure 2A). Vessel-based reconnaissance was conducted using a depth sounder to evaluate the substrate and depth profiles and potential for coarse substrate in intertidal, upper subtidal and shallow subtidal (<-3 m CD) zones. Results of this vessel-based reconnaissance were used to select a general Reference Area. The dive team then conducted a subtidal site characterization to confirm that the area would contain coarse substrates at similar depth contours to that of the Freight Dock offset habitat. Once confirmed, the dive team conducted Reference Area mapping, described in Section 2.4.

2.3 Overview of Field Surveys

Field surveys of the Freight Dock offset habitat and Reference Area were conducted during August 2020 by a four-person Golder biological SCUBA dive team, using Baffinland's 30-foot Research Vessel. The dive team were certified in accordance with Canadian Standard Association Z275:4-97 and WorkSafe BC Regulations Part 24.

Field surveys included the following components:

- A visual assessment at the Freight Dock during lowest low tide (0.4 m chart datum [CD] at 9:02am) to document intertidal offset habitat and inspect of coarse substrate stability, where possible.

- Freight Dock offset habitat was delineated to determine survey area and approximate offset habitat area in relation to the Freight Dock FAA.
- Subtidal dive transect/quadrat surveys to quantitatively evaluate macroalgae, sessile and motile invertebrates and fish occurrence within both the Freight Dock offset habitat and Reference Area.
- Opportunistic observations[5] of macroalgae, fish and motile/sessile invertebrates during mapping.
- Subtidal assessment of stability of the coarse substrate along the perimeter of the Freight Dock offset habitat.
- The Reference Area was delineated to encompass similar depth contours and substrate types that would represent those identified at the Freight Dock offset habitat to compare habitat features, including macroalgae, sessile/motile invertebrates and fish.

A summary of the field surveys conducted for the Year 1 Freight Dock offset habitat monitoring are shown below, in Table 2.

Table 2: Summary of Field Surveys Conducted at the Freight Dock Offset Habitat and Reference Area

Survey Location	Survey Type	Dates of Survey
Freight Dock Offset Habitat	Survey and visual assessment at Low Tide	7 August 2020
	Dive Transect/ Quadrat (T) Survey (T1- T4)	8 August 2020
	Dive Transect/ Quadrat Survey (T5- T11)	14 August 2020
	Offset Habitat Mapping	8 and 14 August 2020
Reference Area	Dive Transect/ Quadrat Survey (T1- T2)	9 August 2020
	Dive Transect/ Quadrat Survey (T3-T4)	13 August 2020
	Survey Area Mapping	9 August 2020

[5] Opportunistic observations refer to observations that were recorded during diver-collected video to document presence/absence in a qualitative manner rather than quantitatively assessed during the transect/quadrat survey.

LEGEND

- TRANSECT
- OFFSET HABITAT EXTENT
- REFERENCE AREA

HABITAT TYPE

- HARD INTERTIDAL (+2.3 to 0 m CD)
- INTERTIDAL (+2.3 to 0 m CD)
- HARD UPPER SUBTIDAL (0 to -3 m CD)
- UPPER SUBTIDAL (0 to -3 m CD)
- SHALLOW SUBTIDAL (<-3 m CD)

REFERENCE(S)

PROJECTION: UTM ZONE 17 DATUM: NAD 83

CLIENT
BAFFINLAND IRON MINES CORPORATION

PROJECT
MARY RIVER PROJECT – YEAR 1 FREIGHT DOCK OFFSET MONITORING

CONSULTANT
GOLDER

YYYY-MM-DD	2021-03-03
DESIGNED	EG
PREPARED	AJA
REVIEWED	MW
APPROVED	DK

TITLE
OFFSET HABITAT DIVE SURVEY

PROJECT NO.	CONTROL	REV.	FIGURE
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2.4 Subtidal Mapping

To fulfill FAA Condition 4.1.1, the outer and inner perimeters of both the Freight Dock offset habitat and Reference Area were mapped by divers. The dive team first swam the outer perimeter of coarse material placed at the Freight Dock using a taut-line buoy attached to surface Garmin WAAS[6]-enabled Global Positioning System (GPS)[7] that tracked position at 30 second intervals. The mapping exercise included recording start and end coordinates as well as coordinates of additional points of interest. One diver maintained the taut-line buoy system while the other diver recorded video of the survey area using an underwater digital video camera[8] and took general notes of habitat features. The inner margin of the Freight Dock offset habitat was then recorded to complete the polygon. Because the Freight Dock offset habitat mapping was conducted during a low to mid tidal height, a portion of the intertidal area was not included in the mapped polygon. Using a digital aerial photograph taken at a higher tide and GIS mapping methods, a portion of the intertidal area outside of what was mapped was estimated.

At the Reference Area, subtidal mapping of the reference area followed a similar approach to the Freight Dock offset habitat mapping; however, the offshore extent of the mapping was defined by the dive team's knowledge of the depths at the Freight Dock offset habitat to provide a comparison of a similar substrate and subsequent habitat features.

The outer and inner extents of offset habitat at the Freight Dock were delineated by divers using visual cues to distinguish between constructed and natural habitats; for example, the placed material was distinguishable relative to naturally existing coarse substrate (i.e., gravel, cobble, boulder) by its grey and angular appearance with minimal macroalgae growth. In contrast, native substrate materials were various colours, smooth in texture, and showed colonization of macroalgae and sessile invertebrates.

2.5 Transect/Quadrat Surveys

To fulfill FAA Condition 5.1.1 and Section 2.3 of the Monitoring Plan (Golder 2019a), quantitative data were collected in general accordance with DFO's Marine Foreshore Environmental Assessment Procedure with specific methods determined following identification of a suitable reference site (Golder 2019a). Quadrats were placed along transects that extended from the offshore perimeter to the inshore intertidal zone within each survey area. The beginning and end of each transect was marked with a taught-line buoy and the coordinates were recorded with a GPS. The location and depth of each transect by area are provided in Table 3.

Transects were established within the survey area using a weighted measuring tape and beginning at the outer extent of the mapped area. A 1.0-m^2 quadrat was placed at 1-m to 5-m intervals along the transect, depending on its length. Longer transects had larger intervals (i.e., 5-m) between the quadrats and shorter transects had shorter intervals (e.g., 1-m) between the quadrats. The first quadrat (Q1) was placed at the offshore extent of the transect, with all transects positioned perpendicular to shore and conducted in an offshore to onshore approach (locations shown on Figure 2). Transect/ Quadrat data were recorded on project-specific datasheets, according to the following criteria[9]:

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[6] Wide Area Augmentation System

[7] The accuracy of this Global Positioning System (GPS) format is typically ±3 m

[8] Divers operated a SONY RX100 V camera in Fantasea underwater housing and Big Blue video light for all underwater surveys. The camera has high-definition video capability and still photography features.

[9] Recorded data were in general accordance with Fisheries and Oceans Canada (DFO) Marine Foreshore Environment Assessment Procedure (MFEAP) (provided in Appendix C)

- Substrate type was visually estimated according to the size ranges: bedrock; boulder (>256 mm diameter); cobble (64 to 256 mm); gravel (2 to 64 mm); sand (0.0625 to 2 mm); silt/mud/clay (<0.0625 mm) and relative composition (i.e., as a percentage areal coverage).
- Marine vegetation was identified to the lowest practical level (LPL) and areal coverage was estimated according to the MFEAP coverage categories (i.e., <5%; 5-25%; >25-50%; >50-75%; and >75 100%).
- Sessile animals, such as clams and mussels, were identified to LPL and areal coverage was estimated (as above).
- Motile animals (e.g., fish, urchins, limpets) were identified to LPL and enumerated. Density was estimated if relatively large numbers of motile species were present.
- Photographs showing representative biological features and aiding in species identification were taken.

Table 3: Summary of Survey Area, Transect Location and Depth of Survey at the Inshore and Offshore Extents

Area	Transect	Location (NAD 83 UTM 17N)		Transect Length (m) [Number of Quadrats]	Depth (m below CD)[1]	
		Inshore	Offshore		Start	End
Freight Dock (FD)	FD-T1	503934 7976559	7976559 503931	3 [2]	-0.5	0.5
	FD-T2	503936 7976605	7976605 503935	3 [2]	-0.4	0.6
	FD-T3	503901 7976609	7976609 503900	3 [2]	-0.4	0.6
	FD-T4	503897 7976625	7976625 503893	3 [2]	-0.4	0.6
	FD-T5	503951 7976665	7976665 503951	25 [6]	-7.1	-0.2
	FD-T6	503969 7976662	7976662 503968	31 [7]	-8.4	-2.9
	FD-T7	504001 7976659	7976659 504000	31 [7]	-8.1	-0.4
	FD-T8	504044 7976630	7976630 504048	4 [4]	-0.3	0.1
	FD-T9	504023 7976605	7976605 504023	4 [4]	0.0	0.0
	FD-T10	504005 7976602	7976602 504008	5 [4]	0.0	0.0
	FD-T11	504005 7976593	7976593 504012	6 [3]	-0.6	0.6
Reference Area (REF)	REF-T1	505456 7978199	7978199 505439	31 [7]	-12.2	-0.5
	REF-T2	505494 7978198	7978198 505484	26 [6]	-4.5	0.6
	REF-T3	505528 7978213	7978213 505511	31 [7]	-5.4	-0.2
	REF-T4	505561 7978232	7978232 505545	41 [9]	-16.5	-0.3

[1] Diver depth gauge was converted to meters chart datum (CD), estimated using tide table for Milne Inlet, Nunavut (http://www.tides.gc.ca/eng [accessed October 2020]). The negative (-) numbers indicate ‘below’ CD and positive (+) numbers indicate ‘above’ CD.

2.6 Physical Stability

To fulfill Section 2.3.4 of the Monitoring Plan (Golder 2019a), at the Freight Dock offset habitat, physical stability of the coarse substrate was photographed and qualitatively evaluated for indication of movement, slumping, crumbling or where algae showed signs of abrasion, according to the following criteria:

- Exposure of crushed rockfill
- Rock armouring extending outside of the coarse substrate footprint (i.e., indicating movement of the coarse substrate)
- Obvious signs of slumping or pockets evident in the coarse rock armouring
- Other physical alteration that may affect the suitability of the substrate

Measurements of the approximate area were also recorded and estimated from photographs and video footage.

2.7 Data Analysis

Mapped polygons of the Freight Dock offset habitat and the Reference Area were downloaded from the GPS and plotted by Geographic Information System (GIS) using arial images, base map (hydrographic map) and/or bathymetry (data references provided on figures).

Diver-collected transect/quadrat data were entered into an excel spreadsheet by one biologist and verified by second biologist for transcription errors. For the Reference Area, quadrat data that contained >50% soft sediments were removed from analysis to provide comparisons between coarse substrates (i.e., bedrock, boulder, cobble).

To fulfill FAA Condition 5.1.1 and Sections 2.3 and 2.4 in The Monitoring Plan (Golder 2019a), the following analyses were performed on the clean dataset:

- Quadrat data were analyzed by area (Freight Dock, Reference Area) by depth contour (m below CD), representative of intertidal (+2.3 to -0.5 m CD; referred to as +2.3 to 0 m CD), upper subtidal (-0.6 to -3 m CD; referred to as <0 to -3 m CD), and shallow subtidal (< -3 m CD).
- For macroalgae and sessile invertebrates, mean percent areal cover was calculated by transect (by depth contour and by area [Freight Dock, Reference Area]), then was combined for an overall mean and standard error representative of the depth contour for each area. This allowed for comparison between areas by depth contour. The range represents the lowest and highest percent areal cover observed per quadrat within the depth contour and area.
- For motile invertebrates and fish, mean density (org/m^2) was calculated by transect (by depth contour) and by area (Freight Dock, Reference Area), then combined for an overall mean and standard error representative of the depth contour for each area. This allowed for comparison between areas. The range represents the lowest and the highest density per quadrat within the depth contour and area.
- Mean taxa richness and standard error of the mean was calculated based on number of taxa by depth contour and area. The range represents the lowest and highest taxa observed per quadrat by depth contour and area.

2.8 Quality Assurance/Quality Control

The following quality assurance and quality control (QA/QC) measures were implemented:

- Field survey data sheets were checked and validated before leaving the site.
- Dive survey video and photographs, GIS tracks and waypoints were saved to a laptop computer and external hard drive at the end of each field day.
- Taxa identifications, including common and species name, were verified using references[10].
- Transect/quadrat data were entered into an excel spreadsheet where a second biologist conducted a data review for transcription errors.
- Calculations were checked for errors by a second biologist during a data review.

[10] References used during the surveys, included: Küpper et al. (2016), Coad and Reist (2018), Golder (2019b), WoRMS (2020), Guiry and Guiry (2020)

3.0 RESULTS

The transect survey locations and areal extent of the offset habitat are shown on Figure 2. Representative photographs and stills from video footage are provided in Appendix D. Quadrat/transect data are tabulated in Appendix E. A species list with common and scientific names is provided in Appendix F.

3.1 Subtidal Mapping

Reference Area

Table 4 identifies the Reference Area that was mapped according to depth contour, below.

Table 4: Coarse Material Substrate Area Estimates from Reference Area Mapping

Substrate Type	Depth Contour	Area Estimate (m^2)
Intertidal	(+2.3 to 0 m CD)	590
Upper subtidal	(0 to -3 m CD)	2,140
Shallow subtidal	(<-3 m CD)	1,210
Total mapped area (total estimated Reference Area)		**3,940 (4,670)**

The Reference Area was more difficult to determine boundaries because there was no defined rocky reef compared to that of the Freight Dock offset habitat (Figure 3). The focus of the mapping was to determine boundaries for the transect/quadrat data collection by encompassing the three depth contours and substrate comparable to the Freight Dock offset habitat. In addition to the 3,940 m^2 of total mapped coarse substrate, an additional intertidal portion of the Reference Area was estimated at 730 m^2. This area was intertidal coarse material that was not accessible during the time of the dive mapping survey due to tide height and angle of coarse material. The shallow portions (intertidal) were difficult to survey as substrate consisted of shallow, low gradient boulders. Subsequent surveys at the Reference Area should consider tides by conducting the intertidal work at high tides, as practical.

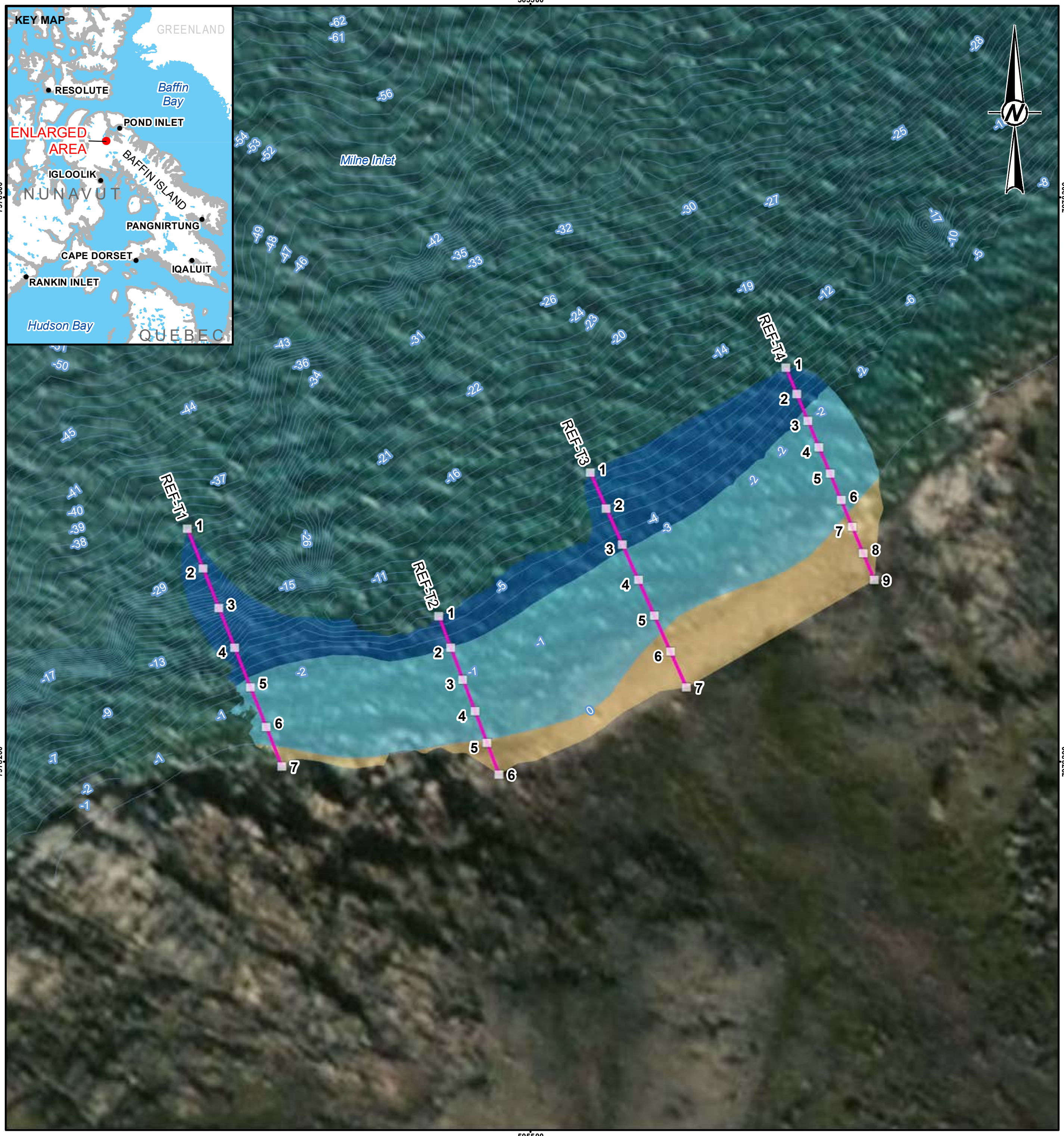
Freight Dock

Table 5 identifies the coarse rock substrate area that were mapped at the Freight Dock according to depth contour, below.

Table 5: Coarse Material Substrate Area Estimates from Freight Dock Mapping

Substrate Type	Depth Contour	Area Estimate (m^2)
Intertidal	(+2.3 to 0 m CD)	1,540
Upper subtidal	(0 to -3 m CD)	1,470
Shallow subtidal	(<-3 m CD)	675
Total mapped area (total estimated coarse material area)		**3,685 (4,155)**

In addition to the 3,685 m^2 of total mapped coarse substrate, an additional intertidal portion of the north face of the Freight Dock was estimated at 470 m^2 (Figure 4). This area was intertidal coarse material that was not accessible during the time of the dive mapping survey due to tide height.



LEGEND

□ QUADRAT LOCATION

BATHYMETRY CONTOUR (1 m INTERVAL)

TRANSECT

REFERENCE AREA - SUBSTRATE TYPE

INTERTIDAL (+2.3 to 0 m CD)

UPPER SUBTIDAL (-0.1 to -3 m CD)

SHALLOW SUBTIDAL (<-3 m CD)

0 20 40

1:1,000 METRES

REFERENCE(S)

BATHYMETRY CREATED BY GOLDER FROM MULTIPLE DATA SOURCES. CHART 7212 AND 4013647 OBTAINED FROM THE CANADIAN HYDROGRAPHIC SERVICE AND PURSUANT TO CHS DIRECT USER LICENCE NO. 2017-0531-1260-G. IMAGERY COPYRIGHT © 20190802 ESRI AND ITS LICENSORS. SOURCE: MAXAR VIVID. USED UNDER LICENSE, ALL RIGHTS RESERVED. PROJECTION: UTM ZONE 17 DATUM: NAD 83

CLIENT
BAFFINLAND IRON MINES CORPORATION

PROJECT
MARY RIVER PROJECT – YEAR 1 FREIGHT DOCK MONITORING

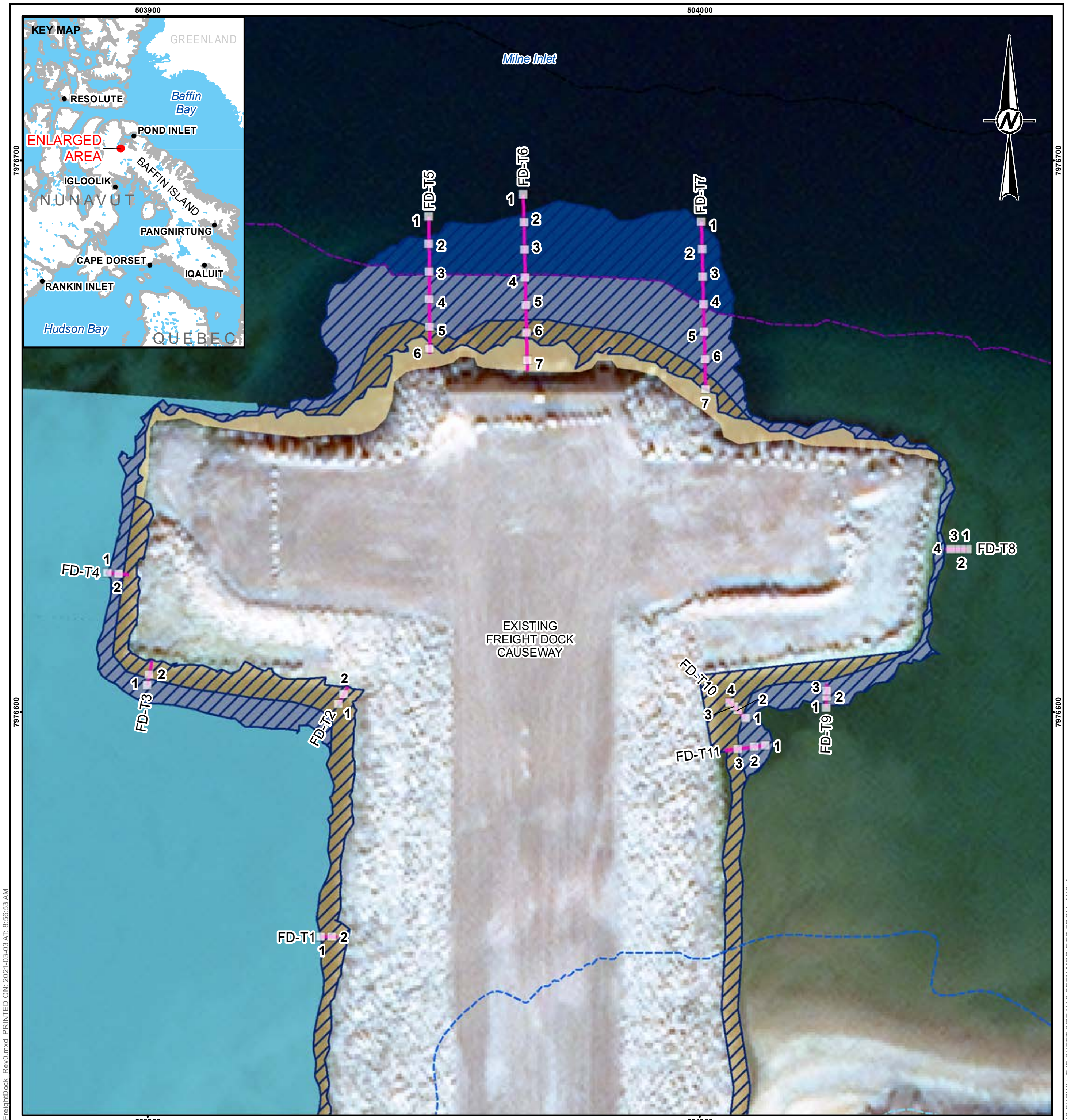
TITLE
REFERENCE AREA SURVEY

CONSULTANT

GOLDER

YYYY-MM-DD	2021-03-03
DESIGNED	EG
PREPARED	AJA
REVIEWED	DK
APPROVED	DK

PROJECT NO.	CONTROL	REV.	FIGURE
1663724	34000-05	0	3



LEGEND

- QUADRAT LOCATION
- HIGHER HIGH WATER LARGE TIDE (EL. 2.3 m)
- LOWER LOW WATER LARGE TIDE (EL. 0.0 m)
- EL. -3 m
- EL. -15 m
- TRANSECT
- OFFSET HABITAT EXTENT

HABITAT TYPE

- ADDITIONAL INTERTIDAL (+2.3 to 0 m CD)
- HARD INTERTIDAL (+2.3 to 0 m CD)
- HARD UPPER SUBTIDAL (0 to -3 m CD)
- UPPER SUBTIDAL (0 to -3 m CD)
- SHALLOW SUBTIDAL (<-3 m CD)

0 20 40

1:1,000 METRES

REFERENCE(S)

AS-BUILT BATHYMETRY PROVIDED BY CLIENT, MAY 21, 2020. MILNE PORT IMAGERY CAPTURED AUGUST 2020 © 2020 DIGITAL GLOBE.
PROJECTION: UTM ZONE 17 DATUM: NAD 83

CLIENT
BAFFINLAND IRON MINES CORPORATION

PROJECT
MARY RIVER PROJECT – YEAR 1 FREIGHT DOCK MONITORING

TITLE
FREIGHT DOCK SURVEY

CONSULTANT
GOLDER

YYYY-MM-DD	2021-03-03
DESIGNED	EG
PREPARED	AJA
REVIEWED	DK
APPROVED	DK

PROJECT NO.	CONTROL	REV.	FIGURE
1663724	34000-05	0	4

PATH: I:\2016\1663724\Mapping\MXD\34000_2020_MEEMP\Task_0511663724_34000_05_Fig4_FreightDock_Rev0.mxd PRINTED ON: 2021-03-03 AT: 8:56:53 AM

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI A
25mm
0

3.2 Macroalgae Colonization

3.2.1 Overview

The mean percent cover of macroalgae at the Freight Dock offset habitat during Year 1 was generally low to moderate; highest occurrence was associated with the upper subtidal zone, which showed a mean areal cover of 31.9 ± 11.5% (Standard Error, SE) (Table 6). Macroalgae areal coverage in the Reference Area was greatest in the upper subtidal zone but high mean cover of 95 ± 2.9%, ranging between 90 and 100% cover. Taxa richness at the Freight Dock for Year 1 was lower relative to the Reference Area at all depth contours surveyed.

A detrital veneer that appeared to consist of phytoplankton/diatoms and silt was observed and recorded at most Freight Dock transect locations (Photo 1); however, this was not included as part of the macroalgae percent areal cover estimation. Also of note was potential mysid (opossum shrimp; Order Mysidae) fecal material on the offset substrate.

