

**REPORT**

## Mary River Project

*Year 2 Freight Dock Offset Habitat Monitoring Report (Fisheries Act Authorization 18-HCAA-00160)*

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## Executive Summary

Baffinland Iron Mines Corporation (Baffinland, the Proponent) constructed the Freight Dock in Milne Port in 2019, involving a permanent causeway and a seasonal floating barge. Installation of the Freight Dock resulted in unavoidable loss of fish habitat amounting to 26,449 m<sup>2</sup> (2,170 Habitat Equivalent Units; Baffinland, 2019 f). To offset the loss of fish habitat, Baffinland installed 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. Baffinland submitted an application on 27 February 2019 for an authorization under paragraph 35(2)(b) of the *Fisheries Act* to Fisheries and Oceans Canada (DFO). DFO issued an authorization for the proposed works (DFO 2019) on 21 March 2019, which included requirements for offsetting measures in addition to prescribed 10-year monitoring and reporting requirements for the Freight Dock offset habitat. The first year of monitoring (Year 1) occurred in 2020. Year 2 of offset habitat monitoring was undertaken during August 2021. As part of Year 2 monitoring, biophysical surveys were conducted in the Freight Dock offset habitat area and in a suitable Reference Area approximately 2.25 km northeast of the Freight Dock. Biophysical surveys comprised the following components, designed to achieve compliance with Section 5 of the FAA:

- A visual assessment at the Freight Dock during low tide (0.7 m chart datum [CD]) to document intertidal offset habitat and inspect coarse substrate stability.
- Mapping of as-built Freight Dock offset habitat.
- Mapping of a nearby Reference Area for comparison with 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 habitat mapping.
- Subtidal assessment of stability of the coarse substrate along the perimeter of the Freight Dock offset habitat.

Survey results indicate that macroalgae colonization was low to moderate in 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 2 of a 10-year monitoring program. An overview of the macroalgae results of the Freight Dock offset habitat included: (1) trace occurrence of sugar kelp (*Laminaria saccharina* - understory kelp) in the shallow subtidal depth contour which was also recorded in the Reference Area, and (2) turf macroalgae in low to moderate cover consisting of two species of brown filamentous algae (cf. *Coelocladia arctica*, and *Desmarestia* spp.), and two species of green filamentous algae (cf. *Urospora neglecta* and an unidentified green filamentous). Taxa occurring exclusively in the Reference Area included one species of brown-bladed understory kelp, sea colander (*Agarum clathratum*), a brown filamentous turf algae (*Battersia* spp.), crustose coralline algae (Corallinales indet.) and two species of red foliose turf algae (*Coccotylus truncatus* and *Dilsea socialis*).

In the Freight Dock offset habitat area, sessile invertebrates occurred in low coverage in the upper and shallow subtidal zones and included an unidentified species of tunicate (Tunicata indet.). In the Reference Area, sessile invertebrates observed included tunicates, mussels, and wrinkled rock-borer clams (*Hiatella arctica*). Motile



invertebrates were limited to the shallow subtidal zone in both the Freight Dock offset habitat area and the Reference Area, with slightly higher species densities observed in the Reference area. Species observed in the Freight Dock offset habitat area included green urchin (*Strongylocentrotus droebachiensis*) and brittle stars (Ophiuroidea indet.) in low densities. Species observed in the Reference Area included chitons (*Tonicella spp.*) and brittle stars. Taxa richness was similar in both areas.

Fish density and taxa richness were similar between the Freight Dock offset habitat and the Reference Area. Shorthorn sculpin (*Myoxocephalus scorpius*) were recorded in both areas. Fourhorn sculpin (*Myoxocephalus quadricornis*) and two Arctic char (*Salvelinus alpinus*) were recorded opportunistically during perimeter mapping of the Freight Dock habitat offset. In the Reference Area, two Atlantic lump sucker (*Eumicrotremus spinosus*) and one unidentified fish species were opportunistically recorded.

Overall, Year 2 of habitat offset monitoring indicated that the three-dimensional structure of the introduced offset habitat at the Freight Dock is providing a suitable and stable substrate for continued colonization and growth of marine organisms including macroalgae, fish and motile/sessile invertebrates. However, there are several localized areas where the crushed rockfill foundation is exposed; these exposed areas may be vulnerable to erosion from seasonal abiotic processes (i.e., ice scour, wave action). The stability assessment planned for Year 5 (i.e., in 2024) 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
CD	chart datum
cf.	Compare
DFO	Fisheries and Oceans Canada
FAA	<i>Fisheries Act</i> Authorization
FD	Freight Dock offset habitat
GIS	Geographic Information System
GPS	Global Positioning System
HEU	Habitat equivalency unit
Indet.	Indeterminate
km	Kilometres
LPL	lowest practical taxonomic level
m	Metres
m <sup>2</sup>	square metres
mm	Millimetres
MEEMP	Marine Environmental Effects Monitoring Program
MFEAP	Marine Foreshore Environmental Assessment Procedure
Mtpa	Million Tonnes per Annum
NAD	North American Datum
NIRB	Nunavut Impact Review Board
org.	Organisms
Q	Quadrat
QA/QC	quality assurance/quality control

Acronym or Abbreviations	Definition
REF	Reference Site
SE	Standard error
sp.	Single species
spp.	Multiple species
T	Transect
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 Baffinland 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. In 2021, a total of 5.6 Mtpa was shipped via 74 ore carrier voyages.

#### 1.1.2 Freight Dock

In 2019, a Freight Dock was installed 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)<sup>1</sup>. The construction of the Freight Dock resulted in unavoidable loss of fish habitat and serious harm to fish amounting to 26,449 m<sup>2</sup> (2,170 Habitat Equivalent Units (HEUs); 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 and provide fish habitat. Baffinland submitted an application on 27 February 2019 for an authorization under paragraph 35(2)(b) of the *Fisheries Act* to Fisheries and Oceans Canada (DFO). DFO issued an authorization for the proposed works (DFO 2019) on 21 March 2019, which included requirements for offsetting measures in addition to prescribed 10-year monitoring and reporting requirements for the Freight Dock offset habitat. The construction of the Freight Dock and addition of coarse rock around its perimeter was completed in 2019 (Golder 2020b). Additional habitat offsetting is also being considered in a *Fisheries Act* Authorization (FAA) amendment application. The Freight Dock location is shown on Figure 1.

The first year of habitat offset monitoring (Year 1) occurred in 2020. Year 2 of offset habitat monitoring was undertaken during August 2021. As part of Year 2 monitoring, biophysical surveys were conducted in the Freight Dock offset habitat area and in a suitable Reference Area approximately 2.25 km northeast of the Freight Dock.

##### 1.1.2.1 FAA Monitoring Requirements

DFO issued a 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:*

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<sup>1</sup> 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).

*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):*

*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<sup>2</sup>.*

*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.*

Monitoring the effectiveness of the Freight Dock offset habitat began in 2020 (i.e. Year 1) with results presented in Golder (2021). The present report presents the results of Year 2 of offset habitat monitoring completed at Milne Port during the 2021 open-water season as prescribed in the FAA.

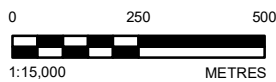
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<sup>2</sup> Condition 5.1.3. was met with submission of the *Environmental Monitoring Completion Report: Milne Port Freight Dock Construction Project* (Golder 2020b).



**LEGEND**

- OFFSET HABITAT EXTENT
- REFERENCE AREA



**REFERENCE(S)**

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CLIENT  
**BAFFINLAND IRON MINES CORPORATION**

PROJECT  
**MARY RIVER PROJECT – YEAR 2 FREIGHT DOCK MONITORING**

TITLE  
**FREIGHT DOCK OFFSET HABITAT AND REFERENCE AREA LOCATION**

CONSULTANT  
 YYYY-MM-DD 2022-03-16



**GOLDER**  
 MEMBER OF WSP

DESIGNED	KW
PREPARED	AJA
REVIEWED	PR
APPROVED	SR

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 Year 2 offset habitat monitoring undertaken in August 2021. Monitoring completed in Year 2 aimed to satisfy DFO's requirement to demonstrate how the introduced offsetting measures has influenced fisheries productivity in the local marine environment using clear and measurable criteria (Condition 5.1.1). To this end, an 'Effectiveness Monitoring Plan' for the proposed coarse rock offset habitat was developed and submitted to DFO as a Condition of the FAA (Golder 2019a; Appendix B), hereafter referred to as "The Monitoring Plan").

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

- Documentation of the offset habitat using repeatable photographs and videos taken on an annual basis along established transects across a range of depths to demonstrate the extent of community establishment compared to similar coarse rock habitat (i.e., similar depth and habitat features) near Milne Port.
- Assess abundance<sup>3</sup>, density<sup>4</sup> and diversity of taxa and functional groups.
- Assess presence and habitat usage by fish and motile invertebrates.
- Delineate the offset habitat to confirm that the introduced coarse rock habitat was constructed as designed and was shown to remain structurally stable 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 any identified problems with the offset habitat.

### 1.2.1 Indicators and Metrics

To address the objectives of the program and evaluate the functionality of the offset habitat, effectiveness monitoring of the offset habitat includes an evaluation of 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 (*Salvelinus alpinus*) prey species e.g., krill, mysid shrimp, other fish species.
- Physical stability of coarse rock habitat.

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<sup>3</sup> Abundance refers to a quantity/ amount of the taxa/functional group.

<sup>4</sup> Density refers to a quantity of a taxa/functional group in a given area.

Table 1 outlines the habitat offset monitoring activities completed to date relevant to the selected indicators for the Freight Dock habitat offset monitoring program

**Table 1: Milne Port Freight Dock – 10-year Offset Habitat –10-year Monitoring Schedule Showing Monitoring Activities Completed to Date**

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 in an established Reference Area located in south Milne Inlet (Figure 2).

- **Freight Dock offset habitat:** The perimeter of the offset habitat was mapped and 11 shore-perpendicular transects were established with three to nine 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 Overview of Field Surveys

Field surveys undertaken in the offset habitat area and Reference Area followed the methodology established in Year 1 (Golder 2021). Year 2 effectiveness monitoring was conducted in August 2021 by Golder's four-person SCUBA-based marine biologist dive team, using Baffinland's 30-foot Research Vessel. The dive team was 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 conducted during the low tide (0.7 m chart datum [CD]) to delineate (i.e., map) and document the stability of the intertidal offset habitat (i.e., coarse rock substrate) to the extent possible.
- The assessment area was delineated at the Freight Dock offset habitat and Reference Area to document survey extent.
- Subtidal dive transect/quadrat surveys were conducted to describe and quantify the occurrence of macroalgae, sessile and motile invertebrates and fish in both the offset habitat area and Reference Area.
- Opportunistic observations<sup>5</sup> of macroalgae, fish and motile/sessile invertebrates were recorded during habitat perimeter mapping.
- A subtidal assessment along the perimeter of the Freight Dock offset habitat was conducted to delineate and document the stability of the subtidal offset habitat (i.e., coarse rock substrate).

Biophysical surveys conducted in the offset habitat area and the Reference Area are outlined in Table 2.

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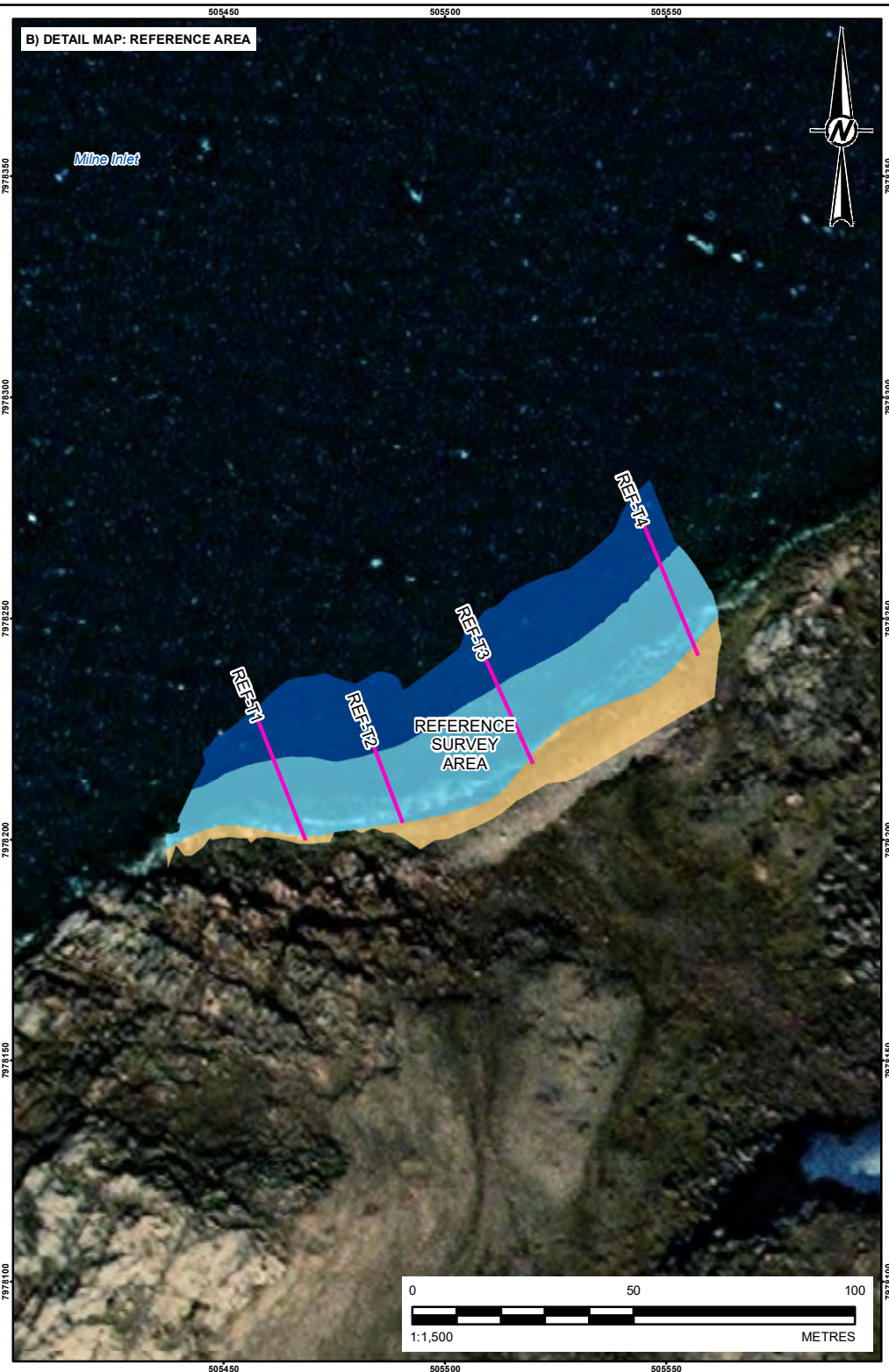
<sup>5</sup> Opportunistic observations refer to observations that were recorded during diver-collected video to document presence/absence in a qualitative manner rather than quantitatively assessed during the transect/quadrat survey.



