2016 Milne Ore Dock Fish Offset Monitoring

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EXECUTIVE SUMMARY

Baffinland Iron Mines Corporation (Baffinland) operates an approved iron ore mine (the Mary River Project) on North Baffin Island, Nunavut. The project includes transporting ore from the mine site to Milne Port for shipping during ice-free months. Baffinland completed the addition of coarse rock material around the perimeter of the Milne ore dock as a requirement under the Fisheries Act to offset effects associated with ore dock construction. Under the Fisheries Act Authorization issued for the project, Baffinland was required to undertake monitoring and reporting of the structural stability and biological utilization of offsetting measures at the Milne ore dock. SEM completed the second year of monitoring of the effectiveness of the fish offset in August 2016. Monitoring studies included: (i) underwater video surveys to assess the structural stability and examine for evidence of siltation and sediment; (ii) underwater video surveys to qualitatively evaluate biological utilization of the armour stone; (iii) use of artificial substrate baskets to monitor biological colonization (e.g., encrusting epifauna); (iv) use of larval traps for determining fish larvae occurrence; (v) zooplankton sampling for presence of ichthyoplankton; and (vi) use of Fukui traps to determine the presence of fish and mobile epifauna.

Two approaches were used in collection of underwater video. Video was collected by conducting transects both around the perimeter of the armour stone to view the shallow coarse rock and associated biota. Stationary drop camera video was collected with the camera oriented to capture a side view of the water column for a period of time without moving the camera.

Video transects documented the extents of the armour stone in the vicinity of the caisson. Video data were assessed for evidence of instability or movement of the armour stone and, generally, the coarse rock material was stable with no evidence of any movement or slumping. Video data were assessed for siltation and/or sedimentation and only minor indications of silt deposit on the armour stone were apparent in shallower areas protected from wave action. There was also limited evidence of fines along the caisson in an area of expected deposition of fines during ore loading and it is possible that prop wash from ore carriers is redistributing deposited fines. There was also evidence of possible bulk spillage of ore at one location along the caisson.

Monitoring of the biological utilization of the armour stone provided evidence of utilization by a wide variety of taxa representing several trophic levels. Observations of fauna included zooplankton; invertebrates including krill, mysid shrimp, sea urchins and brittle stars; juvenile

and adult fish including Arctic cod, sculpin species, and eelpout; and ringed seal. Observations of flora included four taxa of algae with green algae (*Urospora* sp.) and brown algae (*Desmarestia* sp.) being the most dominant taxa. The presence of organisms from all levels of the ecosystem provides evidence that the ore dock offset is supporting biological productivity at all trophic levels.

There was considerable evidence of algal production on the armour stone indicating sufficient nutrients were available to support this production. It is probable that terrestrially derived nutrients, from Robertson Creek to the east of the ore dock, is providing a nutrient source to support biological productivity at the offset. Krill or mysid shrimp were also in abundance and these taxa are an important food resource for Arctic char and Arctic cod, as well as seabirds, whales and seals. Arctic cod were present as juveniles, and in great abundance, and this species is also important forage for Arctic char, as well as other fish species, marine mammals, and birds. Presence of large schools of juvenile cod suggested successful reproduction in inner Milne Inlet or potentially in association with the ore dock.

The process of biological invasion and colonization of the offset habitats was expected to be slow. This was confirmed by slow colonization of settlement baskets deployed near the ore dock in 2014. Monitoring in 2016 has however indicated a more rapid process of biological colonization of the fish offset than expected with productivity evident at all trophic levels. This is encouraging and supports the underlying biological concept for the offset that increasing habitat complexity and heterogeneity will lead to increased biological productivity.

1.0 INTRODUCTION

The Mary River Project (the Project) is an approved iron ore mine and associated facilities located on North Baffin Island, in the Qikiqtani Region of Nunavut (Figure 1). The Project Certificate issued by the Nunavut Impact Review Board (NIRB) in 2012, was based on a series of Terms and Conditions that govern all aspects of the construction and operation of the mine, especially in relation to potential impacts on the natural environment. The proponent, Baffinland Iron Mines Corporation (Baffinland) submitted a proposal for an Early Revenue Phase (ERP) component of the project. The ERP involved transporting iron ore from the mine site over the Tote Road and stockpiling the ore at Milne Port for transport during ice-free months. Following the submission of an Environmental Impact Statement Addendum, the ERP was approved by NIRB in May 2014, and Project Certificate #005 was amended to reflect Project changes.

During the environmental assessment of the Mary River Project, it was determined by Fisheries and Oceans Canada (DFO) that the construction of the Milne Ore Dock would result in serious harm to fish that are considered part of a 'commercial, recreational or Aboriginal fishery, or serious, permanent change to ecosystem productivity that support such a fishery'. In order for the ore dock to be constructed, Baffinland committed to offsetting the serious harm in accordance with Section 36 of the Fisheries Act. Baffinland submitted a Fish Offset plan (SEM 2014a) to DFO which involved the addition of coarse rock substrate material around the perimeter of the ore dock to create fish habitat to offset losses associated with ore dock construction. The Minister of DFO subsequently issued a Fisheries Act Authorization (FAA, Fisheries Act Authorization 14-HCAA-00525, Appendix A) to permit the ore dock construction subject to the completion of the proposed offsetting.

The FAA also required Baffinland to undertake monitoring and reporting of the structural stability and biological utilization of offsetting measures at the Milne ore dock. Monitoring of the effectiveness of the fish offset was initiated in August 2015, and Sikumiut Environmental Management Ltd. (SEM) completed the second year of monitoring in August 2016. This report documents the 2016 monitoring of the fish offset at the Milne ore dock.

FIGURE ID: 070-025-1-011 Overview Map of the Mary River Project

Legend

- Site Locations
- Tote Road
- Milne Shipping Route

NOTES
1. BASE MAP: ESRI CANADA, DIGITAL CHART OF THE WORLD.

0 20 40 60 km

BAFFINLAND IRON MINES CORPORATION

MARY RIVER PROJECT

Overview Map of the Mary River Project

SEM

REF NO. **070-025-1-011**

FIGURE 1

REV 0

2.0 OBJECTIVES AND WORK SCOPE

The objective of studies in 2016 was to assess effectiveness of the fish habitat offset at the Milne ore dock by evaluating structural stability and biological utilization of the constructed fish habitat as described in the FAA 14-HCAA-00525.

The tasks associated with monitoring of the fish offset in 2016 included:

1. Complete video (underwater) and camera (above water) surveys to assess the structural stability of the coarse rock material and to examine for any evidence of siltation and sediment accumulation.
2. Use the underwater videography (above) to qualitatively evaluate the use of ore dock armour stone by marine biota, including periphyton, encrusting epifauna, other invertebrates and fish.
3. Deploy and retrieve artificial substrate collection baskets in the vicinity of the coarse substrate for monitoring benthic invertebrate production (encrusting epifauna).
4. Deploy larval traps for determining fish larvae occurrence.
5. Conduct zooplankton sampling for presence of ichthyoplankton.
6. Deploy Fukui traps to determine the presence of fish and mobile epifauna.
7. Complete a feasibility study, in cooperation with Baffinland environmental staff at Milne Port, to implement continuous video surveillance of the coarse rock substrate for utilization by the local fish community (this was deferred to a future year).
8. Complete a monitoring report on the status of the habitat offset for the ore dock in 2016.

3.0 MATERIALS AND METHODS

All appropriate approvals and permits were obtained from the Federal and Nunavut governments prior to the commencement of field studies. A copy of the DFO experimental fishing licence is provided in Appendix B. Approvals from DFO also included an approved Animal Use Protocol (AUP) which defined how experimental animals were to be handled during the survey program (Appendix B). The camp at Milne Inlet was used as the headquarters for all field studies. Work was conducted from August 5 to 21, 2016.

3.1 Field Team

The SEM field team for the fish offset monitoring included G. Vivian, C. Moore-Gibbons and J. Pennell. Studies were supported by vessel charter out of Pond Inlet with Inuarak Outfitting Inc. The vessel crew included L. Inuarak and R. Komangapik. The Project Manager for SEM was Dave Scruton while Niko Inuarak managed the vessel charter for Inuarak Outfitting Inc.