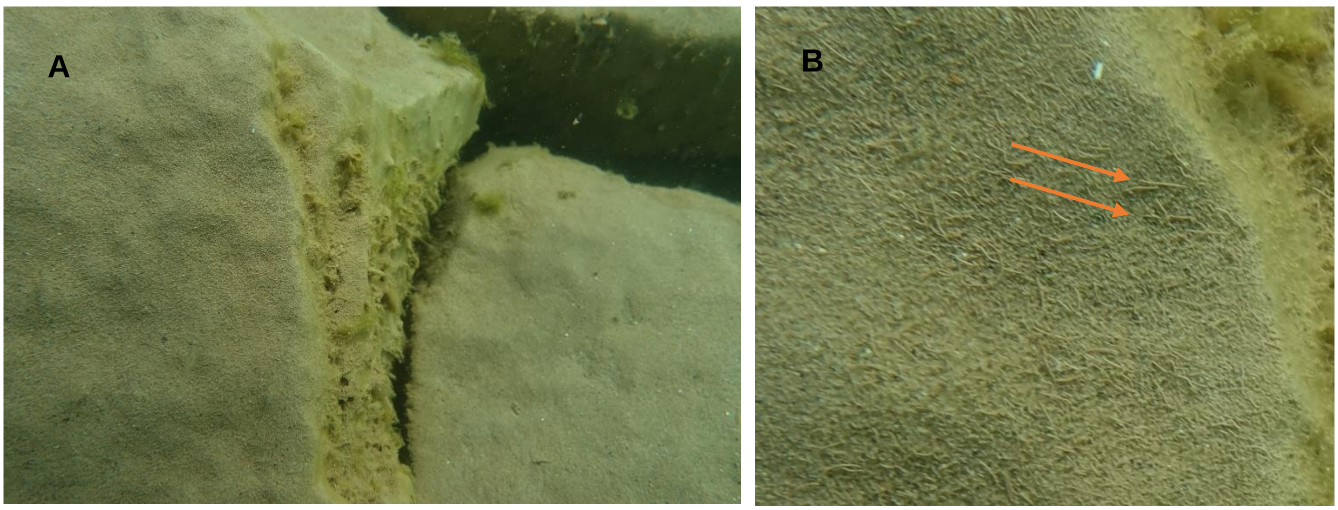


Photo 1: Shows the Freight Dock offset habitat substrate, with left frame (A) showing the detrital veneer on the upper surface of the riprap and right frame (B) showing a zoomed in crop of photo A with the fecal material (orange arrows) evident and potentially from the swarms of mysid shrimp occurring in the area of the offset habitat.

Table 6: Overall Macroalgae Cover and Taxa Richness by Area and Depth Contour

Survey Area	Number of Quadrats Analyzed (Total number of quadrats)[1]	Macroalgae [2]			
		Areal Cover (%)		Taxa Richness	
		Mean ± SE [3]	Range [4]	Mean ± SE [3]	Range [4]
Intertidal (+2.3 to 0 m CD)					
Freight Dock	22 (22)	26.6 ± 3.6	2-50	1.3 ± 0.1	1-2
Reference	8 (8)	88.8 ± 9.2	15-100	3.5 ± 0.4	1-5
Upper subtidal (<0 to -3 m CD)					
Freight Dock	7 (7)	31.9 ± 11.5	2-75	1.4 ± 0.2	1-2
Reference	5 (7)	95.0 ± 2.9	90-100	3.8 ± 0.5	3-5
Shallow subtidal (<-3 m CD)					
Freight Dock	13 (13)	22.8 ± 7.5	2-70	1.5 ± 0.3	1-2
Reference	6 (14)	44.1 ± 28.8	4-100	2.7 ± 0.7	1-4

[1] Quadrat data was omitted from analysis when the dominant substrate was soft (>50% areal cover). Number represents number of quadrats used for analysis and number in brackets represents the total number of quadrats surveyed.
[2] Percent areal cover and taxa richness was calculated using mean values per transect for the area surveyed. Overall ‘macroalgae’ includes turf and understory kelp.
[3] SE = standard error of the mean
[4] Range represents the lowest and highest number of percent cover and taxa observed.

3.2.2 Understory Kelp

Two species of brown-bladed understory kelp – sugar kelp (*Laminaria saccharina)* and sea colander (*Agarum clathratum*) – were recorded within the shallow subtidal zone of the Reference Area at trace percent cover and with low associated taxa richness (Table 7; Appendix D, Photo 19). Understory kelp was not recorded at the Freight Dock offset habitat in Year 1 of post-construction monitoring.

Table 7: Understory Kelp Percent Areal Cover and Taxa Richness by Area and Depth Contour

Survey Area	Number of Quadrats Analyzed (Total number of quadrats)[1]	Understory Kelp[2]				
		% Areal Cover		Taxa Richness		Dominant Taxa
		Mean ± SE[3]	Range[4]	Mean ± SE[3]	Range[4]	
Intertidal (0 to +2.3 m CD)						
Freight Dock	22 (22)	0	0	0	0	none
Reference	8 (8)	0	0	0	0	none
Upper subtidal (<-0 to -3 m CD)						
Freight Dock	7 (7)	0	0	0	0	none
Reference	5 (7)	0	0	0	0	none
Shallow subtidal (<-3 m CD)						
Freight Dock	13 (13)	0	0	0	0	none
Reference	6 (14)	0.1 ± 0.1	0-2	0.1 ± 0.1	0-1	Sugar kelp

[1] Quadrat data was omitted from analysis when the dominant substrate was soft (>50% areal cover). Number represents number of quadrats used for analysis and number in brackets represents the total number of quadrats surveyed.
[2] Percent areal cover and taxa richness of algae was calculated using mean values per transect for the area surveyed.
[3] SE = standard error of the mean
[4] Range represents the lowest and highest number of percent cover and taxa observed.

3.2.3 Turf Macroalgae

Turf macroalgae occurred in low cover at the Freight Dock and in high cover at the Reference Area (Table 8). An epilithic[11] brown filamentous algae, *Pylaiella* spp. (Appendix D, Photo 10), was ubiquitous within each depth contour and at both the Freight Dock and Reference Area. Rockweed (*Fucus distichus*) was dominant within the Reference Area (Appendix D, Photos 22, 23) but not the Freight Dock, which instead was dominated by an unidentified fine green filamentous algae (Appendix D, Photo 9). Other taxa occurring at the Reference Area included *Battersia* spp. (short branched tuft; Appendix D, Photo 23) in the intertidal and upper subtidal, *Halosiphon tomentosus* in the intertidal, and unidentified red algae at each tidal zone (Table 10).

[11] Epilithic is defined in Kupper et al. (2016) as an algae taxon that grows on rock or hard substrate.

Table 8: Turf Macroalgae Percent Areal Cover and Taxa Richness by Area and Depth Contour

Survey Area	Number of Quadrats Analyzed (Total number of quadrats)[1]	Turf Macroalgae[2]				
		Areal Cover (%)		Taxa Richness		Dominant Taxa
		Mean ± SE[3]	Range[4]	Mean ± SE[3]	Range[4]	
Intertidal (0 to +2.3 m CD)						
Freight Dock	22 (22)	26.6 ± 3.6	2-50	1.3 ± 0.1	1-2	*Pylaiella* spp., fine green filamentous algae
Reference	8 (8)	88.8 ± 9.2	15-100	3.5 ± 0.4	1-5	*Pylaiella* spp., rockweed
Upper subtidal (0 to -3 m CD)						
Freight Dock	7 (7)	31.9 ± 11.5	2-75	1.4 ± 0.2	1-2	Brown filamentous algae, fine green filamentous algae
Reference	5 (7)	95.0 ± 2.9	90-100	3.8 ± 0.5	3-5	*Pylaiella* spp., rockweed
Shallow subtidal (<-3 m CD)						
Freight Dock	13 (13)	22.8 ± 7.5	2-70	1.5 ± 0.3	1-2	Brown filamentous algae, *Pylaiella* spp.
Reference	6 (14)	43.9 ± 28.9	0-8	2.6 ± 0.7	1-4	*Pylaiella* spp., rockweed

[1] Quadrat data was omitted from analysis when the dominant substrate was soft (>50% areal cover). Number represents number of quadrats used for analysis and number in brackets represents the total number of quadrats surveyed.
[2] Percent areal cover and taxa richness of algae was calculated using mean values per transect for the area surveyed.
[3] SE = standard error of the mean
[4] Range represents the lowest and highest number of percent cover and taxa observed.

3.2.4 Encrusting Algae

Encrusting algae was not observed on the Freight Dock offset habitat but was associated with the Reference Area; specifically, a crustose coralline algae (Corallinales indet.) was observed at trace cover in the intertidal (range: 0-15%) and at higher cover in the shallow subtidal zone (range: 0-75%) (Table 9; Appendix D, Photo 32-35).

At the Reference Area, taxa richness was slightly higher in the shallow subtidal zone relative to the intertidal, though crustose coralline algae was the only encrusting taxa identified (Table 10).

Table 9: Encrusting Algae Percent Areal Cover and Taxa Richness by Area and Depth Contour

Survey Area	Number of Quadrats Analyzed (Total number of quadrats)[1]	Encrusting Macroalgae[2]				
		Areal % Cover		Taxa Richness		Dominant Taxa
		Mean ± SE[3]	Range[4]	Mean ± SE[3]	Range[4]	
Intertidal (0 to +2.3 m CD)						
Freight Dock	22 (22)	0	0	0	0	none
Reference	8 (8)	1.7 ± 2.2	0-15	0.2 ± 0.2	0-1	Crustose coralline algae
Upper subtidal (0 to -3 m CD)						
Freight Dock	7 (7)	0	0	0	0	none
Reference	5 (7)	0	0	0	0	none
Shallow subtidal (<-3 m CD)						
Freight Dock	13 (13)	0	0	0	0	none
Reference	6 (14)	30.4 ± 20.7	0-75	0.5 ± 0.2	0-1	Crustose coralline algae

[1] Quadrat data was omitted from analysis when the dominant substrate was soft (>50% areal cover). Number represents number of quadrats used for analysis and number in brackets represents the total number of quadrats surveyed.
[2] Percent areal cover and taxa richness of algae was calculated using mean values per transect for the area surveyed.
[3] SE = standard error of the mean
[4] Range represents the lowest and highest percent cover and taxa observed.

Table 10: Opportunistic Observations of Macroalgae[1] Taxa Recorded during Perimeter Mapping and Review of Video

Taxon	Freight Dock	Reference Area
Halosiphon tomentosus	x	x
Pylaiella spp.	x	x
Brown filamentous algae	x	x
Fine green filamentous algae	x	-
Sugar kelp *(Laminaria saccharina)*	-	x
Rockweed *(Fucus distichus)*	-	x
Short branched tuft (*Battersia* spp.)	-	x
Crustose coralline algae (CCA)	-	x
Red filamentous	-	x
Red foliose	-	x
Green slimy algae	-	x
Sea Colander (*Agarum clathratum*)	-	x

[1]Taxa were observed during transect/quadrat, mapping and review of video and are provided here as a qualitative assessment of presence/absence of organisms.

3.3 Invertebrates

Sessile Invertebrates

Sessile invertebrates were not observed at the Freight Dock offset habitat but were recorded in the Reference Area at low mean areal cover across the various tidal zones (Table 11). Mean taxa richness was highest in the shallow subtidal, ranging from 0-7 taxa. In the intertidal, dominant species included wrinkled rock-borer *Hiatella arctica* and *Mya* spp. – both types of clam. In the upper subtidal and the shallow subtidal, dominant taxa were tunicate (Tunicata indet.) and clam (wrinkled rock-borer and *Mya* spp.) (Appendix D, Photo 29).

Table 11: Summary Metrics of Sessile Invertebrates Recorded during Transect/Quadrat Survey by Area and Depth Contour

Survey Area	Number of Quadrats Analyzed (Total number of quadrats)[1]	Sessile Invertebrate (% cover)		Taxa Richness		Dominant Taxa
		Mean ± SE[1,2]	Range[3]	Mean ± SE[1,2]	Range[3]	Sessile Invertebrate
Intertidal (0 to +2.3 m CD)						
Freight Dock	22 (22)	0	0	0	0	-
Reference	8 (8)	2.5 ± 2.2	0-22	0.3 ± 0.2	0-2	Clam
Upper subtidal (0 to -3 m CD)						
Freight Dock	7 (7)	0	0	0	0	-
Reference	5 (7)	2.0 ± 0.8	0-4	0.9 ± 0.4	0-2	Tunicate, clam
Shallow subtidal (<-3 m CD)						
Freight Dock	13 (13)	0	0	0	0	-
Reference	6 (14)	13.3 ± 6.7	0-61	3.5 ± 1.8	0-7	Tunicate, clam

[1] Number represents number of quadrats used for analysis and number in brackets represents the total number of quadrats surveyed.
[2] Percent areal cover, density, and taxa richness of invertebrates was calculated using mean values per transect for the area surveyed.
[3] SE = standard error of the mean
[4] Range represents the lowest and highest number of percent cover, density and taxa observed.

Motile Invertebrates

Motile invertebrates were not observed within intertidal or upper subtidal depth contours at either survey site; however, several taxa were recorded in the shallow subtidal zone. The Freight Dock offset habitat supported a trace motile invertebrate mean density (1 ± 0.5 org/m^2) that included green urchin (*Strongylocentrotus droebachiensis*) and brittle star (Ophiuroidea indet.) (Appendix D, Photo 12; Table 12). In contrast, the shallow subtidal zone at the Reference Area supported a higher mean density (10 ± 7.8 org/m^2) and an increase in species richness compared to the Freight Dock that was primarily dominated by shrimp. Other motile invertebrates observed in the Reference Area are listed in Table 17 with photo documentation in Appendix D (Photos 27, 33-35).

Table 12: Summary Metrics of Motile Invertebrates Recorded during Transect/Quadrat Survey by Area and Depth Contour

Survey Area	Number of Quadrats Analyzed (Total number of quadrats)[1]	Motile Invertebrate (org/m^2)		Taxa Richness		Dominant Taxa
		Mean ± SE[1,2]	Range[3]	Mean ± SE[1,2]	Range[3]	Motile Invertebrate
Intertidal (0 to +2.3 m CD)						
Freight Dock	22 (22)	0	0	0	0	none
Reference	8 (8)	0	0	0	0	none
Upper subtidal (0 to -3 m CD)						
Freight Dock	7 (7)	0	0	0	0	none
Reference	5 (7)	0	0	0	0	none
Shallow subtidal (<-3 m CD)						
Freight Dock	13 (13)	1 ± 0.5	0–6	0.3 ± 0.1	0-2	Green urchin
Reference	6 (14)	10 ± 7.8	0-25	2.0 ± 1.5	0-5	Shrimp

[1] Number represents number of quadrats used for analysis and number in brackets represents the total number of quadrats surveyed.
[2] Percent areal cover, density, and taxa richness of invertebrates was calculated using mean values per transect for the area surveyed.
[3] SE = standard error of the mean
[4] Range represents the lowest and highest number of percent cover, density and taxa observed.

Mysids (opossum shrimp, Order Mysida) were abundant at both the Freight Dock offset habitat and Reference Area with density tending to increase with depth, as shown in Table 13. Highest estimated mean density was observed at the Freight Dock with 124 ± 44.5 org/m^2 and ranged from 0 to 500 (Appendix D, Photos 17, 26).

Opportunistic observations were made of species outside the quadrats, and these are listed in Table 14. Of note, several species of metazoan zooplankton – including sea angel *(Clione limacina*), sea butterfly (*Limacina helicina*), Arctic comb jelly (*Mertensia ovum*), hydromedusae jellies, Lion's mane jelly (*Cyanea capillata*) and other jellies (Scyphozoa) – were observed throughout the survey area at both locations (Freight Dock, Reference Area) (Appendix D, Photos 18, 30).

Table 13: Summary Metrics of Mysids (Opossum shrimp, Order Mysida) Recorded during Transect/Quadrat Survey by Area and Depth Contour

Survey Area	Number of Quadrats Analyzed (Total number of quadrats)[1]	Density (org/m^2)	
		Mean ± SE[2,3]	Range[4]
Intertidal (0 to +2.3 m CD)			
Freight Dock	22 (22)	46 ± 39.6	0-400
Reference	8 (8)	19 ± 1.9	0-50
Upper subtidal (0 to -3 m CD)			
Freight Dock	7 (7)	46 ± 27.6	0-200
Reference	5 (7)	79 ± 41.5	0-200
Shallow subtidal (<-3 m CD)			
Freight Dock	13 (13)	124 ± 44.5	0-500
Reference	6 (14)	100 ± 100	0-300

[1] Number represents number of quadrats used for analysis and number in brackets represents the total number of quadrats surveyed.
[2] Density and taxa richness of mysids were calculated using mean values per transect for the area surveyed.
[3] SE = standard error of the mean
[4] Range represents the lowest and highest number of percent cover, density and taxa observed.

Table 14: Opportunistic Observations of Invertebrates[1] Recorded during Perimeter Mapping and Review of Video

Taxa List	Freight Dock	Reference Area
Green urchin (*Strongylocentrotus droebachiensis*)	x	x
Brittle star (Ophiuridae indet.)	x	x
Cone worm (*Cistenides granulata*)	-	x
Anemone/ Tube-dwelling anemone (Subclass Ceriantharia)	-	x
Scallop (Family Pectinidae)	-	x
Icelandic scallop (*Chlamys islandica*)	-	x
Wrinkled rock-borer (*Hiatella arctica*)	-	x
Mya spp.	-	x
Orange crust sponge	-	x
Tube sponge	-	x
Tunicate/ Circular hairy tunicate/ Stalked hairy tunicate	-	x
Shrimp	-	x
Creeping pedal sea cucumber (Family Psolidae)	-	x
Chiton (*Tonicella* spp.)	-	x
Snail	-	x
Sea angel *(Clione limacine)*	x	x
Sea butterfly (*Limacina helicina*)	x	x
Mysid (Order Mysida)	x	x
Lion's mane jelly (*Cyanea capillata*)	x	-
Hydromedusae jelly	x	x
Jellies (Scyphozoa)	x	x
Arctic comb jelly (*Mertensia ovum*)	x	x

[1]Taxa were observed during transect/quadrat, mapping and review of video and are provided here as a qualitative assessment of presence/absence of organisms.

3.4 Fish Usage

Fish density and taxa richness were comparable between the Freight Dock and the Reference Area (Table 15). Highest densities were recorded in the upper subtidal depth contour for both the Freight Dock and Reference Areas (0.4 ± 0.4 fish/m^2 and 0.3 ± 0.25 fish/m^2, respectively). Highest taxa richness (0.5 ± 0.3 taxa) was recorded in intertidal depth contour of the Reference Area while no fish were observed in adjacent shallow subtidal depth contour.

The fish observed during the transect/quadrat survey were sculpins (Family Cottidae), consisting of the species shorthorn sculpin (*Myoxocephalus scorpius*), fourhorn sculpin (*Myoxocephalus quadricornis*), as well as individuals that were too small to identify (Appendix D, Photo 10, 13, 16). One Greenland cod (*Gadus ogac*) was opportunistically observed during perimeter mapping of the Reference Area (Table 16).

Table 15: Summary Metrics of Fish Recorded during Transect/Quadrat Survey by Area and Depth Contour

Survey Area	Number of Quadrats Analyzed (Total number of quadrats)[1]	Abundance (number)	Density (fish/m^2)		Taxa Richness	
			Mean ± SE[2,3]	Range[4]	Mean ± SE[2,3]	Range[4]
Intertidal (0 to +2.3 m CD)						
Freight Dock	22 (22)	3	0.1 ± 0.1	0-1	0.1 ± 0.1	0-1
Reference	8 (8)	2	0.3 ± 0.2	0-1	1 ± 0.3	0-1
Upper subtidal (0 to -3 m CD)						
Freight Dock	7 (7)	2	0.4 ± 0.4	0-2	0.2 ± 0.2	0-1
Reference	5 (7)	1	0.3 ± 0.3	0-1	0.3 ± 0.3	0-1
Shallow subtidal (<-3 m CD)						
Freight Dock	13 (13)	1	0.1 ± 0.1	0-0.2	0.1 ± 0.1	0-1
Reference	6 (14)	0	0	0	0	0

[1] Number represents number of quadrats used for analysis and number in brackets represents the total number of quadrats surveyed.
[2] Density and taxa richness of fish were calculated using mean values per transect for the area surveyed.
[3] SE = standard error of the mean
[4] Range represents the lowest and highest number of percent cover, density or taxa observed.

Table 16: Opportunistic Observations of Fish[1] Recorded during Perimeter Mapping and Review of Video

Taxa List	Freight Dock	Reference Area
Sculpin (Family Cottidae)	x	x
Shorthorn sculpin (*Myoxocephalus scorpius*)	x	x
Fourhorn sculpin (*Myoxocephalus quadricornis*)	x	-
Greenland cod (*Gadus ogac*)	-	x

[1] Taxa were observed during transect/quadrat, mapping and review of video and are provided here as a qualitative assessment of presence/absence of organisms.

3.5 Physical Stability

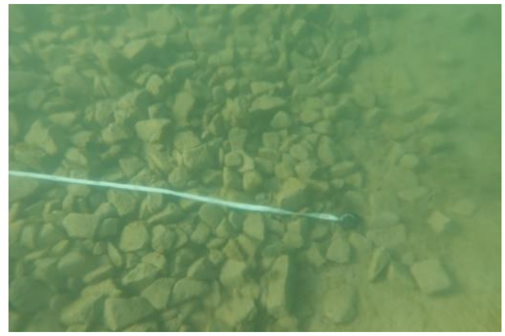
The construction of the Freight Dock offset habitat was proposed to consist of a crushed rockfill foundation with rock armour in areas that were likely to be in direct contact with water (Baffinland 2019). Accordingly, physical stability of the Freight Dock coarse rock substrate was qualitatively assessed during perimeter mapping and quadrat surveys. Observations from August 2020 surveys with description and photo documentation are provided in Table 17 and shown on Figure 5.

Outside of the above occurrences 1-7, the offset habitat as constructed appeared to be stable and when physically pushed by divers at various locations, remained in place. Areas of depressions or slumping was not observed.

Table 17: Physical Stability Issues Observed at Freight Dock Offset Habitat

Issue Number	Description	Photo Documentation
1	Rock armouring extending past the coarse substrate footprint on the southwest side of Freight Dock at FD-T3 Dimensions: 2 x 5 m	

Issue Number	Description	Photo Documentation
2	Exposed crushed rockfill located approximately 30 m west of FD-T5 Dimensions: 3 x 1.5 m	
3	Exposed crushed rockfill (on right side of photo) and riprap armouring located outside the immediate offset habitat footprint (on left side of photo). Location was offshore of Issue 2 (above). Dimensions: 2 x 1.5 m	
4	Exposed crushed rockfill with minimal rock armouring located approximately 10 m east of FD-T7. Dimensions: 4 x 8 m	
5	Exposed crushed rockfill with minimal rock armouring located at -7.1 m CD at FD-T5. Dimensions: 2 x 2 m	

Issue Number	Description	Photo Documentation
6	Crushed rockfill extending outside of typical coarse substrate footprint at FD-T11. Dimensions: 8 x 8 m	
7	Geotextile material extending outside of rock armouring and into the water column in area of FD-T5. Dimensions: 5 x 2 m	

Notes: The crushed rockfill was cobble-sized (64 to 256 mm) angular rock and rock armour was riprap-sized (>256 mm) angular rock.

LEGEND

PHOTO LOCATION

0 25 50

1:1,500 METRES

REFERENCE(S)

MILNE PORT IMAGERY CAPTURED AUGUST 2020 © 2020 DIGITAL GLOBE.
PROJECTION: UTM ZONE 17 DATUM: NAD 83

CLIENT
BAFFINLAND IRON MINES CORPORATION

PROJECT
MARY RIVER PROJECT – YEAR 1 FREIGHT DOCK MONITORING

TITLE
PHYSICAL STABILITY PHOTOGRAPH LOCATIONS AT FREIGHT DOCK OFFSET HABITAT

CONSULTANT

GOLDER

YYYY-MM-DD	2021-03-03
DESIGNED	EG
PREPARED	AJA
REVIEWED	DK
APPROVED	DK

PROJECT NO.	CONTROL	REV.	FIGURE
1663724	34000-05	0	5

PATH: I:\2016\1663724\Mapping\MXD\34000_2020_MEEMP\Task_0511663724_34000_05_Fig5_FreightDock_PhotoLocations_Rev0.mxd PRINTED ON: 2021-03-03 AT: 8:57:46 AM

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI A

25mm

0

4.0 SUMMARY

Table 18 provides a summary of the monitoring results with range based on the current Reference Area with +/- 20% range target. These results indicate that the Freight Dock offset is colonizing and is expected to continue to do so. The Reference Area is considered the late successional stage that the Freight Dock offset is expected to be reached by Year 10.

Table 18: Summary of Year 1 Habitat Offset Monitoring Results

Indicators: Metrics	FAA Condition/ Monitoring Plan (Golder 2019a)	Year 1 Monitoring Results	Target	Colonization Timing
Structural integrity	FAA Condition 5.1.1/ Section 2.3.4	Areas of exposed rockfill foundation. The stability assessment planned for Year 2 (in 2021) will provide additional information on the physical stability of these areas and whether remedial work is required.	Ongoing visual assessment	Not applicable
Macroalgae: % cover	FAA Condition 5.1.1/ Section 2.3	Intertidal: requires 71–100% cover Upper subtidal: requires 76-100% cover Shallow subtidal: 35-53% cover	+/- 20% of reference site	Immediate to medium; short to medium for kelp
Sessile invertebrates: % cover	FAA Condition 5.1.1/ Section 2.3	Intertidal: requires 2-3% cover Upper subtidal: requires 1.6-2.4% cover Shallow subtidal: requires 11-16% cover	+/- 20% of reference site	Immediate to medium
Motile invertebrates: density, diversity	FAA Condition 5.1.1/ Section 2.3	Intertidal: none Upper subtidal: none Shallow subtidal: requires 8 – 12 org/m^2	+/- 20% of reference site	Immediate to medium
Fish: density, diversity	FAA Condition 5.1.1/ Section 2.3	Intertidal: 0.2 – 0.4 fish/m^2 Upper subtidal: 0.2 – 0.4 fish/m^2 Shallow subtidal: none	+/- 20% of reference site	Immediate to medium
Arctic char prey species: density, diversity	FAA Condition 5.1.1/ Section 2.3	Intertidal: 15 – 23 org/m^2 Upper subtidal: 63 – 95 org/m^2 Shallow subtidal: 80 – 120 org/m^2	+/- 20% of reference site	Immediate to medium

Notes: Macroalgae - % cover – target range given based on +/- 20% of the reference area (Table 6) by depth contour, example: intertidal reference area 7.1 x 0.2 = 1.4 (range would be 7.1 – 1.4 to 7.1 + 1.4)
Sessile invertebrates - % cover – no sessile invertebrates were identified at the Freight Dock offset (Table 11) and therefore target not quantified for Year 1.
Motile invertebrates – diversity/density – no motile invertebrates were identified at Freight Dock or Reference (Table 12) for intertidal or shallow subtidal.
Fish – density/diversity – no fish identified at shallow subtidal Reference Area and is therefore not assessed in Year 1 (Table 15).
Colonization Timing: Immediate (1 to 2 years), short (5 to 6 years), and medium (9 to 10 years) terms (Golder 2019a).

5.0 DISCUSSION

The 2020 habitat offset monitoring program was designed to fulfill Year 1 monitoring requirements under Sections 5.1 and 5.2 of FAA #18-HCAA-00160 using diver-based transect/quadrat surveys supplemented with photo and video documentation. The objectives outlined in Section 1.2 above – including documenting macroalgae, sessile and motile invertebrate and fish occurrence, and qualitatively comparing productivity metrics (i.e., percent cover, density, diversity) between the Freight Dock offset habitat and coarse substrate at a Reference Area – were achieved.

Year 1 monitoring indicates that macroalgae, motile invertebrates, and fish have begun to colonize the Freight Dock offset habitat. For macroalgae, the Freight Dock offset habitat appeared to support low to moderate cover at all depth contours and documented taxa were predominantly faster growing algae varieties and ephemeral macroalgae (e.g., *Pylaiella* spp., fine green filamentous algae) (Küpper et al. 2016); slower growing perennials, such as rockweed and understory kelp, were not documented in Year 1 monitoring. This is to be expected given that, in Arctic marine waters, perennial macroalgae taxa are slow growing compared to temperate regions and are indicators of later stages of colonization (Golder 2019b). In general, taxa identified at the offset habitat were similar to those identified in the Reference Area. Occurrence of understory kelp at the Reference Area was minimal with low sugar kelp occurrence (0.1 ± 0.1 % areal cover) within the shallow subtidal depth contour. These results are expected as kelp (i.e., *Laminaria* sp., *Agarum* sp., *Alaria* sp.) occur in the Arctic with an upper limit of approximately 5 m, extending to 10 to 12 m depth with patchy distribution below 15 m (Küpper et al. 2016). Biotic or abiotic factors limit macroalgae colonization and growth; for example, in Arctic regions, perennial vegetation is often lacking from shallow surfaces (to -3 m CD) where ice scour is most prominent (Küpper et al. 2016; Zacher et al. 2009). This was evident at the Reference Area with rockweed growing in crevices between boulders and absent from the exposed areas (Appendix D; Photo 38).