**Table 2: Biophysical Surveys Conducted in the Freight Dock Offset Habitat Area and Reference Area**

Survey Location	Survey Type	Dates of Survey
Freight Dock Offset Habitat	Survey and visual assessment at Low Tide (0.7 m CD)	18 Aug 2021 at 14:20
	Dive Transect/ Quadrat (T) Survey (T1-T4)	10 Aug 2021
	Dive Transect/ Quadrat Survey (T5 – T8)	15 Aug 2021
	Dive Transect/ Quadrat Survey (T9 – T11)	14 Aug 2021
	Offset Habitat Mapping	10, 14, 15, and 16 Aug 2021
Reference Area	Dive Transect/ Quadrat Survey (T1 – T2)	7 Aug 2021
	Dive Transect/ Quadrat Survey (T3)	3 Aug 2021
	Dive Transect/ Quadrat Survey (T4)	11 Aug 2021
	Survey Area Mapping	11 Aug 2021





- LEGEND**
- 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
  - REFERENCE AREA
- HABITAT TYPE**
- ADDITIONAL INTERTIDAL (+2.3 to 0 m CD)
  - INTERTIDAL (+2.3 to 0 m CD)
  - UPPER SUBTIDAL (0 to -3 m CD)
  - SHALLOW SUBTIDAL (<-3 m CD)

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 MARY RIVER PROJECT – YEAR 2 FREIGHT DOCK MONITORING

CONSULTANT	YYYY-MM-DD	2022-03-16
DESIGNED	KW	
PREPARED	AA	
REVIEWED	PR	
APPROVED	SR	

TITLE  
**MILNE PORT FREIGHT DOCK – LOCATION OF DIVE SURVEYS IN OFFSET HABITAT AREA AND REFERENCE AREA**

PROJECT NO.	CONTROL	REV.	FIGURE
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## 2.3 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 surveyed the outer perimeter of the placed coarse rock material using a taut-line buoy attached to surface Garmin WAAS<sup>6</sup>-enabled Global Positioning System (GPS)<sup>7</sup> that tracked the diver position at 5 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<sup>8</sup> and took general notes of habitat features. The inner perimeter of the placed coarse rock material was then surveyed by the dive team to complete mapping of the habitat offset polygon. The placed coarse rock material was distinguishable from naturally existing coarse substrate (i.e., gravel, cobble) by its angular appearance. Because the offset habitat mapping was conducted during a low to mid tidal event, a limited portion of the intertidal area was not able to be mapped. This portion of the polygon was estimated using an ortho-rectified digital aerial photograph taken of the coarse rock offset habitat during a high tide event.

Subtidal substrate mapping in the Reference Area followed a similar approach to the Freight Dock offset habitat, with the offshore extent of the survey area consistent with the offshore extent of the Freight Dock offset habitat. The reference area selected offered similar substrate and habitat features within similar depth as the Freight Dock offset habitat area, as confirmed by the dive team.

## 2.4 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 (Golder 2019a; Appendix C). Quadrats were placed along a series of transects that extended from the offshore survey perimeter to the intertidal zone in each survey area (Freight Dock and Reference Area). The beginning and end of each transect were recorded using a handheld GPS. Each transect's location and depth range are provided in Table 3.

Transects were established within each survey area using a weighted measuring tape and beginning at the outer (offshore) margin of the survey area (progressing shoreward). A 1.0-m<sup>2</sup> quadrat was placed at 1-m to 5-m intervals along the transect, depending on overall transect length (Appendix C, Photo 21). 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 inshore direction (see Figure 2). Transect/ quadrat data were recorded on customized datasheets, according to the following criteria<sup>9</sup>:

- 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 cover).

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<sup>6</sup> Wide Area Augmentation System

<sup>7</sup> The accuracy of this Global Positioning System (GPS) format is typically  $\pm 3$  m

<sup>8</sup> 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.

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

- Macroalgae was identified to the lowest practical level (LPL) and areal cover was estimated.
- Sessile animals, such as clams and mussels, were identified to LPL and areal cover was estimated.
- Motile animals (e.g., fish, urchins, limpets) were identified to LPL and enumerated.
- Photographs showing representative biological features and aiding in species identification were taken.

**Table 3: Survey Transect Locations and Depth Ranges in Offset Habitat Area and Reference Area**

Area	Transect	Location (NAD 83 UTM 17N)		Transect Length (m) [Number of Quadrats]	Depth (m below CD) <sup>1</sup>	
		Inshore	Offshore		Start	End
Freight Dock (FD)	FD-T1	503936 7976559	503931 7976559	3.4 [3]	0.3	1.2
	FD-T2	503935 7976602	503934 7976600	5.4 [3]	0.2	1.1
	FD-T3	503901 7976611	503900 7976606	4.6 [4]	-0.4	0.7
	FD-T4	503897 7976625	503892 7976625	3.7 [3]	-0.1	0.6
	FD-T5	503951 7976670	503951 7976686	25 [5]	-7.0	-2.0 <sup>2</sup>
	FD-T6	503969 7976671	503968 7976690	35.7 [7]	-8.7	-1.1 <sup>2</sup>
	FD-T7	504001 7976662	504000 7976688	29 [6]	-7.2	-0.5 <sup>2</sup>
	FD-T8	504003 7976604	504009 7976599	6.5 [6]	-0.2	1.4
	FD-T9	504023 7976609	504023 7976605	6 [7]	-0.1	1.5
	FD-T10	504043 7976630	504045 7976630	9 [9]	0.0	1.3
	FD-T11	504003 7976593	504005 7976593	4.6 [4]	0.4	1.4
Reference Area (REF)	REF-T1	505468 7978200	505457 7978228	33 [7]	-15.1	0.2
	REF-T2	505490 7978204	505483 7978222	26 [6]	-8.0	0.4
	REF-T3	505520 7978217	505508 7978239	29 [7]	-9.4	0.0
	REF-T4	505557 7978242	505545 7978271	45.7 [9]	-16.0	0.1

<sup>1</sup> 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.

<sup>2</sup> Freight Dock Transect 5 (FD-T5), FD-T6, and FD-T7 could not be surveyed within the intertidal zone due to heavy shore-pounding waves making it unsafe for diving.

## 2.5 Physical Stability

To fulfill Section 2.3.4 of the Monitoring Plan (Golder 2019a), physical stability of the introduced coarse rock 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 recorded and estimated from the available photographs and underwater video footage.

## 2.6 Data Analysis

Mapped polygons of the Freight Dock offset habitat area and the Reference Area were downloaded from the GPS and plotted by GIS using aerial images, base map (hydrographic map) and/or bathymetry, where appropriate<sup>10</sup>.

Diver-collected transect/quadrat data were entered into an excel spreadsheet by a Golder marine biologist and verified by a second Golder marine biologist for transcription errors. For the Reference Area, quadrat data that contained >50% soft sediments were removed from the analysis to allow for a more effective comparison of coarse substrate (i.e., bedrock, boulder, cobble) between the two survey areas.

To fulfill FAA Condition 5.1.1 and Sections 2.3 and 2.4 in The Monitoring Plan (Golder 2019a), the following monitoring parameters were measured and/or analyzed in the offset habitat area and the Reference Area:

- Relative abundance of macroalgae and epifauna (% cover and/or organisms/m<sup>2</sup>) in survey quadrats presented by depth category, representative of intertidal +2.3 to 0 m CD), upper subtidal (<0 to -3 m CD) and shallow subtidal (< -3 m CD) zones.
- Mean taxa richness (mean number of unique taxa) by depth category as above.

## 2.7 Quality Assurance/Quality Control

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

- Field survey data sheets were verified and cross-validated in the field.
- Dive survey video and photographs, GIS tracks and survey waypoints were saved to a laptop computer and external hard drive at the end of each field day.

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<sup>10</sup> Data references are provided on figures under "References".

- Taxa identifications, including common and species names, were verified using established reference sources<sup>11</sup>.
- Transect/quadrat data were entered into an electronic database where a second biologist conducted a data quality check and review for detection of transcription errors.
- Summary statistics calculations were verified by a second biologist for errors as part of the data review process.

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<sup>11</sup> References used during the surveys, included: Mecklenburg et al. (2007), Küpper et al. (2016), Coad and Reist (2018), Golder (2019b), WoRMS (2020), Guiry and Guiry (2020)



## 3.0 RESULTS

Transect and quadrat sampling locations are shown in Figure 3 and Figure 4. Representative photographs and stills from underwater video footage are included in Appendix D. Quadrat/transect data are tabulated in Appendix E. A taxa list with common and scientific names are provided in Appendix F.

### 3.1 Subtidal Mapping

#### Reference Area

Table 4 summarizes the size (m<sup>2</sup>) of the habitat areas surveyed by the dive team in the Reference Area presented by depth category.

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

Substrate Type	Depth Contour	Area Estimate (m <sup>2</sup> )
Intertidal	+2.3 to 0 m CD	155
Upper subtidal	0 to -3 m CD	2,240
Shallow subtidal	<-3 m CD	1,745
<b>Total mapped area (total estimated Reference Area)</b>		<b>4,140 (4,770)</b>

The spatial boundaries of the survey grid in the Reference Area were approximate as there was no defined coarse substrate berm for divers to use as a point of reference such as that available in the Freight Dock offset habitat area (Figure 3). However, the dive team confirmed that the transect/quadrat sampling encompassed the three established depth contours in substrate type directly comparable to that available in the offset habitat area. In addition to the 4,140 m<sup>2</sup> of total mapped coarse substrate, an additional intertidal portion of the Reference Area was estimated to measure at 630 m<sup>2</sup>, resulting in a total survey footprint of 4,770 m<sup>2</sup>. This area comprised intertidal coarse substrate that was not accessible during the time of the dive 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 and time constraints due to inclement weather did not allow for diving during an adequate high tide.

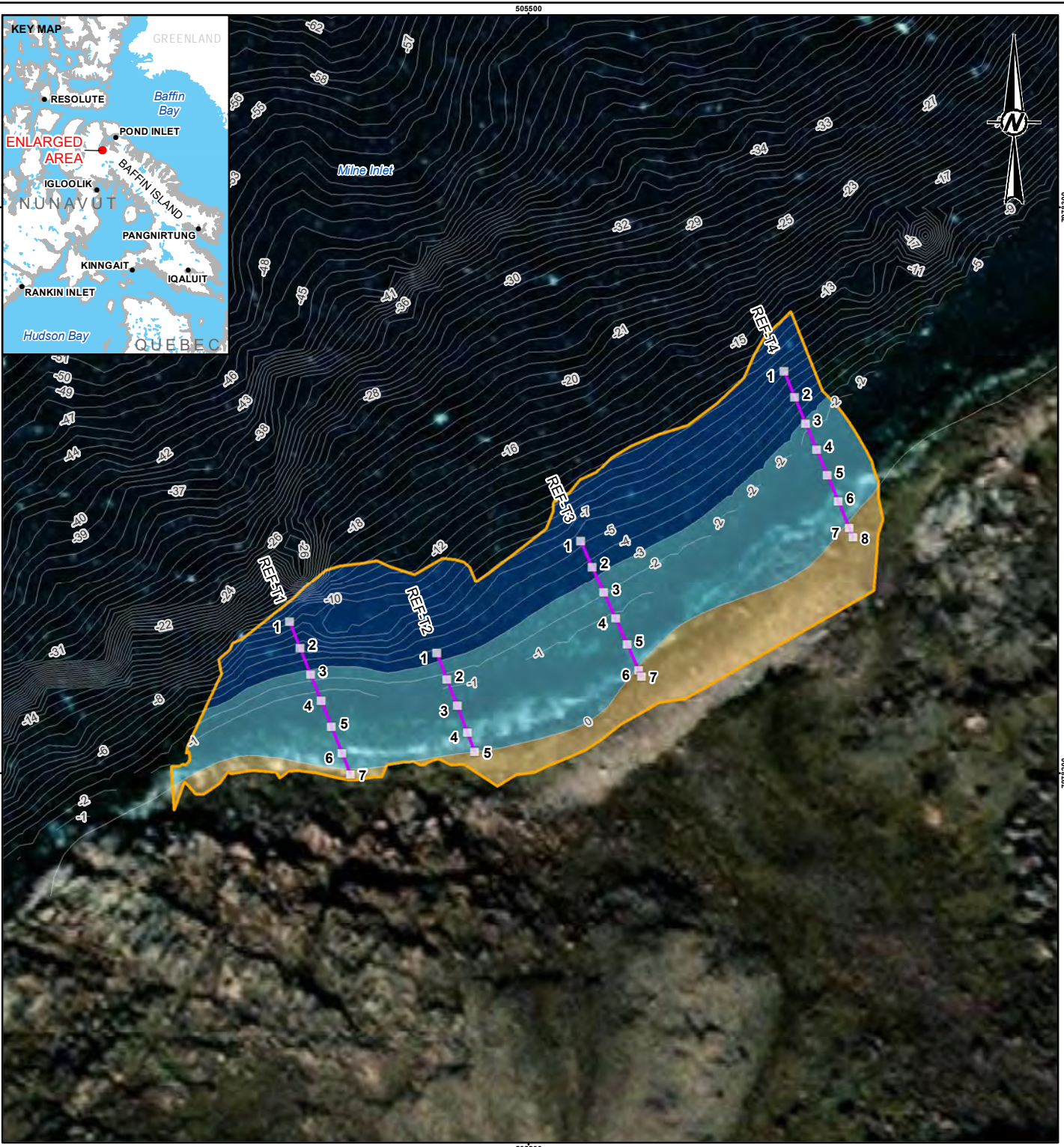
#### Freight Dock

Table 5 summarizes the size (m<sup>2</sup>) of the habitat areas surveyed by the dive team in the Freight Dock offset habitat area, presented by depth category.

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

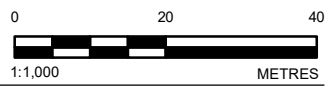
Substrate Type	Depth Contour	Area Estimate (m <sup>2</sup> )
Intertidal	+2.3 to 0 m CD	1,545
Upper subtidal	0 to -3 m CD	1,470
Shallow subtidal	<-3 m CD	675
<b>Total mapped area (total estimated coarse material area)</b>		<b>3,690 (4,165)</b>

In addition to the 3,690 m<sup>2</sup> of total mapped coarse substrate, an additional intertidal portion of the north face of the Freight Dock offset habitat was estimated and measured at 475 m<sup>2</sup>, resulting in a total survey footprint of 4,165 m<sup>2</sup>(Figure 4). This area comprised intertidal coarse material that was not accessible during the time of the dive survey due to tide height.