3.2 Platform Support

Two vessels were used during the field studies including an 8.0 m Silver Dolphin powered by two Evinrude 115 HP two-stroke outboard motors, and a 4.6 m Zodiac with a 20 HP Yamaha four-stroke outboard motor (Figure 2).

Figure 2 Silver Dolphin (left panel) and Zodiac (right panel) Used in Monitoring Studies at the Milne Ore Dock, 2016.

3.3 Safety

SEM has a well-developed Safety Management Plan and associated Standard Operating Procedures (SOPs) which were used to assess hazards associated with implementation of the FAA monitoring. SEM developed a Project Safety Management Plan specific to the activities, location, logistical requirements, and other considerations of the FAA monitoring. All SEM staff were fully briefed and trained in all aspects of the Safety Management Plan and team members were tasked with various levels of responsibility within this plan.

All field staff completed an on-line site orientation course and provided medical questionnaires to Baffinland site medical staff. Upon arrival at site and prior to commencing field work, a site survey and orientation of the vessels, including the location of PFDs and fire extinguishers, was completed. All field staff attended a Health and Safety Briefing presented by Baffinland. On a daily basis, prior to field crew departing the dock, a 'tool box' meeting was held to discuss daily activities, potential safety hazards and mitigations. An emergency response and communications plan was developed by SEM and submitted to Baffinland's on-site environment department. This plan included communications by radio or e-mail following the return to shore daily. In addition, an InReach satellite communicator/beacon was available for communications and emergency use during the entire field program.

3.4 Underwater Video – Structural Integrity

Underwater video provided the means to assess the structural integrity, extents and degree of siltation and sedimentation of the coarse armour stone around the ore dock's perimeter. Underwater video transects were conducted parallel to the ore dock to document the structural integrity of the offset.

Underwater video surveys involved the use of an underwater video camera system (Deep Blue Pro) with high powered LED lights, laser scaler, fins, weights and an umbilical cord connecting the camera assembly to the surface. The communication cable connected the camera to an onboard Panasonic Toughbook computer to permit data viewing and logging in real time. A GPS signal was logged every second, concurrent with the collection and storage of video data and time, and fed into the computer system to geo-reference the underwater camera track. In addition to the concurrent GPS feed, an inline GPS overlay utility was installed to embed live GPS information onto the raw video footage. This feature provided a quality control check when plotting the camera lines during post-processing. At the completion of each survey, the video data was backed up and archived on separate digital media (i.e., a portable hard drive). All data were digitally logged along with the necessary metadata information.

Around the perimeter of the ore dock armour stone, video was collected by securing the camera in a side-view orientation, intended to view the shallow armour stone and associated biota that surrounding the ore dock. Perimeter video was collected both at the surface and underwater. Stationary drop camera video was conducted by orienting the camera so that it would capture a side view of the water column. The camera was then lowered over the edge of the ore dock caisson and kept stationary while recording for a period of 5 to 10 minutes, allowing the marine fauna to become accustomed to the camera's presence and resume their normal activity. This was repeated six to eight times on both the east and west sides of the ore dock.

A laser scale was installed prior to operation, however, due to lack of consistent performance in the past, a ball weight was also installed approximately 1 m from the camera lens in the field of view to assist in gauging camera distance from the bottom. Both of these features provided a size reference for video interpretation. Depending on camera orientation and height above the bottom, a field of view of approximately 2 m on either side of the centerline (4 m frame of reference) was recorded.

3.4.1 Analysis and Interpretation

The video data were examined to assess the structural integrity of the armour stone in terms of evidence of any shifting and/or movement of the stone. Data were also used to assess evidence of siltation and sedimentation of the armour stone related to ore handling at the ore dock, or in relation to coastal sediment transport of fine materials.

3.5 Underwater Video – Biological Utilization

Underwater video provided a qualitative means to identify periphyton, macroflora, benthic epifauna including encrusting epifauna, and fish associated with coarse rock substrate at the Milne ore dock. Biological utilization was assessed from the video transects collected to assess stability and using stationary drop camera techniques from the zodiac and along the perimeter of the ore dock as described in Section 3.4 (above).

3.5.1 Analysis and Interpretation

All video data were examined by qualified biological technicians to identify flora and fauna to the lowest practical taxonomic level (LPL). Analyses of the imagery enabled the documentation of the presence and relative abundance of specific marine flora and fauna associated with the coarse rock substrate material.

3.6 Encrusting Epifauna

Settlement baskets for colonization by encrusting epifauna were deployed in 2014 and were retrieved in 2015 and redeployed as there was little evidence of biological colonization. Unfortunately in August 2016, the SEM field crew was unable to locate the settlement baskets deployed close to the Milne ore dock, despite considerable effort using the underwater video system to locate the baskets. It is unclear what happened to these baskets between 2015 and 2016, however it is possible they were inadvertently moved by the ongoing vessel activity at the ore dock.

Additional settlement baskets were again deployed in 2016 at the ore dock for colonization and these baskets will be collected and sampled at a future date, likely in 2018 based on the rate of colonization of the baskets deployed in 2014. Settlement baskets measured 16.5 cm in diameter and 28 cm in length and were filled with cobble ranging in size from 8 cm to 12 cm (Figure 3). Deployment location was recorded on a Garmin 76Cx GPS. The baskets were placed a group of three and joined by nylon rope and aviation cable. They were tethered to the west side of the ore dock at the southwestern edge of the caisson. The tethered cable will increase the likelihood of retrieving the baskets in future years, as well as preventing loss of the baskets due to ice scour. Upon retrieval, all encrusting epifauna on the cobble will be photographed and then removed by manual scraping into a sample container and preserved in 95% ethanol.

Figure 3 **Settlement Baskets Deployed for Monitoring Encrusting Epifauna at the Milne Ore Dock, 2016.**

3.6.1 Analysis and Interpretation

All encrusting epifauna samples will be sent to a qualified taxonomist for analyses. All organisms will be identified to LPL, typically genus or species, using a stereo-zoom microscope and/or compound microscope. Species abundance and number of taxa will also be determined for each sample and juveniles will be recorded separately. Taxonomic keys used for identification purposes will be identified. A validated reference collection will be maintained by the selected analytical laboratory.

3.7 Marine Fish, Larval Fish, and Mobile Invertebrates

Baited Fukui traps were used to collect marine fish and mobile invertebrates in the vicinity of the ore dock. Fukui traps measured 61 cm x 46 cm x 20 cm, with 1.25 cm stretch mesh and were baited with salted herring and mackerel placed in a plastic bait container that was checked after each haul and bait replaced as necessary. Traps close to the ore dock were deployed individually, with the exception of one set (FT-9) which was deployed as a set of ten traps arranged in series (Figure 4). Traps were located for retrieval by use of a handheld Garmin 76cx GPS and visually identifying the orange buoys at each end of the set. All fish and invertebrates collected were identified to species and released alive. All fish were sampled for length and weight and photographed (to help confirm the identification of sculpin species).

Figure 4 Fukui Traps Prepared for Deployment at the Milne Ore Dock, 2016.

Fish larval traps were deployed close to the ore dock armour stone in an effort to document presence of larval fish, which in turn could indicate reproductive activity associated with the ore dock (Figure 5). Larval traps were constructed of clear polycarbonate with tubes arranged in a cloverleaf shape, with a central tube where a light was inserted to attract organisms to the trap. Each unit measured 30 cm in diameter and 25 cm in height, with four entry slits each measuring approximately 5 mm wide. The collection dish attached to the bottom of each trap comprised a 250 μm mesh to filter catch during retrieval. Each trap was deployed in the water column, at least two metres off the bottom, by tethering to an anchor line. Traps were identified using orange floats at the surface and checked every 24 hours.

Figure 5 Fish Larval Traps Deployed in Milne Inlet, 2016.

During monitoring activities, the SEM field crew also observed a large number of juvenile fish between the docked ore vessels and the ore dock caisson. These fish were too large to enter the larval traps and too small to be retained in the Fukui traps, so the field crew improvised a juvenile fish sampler from a 500 mm sieve bucket and rope (Figure 6). The bucket was attached to the rope and lowered from the edge of the ore dock caisson approximately 1-2 m below the surface of the water. The bucket was observed for several minutes until juvenile fish were acclimated to its presence. Once fish were observed swimming over the top of the bucket, it was slowly raised until nearing the surface and removed from the water with a final jerking motion to collect the specimens.