At the Freight Dock, a detrital veneer was observed and recorded at most transect locations, though were not included as part of the macroalgae percent areal cover estimation. The detrital veneer on seafloor surfaces is a natural biological component of the Arctic marine environment where organic matter sinks from surface water (Rossel et al. 2016). The amount of marine organic matter – a component of the detrital veneer - is largely seasonally influenced and driven by diatom blooms (Mohan et al. 2016).

Sessile invertebrates were not documented at the Freight Dock offset habitat. The result that sessile invertebrates have not colonized the offset habitat after one year is aligned with what other Arctic recruitment studies have found. A study by Meyer-Kaiser et al. (2019) in Fram Strait, Arctic Ocean found that recruitment on two substrate types (plastic and brick) from 1999-2017 showed very low recruitment with foraminiferans evident after four years and metazoans (hydroid *Halispiphonia arctica*) evident after 12 years. Sessile invertebrates occurred at low abundance across all depth contours at the Reference Area; highest occurrence was documented within the shallow subtidal depth contour (13.3 ± 6.7 % areal cover). The dominant sessile invertebrate taxa were clams (wrinkled rock-borer and *Mya* spp.) and tunicates (Tunicata indet.) with low occurrence of sponges (Porifera indet.). It is expected that the Freight Dock offset habitat will colonize with sessile invertebrate taxa over time similar to the existing Ore Dock offset habitat that has been colonized by barnacles and bryozoans (Golder 2020a).

Motile invertebrates, including green urchin and brittle star, occurred in the shallow subtidal zone at low densities in the Freight Dock offset habitat (1 ± 0.5 org/m^2). At the Reference Area, shrimp were the dominant taxa observed with a higher relative density (10 ± 7.8 org/m^2). Observed differences in densities between the two survey areas are likely linked to abundance of marine vegetation. Occurrence of motile invertebrates is correlated with percent cover of macroalgae, which provides both a food source for grazers as well as cover from predators (Dunton and Schell 1987; Golder 2019b); as such, motile invertebrate density is anticipated to increase as macroalgae continue to colonize the offset habitat. In general, motile grazers and scavengers such as crustaceans, echinoderms, and molluscs colonize habitats prior to sessile invertebrates (Bluhm and Gradinger 2008; Golder 2019b), which is consistent with Year 1 results for the Freight Dock offset habitat.

Multiple species of sculpin dominated fish assemblages within both survey areas, suggesting that sculpins are quick to colonize and establish territories within complex hard substrate habitat. Fish productivity metrics (i.e., density and diversity) were comparable between the Freight Dock and the Reference Area. High densities of prey items, particularly mysids (opossum shrimp), were recorded at the Freight Dock; mysids are an important abundant food source during the open-water season for marine birds and anadromous fishes, including Arctic char (Dunton et al. 2006). This indicates that the offset habitat is providing both suitable cover/habitat and foraging opportunities for fish; in fact, fish usage and mysid occurrence are consistent with what was documented at the existing Ore Dock offset habitat in the earlier years of the 6-year monitoring program (Golder 2020a).

Overall, the offset habitat provides a suitable and stable substrate for continued colonization and growth of marine organisms. However, there are a few small and localised areas where the crushed rockfill foundation has become exposed; these exposed areas are vulnerable to erosion and may possibly be impacted further by seasonal abiotic processes (i.e., ice scour, wave action). The stability assessment planned for Year 2 (i.e., in 2021) will provide additional information on the physical stability of these areas and whether remedial work may be considered.

6.0 CLOSURE

We trust that this report provides sufficient information for your current needs. Please contact the undersigned at 250-881-7372 if you have any questions.

Golder Associates Ltd.

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https://golderassociates.sharepoint.com/sites/11206g/deliverables (do not use)/issued to client_for wp/1663724-253-r-rev0-34000/1663724-253-r-rev0-34000-bim y1 freight dock monitoring 03mar_21.docx

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APPENDIX A

Paragraph 35(2)(b) *Fisheries Act* Authorization (18-HCAA-00160)

PATH No.: 18-HCAA-00160

Other DFO File No.:

PARAGRAPH 35(2)(*b*) *FISHERIES ACT* AUTHORIZATION

Authorization issued to
Baffinland Iron Mines Corporation (hereafter referred to as the "Proponent")

Attention to: Phil Dutoit
2275 Upper Middle Road East Suite 100
Oakville, ON
L6H 0C3

Location of Proposed Project
The project is located at Milne Port, which is located 134 km southwest of Pond Inlet.

Nearest community (city, town, village): Pond Inlet
Municipality, district, township, county: Baffin Region
Territory: Nunavut
Name of watercourse, waterbody: Milne Inlet
Longitude and latitude, UTM Coordinates: 71.889403°, Longitude: -80.887592°, Zone: 17 W, Easting: 503900 m E, Northing: 7976600 m N

Description of Proposed Project

The proposed project is the construction of a Freight dock at the port in Milne Inlet. The work, undertaking or activity authorized is associated with The Mary River Project, an operating iron ore mine located on Baffin Island in the Qikiqtani Region of Nunavut. The Early Revenue Phase of the Mary River Project will involve mining and shipment of iron ore via the port at Milne Inlet. The new freight dock will allow more efficient use of the port for shipping purposes.

Description of Authorized work(s), undertaking(s) or activity(ies) likely to result in serious harm to fish

The work(s), undertaking(s), or activity(ies) associated with the proposed project described above, that are likely to result in serious harm to fish, are:

> The infilling of fish habitat in Milne Inlet resulting from the construction of the freight dock and mooring structures. Construction activities for the Freight Dock include:
>
> - Construction of a rock-fill berm
> - Removal of Sea Ice
> - Dredging and disposal of dredged material
> - Placement of rock/fill
> - Vibratory Pile driving

The serious harm to fish likely to result from the proposed work(s), undertaking(s), or activity(ies), and covered by this authorization includes

Permanent destruction of 26,449 m^2 ([2,170] Habitat Equivalent Units) of fish habitat in Milne Inlet including:

- 12,829m^2 Intertidal marine habitat
- 12,357m^2 Subtidal marine habitat
- 1,263m^2 Intertidal unnamed stream

Conditions of Authorization

The above described work, undertaking or activity that is likely to result in serious harm to fish must be carried on in accordance with the following conditions.

1. **Conditions that relate to the period during which the work, undertaking or activity that will result in serious harm to fish can be carried on**

   The work, undertaking or activity that results in serious harm to fish is authorized to be carried on during the following period:

   From the date of issuance to June 1, 2020

   If the Proponent cannot complete the work, undertaking or activity during this period, Fisheries and Oceans Canada (DFO) must be notified in advance of the expiration of the above time period. DFO may, where appropriate, provide written notice that the period to carry on the work, undertaking or activity has been extended.

   The periods during which other conditions of this authorization must be complied with are provided in their respective sections below. DFO may, where appropriate, provide written notice that these periods have been extended, in order to correspond to the extension of the period to carry on a work, undertaking, or activity.

2. **Conditions that relate to measures and standards to avoid and mitigate serious harm to fish**

2.1 Sediment and erosion control: Sediment and erosion control measures must be in place and shall be upgraded and maintained, such that release of sediment is avoided at the location of the authorized work, undertaking, or activity.

2.1.1 Before commencing any works, undertakings and/or activities that have the potential to release sediment into Milne Inlet or the unnamed stream, the Proponent shall prepare and implement site specific sediment and erosion control plans for any near or in-water works under the guidance of a certified Professional in erosion and sediment control (CPESC or equivalent). This plan shall be provided to DFO for review and approval before commencement of construction.

2.1.2 The erosion and sediment control plans shall include, but not to be limited to, the following:

- Delineation of areas of work;
- Plan for construction staging and storage logistics, including disposal of spoils;
- Anticipated construction schedule and construction duration;
- A description of erosion and sediment control measures to be used during and following construction (purpose, type, location, dimensions and design considerations);
- A description of the inspection and maintenance program and schedule; and
- Areas of the site susceptible to erosion problems

2.1.3 Turbidity levels shall be monitored in water adjacent to the work zone as the ice melts to evaluate potential movement of sediments. DFO shall be notified immediately of any exceedances of the current version of the Canadian Council of Ministers of the Environment (CCME) Canadian Water Quality Guidelines for the Protection of Aquatic Life for suspended sediment (TSS) levels, temperature, and dissolved oxygen in water released from the site into any fish bearing waterbodies. Monitoring and regular reporting of the incident and corrective actions must be made to DFO until stabilization of the work site and construction areas is completed, and the situation has passed.

2.1.4 A qualified on-site environmental inspector shall be employed by the Proponent and be present throughout construction to ensure adherence to the proper codes of environmentally responsible construction practice. The environmental inspector shall ensure that all mitigation is implemented properly, photograph (with dates) and record construction activities and conduct suspended sediment monitoring. A report detailing the nature of the works or undertakings, the construction methods used, the mitigation measures employed, the effectiveness of the mitigation works, and the results of any monitoring programs undertaken shall be included in the annual report as per Condition 5.

2.2 Measures and standards to avoid and mitigate serious harm to fish resulting from the construction of the freight dock shall be implemented prior to the commencement of in or above water works (in the case of on ice work) as described below and as set out in the Proponent's Baffinland Iron Mines Corp. Mary River Project, Floating Freight Dock Application For *Fisheries Act* Authorization, dated February 27, 2019 or any subsequent, DFO approved, versions (hereafter referred to as the "Freight Dock Application"):

2.2.1 All blasting activities shall be conducted following Cott and Hanna's 'Monitoring Explosive-Based Winter Seismic Exploration in Waterbodies, NWT 2000-2002' (2005).

2.2.2 All construction activities shall be undertaken as outlined in the Freight Dock Application to minimize the potential for stress related behaviour or death of fishes and marine mammals

2.2.3 While conducting vibratory pile driving, dredging and infilling, a marine mammal exclusion zone of 200m radius shall be established. The marine mammal exclusion zone will be monitored for marine mammal presence starting 30 minutes prior to the commencement of vibratory pile driving, dredging or infilling activities. All activities shall cease if marine mammals are observed within the exclusion zone and shall not recommence until 30 minutes after the marine mammal was last observed or 30 minutes after the marine mammal is seen leaving the exclusion zone.

2.2.4 Field measurements shall be undertaken to verify that underwater sound pressure and noise levels at the edge of the exclusion zone shall not exceed 100 dB re 1 μPa root-mean-square (rms) sound pressure level (SPL) to prevent auditory injury to marine mammals during construction. If measured underwater noise levels exceed the 100db threshold, the following contingency measures shall be implemented: expansion of the marine mammal exclusion zone and the installation of bubble curtains.

2.2.5 In-air sound levels during the iced-season shall not exceed the in-air acoustic threshold of 100dB re 20μPa root-mean-square (rms) when pinnipeds are observed on the ice during construction activities.

2.3 Works shall be halted if monitoring required in condition 3 and 4 below indicated that the measures and standards to avoid and mitigate serious harm to fish are not successful.

2.4 Measures and standards to avoid and mitigate serious harm to fish shall be implemented prior to the commencement of construction.

3. **Conditions that relate to monitoring and reporting of measures and standards to avoid and mitigate serious harm to fish from the ore dock construction**

3.1 The Proponent shall monitor the implementation of avoidance and mitigation measures referred to in section 2 of this authorization and provide a report to DFO, by February 28, 2020, and indicate whether the measures and standards to avoid and mitigate serious harm to fish were conducted according to the conditions of this authorization. This shall be done, by:

- 3.1.1 Providing inspection reports supported by dated photographs to demonstrate effective implementation and functioning of mitigation measures and standards described above to limit the serious harm to fish to what is covered by this authorization.
- 3.1.2 Providing details of any contingency measures that were followed, to prevent impacts greater than those covered by this authorization in the event that mitigation measures did not function as described.

4. **Conditions that relate to the offsetting of the serious harm to fish likely to result from the authorized work, undertaking or activity**

4.1 Scale and description of offsetting measures:

- 4.1.1 Course rock substrate will be placed around the perimeter of the freight dock and moorings at Milne Inlet to provide 2729 HEUs of potential fish habitat

4.2 Contingency measures: If the results of monitoring indicates that the offsetting measures are not completed and/or functioning according to the monitoring criteria as outlined in the approved monitoring plan, as referenced in 5.1.1, the Proponent shall give written notice to DFO and shall implement the contingency measures and associated monitoring measures, as contained within an approved contingency plan, to ensure the implementation of the offsetting measures is completed and/or functioning as required by this authorization. The following conditions relate to the contingency measures:

- 4.2.1 The Proponent shall submit an updated contingency plan to DFO by February 28, 2020. The updated contingency plan shall be agreed by DFO and shall be informed by Inuit and/or indigenous groups and shall demonstrate viability.
- 4.2.2 The Proponent shall develop a monitoring plan for the contingency measures. The plan shall be developed specifically for monitoring of contingency measures. The plan shall be submitted to DFO and approved, in writing, by February 28, 2020 and shall be reviewed and approved by DFO, in writing, as required.

4.3 The Proponent shall not carry on any work, undertaking or activity that will adversely disturb or impact the offsetting measures.

5. **Conditions that relate to monitoring and reporting of implementation of offsetting measures (described above in section 4):**

5.1 The Proponent shall conduct monitoring of the implementation of offsetting measures according to the approved timeline and criteria in the Freight Dock Application, Section 9 in addition to an approved updated monitoring plan as follows:

- 5.1.1 The Proponent shall submit an updated offsetting monitoring plan for the proposed offsetting for review by DFO on or before May 31, 2019. The monitoring plan must satisfy DFO's requirements to demonstrate through clear and measurable criteria, fisheries productivity changes as a result of the offsetting measures. To address uncertainty in the effectiveness of the proposed offsetting measures, the proposed monitoring must have sufficient statistical power to determine if changes to productivity are occurring as a result of the offsetting measures within a defined timeframe, and must employ the most up-to-date and proven methodologies demonstrated to be effective under Arctic conditions.

5.1.2 Monitoring of offsetting shall be conducted over ten years, with a five year monitoring program (years 1, 2, 5, 8, 10) as outlined in the Freight Dock Application, Section 8, or as outlined in an updated monitoring plan and/or subsequent versions and as approved by DFO.

5.1.3 In addition to the outlined criteria, a digital photographic record of pre-construction, during construction and post-construction conditions using the same vantage points and direction to show that the approved works have been completed in accordance with the Freight Dock Application and subsequent plans approved by DFO

5.2 List of reports to be provided to DFO: The Proponent shall report to DFO on whether the offsetting measures were conducted according to the conditions of this authorization by providing the following:

5.2.1 Post-construction evaluation report shall be submitted to the DFO-Yellowknife Office within three months of the completion of the Freight Dock construction.

5.2.2 Monitoring reports shall be submitted to the DFO-Yellowknife Office by March 31 following each monitoring year, as will be outlined in the approved monitoring plan.

6. **Conditions that relate to the letter(s) of credit as part of the application for this authorization**

6.1 Letter of credit: DFO may draw upon funds available to DFO as the beneficiary of the letters of credit provided to DFO as part of the application for this authorization, to cover the costs of implementing the offsetting measures required to be implemented under this authorization, including the associated monitoring and reporting measures included in section 6, in instances where the Proponent fails to implement these required measures.

6.1.1 A letter of credit in the amount of $3,000,000 has been provided to cover the costs of implementing the offsetting measures required to be implemented under this authorization.

6.1.2 A letter of credit in the amount of $500,000 has been provided to cover the costs of implementing the monitoring required to be implemented under this authorization.

6.1.3 A letter of credit in the amount of $250,000 has been provided to cover the costs associated with the development and implementation of an adequate offsetting monitoring plan, which will be returned to the Proponent once an approved monitoring plan is finalized and approved in writing by DFO as referenced in section 5.1.1.

6.1.4 A letter of credit in the amount of $500,000 has been provided to cover the costs of the development and implementation of contingency measures, which includes costs associated with Indigenous consultation. If the Proponent fails to provide a feasible and acceptable contingency plan, this letter of credit shall be used for the cost of DFO to solicit, consult, and hire a consultant to develop a contingency plan. This will be returned to the Proponent once an approved contingency plan is finalized and approved by DFO as referenced in section 4.3.

Authorization Limitations and Application Conditions

The Proponent is solely responsible for plans and specifications relating to this authorization and for all design, safety and workmanship aspects of all the works associated with this authorization.

The holder of this authorization is hereby authorized under the authority of Paragraph 35(2)(*b*) of the *Fisheries Act*. R.S.C., 1985, c.F. 14 to carry on the work(s), undertaking(s) and/or activity(ies) that are likely to result in serious harm to fish as described herein. This authorization does not purport to release the applicant from any obligation to obtain permission from or to comply with the requirements of any other regulatory agencies.

This authorization does not permit the deposit of a deleterious substance in water frequented by fish. Subsection 36(3) of the *Fisheries Act* prohibits the deposit of any deleterious substances into waters frequented by fish unless authorized by regulations made by Governor in Council.

This authorization does not permit the killing, harming, harassment, capture or taking of individuals of any aquatic species listed under the *Species at Risk Act* (SARA) (s. 32 of the SARA), or the damage or destruction of residence of individuals of such species (s. 33 of the SARA) or the destruction of the critical habitat of any such species (s. 58 of the SARA).]

At the date of issuance of this authorization, no individuals of aquatic species listed under the *Species at Risk Act* (SARA) were identified in the vicinity of the authorized works, undertakings or activities.

The failure to comply with any condition of this authorization constitutes an offence under Paragraph 40(3)(*a*) of the *Fisheries Act* and may result in charges being laid under the *Fisheries Act*.
This authorization must be held on site and work crews must be made familiar with the conditions attached.

This authorization cannot be transferred or assigned to another party. If the work(s), undertaking(s) or activity(ies) authorized to be conducted pursuant to this authorization are expected to be sold or transferred, or other circumstances arise that are expected to result in a new Proponent taking over the work(s), undertaking(s) or activity(ies), the Proponent named in this authorization shall advise DFO in advance.

Date of Issuance: March 21, 2019

Approved by:

Scott Gilbert
A/Regional Director General
Central and Arctic Region
Fisheries and Oceans Canada

APPENDIX B

Revised Effectiveness Monitoring Plan for Coarse Rock Offsetting Habitat as a Condition of the *Fisheries Act* Authorization

REPORT

Floating Freight Dock Project

Revised Effectiveness Monitoring Plan for Coarse Rock Offsetting Habitat as a Condition of the Fisheries Act Authorization (18-HCAA-00160)

Submitted to:

Baffinland Iron Mines Corporation
2275 Upper Middle Road East
Suite 300
Oakville, ON
L6H 0C3

Submitted by:

Golder Associates Ltd.
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1663724-121-R-Rev0-30000

31 May 2019

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1.0 INTRODUCTION

1.1 Background

Baffinland Iron Mines Corporation (Baffinland) is the owner and operator of the Mary River Project (the Project), an operational open-pit iron ore mine located on North Baffin Island in the Qikiqtani Region of Nunavut. Project Certificate No. 005, amended by the Nunavut Impact Review Board (NIRB) on 27 May 2014, authorized Baffinland to mine up to 22.2 million tonnes per annum (Mtpa) of iron ore from Deposit No. 1. Of this 22.2 Mtpa, Baffinland is currently authorized to transport 18 Mtpa of ore by rail to Steensby Port for year-round shipping through the Southern Shipping Route (via Foxe Basin and Hudson Strait), and 4.2 Mtpa of ore by truck to Milne Port for open water shipping through the Northern Shipping Route using chartered ore carrier vessels (the Approved Project). A Production Increase to ship 6.0 Mtpa from Milne Port was approved for 2018 and 2019.

The approved Project included construction of an ore dock and loading facility at Milne Port for loading iron ore, as well as a Freight Dock to allow for import of containerized supplies, break bulk, and special cargo (Figure 1). The ore dock was constructed in 2014 and has been operational since 2015. Construction of the original ore dock at Milne Port was predicted to result in serious harm to fish through the permanent loss of 24,847 m^2 of marine fish habitat. Baffinland submitted to Fisheries and Oceans Canada (DFO) an application for a paragraph 35(2)(b) *Fisheries Act* Authorization (FAA) including a Marine Habitat Offset Plan (Offset Plan), which proposed the addition of coarse rock material around the perimeter of the ore dock for installation of the ore dock. DFO issued a FAA for the ore dock on 30 June 2014 (#14-HCAA-00525). One of the conditions of the FAA was for Baffinland to undertake monitoring and reporting of the structural stability and biological utilization of offsetting measures at the Milne Port ore dock; effectiveness monitoring of the offset habitat is currently in Year 4 (2018) of an annual six-year monitoring program.

The Freight Dock, currently being constructed, will comprise a floating spud barge and a permanent causeway. The Freight Dock will result in localised infilling of intertidal and subtidal habitat and was determined to result in serious harm to fish through the permanent alteration and destruction of 26,449 m^2 marine fish habitat. As a result, Baffinland submitted to DFO a FAA application (27 February 2019, Rev 4) that included measures to offset for the permanent loss of fish habitat due to installation of the Freight Dock. The application included a similar Marine Habitat Offset Plan, which proposed the addition of coarse rock material around the perimeter of the Freight Dock to increase habitat complexity in Milne Port and serve as functional habitat for marine benthic invertebrate and fish species. DFO issued a FAA for the Freight Dock on 21 March 2019 (#18-HCAA-00160, Appendix A), which included a requirement for habitat offset monitoring to be conducted five times over a of 10-year period to confirm the coarse rock habitat is functioning as intended. One condition of the FAA, related to offset monitoring, was to provide an updated offsetting monitoring plan:

5. *Conditions that relate to monitoring and reporting of implementation of offsetting measures (described above in section 4):*

5.1. *The Proponent shall conduct monitoring of the implementation of offsetting measures according to the approved timeline and criteria in the Freight Dock Application, Section 9 in addition to an approved updated monitoring plan as follows:*

5.1.1. *The Proponent shall submit an updated offsetting monitoring plan for the proposed offsetting for review by DFO on or before May 31, 2019. The Monitoring plan must satisfy DFO's requirements to demonstrate through clear and measurable criteria, fisheries productivity changes as a result of the offsetting measures. To address uncertainty in the effectiveness of the proposed offsetting measures, the proposed monitoring must have sufficient statistical power to determine if changes to productivity are occurring as a result of the offsetting measures within a defined timeframe, and must employ the most up-to-date and proven methodologies demonstrated to be effective under Arctic conditions.*

In accordance with Condition 5.1 of the FAA, this revised effectiveness monitoring plan aims to satisfy DFO's requirements to demonstrate through clear and measurable criteria, fisheries productivity changes as a result of the proposed offsetting measures. To address uncertainty in the effectiveness of the proposed offsetting measures, a monitoring framework is presented that employs sufficient statistical power to determine if changes to productivity are occurring as a result of the introduced offsetting measures within a defined time frame, using up-to-date and proven monitoring methods that are demonstrated to be effective under Arctic conditions.

1.2 Offsetting Plan for Freight Dock

Determination of offset requirements for the Freight Dock largely followed methodology used in the FAA application for the original ore dock. Over half of the anticipated habitat that will be lost due to the Freight Dock footprint is located in the intertidal zone (+2.3 m to 0.0 m chart datum), an area where habitat is generally associated with very low productivity due to seasonal ice impacts (e.g. ice scour), extreme air temperatures during low tides, and high wave exposure which limits biotic growth and recruitment. The remainder of the footprint is located primarily within the upper subtidal zone (0 m to -3 m), which in the Arctic is generally associated with low fish productivity due to the dynamic nature of this habitat. A relatively minor proportion of the habitat losses will occur in the moderately productive shallow subtidal zone (-3 m to -15 m). The majority of the substrate of the impacted subtidal area is a mix of fine and coarse materials (sand, gravel and cobble). There is limited large three-dimensional coarse material in or near Milne Port that provides a stable hard surface habitat for colonizing species, specifically macroalgae and invertebrate species. Baffinland determined that coarse rock (riprap 0.5 m to 1.0 m) installed along the sideslopes of the causeway as part of its construction has the potential to offset for the substrate being lost by providing higher productivity habitat relative to the soft substrate currently present in Milne Port. The addition of larger and more structurally complex substrates provides three-dimensional habitat with greater surface area for organisms to colonize and more complex cover than soft substrates (Appendix B). During five years of the Marine Environmental Effects Monitoring Program, sediment along three transects, one extending approximately 4.2 km along the eastern shore of Milne Inlet (Figure 2-1 in Golder 2019), was predominantly soft substrate along the 15 m depth contour. A large proportion of the coarse rock will be placed in the shallow subtidal zone, increasing the amount of higher-valued habitat within the more productive depth range, where there is currently limited higher value substrate.

1.3 Objective

The objective of the effectiveness monitoring program is to evaluate the coarse rock offsetting habitat for stability and function as productive fish habitat, and to demonstrate it is functioning as anticipated. The following will be used to evaluate the offset habitat:

- Document the offset habitat using repeatable photographs and videos taken annually along established transects at a range of depths to demonstrate extent of community establishment compared to similar coarse rock habitat (i.e. similar depth and habitat features) near Milne Port, and relative to soft-bottom habitat similar to substrate under the Freight Dock footprint. If a suitable coarse rock reference site cannot be found, only the soft-bottom habitat reference site will be used.
- Assess abundance, diversity and biomass for taxa and functional groups.
- Assess presence and habitat usage by fish and motile invertebrates.

- Delineate the offset habitat to confirm the coarse rock habitat has been constructed as designed and assess stability over the 10-year monitoring period.
- Assess the functionality of the coarse rock, identify any structural failures or problems with the offset habitat, and implement actions to remediate problems.

1.3.1 Indicators

To address the objectives and evaluate the functionality of the offsetting coarse rock habitat, the effectiveness monitoring program will include the following indicators:

- Recruitment of propagules to rock substrate
- Primary producers - diatoms, seaweed propagules, perennial/ephemeral macroalgae species, canopy/non-canopy forming bladed kelps
- Sessile colonizers - bryozoans, polychaetes, spirorbids, barnacles, anemones, sponges and corallines, trophic level, biological traits, habitat influence
- Fish and motile invertebrate use
- Arctic char prey species e.g. krill, mysid shrimp, other fish species
- Physical stability of coarse rock habitat.

2.0 EFFECTIVENESS MONITORING PLAN

The goal of the effectiveness monitoring plan is to determine whether the coarse rock offset habitat is functioning from a biological perspective (Bradford et al. 2017). Monitoring will involve visual observations and measurements of habitat quantity, and parameters of physical and biological condition. Given the relatively narrow open-water timing window and challenges with frequent and continual disturbance of shallow Arctic marine environments by ice scour, the monitoring plan has been designed to generate results useful for evaluating success of the coarse rock offset habitat in the Arctic environment. Choosing an appropriate experimental design and an appropriate scale were considered for the monitoring plan.

2.1 Sampling Frequency and Period

Once construction of the habitat offset is complete, monitoring will be conducted during five years over a 10-year period (in years 1, 2, 5, 8 and 10) to evaluate colonisation and trend. Due to the logistics of site access, and the short open-water season in the Arctic, sampling can only occur during the summer months from late July to early September.