- LEGEND**
- QUADRAT LOCATION
  - BATHYMETRY CONTOUR (1 m INTERVAL)
  - TRANSECT (2021)
  - ▭ REFERENCE AREA (2021)

- REFERENCE AREA (2021) - SUBSTRATE TYPE**
- INTERTIDAL (+2.3 to 0 m CD)
  - UPPER SUBTIDAL (-0.1 to -3 m CD)
  - SHALLOW SUBTIDAL (<-3 m CD)



**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 2 FREIGHT DOCK MONITORING**

TITLE  
**TRANSECT/QUADRAT SAMPLING LOCATIONS IN OFFSET HABITAT REFERENCE AREA IN MILNE PORT**

CONSULTANT	YYYY-MM-DD	2022-03-16
	DESIGNED	KW
	PREPARED	AJA
	REVIEWED	PR
	APPROVED	SR



PROJECT NO.	CONTROL	REV.	FIGURE
1663724	44000-05	0	3

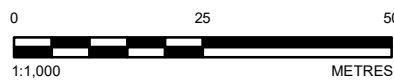
PATH: I:\2018\1663724\Map\print\MXD\4100\_2021\_MEE\MP1663724\_44000\_05\_Fig3\_ReferencesArea\_Rev0.mxd PRINTED ON: 2022-03-16 AT: 12:11:54 PM

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





- 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
- HABITAT TYPE**
- ADDITIONAL INTERTIDAL (+2.3 to 0 m CD)
  - HARD INTERTIDAL (+2.3 m to 0 m)
  - HARD UPPER SUBTIDAL (0 m to -3 m)
  - SHALLOW SUBTIDAL (-3.1 to -15 m CD)



**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 2 FREIGHT DOCK MONITORING**

TITLE  
**TRANSECT/QUADRAT SAMPLING LOCATIONS IN FREIGHT DOCK OFFSET HABITAT AREA IN MILNE PORT**

CONSULTANT	YYYY-MM-DD	2022-03-16
DESIGNED	KW	
PREPARED	AJA	
REVIEWED	PR	
APPROVED	SR	

PROJECT NO.	CONTROL	REV.	FIGURE
1663724	44000-05	0	4



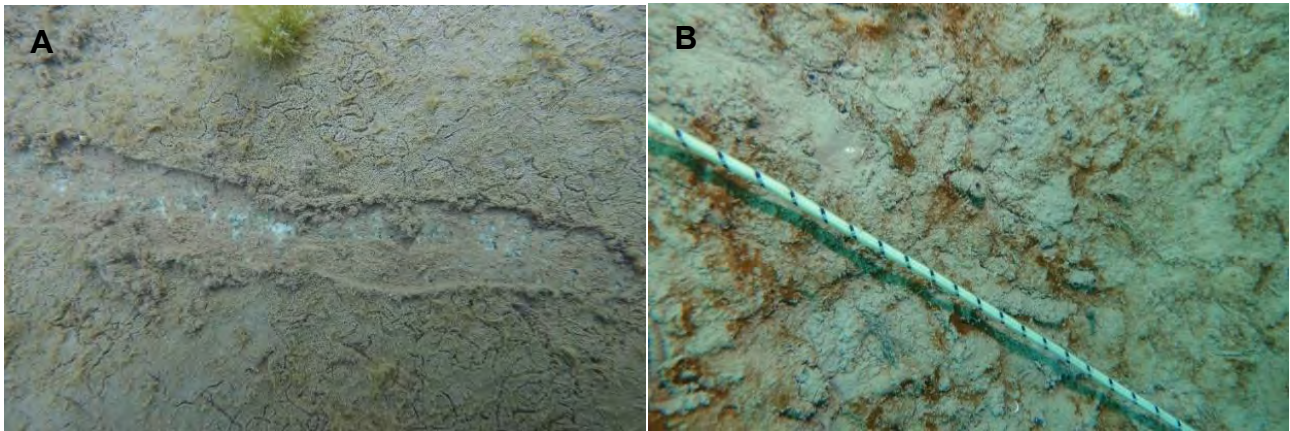
## 3.2 Macroalgae Colonization

### 3.2.1 Overview

Mean percent areal cover of macroalgae in the Freight Dock habitat offset survey area was generally low to moderate. The highest occurrence of macroalgae was within the upper subtidal zone with a mean areal cover of  $46.7 \pm 10.1\%$  (Standard Error, SE) (Table 6). In the Reference Area, macroalgae mean percent areal cover was greatest in the upper subtidal zone with  $100 \pm 0$  SE%.

Taxa richness in the Freight Dock offset habitat area was lower compared to the Reference Area in the intertidal and upper subtidal zones. However, taxa richness in the shallow subtidal zone in the Freight Dock offset habitat area was similar compared to the Reference Area ( $2.2 \pm 0.8$  taxa and  $2.1 \pm 0.7$  taxa, respectively).

A detrital veneer that appeared to consist of phytoplankton/diatom and silt cover was recorded along most of the transects in the Freight Dock offset habitat area (Photo 1A) and in the shallow subtidal zone of most transects in the Reference Area (Photo 1B). The detrital veneer was not included as part of the macroalgae percent areal cover estimates and did not appear to limit macroalgae attachment to the substrate.



**Photo 1: Detrital veneer observed on (A) coarse rock offset habitat in intertidal zone and (B) the Reference Area on soft substrate in the shallow subtidal zone.**

**Table 6: Macroalgae – Per Cent Cover and Taxa Richness by Survey Area and Depth Contour**

Survey Area	Number of Quadrats Analyzed (Total number of quadrats) <sup>1</sup>	Macroalgae <sup>2</sup>			
		Areal Cover (%)		Taxa Richness	
		Mean ± SE <sup>3</sup>	Range <sup>4</sup>	Mean ± SE <sup>3</sup>	Range <sup>4</sup>
<b>Intertidal (0 to +2.3 m CD)</b>					
Freight Dock	40 (40)	35.0 ± 4.9	2-85	1.5 ± 0.2	1-3
Reference	8 (8)	69.9 ± 3.1	30-100	2.6 ± 0.1	2-3
<b>Upper subtidal (0 to -3 m CD)</b>					
Freight Dock	4 (4)	46.7 ± 10.1	30-65	2.3 ± 0.3	2-3
Reference	4 (8)	100.0	100-100	3.2 ± 0.4	2-4
<b>Shallow subtidal (&lt;-3 m CD)</b>					
Freight Dock	13 (13)	18.2 ± 3.0	6-30	2.2 ± 0.1	1-3
Reference	7 (13)	54.5 ± 15.4	0-100	2.1 ± 0.7	0-5

<sup>1</sup> 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.

<sup>2</sup> Percent areal cover and taxa richness was calculated using mean values per transect for the area surveyed. Overall 'macroalgae' includes turf and encrusting algae, and understory kelp.

<sup>3</sup> SE = standard error of the mean

<sup>4</sup> 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 (*Saccharina latissima*) and sieve kelp (*Agarum clathratum*) – were recorded in the shallow subtidal zone of the Reference Area at trace percent cover and was associated with low taxa richness (Table 7, Appendix D, Photos 22 - 24). Sugar kelp was also observed at trace percent cover in the shallow subtidal zone of the Freight Dock and within the same depth range as recorded in the Reference Area (Appendix D, Photo 9). Understory kelp taxa richness is low for both the Freight Dock offset habitat and Reference Area. Year 2 is the first year of monitoring where kelp was observed at the newly constructed Freight Dock.



**Table 7: Understory Kelp - Percent Cover and Taxa Richness by Survey Area and Depth Contour**

Survey Area	Number of Quadrats Analyzed (Total number of quadrats) <sup>1</sup>	Understory Kelp <sup>2</sup>				
		% Areal Cover		Taxa Richness		Dominant Taxa
		Mean $\pm$ SE <sup>3</sup>	Range <sup>4</sup>	Mean $\pm$ SE <sup>3</sup>	Range <sup>4</sup>	
<b>Intertidal (0 to +2.3 m CD)</b>						
Freight Dock	40 (40)	0	0	0	0	none
Reference	8 (8)	0	0	0	0	none
<b>Upper subtidal (0 to -3 m CD)</b>						
Freight Dock	4 (4)	0	0	0	0	none
Reference	4 (8)	0	0	0	0	none
<b>Shallow subtidal (&lt;-3 m CD)</b>						
Freight Dock	13 (13)	0.2 $\pm$ 0.2	0-2	0.1 $\pm$ 0.1	0-1	Sugar kelp
Reference	7 (13)	0.8 $\pm$ 0.5	0-2	0.4 $\pm$ 0.2	0-1	Sugar kelp, Sieve kelp

<sup>1</sup> 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.

<sup>2</sup> Percent areal cover and taxa richness of algae was calculated using mean values per transect for the area surveyed.

<sup>3</sup> SE = standard error of the mean

<sup>4</sup> Range represents the lowest and highest number of percent cover and taxa observed.

### 3.2.3 Turf Macroalgae

Turf macroalgae ranged from low to moderate cover in the Freight Dock offset habitat area, and from moderate to high cover in the Reference Area (Table 8). An epilithic<sup>12</sup> brown filamentous algae, *Pylaiella* spp. (Appendix D, Photos 12 and 21 – 22), was ubiquitous within each depth contour and observed at both the Freight Dock offset habitat area and Reference Area. Rockweed (*Fucus distichus*) and *Battersia* spp. were dominant within the Reference Area (Appendix D, Photo 21 – 22 and 25 – 26). The Freight Dock offset habitat area supported low to moderate cover of two species of green filamentous macroalgae (cf. *Urospora neglecta*<sup>13</sup> and an unidentified green filamentous tuft) and two species of brown filamentous macroalgae (cf. *Coelocladia arctica*, and *Desmarestia* spp.) (Appendix D, Photo 10 and 12 – 14). Another taxon occurring in the Freight Dock offset habitat area was *Halosiphon tomentosus* (Appendix D, Photo 11), observed in the intertidal zone. Taxa occurring exclusively in the Reference Area included an unidentified red filamentous algae in the upper and shallow subtidal zone (Appendix D, Photo 24) and two species of red foliose algae, *Coccotylus truncatus* and *Dilsea socialis* (Appendix D, Photos 27 – 28), in the shallow subtidal zone (Table 10). Taxa richness in the Freight Dock offset habitat area was lower than that in the Reference Area for both intertidal and upper subtidal zones but was in the same range as taxa richness observed in the shallow subtidal zone of the Reference Area.

<sup>12</sup> Epilithic is defined in Kupper et al. (2016) as an algae taxon that grows on rock or hard substrate.

<sup>13</sup> cf. "compare with", in taxonomy refers to a taxonomic designation that indicates an inexact match to the indicated taxon. The specimen may represent a similar related species, an undescribed morph, or the specimen may be lacking characteristics that allow for a positive identification.

**Table 8: Turf Macroalgae - Percent Cover and Taxa Richness by Survey Area and Depth Contour**

Survey Area	Number of Quadrats Analyzed (Total number of quadrats) <sup>1</sup>	Turf Macroalgae <sup>2</sup>				Dominant Taxa
		Areal Cover (%)		Taxa Richness		
		Mean $\pm$ SE <sup>3</sup>	Range <sup>4</sup>	Mean $\pm$ SE <sup>3</sup>	Range <sup>4</sup>	
<b>Intertidal (0 to +2.3 m CD)</b>						
Freight Dock	40 (40)	35.0 $\pm$ 4.9	2-85	1.5 $\pm$ 0.2	1-3	<i>Urospora neglecta</i> , <i>Pylaiella</i> spp., Green filamentous tuft
Reference	8 (8)	69.6 $\pm$ 3.1	30-100	2.6 $\pm$ 0.1	2-3	Rockweed, <i>Pylaiella</i> spp., <i>Battersia</i> spp.
<b>Upper subtidal (0 to -3 m CD)</b>						
Freight Dock	4 (4)	46.7 $\pm$ 10.1	30-65	2.3 $\pm$ 0.3	2-3	<i>Pylaiella</i> spp., <i>Coelocladia arctica</i>
Reference	4 (8)	100 $\pm$ 0	100-100	3.2 $\pm$ 0.4	2-4	Rockweed, <i>Battersia</i> spp.
<b>Shallow subtidal (&lt;-3 m CD)</b>						
Freight Dock	13 (13)	18.1 $\pm$ 3.1	4-30	2.1 $\pm$ 0.1	1-3	<i>Pylaiella</i> spp., <i>Coelocladia arctica</i> , <i>Desmarestia</i> spp.
Reference	7 (13)	27.1 $\pm$ 12.2	0-92	1.6 $\pm$ 0.8	0-5	<i>Pylaiella</i> spp., <i>Battersia</i> spp.

<sup>1</sup> 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.

<sup>2</sup> Percent areal cover and taxa richness of algae was calculated using mean values per transect for the area surveyed.

<sup>3</sup> SE = standard error of the mean

<sup>4</sup> Range represents the lowest and highest number of percent cover and taxa observed.

### 3.2.4 Encrusting Algae

Encrusting algae was not observed in the Freight Dock offset habitat area but was observed in the Reference Area; specifically, a crustose coralline algae (Corallinales indet.) was observed in the shallow subtidal zone at 26.6  $\pm$  17.6% cover (Table 9; Appendix D, Photos 23 and 27).

**Table 9: Encrusting Algae - Percent Cover and Taxa Richness by Survey Area and Depth Contour**

Survey Area	Number of Quadrats Analyzed (Total number of quadrats) <sup>1</sup>	Encrusting Macroalgae <sup>2</sup>				Dominant Taxa
		Areal % Cover		Taxa Richness		
		Mean ± SE <sup>3</sup>	Range <sup>4</sup>	Mean ± SE <sup>3</sup>	Range <sup>4</sup>	
<b>Intertidal (0 to +2.3 m CD)</b>						
Freight Dock	40 (40)	0	0	0	0	none
Reference	8 (8)	0	0	0	0	none
<b>Upper subtidal (0 to -3 m CD)</b>						
Freight Dock	4 (4)	0	0	0	0	none
Reference	4 (8)	0	0	0	0	none
<b>Shallow subtidal (&lt;-3 m CD)</b>						
Freight Dock	13 (13)	0	0	0	0	none
Reference	7 (13)	26.6 ± 17.6	0-98	0.4 ± 0.2	0-1	Encrusting coralline

<sup>1</sup> 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.

<sup>2</sup> Percent areal cover and taxa richness of algae was calculated using mean values per transect for the area surveyed.

<sup>3</sup> SE = standard error of the mean

<sup>4</sup> Range represents the lowest and highest percent cover and taxa observed.