Figure 6 Improvised Juvenile Fish Sampler Utilized at the Milne Ore Dock, 2016.

3.7.1 Analysis and Interpretation

Fish and invertebrate species collected at the ore dock were identified on site by the field crew. In cases where species identification was uncertain, photographs were taken and juvenile fish samples were preserved for subsequent identification. Species' identity was later confirmed by a qualified fisheries technician supported by reference documents such as Decker (2008) and Arctic Oceans Diversity (2016).

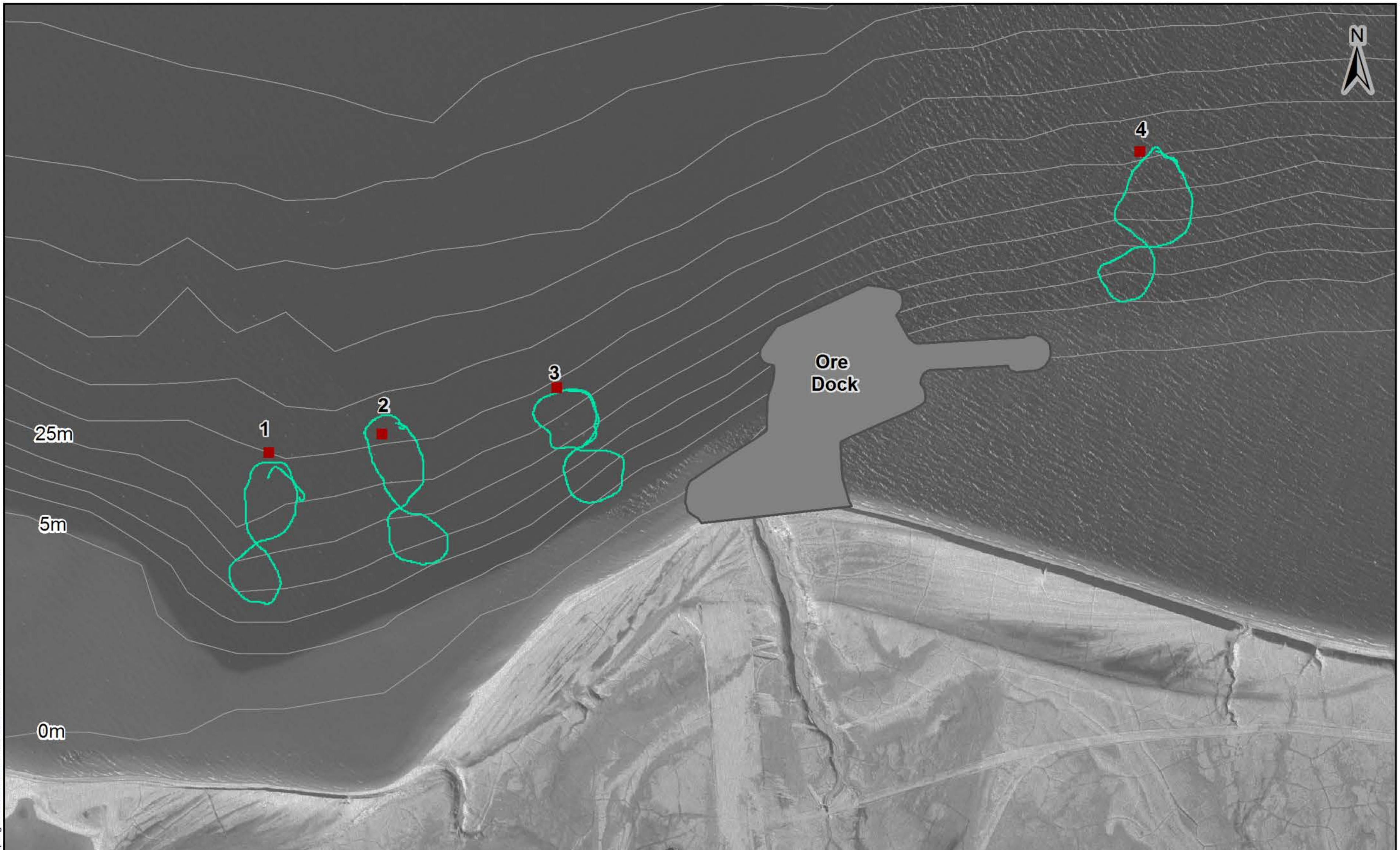
All catches from the larval traps and catches from the juvenile fish sampler were identified by a qualified fisheries technician supported by reference documents as required.

3.8 Zooplankton

Open water zooplankton samples were collected as part of an aquatic invasive species (AIS) monitoring program which was completed as part of a separate Marine Ecological Effects Monitoring Program (MEEMP). This sampling was primarily intended to more fully characterize the zooplankton community in the vicinity of the port site as well as to identify any species that could be considered non-native or invasive. The samples were also examined for the presence of ichthyoplankton that could indicate fish reproduction in the vicinity of the ore dock.

3.8.1 Sample Collection, Analysis and Interpretation

Zooplankton were collected by vertical tows with a 80 µm mesh plankton net and oblique tows using a 243 µm mesh plankton net at four sample locations (Figure 7). Vertical samples were collected by lowering the plankton net to 3 m above the bottom and retrieving the net to the surface at a rate of 1 m/s. Vertical samples were each composed of three composite tows. Oblique samples were collected by towing the plankton net at the water surface behind a vessel travelling 2-3 km/h for a period of ten minutes. Plankton samples were transferred to 250 ml glass jars. All samples were fixed in the field with 95% ethanol, labelled and packaged for shipment. Samples were sent to SpryTech Biological Services in Bedford, NS, for taxonomic analysis.



Legend

- Vertical Zooplankton Tow
- Horizontal Zooplankton Tow

NOTES
1. BASE MAP: COPYRIGHT EAGLE MAPPING, SATELLITE IMAGERY.
2. BATHYMETRIC CONTOUR INTERVAL: 5m
3. NUMBERS REFER TO SAMPLE ID

0 50 100 150 Meters

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Zooplankton Sampling Locations, Milne Ore Dock, 2016

SEM

REF NO. 070-026-1-002

FIGURE 7

REV 0

FIGURE ID: 070-026-01-002 Zooplankton Sampling Locations Milne Ore Dock 2016.mxd

4.0 RESULTS AND DISCUSSION

4.1 Underwater Video

Underwater video was collected in relation to assessing the armour stone placed at the Milne ore dock on August 13, 19 and 20. The lengths and water depths along the video transects recorded along the north side, or front, of the ore dock are presented in Table 1 and illustrated in Figure 8. Videos 1 to 3 were taken at increasing distance from the ore dock in order to document the extent of the armour stone placed at the base of the caisson. Data were also examined for structural integrity, evidence of siltation or sedimentation, and biological utilization of the armour stone in front of the ore dock along the caisson. This is the deepest area around the ore dock and also the location where any ore deposition as dust or spillage would be expected.