Monitoring will be scheduled during August or September coinciding with the open water season and at which time peak growth for macroalgae and invertebrates is anticipated, which will facilitate species identification. Monitoring will occur along the constructed coarse rock habitat and at reference sites at a range of depths between 0 m and -15 m chart datum (CD), reflective of the depths of the offset habitat.

2.2 Sampling Locations and Design

As observed during year 4 (2018) of the 6-year offset habitat effectiveness monitoring program for the existing ore dock (SEM 2015, 2016; Golder 2017, 2018), coarse rock colonization varies depending on the location along the ore dock i.e. east or west side. A higher percent cover of aquatic vegetation was observed on the west side of the ore dock than on the east side, and the distribution of vegetation types varied spatially throughout the coarse rock substrate. Sessile fauna such as barnacles and serpulids were also observed in higher densities on the west side.

Similarly, there will likely be differences in coarse rock colonization around the Freight Dock based on the presence of the unnamed stream on the east side, vessel activity on the north side, and partial protection from the existing ore dock on the west side. Sample locations will be selected and observations will be conducted on the east, north, and west side of the Freight Dock to account for these differences.

Evaluation of offset sample locations will be compared to:

1) Reference site similar in substrate, at a comparable range of depths and with similar habitat features as the Project site footprint prior to construction of the Freight Dock. As part of the ongoing Phase 1 Marine Ecological Effects Monitoring Program (MEEMP), sediment characterization, benthic infauna identification, and macroflora, benthic epifauna and fish observations have been conducted in and adjacent to the Freight Dock footprint. The MEEMP provides baseline information and will continue to collect baseline information adjacent to the Freight Dock until 2026, which will be used for comparison. To supplement this information and ensure sampling is conducted in the same years and using the same methods as this monitoring plan, additional sampling sites will be selected to the east of the Freight Dock and representative of the impacted or “built-over” habitat. A before-after control-impact (BACI) design will be used for the comparison.

2) Rock habitat reference site – a reference site will be selected if a rock reef or subtidal rock shoreline can be identified within 5 km of the Project and with a similar depth range, aspect, fetch, and salinity as the offset habitat. Coarse rock habitat was chosen as an offset option as the MEEMP studies indicate this habitat type is likely limiting in Milne Inlet, which also means that a suitable reference site may not be found. If suitable rock habitat reference site is not found, the offsetting habitat may only be compared to soft substrate habitat as above.

3) Temporal trend analysis to show colonization and increased fish use of the coarse rock habitat over the 10-year monitoring period.

2.3 Methods

The selected metrics (Table-1) are considered habitat offsetting currency of the “habitat characteristics and function” and “habitat suitability for select species” type as described by Bradford et al. (2017). Measurements of density, abundance, diversity, and biomass are proposed to compare productivity of the offsetting habitat to an impacted reference site representative of the built-over habitat type, and if available, a rock habitat reference site. The criterion for fish usage is presented as a qualitative presence/absence because the presence of migratory and seasonal fish such as Arctic char can be highly variable due to factors unrelated to the specific habitat conditions, as acknowledged by Bradford et al. (2017). Habitat suitability will also be considered in the context of Arctic char behaviour, habitat preferences and prey species, which include other fish species, while in the marine environment.

Success of the offset habitat will be confirmed if it is physically stable, and macroalgae growth, motile species use, and invertebrate colonization of the coarse rock substrate is similar to that measured at the reference site, or habitat quality/functionality of the coarse rock represents an improvement to that recorded at the “built-over” reference site (Section 2.5). Reference sites will be identified during summer of 2019 or the next summer following completion of the Freight Dock construction.

Table-1: Selection of Species and Functional Groups for Monitoring as a Performance Standard for Coarse Rock Offset Habitat

<table>
<tr><th>Indicators (Species/Functional Group)</th><th>Metric of Productivity</th><th>Target</th><th>Colonization Timing</th></tr>
<tr><td colspan="4">Artificial Substrate (Recruitment)</td></tr>
<tr><td>Primary Producers</td><td rowspan="3">Density, Diversity, Abundance, Biomass</td><td rowspan="3">>10% of impact site or ±20% of reference site</td><td rowspan="2">Immediate to Medium</td></tr>
<tr><td>Sessile colonizers</td></tr>
<tr><td>Bladed kelps</td><td>Short to Medium</td></tr>
<tr><td colspan="4">Towed Video and Fixed Transects</td></tr>
<tr><td>Primary Producers - diatoms, seaweed propagules, perennial/ephemeral macroalgae species, canopy / non-canopy forming</td><td rowspan="3">% Cover</td><td rowspan="5">>10% of impact site or ±20% of reference site</td><td rowspan="2">Immediate to Medium</td></tr>
<tr><td>Sessile colonizers - bryozoans, polychaetes, spirorbids, barnacles, anemones, sponges and corallines, trophic level, biological traits, habitat influence</td></tr>
<tr><td>Bladed kelps</td><td>Short to Medium</td></tr>
<tr><td>Fish and motile invertebrate use</td><td rowspan="2">Diversity, Abundance</td><td rowspan="2">Immediate to Medium</td></tr>
<tr><td>Arctic char prey species</td></tr>
</table>

Note: immediate (1 to 2 years), short (5 to 6 years), and medium (9 to 10 years) terms (Smokorowski et al. 2015)

The methods described below are adapted from DFO’s Marine Foreshore Environmental Assessment Procedure (Appendix to G3 Consulting Ltd. 2003) and from methods used in similar environments to measure colonisation, habitat use, and succession on rocky reefs. Due to the differences in comparing offset habitat to coarse rock or soft sediment reference habitats, more detailed methodology will be determined following the identification of suitable reference sites.

2.3.1 Recruitment

Many early colonizer species are cryptic and not readily identifiable from photographs or video, or settle to surfaces that may not be readily photographed such as the sides and undersides of rocks. Recruitment will be evaluated using the following procedures:

1) Sets of artificial substrate of similar size and texture to the rocks used for the coarse rock habitat or settlement baskets filled with rocks of the same size and shape will be placed among the coarse rock substrate at -3 m,

-8 m and -15 m, along the east, north and west sides of the Freight Dock, as well as at similar depths at the reference sites. Placing all the artificial substrates for the subsequent survey years at the start of monitoring will allow for measurements of short- to medium-term colonisation during later survey years.

2) Settlement substrate at the soft sediment reference sites will include sediment trays containing substrate similar to the soft bottom habitat. Each set deployed at the offset habitat and reference sites will contain five artificial substrates/settlement baskets, one of which will be retrieved for analysis during each survey year.

3) During each survey year, the retrieved substrate will be photographed from multiple angles and the biota on the artificial substrate will be scraped off and sent for identification to the lowest taxonomic level and the artificial substrate redeployed. Measurements of biomass will also be made for each. In subsequent survey years, the redeployed substrate will be compared to substrates deployed from the start of monitoring to determine differences in immediate-term colonisation to short- and medium-term colonisation.

4) Observations will be made of the percent cover, density, diversity, abundance and biomass of primary producers and sessile invertebrates, by species and as functional groups, relative to reference sites, with a focus on bladed kelp species, particularly in the later monitoring years. It is presumed that diversity of function will be increased by the addition of coarse rock habitat relative to soft-substrate habitat.

2.3.2 Macroalgae and Sessile Invertebrate Colonization

The coarse rock habitat on the east, north and west sides of the Freight Dock will be monitored using dive surveys and towed underwater video along transect lines that will be established following construction of the Freight Dock.

1) In the first sampling year, a total of 18 1-m quadrats will be placed randomly on the coarse rock substrate at -3 m, -8 m and -15 m, focusing on the expected productive range between -3 m and -15 m. Permanent markers will be placed at the quadrat corners, allowing for repeat measurements of the same quadrats in subsequent sample years, similar to methods used by Beuchel and Gulliksen (2008) to monitor Arctic benthic community development over a 20-year period.

2) A high-resolution underwater camera will be used to photograph the area within each quadrat, using the permanent quadrat markers as a guide to ensure the quadrat is photographed at similar angles during each survey. The photographs will be examined and organisms identified to the lowest possible taxonomic level, and classified by functional groups. Functional groups of primary producers will include ephemeral/perennial categories, as well as canopy/non-canopy formers. Invertebrate functional groups will be determined by traits such as feeding mechanism (suspension feeders, detritivores, herbivores, predators), biological traits (fecundity, longevity, colonisers, body shape), and habitat influencers (builders, burrowers, bioturbators, providers). It is presumed that diversity of function will be increased by the addition of coarse rock habitat relative to soft-substrate habitat.

3) Additionally, percent cover of macroalgae and sessile invertebrates will be visually estimated and assigned to percent cover categories (i.e., >0 to 5%; >5 to 25%; >25 to 50%; >50 to 75%; and >75 to 100%). The habitat will also be photographed from several viewpoints during each sampling event to provide photo documentation of changes to the habitat over time. A permanent belt transect will be installed along the coarse rock substrate and towed underwater video will be used to monitor presence and abundances of macroalgae and invertebrates during sample years and to monitor change between sample years.

4) If suitable rock habitat sites are identified, up to two sites will be selected as reference and will be sampled in the same manner as described above with a total of 12 quadrats placed at each location at a similar depth range as on the coarse rock habitat. The reference areas will be selected at the time of sampling and may include a location representative of a natural rocky subtidal habitat in Milne Inlet in addition to a soft-bottom habitat comparable to the substrate built over by the Freight Dock.

2.3.3 Motile Macrofaunal Colonisation

Motile macrofauna utilisation and colonisation of the coarse rock substrate will be evaluated by examining the quadrat photographs and the video transect footage.

1) Macrofaunal organisms (e.g., urchins, fish) will be identified to the lowest possible taxonomic level and enumerated. Diversity and abundance of fish and motile invertebrates will be quantified relative to reference sites, with a particular focus on prey species of Arctic char such as mysid shrimp, krill and other fish species, determined through literature review and documented stomach contents of fish caught in Milne Port during MEEMP studies.
2) Observation of the usage of the offset habitat will be made to determine the association between the macrofauna and the coarse rock habitat. The selected reference sites will be sampled in the same manner.

2.3.4 Physical Stability

The coarse rock habitat will be surveyed using photographic and towed underwater video methods as part of the offset monitoring program. Video footage and photos of the coarse rock habitat will be compared to previous survey years and assessed for signs of potential slumping, failure, or movement of the coarse rock or other physical alteration that may affect the suitability of the substrate. Observations of sedimentation or siltation will also be noted.

2.4 Statistical Analysis

Statistical analysis will be based on recommendations listed in Smokorowski et al. (2015; Table 2) by comparing differences between the offset habitat and the reference sites in the immediate (1 to 2 years), short (5 to 6 years), and medium (9 to 10 years) terms.

Temporal trend analysis will also be presented in the final monitoring report (year 10) to evaluate the colonisation and fish use of the coarse rock offset habitat. Trend analysis can be used to show if metrics are trending towards being greater than the “built-over” reference site or within 20% of the rock habitat reference sites.

2.5 Summary

During the 10-year effectiveness monitoring program for the coarse rock offset habitat, productivity will be measured using indicators as summarised in Table-2.

Table-2: Analytical Methods for Determining Productivity of Coarse Rock Offset Habitat

Indicators (Species/Functional Group)	Methods	Metrics	Schedule
Recruitment	Artificial Substrate	Taxa identification Functional group identification Percent cover, density, diversity, abundance and biomass	Years 1, 2, 5, 8, 10
Macroalgae/Sessile Invertebrate Colonization	Towed Underwater Video Fixed Quadrats	Taxa identification Functional group identification Percent Cover	
Motile Macrofauna Colonisation	Towed Underwater Video Fixed Quadrats	Taxa identification Diversity and abundance Habitat association and use	
Physical Stability	Towed Underwater Video Fixed Quadrats	Evidence of slumping, sedimentation, siltation	

3.0 EVALUATING SUCCESS OF THE OFFSETTING HABITAT

The observations and measurements of the coarse rock offset habitat during each monitoring event will be compared to equivalent measurements made at soft substrate habitat adjacent to the freight dock and or rock habitat reference sites near Milne Port. Potential rock habitat reference sites for offset monitoring will be identified during summer field programs undertaken as part of the 2019 Marine Environmental Effects Monitoring Program (MEEMP) scheduled at Milne Port during August 2019. Reference sites will have similar coarse rock habitat at a comparable range of depths and contain similar habitat features as the offset habitat. Soft-substrate habitat reference sites will also be located. These sites will act as the sole reference sites in the event suitable rock habitat cannot be located. The soft-substrate habitat will be similar in substrate, at a comparable range of depths and would contain similar habitat features as the Project site footprint prior to construction of the Freight Dock. The soft-substrate reference site will be used to assess changes in productivity relative to the baseline, with success being measured as greater productivity, and diversity of function compared to the soft-substrate habitat.

Success of the offset coarse rock as fish habitat will not be defined as “statistically similar” to the reference sites, rather species and functional group diversity / assemblages and percent areal cover will be used for comparison as outlined in Table-1 and Table-2.

Although Bradford et al. (2016) characterize the uncertainty associated with “habitat characteristics and function” type metrics as moderate (i.e., ±10 to 50%), a success metric of mean ± 20% for colonisation is considered appropriate because:

- The success of coarse rock habitat creation is well documented
- The proposed habitat offsetting is to create a heterogenous structure in an area dominated by homogenous lower productivity and commonly-occurring soft substrate in Milne Inlet
- Unequal variance in the “population” of data collected from the reference habitat versus the constructed habitat could result in statistical “dissimilarity” when the offsetting habitat is in fact providing similar function where a majority of the measurements are reflective of reference conditions

Table-3: Decision Criteria for Evaluating Success of Constructed Offsetting Habitat

Category	Decision Criteria
Recruitment	Density, diversity, abundance and biomass on artificial substrate placed among the coarse rock habitat is within 20% of the mean of the reference rock habitat. Function group diversity is within 20% of the reference rock habitat.
Macroalgae and Sessile Invertebrate Colonization	The mean percent cover of the offset habitat by primary producers and sessile colonizing invertebrates is within 20% of the mean of the reference rock habitat, and greater than 10% on soft-substrate reference habitat
Motile Macrofauna Colonisation	Diversity and abundance of motile macrofauna using and associating with the offset habitat is within 20% of the reference rock habitat. Diversity and abundances of known Arctic char prey species observed around the coarse rock habitat is within 20% of the mean at the reference rock habitat Functional group diversity is greater than 10% on soft-substrate reference habitat
Bladed Kelp Abundance	The mean density, biomass, abundance and diversity of perennial canopy forming bladed kelp species is within 20% of the mean of the reference rock habitat, and greater than 10% on soft-substrate reference habitat
Physical Stability	The coarse rock habitat is structurally stable and shows no signs of potential slumping, failure, movement, or other physical alteration.

4.0 REPORTING

A monitoring report will be submitted to DFO by 31 March of the following year for each of the five years that monitoring will be conducted, as required by the FAA. Annual reports will include:

- Assessment of the coarse rock structural integrity. Identification of any slumping, deterioration and or sedimentation using video surveys will be documented in the annual monitoring report. If repairs are required, the report will outline recommendations and timelines of repairs.
- Results of the video surveys of the coarse rock structure to document colonisation of the types and percent cover of aquatic vegetation.
- Fish and benthic invertebrates recorded in the video, and photographs will be identified and quantified, with results included in the annual monitoring report.
- Retrieval of artificial substrates and settlement plates and taxonomic identification of biota colonising the substrate.

The report for the fifth monitoring year will also include a summary of the 5 years of sampling over the 10-year period and include a description of any revisions to methodology, and all observations and results. The report will provide a professional opinion based on the performance standards, data collected, and other relevant observations to determine success of the coarse rock offset habitat, including a temporal trend analysis.

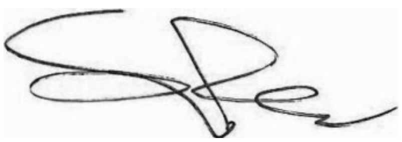
5.0 CLOSURE

We trust that this technical memorandum provides sufficient information for your present needs. If you have any questions, please contact the undersigned at 604-296-4200.

Golder Associates Ltd.

Christine Bylenga, PhD
Biologist

Derek Nishimura, MSc, RPBio
Senior Biologist



Shawn Redden, RPBio
Associate, Senior Fisheries Biologist

CB/DN/SR/lih/lmk

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LEGEND

- MILNE INLET TOTE ROAD
- PROPOSED NORTH RAILWAY
- WATERCOURSE
- EXISTING ORE DOCK
- PROPOSED FREIGHT DOCK AND CAUSEWAY
- PROPOSED SECOND ORE DOCK AND CAUSEWAYS
- PDA / QIA COMMERCIAL LEASE
- REVISED PDA FOR PHASE 2 PROPOSAL
- INAC FORESHORE LEASE
- WATERBODY

DRAFT

0 5 10
1:250,000 KILOMETRES

REFERENCE(S)
MILNE PORT INFRASTRUCTURE DATA OBTAINED FROM CLIENT, MAY 28, 2018, AND BY HATCH, JANUARY 25, 2017, RETRIEVED FROM KNIGHT PIESOLD LTD. FULCRUM DATA MANAGEMENT SITE MAY 19, 2017. HYDROGRAPHY AND TOPOGRAPHY DATA BY EAGLE MAPPING (2005), RETRIEVED FROM KNIGHT PIESOLD LTD. FULCRUM DATA MANAGEMENT SITE, MAY 2017. HYDROGRAPHY, POPULATED PLACE, AND PROVINCIAL BOUNDARY DATA OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.
PROJECTION: UTM ZONE 17 DATUM: NAD 83

CLIENT
BAFFINLAND IRON MINES CORPORATION

PROJECT
MARY RIVER PROJECT – FREIGHT DOCK HABITAT OFFSETTING

TITLE
LOCATION OF THE FREIGHT DOCK IN MILNE PORT AND RELEVANT LOCATIONS

CONSULTANT
GOLDER

YYYY-MM-DD	2019-05-08
DESIGNED	CB
PREPARED	AA
REVIEWED	
APPROVED	

PROJECT NO.	CONTROL	REV.	FIGURE
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APPENDIX A

Paragraph 35(2)(b) *Fisheries Act* Authorization (18-HCAA-00160)

PATH No.: 18-HCAA-00160

Other DFO File No.:

PARAGRAPH 35(2)(*b*) *FISHERIES ACT* AUTHORIZATION

Authorization issued to
Baffinland Iron Mines Corporation (hereafter referred to as the "Proponent")

Attention to: Phil Dutoit
2275 Upper Middle Road East Suite 100
Oakville, ON
L6H 0C3

Location of Proposed Project
The project is located at Milne Port, which is located 134 km southwest of Pond Inlet.

Nearest community (city, town, village): Pond Inlet
Municipality, district, township, county: Baffin Region
Territory: Nunavut
Name of watercourse, waterbody: Milne Inlet
Longitude and latitude, UTM Coordinates: 71.889403°, Longitude: -80.887592°, Zone: 17 W, Easting: 503900 m E, Northing: 7976600 m N

Description of Proposed Project

The proposed project is the construction of a Freight dock at the port in Milne Inlet. The work, undertaking or activity authorized is associated with The Mary River Project, an operating iron ore mine located on Baffin Island in the Qikiqtani Region of Nunavut. The Early Revenue Phase of the Mary River Project will involve mining and shipment of iron ore via the port at Milne Inlet. The new freight dock will allow more efficient use of the port for shipping purposes.

Description of Authorized work(s), undertaking(s) or activity(ies) likely to result in serious harm to fish

The work(s), undertaking(s), or activity(ies) associated with the proposed project described above, that are likely to result in serious harm to fish, are:

> The infilling of fish habitat in Milne Inlet resulting from the construction of the freight dock and mooring structures. Construction activities for the Freight Dock include:
>
> - Construction of a rock-fill berm
> - Removal of Sea Ice
> - Dredging and disposal of dredged material
> - Placement of rock/fill
> - Vibratory Pile driving

The serious harm to fish likely to result from the proposed work(s), undertaking(s), or activity(ies), and covered by this authorization includes

Permanent destruction of 26,449 m^2 ([2,170] Habitat Equivalent Units) of fish habitat in Milne Inlet including:

- 12,829m^2 Intertidal marine habitat
- 12,357m^2 Subtidal marine habitat
- 1,263m^2 Intertidal unnamed stream

Conditions of Authorization

The above described work, undertaking or activity that is likely to result in serious harm to fish must be carried on in accordance with the following conditions.

1. **Conditions that relate to the period during which the work, undertaking or activity that will result in serious harm to fish can be carried on**

   The work, undertaking or activity that results in serious harm to fish is authorized to be carried on during the following period:

   From the date of issuance to June 1, 2020

   If the Proponent cannot complete the work, undertaking or activity during this period, Fisheries and Oceans Canada (DFO) must be notified in advance of the expiration of the above time period. DFO may, where appropriate, provide written notice that the period to carry on the work, undertaking or activity has been extended.

   The periods during which other conditions of this authorization must be complied with are provided in their respective sections below. DFO may, where appropriate, provide written notice that these periods have been extended, in order to correspond to the extension of the period to carry on a work, undertaking, or activity.

2. **Conditions that relate to measures and standards to avoid and mitigate serious harm to fish**

2.1 Sediment and erosion control: Sediment and erosion control measures must be in place and shall be upgraded and maintained, such that release of sediment is avoided at the location of the authorized work, undertaking, or activity.

2.1.1 Before commencing any works, undertakings and/or activities that have the potential to release sediment into Milne Inlet or the unnamed stream, the Proponent shall prepare and implement site specific sediment and erosion control plans for any near or in-water works under the guidance of a certified Professional in erosion and sediment control (CPESC or equivalent). This plan shall be provided to DFO for review and approval before commencement of construction.

2.1.2 The erosion and sediment control plans shall include, but not to be limited to, the following:

- Delineation of areas of work;
- Plan for construction staging and storage logistics, including disposal of spoils;
- Anticipated construction schedule and construction duration;
- A description of erosion and sediment control measures to be used during and following construction (purpose, type, location, dimensions and design considerations);
- A description of the inspection and maintenance program and schedule; and
- Areas of the site susceptible to erosion problems

2.1.3 Turbidity levels shall be monitored in water adjacent to the work zone as the ice melts to evaluate potential movement of sediments. DFO shall be notified immediately of any exceedances of the current version of the Canadian Council of Ministers of the Environment (CCME) Canadian Water Quality Guidelines for the Protection of Aquatic Life for suspended sediment (TSS) levels, temperature, and dissolved oxygen in water released from the site into any fish bearing waterbodies. Monitoring and regular reporting of the incident and corrective actions must be made to DFO until stabilization of the work site and construction areas is completed, and the situation has passed.

2.1.4 A qualified on-site environmental inspector shall be employed by the Proponent and be present throughout construction to ensure adherence to the proper codes of environmentally responsible construction practice. The environmental inspector shall ensure that all mitigation is implemented properly, photograph (with dates) and record construction activities and conduct suspended sediment monitoring. A report detailing the nature of the works or undertakings, the construction methods used, the mitigation measures employed, the effectiveness of the mitigation works, and the results of any monitoring programs undertaken shall be included in the annual report as per Condition 5.

2.2 Measures and standards to avoid and mitigate serious harm to fish resulting from the construction of the freight dock shall be implemented prior to the commencement of in or above water works (in the case of on ice work) as described below and as set out in the Proponent's Baffinland Iron Mines Corp. Mary River Project, Floating Freight Dock Application For *Fisheries Act* Authorization, dated February 27, 2019 or any subsequent, DFO approved, versions (hereafter referred to as the "Freight Dock Application"):

2.2.1 All blasting activities shall be conducted following Cott and Hanna's 'Monitoring Explosive-Based Winter Seismic Exploration in Waterbodies, NWT 2000-2002' (2005).

2.2.2 All construction activities shall be undertaken as outlined in the Freight Dock Application to minimize the potential for stress related behaviour or death of fishes and marine mammals

2.2.3 While conducting vibratory pile driving, dredging and infilling, a marine mammal exclusion zone of 200m radius shall be established. The marine mammal exclusion zone will be monitored for marine mammal presence starting 30 minutes prior to the commencement of vibratory pile driving, dredging or infilling activities. All activities shall cease if marine mammals are observed within the exclusion zone and shall not recommence until 30 minutes after the marine mammal was last observed or 30 minutes after the marine mammal is seen leaving the exclusion zone.

2.2.4 Field measurements shall be undertaken to verify that underwater sound pressure and noise levels at the edge of the exclusion zone shall not exceed 100 dB re 1 μPa root-mean-square (rms) sound pressure level (SPL) to prevent auditory injury to marine mammals during construction. If measured underwater noise levels exceed the 100db threshold, the following contingency measures shall be implemented: expansion of the marine mammal exclusion zone and the installation of bubble curtains.

2.2.5 In-air sound levels during the iced-season shall not exceed the in-air acoustic threshold of 100dB re 20μPa root-mean-square (rms) when pinnipeds are observed on the ice during construction activities.

2.3 Works shall be halted if monitoring required in condition 3 and 4 below indicated that the measures and standards to avoid and mitigate serious harm to fish are not successful.

2.4 Measures and standards to avoid and mitigate serious harm to fish shall be implemented prior to the commencement of construction.

3. **Conditions that relate to monitoring and reporting of measures and standards to avoid and mitigate serious harm to fish from the ore dock construction**

3.1 The Proponent shall monitor the implementation of avoidance and mitigation measures referred to in section 2 of this authorization and provide a report to DFO, by February 28, 2020, and indicate whether the measures and standards to avoid and mitigate serious harm to fish were conducted according to the conditions of this authorization. This shall be done, by:

3.1.1 Providing inspection reports supported by dated photographs to demonstrate effective implementation and functioning of mitigation measures and standards described above to limit the serious harm to fish to what is covered by this authorization.

3.1.2 Providing details of any contingency measures that were followed, to prevent impacts greater than those covered by this authorization in the event that mitigation measures did not function as described.

4. **Conditions that relate to the offsetting of the serious harm to fish likely to result from the authorized work, undertaking or activity**

4.1 Scale and description of offsetting measures:

4.1.1 Course rock substrate will be placed around the perimeter of the freight dock and moorings at Milne Inlet to provide 2729 HEUs of potential fish habitat

4.2 Contingency measures: If the results of monitoring indicates that the offsetting measures are not completed and/or functioning according to the monitoring criteria as outlined in the approved monitoring plan, as referenced in 5.1.1, the Proponent shall give written notice to DFO and shall implement the contingency measures and associated monitoring measures, as contained within an approved contingency plan, to ensure the implementation of the offsetting measures is completed and/or functioning as required by this authorization. The following conditions relate to the contingency measures:

4.2.1 The Proponent shall submit an updated contingency plan to DFO by February 28, 2020. The updated contingency plan shall be agreed by DFO and shall be informed by Inuit and/or indigenous groups and shall demonstrate viability.

4.2.2 The Proponent shall develop a monitoring plan for the contingency measures. The plan shall be developed specifically for monitoring of contingency measures. The plan shall be submitted to DFO and approved, in writing, by February 28, 2020 and shall be reviewed and approved by DFO, in writing, as required.

4.3 The Proponent shall not carry on any work, undertaking or activity that will adversely disturb or impact the offsetting measures.