**Table 10: Opportunistic Observations of Macroalgae<sup>1</sup> Taxa Recorded during Perimeter Mapping and Review of Video**

Taxon	Freight Dock	Reference Area
Sugar kelp ( <i>Laminaria saccharina</i> )	√	√
Sieve kelp ( <i>Agarum clathratum</i> )	-	√
Rockweed ( <i>Fucus distichus</i> )	-	√
<i>Pylaiella</i> spp.	√	√
<i>Halosiphon tomentosus</i>	√	-
<i>Battersia</i> spp.	-	√
Acid weed ( <i>Desmarestia</i> spp.)	√	√
Brown filamentous 1 (cf. <i>Coelocladia arctica</i> )	√	√
<i>Coccotylus truncatus</i>	-	√
<i>Dilsea (Dilsea socialis)</i>	-	√
Red filamentous	-	√

Taxon	Freight Dock	Reference Area
Green filamentous tuft 1 (Chlorophyta indet.)	√	√
Green filamentous 2 (cf. <i>Urospora neglecta</i> )	√	-
Encrusting coralline	-	√

<sup>1</sup>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

In the Freight Dock habitat offset area, a single species of unidentified tunicate (Tunicata indet.; Appendix D, Photo 15) was observed in the upper subtidal and shallow subtidal zones. This was compared to no sessile invertebrates recorded in the Freight Dock habitat offset area in Year 1 (Golder 2021).

In the Reference Area, sessile invertebrates were recorded in very low cover in all depth categories. Taxa richness was highest in the shallow subtidal zone ( $3.5 \pm 1.0$ , range: 0-7 taxa). In the intertidal zone, the sole taxon present was the same species of tunicate observed in the Freight Dock offset habitat area (Appendix D, Photo 29). Tunicates (two species) and mussels were the dominant taxa observed in the upper subtidal zone, while tunicates (three species) and wrinkled rock-borer clam (*Hiatella arctica*; Appendix D, Photo 31) where the dominant taxa observed in the shallow subtidal zone.

**Table 11: Sessile Invertebrates Recorded During Transect/Quadrat Surveys by Survey Area and Depth Contour**

Survey Area	Number of Quadrats Analyzed (Total number of quadrats) <sup>1</sup>	Sessile Invertebrate (% cover)		Taxa Richness		Dominant Taxa
		Mean $\pm$ SE <sup>1,2</sup>	Range <sup>3</sup>	Mean $\pm$ SE <sup>1,2</sup>	Range <sup>3</sup>	
<b>Intertidal (0 to +2.3 m CD)</b>						
Freight Dock	40 (40)	0	0	0	0	None
Reference	8 (8)	$1.5 \pm 1.5$	0-12	$0.1 \pm 0.1$	0-1	Tunicate
<b>Upper subtidal (0 to -3 m CD)</b>						
Freight Dock	4 (4)	$3.2 \pm 1.7$	0-12	$0.5 \pm 0.3$	0-1	Tunicate
Reference	4 (8)	$2.0 \pm 1.0$	0-4	$1.0 \pm 0.0$	0-2	Tunicate, Mussel
<b>Shallow subtidal (&lt;-3 m CD)</b>						
Freight Dock	13 (13)	$6.1 \pm 1.2$	0-20	$0.6 \pm 0.1$	0-1	Tunicate
Reference	7 (13)	$14.9 \pm 7.4$	0-46	$3.5 \pm 1.0$	0-7	Clam, Tunicate

<sup>1</sup> Number represents number of quadrats used for analysis and number in brackets represents the total number of quadrats surveyed.

<sup>2</sup> Percent areal cover, density, and taxa richness of invertebrates was calculated using mean values per transect for the area surveyed. Polychaete tubes were not included in analysis.

<sup>3</sup> SE = standard error of the mean

<sup>4</sup> Range represents the lowest and highest number of percent cover, density and taxa observed.

## Motile Invertebrates

Motile invertebrates were not observed within the intertidal or upper subtidal zones in either the Freight Dock offset habitat area or the Reference Area. However, several taxa were recorded in the shallow subtidal zone in both areas. Mean density was low ( $0.9 \pm 0.2$  organisms/m<sup>2</sup> [org/m<sup>2</sup>]) in the shallow subtidal zone of the Freight Dock, with two taxa observed: green urchin (*Strongylocentrotus droebachiensis*) and brittle star (Ophiuroidea indet.) (Appendix D, Photos 16 – 17; Table 12). In contrast, mean density was higher in the shallow subtidal zone of the Reference Area ( $1.3 \pm 0.8$  org/m<sup>2</sup>), with observed species including chitons (*Tonicella* spp.; Appendix D, Photo 35) and brittle stars. Taxa richness was similar for motile invertebrates in both survey areas.

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

Survey Area	Number of Quadrats Analyzed (Total number of quadrats) <sup>1</sup>	Motile Invertebrate (org/m <sup>2</sup> )		Taxa Richness		Dominant Taxa
		Mean $\pm$ SE <sup>1,2</sup>	Range <sup>3</sup>	Mean $\pm$ SE <sup>1,2</sup>	Range <sup>3</sup>	
<b>Intertidal (0 to +2.3 m CD)</b>						
Freight Dock	40 (40)	0	0	0	0	none
Reference	8 (8)	0	0	0	0	none
<b>Upper subtidal (0 to -3 m CD)</b>						
Freight Dock	4 (4)	0	0	0	0	none
Reference	4 (8)	0	0	0	0	none
<b>Shallow subtidal (&lt;-3 m CD)</b>						
Freight Dock	13 (13)	$0.9 \pm 0.2$	0-6	$0.4 \pm 0.1$	0-2	Green urchin, Brittle star
Reference	7 (13)	$1.3 \pm 0.8$	0-6	$0.5 \pm 0.4$	0-3	Chiton, Brittle star

<sup>1</sup> Number represents number of quadrats used for analysis and number in brackets represents the total number of quadrats surveyed.

<sup>2</sup> Percent areal cover, density, and taxa richness of invertebrates was calculated using mean values per transect for the area surveyed.

<sup>3</sup> SE = standard error of the mean

<sup>4</sup> Range represents the lowest and highest number of percent cover, density and taxa observed.

Mysid (opossum) shrimp (Order Mysida; Appendix D, Photo 18) were observed in the shallow subtidal zone of the Freight Dock offset habitat area and in the upper subtidal zone of the Reference Area (Table 13). Mean densities of mysid shrimp in both areas were lower ( $0.3 \pm 0$  org/m<sup>2</sup>) than those reported in Year 1 of monitoring where mean densities ranged between  $19 \pm 1.9$  org/m<sup>2</sup> and  $124 \pm 44.5$  org/m<sup>2</sup> (Golder 2021). One opportunistic observation included a school of approximately 200 mysid shrimp in the Freight Dock offset habitat area, otherwise, mysid shrimp were generally recorded as single individuals or in small swarms in both survey areas.

**Table 13: Summary Metrics of Mysid Shrimp Recorded during Transect/Quadrat Survey by Survey Area and Depth Contour**

Survey Area	Number of Quadrats Analyzed (Total number of quadrats) <sup>1</sup>	Density (org/m <sup>2</sup> )	
		Mean ± SE <sup>2,3</sup>	Range <sup>4</sup>
<b>Intertidal (0 to +2.3 m CD)</b>			
Freight Dock	40 (40)	0	0
Reference	8 (8)	0	0
<b>Upper subtidal (0 to -3 m CD)</b>			
Freight Dock	4 (4)	0	0
Reference	4 (8)	0.3 ± 0.0	0-1
<b>Shallow subtidal (&lt;-3 m CD)</b>			
Freight Dock	13 (13)	0.3 ± 0.0	0-4
Reference	7 (13)	0	0

<sup>1</sup> Number represents number of quadrats used for analysis and number in brackets represents the total number of quadrats surveyed.

<sup>2</sup> Density and taxa richness of mysids were calculated using mean values per transect for the area surveyed.

<sup>3</sup> SE = standard error of the mean

<sup>4</sup> Range represents the lowest and highest number of percent cover, density and taxa observed.

Opportunistic observations of taxa recorded outside the transect/quadrat survey are summarized in Table 14, including occurrences of Arctic comb jelly (*Mertensia ovum*) in the Freight Dock offset habitat area and sea spider (Class Pycnogonida; Appendix D, Photo 37) in the Reference Area (Table 14).

**Table 14: Opportunistic Observations of Invertebrates<sup>1</sup> Recorded during Perimeter Mapping and Review of Video**

Taxa List	Freight Dock	Reference Area
Mysid (Order Mysida)	√	√
Barnacle (Class Balanomorpha)	-	√
Cone worm ( <i>Cistenides granulata</i> )	-	√
Creeping pedal sea cucumber (Family Psolidae)	-	√
Green urchin ( <i>Strongylocentrotus droebachiensis</i> )	√	√
Brittle star (Family Ophiuridae)	√	√
Anemone (Order Actiniaria)	-	√
Tube-dwelling anemone (Family Cerianthidae)	-	√
Icelandic scallop ( <i>Chlamys islandica</i> )	-	√
Wrinkled rock-borer ( <i>Hiatella arctica</i> )	-	√
Blunt gaper ( <i>Mya</i> spp.)	-	√
Astarte clam ( <i>Astarte</i> spp.)	-	√
Chiton ( <i>Tonicella</i> spp.)	-	√
Limpet (Family Lottidae)	-	√
Mussel (Order Mytilida)	-	√
Circular hairy tunicate 1	-	√
White large circular tunicate 2	-	√
Tunicate 3	√	√
Solitary orange tunicate 4	-	√
Bryozoan (Phylum Bryozoa)	-	√
Articulated brachiopod (Phylum Brachiopoda)	-	√
Sea spider (Class Pycnogonida)	-	√
Arctic comb jelly ( <i>Mertensia ovum</i> )	√	-
Ctenophore	√	-

<sup>1</sup>Taxa were observed during transect/quadrate, mapping and review of video and are provided here as a qualitative assessment of presence/absence of organisms.

### 3.4 Fish

Fish density and taxa richness were comparable between the Freight Dock offset habitat area and the Reference Area (Table 15). Fish were observed in the shallow subtidal zone in both survey areas ( $0.15 \pm 0.08$  fish/m<sup>2</sup> in Freight Dock area and  $0.13 \pm 0.13$  fish/m<sup>2</sup> in Reference area). Fish were only recorded in the intertidal zone in the Freight Dock offset habitat area ( $0.04 \pm 0.03$  fish/m<sup>2</sup>). Shorthorn sculpin (*Myoxocephalus scorpius*; Appendix D, Photo 38) and sculpins that were too small to identify to species were observed in both areas (Appendix D, Photo 19).

**Table 15: Fish Recorded during Transect/Quadrat Survey by Survey Area and Depth Contour**

Survey Area	Number of Quadrats Analyzed (Total number of quadrats) <sup>1</sup>	Abundance (number)	Density (fish/m <sup>2</sup> )		Taxa Richness	
			Mean $\pm$ SE <sup>2,3</sup>	Range <sup>4</sup>	Mean $\pm$ SE <sup>2,3</sup>	Range <sup>4</sup>
<b>Intertidal (0 to +2.3 m CD)</b>						
Freight Dock	40 (40)	2	$0.04 \pm 0.03$	0-1	$0.04 \pm 0.03$	0-1
Reference	8 (8)	0	0	0	0	0
<b>Upper subtidal (0 to -3 m CD)</b>						
Freight Dock	4 (4)	0	0	0	0	0
Reference	4 (8)	0	0	0	0	0
<b>Shallow subtidal (&lt;-3 m CD)</b>						
Freight Dock	13 (13)	2	$0.15 \pm 0.08$	0-1	$0.15 \pm 0.08$	0-1
Reference	7 (13)	1	$0.13 \pm 0.13$	0-1	$0.13 \pm 0.13$	0-1

<sup>1</sup> Number represents number of quadrats used for analysis and number in brackets represents the total number of quadrats surveyed.

<sup>2</sup> Density and taxa richness of fish were calculated using mean values per transect for the area surveyed.

<sup>3</sup> SE = standard error of the mean

<sup>4</sup> Range represents the lowest and highest number of percent cover, density or taxa observed.

During perimeter mapping of the Freight Dock offset habitat area, several Fourhorn sculpin (*Myoxocephalus quadricornis*) (Appendix D, Photo 20) and two Arctic char (*Salvelinus alpinus*) were recorded opportunistically (Table 16). Both Arctic char were observed swimming offshore along the north side of the Freight Dock as single individuals. Two Atlantic lump sucker (*Eumicrotremus spinosus*; Appendix D, Photo 39) were recorded opportunistically in the Reference Area along REF-T1 and during perimeter mapping. One unidentified fish species was also opportunistically observed in the Reference Area (Appendix D, Photo 40).



**Table 16: Opportunistic Observations of Fish<sup>1</sup> Recorded during Perimeter Mapping and Review of Video**

Taxa List	Freight Dock	Reference Area
Shorthorn sculpin ( <i>Myoxocephalus scorpius</i> )	√	√
Fourhorn sculpin ( <i>Myoxocephalus quadricornis</i> )	√	-
Sculpin (Family Cottidae)	√	√
Atlantic spiny lump sucker ( <i>Eumicrotremus spinosus</i> )	-	√
Arctic char ( <i>Salvelinus alpinus</i> )	√	-
Unidentified fish species	-	√


<sup>1</sup> 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). Physical stability of the Freight Dock coarse rock substrate was qualitatively assessed during perimeter mapping and transect/quadrat surveys, with results and photographs presented in Table 17 and Appendix D (Photos 1 – 8) and shown in Figure 5.



Outside of the occurrences flagged in Table 17 (# 1-6), the offset habitat as constructed appears to be stable and remained in place when physically manipulated (i.e. pushed) by divers at various locations along the offset structure. No areas of depressions or slumping were observed.

**Table 17: Physical Stability Observations at Freight Dock Offset Habitat**

Number	Description	Photo Documentation
1	Small section of rock armouring (rip rap boulder) located outside the immediate habitat offset footprint. Located approximately 30 m west of FD-T5.	