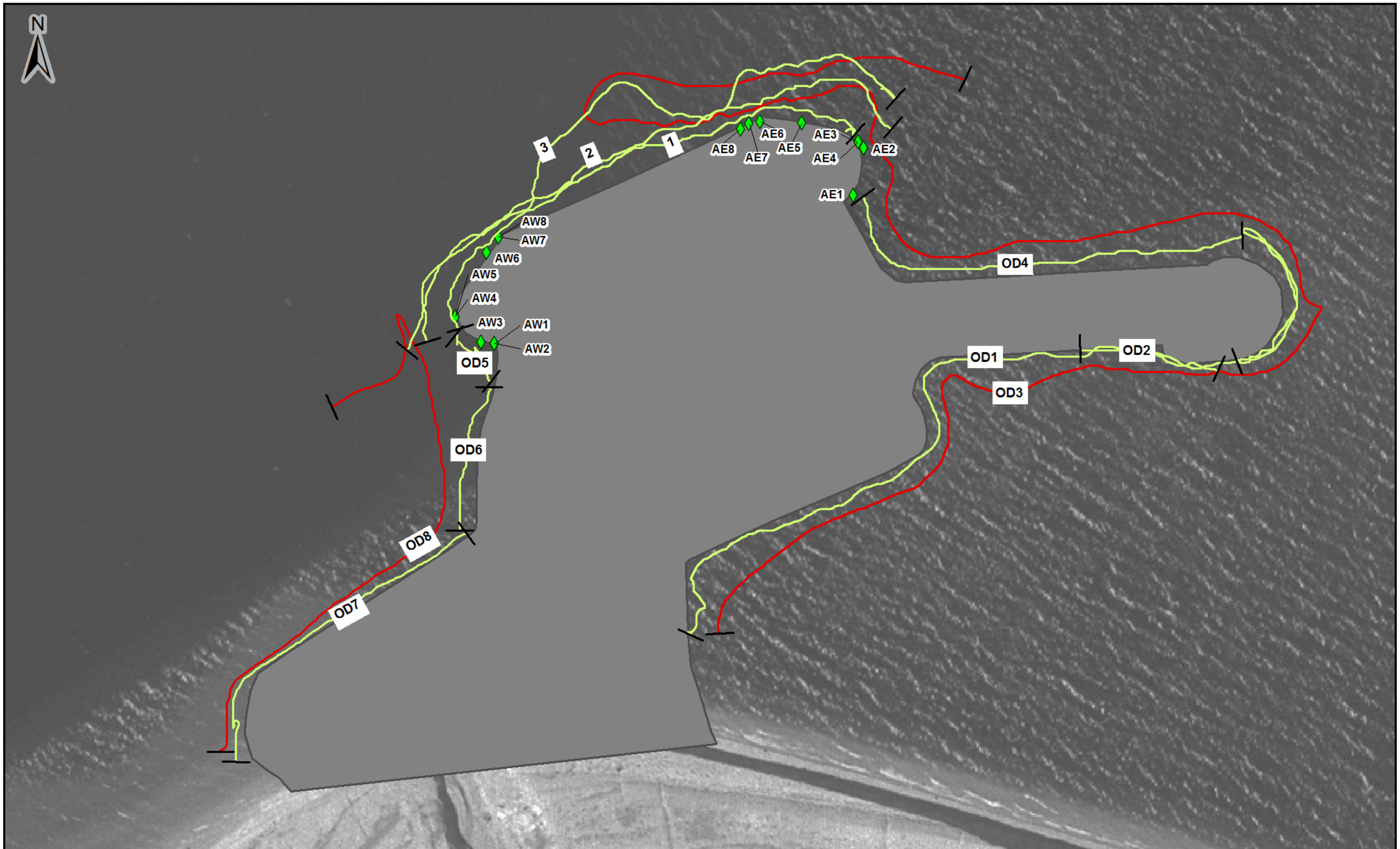
Table 1 Video Transects of Armour Stone at the Milne Ore Dock, 2016.

Armour Stone Video ID	Date (2016)	Location	Depth (m)	Length (m)
Near – 1	August 19	North Side (front) of Ore Dock	18-20	203
Mid – 2	August 19	North Side (front) of Ore Dock	20-22	211
Far – 3	August 19	North Side (front) of Ore Dock	22-24	241

Video transects conducted along the perimeter of the armour stone are illustrated in Figure 8, and the length (m) of each video transect is presented in Table 2. This video was also used to assess structural integrity, siltation or sedimentation, and biological utilization of the armour stone along the perimeter of the ore dock.

Table 2 Video Transects Along the Perimeter of the Milne Ore Dock, 2016.

Ore Dock Perimeter Video ID	Date (2016)	Location	Length of perimeter recorded (m)
OD1	August 13	Underwater – East Side of Ore Dock	371
OD2	August 13	Underwater – East Side of Ore Dock	47
OD3	August 13	Surface – East Side of Ore Dock	699
OD4	August 13	Underwater – East Side of Ore Dock	141
OD5	August 13	Underwater – West Side of Ore Dock	25
OD6	August 13	Underwater – West Side of Ore Dock	50
OD7	August 13	Underwater – West Side of Ore Dock	119
OD8	August 13	Surface – West Side of Ore Dock	224



Legend

- Vertical Drop Video
- Surface Video
- Underwater Video

NOTES
1. BASE MAP: COPYRIGHT EAGLE MAPPING, SATELLITE IMAGERY

0 30 60 90 Meters

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Underwater Video of Fish Habitat Offset, Milne Ore Dock, 2016

SEM

REF NO. 070-025-1-009

FIGURE 15

REV 0

FIGURE ID: 070-025-1-009 Underwater Video of Fish Habitat.mxd

The locations of drop camera video collection are presented in Table 3 and illustrated in Figure 8. These stationary video recordings were primarily used to evaluate utilization by fish and other biota of the armour stone as an offset for fish habitat.

Table 3 Locations of Drop Camera Video at the Milne Ore Dock, 2016.

Drop Camera Video ID	Date (2016)	Location	
		Easting	Northing
AW1 Armour-West-1	August 19	503228	7976604
AW2 Armour-West-2	August 19	503228	7976604
AW3 Armour-West-3	August 19	503224	7976605
AW4 Armour-West-4	August 19	503216	7976613
AW5 Armour-West-5	August 19	503216	7976613
AW6 Armour-West-6	August 19	503226	7976634
AW7 Armour-West-7	August 19	503230	7976638
AW8 Armour-West-8	August 19	503230	7976638
AE1 Armour-East-1	August 20	503344	7976652
AE2 Armour-East-2	August 20	503347	7976667
AE3 Armour-East-3	August 20	503345	7976669
AE4 Armour-East-4	August 20	503345	7976669
AE5 Armour-East-5	August 20	503327	7976675
AE6 Armour-East-6	August 20	503314	7976675
AE7 Armour-East-7	August 20	503310	7976675
AE8 Armour-East-8	August 20	503307	7976673
UTM NAD 83, Zone 17 coordinates.			

All of the collected video data were assessed by experienced marine technicians and a summary of the video data that were assessed, including the proportion of video data that was uninterpretable, is provided in Table 4. Any uninterpretable data was a result of the camera being out of the water, the camera being off the bottom and the image not in focus, or the recorded camera image either being black or blank.

Table 4 Locations of Video Data Collection at the Milne Ore Dock, 2016.

Location	Segment ID	Video Start and End Time	Video Length (m)	Total Video Length (m)	% Not Interpretable[1]
Extent Video	OD Front 1	0:00:01 – 0:09:52	203	655	9.9
	OD Front 2	0:00:01 – 0:08:49	211		
	OD Front 3	0:00:01 – 0:08:58	241		
Ore Dock Perimeter -East	OD1	0:00:01 – 0:11:56	371	1,117	0
	OD2	0:00:01 – 0:01:56	47		
	OD3	0:00:01 – 0:12:47	699		
Ore Dock Perimeter -West	OD4	0:00:01 – 0:03:48	141	1,542	0
	OD5	0:00:01 – 0:01:41	25		
	OD6	0:00:01 – 0:02:42	50		
	OD7	0:00:01 – 0:02:41	119		
	OD8	0:00:01 – 0:04:00	224		
Stationary Drop Camera -West	AW1	0:00:01 – 0:10:02	NA	NA	13.1
	AW2	0:00:01 – 0:10:03	NA		
	AW3	0:00:01 – 0:10:00	NA		
	AW4	0:00:01 – 0:11:41	NA		
	AW5	0:00:01 – 0:00:56	NA		
	AW6	0:00:01 – 0:13:46	NA		
	AW7	0:00:01 – 0:12:23	NA		
	AW8	0:00:01 – 0:01:29	NA		
Stationary Drop Camera -East	AE1	0:00:01 – 0:09:11	NA	NA	11.4
	AE2	0:00:01 – 0:10:33	NA		
	AE3	0:00:01 – 0:00:16	NA		
	AE4	0:00:01 – 0:10:56	NA		
	AE5	0:00:01 – 0:10:56	NA		
	AE6	0:00:01 – 0:13:57	NA		
	AE7	0:00:01 – 0:13:20	NA		
	AE8	0:00:01 – 0:03:31	NA		

[1] Video length analyzed was uninterpretable due to camera being out of the water, camera being off the bottom, image being out of focus, camera image being black or blank and other similar reasons.
OD – Ore Dock
AW – Armour West
AE – Armour East

4.1.1 Structural Integrity

Three video transects were completed to document the extents of the armour stone at the ore dock in the vicinity of the caisson. This was to supplement the video collected during as-built surveys in 2015 as the area around the caisson could not be surveyed at that time due to the constant use of the area by ore carriers. In 2016, maintenance of the ore loading equipment permitted SEM the opportunity to complete video transects of the armour stone extents around the caisson. The documented extents of the armour stone at the ore dock are provided in Figure 9.