5. **Conditions that relate to monitoring and reporting of implementation of offsetting measures (described above in section 4):**

5.1 The Proponent shall conduct monitoring of the implementation of offsetting measures according to the approved timeline and criteria in the Freight Dock Application, Section 9 in addition to an approved updated monitoring plan as follows:

5.1.1 The Proponent shall submit an updated offsetting monitoring plan for the proposed offsetting for review by DFO on or before May 31, 2019. The monitoring plan must satisfy DFO's requirements to demonstrate through clear and measurable criteria, fisheries productivity changes as a result of the offsetting measures. To address uncertainty in the effectiveness of the proposed offsetting measures, the proposed monitoring must have sufficient statistical power to determine if changes to productivity are occurring as a result of the offsetting measures within a defined timeframe, and must employ the most up-to-date and proven methodologies demonstrated to be effective under Arctic conditions.

5.1.2 Monitoring of offsetting shall be conducted over ten years, with a five year monitoring program (years 1, 2, 5, 8, 10) as outlined in the Freight Dock Application, Section 8, or as outlined in an updated monitoring plan and/or subsequent versions and as approved by DFO.

5.1.3 In addition to the outlined criteria, a digital photographic record of pre-construction, during construction and post-construction conditions using the same vantage points and direction to show that the approved works have been completed in accordance with the Freight Dock Application and subsequent plans approved by DFO

5.2 List of reports to be provided to DFO: The Proponent shall report to DFO on whether the offsetting measures were conducted according to the conditions of this authorization by providing the following:

5.2.1 Post-construction evaluation report shall be submitted to the DFO-Yellowknife Office within three months of the completion of the Freight Dock construction.

5.2.2 Monitoring reports shall be submitted to the DFO-Yellowknife Office by March 31 following each monitoring year, as will be outlined in the approved monitoring plan.

6. **Conditions that relate to the letter(s) of credit as part of the application for this authorization**

6.1 Letter of credit: DFO may draw upon funds available to DFO as the beneficiary of the letters of credit provided to DFO as part of the application for this authorization, to cover the costs of implementing the offsetting measures required to be implemented under this authorization, including the associated monitoring and reporting measures included in section 6, in instances where the Proponent fails to implement these required measures.

6.1.1 A letter of credit in the amount of $3,000,000 has been provided to cover the costs of implementing the offsetting measures required to be implemented under this authorization.

6.1.2 A letter of credit in the amount of $500,000 has been provided to cover the costs of implementing the monitoring required to be implemented under this authorization.

6.1.3 A letter of credit in the amount of $250,000 has been provided to cover the costs associated with the development and implementation of an adequate offsetting monitoring plan, which will be returned to the Proponent once an approved monitoring plan is finalized and approved in writing by DFO as referenced in section 5.1.1.

6.1.4 A letter of credit in the amount of $500,000 has been provided to cover the costs of the development and implementation of contingency measures, which includes costs associated with Indigenous consultation. If the Proponent fails to provide a feasible and acceptable contingency plan, this letter of credit shall be used for the cost of DFO to solicit, consult, and hire a consultant to develop a contingency plan. This will be returned to the Proponent once an approved contingency plan is finalized and approved by DFO as referenced in section 4.3.

Authorization Limitations and Application Conditions

The Proponent is solely responsible for plans and specifications relating to this authorization and for all design, safety and workmanship aspects of all the works associated with this authorization.

The holder of this authorization is hereby authorized under the authority of Paragraph 35(2)(*b*) of the *Fisheries Act*. R.S.C., 1985, c.F. 14 to carry on the work(s), undertaking(s) and/or activity(ies) that are likely to result in serious harm to fish as described herein. This authorization does not purport to release the applicant from any obligation to obtain permission from or to comply with the requirements of any other regulatory agencies.

This authorization does <u>not</u> permit the deposit of a deleterious substance in water frequented by fish. Subsection 36(3) of the *Fisheries Act* prohibits the deposit of any deleterious substances into waters frequented by fish unless authorized by regulations made by Governor in Council.

This authorization does not permit the killing, harming, harassment, capture or taking of individuals of any aquatic species listed under the *Species at Risk Act* (SARA) (s. 32 of the SARA), or the damage or destruction of residence of individuals of such species (s. 33 of the SARA) or the destruction of the critical habitat of any such species (s. 58 of the SARA).]

At the date of issuance of this authorization, no individuals of aquatic species listed under the *Species at Risk Act* (SARA) were identified in the vicinity of the authorized works, undertakings or activities.

The failure to comply with any condition of this authorization constitutes an offence under Paragraph 40(3)(*a*) of the *Fisheries Act* and may result in charges being laid under the *Fisheries Act*.
This authorization must be held on site and work crews must be made familiar with the conditions attached.

This authorization cannot be transferred or assigned to another party. If the work(s), undertaking(s) or activity(ies) authorized to be conducted pursuant to this authorization are expected to be sold or transferred, or other circumstances arise that are expected to result in a new Proponent taking over the work(s), undertaking(s) or activity(ies), the Proponent named in this authorization shall advise DFO in advance.

Date of Issuance: March 21, 2019

Approved by:

Scott Gilbert
A/Regional Director General
Central and Arctic Region
Fisheries and Oceans Canada

APPENDIX B

Rationale for Placement of Coarse Rock as A Habitat Offsetting Measure in High Latitude Marine Environments

TECHNICAL MEMORANDUM

DATE 31 May 2019 **Reference No.** 1663724-122-TM-Rev0-30000

TO Lou Kamermans, Director of Sustainability
Baffinland Iron Mines Corporation

FROM Derek Nishimura; Christine Bylenga **EMAIL Derek_Nishimura@golder.com**

RATIONALE FOR PLACEMENT OF COARSE ROCK AS A HABITAT OFFSETTING MEASURE IN HIGH LATITUDE MARINE ENVIRONMENTS (DRAFT)

1.0 INTRODUCTION

1.1 Background

Baffinland Iron Ore Mines Corporation (Baffinland) submitted an application for a paragraph 35(2)(b) *Fisheries Act* Authorization (FAA), including a Marine Habitat Offset Plan, for the permanent alteration and destruction of fish habitat due to installation of the Freight Dock. The original application for an FAA was submitted to Fisheries and Oceans Canada (DFO) on 22 February 2018. A final application revision (Revision 4) was submitted on 27 February 2019 (Knight Piésold 2019). DFO issued an FAA for the Freight Dock on 21 March 2019 (18-HCAA-00160). However, prior to issuing the FAA, DFO (2018) indicated during their application completeness review that “there is substantial uncertainty respecting the functioning of the current proposed offsetting option” i.e., placement of coarse rock around the Freight Dock. Additionally, DFO “does not have enough evidence to support the conclusion that placing additional rock over the naturally occurring substrate (primarily sand with low gravel, silt and clay composition) will provide a sufficient increase in fisheries productivity in Milne Inlet to adequately offset the losses” (DFO 2018, Appendix A).

This technical memorandum presents a scientific rationale on how placement of coarse rock as offset habitat in the marine environment at Milne Port can be successful at enhancing local habitat productivity based on existing site conditions at Milne Port. The memo is a comprehensive literature review that focuses on marine colonization (e.g., species, temporal, succession, physical factors) and productivity of rocky reef habitats in similar environments (Arctic/Antarctic), and on results from the ongoing offsetting habitat effectiveness monitoring and Project effects monitoring completed at Milne Port (i.e., ore dock) to date. The scientific rationale was used to inform the revised effectiveness monitoring plan as required in Condition 5.1.1 of the FAA (18-HCAA-00160).

1.2 Offsetting Plan for Freight Dock

Determination of offset requirements for the Freight Dock largely followed methodology in the application for an FAA for the original ore dock. Over half of the anticipated footprint that will be lost due to the Freight Dock is located in the intertidal zone (+2.3 m to 0.0 m chart datum), an area where habitat is generally considered to be associated with very low productivity due to seasonal ice impacts (e.g., scour) and high wave exposure which limits biotic growth and recruitment (see Section 3.0). Most of the remainder of the footprint (44%) is located within the upper subtidal zone (0 m to -3 m), which in the Arctic is generally associated with low fish productivity due to this habitat being subjected to dynamic conditions such as ice scour. A relatively minor proportion (<3%) of the habitat losses will occur in the moderately productive shallow subtidal zone (-3 m to -15 m). The majority of the substrate of the impacted upper and shallow subtidal area is a mix of fine and coarse materials (sand, gravel and cobble). There are limited large three-dimensional coarse materials in or near Milne Port that provide a stable hard surface habitat for colonizing species, specifically macroalgae and invertebrate species (Golder 2018b). Baffinland determined that coarse rock (riprap 0.5 m to 1.0 m) installed along the sideslopes of the causeway as part of its construction has the potential to offset for the substrate being lost by providing higher productivity habitat. The addition of larger and more structurally complex substrates provides a greater surface area for organisms to colonize and more complex cover than fine substrates, providing higher value habitat. Additionally, a large proportion of the coarse rock will be placed in the upper subtidal zone (0 m to -3 m), increasing the amount of stable and protective higher-valued habitat within this depth range.

1.3 Purpose

The placement of coarse rock in the marine environment has been successful along the coasts of British Columbia, Newfoundland and other maritime provinces for the creation of rocky reef habitat, which provides high value habitat for the attachment of macroalgae and invertebrates, substrate and crevasses for invertebrate and fish refuge, rearing, and spawning, and biogenic habitat for macroalgae colonization (Naito 2001; Warren and Roberge 2017). Preliminary results from the fish habitat monitoring program in Roberts Bay for the Doris North Project in Nunavut indicate colonization of artificial rocky reef structures and fish use comparable to reference habitats (Rescan 2010).

The objectives of this technical memorandum are to present results of a literature review that focused on substrate colonization in high latitude environments that presents the current state of knowledge regarding colonization potential of rocky reef and foreshore substrate in this environment, and to indicate the viability and benefits of using coarse rock placement in the marine environment as a suitable habitat offsetting option. The suitability of creating rocky reef habitat for offsetting purposes was based on:

- A literature review of high latitude marine habitat with a focus on rocky reef structures in the intertidal and shallow subtidal, as well as the species that use and depend on rocky reefs in the Arctic.
- Observations from effectiveness monitoring of offset habitat provided for the original ore dock (i.e., coarse rock placement) in a similar environment, and from the Marine Environmental Effects Monitoring Program (MEEMP).

2.0 DESCRIPTION OF MILNE PORT MARINE ENVIRONMENT

Baseline studies conducted in support of the Approved Project (Baffinland 2012) and subsequent environmental effects monitoring programs conducted for the Project were referenced to describe existing conditions in Milne Port and the south end of Milne Inlet (Figure 1). Conditions in this area were described as typical of a fjord carved into bedrock, with a landfast ice dominated regime. The area in the vicinity of the proposed Freight Dock was described as a coarse-grained deltaic front, with substrate primarily dominated by ice-impacted sand. The shoreline consisted of a mix of coarse sediment beaches characterized by ice push features such as raised ridges. Ice gouging was less apparent below -10 m, although gouges were apparent at up to -40 m, indicating the likely occasional presence of grounded icebergs in this area. Sediment in Southern Milne Inlet was described as a mix of sand and silt, with substrate in the subtidal area near the Port described as sandy gravel and gravely sand, with finer grained sediment observed in the deeper subtidal area (Photos 1, 2, and 3) (Golder 2017, 2018).

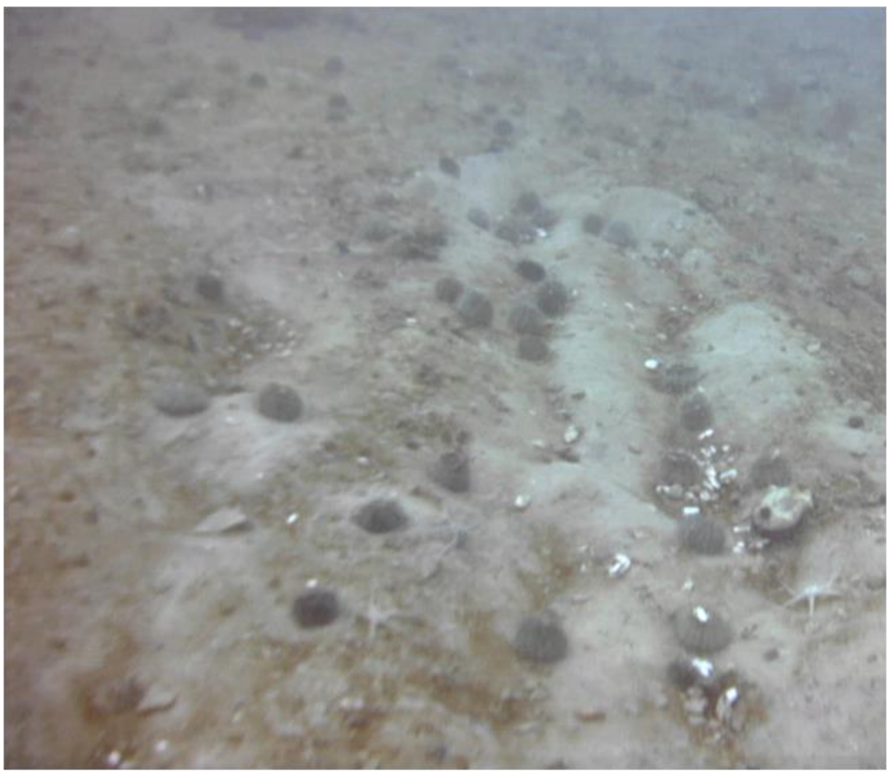

Photo 1: Sea urchins and brittle stars observed on soft substrate from underwater video along West Transect at -15 m depth contour in Milne Port, 3 September 2017 (Golder 2018b)

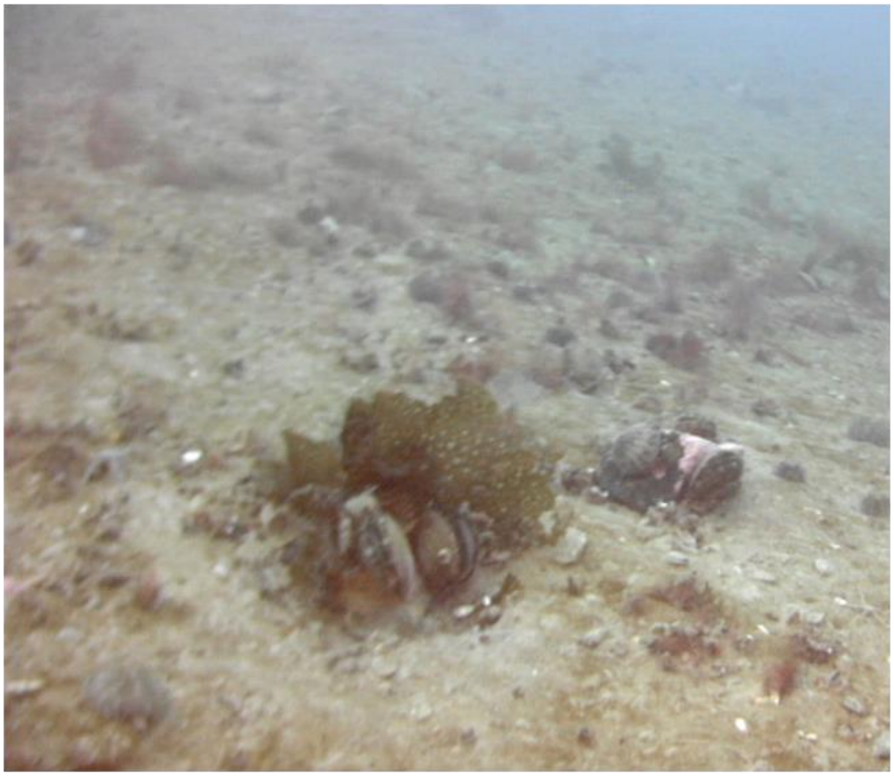

Photo 2 Sea colander and bivalves from underwater video along West Transect at -15 m depth contour, 3 September 2017 (Golder 2018b)

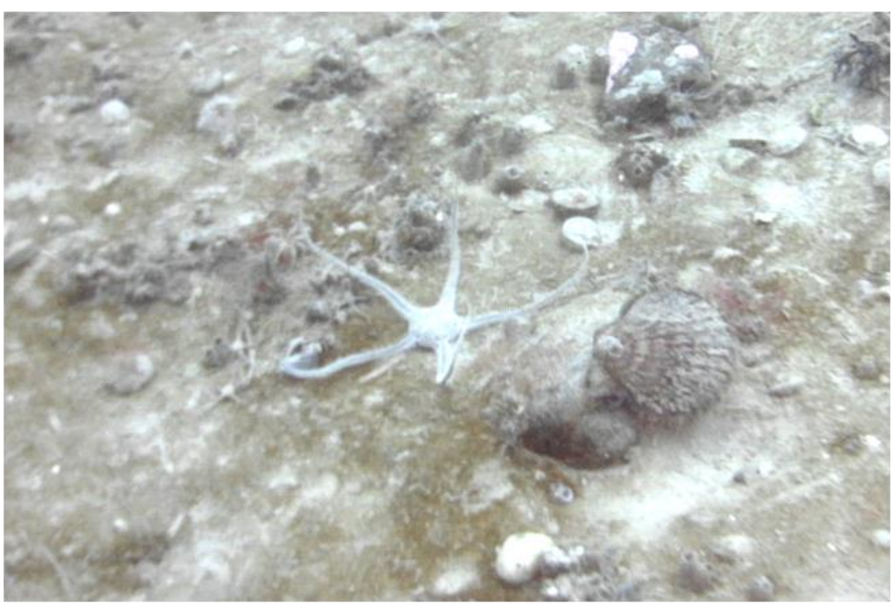

Photo 3 Brittle star and deep sea scallop from underwater video along East Transect at -15 m depth contour, 2 September 2017 (Golder 2018b)

2.1 Biological

Phytoplankton primary production in the southern end of Milne Inlet was low overall, generally higher during ice cover season, but within range for other Arctic waters (Baffinland 2012). Maximum chlorophyll *a* concentrations were typically found near the bottom of the mixing layer. Zooplankton community composition was comparable to nearby Lancaster Sound, dominated by cyclopoid and calanoid copepods.

Intertidal biota in southern Milne Inlet near the proposed location for the Freight Dock was typical for ice-dominated areas; generally sparse and discontinuous (Baffinland 2012). Where present, marine vegetation in the nearshore environment was mainly macroalgae (bladed kelps and foliose red algae) and was noted to be less abundant than observed in Steensby Inlet, on Baffin Island. Overall, percent cover of algae was shown to be low; drop camera surveys indicated <5% cover between 0 m and -3 m (primarily filamentous brown algae), bladed kelps were the most abundant between -3 m to -15 m but still less than 40% cover. Highest algal cover was observed between -3 m to -15 m. Below -15 m, algal cover decreased but the community composition remained similar to shallower depths. Coralline algae was only observed on boulders in the deeper regions (> -15 m).

Like many places at high latitudes, epifauna was depth-stratified, being more abundant in deeper areas, and generally sparse, with the most dominant epifaunal taxa being clams, brittle stars and sea urchins. Benthic infauna abundances also generally increased with water depth, however relative abundances between taxa varied at different depth gradients. Infauna at Milne Port was found to decrease in density with depth and was dominated by polychaetes, ostracods, copepods, amphipods and clams.

The nearshore fish community was considered low in abundance and diversity (Baffinland 2012). The nearby Tugaat and Robertson rivers support Arctic char (*Salvelinus alpinus*) populations which spend time in the nearshore marine environment along the coast of Milne Inlet to feed. Char in these rivers are harvested by local communities and are considered an important domestic sustenance fishery for the region. Tugaat and Robertson rivers have also supported small commercial fisheries in the past, which were closed in 1993 and the mid-1970s, respectively, following noted population declines in the area. Stomach content analysis of Arctic char collected at Milne Port indicated prey preference of amphipods and Cottid larvae during their marine seasonal residency period.

3.0 LITERATURE REVIEW OF HIGH LATITUDE MARINE ENVIRONMENTS

The shallow subtidal and intertidal marine environment at high latitudes is a highly dynamic and disturbed environment. Extreme temperatures, ice scouring and other abiotic factors govern the extent of recruitment, colonization, and the formation of biotic communities in these ecosystems (Campana et al. 2009). On a local scale, disturbance is more frequent and intense than in temperate and tropical environments, and depth-stratified communities often develop based on ice dynamics (Conlan et al. 1998). Generally, high latitude organisms are adapted for these disturbances, however, recolonization and growth are slow relative to temperate organisms, and “climax” or mature communities may not develop in areas with more frequent ice disturbances (Barnes and Conlan 2007; Campana et al. 2009). For example, sheltered bays, or deeper and less disturbed areas generally result in a change in the distribution of kelp species towards higher diversity, particularly in epiphytic species (Campana et al. 2009; Küpper et al. 2016).

The Arctic shallow benthos has a well-developed depth zonation, largely governed by sea ice (Gutt 2001). Iceberg grounding and scouring can lead to large scale and frequent disturbances in shallow environments, the impacts of which are comparable to trawling and dredging (Conlan et al. 1998). Areas with high levels of ice scouring tend not to recover due to the slow growth rates in polar fauna, relative to temperate species (Gutt 2001). In some deep areas, the scars are still notable millennia after the disturbance (Conlan et al. 1998). In areas of frequent ice movements, such as the Beaufort Sea, scouring can occur over all areas shallower than -40 m, and it is estimated that the area between -6 m to -14 m is completely disturbed every 50 years (Conlan et al. 1998).

There are relatively few macroalgal species endemic to the Arctic, and the majority are a subset of Atlantic species, particularly in European Arctic waters (Lee 1973; Wulff et al. 2009). The Canadian High Arctic, primarily the Baffin Bay area, has approximately 55 species of algae identified, with a large proportion of these being of Pacific lineage (Wulff et al. 2009).

Generally, there is a trend for small scattered algal communities across the Canadian Arctic, attributable to the infrequency of exposed boulder and bedrock substrate providing suitable substrate for settlement (Lee 1973). Unattached communities may form in areas where there is ample nutritional input (Lee 1973). Large populations of a single species may form in some cases; however, this is considered to be due to a general lack of competition rather than a specific adaptation giving one species an edge. Recruitment in these environments is still limited by other factors such as silt cover, sedimentation and light regime.

3.1 Intertidal Environment

The intertidal area in the Arctic is dynamic. Succession is largely driven by exposure to extreme mechanical disturbance due to ice foot formation, ice grounding and movement, and wave action, in addition to a wide range of other abiotic factors including thermal extremes, UV exposure, freeze/thaw cycles, and freshwater input (Campana et al. 2009). Development of assemblages in the intertidal area is very limited, typically remaining in the early stages of colonization with the majority of organisms not reaching reproductive age (Kukliński 2009). Intertidal algae is generally absent or sparse, typically limited to areas sheltered from ice impacts, such as platforms or between boulders, as well as generally being composed of annual species (Zacher et al. 2009; Küpper et al. 2016). However, even in areas with suitable and stable substrate, recolonization is slow compared to temperate rates and populations that can form are sparse, potentially due to the extreme air temperatures these areas may be exposed to (Lee 1973). Species abundances generally mirror the meroplankton, being composed of the organisms that happen to settle. There is a general lack of organisms that are Arctic intertidal specialists.

3.2 Subtidal Environment

Similar to the intertidal, the subtidal area is controlled by abiotic factors like ice scouring in addition to biotic factors like competition (Kukliński 2009). In soft-bottom areas, shallow subtidal assemblages in scours are dominated by deposit feeders and predators (Conlan et al. 1998).

In hard-bottom areas, where conditions allow, the top surfaces of rocks in the photic zone are colonized by calcareous algae, which outcompetes most organisms (Kukliński 2009). Generally, algal colonization occurs between -5 m and -10 m, due to upper bounds of ice scour and lower bounds of light availability (Zacher et al.

2009), although the depth of the photic zone in the Arctic is dependent on multiple factors including the thickness, structure, extent, snow cover and seasonality of sea ice (Laney et al. 2017). Most macroalgae are in the subtidal area in polar regions, as conditions in the intertidal zone generally are too dynamic to support their growth (Campana et al. 2009). Few macroalgae are found on rocks and pebbles in the first 3 m below low tide level, with kelps and other macroalgae found within the photic zone below -3 m; by -15 m, where light penetration dissipates, the algal community is dominated by coralligenous species (Küpper et al. 2016). Generally, perennial macroalgae diversity decreases with ice presence, however, overall algal diversity may increase due to opportunistic colonization by annual species (Gutt 2001).

3.3 Rocky Reefs

Rocky reefs provide a three-dimensional structure that increases habitat availability and influences local biodiversity. Many biotic and functional groups rely on, or are enhanced by, the presence of these structures (Wilce and Dunton 2014), and their diversity is improved. A diversity of functional groups may be more important than a diversity of species in these environments, as functionally diverse communities are more resistant to biological invasion, and are more productive, more efficient, and provide more ecosystem services (Meyer 2016).

In the Arctic, areas of hard substrate generally support communities that are significantly more productive, diverse and abundant than neighbouring soft sediment (Yesson et al. 2017), due to a more stable structure. Hard substrate allows for the establishment of algal communities, as it provides suitable complex substrate for settlement of a variety of species and recruitment of fish species (Lee 1973; Hamilton and Konar 2007). Macroalgal canopies formed of perennial species provide habitat stability for fish and support diverse invertebrate communities. Within the photic zone, hard-strata algal communities are generally formed of perennial algae rather than ephemeral species. In most cases, macroalgae require hard substrate in order to settle and develop.

Only a few limited algal species are capable of settling in soft sediments (Wulff et al. 2009). This is notable in areas such as the Boulder Patch in the Beaufort Sea, where localised rock accumulations support diverse macroalgal communities in contrast to surrounding soft sediment (Wilce and Dunton 2014). Within the Boulder Patch, ephemeral and annual algal species were notably few among the 78 identified species during a comprehensive survey, with the dominant algae being large kelp, crustose algae, and delicate and coarse thalloid red and brown algae (Wilce and Dunton 2014).

In high latitude environments, algae typically dominate upward-facing strata, while fauna dominate the more light-limited vertical or downward-facing sides (Barnes and Kukliński 2003; Konar and Iken 2005, Campana et al. 2009). Macroalgae are major primary producers with the capacity to form large standing stocks in nearshore polar waters where substrate and conditions are stable enough (Gutt 2001; Küpper et al. 2016). Macroalgae support diverse communities through the provision of habitat and protection, where greater macroalgal community complexity is reflected in greater densities and diversity of fish and invertebrate species (Hamilton and Konar 2007; Cárdenas et al. 2016; Küpper et al. 2016).

Perennial algae may be of particular importance to grazer and detritivore species, such as mysid crustaceans, as kelp detritus provides a source of carbon during the dark, winter months when phytoplankton are absent from the water column (Dunton and Schell 1987). Sponges are also an important part of high latitude rocky reefs; however, difficulties with in-situ identification has led to a general underestimation of their abundances (Campana et al. 2009). Recruitment on rock structures is generally positively correlated with stone size, with smaller stones typically being in a state of constant transformation as they are more likely to be overturned. Larger, more stable stones have a higher probability of fauna being present, generally also supporting greater species assemblages and competition (Kukliński 2009).

Within the Arctic, climax communities may not form above -15 m, due to slow recruitment and the frequencies of disturbance above -15 m, even within more protected areas. Areas with no protection, such as soft bottom communities, are generally dominated by more motile or ephemeral species. Rocky reefs offer protection within the ice dominated intertidal and shallow subtidal, allowing for the establishment of longer-term communities of sessile and perennial species.