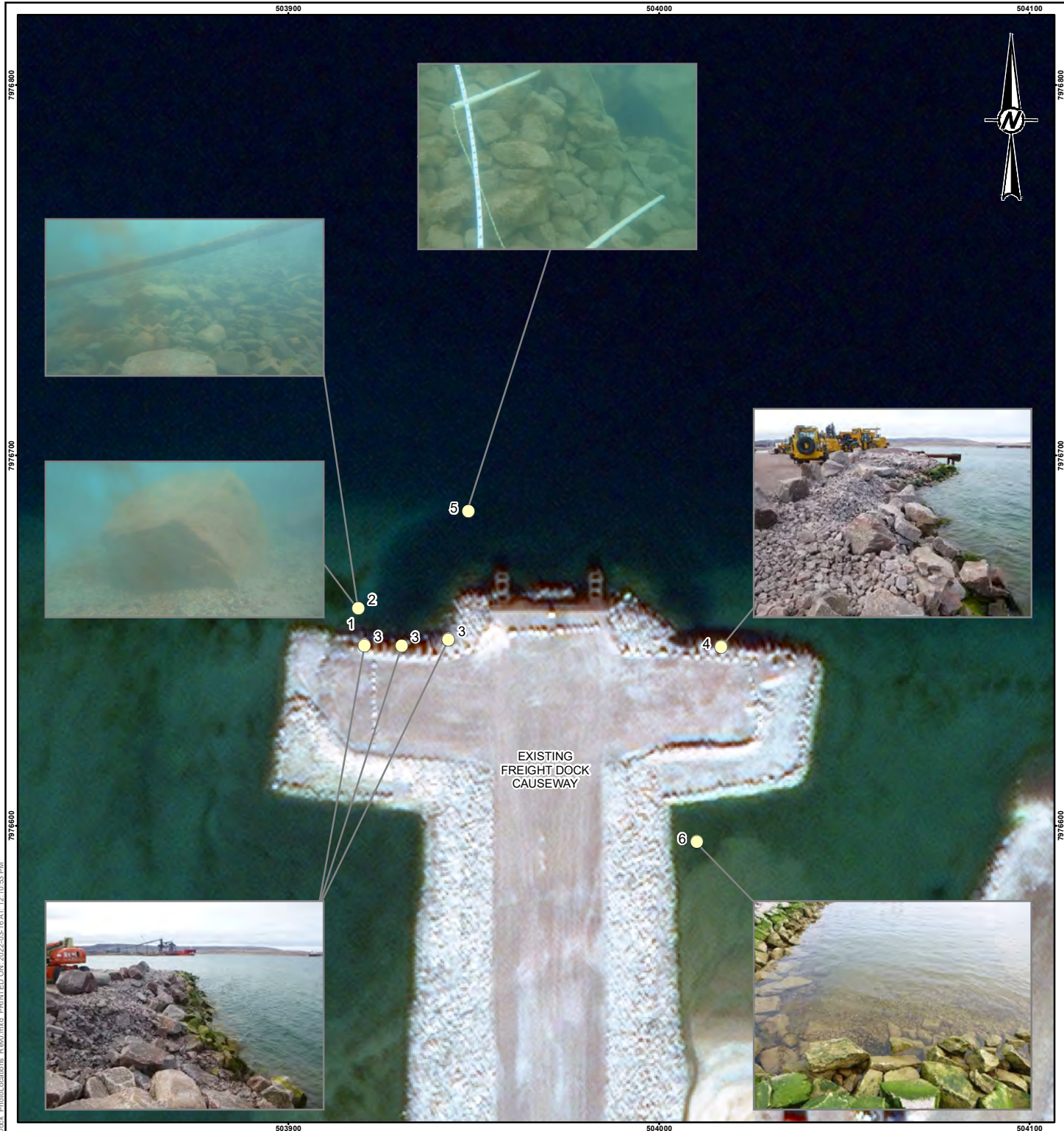
Number	Description	Photo Documentation
2	<p>Exposed crushed rockfill located approximately 30 m west of FD-T5.</p> <p>Dimensions: 3 x 1.5 m</p>	
3	<p>Three areas of exposed crushed rockfill with minimal rock armouring located approximately 10 m west of FD-T5. Two of the areas identified in the photograph in red circles.</p> <p>Dimensions: 2 x 4 m / area</p>	

Number	Description	Photo Documentation
4	<p>Exposed crushed rockfill with minimal rock armouring located approximately 10 m east of FD-T7.</p> <p>Dimensions: 3 x 8 m</p>	 <p>The photo documentation consists of three vertically stacked photographs. Each photograph shows a shoreline with a mix of large, angular rock armouring and smaller, crushed rockfill. Red circles are drawn around specific areas of crushed rockfill in each image. The top photo shows a yellow excavator in the background and a person standing on the shore. The middle photo shows a yellow excavator and a larger area of crushed rockfill. The bottom photo shows a closer view of the rockfill area near the water's edge.</p>

Number	Description	Photo Documentation
5	<p>Exposed crushed rockfill with minimal rock armouring located along FD-T5.</p> <p>Dimensions: 2 x 4 m at -6.1 m CD 2 x 1 m at -4.3 m CD (depicted in photo)</p>	
6	<p>Crushed rockfill extending outside of typical coarse substrate footprint at FD-T10 and FD-T11.</p> <p>Dimensions: 8 x 4 m</p> <p>Sediment observed at base of offset habitat (indicated by red arrow in photo). Sediment was not observed on offset habitat. Creek M11-1 enters the marine environment approximately 10 m to the south of photo.</p>	

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



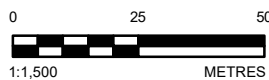


**LEGEND**

- PHOTO LOCATION

**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 2 FREIGHT DOCK MONITORING**

TITLE  
**PHYSICAL STABILITY PHOTOGRAPH LOCATIONS IN FREIGHT DOCK OFFSET HABITAT AREA**

CONSULTANT  
 YYYY-MM-DD 2022-03-16



**GOLDER**  
 MEMBER OF WSP

DESIGNED	KW
PREPARED	AJA
REVIEWED	PR
APPROVED	SR

PROJECT NO. 1663724 CONTROL 44000-05 REV. 0 FIGURE 5

PATH: I:\2018\1663724\Map\mxd\44000\_2021\_MEE\MP1663724\_44000\_05\_Frht\_Dock\_PhotoLocations\_Rev0.mxd PRINTED ON: 2022-03-16 AT: 12:10:03 PM

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25mm

## 4.0 SUMMARY

Table 18 provides a summary of the Year 2 monitoring results in comparison to the 10-year productivity metric targets (+/- 20% of reference area). These results indicate that the Freight Dock offset habitat is being colonized and is expected to continue to do so. The Reference Area is considered the late successional stage that the Freight Dock offset habitat is expected to be reached by Year 10.

**Table 18: Summary of Year 2 Habitat Offset Monitoring Results**

Indicators: Metrics	FAA Condition/ Monitoring Plan (Golder 2019a)	10-year Productivity Targets	Year 2 Monitoring Results at Freight Dock Relative to Target	Colonization Timing
Structural integrity	FAA Condition 5.1.1/ Section 2.3.4	Ongoing visual assessment	Areas of exposed rockfill foundation. The stability assessment planned for Year 5 (in 2024) will provide additional information on physical stability and whether remedial work is required.	Not applicable
Macroalgae: % cover	FAA Condition 5.1.1/ Section 2.3	+/- 20% of Reference Area	Intertidal: +/- 50% of Reference Area Upper subtidal: +/- 53% of Reference Area Shallow subtidal: +/- 67% of Reference Area	Immediate to medium; short to medium for kelp
Sessile invertebrates: % cover	FAA Condition 5.1.1/ Section 2.3	+/- 20% of Reference Area	Intertidal: +/- 0% of Reference Area Upper subtidal: +/- 60% of Reference Area Shallow subtidal: +/- 60% of Reference Area	Immediate to medium
Motile invertebrates: density, diversity	FAA Condition 5.1.1/ Section 2.3	+/- 20% of Reference Area	Intertidal: n/a Upper subtidal: n/a Shallow subtidal: +/- 30% of Reference Area	Immediate to medium
Fish: density, diversity	FAA Condition 5.1.1/ Section 2.3	+/- 20% of Reference Area	Intertidal: n/a Upper subtidal: n/a Shallow subtidal: +/- 10% of Reference Area	Immediate to medium
Arctic char prey species: density, diversity	FAA Condition 5.1.1/ Section 2.3	+/- 20% of Reference Area	Intertidal: n/a Upper subtidal: +/- 0% of Reference Area Shallow subtidal: +/- 30% of Reference Area	Immediate to medium

Notes: Motile invertebrates – diversity/density – no motile invertebrates were identified at Freight Dock offset habitat or Reference (Table 12) for intertidal or shallow subtidal.

Fish – density/diversity – no fish identified at intertidal or upper subtidal Reference Area and are therefore not assessed in Year 2 (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 2021 habitat offset monitoring program was designed to fulfill Year 2 monitoring requirements under Sections 5.1 and 5.2 of FAA #18-HCAA-00160 using diver-based transect/quadrat survey methods supplemented with photographs and video documentation. The objectives outlined in Section 1.2 were achieved, including documenting macroalgae, sessile and motile invertebrate and fish occurrence, and qualitatively comparing productivity metrics (i.e., percent cover, density, diversity) of the coarse substrate habitat between the Freight Dock offset habitat area and the established Reference Area.

Year 2 monitoring indicates that macroalgae, motile invertebrates, and fish continue to colonize the Freight Dock offset habitat. In general, taxa identified at the offset habitat were similar to those identified in the Reference Area. For macroalgae, the Freight Dock offset habitat supported low to moderate cover at all depth contours and documented taxa were predominantly ephemeral and faster growing macroalgae varieties (e.g., *Pylaiella* spp., *Desmarestia* spp., cf. *Urospora neglecta*) (Küpper et al. 2016). These results are consistent with observations of *Desmarestia* spp. and *Urospora* spp. during Year 2 monitoring of the existing Ore Dock offset habitat (SEM 2017).

Sugar kelp, an understory perennial kelp, was documented for the first time in the Freight Dock offset habitat area, and was limited to trace cover in the shallow subtidal. Sugar kelp was also recorded in limited cover at the Reference Area at the same depth contour. At the Ore Dock, kelp (i.e. *Laminaria* spp.) was first observed during Year 3 of monitoring and quantified at >50 to 75% cover along a transect on the west side of the Ore Dock in Year 4 of monitoring (Golder 2018). The existing kelp at the Ore Dock may be acting as a source for kelp propagules. Depth stratification of kelp as seen in the Reference Area is occurring as expected based on available literature on Arctic kelp (i.e., *Laminaria* sp., *Agarum* sp., *Alaria* sp.) which show an upper habitat limit of approximately -5 m, extending to 10 to 12 m depth with only patchy distributions reported below 15 m (Küpper et al. 2016). Both biotic and abiotic factors limit macroalgae colonization and growth. For example, in Arctic regions, perennial vegetation is often lacking from growing on shallow surfaces (to -3 m CD) where ice scour is most prominent (Küpper et al. 2016; Zacher et al. 2009). This was evident in the Reference Area with rockweed (*Fucus distichus*) growing in crevices between boulders and absent from exposed areas (Appendix D; Photo 26). Rockweed, a slower growing perennial, was not documented in Year 2 of monitoring. In comparison, rockweed was observed in trace cover in Year 2 and Year 4 of monitoring at the Ore Dock offset habitat. Perennial macroalgae taxa are slow growing compared to temperate regions and are indicators of later stages of colonization (Golder 2019a).

Similar to Year 1 monitoring in the Freight Dock offset habitat area, a detrital veneer was observed and recorded at most transect locations, though were not included as part of the macroalgae percent cover estimates. Detrital veneer on the seafloor is a natural biological component of the Arctic marine environment where organic matter sinks from surface water and throughout the water column onto the seabottom (Rossel et al. 2016). The amount of marine organic matter – a component of the detrital veneer - is largely seasonally influenced and driven by diatomic blooms (Mohan et al. 2016).

Sessile invertebrates were not present in the Freight Dock offset habitat area during Year 1 of monitoring, but were observed in Year 2 of monitoring in the form of a single unidentified tunicate species (*Tunicata indet.*) within the upper subtidal and shallow subtidal zones. The same tunicate species was also present in the Reference Area in all depth categories. Overall, sessile invertebrates were documented in low abundances across all depth contours in the Reference Area, with the highest cover and taxa richness observed in the shallow subtidal zone. The dominant species in this zone were wrinkled rock-borer clam (Appendix D, Photo 31) and four species of tunicates. It is expected that the coarse rock offset habitat will be increasingly colonized by sessile invertebrate taxa over time similar to colonization reported for the existing Ore Dock offset habitat by barnacles, bryozoans,



tunicates, clams (*Hiatella artica* and Blunt gaper; *Mya truncata*), scallops (*Chlamys islandica*), and sponges (Golder 2020).

Motile invertebrates were not observed in the intertidal or upper subtidal zones in either the Freight Dock offset habitat area or the Reference Area. However, several taxa were recorded in the shallow subtidal zone including green urchin, chiton, and brittle stars (Ophiuroidea indet.). These taxa were also observed in the Ore Dock habitat offset area during the early years of colonization (Golder 2019a). In general, motile grazers and scavengers such as crustaceans, echinoderms, and molluscs colonize habitats prior to sessile invertebrates (Bluhm and Gradinger 2008; Golder 2019a), which is consistent with Year 2 monitoring results for the Freight Dock offset habitat.

Several species of sculpin (Family Cottidae) were observed within the Freight Dock offset habitat area and the Reference Area. Fish community metrics (i.e., density and richness) were comparable between the Freight Dock offset habitat area and the Reference Area although fish were observed in lower densities compared to Year 1 of monitoring. Lower fish prey densities, particularly mysid shrimp, were also recorded in the Freight Dock offset habitat area and in the Reference Area compared to Year 1. Mysid shrimp are an important food source during the open-water season for marine birds and anadromous fishes, including Arctic char (Dunton et al. 2006).

Overall, the Freight Dock offset habitat appears to be providing 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 is exposed; these exposed areas may be vulnerable to erosion from seasonal abiotic processes (i.e., ice scour, wave action). The stability assessment planned for Year 5 (i.e., in 2024) will provide additional information on the physical stability of these areas and whether remedial work may be considered.

## 6.0 CLOSURE

We trust this information is sufficient for your needs at this this time. Should you have any questions or concerns, please do not hesitate to contact the undersigned.