Figure 9 Ore Dock Armour Stone Extents, Milne Ore Dock, 2016.

The underwater video data were assessed for any evidence of instability or movement of the armour stone from where it was initially placed during construction of the ore dock. Structural integrity could only be generally interpreted as it was not practical to replicate video surveys taken during as-built surveys. Generally, the armour stone was determined to be stable and there was no evidence of any movement or slumping. This was to be expected owing to the large and angular shape of the armour stone. Selected screen captures from the underwater video footage of the armour stone are provided in Figure 10.

Figure 10 Screen Captures for Video Documenting the Stability of Armour Stone at the Milne Ore Dock, 2016.

Similarly, the underwater video data were assessed for any evidence of siltation and/or sedimentation. There were only minor indications of silt deposit on the armour stone and much of it was evident in the shallower areas between the eastern 'finger' of the ore dock and the shoreline. This area is largely protected from wave action by the ore dock and is also the area where coastal transport of finer materials may be deposited over time. Previous studies determined that ocean circulation in Milne Inlet is primarily wind-induced and there is a weak clockwise circulation regime in the Inlet (CORI 2014). This current pattern suggested that fine sediments may be transported along the southern coastline of the inlet and deposited along the eastern extent of the ore dock due to localized disruption of the circulation.

The deposition of fines could be expected along the caisson from dust and spillage during ore loading, however, there was limited evidence of fines having been deposited there. It is possible that prop wash from the ore carriers in this area is playing a role in the redistribution of any deposited fines. There was indication of bulk spillage of ore at one location along the caisson (Figure 11).

Figure 11 Indication of Ore Spillage at the Milne Ore Dock, 2016.

4.1.2 Biological Utilization

A summary of the fauna identified in the underwater video data is provided in Table 5. Organisms were identified to the lowest taxonomic level possible based on interpretation of the images. Frequently, organisms could only be identified to genus (e.g., sculpins) or group (zooplankton) and some organisms were too numerous to count and were described as abundant. The underwater video observations confirmed there was a diversity of fauna associated with the armour stone at the ore dock, including marine mammals, fish, invertebrates and plankton.

Table 5 Fauna Identified Video Surveys at the Milne Ore Dock, 2016.

Common Name	Taxa	Drop Camera Video		Perimeter video		Extent Video
		West	East	West	East	
Marine Mammals						
Ringed seal	*Pusa hispida*	1 (3)				
Fish						
Sculpin sp.	*Cottidae sp.*	3	4		1	7
Eelpout sp.	Zoarcidae family		1			2
Arctic cod	*Boreogadus saida*	abundant	abundant			
Invertebrates						
Jellyfish	*Cnidarian sp.*	8	10			4
Sea gooseberries	*Ctenophore sp.*	6				11
Sea butterfly	*Limacina helicina*	12	19		1	14
Unidentified sea urchin	*Strongylocentrotus sp.*	2	7			257*
Brittle star	*Ophiuridea sp.*					312**
Shrimp	*Pandalus sp*.	1				1
Krill	*Euphausiacea*	abundant				
Plankton						
Zooplankton		abundant				

Notes:
*Urchins were classified separately as observed on armour stone (257) or sea floor (192)
**Brittle stars were only observed on sea floor.

Ringed seals were observed on the west side ore dock in the stationary drop camera video (Armour West 4), underwater and adjacent to the caisson (Figure 12). All three sightings were in the same video and within a four minute period suggesting it was likely the same seal observed three times. The association of the seal with the ore dock suggest the seal may have been foraging for food which provides evidence of the productivity of the armour stone. Ringed seals eat a variety of small prey including fish and invertebrates. Their prey of choice includes mysids, shrimp and arctic cod. Dunbar (1941) found that ringed seals in Baffin Island fed mostly on amphipods and mysids.

Figure 12 Ringed Seal Along the Armour Stone at the Milne Ore Dock, 2016.

A total of seven sculpin, not identified to species, and three eelpout were observed associated with the armour stone, providing evidence of adult fish utilizing the newly created fish habitat. These fish were likely using these habitats for cover/shelter and/or feeding. Large schools of juvenile fish were also observed along the caisson and these fish were later confirmed, based on collected samples, to be Arctic cod (Figure 13). The Arctic cod were observed in the stationary drop camera videos on both the east (East 6, 7 and 8) and west (West 4, 7, and 8) side of the ore dock and when observed were always in large schools. The Arctic cod, based on their size, were juveniles suggesting there was successful recruitment in the area. This provides evidence that the offset habitats are being used extensively by this species but could also be evidence of successful spawning by this species in association with the ore dock or the inner portion of Milne Inlet. This is the first time this species has been captured in inner Milne Inlet in fish sampling during three years of baseline data collection (2010, 2013, 2014) and one year of monitoring (2015), although Arctic cod have been previously found in the stomach contents of fish captured in Milne Inlet.

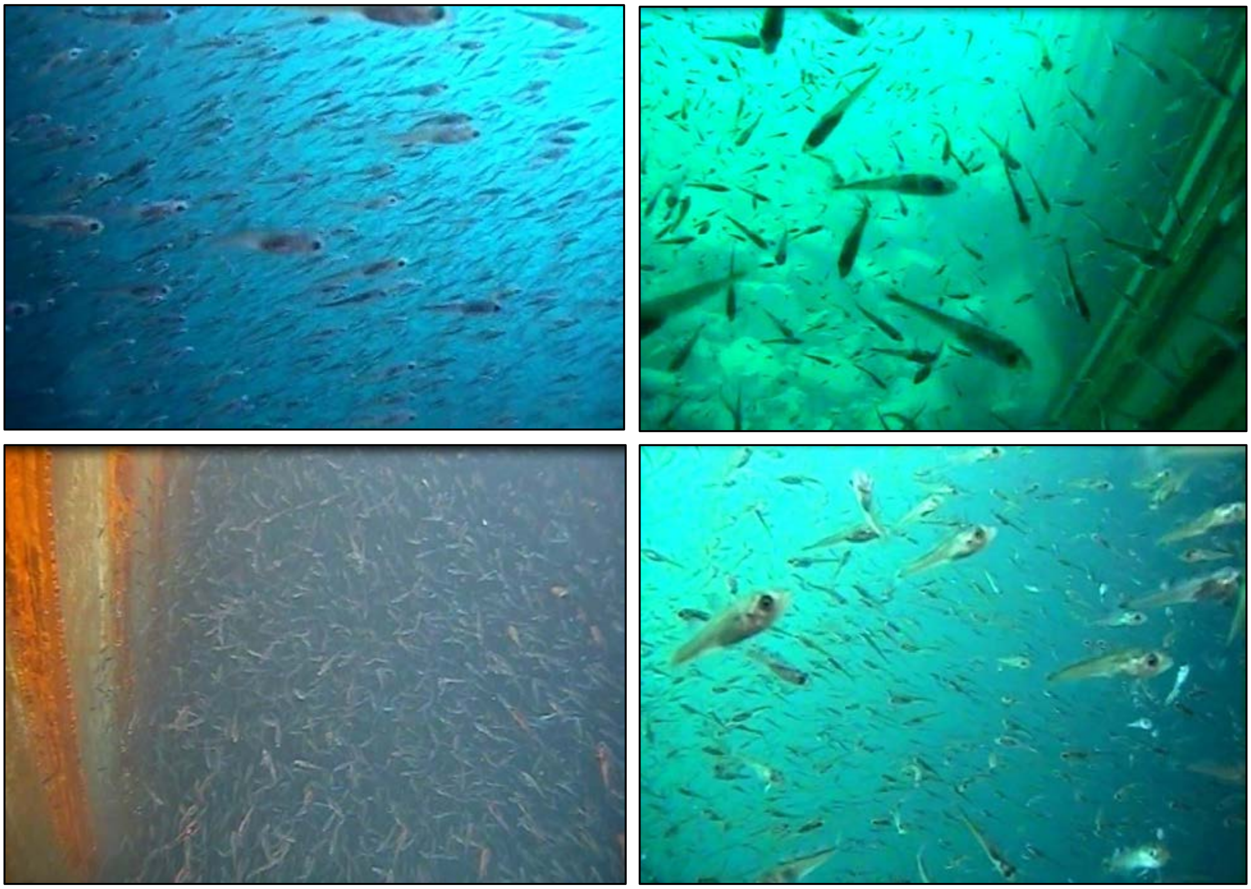

Figure 13 Schools of Juvenile Arctic Cod at the Milne Ore Dock, 2016.