Between 1980 and 1983, the Baffin Island Oil Spill (BIOS) Project, an experimental oil spill project, took place at Cape Hatt, near Ragged Island, 75 km north of Milne Port. As part of this project, a baseline assessment of the nearshore shallow water was undertaken. The baseline described the substrate as a mix of silt, sand, gravel and boulders (Snow et al. 1987). Macroalgae was noted attached to hard substrate but the majority was loose on softer substrate (Cross et al. 1987). Notably, during the assessment, it was observed that at depths between -10 m and -30 m, a dominant macroalgae (*Agarum cribrosum*, accepted as *A. clathratum*) formed clumps on large boulders. This macroalgae supported large numbers of mysids, shrimp, juvenile and adult fish, along with a variety of other species. During observations, it was noted that all the benthic species, including fish, were observed to use some form of cover which included algal cover, hiding amongst rocks, or in crevices (Snow et al. 1987), indicating the importance of hard substrates to community structure in the Milne Port area. The use and importance of rocky reefs by various fish species observed in the Milne Port area is detailed further in Knight Piésold 2019 as part of the FAA application.

3.3.1 Methods of Recruitment and Succession on Rocky Reefs

Recruitment of propagules to high-latitude rocky reefs may be dependent on factors such as geography, bathymetry, fish species composition and life history stage, larval supply, sedimentation, season, and substrate (Barnes and Conlan 2007; Kukliński 2009; Campana et al. 2009; Meyer et al. 2017), and occurs through the settlement of propagules and by vegetative growth (Konar 2013). Recruitment by larval transport is dependant on meroplankton composition. If there are few hard-bottom communities in relatively close proximity to the cleared hard substrate, meroplankton may be dominated by soft-bottom community species which may not recruit to hard surfaces (Kukliński et al. 2013). Recruitment may instead rely on larval transport from hard-bottom community sources further away.

Following disturbance events in the Arctic, percent cover by settled organisms has been observed to remain low (<10%) years following the disturbance, and recovery to pre-disturbance abundances may take over a decade (Beuchal and Gulliksen 2008; Konar 2013). Small scale disturbances may recover faster due to colonization by vegetative growth from neighbouring communities (Konar 2007). Recruitment may also be positively influenced by microhabitat heterogeneity (Barnes and Kukliński 2005).

Unlike temperate environments, grazers do not appear to play a significant role on recruitment in the Arctic, although they do alter competitive interactions between algal species, generating open space and increasing spatial heterogeneity (Konar 2007, 2013; Campana et al. 2009).

3.3.2 Successional Timing

Due to the dynamic nature of high latitude subtidal environments, as well as the slow growth rates of polar organisms, succession and recovery on rocky reefs may be a lengthy process. Recovery to pre-disturbance total abundances in hard-substrate communities has been observed to be slower when compared to soft-bottom communities following disturbances from bottom trawling (Yesson et al. 2017). However, this may be due to organism abundances being initially high in soft-bottom communities due to motile scavengers appearing quickly following disturbance events. Colonization rates on rocky reefs following disturbance have been observed to vary from slow, but continual growth, to no colonization followed by a rapid mass colonization event (Barnes and Kukliński 2005; Barnes and Conlan 2007; Konar 2007). A return to pre-disturbance levels of abundance and diversity may take years or even decades (Konar 2007, 2013; Gutt 2001).

The pattern of succession may be dependent on environmental condition, where shifts in community occur in response to changing temperature and light regimes (Renaud and Bikkby 2013). Depth may also influence site recovery rates. For example, shallow intertidal sites at Jan Mayen, Svalbard, Norway had communities on new substrate resemble natural habitats within 15 years, while deeper sites (>15 m) were still not recovered after 30 years (Renaud and Bikkby 2013).

Recruitment and succession will also be dependent on the timing of local reproduction and spawning. In the Arctic, larval abundances in the water column are generally highest in late spring through early summer to coincide planktotrophic larval development with phytoplankton blooms; however, settlement can occur even in winter months (Kukliński et al. 2013; Konar 2013; Meyer et al. 2017). Underrepresentation of some taxa is sometimes observed during colonization, which may be related to seasonally dependent settlement, or temporally rare and variable larval pools (Barnes and Conlan 2007; Konar 2013).

3.3.3 Patterns of Succession

Successional growth on cleared substrate has been observed to occur in stages. Settlement assemblages also may vary significantly between sites, even with similar conditions (Meyer et al. 2017). Generally, motile grazers and scavengers such as crustaceans, molluscs and echinoderms are typically the first fauna to appear in recently cleared areas, followed by bivalves (Campana et al. 2009; Beuchel and Gulliksen 2008; Renaud and Bikkby 2013; Yesson et al. 2017). These species may dominate areas where disturbances are frequent. However, these organisms are generally more opportunistic and their presence may not represent the recovery of an area. Early sessile colonizers to hard substrates vary with location, depth, as well as the resolution of the observation method, but generally include small bryozoans, polychaetes, spirorbids, barnacles, anemones, sponges and corallines (Barnes and Kukliński 2005; Konar 2007; Beuchel and Gulliksen 2008). These are typical early colonizer species, and their abundances in the first successional stages may not be represented or reflected in mature communities (Konar 2013; Meyer et al. 2017).

Early succession may be marked by a low diversity of higher taxonomic levels while maintaining high species richness (Barnes and Kukliński 2005). Underrepresentation of certain taxa may be observed during early stages of succession, despite observed local occurrences of adults of the same species. This may be related to life history with settlement favouring propagules from broadcast spawners rather than brooders (Meyer et al. 2017). Later successional species may coincide with a decrease in abundance of early colonizers to be replaced with higher abundances of other species such as perennial algae and urchins (Beuchel and Gulliksen 2008).

Alternatively, late successional communities may be characterised by overall lower abundances, but greater overall biomass, due to establishment of larger or colonial species (Yesson et al. 2017).

Recolonization of algal species is generally slow, with diatoms, seaweed propagules and ephemeral macroalgae species represented among early colonizers (Meyer 2016, Campana et al. 2009). Macroalgal diversity in both early and late successional stages may be impacted by UV exposure (Campana et al. 2009). In one study, seven years following disturbance, no regrowth of coralline or foliose algae was observed (Konar 2013).

3.4 Arctic Char

Arctic char are an important part of sustenance fishing in the Arctic, and populations originating from the Tugaat and Robertson Rivers, less than 30 km north of Milne Port, support sustenance fisheries for residents of nearby Pond Inlet. Following noted declines, commercial fisheries targeting populations in the Tugaat River were closed in the 1970s, followed by closures of Robertson River commercial fisheries in the 1990s (Baffinland 2012). Arctic char are anadromous and spend the majority of their lives in a freshwater environment. Juvenile Arctic char spend the first 2 to 9 years in freshwater, dependent on latitude, before out-migrating in spring prior to ice breakout in the marine environment (Mulder 2018). Adult char typically spend only a few weeks feeding in the marine environment before returning to freshwater to avoid sub-zero seawater temperatures (Moore et al. 2016). Arctic char are generally supported by freshwater systems that have year-round unfrozen and oxygenated water required for spawning and overwintering (Harwood and Babaluk 2014).

Research indicates that a short time spent in marine habitat can balance the energetic costs of migration, support spawning, and maintain the fish through relatively low food availability in winter months (Harwood and Babaluk 2014; Mulder 2018). Marine food sources may account for over 90% of the total annual diet in Arctic char and up to 44% of total productivity within the population (including non-anadromous char), despite the short time spent in the marine environment, indicating marine prey availability is critical for this species (Swanson et al. 2011). When in the marine environment, Arctic char, females and juveniles in particular, tend to remain in shallower water close to shore and typically within 30 km of their natal river, having a preference for reduced movement in the marine environment (Harwood and Babaluk 2014; Moore et al. 2016; Mulder 2018; Spares et al. 2015). When char are mobile in the marine environment away from their natal river system, they generally travel between adjacent estuaries which appear to be critical habitat areas. Char have been reported to hold in estuarine areas for several days between their transitory movements in saltwater (Moore et al. 2016; Spares et al. 2015). During marine travel, char display a preference for nearshore habitat (Moore et al. 2016)

Arctic char are shallow water feeders in the marine environment, preferring the upper three metres of the water column (Mulder 2018; Rikardsen et al. 2007). High energy, as well as large and slow prey, are favoured including amphipod, capelin, sandlance, cod, and sculpin. Char have been shown to consume up to 7.5% of their body mass per day while in the marine environment (Harwood and Babaluk 2014; Spares et al. 2012). Stomach analysis of char caught in Milne Port indicates a diet that included amphipods, mysid shrimp, copepods, polychaete worms, Arctic cod, and sculpin (SEM 2016, 2017; Golder 2018b, 2019). In order to avoid drops in internal body temperature, Arctic char descend to feed at depth using short repetitive dives with long rests near the surface or in the intertidal area, generally following the diel migration of their prey (Mulder 2018; Rikardsen et al. 2007, Spares et al. 2012). Smaller fish are more susceptible to cold and are generally limited by dive time (Mulder 2018). Prey availability at shallower depths such as in the intertidal and shallow subtidal optimizes feeding in the marine environment (Mulder 2018; Spares et al. 2012).

4.0 REVIEW OF THE HABITAT OFFSET EFFECTIVENESS MONITORING FOR THE EXISTING ORE DOCK

The Early Revenue Phase (ERP) of the Project included construction of an ore dock at Milne Port during the 2014 open water season. It was anticipated that the construction would result in the permanent destruction of 24,847 m^2 of fish habitat. The substrate at the site of the ore dock was described as homogenous in character, with low relief, and was determined to be relatively unproductive fish habitat composed mostly of soft silt and sand, sediments, and gravel. The loss of habitat was offset by the addition of coarse rock material to the base of the ore dock mooring structures between 0 and -15 m that would increase habitat complexity and heterogeneity, similar to habitat offsetting being proposed for the Freight Dock. This coarse rock was anticipated to be analogous to a rocky reef structure, serving as functional habitat for invertebrates and fish, in turn enhancing productivity and food supply for resident fish including Arctic char and Arctic cod.

4.1 Monitoring Results

Initial monitoring of the rocky reef habitat began in 2015 following completion of ore dock construction and has occurred annually to 2018. Monitoring included an assessment of the stability of the offset habitat and effectiveness of the offsetting measures. The coarse rock substrate was observed to be stable and compliant with the FAA conditions (SEM 2015). Monitoring in 2016, 2017, and 2018 consisted of video surveys to assess structural stability of the coarse rock habitat, sedimentation and siltation of coarse rock surfaces, and biological utilization of the offset habitat (SEM 2017).

During surveys, the coarse rock was found to be stable with no indications of slumping or movement of the substrate. Minor silt deposits were observed in some locations, but these were attributed to coastal transport. Locations with heavier silt deposition were attributed to sheltering from propwash from vessels along the ore dock.

Marine organisms recorded during offset monitoring are presented in Table-1. Video surveys in 2017 recorded large amounts of unidentified algal growth on the west and east sides of the ore dock, and to a lesser extent on rocks directly adjacent to the caisson, comparable to observations in 2016 (Golder 2017). Large numbers of sessile invertebrates were observed in video surveys, as well as adult Arctic cod and sculpin species (Table-1). Full identification of algae and faunal species in the area was limited by video resolution, preventing an accurate estimate of species diversity.

Observations of large schools of juvenile Arctic cod suggested successful recruitment of the species in the vicinity. Additionally, high abundances of mysid shrimp or krill were noted in certain locations along the coarse rock. Similar to juvenile Arctic cod, mysid shrimp and krill are an important link between trophic levels. Overall, monitoring indicated that the offset habitat was functioning as anticipated with utilization by a wide variety of taxa, and that the ore dock was supporting biological productivity across multiple trophic levels.

2018 marked the fourth year of offset monitoring. Underwater video was used to identify vegetation type and broad categories of percent cover, as well as to identify and enumerate marine biota (Golder 2018a). Aquatic vegetation cover was high and generally comparable to previous years. However, type and distribution differed between years with larger kelps being observed on the west side, where they were not observed in 2016. The high density of kelp was considered an indication of the stability of the coarse rock substrate. Notably, where present, density of bladed kelps was estimated at 50% to 75% cover, higher than observations during baseline studies in Milne Port where bladed kelps were most abundant between -3 m and -15 m, but were still less than 40% cover (Baffinland 2012). Overall, a greater diversity and abundance of invertebrates was observed compared to 2016, although a direct comparison could not be made as species abundance was not previously quantified.

Table-1: Species Recorded on Video Surveys During Habitat Offset Monitoring for Original Ore Dock at Milne Port

Year	Classification	Taxa	Common Name	Abundance[1]
2016	Mammals	*Pusa hispida*	Ringed Seal	1
	Fish	Cottidae	Unidentified sculpin	7
		Zoarcidae	Unidentified eelpout	1
		Boreogadus saida	Arctic cod (juveniles)	Abundant
	Invertebrates	Cnidaria	Unidentified jellyfish	18
		Ctenophora	Unidentified sea gooseberry	6
		Limacina helicina	Sea butterfly	31
		Strongylocentrotus sp.	Unidentified sea urchin	9
		Ophiuroidea	Unidentified brittle stars	312
		Pandalus sp.	Unidentified shrimp	1
		Euphausiacea	Unidentified euphausiid	Abundant
	Zooplankton	N/A	Various species	Abundant
	Algae	*Urospora* sp.	Unidentified green algae	Patchy/Dense
		Desmarestia sp.	Unidentified brown algae	Heavy-full
		Chorda filum	Brown algae	Low
		Fucus sp.	Unidentified wrack	Low
2017	Fish	*Gadus odac*	Greenland cod (adult)	1
		Gadidae	Unidentified cod (adult)	2
		Cottidae	Unidentified sculpin	3
	Invertebrates	Cnidaria	Unidentified hydroids	Abundant
		Echinoidea	Unidentified sea urchins	Not specified
		Ophiuroidea	Unidentified brittle stars	Not specified
		Cirripedia	Unidentified barnacles	Abundant
		Euphausiacea	Unidentified euphausiid	Abundant
		Polychaeta	Unidentified tube worms	Not specified
		Porifera	Unidentified sponges	Abundant
2018	Fish	*Myoxocephalus scorpius*	Shorthorn sculpin	1
		Myoxocephalus quadricornis	Fourhorn sculpin	5
		Gadus odac	Greenland cod	1
	Invertebrates	Cnidaria	Unidentified jellyfish	Abundant
		Hiatella arctica	Wrinkled rock borer	15
		Bivalvia	Unidentified bivalve	11
		Limacina helicina	Sea butterfly	24
		Buccinidae	Unidentified whelk	1

Year	Classification	Taxa	Common Name	Abundance[1]
		Echinoidea	Unidentified sea urchins	8
		Ophiura sp.	Unidentified brittle star	2
		Balanomorpha	Unidentified barnacles	0-50% cover
		Euphausiacea	Unidentified euphausiid	Abundant
		Serpulidae	Unidentified calcareous tube worm	33
		Bryozoa	Unidentified bryozoan	0-25% cover
		Polycarpa sp.	Unidentified tunicate	7
	Algae	*Desmarestia* sp.	Sour weed species	0-75% cover
		Laminaria sp.	Bladed brown kelp species	50-75% cover
		Urospora sp.	Unidentified green algae	0-75% cover
		Fucus sp.	Unidentified rockweed	0-10% cover

[1] specific areas were not indicated and were likely variable between years due to differences in survey methodology.

Settlement baskets were deployed in 2016 to monitor recruitment of propagules. Upon recovery of the baskets in 2017, invertebrate colonization was determined to be too limited for analysis so the baskets were redeployed with additional settlement plates. It was noted that the lack of colonization observed in the settlement baskets suggested that the coarse rock along the ore dock was providing more suitable invertebrate habitat in comparison to the settlement baskets. The settlement baskets were retrieved again during 2018 surveys along with the settlement plates added in 2017. Settlement baskets were only examined for epifaunal abundance (algal presence and abundance was not recorded). A summary of the species observed with recorded abundances is provided in Table 2. The majority of individual organisms identified on the settlement baskets were barnacles with the most diverse taxa group being bryozoans. In total, 1,733 encrusting organisms were counted from eight different taxa. Resolution of observation is much finer with the settlement baskets when compared to the video surveys, therefore comparison of the successional patterns between the methods was not possible.

Table 2: Observed Taxa and Epifauna Abundance Recorded on Settlement Baskets in Milne Port in 2017/2018

Classification	Taxa	Abundance
Barnacles	Balanomorpha sp.	1,674
Bivalves	*Hiatella arctica*	29
	Mya sp.	2
Bryozoans	*Alcyonidium gelatinosum*	1
	Alcyonidium disciforme	1
	Disporella sp.	16
	Disporella hispida	7
	Infundibulipora prolifera	1
Polychaetes	*Circeis* sp.	2

5.0 COARSE ROCK AS ROCKY REEF OFFSET HABITAT

An effectiveness monitoring plan should include clearly articulated measures of success that are linked to the objective of the offsets and that provide benchmarks for measuring progress (Smokorowski et al. 2015). Another important monitoring objective is to understand whether or not the offsetting habitat functions as designed (Smokorowski et al. 2015).

The majority of the marine area that will be impacted by the proposed Freight Dock is a mix of intertidal (53%) and upper subtidal (44%), with a small shallow subtidal component (<3%). The substrate in these areas is classified as fine sand, gravel and cobble. The creation of a rocky reef structure provides fish rearing and refuge habitat to support increasing overall fisheries productivity in the area, as well as a substrate for the recruitment and establishment of lower trophic levels, such as algae, epifauna and infauna that serve as food sources for fish species. The overall objective of the structure is to increase fish habitat quality relative to the current local intertidal and subtidal areas.

Habitat offsetting in comparable environments to Milne Port area is underperformed, therefore it is difficult to draw conclusions about what form of offsetting may be most successful or lead to greater improvements in habitat use by marine species in Arctic environments. It may be better to consider what habitat types are most beneficial to fish species that may be impacted by Project activities.

5.1 Fish Productivity Increases

Results from the literature review indicate the viability of coarse rock reefs as an offsetting option for the Milne Port area. The creation of a rocky reef structure in the subtidal area of Milne Port would help to support Arctic char populations from the Tugaat and Robertson Rivers during their marine residency period. These fish are part of important sustenance fish stocks for the nearby community of Pond Inlet. Arctic char are not known to be directly benefited by reef structures, however they display a marked preference for productive shallow water habitats close to estuaries and their natal streams, which would be created by the establishment of the coarse rock habitat in the Milne Port area. Offsetting habitat for the original ore dock has been shown to support species that have been found in the stomachs of char collected in Milne Port, indicating that rocky reefs have the potential to improve prey availability for Arctic char and act as important marine habitat for this species.

Rocky reefs may appear to be slower developing when compared to soft sediment communities, however, biotic abundances and diversity are greater on coarse rock structures, and soft sediment communities more ephemeral. In general, a reef in the early stages of succession may be more productive than an undisturbed soft sediment community. At a variety of depths, rocky reef structures can have greater levels of productivity compared to low-profile soft bottom habitats in the Arctic. Rocky reefs provide protection from ice scour and grounding of ice, particularly when composed of larger sized rocks. They also provide solid, stable substrates upon which algae and sessile species can recruit. Perennial algal species are more likely to be found on rocky reefs, and on these structures can form large standing stocks of primary producing biomass. Macroalgae support diverse communities through the provision of habitat and protection, where greater macroalgal community complexity is reflected in greater densities and diversity of fish and invertebrate species (Hamilton and Konar 2007; Cárdenas et al. 2016; Küpper et al. 2016). The larger perennial algae also provide a food source during winter months to grazer and detritivore species such as mysid crustaceans, which in turn are an important food source for fish species.

Recruitment to rocky reef structures may be dependent on there being suitable propagules, which are dependent on the availability of adult stock in the vicinity. An assessment of macroalgal biomass in Milne Port during baseline studies indicated that overall biomass was low (Baffinland 2012). Drop camera surveys indicated that between a depth of 0 m and -3 m, cover was less than 5%, primarily consisting of filamentous brown algae. Bladed kelps were the most abundant between a depth of -3 m to -15 m, but were still less than 40% cover. Despite relatively low kelp cover, recruitment and growth of bladed kelp to the coarse rock offset habitat between 0 and -15 m at Milne Port was observed by Year 4 of monitoring (Golder 2018a), indicating that propagule abundances were sufficient for recruitment to coarse rock habitat in this area. Propagules may originate from nearby habitats with established benthic communities. The BIOS project recorded 60 species of benthic algae in the upper subtidal at Cape Hatt. The algae was mostly filamentous brown algae (76% of biomass), but larger species, including bladed kelps, made up approximately 13% of the biomass (Cross et al. 1987; Snow et al. 1987). Cape Hatt is located near Ragged Island, indicating the site may be a potential propagule source for Milne Port.

Within the first years of offset monitoring for the Phase 1 Ore Dock at Milne Port, multiple species of sessile and motile invertebrates, as well as perennial algal species were observed on offset habitat, in addition to observations of use of the structure by juvenile and adult fish species. Additionally, in some areas, percent cover was notably higher than observed on soft bottom communities in Milne Port during the baseline studies, notably for bladed kelp. This indicates that recruitment and establishment to hard substrates of a range of species and functional groups is possible in Milne Port in densities greater than on current substrate, supporting the use of rocky reef habitat as an offsetting option in Milne Port.

5.2 Metrics and Indicators for Monitoring Effectiveness

Monitoring of the offset habitat for the Freight Dock will occur over 10 years following the construction of the habitat, in years 1, 2, 5, 8 and 10, as required by the Paragraph 35(2)(*b*) of the FAA for the Freight Dock (18-HCAA-00160). Indicators will be identified to monitor colonization and use of the offset habitat relative to comparable reference sites with similar substrate and depths as the proposed coarse rock habitat in Milne Inlet and to the soft-sediment habitat where the Freight Dock was constructed.

Primary producers are expected to be among the early colonizers of the coarse rock substrate, with diatoms, seaweed propagules and ephemeral macroalgae colonizing initially, succeeding to perennial algal species and bladed kelps in later years. During offset monitoring for the original ore dock, abundances and diversity measurements from settlement baskets were limited to invertebrate colonizers (SEM 2015, 2017, Golder 2017, 2018). Offset monitoring for the Freight Dock will include observations and measurements from the settlement baskets and/or artificial substrates, photographs and towed video footage. Parameters will include percent cover, density, diversity, abundance and biomass of primary producers, by species and as functional groups, relative to reference sites, with a particular focus on perennial bladed kelp species, due to their role as later colonizers in successional timing. Functional groups of primary producers will include ephemeral/perennial categories, as well as canopy/non-canopy formers.

Early colonizers also include sessile invertebrates such as polychaetes, bryozoans and barnacles, among others. As with primary producers, observations will be made of the percent cover, density, diversity, abundance and biomass of sessile invertebrates, by species and as functional groups, relative to reference sites. Functional groups will be determined by traits such as feeding mechanism (filter feeders, detritivores, herbivores, predators), biological traits (fecundity, longevity, colonizers, body shape), and habitat influence (builders, burrowers, bioturbators, providers).

Fish and motile invertebrates such as brittle stars and urchins are anticipated to be associated with the coarse rock habitat throughout all succession stages. Their relative abundances and diversity will likely vary depending on the succession and condition of the coarse rock habitat. Motile scavengers may have high abundances during early colonization or disturbance events, with numbers that decrease over time. Other species such as sculpin may increase as the habitat and macroalgal cover becomes more complex. Observations will be made of the diversity and abundance of fish and motile invertebrates, relative to reference sites, with a particular focus on prey species of Arctic char.

Monitoring programs should be designed to assess effectiveness of offsetting at meeting success criteria (biological targets) and ultimately to determine if the offsetting habitat is ecologically stable and self-sustaining (Smokorowski et al. 2015). Based on the literature review and results of the effectiveness monitoring undertaken to date for the original ore dock offsetting habitat, potential metrics, indicators, and targets to determine likelihood of success for the coarse rock placed adjacent to the Freight Dock have been selected (Table 3).

Table 3: Selection of Potential Species/Functional Groups to Monitor as a Performance Standard for Coarse Rock Placement

<table>
<tr><th>Species/Functional Group (Metric)</th><th>Indicator</th><th>Target</th><th>Colonization Timing</th></tr>
<tr><td colspan="4">Settlement Baskets and Artificial Substrate</td></tr>
<tr><td>Primary Producers</td><td rowspan="3">Density, Diversity, Abundance, Biomass</td><td rowspan="3">>10% of impact site or ±20% of reference site</td><td rowspan="2">Immediate to Medium</td></tr>
<tr><td>Sessile colonizers</td></tr>
<tr><td>Bladed kelps</td><td>Short to Medium</td></tr>
<tr><td colspan="4">Towed Video and Fixed Transects</td></tr>
<tr><td>Primary producers - diatoms, seaweed propagules, perennial/ephemeral macroalgae species, canopy/non-canopy forming</td><td rowspan="3">% Cover</td><td rowspan="5">>10% of impact site or ±20% of reference site</td><td rowspan="2">Immediate to Medium</td></tr>
<tr><td>Sessile colonizers - bryozoans, polychaetes, spirorbids, barnacles, anemones, sponges and corallines, trophic level, biological traits, habitat influence</td></tr>
<tr><td>Bladed kelps</td><td>Short to Medium</td></tr>
<tr><td>Fish and motile invertebrate use</td><td rowspan="2">Diversity, Abundance</td><td rowspan="2">Immediate to Medium</td></tr>
<tr><td>Arctic char prey species</td></tr>
</table>

Note: immediate (1 to 2 years), short (5 to 6 years) and medium (9 to 10 years) terms (Smokorowski et al. 2015)

6.0 CONCLUSIONS

High latitude coarse rocky reefs provide complex habitat that shelters marine biota from ice impacts. Stable and large heterogeneous stone structures allow for growth and development of perennial species of macroalgae, which in turn support diverse, higher-trophic level communities through the provision of habitat, food and protection. These provisions can, in turn, create greater densities and diversity of fish and invertebrate species during their different life stages.

The habitat in the vicinity of the proposed Freight Dock is currently homogenous and prone to frequent and regular ice impact and scour. It is likely that communities that currently develop here are largely ephemeral and composed of the more opportunistic early colonizer species. The intertidal community is generally sparse and discontinuous, with subtidal vegetation described as less than other comparable areas. The nearshore fish community reflects the intertidal and subtidal community, being low in abundance and diversity.

Juvenile and adult fish use of the coarse rock habitat as well as the level of invertebrate and perennial algal recruitment observed during offset habitat monitoring for the original ore dock indicates that rocky reefs are a viable offset option in Milne Port, with the structure observed to be stable in subsequent years. The offset habitat has exhibited recruitment of perennial algal species in densities greater than observed during baseline studies of the soft sediment habitat, in addition to recruitment of invertebrates. Evidence of fish occupancy/use of the existing offset habitat for the original ore dock has been observed, including schools of juvenile fish.

Construction of a rocky reef in Milne Port to offset anticipated serious harm to fish and fish habitat due to the construction of the proposed Freight Dock would provide a heterogenous structure to a homogenous community, with the expectation of improved diversity and abundance of benthic biota. This would support the nearshore fish community, providing feeding, rearing and refuge habitat. Arctic char from the nearby Tugaat and Robertson Rivers would be among the species with potential to benefit by this improved habitat.

Species diversity and abundance metrics have been linked to productivity and creation of an ecosystem for use by fish, including Arctic Char and juvenile Arctic cod.

7.0 CLOSURE

We trust the information in this report is sufficient for your current needs. Should you have any additional questions regarding the project, please do not hesitate to contact Derek Nishimura at 604-296-7327.