### Golder Associates Ltd.



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NOB/KW/PR/SR/asd

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**APPENDIX A**

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



## 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<sup>2</sup> ([2,170] Habitat Equivalent Units) of fish habitat in Milne Inlet including:

- 12,829m<sup>2</sup> Intertidal marine habitat
- 12,357m<sup>2</sup> Subtidal marine habitat
- 1,263m<sup>2</sup> 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  $\mu$ Pa 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 20 $\mu$ Pa 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**

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Submitted by:

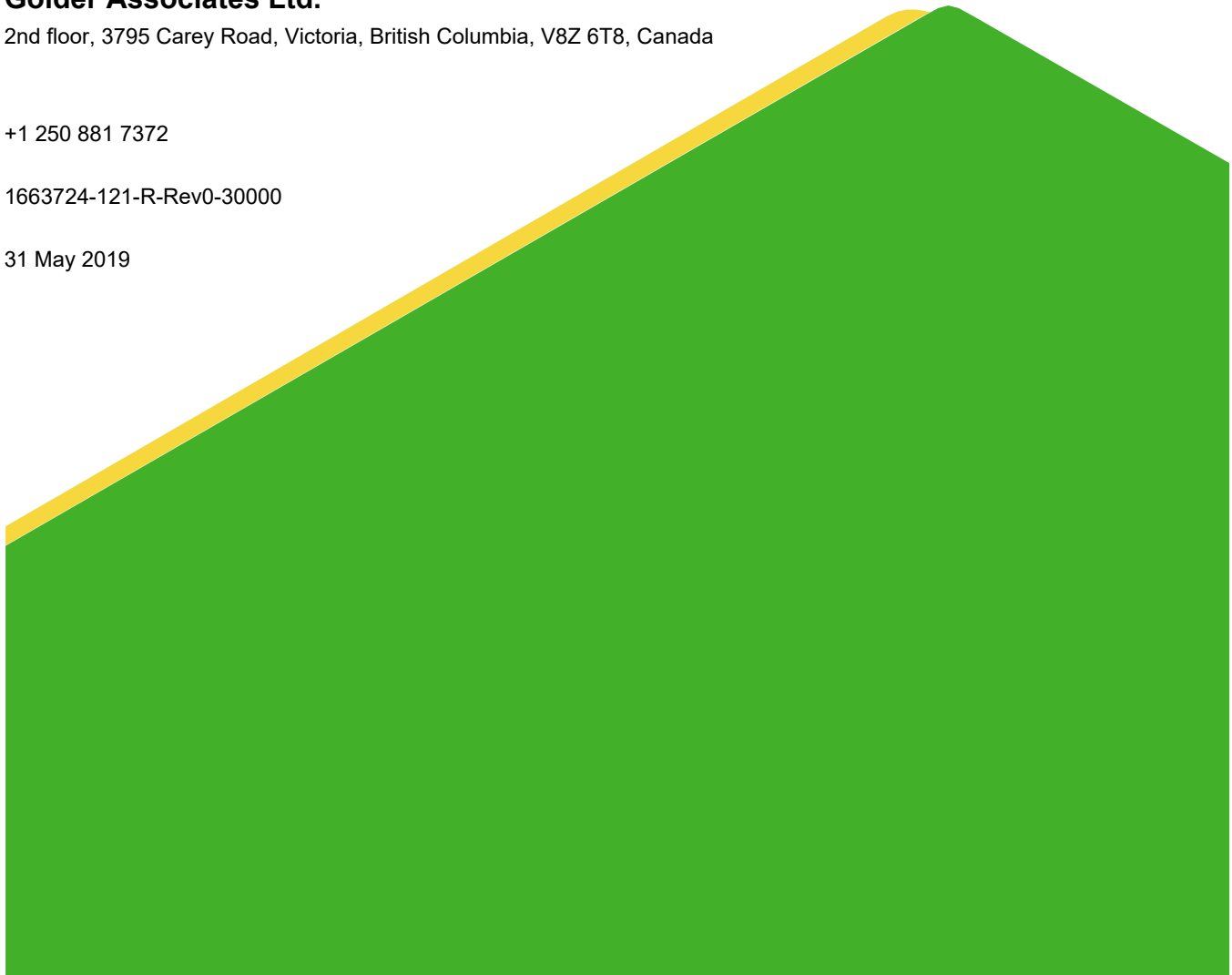
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31 May 2019



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Figure 1: Location of The Freight Dock In Milne Port and Relevant Locations

## **APPENDICES**

### **APPENDIX A**

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

### **APPENDIX B**

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

## 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<sup>2</sup> 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 localized 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<sup>2</sup> 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 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**

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

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.,  $\pm 10$  to 50%), a success metric of mean  $\pm 20\%$  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.

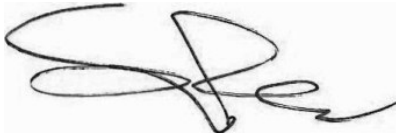
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Shawn Redden, RPBio  
*Associate, Senior Fisheries Biologist*

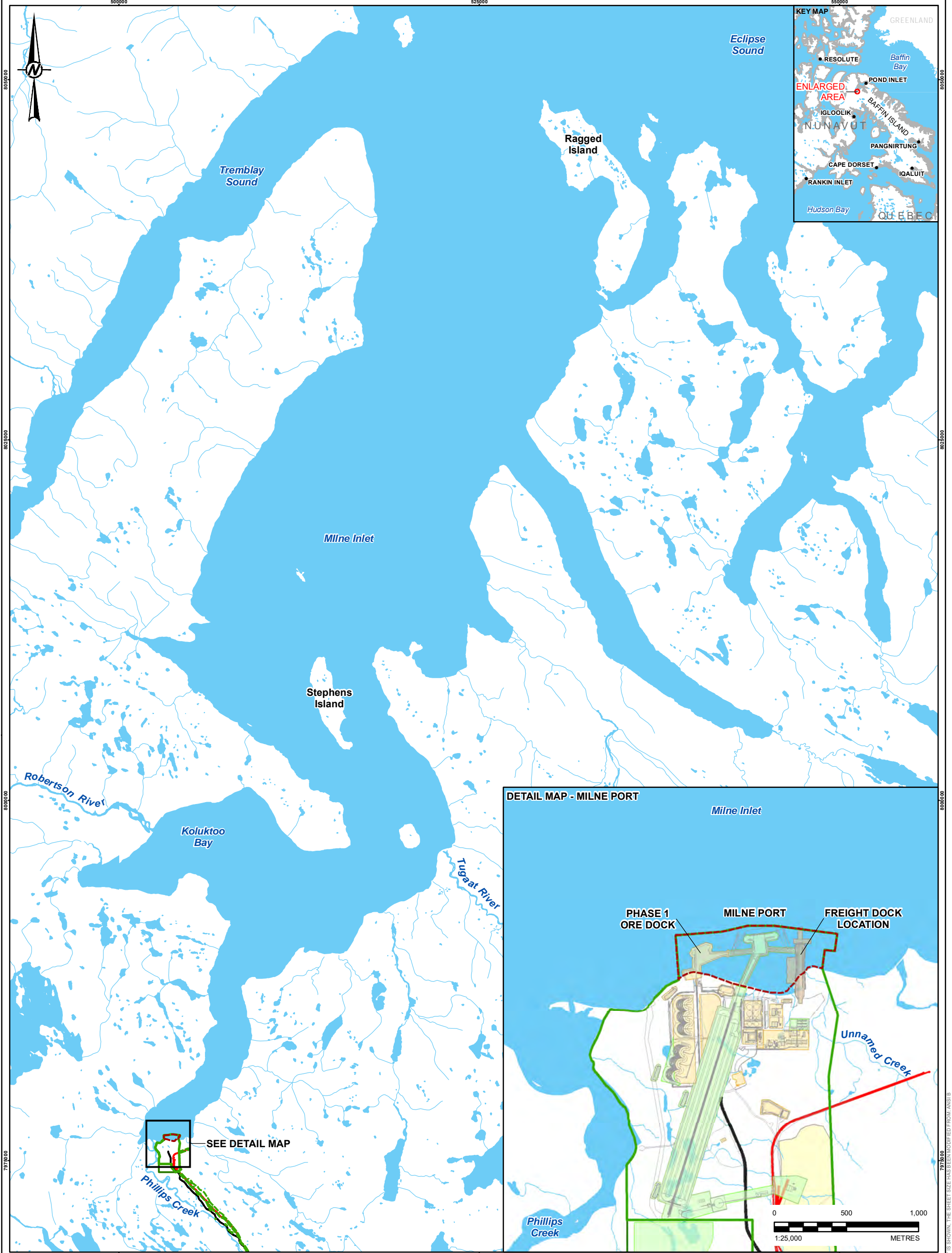
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## 6.0 REFERENCES

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- SEM (Sikumiut Environmental Management Ltd.). 2017. 2016 Milne Ore Dock Fish Offset Monitoring. Prepared for Baffinland Iron Mines Corporation. St. John's, NL: Sikumiut Environmental Management Ltd. SEM; 12 January 2017. 36 p.
- Smokorowski KE, Bradford MJ, Clarke KD, Clément M, Gregory RS, Randall RG. 2015. Assessing the effectiveness of habitat offset activities in Canada: Monitoring design and metrics. *Can. Tech. Rep. Fish. Aquat. Sci.* 3132: vi + 48 p.



- 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

**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. 1663724 CONTROL 32000-04 REV. A FIGURE 1

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM A3/B



**APPENDIX A**

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



## 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<sup>2</sup> ([2,170] Habitat Equivalent Units) of fish habitat in Milne Inlet including:

- 12,829m<sup>2</sup> Intertidal marine habitat
- 12,357m<sup>2</sup> Subtidal marine habitat
- 1,263m<sup>2</sup> 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  $\mu$ Pa 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 20 $\mu$ Pa 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**

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

## TECHNICAL MEMORANDUM

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### 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).

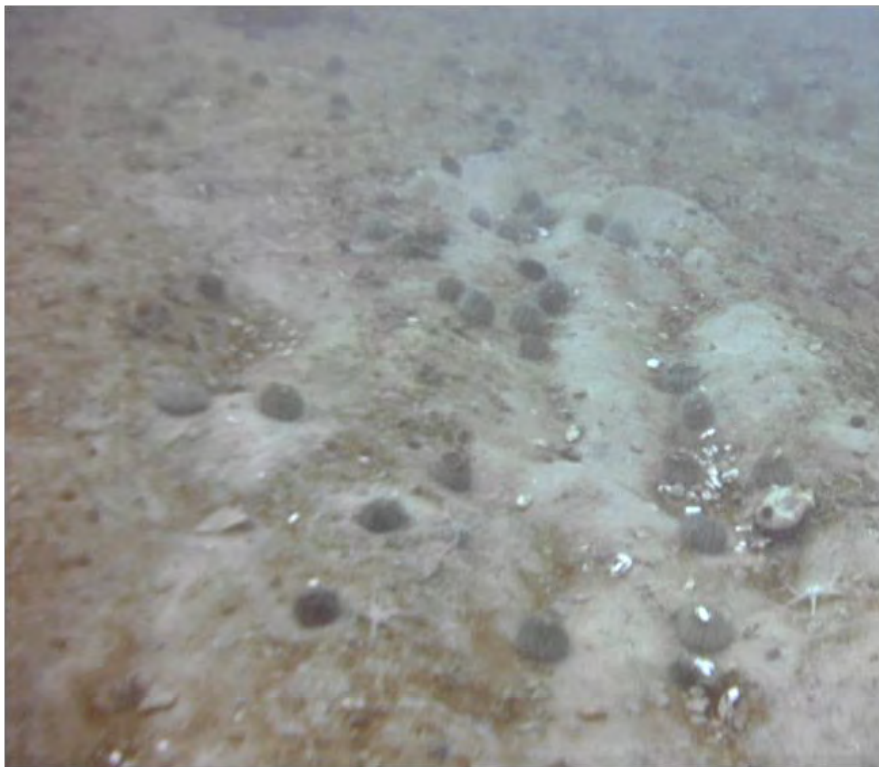
The objectives of this technical memorandum are to present results of a literature review that focused on substrate colonization in high latitude environments that presents the current state of knowledge regarding colonization potential of rocky reef and foreshore substrate in this environment, and to 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<sup>2</sup> 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 <sup>1</sup>
2016	Mammals	<i>Pusa hispida</i>	Ringed Seal	1
	Fish	Cottidae	Unidentified sculpin	7
		Zoarcidae	Unidentified eelpout	1
		<i>Boreogadus saida</i>	Arctic cod (juveniles)	Abundant
	Invertebrates	Cnidaria	Unidentified jellyfish	18
		Ctenophora	Unidentified sea gooseberry	6
		<i>Limacina helicina</i>	Sea butterfly	31
		<i>Strongylocentrotus</i> sp.	Unidentified sea urchin	9
		Ophiuroidea	Unidentified brittle stars	312
		<i>Pandalus</i> sp.	Unidentified shrimp	1
		Euphausiacea	Unidentified euphausiid	Abundant
	Zooplankton	N/A	Various species	Abundant
	Algae	<i>Urospora</i> sp.	Unidentified green algae	Patchy/Dense
		<i>Desmarestia</i> sp.	Unidentified brown algae	Heavy-full
<i>Chorda filum</i>		Brown algae	Low	
<i>Fucus</i> sp.		Unidentified wrack	Low	
2017	Fish	<i>Gadus odac</i>	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	<i>Myoxocephalus scorpius</i>	Shorthorn sculpin	1
		<i>Myoxocephalus quadricornis</i>	Fourhorn sculpin	5
		<i>Gadus odac</i>	Greenland cod	1
	Invertebrates	Cnidaria	Unidentified jellyfish	Abundant
		<i>Hiatella arctica</i>	Wrinkled rock borer	15
		Bivalvia	Unidentified bivalve	11
		<i>Limacina helicina</i>	Sea butterfly	24
Buccinidae	Unidentified whelk	1		

Year	Classification	Taxa	Common Name	Abundance <sup>1</sup>
		Echinoidea	Unidentified sea urchins	8
		<i>Ophiura</i> 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
		<i>Polycarpa</i> sp.	Unidentified tunicate	7
	Algae	<i>Desmarestia</i> sp.	Sour weed species	0-75% cover
		<i>Laminaria</i> sp.	Bladed brown kelp species	50-75% cover
		<i>Urospora</i> sp.	Unidentified green algae	0-75% cover
		<i>Fucus</i> sp.	Unidentified rockweed	0-10% cover

<sup>1</sup> 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	<i>Hiatella arctica</i>	29
	<i>Mya</i> sp.	2
Bryozoans	<i>Alcyonidium gelatinosum</i>	1
	<i>Alcyonidium disciforme</i>	1
	<i>Disporella</i> sp.	16
	<i>Disporella hispida</i>	7
	<i>Infundibulipora prolifera</i>	1
Polychaetes	<i>Circeis</i> 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**

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

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 heterogeneous 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.