Arctic cod are an important component of marine food webs (Bradstreet 1982: Bradstreet *et al*., 1986; Hobson and Welch, 1992), and are the most abundant forage fish in the high Arctic (Lowry and Frost, 1981). Craig *et al.* (1982) noted Arctic cod as a 'key species in the Arctic ocean ecosystem based on abundance, widespread distribution and importance in the diets of marine mammals, birds and other fish'. Bradstreet *et al*. (1986) identified Arctic cod as the major link in the transfer of energy from lower to higher trophic levels. Arctic cod are a key seasonal food resource for Arctic char when they do most of their feeding and growth in the marine environment. As such, nearshore habitats are considered to be a key marine habitat component for juvenile and adult stages of Arctic cod and these nearshore habitats would be utilized during the ice free period, extending from July to September.

A wide variety of invertebrates were also observed on the armour stone including crustaceans (shrimp, krill), Cnidarians (jellyfish), Echinoderms (brittle stars, sea urchins), gastropods (sea butterfly) and Ctenophores (sea gooseberries) and these organisms are a subset of the invertebrate fauna documented in previous baseline (SEM 2014b, 2015) and monitoring (SEM 2016) studies.

Krill or possibly small mysid shrimp were observed in the stationary drop camera videos on the west side of the ore dock (West 1, 2 and 3) and when observed were in abundance (Figure 14). The addition of coarse rock material as an offset at the Milne ore dock was completed to provide additional habitat for both amphipods and mysids and increased cover for sculpin and other fish species in the inner Milne Inlet (SEM 2014a). Amphipods and mysids are important in the diet of Arctic cod, and mysids and cottidae larva were found in Arctic char stomachs sampled in Milne Inlet in 2010. This enhanced productivity was also to provide an increased food resource for both Arctic char and Arctic cod to offset impacts on fish habitat related to ore dock construction.

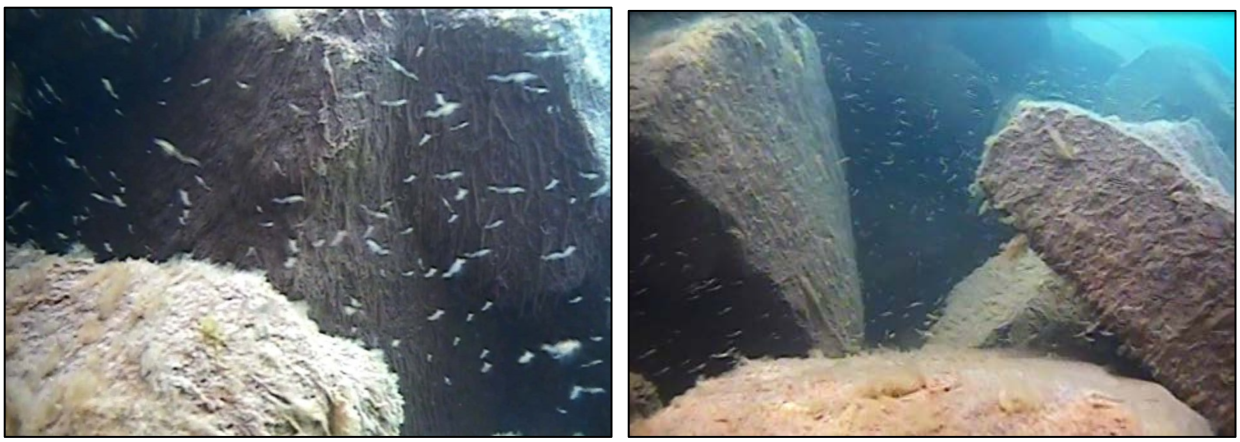

Figure 14 Krill or Small Shrimp Associated with the Armour Stone at the Milne Ore Dock, 2016.

The observation of krill or mysid shrimp in the video is an important observation in relation to the productivity of the armour stone. Krill or mysid shrimp are small swimming crustaceans that live in schools and are an important food resource for whales, seals, fish, squid and seabirds, and many animals have developed morphological adaptations for harvesting krill. Krill and shrimp are an important link in Arctic food webs providing the linkage between lower trophic levels (phytoplankton and zooplankton) and the higher predators. Adult krill are more often associated with deeper waters, especially during winter, while juveniles are usually found at the surface of inshore waters under ice or during the open water period.

The underwater video determined that sea urchins were frequently observed in association with the armour stone and the sea floor adjacent to the ore dock (Figure 15). Brittle stars were also abundant on the sea floor adjacent to the ore dock but were not observed to be using the armour stone as habitat. The observation of these two species in proximity to the ore dock is important as it suggests the sea floor habitat was not significantly disturbed during ore dock construction. Sea urchins have a very diverse diet and utilize various feeding modes including herbivory and grazing, omnivory and scavenging, and predation. Urchins feed on a wide variety of plant and animal matter including kelp and other algae, dead fish, sponges, mussels and barnacles. Green sea-urchins (*Strongylocentrotus droebachiensis*) strongly prefer brown kelps (*Laminaria* sp.) however will eat most algal species. The presence of urchins on the armour stone is likely confirmation of good algal production.

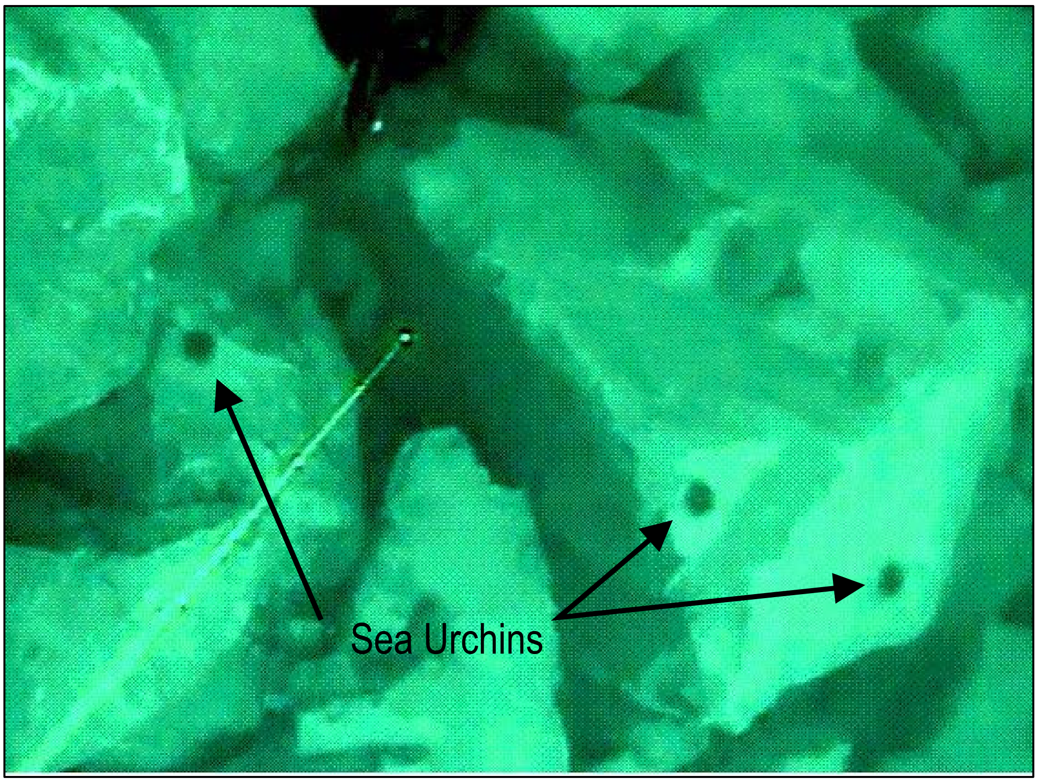

Figure 15 Sea Urchins on the Armour Stone at the Milne Ore Dock, 2016.