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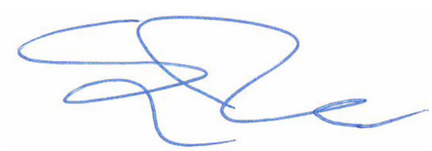

Shawn Redden, RPBio
Associate, Senior Fisheries Biologist

CHB/DN/SR/lih

Attachments: Figure 1 – Location of the Freight Dock in Milne Port and Relevant Locations

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LEGEND

- MILNE INLET TOTE ROAD
- PROPOSED NORTH RAILWAY
- WATERCOURSE
- EXISTING ORE DOCK
- PROPOSED FREIGHT DOCK AND CAUSEWAY
- PROPOSED SECOND ORE DOCK AND CAUSEWAYS
- PDA / QIA COMMERCIAL LEASE
- REVISED PDA FOR PHASE 2 PROPOSAL
- INAC FORESHORE LEASE
- WATERBODY

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REFERENCE(S)

MILNE PORT INFRASTRUCTURE DATA OBTAINED FROM CLIENT, MAY 28, 2018, AND BY HATCH, JANUARY 25, 2017, RETRIEVED FROM KNIGHT PIESOLD LTD. FULCRUM DATA MANAGEMENT SITE MAY 19, 2017. HYDROGRAPHY AND TOPOGRAPHY DATA BY EAGLE MAPPING (2005), RETRIEVED FROM KNIGHT PIESOLD LTD. FULCRUM DATA MANAGEMENT SITE, MAY 2017. HYDROGRAPHY, POPULATED PLACE, AND PROVINCIAL BOUNDARY DATA OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.
PROJECTION: UTM ZONE 17 DATUM: NAD 83

CLIENT
BAFFINLAND IRON MINES CORPORATION

PROJECT
MARY RIVER PROJECT – FREIGHT DOCK HABITAT OFFSETTING

TITLE
LOCATION OF THE FREIGHT DOCK IN MILNE PORT AND RELEVANT LOCATIONS

CONSULTANT

GOLDER

YYYY-MM-DD	2019-05-08
DESIGNED	CB
PREPARED	AA
REVIEWED	
APPROVED	

PROJECT NO.	CONTROL	REV.	FIGURE
1663724	32000-04	A	1

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APPENDIX A

Communication with DFO Regarding Coarse Rock as Offset Habitat

501 University Crescent,
Winnipeg, Manitoba
R3T 2N6

March 29, 2018

Our file *Notre référence*
18-HCAA-00160

Megan Lord-Hoyle
Director, Sustainable Development
Baffinland Iron Mines Corporation
2275 Upper Middle Road East, Suite 300
Oakville, ON
Canada L6H 0C3

Dear Megan Lord-Hoyle:

Subject: Application for a Paragraph 35(2)(b) *Fisheries Act* Authorization – Incomplete

Further to the receipt of your application for a Paragraph 35(2)(b) *Fisheries Act* authorization on February 22, 2018, the Fisheries Protection Program of Fisheries and Oceans Canada (DFO-FPP) has reviewed the application. Our review has determined that some of the information and documentation set out in the *Applications for Authorization under Paragraph 35(2)(b) of the Fisheries Act Regulations* has not been provided and as such, the application is incomplete.

The following information and documentation is required in order for the application to be complete:

- Please provide documentation of consultation and engagement conducted with local communities regarding the specific offsetting plan for the proposed new freight dock as a separate project. Under paragraph 8 (1)(d) of the Applications for Authorization under Paragraph 35 (2) b of the Fisheries Act Regulations, consultation is required with Aboriginal groups potentially affected by DFO's decision under paragraph 35(2)(b) the Fisheries Act authorization. (See Attachment 1)
- Please provide clarification on the origin of the Habitat Suitability Indices (HSIs) that were used to calculate the Habitat Equivalent Units and provide the rationale for the HSI values that were used in the application.
- DFO-FPP notes that loss of fish habitat for all species is of importance to DFO. DFO-FPP also notes that only 2 out of the 11 fish species identified in the project area were accounted for when calculating habitat losses. Both fished species and fish that support higher trophic levels are important. Please consider all fish species when calculating

habitat losses. In the event that HSI values are not available for all species, please provide information on how species specific habitat losses will be accounted for.

- Please provide the complete breakdown of habitat losses and gains associated with the project. This should include the breakdown of losses from specific works including infilling, pile driving, spuds, anchors, stream diversion, etc. Raw data and calculations can be provided to aid DFO-FPP in the review of your application.
- DFO-FPP is unclear if habitat losses associated with the unnamed stream have been accounted for. Please clarify these losses and provide further information on the unnamed stream, including, but not limited to stream width, length and depth of channel.
- DFO-FPP notes that there is no mention of the design of the unnamed stream re-alignment. Please provide details on the proposed stream diversion channel and any fish habitat features proposed for the new alignment, which could help to mitigate the proposed losses.
- DFO-FPP is unclear on the design and effectiveness of the proposed sediment curtains. DFO-FPP notes that on page 26 of the application, it states: "Develop and implement an Erosion and Sediment Control Plan for the site that minimizes risk of sedimentation of the waterbody during all phases of the project." Please provide DFO-FPP with a fully developed Erosion and Sediment Control Plan as part of the Application for Authorization, which includes sediment curtain placement designs and contingencies.
- Section 3 (b) of the Application for Authorization under Paragraph 35(2) (b) of the *Fisheries Act* Regulations requires that an irrevocable letter of credit issued by a recognized Canadian financial institution to cover the costs of implementing the offsetting plan. (See Attachment 1 and 2)

Upon receipt of this outstanding information and documentation, The Program will notify you to confirm receipt. Within a period of 60 days beginning on the date of receipt of this outstanding information and documentation, the Program will notify you as to whether the application is complete.

If your plans have changed or if the description of your proposal is incomplete or changes during the review of your application, you should contact this office to avoid any unnecessary delays in the review of your application.

If you have any questions, please contact Laura Watkinson at our Yellowknife office at 867-669-4920, or by email at Laura.Watkinson@dfo-mpo.gc.ca. Please refer to the file number referenced above when corresponding with the Program.

Yours sincerely,

Bev Ross
Regional Manager, Regulatory Reviews
Central and Arctic Region
Fisheries and Oceans Canada

Attachment 1 - Applications for Authorization under Paragraph 35 (2) b of the Fisheries Act Regulations, SOR/2013-191

Attachment 2 – An Applicant's Guide to Submitting an Application for Authorization under Paragraph 35(2)(b) of the Fisheries Act.

cc.

Laura Watkinson, DFO

Oscar Gustafson, Knight Piésold Consulting

Fisheries and Oceans Canada | Pêches et Océans Canada

501 University Crescent,
Winnipeg, Manitoba
R3T 2N6

June 07, 2018

Our file *Notre référence*
18-HCAA-00160

Megan Lord-Hoyle
Director, Sustainable Development
Baffinland Iron Mines Corporation
2275 Upper Middle Road East, Suite 300
Oakville, ON
Canada L6H 0C3

Dear Megan Lord-Hoyle:

Subject: Time Limit Ceased to Apply to the Review of your Application for a Paragraph 35(2)(b) *Fisheries Act* Authorization

The Fisheries Protection Program (the Program) of Fisheries and Oceans Canada has been reviewing your application for a paragraph 35(2)(b) *Fisheries Act* authorization.

This is to notify you that, pursuant to the *Applications for Authorization under Paragraph 35(2)(b) of the Fisheries Act Regulations*, the time limit for the review of your application has ceased to apply due to the following circumstance.

- Under paragraph 8 (1)(d) of the Regulations, consultation is required with Aboriginal groups potentially affected by our decision under paragraph 35(2)(b) the *Fisheries Act* authorization

In addition, your application can not be considered complete until the following have been provided:

1) Updated, detailed calculations of Habitat Suitability Indices (HSI) that include but are not limited to:

- o Revised calculations of habitat /fisheries productivity losses and gains that include representation from all fish species and trophic levels (i.e. gains and losses of potential food sources for marine mammals; benthic and forage species). This information requirement is set out in (SOR/2013 -191) '*Schedule 1 – Information and documentation to be provided for a paragraph 35(2)(b) Fisheries Act Authorization – checklist*':
  - ▪ Section 8(1) of Schedule 1requires a description of the likely effects of the proposed work, undertaking or activity on fish that are part of a

commercial, recreational, or Aboriginal fishery, or on fish that support such a fishery, and the likely effect on the habitat on those fish. The description must include:
a) the fish species likely to be affected and the life stages of the individuals of those species ..[and]..

- 8(2) a description of how the effects referred to in subsection (1) are likely to result in serious harm to fish that are part of CRA fishery or fish that support such a fishery.

- Please refer to attached addendum for further details and description of information gaps that were noted in your submitted '*Application for a Paragraph 35(2)(b) Fisheries Act Authorization*' .

2) An irrevocable Letter of Credit (LOC) that adequately covers the costs of implementing the proposed offsetting plan(s);

3) Updated contingency offsetting measures (as per SOR/2013-191, Section 13(f) of Schedule 1) that are informed by adequate Indigenous consultation and engagement / advice that describe contingency measures, and associated monitoring measures that will be put into place should any approved offsetting plan not successfully offset the serious harm to fish.

The Program will notify you in writing of the next steps once the above-noted requirements are addressed.

If your plans have changed or if the description of your proposal is incomplete, or changes during the review of your application, you should contact this office to avoid any unnecessary delays in the review of your application.

If you have any questions, please contact Laura Watkinson at our Yellowknife office at 867-669-4920 or by email at Laura.Watkinson@dfo-mpo.gc.ca. Please refer to the file number referenced above when corresponding with the Program.

Yours sincerely,

Bev Ross
Regional Manager, Regulatory Reviews
Central and Arctic Region
Fisheries and Oceans Canada

Attached: Addendum – *Application for a Paragraph 35(2)(b) Fisheries Act Authorization* detailed review comments and informational gaps

cc. Oscar Gustafson, Knight Piésold Consulting

Laura Watkinson, DFO

Addendum

***Application for a Paragraph 35(2)(b) Fisheries Act Authorization* detailed review comments and informational gaps**

Further to the Fisheries Protection Program of Fisheries and Oceans Canada's (DFO-FPP) 'Time Limit Ceased to Apply to the Review of your Application for a Paragraph 35(2)(b) *Fisheries Act* Authorization' letter to Baffinland, dated June 07, 2018, the following are Fisheries and Oceans Canadas detailed review comments and informational gaps:

1. DFO-FPP notes that in Baffinland's updated Application for *Fisheries Act* Authorization, section 7.1 on page 36, it states "*HSIs were developed based on the methodology presented in Kelly et al. (2009 draft).*" DFO-FPP notes that Baffinland has altered the HSI methodology used in the reference document, titled "A System for Characterizing and Quantifying Coastal Marine Habitat in Newfoundland and Labrador", and DFO-FPP is currently unclear how HSI values and subsequently habitat unit values were reached. DFO-FPP acknowledges recent email correspondence from Baffinland on May 18, 2018, outlining more details on the process used to calculate HSI values. However, DFO-FPP reiterates the need to review specific calculations and the steps used to arrive at the final HSI numbers. DFO-FPP recommends that Baffinland provide tables similar to those provided in the referenced document Kelly et al. (2009 draft), as part of the "*Example: Marine Habitat Classification and Quantification"* discussed on pages 45 through 65; specifically tables 15, 17, 19, 21, 23, 25 and 27 for each representative species. Providing this amount of data in a similar format to the reference document will aid DFO-FPP in the review of your application.

2. DFO-FPP notes that the intertidal area is assigned a nil (0) HSI value. However, in section 1.6 of Appendix D of the updated *Application for Fisheries Act Authorization*, it states: "*the preferred marine habitat of juvenile and adult Arctic char can be characterized as that area along the coastline ranging out to the 10 m contour within 25 km of freshwater breeding areas*." DFO-FPP notes that Arctic char prefer to reside along the coastline, and that the intertidal area is the nearest to the coastline. Please reconsider the intertidal habitat for Arctic char and provide updated calculations to reflect the usage of the intertidal zone.

3. DFO-FPP notes that Baffinland has applied a temporal factor while calculating the HSI values for Arctic char and Arctic cod. Under the notes for Table 7-2 on page 37, in section 7 of the updated *Application for Fisheries Act Authorization*, it states: "*As juvenile and adult Arctic char only utilize the marine environment for a three month period (mid-June to mid – September inclusive) values have been adjusted by a factor of 0.25*." However, in Table 7-6 on page 40, in

section 7 of the updated *Application for Fisheries Act Authorization*, the HSI value has not been adjusted by a factor of 0.25 when accounting for fish habitat offsetting gains. DFO-FPP notes that if this temporal factor is applied for fish habitat losses, it will be required to be applied to any habitat offsetting gains as well, as Arctic char will still only utilize the marine environment for a three month period, despite substrate changes. Please provide updated HSI and HEU values, which reflect consistent HSI calculations for fish habitat losses and gains.

4. Loss of fish habitat for all species is of importance to DFO. Section 35 (1) of the *Fisheries Act* states: "*No person shall carry on any work, undertaking or activity that results in serious harm to fish that are part of a commercial, recreational or Aboriginal fishery,* ***or to fish that support such a fishery****."* DFO-FPP notes that only 2 out of the 11 fish species identified in the project area were accounted for when calculating habitat losses. DFO-FPP recognizes Baffinland's use of Arctic char and Arctic cod as the two representative species; however, DFO-FPP notes that fish that support the Arctic char and Arctic cod fisheries, such as forage and benthic species are not represented in the calculation of fish and fish habitat losses. DFO-FPP also notes that potential impacts on habitat /fisheries productivity from all trophic levels (i.e. gains and losses of potential food sources for marine mammals) have not been adequately assessed or discussed. Including all fish species and representative trophic levels are required to accurately assess and offset all potential impacts to fish habitat/ fisheries productivity losses within the project area. Please consider all fish species and trophic levels when calculating habitat losses and gains.

5. Table 11-1 on page 56, section 11 of Baffinland's updated Application for *Fisheries Act* Authorization, outlines the "*cost estimate for three years of effectiveness monitoring*" and the total proposed amount for a Letter of Credit as required under Section 3 (b) of the Application for Authorization under Paragraph 35(2) (b) of the *Fisheries Act* Regulations. DFO-FPP notes that this amount may need adjusting as the letter of credit must be sufficient to cover the cost for implementing all elements of the offsetting plan, including monitoring measures. DFO-FPP also notes that costing of an LOC must consider mobilization of equipment and personnel for both construction, implementation and monitoring of the offsetting plan to Milne Inlet.

6. Adequate contingency offsetting measures that were informed by Indigenous consultation and engagement have not been provided. Section 13(f) of Schedule 1 states *"a description of the contingency measures and associated monitoring measures that will be put into place if the measures referred to in paragraph (a) are not successful in offsetting the serious harm to fish".* Section 13 (g) of Schedule 1 "*an estimate of the cost of implementing each element of the offsetting plan*".

If you have any questions, please contact Laura Watkinson at our Yellowknife office at 867-669-4920, or by email at Laura.Watkinson@dfo-mpo.gc.ca.

Fisheries and Oceans Canada | Pêches et Océans Canada

501 University Crescent,
Winnipeg, Manitoba
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August 17, 2018

Our file *Notre référence*
18-HCAA-00160

Megan Lord-Hoyle
Director, Sustainable Development
Baffinland Iron Mines Corporation
2275 Upper Middle Road East, Suite 300
Oakville, ON
Canada L6H 0C3

Dear Megan Lord-Hoyle:

Subject: Application for a Paragraph 35(2)(b) *Fisheries Act* Authorization – Incomplete

Further to the receipt of your updated application for a Paragraph 35(2)(b) *Fisheries Act* authorization on August 1, 2018, the Fisheries Protection Program (the Program) of Fisheries and Oceans Canada has reviewed the updated information.

DFO-FPP recognizes that Baffinland has provided additional information for items 2-5 of the Addendum – *Application for a Paragraph 35(2)(b) Fisheries Act Authorization detailed review comments and informational gap*, as part of DFO-FPP's correspondence dated June 7, 2018. This included reconsideration of the intertidal zone, updated Habitat Suitability Indices (HSI) and Habitat Equivalency Units (HEU) values, reconsideration of fish species and trophic levels, and an updated proposed letter of credit.

Additionally, DFO-FPP acknowledges receipt of letters of support for the freight dock project from the Mittimatalik Hunters & Trappers Organization and from the Qikiqtani Inuit Association.

However, our review has determined that some of the information and documentation set out in the *Applications for Authorization under Paragraph 35(2)(b) of the Fisheries Act Regulations* has still not been provided, or is not deemed sufficient, and as such, the application remains incomplete.

The following information and documentation is required in order for the application to be complete:

- Adequate contingency offsetting measures that were informed by Indigenous consultation and engagement have not yet been provided. Section 13(f) of Schedule 1 states *"a description of the contingency measures and associated monitoring measures that will be put into place if the measures referred to in paragraph (a) are not successful in offsetting the serious harm to fish".* Section 13 (g) of Schedule 1 "*an estimate of the cost of implementing each element of the offsetting plan*". DFO-FPP notes that this was requested as item 6 in DFO-FPP's correspondence dated June 7, 2018: Addendum – *Application for a Paragraph 35(2)(b) Fisheries Act Authorization detailed review comments and informational gap*. DFO-FPP reiterates the importance of providing contingency measures as part of an application for a Paragraph 35(2)(b) *Fisheries Act* authorization.
- DFO-FPP notes that as part of Baffinland's updated Application for *Fisheries Act* Authorization, section 7.4 on page 46 "*The net habitat balance of fish habitat losses (-1,845 HEUs) plus fish habitat gains (1,448 HEUs) is negative*." DFO-FPP understands this to mean that the current proposed offsetting plan does not adequately offset the losses from the proposed project. DFO-FPP also notes in section 9.1, on page 49 that "*Baffinland proposes to create an additional 398 HEUs of fish habitat by placing coarse rock substrate in the upper subtidal and shallow subtidal areas adjacent to the proposed freight dock. This coarse rock placement will occur as part of construction for the freight dock. The total amount of offsetting measures is equivalent to 1,845 HEUs*." DFO-FPP further notes conflicting information respecting the habitat function in the area of offsetting; in section 5.1.1 on page 22, it reads "*while in the marine environment adult Arctic char have no specific substrate preferences"* and section 5.1.2 on page 23 states "*YOY, juvenile and adult Arctic cod have no specific substrate preferences although Craig (1984) did note that, in a study from the Beaufort Sea, the diversity and abundance of fishes was lower in an area of rocky bottom than adjacent areas with mud and sand substrates*." Therefore, DFO-FPP notes there is substantial uncertainty respecting the functioning of the current proposed offsetting option. DFO-FPP does not have enough evidence to support the conclusion that placing additional rock over the naturally occurring substrate (primarily sand with low gravel, silt and clay composition) will provide a sufficient increase in fisheries productivity in Milne Inlet to adequately offset the losses. DFO-FPP recommends that Baffinland consider additional offsetting options to account for the net habitat losses. In addition, DFO-FPP requires that Baffinland account for the uncertainty in the proposed offsetting (i.e. consider a higher offsetting ratio).
- DFO-FPP acknowledges Baffinland provided an updated Letter of Credit valuation. DFO-FPP is unclear on how Baffinland arrived at the proposed costs outlined in the current rationale and provided table in Baffinland's updated Application for *Fisheries Act* Authorization in section 11, on page 62. DFO-FPP recommends Baffinland provide

additional rationale and/or cost breakdown for the proposed values for DFO-FPP to review.

Upon receipt of this outstanding information and documentation, The Program will notify you to confirm receipt. Within a period of 60 days beginning on the date of receipt of this outstanding information and documentation, the Program will notify you as to whether the application is complete.

If your plans have changed or if the description of your proposal is incomplete or changes during the review of your application, you should contact this office to avoid any unnecessary delays in the review of your application.

If you have any questions, please contact Laura Watkinson at our Yellowknife office at 867-669-4920, or by email at Laura.Watkinson@dfo-mpo.gc.ca. Please refer to the file number referenced above when corresponding with the Program.

Yours sincerely,

Stephanie Martens
A/Regional Manager, Regulatory Reviews
Central and Arctic Region
Fisheries and Oceans Canada

cc. Oscar Gustafson, Knight Piésold Consulting
Laura Watkinson, DFO
Mark D’Aguiar, DFO

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APPENDIX C

DFO's Marine Foreshore Environmental Assessment Procedure

MARINE FORESHORE ENVIRONMENTAL ASSESSMENT PROCEDURE

Marine development projects have the potential to effect fish[1] and fish habitat[2]. Fisheries and Oceans Canada (DFO) is responsible for the protection and management of fish habitats under the authority of the *Fisheries Act* and may request plans, specifications and environmental assessments specific to marine projects where more detailed information is required. Assessments may be necessary for all types of projects, including, but not limited to aquaculture, log handling, industrial port development, marinas, private moorage facilities, marine repair facilities, pipeline or outfall installations, vessel launches or barge ramps, dredging projects and shoreline protection projects (breakwaters and seawalls). Presented below are standardized, transect-based assessment procedures intended to provide DFO with the basic information required to determine the potential effects of a development project on fish habitat.

Assessment Area

For comparative purposes, the assessment area should include both the foreshore site proposed for development as well as the adjacent foreshore. This will provide a context for the project and may provide data about cumulative effects if similar developments already occur on-site. A large scale site plan, preferably an enlargement of the hydrographic chart, with a small scale insert of the general geographic location will serve as a base map of the study area.

Tidal Height and Water Depth Measurements

The lowest normal tide (0.0 m), or chart datum, will be used as the reference point for the measurement of tidal height and water depth. Tidal height is recorded as positive relative to chart datum, while water depth below chart datum will be recorded as a negative value. For example, if the assessment is made when the tide is at 2 m, and observations are taken at a water depth of 6 m, then the depth will be recorded as -4 m. Tidal height will be corrected using the closest secondary port to the reference port found in the Canadian Tide and Current Tables, with further correction made for daylight savings time as required.

Transect Layout

Transects should be established perpendicular to the shoreline at regular intervals both within and adjacent to the proposed or active development area so as to sample representative fish habitat conditions. A preliminary low water reconnaissance or dive survey may be advisable to establish

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[1] shellfish, crustaceans, marine animals and any parts of shellfish, crustaceans or marine animals, and the eggs, sperm, spawn, larvae, spat and juvenile stages of fish, shellfish, crustaceans and marine animals;

[2] shellfish, crustaceans, marine animals and any parts of shellfish, crustaceans or marine animals, and the eggs, sperm, spawn, larvae, spat and juvenile stages of fish, shellfish, crustaceans and marine animals;

appropriate boundaries for the assessment. Transects should begin at the highest high water mark (HHWM: distance referenced as Station 0.0 m) and, at a minimum, extend to a depth of -20 m (–30 m if the development has the potential to effect deeper benthic habitats). Though small-scale intertidal projects may only require intertidal transects, care must be taken to ensure that a representative sample is collected across the proposed development area. Procedural manuals are available from DFO if sampling of intertidal clam or benthic invertebrates is required. To ensure complete assessment of marine plants and animals in the photic zone, deeper transects may be necessary, especially to determine the effects of sunken debris or woodwaste accumulations resulting from existing developments. Transects should be spaced approximately 25 m apart, although this interval may vary depending on the width of the site. The number of transects required will depend on the nature of the foreshore development proposed, anticipated effects of the development, and local site conditions (tides and currents, geography, fetch, geology, etc.). Transects should be individually numbered and indicated on the site plan, and their commencement point referenced to benchmarks, where possible.

Recording Observations

Habitat inventories should be conducted during the more productive spring and summer months. At that time, algae and saltmarsh species are more readily identifiable, enabling a better assessment of the productive capacity of the site.

Observations should be recorded every 5 m along the transect or at significant changes in habitat type. Observations should include substrate type and composition, presence and relative abundance of marine animals and plants, and any other notable features (e.g., debris accumulations) using the following format:

Substrate

Substrate types are to be subdivided into the following size class categories:

- Bedrock
- Boulder (>256 mm diameter)
- Cobble (64-256 mm diameter)
- Gravel (2-64 mm diameter)
- Sand (0.0625-2 mm diameter)
- Silt/Mud/Clay (<0.0625 mm diameter)

Substrate types are recorded cumulatively as percentages out of a total of 100% (e.g., Boulder 5%; Cobble 15%; Gravel 60%, Sand 20%)

Marine Plants

Marine plants include rooted vascular vegetation (e.g., eelgrass, saltmarsh vegetation, etc.) and marine algae (e.g., rockweed, kelp, etc.). Marine plant observations are recorded as percent areal coverage estimated per 5 m × 1 m transect segment. Observations can be recorded as percentages (5%, 10%, 15%, etc.) or by utilizing the following areal coverage classes:

+	<5%
1	5-25%
2	>25-50%
3	>50-75%
4	>75-100%

Sessile Animals

Many marine animals permanently attached to substrates function as important fish habitat (e.g., barnacles, bay mussels, etc.). Sessile animals are recorded as percent areal coverage along the transect line using either estimated percentages or by areal coverage classes, as presented above.

Motile Animals

Motile animals include fish and marine invertebrates such as crabs and snails. These can be individually counted along the transect or, where too numerous, their estimated numbers can be recorded. Population estimates will most likely be applied to species such as herring or mysid shrimp that naturally occur in large numbers.

Other Features

Accumulations of wood bark and debris, sunken logs or other waste materials arising from onsite or nearby development activities should also be recorded. For wood bark and related small size debris, observations are recorded as percent areal coverage estimates per 5 m × 1 m transect segment and estimated deposition depth (e.g., 15% / 10 cm). For larger materials (sunken logs, wood chunks, etc.), observations can be recorded by individual piece count or by estimate of percent areal coverage.

Observations should be correlated to the transect distance from the HHWM and (corrected) tidal height or water depth (e.g., Sta. 0+80 m / +4.5 m), with information compiled in tabular form, by transect. Common names of observed animals and plants are acceptable for the data table; a species list with scientific names should, however, be appended to the report.

General marine plant categories (e.g., rockweed, eelgrass, bull kelp, saltmarsh, etc.) and any other notable features should be sketched to scale directly on a copy of the site plan, drawings or photographs of the site. A site profile should be prepared for each transect showing the slope of the foreshore and the location of indicator marine plants or invertebrates. A sketch of the proposed marine development should be superimposed over the site plan so that any potential effect of the project on fish habitat is clear. Compensatory habitat proposed for offsetting altered habitat should also be sketched on site maps and profiles to enable review of the positioning of replacement habitat relative to the project.

Photographic Documentation

It is essential to produce a photographic record along the intertidal and subtidal transects. A videographic record of subtidal transects is also recommended. Photos and videos provide a real-time record of characteristic fish habitat at the proposed site and can be invaluable to future post-development site monitoring. Photographic records also facilitate comparison of the productivity of natural habitats with any compensatory habitat constructed to offset habitat losses. As visibility may be a problem, careful attention should be given to appropriate tidal levels, and midday lighting conditions are recommended. Aerial photos, taken at low tide, are often useful to put the site into context with the surrounding area and to verify information provided from other sources.

Assessment reports should include photographs of representative fish habitat types. Depending upon the scope of the proposed foreshore development, an unedited, labelled copy of the assessment video may also be required for the report submission. The video footage should be referenced with pertinent information (e.g., time, date, depth, heading, etc.), and a written or recorded interpretation should accompany the video.

Summary of information to be submitted

1. Basemap showing tenure area boundaries, surrounding area, transect locations and sampling stations
2. Shoreline video/photographs of intertidal zone
3. Underwater video/photographs of transects
4. Tabular data for each transect describing substrate type and composition, marine plants, sessile and motile marine animals, and other notable features
5. Habitat map showing location of different substrate types, plants, animals and operational infrastructure
6. Profile diagrams of each transect showing slope, sediment types and the major marine plants or animals observed
7. Photographs of site and aerial photographs if available.