### Golder Associates Ltd.



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CHB/DN/SR/lih

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

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## 8.0 REFERENCES

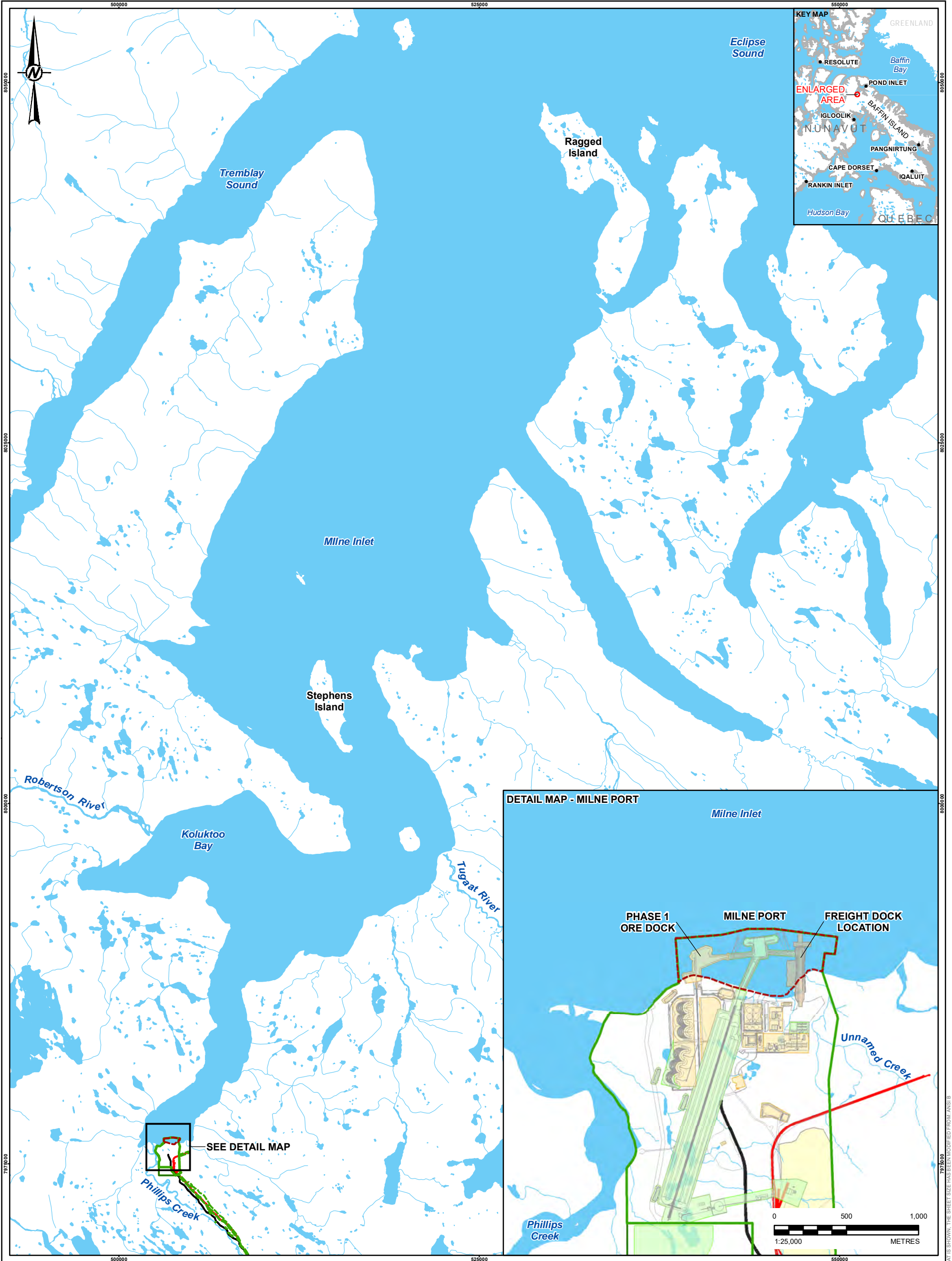
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- LEGEND**
- MILNE INLET TOTE ROAD
  - PROPOSED NORTH RAILWAY
  - WATERCOURSE
  - EXISTING ORE DOCK
  - PROPOSED FREIGHT DOCK AND CAUSEWAY
  - PROPOSED SECOND ORE DOCK AND CAUSEWAYS
  - PDA / QIA COMMERCIAL LEASE
  - REVISED PDA FOR PHASE 2 PROPOSAL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

**REFERENCE(S)**

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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. 1663724 CONTROL 32000-04 REV. A FIGURE 1

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM A3S TO B

**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](mailto:Laura.Watkinson@dfo-mpo.gc.ca). Please refer to the file number referenced above when corresponding with the Program.





Fisheries and Oceans    Pêches et Océans  
Canada                      Canada

Yours sincerely,

A handwritten signature in black ink, appearing to read 'Bev Ross', written in a cursive style.

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    Pêches et Océans  
Canada                      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:
  - 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 1 requires 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](mailto: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



Fisheries and Oceans    Pêches et Océans  
Canada                            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 Canada's 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](mailto:Laura.Watkinson@dfo-mpo.gc.ca).





Fisheries and Oceans    Pêches et Océans  
Canada                      Canada

501 University Crescent,  
Winnipeg, Manitoba  
R3T 2N6

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](mailto: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<sup>1</sup> and fish habitat<sup>2</sup>. 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

---

<sup>1</sup> 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;

<sup>2</sup> 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: East side of Freight Dock (facing northeast) during site visit on 18 August 2021 at 0.7 m tide. Green filamentous macroalgae observed on coarse rock substrate in intertidal zone.**



**Photo 2: North side of Freight Dock (facing east) during site visit on 18 August 2021 at 0.7 m tide. Green filamentous macroalgae observed on coarse rock substrate in intertidal zone.**





**Photo 3: North side of Freight Dock (facing northwest) during site visit on 18 August 2021 at 0.7 m tide.**



**Photo 4: North side of Freight Dock (facing west) during site visit on 18 August 2021 at 0.7 m tide. Green filamentous macroalgae observed on coarse rock substrate in intertidal zone.**





**Photo 5: West side of Freight Dock (facing south) during site visit on 18 August 2021 at 0.7 m tide. Green filamentous macroalgae observed on coarse rock substrate in intertidal zone.**



**Photo 6: West side of Freight Dock (facing southeast) during site visit on 18 August 2021 at 0.7 m tide.**



**Photo 7: West side of Freight Dock (facing north) during site visit on 18 August 2021 at 0.7 m tide. Green filamentous macroalgae observed on coarse rock substrate in intertidal zone.**



**Photo 8: West side of Freight Dock (facing west towards Ore Dock) during site visit on 18 August 2021 at 0.7 m tide.**





Photo 9: Sugar kelp (*Saccharina latissima*) observed during perimeter mapping of Freight Dock offset habitat in the shallow subtidal zone.



Photo 10: Green filamentous macroalgae (cf. *Urospora neglecta*) growing on Freight Dock offset habitat in the intertidal zone (Freight Dock Transect 2 [FD-T2]; 0.6 to 1.1 m Chart Datum [CD]).

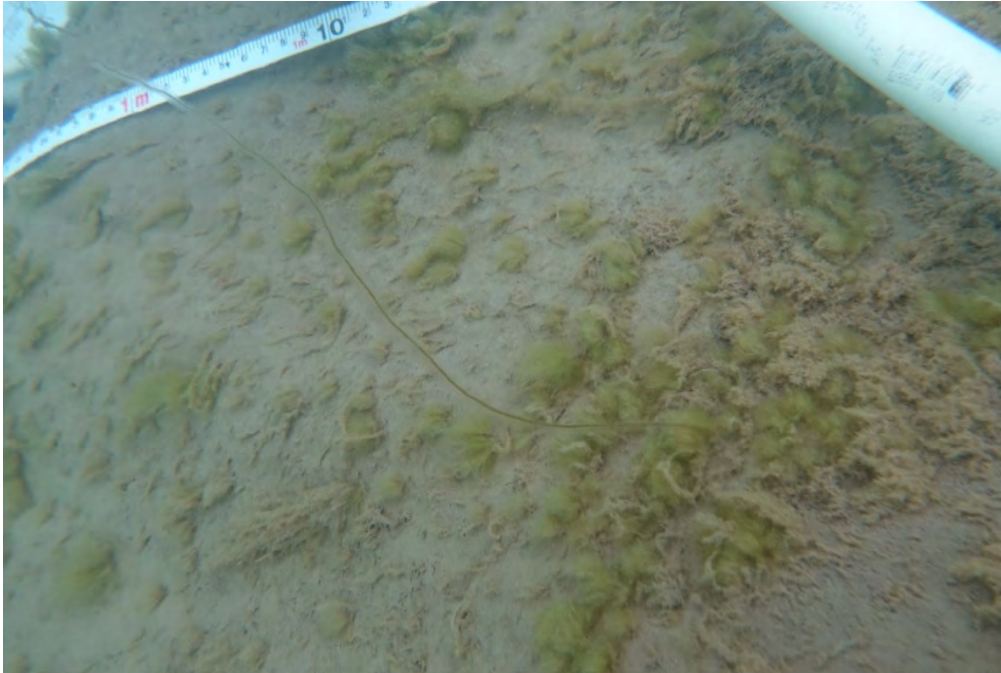


Photo 11: *Halosiphon tomentosus* (long strand in center of photo) and green filamentous tuft 1 macroalgae (*Chlorophyta* indet.) growing on Freight Dock offset habitat in the intertidal zone (FD-T4; -0.1 m CD).



Photo 12: Brown filamentous macroalgae and *Pylaiella* spp. Growing on Freight Dock offset habitat in the shallow subtidal zone (FD-T5; -4.3 to -7.0 m CD).





Photo 13: Green filamentous tuft macroalgae (*Chlorophyta* indet.) growing on Freight Dock offset habitat in the intertidal zone (FD-T8; 0.3 to -0.2 m CD).



Photo 14: Acid weed (*Desmarestia* spp.) growing on Freight Dock offset habitat in the shallow subtidal zone (FD-T7; -3.1 m CD).

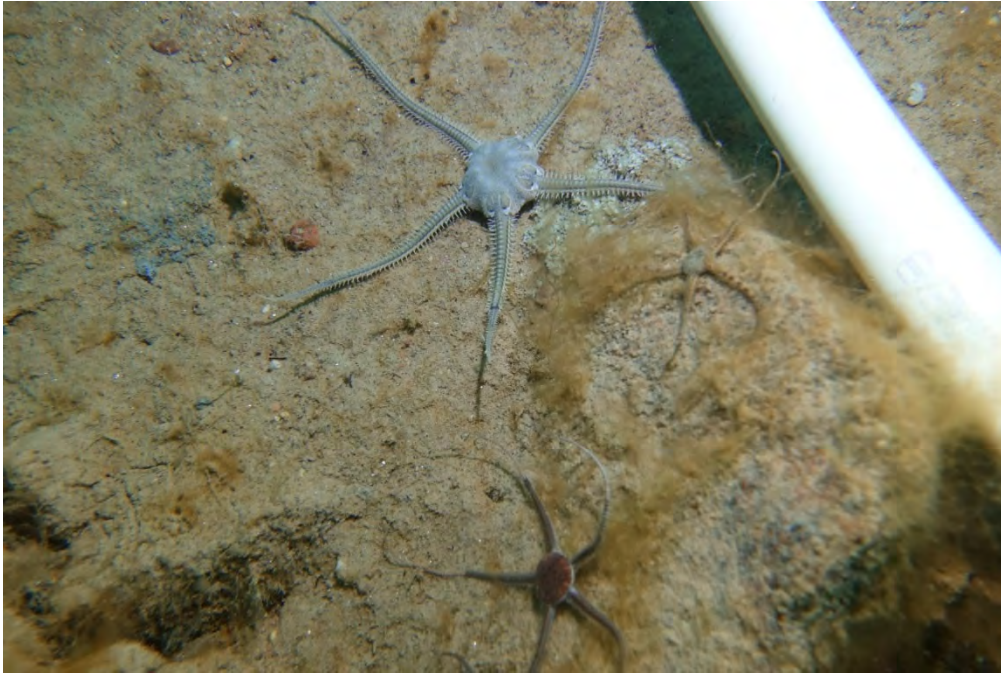


Photo 15: Unidentified tunicate spp. 3 (*Tunicata* indet.) and detrital veneer observed on Freight Dock offset habitat in the shallow subtidal zone (FD-T5; -4.8 to -6.1 m CD).

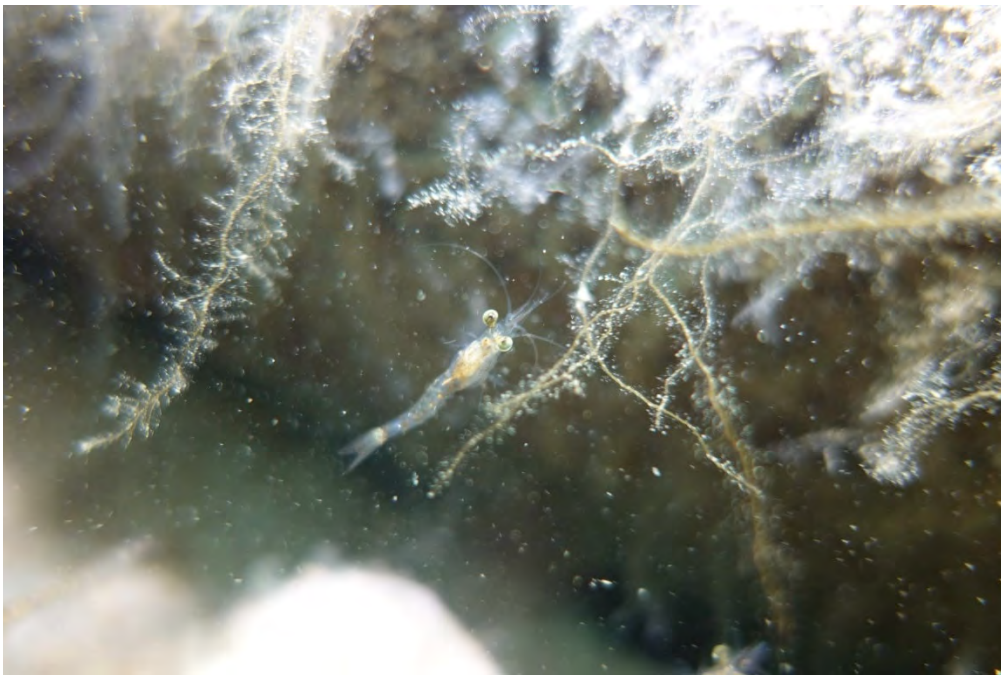


Photo 16: Green urchin (*Strongylocentrotus droebachiensis*) and acid weed (*Desmarestia* spp.) observed on Freight Dock offset habitat in the shallow subtidal zone (FD-T6; -8.7 m CD).





**Photo 17: Brittle stars (Ophiuridae indet.) observed on Freight Dock offset habitat in the shallow subtidal zone (FD-T6; -8.7 m CD).**



**Photo 18: Mysid shrimp (Order Mysida) observed in Freight Dock offset habitat area in the shallow subtidal zone (FD-T5; -6.1 m CD).**



**Photo 19: Juvenile sculpin (Family Cottidae) with green filamentous tuft (Chlorophyta indet.) algae recorded in Freight Dock offset habitat area in the intertidal zone (FD-T3; 0.0 to -0.4 m CD).**



**Photo 20: Fourhorn sculpin (*Myoxocephalus quadricornis*) observed during Freight Dock offset habitat perimeter mapping in the shallow subtidal zone.**



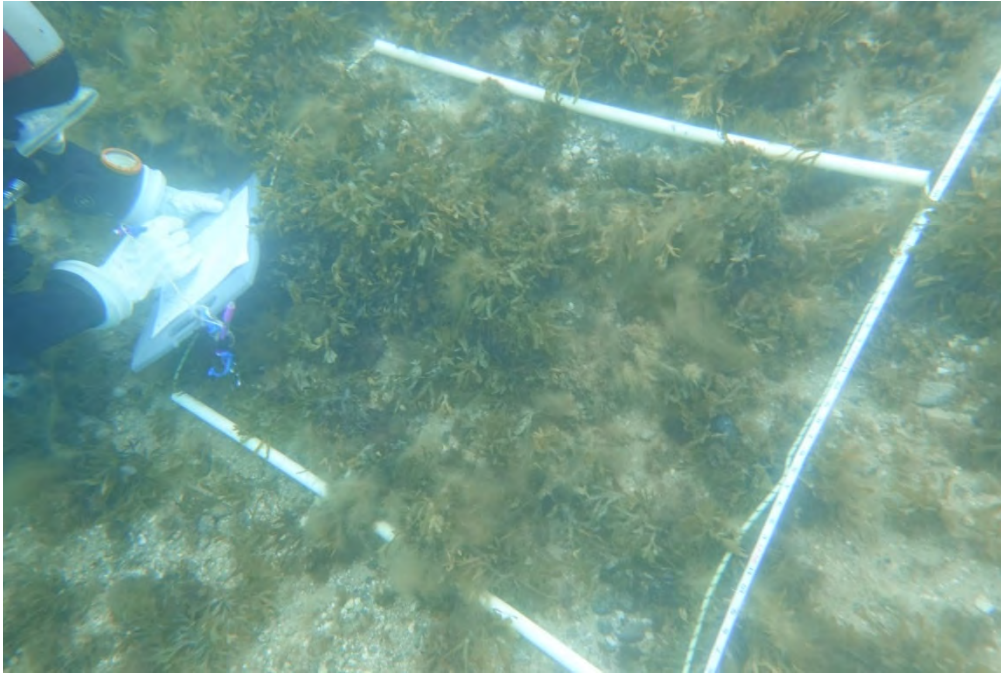


Photo 21: Diver surveying quadrat in Reference Area in upper subtidal zone (Reference Area Transect 4 [REF-T4]; -2.9 m CD). Rockweed (*Fucus distichus*) and *Pylaiella* spp. observed within quadrat.