The plankton identified in the video were most likely zooplankton as phytoplankton would be much smaller and harder to observe in the video. The plankton, when observed, were in large concentrations in the water column. The plankton were too small to permit more detailed identification and could possibly be planktonic fish eggs and/or larvae (ichthyoplankton), juvenile krill or mysid shrimp. The observation of plankton is also important as it provides evidence of biological productivity at lower trophic levels. Primary production via photosynthesis is a key process and forms the base of food webs in the oceans. Zooplankton then feed on the phytoplankton and zooplankton themselves become a key food resource for krill or mysid shrimp as well as juvenile Arctic cod.

A summary of the macroflora identified in the underwater video data is provided in Table 6. The macroflora were identified to the lowest taxonomic level possible, genus, species or vegetation class, based on interpretation of the images. The occurrence or relative abundance of the algal types were not determined, however the underwater video confirmed there was a variety of flora associated with the armour stone at the ore dock.

Table 6 Flora Identified in Video Surveys at the Milne Ore Dock, 2016.

Common Name	Taxa	Stationary Drop Camera Video		Perimeter video		Extent Video
		West	East	West	East	
Green algae	*Urospora sp.*			X	X	
Brown algae	*Desmarestia sp.*	X	X	X	X	
Brown algae	*Chorda filum*			X	X	
Wrack	*Fucus sp.*					X

Urospora sp., a green algae, was an important component of the algal growth on the ore dock armour stone. This algae had a relatively dense covering of 95-100% of the armour stone on the east side of the caisson, and the density became less with depth. On the west side of the caisson the density was less, covering about 70% of the armour stone. An example of the dense growth of Urospora sp. is provided in Figure 16.

Figure 16 Growth of *Uropsora* sp. on the Armour Stone at the Milne Ore Dock, 2016.

Desmarestia, a genus of brown algae found in shallow intertidal areas, was a dominant algae associated with the armour stone at the ore dock. *Desmarestia* sp. had heavy, almost full, coverage on all armour stone and caisson surfaces on the east side of the caisson with the coverage decreasing with increasing depth. On the west side of the caisson, *Desmarestia* sp. also completely covered the armour stone in the shallower areas, also decreasing in coverage with increasing depth. Generally, *Desmarestia* sp. density was greater in shallower waters and decreased with increasing depth (Figure 17).

Figure 17 Presence of *Desmarestia* sp. on the Armour Stone at the Milne Ore Dock, 2016.

Chorda filum, a brown algae, are commonly found in sheltered areas in lower intertidal and shallow subtidal habitats anchored to substrate materials of a variety of sizes. *Chorda filum* was only observed on the east side of the caisson in low abundance and only growing on the seabed.

Fucus, a genus of brown algae found in the intertidal zones of rocky shorelines, was observed in very low abundance in the deeper areas associated with the caisson.

The observed macroflora were a sub-set of flora identified during baseline surveys in the Milne Port area in 2013. In 2013, brown algae was the dominant macroalgal group present at the Milne Port site and consisted of *Desmarestia* sp., *Fucus* sp., *Laminaria* sp. and *Agarum cribrosum*. Green algae (*Ulva lactuca*) were also observed in very low abundance.

4.2 Encrusting Epifauna

As previously indicated, settlement baskets deployed in 2014 for colonization by encrusting epifauna were not retrieved as they could not be located. Three additional settlement baskets were deployed in August 2016, with plans to retrieve the baskets in 2018.

4.3 Marine Fish, Larval Fish, and Mobile Invertebrates

Fish catches from the larval traps, juvenile fish sampling at the ore dock, and ore dock Fukui traps are provided in Table 7. The juvenile fish were sampled from surface between the ore dock and a docked ore carrier using an improvised juvenile fish sampler. Fish larval trap, Fukui trap and juvenile fish sampling locations are presented in Figure 18.

Table 7 Fish, Juvenile Fish and Fish Larvae Catches from Milne Ore Dock, 2016.

Gear	Date (2016)	Location		Fish Larvae	Arctic Cod	Fourhorn Sculpin	Longhorn Sculpin
		Easting	Northing	N	N	N	N
LT-1 Larval Trap 1	August 8	503468	7976662				
LT-2 Larval Trap 2	August 8	503123	7976536				
LT-3 Larval Trap 3	August 12	503470	7976656				
LT-4 Larval Trap 4	August 12	503143	7976540				
LT-5 Larval Trap 5	August 17	503342	7976660				
LT-6 Larval Trap 6	August 17	503354	7976639				
LT-7 Larval Trap 7	August 17	503221	7976600		1		
LT-8 Larval Trap 8	August 17	503222	7976589				
FTO-1 Ore Dock Fukui 1	August 16	503369	7976576			2	
FTO-2 Ore Dock Fukui 2	August 16	503465	7976642				
FTO-3 Ore Dock Fukui 3	August 16	503146	7976499			3	1
FT-9 Fukui Trap Series 9	August 16	503469	7976592			5	
JFS-1 Juvenile Fish Sampler 1	August 20	503250	7976648		1		
JFS-2 Juvenile Fish Sampler 2	August 20	503270	7976658		1		
Total				**1**	**3**	**10**	**1**

Note*: LT = Larval Trap, FTO = Fukui Trap at Ore dock, JFS = Juvenile Fish Sampler
UTM NAD 83, Zone 17 coordinates.

Legend

- Juvenile Fish Sample
- Larval Trap
- Fukui Trap

NOTES
1. BASE MAP: BIM UAV IMAGERY

0 30 60 90 Meters

BAFFINLAND IRON MINES CORPORATION

MARY RIVER PROJECT

Fishing Efforts at Fish Offset, Milne Ore Dock, 2016

SEM

REF NO. 070-025-1-010

FIGURE 16

REV 0

FIGURE ID: 070-025-1-010 FAA Fish Sampling Locations.mxd

A total of 13 fish were captured at the Milne ore dock in 2016 using Fukui traps and an improvised juvenile fish sampler. Species captured included fourhorn sculpin (*Myoxocephalus quadricornis*, n=10), longhorn sculpin (*Myoxocephalus octodecimspinosus*, n=1) and juvenile Arctic cod (*Boreogadus saida*, n=2). One fish was captured in the larval fish traps and was later identified as Arctic cod. As previously reported, unidentified sculpin sp. (n=7), eelpout (n=3) and large schools of Arctic cod were observed in the underwater video. Representative photographs of the two sculpin species are provided in Figure 19.

Figure 19 Fourhorn Sculpin (left panel) and Longhorn Sculpin (right panel) Captured at the Milne Ore Dock, 2016.

Fishing efforts in other parts of inner Milne Inlet in 2016 using Fukui traps and gill nets also captured Arctic char (*Salvelinus alpinus*), shorthorn sculpin (*Myoxocephalus scorpius*) and fishdoctor (*Gymnelus viridis*). Other species captured at inner Milne Inlet during previous sampling in 2010 (CORI 2010), 2013 (SEM 2014b), 2014 (SEM 2015) and 2015 (SEM 2016) have included twohorn sculpin (*Icelus bicornis*), Arctic staghorn sculpin (*Gymnocanthus tricuspis*), Atlantic hookear sculpin (*Artediellus atlanticus*), Arctic sculpin (*Myoxocephalus scorpioides*), common lumpfish (C*yclopterus lumpus*) and Greenland cod (*Gadus ogac*).