APPENDIX D

Photographs

Photo 1: West side of Freight Dock, looking southeast, during site visit on 7 August 2020 at 0.4 m tide. Intertidal and upper subtidal extending to the sand beach (approx. water depth: -0.1 to -0.4 m below chart datum (CD)). Green filamentous algae observed in intertidal. A school of larval fish (approx. 50 individuals) observed in area of riprap substrate.

Photo 2: North side of Freight Dock, looking northeast during site visit on 7 August 2020 at 0.4 m tide. Water depth approx. -1.0 to -1.2 m CD. Green filamentous algae observed on the sides/edges of riprap substrate within intertidal/upper subtidal depth contours.

Photo 3: North side of Freight Dock, looking north during site visit on 7 August 2020 at 0.4 m tide. Water depth approx. -1.0 m CD. Submerged cut steel pile offshore of offset habitat.

Photo 4: North face of Freight Dock, looking north during site visit on 7 August 2020.

Photo 5: North side of Freight Dock, looking northwest during site visit on 7 August 2020. Section (3 m wide) of exposed crushed rockfill with minimal rock armouring.

Photo 6: North side of Freight Dock, looking north during site visit on 7 August 2020. Alternate view of same section described in Photo 7, above.

Photo 7: Exposed crushed rockfill in upper subtidal area, offshore of the north face of Freight Dock identified in Photo 5 and 6 (14 August 2020).

Photo 8: East side of Freight Dock, looking south during site visit on 7 August 2020 at 0.4 m tide. Green filamentous algae observed on riprap armouring in intertidal/upper subtidal. Freshwater source observed center-left of photo. Water depth along causeway was approx. -0.1 to -0.8 m CD.

Photo 9: Fine green filamentous algae observed on riprap at Quadrat 2 (FD-T1) (8 August 2020).

Photo 10: Quadrat 1 (FD-T2) showing sculpin with *Pylaiella* spp. and detrital veneer on course substrate (8 August 2020).

Photo 11: Quadrat 1 (FD-T5; -7.1 m CD) showing green urchin (*Strongylocentrotus droebachiensis*) and brown filamentous algae on riprap in shallow subtidal (14 August 2020).

Photo 12: Quadrat 1 (FD-T5; -7.1 m CD) with brittle star, brown filamentous algae and detrital veneer on 14 August 2020.

Photo 13: Shorthorn sculpin (*Myoxocephalus Scorpius*) observed at FD-T6 (-4.1 m CD) in shallow subtidal at Freight Dock, on 14 August 2020.

Photo 14: Fourhorn sculpin (*Myoxocephalus quadricornis*) observed at FD-T6 in shallow subtidal at Freight Dock, on 14 August 2020.

Photo 15: Diver placing Quadrat 3 at FD-T7 (-5.9 m CD) in shallow subtidal at Freight Dock, on 14 August 2020. Swarm of mysids observed in water column throughout Survey Area.

Photo 16: Shorthorn sculpin (*Myoxocephalus Scorpius*) in boulder crevice and *Pylaiella* spp. algae within Quadrat 3 (FD-T9; 0 m CD) in upper subtidal at Freight Dock, on 14 August 2020.

Photo 17: Mysids observed in water column within Freight Dock Offset Habitat on 14 August 2020.

Photo 18: Pelagic organisms observed during perimeter mapping of the Freight Dock offset habitat, including sea angel (*Clinone limacine*), ctenophore jelly, and lion's mane jelly (*Cyanea capillata*) on 14 August 2020.

Photo 19: Sugar kelp (*Laminaria saccharina*) and red foliose algae growing on cobble mixed with sand and silt substrate in shallow subtidal habitat (-9 to -12 m CD depth) at Reference Area, on 9 August 2020.

Photo 20: Subtidal habitat within Quadrat 1 at Reference Transect 1 (-12 m CD depth) on 9 August 2020. Anemone, two chitons, snail and purple crust observed growing on bedrock substrate.

Photo 21: Subtidal habitat within Quadrat 2 at Ref-T1 (-9 m CD depth) on 9 August 2020. *Hiatella arctica* and *Mya* sp. clams embedded within sand/silt soft substrate and bedrock.

Photo 22: Shorthorn sculpin (*Myoxocephalus scorpius*) and rockweed (*Fucus distichus*) observed in upper subtidal in Reference Area on 9 August 2020.

Photo 23: Upper subtidal habitat showing Rockweed (*Fucus distichus*) with *Battersia* spp. (short branched tuft) at Ref-T1 (-1.6 m CD depth) on 9 August 2020.

Photo 24: Intertidal habitat within Quadrat 7 at Ref-T1 (-0.5 m CD depth) on 9 August 2020.

Photo 25: Fourhorn sculpin (*Myoxocephalus quadricornis*) and rockweed (*Fucus distichus*) observed in upper subtidal in Reference Area on 9 August 2020.

Photo 26: Subtidal habitat with swarm of mysid photographed during transect/quadrat surveys in Reference Area on 9 August 2020.

Photo 27: Subtidal soft sediment habitat with brittle star, green urchin and clams (*Hiatella arctica*) during transect/quadrat surveys in Reference Area (Quadrat 1, Ref-T3; -5.4 m CD depth) on 13 August 2020.

Photo 28: Upper subtidal in Reference Area (Ref-T2, Quadrat 4; -0.3 m CD depth) on 9 August 2020. Boulder substrate with rockweed (*Fucus distichus*).

Photo 29: *Hiatella arctica* (thin red arrow) and *Mya* sp. (thick red arrow) clams observed during perimeter mapping of the Reference Area.

Photo 30: Arctic comb jelly (*Mertensia ovum*) observed during perimeter mapping of the Reference Area.

Photo 31: Tube-dwelling anemone and cone worm (*Cistenides granulate*) observed during perimeter mapping of the Reference Area.

Photo 32: Large scallop (*Chlamys islandica*), clam siphons (*Hiatella arctica*), and purple crust observed in deep subtidal habitat with bedrock and silt/sand substrate in Reference Area (Ref-T4, Quadrat 1; -16.5 m CD depth) on 13 August 2020.

Photo 33: Creeping pedal sea cucumber (Family Psolidae), wrinkled rock-borer (*Hiatella arctica*) siphons, and purple crust (CCA) observed in deep subtidal habitat with bedrock and silt/sand substrate in Reference Area (Ref-T4, Quadrat 1; -16.5 m CD depth) on 13 August 2020.

Photo 34: Cone worm (*Cistenides granulata*), snail, wrinkled rock-borer (*Hiatella arctica*) siphons, and crust (CCA) observed in shallow subtidal habitat with bedrock and silt/sand substrate in Reference Area (Ref-T4, Quadrat 1; -16.5 m CD depth) on 13 August 2020.

Photo 35: Brittle star, chiton (*Tonicella* sp.), wrinkled rock-borer (*Hiatella arctica*) siphons, and purple crust observed in shallow subtidal habitat with bedrock and silt/sand substrate in Reference Area (Ref-T4, Quadrat 1; -16.5 m CD depth) on 13 August 2020.

Photo 36: Sugar kelp (*Laminaria saccharina*) and clam siphons (*Hiatella arctica* and *Mya* sp.) observed in shallow subtidal habitat with soft substrate in Reference Area on 13 August 2020.

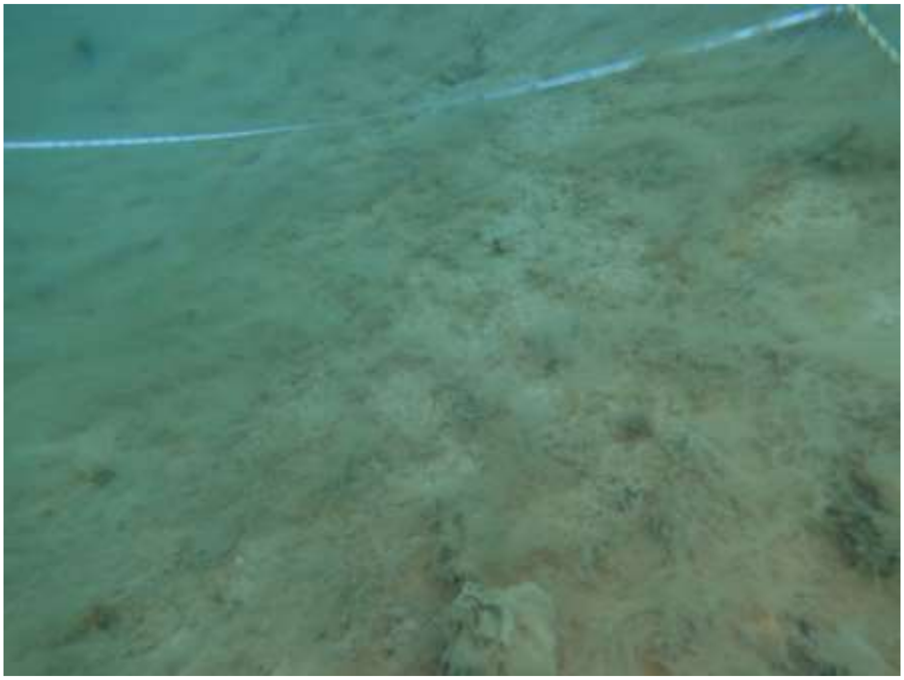

Photo 37: *Pylaiella* spp. and soft substrate observed in shallow subtidal habitat (Quadrat 6, Ref-T4; -3.6 m CD depth) on 13 August 2020.

Photo 38: Upper subtidal in Reference Area (9 August 2020). Boulder substrate with rockweed (*Fucus distichus*).

APPENDIX E

Transect/Quadrat Survey Data

Survey location	Transect Number	Total transect length (m)	Quadrat Number	Distance along transect (m)	Depth (m) Chart Datum	Substrate (% cover)							
						Bedrock	Boulder	Cobble	Gravel	Sand	Silt	Shell	Detrital veneer
Freight Dock (FD)	T1	3	1	0	-0.5	-	100	-	-	-	-	-	35
			2	2	0.5	-	100	-	-	-	-	-	-
	T2	3	1	0	-0.4	-	80	-	-	20	-	-	35
			2	2	0.6	-	95	<1%	-	5	-	-	-
	T3	3	1	0	-0.4	-	25	75	-	-	-	-	95
			2	2	0.6	-	100	-	-	-	-	-	-
	T4	3	1	0	-0.4	-	90	5	-	5	-	-	<1
			2	2	0.6	-	100	-	-	-	-	-	-
	T5	25	1	0	-7.1	-	70	30	-	-	-	-	95
			2	5	-6.3	-	90	10	-	-	-	-	95
			3	10	-4.8	-	25	75	-	-	-	-	95
			4	15	-3.5	-	80	20	-	-	-	-	80
			5	20	-1.1	-	100	-	-	-	-	-	100
			6	24	-0.2	-	100	-	-	-	-	-	100
	T6	31	1	0	-8.4	-	80	5	-	10	5	-	95
			2	5	-6.9	-	30	70	-	-	-	-	95
			3	10	-4.1	-	100	-	-	-	-	-	95
			4	15	-4.1	-	90	10	-	-	-	-	95
			5	20	-4.1	-	90	10	-	-	-	-	95
			6	25	-2.9	-	100	-	-	-	-	-	95
			7	30	-2.9	-	100	-	-	-	-	-	95
	T7	31	1	0	-8.1	-	60	20	-	10	10	<5	95
			2	5	-6.3	-	100	-	-	-	-	-	95
			3	10	-5.9	-	100	-	-	-	-	-	95
			4	15	-5.0	-	70	30	-	-	-	-	95
			5	20	-2.9	-	80	20	-	-	-	-	95
			6	25	-1.9	-	100	-	-	-	-	-	95
			7	30	-0.4	-	100	-	-	-	-	-	95
	T8	4	1	0	-0.3	-	80	20	-	-	-	-	95
			2	1	-0.3	-	70	30	-	-	-	-	95
			3	2	0.0	-	70	30	-	-	-	-	95
			4	3	0.1	-	100		-	-	-	-	70
	T9	4	1	0	0.0	-	-	100	-	-	-	-	90
			2	2	0.0	-	10	90	-	-	-	-	90
			3	3	0.0	-	80	20	-	-	-	-	90
	T10	5	1	0	0.0	-	-	100	-	-	-	-	90
			2	2	0.0	-	-	50	40	5	15	-	90
			3	3	0.0	-	-	75	15	5	5	-	90
			4	4	0.0	-	40	60	-	-	-	-	90
	T11	6	1	0	-0.6	-	-	100	-	-	-	-	90
			2	2	0.6	-	-	100	-	-	-	-	90
			3	5	0.6	-	50	50	-	-	-	-	90

Transect Number	Quadrat Number	Algae (% cover)															
		Brown									Red				Green		
		Sugar kelp *Laminaria saccharina*	Detrital kelp	Rockweed *Fucus distichus*	*Halosiphon tomentosus*	Short branched tuft (*Battersia* spp.)	*Pylaiella* spp.	Brown branched algae	Brown foliose algae	Brown filamentous algae	Crustose coralline algae (CCA)	Dulse (*Palmaria palmata*)	Red filamentous	Red foliose	Green foliose	Green slimy algae	Fine green filamentous algae
T1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	30
	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	50
T2	1	-	-	-	-	-	40	-	-	-	-	-	-	-	-	-	-
	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10
T3	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5
	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	15
T4	1	-	-	-	5	-	-	-	-	-	-	-	-	-	-	-	15
	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	40
T5	1	-	-	-	-	-	-	-	-	15	-	-	-	-	-	-	<5
	2	-	-	-	-	-	-	-	-	15	-	-	-	-	-	-	-
	3	-	-	-	-	-	5	-	-	40	-	-	-	-	-	-	-
	4	-	-	-	-	-	10	-	-	30	-	-	-	-	-	-	-
	5	-	-	-	-	-	-	-	-	30	-	-	-	-	-	-	15
	6	-	-	-	-	-	-	-	-	25	-	-	-	-	-	-	<5
T6	1	-	-	-	-	-	-	-	-	10	-	-	-	-	-	-	-
	2	-	-	-	-	-	-	-	-	10	-	-	-	-	-	-	-
	3	-	-	-	-	-	-	-	-	<5	-	-	-	-	-	-	-
	4	-	-	-	-	-	-	-	-	<5	-	-	-	-	-	-	-
	5	-	-	-	-	-	15	-	-	-	-	-	-	-	-	-	-
	6	-	-	-	-	-	-	-	-	<5	-	-	-	-	-	-	-
	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10
T7	1	-	-	-	-	-	-	-	-	15	-	-	-	-	-	-	-
	2	-	-	-	-	-	15	-	-	5	-	-	-	-	-	-	-
	3	-	-	-	-	-	15	-	-	5	-	-	-	-	-	-	-
	4	-	-	-	-	-	20	-	-	50	-	-	-	-	-	-	-
	5	-	-	-	-	-	<5	-	-	60	-	-	-	-	-	-	-
	6	-	-	-	-	-	15	-	-	60	-	-	-	-	-	-	-
	7	-	-	-	-	-	-	-	-	20	-	-	-	-	-	-	10
T8	1	-	-	-	3	-	20	-	-	-	-	-	-	-	-	-	-
	2	-	-	-	-	-	30	-	-	-	-	-	-	-	-	-	<5
	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	30
	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<5
T9	1	-	-	-	-	-	30	-	-	-	-	-	-	-	-	-	-
	2	-	-	-	-	-	30	-	-	-	-	-	-	-	-	-	-
	3	-	-	-	-	-	30	-	-	-	-	-	-	-	-	-	-
T10	1	-	-	-	-	-	40	-	-	-	-	-	-	-	-	-	-
	2	-	-	-	-	-	30	-	-	-	-	-	-	-	-	-	-
	3	-	-	-	-	-	30	-	-	-	-	-	-	-	-	-	-
	4	-	-	-	-	-	30	-	-	-	-	-	-	-	-	-	-
T11	1	-	<5	-	-	-	-	-	-	-	-	-	-	-	-	-	10
	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10
	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10

Transect Number	Quadrat Number	Sessile Invertebrates (% cover); Motile Invertebrates (number)																							Fish (number)		
		Crustacean		Annelid		Echinoderm					Mollusc								Ctenophore	Sponge		Tunicate					
		Mysid (Order Mysida)	Shrimp	Cone worm (*Cistenides granulata*)	Tube worm (Family Sabellidae)	Creeping pedal sea cucumber (Family Psolidae)	Green urchin (*Strongylocentrotus droebachiensis*)	Brittle star (Ophiuridae indet.)	Tube-dwelling anenome (Ceriantharia indet.)	Anenome	Chiton (*Tonicella* spp.)	Scallop (Family Pectinidae)	Icelandic scallop (*Chlamys islandica*)	Snail	Wrinkled rock-borer (*Hiatella arctica*)	*Mya* spp.	*Clione limacina*	Mussel (Mytilida indet.)	Arctic comb jelly (*Mertensia ovum*)	Orange crust sponge	Tube sponge	Tunicate	Circular hairy tunicate	Stalked hairy tunicate	Sculpin (Family Cottidae)	Shorthorn sculpin (*Myoxocephalus scorpius*)	Fourhorn sculpin (*Myoxocephalus quadricornis*)
T1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
T2	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
T3	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
T4	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
T5	1	50	-	-	-	-	5	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	2	100	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	3	100	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	4	100	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	5	100	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	6	50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
T6	1	50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	2	300	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
	5	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	6	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
T7	1	100	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	2	500	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	3	200	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	4	50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	5	50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	6	200	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	7	400	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
T8	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
T9	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-
T10	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
T11	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-
	2	25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Survey location	Transect Number	Total transect length (m)	Quadrat Number	Distance along transect (m)	Depth (m) Chart Datum	Substrate (% cover)								Algae (% cover)																Sessile Invertebrates (% cover); Motile Invertebrates (number)																							Fish (number)		
														Brown									Red				Green			Crustacean		Annelid		Echinoderm					Mollusc								Ctenophore	Sponge		Tunicate					
						Bedrock	Boulder	Cobble	Gravel	Sand	Silt	Shell	Detrital veneer	Sugar kelp *Laminaria saccharina*	Detrital kelp	Rockweed *Fucus distichus*	*Halosiphon tomentosus*	Short branched tuft (*Battersia* spp.)	*Pylaiella* spp.	Brown branched algae	Brown foliose algae	Brown filamentous algae	Crustose coralline algae (CCA)	Dulse (*Palmaria palmata*)	Red filamentous	Red foliose	Green foliose	Green slimy algae	Fine green filamentous algae	Mysid (Order Mysida)	Shrimp	Cone worm (*Cistenides granulata*)	Tube worm (Family Sabellidae)	Creeping pedal sea cucumber (Family Psolidae)	Green urchin (*Strongylocentrotus droebachiensis*)	Brittle star (Ophiuridae indet.)	Tube-dwelling anemone (Ceriantheridae indet.)	Anemone	Chiton (*Tonicella* spp.)	Scallop (Family Pectinidae)	Icelandic scallop (*Chlamys islandica*)	Snail	Wrinkled rock-borer (*Hiatella arctica*)	*Mya* spp.	*Clione limacina*	Mussel (Mytilida indet.)	Arctic comb jelly (*Mertensia ovum*)	Orange crust sponge	Tube sponge	Tunicate	Circular hairy tunicate	Stalked hairy tunicate	Sculpin (Family Cottidae)	Shorthorn sculpin (*Myoxocephalus scorpius*)	Fourhorn sculpin (*Myoxocephalus quadricornis*)
Reference (REF)	T1	31	1	0	-12.2	80	-	-	-	10	10	10	-	-	-	-	-	-	-	-	-	-	75	-	<5	<5	-	-	-	-	3	-	-	1	1	-	-	<5	11	-	-	-	-	-	-	-	-	-	-	<5	<5	-	-	-	-
			2	5	-9.0	60	-	-	-	20	20	-	<5	<5	-	-	-	-	-	<5	-		10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	50	5	1	-	-	-	-	<5	<5	<5	-	-	-
			3	10	-6.3	-	-	15	-	40	40	-	-	<5	-	-	-	-	-	-	<5	<5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<5	1	-	-	-	-	-	-	-	2	-	-
			4	15	-3.5	-	20	40	-	20	20	-	-	-	-	40	-	-	50	-	-	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10	-	-	-	-	-	-	<5	-	-	-	-	-
			5	20	-1.6	-	60	20	-	10	10	-	-	-	-	80	-	5	5	-	-	5	-	-	5	-	-	-	-	65	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
			6	25	-0.1	-	60	-	-	5	5	-	10	-	-	60	-	10	30	-	-	-	-	-	-	-	-	-	-	15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
			7	30	-0.5	40	-	50	10	-	-	-	10	-	-	-	-	-	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	T2	26	1	0	-4.5	-	85	<5	-	10	10	<5	-	-	-	20	-	-	70	-	-	-	-	-	5	5	-	-	-	300	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<5	-	-	-	-	-
			2	5	-2.4	-	5	15	-	40	40	<5	-	-	-	5	-	10	30	-	-	-	-	-	-	-	<5	-	-	500	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	60	-	-	-	-	-
			3	10	-1.5	-	40	30	-	15	15	-	-	-	5	30	-	30	30	-	-	-	-	-	-	-	-	-	-	200	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	<5	-	-	-	-
			4	15	-0.3	-	80	10	-	5	5	-	-	-	-	80	-	10	10	-	-	-	15	-	-	-	-	-	-	50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<5	-	-	-	-	-	1	-
			5	20	0.6	-	80	10	-	5	5	-	20	-	-	20	-	-	10	-	-	-	5	-	-	20	-	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
			6	25	0.6	-	50	50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	T3	31	1	0	-5.4	-	-	-	-	50	60	5	40	<5	-	-	-	-	5	-	-	-	-	-	-	-	-	-	-	-	-	<5	<5	-	-	1	-	-	-	-	-	-	<5	<5	-	-	-	-	-	-	-	-	-	-	-
			2	5	-3.3	-	-	-	-	50	50	5	5	-	-	-	-	-	20	-	-	-	-	-	-	-	-	-	-	-	-	-	<5	-	-	-	<5	-	-	-	-	-	<5	<5	1	<5	-	-	-	-	<5	-	-	-	-
			3	10	-2.3	-	-	<5	-	50	50	-	<5	-	-	75	-	-	10	-	-	5	-	-	-	-	-	-	-	-	-	<5	-	-	-	-	-	-	-	-	-	-	<5	-	-	<5	-	-	-	-	<5	-	-	-	-
			4	15	-1.1	-	40	10	10	20	20	-	20	-	-	75	-	-	30	-	-	10	-	-	-	-	-	-	-	25	-	-	-	-	-	-	-	-	-	-	-	-	<5	-	-	-	-	-	-	-	<5	-	1	-	-
			5	20	-0.2	-	-	20	30	20	30	-	<5	-	-	30	-	15	40	-	-	15	-	-	-	-	-	-	-	40	-	-	-	-	-	-	-	-	-	-	-	-	20	-	-	-	-	-	-	-	<5	-	-	-	-
			6	25	-0.2	-	-	50	30	10	10	-	<5	-	-	40	-	5	20	-	-	20	-	-	-	-	-	-	-	30	-	-	-	-	-	-	-	-	-	-	-	-	5	-	-	-	-	-	-	-	-	-	-	-	-
			7	30	-0.2	-	70	10	20	-	-	-	80	-	-	45	10	10	20	-	-	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	T4	41	1	0	-16.5	90	-	-	-	10	10	-	20	-	-	-	-	-	-	<5	-	-	70	-	-	<5	-	-	-	-	12	<5	-	-	2	5	-	-	<5	1	5	4	10	<5	-	-	-	-	<5	-	-	<5	-	-	-
			2	5	-13.8	-	-	-	-	50	50	-	50	-	-	-	-	-	-	10	-	<5	<5	-	<5	-	-	-	-	-	-	<5	-	-	1	4	-	-	-	-	-	-	60	-	-	-	-	-	-	-	-	-	-	-	-
			3	10	-11.4	-	-	-	-	50	50	5	50	<5	-	-	-	-	-	<5	-	10	-	5	-	-	-	-	-	-	-	<5	-	-	-	2	-	-	-	-	-	-	20	<5	-	-	-	-	-	-	-	-	-	-	-
			4	15	-8.1	-	-	-	-	50	50	5	50	<5	-	-	-	-	-	5	-	5	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	5	5	-	-	-	-	-	-	-	-	-	-	-
			5	20	-4.8	-	-	-	-	50	50	5	10	-	-	-	-	-	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<5	-	-	-	-	-	-	-	-	-	-	-
			6	25	-3.6	-	-	-	-	50	50	-	10	-	-	<5	-	-	60	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<5	<5	-	-	-	-	-	-	-	-	-	-	-
			7	30	-2.7	-	50	-	-	25	25	-	-	-	-	70	-	5	20	-	-	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<5	-	-	-	-	-
			8	35	-1.5	-	80	-	-	10	10	-	-	-	-	80	-	3	7	-	-	10	-	-	-	-	-	-	-	50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
			9	40	-0.3	-	80	<5	<5	-	10	-	75	-	-	80	-	2	15	-	-	3	-	-	-	-	-	-	-	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-

APPENDIX F

Species List

APPENDIX F
Observed Species Identified During Year 1 Freight Dock Monitoring

Marine Invertebrates	
Common Name	**Scientific Name**
Anemone	Actiniaria indet.
Tube worm	Sabellidae indet.
Tube-dwelling anenome	Cerianthidae indet.
Icelandic scallop	*Chlamys islandica*
Cone worm	*Cistenides granulata*
Sea angel	*Clione limacina*
Sea butterfly	*Limacina helicina*
Shrimp	
Arctic comb jelly	*Mertensia ovum*
Lion's mane jelly	*Cyanea capillata*
Snail	Gastropoda indet.
Wrinkled rock-borer	*Hiatella arctica*
Jelly	Hydromedusae indet.
Sea butterfly	*Limacina helicina*
Mussel	Mytilida indet.
Mysid	Mysida indet.
	Mya spp.
Brittle star	Ophiuridae indet.
Scallop	Pectinidae indet.
Tunicate	
Polychaete	Polychaeta indet.
Orange crust sponge	Porifera indet.
Tube sponge	Porifera indet.
Creeping pedal sea cucumber	Psolidae indet.
Unidentified jellies	Scyphozoa indet.
Green sea urchin	*Strongylocentrotus droebachiensis*
Chiton	*Tonicella* spp.
Tunicate	Tunicata indet.
Circular hairy tunicate	Tunicata indet.
Stalked hairy tunicate	Tunicata indet.

Macroalgae	
Common Name	**Scientific Name**
Short branched tuft	*Battersia* spp.
Green filamentous algae	Chlorophyta indet.
Green slimy algae	Chlorophyta indet.
Green foliose algae	Chlorophyta indet.
Crustose coralline algae (CCA)	Corallinales indet.
Rockweed	*Fucus distichus*
	Halosiphon tomentosus
Dulse	*Palmaria palmata*
Brown filamentous algae	Phaeophyceae indet.
Brown branched algae	Phaeophyceae indet.
Brown foliose algae	Phaeophyceae indet.
Brown tuft algae	Phaeophyceae indet.
Pylaiella spp.	*Pylaiella* spp.
Red filamentous algae	Rhodophyta indet.
Red foliose algae	*Rhodophyta* indet.
Sugar kelp	*Saccharina latissima*
Sea colander	*Agarum clathratum*

Fishes	
Common Name	**Scientific Name**
Fourhorn sculpin	*Myoxocephalus quadricornis*
Shorthorn sculpin	*Myoxocephalus scorpius*
Sculpin	Family Cottidae
Greenland Cod	*Gadus ogac*

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