Photo 22: Sugar kelp (*Saccharina latissima*), rockweed (*Fucus distichus*), *Pylaiella* spp., *Battersia* spp., green filamentous macroalgae (*Chlorophyta* indet.) and a tube worm casing (*Polychaeta* indet.) recorded in Reference Area in shallow subtidal zone (REF-T1; -7.4 m CD).



Photo 23: Sieve kelp (*Agarum clathratum*) and encrusting coralline algae (*Corallinales indet.*) observed in Reference Area in shallow subtidal zone (REF-T1; -15.1 m CD).



Photo 24: Red filamentous (*Rhodophyta indet.*), brown filamentous macroalgae, sugar kelp (*Saccharina latissima*), and unidentified barnacles (*Balanomorpha indet.*) observed in shallow subtidal zone in Reference Area (REF-T2; -4.9 m CD).





Photo 25: Rockweed (*Fucus distichus*), *Battersia* spp. and brown filamentous macroalgae observed in upper subtidal zone in Reference Area (REF-T1; -3.8 m CD).



Photo 26: Rockweed (*Fucus distichus*) and *Pylaiella* spp. observed in intertidal zone in Reference Area (REF-T4, 0.1 m CD).



Photo 27: Red foliose macroalgae (*Coccotylus truncatus*), rockweed (*Fucus distichus*), and encrusting coralline algae (Corallinales indet.) observed in shallow subtidal zone in Reference Area (REF-T1; -10.3 m CD).



Photo 28: *Dilsea socialis* observed in shallow subtidal zone in Reference Area (REF-T2; -4.9 m CD).



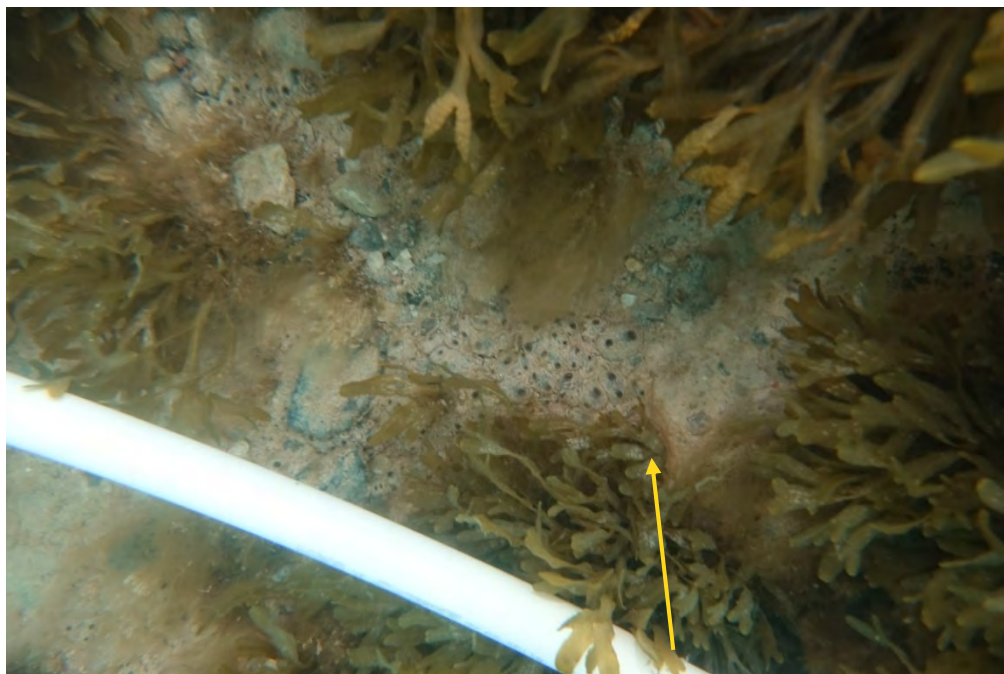


Photo 29: Unidentified tunicate spp. 3 (Tunicata indet.; yellow arrow) observed in intertidal zone in Reference Area (REF-T4; -0.4 m CD).

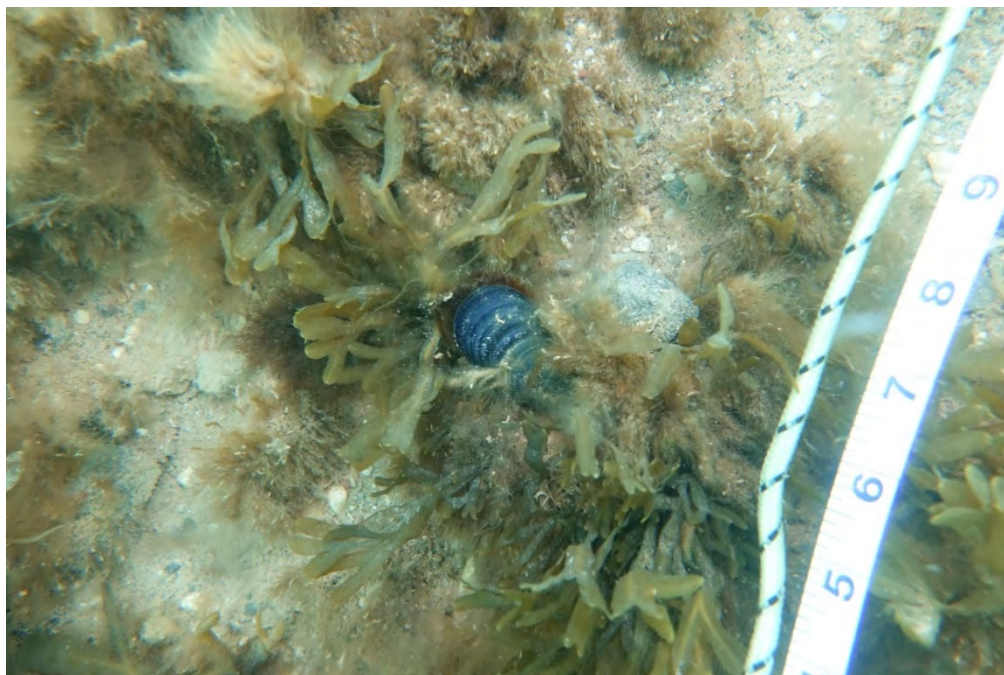


Photo 30: Unidentified mussel (*Mytilida* indet.), rockweed (*Fucus distichus*), *Battersia* spp., and *Pylaiella* spp. observed in upper subtidal zone in Reference Area (REF-T4; -2.9 m CD).



Photo 31: Wrinkled rock-borer clam siphons (*Hiatella arctica*) and encrusting coralline algae (*Corallinales indet.*) observed in shallow subtidal zone in Reference Area (REF-T4; -13.1 to -16 m CD).



Photo 32: Cone worm (*Cistenides granulata*), barnacles (*Balanomorpha indet.*), *Battersia* spp. and rockweed (*Fucus distichus*) observed in shallow subtidal zone in Reference Area (REF-T4; -5.2 m CD).





Photo 29: Creeping pedal cucumber (*Psolidae indet.*) observed in shallow subtidal zone in Reference (REF-T4; -16.0 m CD).



Photo 30: Unidentified anemone (*Actiniaria indet.*) observed in shallow subtidal zone in Reference Area (REF-T1; -10.3 to -15.1 m CD).



Photo 31: Chiton (*Tonicella spp.*) observed on encrusting coralline algae (*Corallinales indet.*) in shallow subtidal zone in Reference Area (REF-T4; -16.0 m CD).



Photo 32: Icelandic scallop (*Chlamys islandica*) observed in shallow subtidal zone in Reference Area (REF-T4; -16.0 m CD).





Photo 33: Sea spider (Class Pycnogonida) opportunistically observed along Transect 4 in shallow subtidal zone of Reference Area (-6.9 m CD).

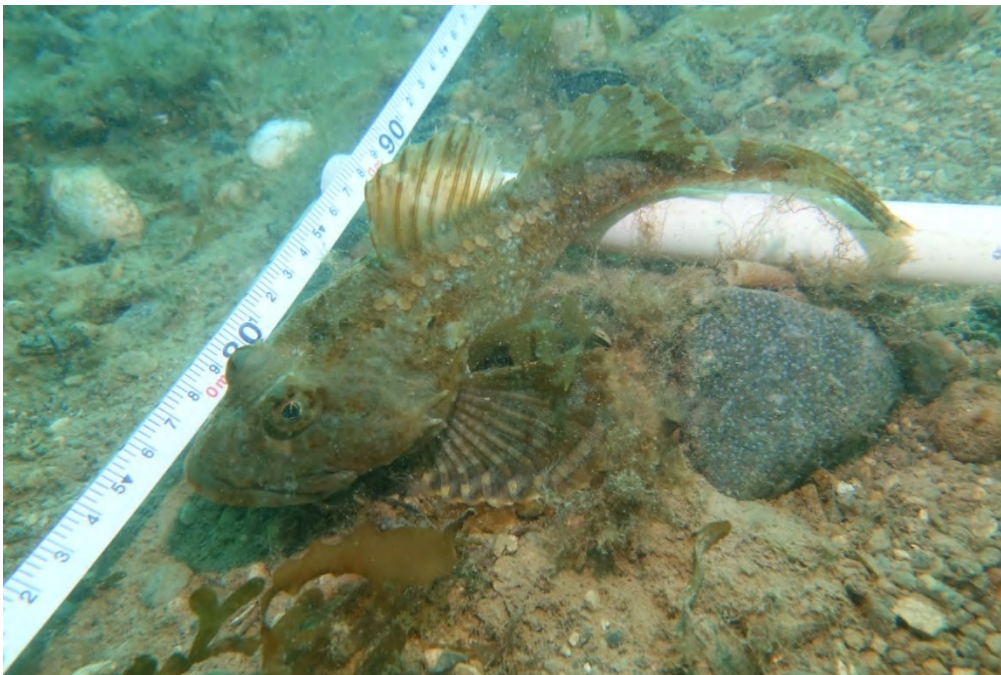


Photo 34: Shorthorn sculpin (*Myoxocephalus scorpius*) recorded in quadrat in shallow subtidal zone of Reference Area (REF-T2; -8.0 m CD).





Photo 35: Atlantic spiny lump sucker (*Eumicrotremus spinosus*) and sugar kelp (*Laminaria saccharina*) opportunistically observed along Transect 1 in shallow subtidal zone of Reference Area (-10.3 m CD).



Photo 40: Unidentified fish opportunistically in shallow subtidal zone of Reference Area (REF-T4; -13.1 m CD).

**APPENDIX E**

**Transect/Quadrat Survey Data**



**APPENDIX F**

**Taxa List**

**APPENDIX F**  
**Observed Taxa Identified During**  
**Year 2 Freight Dock Offset Habitat Monitoring**

<b>Marine Invertebrates</b>	
<b>Common Name</b>	<b>Scientific Name</b>
Mysid	<i>Mysida</i> indet.
Barnacle	<i>Balanomorpha</i> indet.
Tubes	<i>Polychaeta</i> indet.
Cone worm	<i>Cistenides granulata</i>
Creeping pedal sea cucumber	<i>Psolidae</i> indet.
Green sea urchin	<i>Strongylocentrotus droebachiensis</i>
Brittle star	<i>Ophiuridae</i> indet.
Anemone	<i>Actiniaria</i> indet.
Icelandic scallop	<i>Chlamys islandica</i>
Wrinkled rock-borer	<i>Hiatella arctica</i>
Clam	<i>Astarte</i> spp.
Blunt gaper clam	<i>Mya</i> spp.
Chiton	<i>Tonicella</i> spp.
Limpet	<i>Lottiidae</i> indet.
Mussel	<i>Mytilida</i> indet.
Ctenophore	<i>Ctenophore</i> indet.
Circular hairy tunicate	<i>Tunicata</i> indet.
White hairy tunicate	<i>Tunicata</i> indet.
Solitary orange tunicate	<i>Tunicata</i> indet.
Tunicate	<i>Tunicata</i> indet.
Bryozoan	<i>Bryozoa</i> indet.
Articulated brachiopod	<i>Brachiopoda</i> indet.
Arctic comb jelly	<i>Mertensia ovum</i>
Sea spider	<i>Pycnogonida</i> indet.
<b>Macroalgae</b>	
<b>Common Name</b>	<b>Scientific Name</b>
Sugar kelp	<i>Saccharina latissima</i>
Sieve kelp	<i>Agarum clathratum</i>
Rockweed	<i>Fucus distichus</i>
Pylaiella	<i>Pylaiella</i> spp.
	<i>Halosiphon tomentosus</i>
	<i>Battersia</i> spp.
Acid weed	<i>Desmarestia</i> spp.
Brown filamentous 1	cf. <i>Coelocladia arctica</i>
Brown filamentous algae	<i>Phaeophyceae</i> indet.
	<i>Coccotylus truncatus</i>
Dilsea	<i>Dilsea socialis</i>
Red filamentous algae	<i>Rhodophyta</i> indet.
Encrusting coralline algae	<i>Corallinales</i> indet.
Green filamentous tuft 1	<i>Chlorophyta</i> indet.
Green filamentous 2	cf. <i>Urospora neglecta</i>
<b>Fishes</b>	
<b>Common Name</b>	<b>Scientific Name</b>
Shorthorn sculpin	<i>Myoxocephalus scorpius</i>
Fourhorn sculpin	<i>Myoxocephalus quadricornis</i>
Sculpin	Family Cottidae
Arctic char	<i>Salvelinus alpinus</i>
Atlantic spiny lump sucker	<i>Eumicrotremus spinosus</i>
Unidentified fish	<i>Pisces</i> indet.





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