The two sculpin species captured in association with the ore dock are among the more common species that have been captured in the previous 5 years of sampling, while Arctic char, which have been captured every year, were not captured or observed in the underwater video at the ore dock. The SEM field team did however observe schools of Arctic char swimming close to the armour stone while collecting the drop camera video. In all previous sampling, Arctic char have only been captured in gill nets, and never in Fukui traps, which explains why no char were captured at the ore dock in 2016. The observed schools of Arctic char, in consideration of the abundance of Arctic cod and krill or mysid shrimp associated with the armour, suggest Arctic char may have been attracted to the ore dock for foraging. Arctic char are only transient in the Milne Port area but their presence in previous fish surveys confirms that they do use the inner Milne Inlet, including the port area, for rearing and feeding during the limited period they are in the marine environment. As previously indicated, one of the primary objectives of using the armour stone in the fish offset was to enhance productivity of amphipods and mysids/krill, thereby increasing food resources for Arctic char and Arctic cod.

No mobile invertebrates were captured in the Fukui traps associated with the ore dock. Traps were set along the seabed at the margins of the armour stone as it was not possible to set the traps directly on the armour stone without risking tearing the mesh of the traps. Several invertebrate taxa were captured in Fukui traps at other locations in inner Milne Inlet including sea urchins and brittle stars, as observed in the underwater video, as well as Ocean quahog (*Arctica islandia*), razor clam (*Siliqua sp.*), northern propeller clam (*Cyrtodaria siliqua*), and scallop (*Pectinidae* sp.). The four bivalve species not captured at the ore dock are all associated with sandy and fine substrate materials and not substrate the size of the armour stone so their association with the fish offset habitat was not expected.

4.4 Zooplankton

Zooplankton samples were collected from inner Milne Inlet during August 2016 near the ore dock as part of monitoring for aquatic invasive species. Samples included vertical tows at four locations while oblique samples were collected from one continuous tow for 10 minutes at each of the four sites (Table 8). Locations of zooplankton collections are shown in Figure 7. This sampling was not completed as part of the monitoring of the ore dock armour stone, however, results were assessed to confirm the presence of some fauna seen in the underwater video and for the presence of icthyoplankton.

Zooplankton sampling was not completed at the armour stone owing to the difficulty of completing tows in association with the coarse rock material and in very shallow water. SEM may explore the use of other zooplankton sampling techniques (e.g., Schindler-Patalas trap) in future monitoring in an effort to confirm the zooplankton taxa associated with the armour stone.

Table 8 Zooplankton Sampling Locations in Inner Milne Inlet, 2016.

<table>
<tr><th rowspan="2">Sample</th><th rowspan="2">Date (2016)</th><th rowspan="2">Net Depth (m)</th><th rowspan="2" colspan="2">Water Depth (m)</th><th rowspan="2" colspan="2">Number of Tows</th><th colspan="2">Location</th></tr>
<tr><th>Easting</th><th>Northing</th></tr>
<tr><td colspan="9">Vertical Sampling Locations</td></tr>
<tr><td>ZV1</td><td>August 5</td><td>28</td><td colspan="2">33.7</td><td colspan="2">3</td><td>502768</td><td>7976524</td></tr>
<tr><td>ZV2</td><td>August 5</td><td>28</td><td colspan="2">34.1</td><td colspan="2">3</td><td>502866</td><td>7976548</td></tr>
<tr><td>ZV3</td><td>August 5</td><td>24</td><td colspan="2">28.6</td><td colspan="2">3</td><td>503028</td><td>7976580</td></tr>
<tr><td>ZV4</td><td>August 5</td><td>26</td><td colspan="2">31</td><td colspan="2">3</td><td>503570</td><td>7976801</td></tr>
<tr><td colspan="9">Oblique Sampling</td></tr>
<tr><th>Sample</th><th>Date (2016)</th><th colspan="2">Composite Duration (sec)</th><th colspan="2">Speed (km/hr)</th><th colspan="2">Length of Tow (m)</th><th>Number of Tows</th></tr>
<tr><td>ZH1</td><td>August 16</td><td colspan="2">600</td><td colspan="2">2</td><td colspan="2">414</td><td>1</td></tr>
<tr><td>ZH2</td><td>August 16</td><td colspan="2">600</td><td colspan="2">2</td><td colspan="2">395</td><td>1</td></tr>
<tr><td>ZH3</td><td>August 16</td><td colspan="2">615</td><td colspan="2">3</td><td colspan="2">430</td><td>1</td></tr>
<tr><td>ZH4</td><td>August 16</td><td colspan="2">620</td><td colspan="2">3</td><td colspan="2">441</td><td>1</td></tr>
<tr><td colspan="9">UTM NAD 83, Zone 17 coordinates
ZH – zooplankton horizontal tows
HV – zooplankton vertical tows</td></tr>
</table>

Many zooplankton taxa were present in the samples including copepods, molluscs, appendicularians, rotifers, polychaetes, echinoderms and cirripeds. The oblique (horizontal) zooplankton samples were dominated by the larvacean, *Fritillaria*, calanoid copepod juveniles, especially *Acartia* sp. and *Pseudocalanu*s and copepod nauplii. Vertical zooplankton samples were dominated by rotifers, bivalve larvae, copepod nauplii, and small copepods, particularly *Oithona*. Three species of *Calanus* were present, however, *Calanus hyperboreus* was dominant. There were no ichthyoplankton or planktonic forms of krill or mysid shrimp found in the zooplankton samples.

4.5 General Discussion

Monitoring surveys to assess the structural stability of the offset habitat created in association with the Milne ore dock were completed in August, 13 months after completion of the placement of the coarse rock material (July 28, 2015). Surveys confirmed the deposited material was stable and there was no evidence of movement or slumping. The nature of the added coarse rock material, being very large, heavy and angular, indicated that once this material had settled in place there will be no further movement or slumping. The material is also expected to be very stable when exposed to wave action, propeller wash and ice.

There was also very little evidence of sedimentation and/or siltation and any apparent sediment on the armour stone was in areas protected from wave action. Along the caisson in the deeper water at the ore dock there was also little evidence of any sediment accumulation and this is where sediment was expected to accumulate from ore loading activities. It is possible the propeller wash from the ore carriers is playing a role in keeping this area relatively free of sediment. There was evidence at one location along the caisson of spillage of ore. Ocean circulation in Milne Inlet results in a weak clockwise circulation regime in the inlet and this could in turn result in fine sediments being transported along the southern coastline of the inlet in an east to west direction. These transported sediments may be deposited along the eastern extent of the ore dock due to localized disruption of the circulation pattern. Initial monitoring has not confirmed that this is happening.

Deposition of fine sediments could have several possible influences on the productivity of the coarse rock substrate. If large quantities of material are deposited, it could reduce the availability of habitat niches in the interstices of the coarse rock substrate and potentially reduce productivity and diversity of some taxa. Alternatively, deposition of fines could provide more heterogeneity in substrate characteristics providing another habitat niche, particularly for benthic infauna, and some epifauna.

Biological colonization and utilization of the armour stone is the most important aspect of evaluating the effectiveness of the fish offset. The addition of coarse rock substrate at the ore dock was considered analogous to creation of an artificial reef. Artificial reefs, when introduced at locations with homogenous and low relief substrate such as that of lower Milne Inlet, will increase overall habitat complexity and heterogeneity. These habitats are amenable to colonization by plankton, periphyton, algae, large zooplankton (amphipods and mysids) and invertebrate epifauna. These habitats will provide an increased food resource for the two primary species of interest, Arctic char and Arctic cod, and will also provide increased cover for fish from potential predators and will generally provide excellent feeding and rearing habitats for juvenile and adult fish.

Monitoring of the biological utilization of the armour stone at the ore dock in 2016 provided evidence of utilization by a wide variety of taxa representing several trophic levels. Observations of fauna included: zooplankton; invertebrates including krill, mysid shrimp, sea urchins and brittle stars; juvenile and adult fish including Arctic cod, sculpin species, and eelpout; and ringed seal. Observations of flora included four taxa of algae with green algae (*Urospora* sp.) and brown algae (*Desmarestia* sp.) being the most dominant taxa. The presence of organisms from all levels of the ecosystem were an important observation as it provides evidence that the ore dock offset is supporting biological productivity at all trophic levels.

Algal production on the armour stone was a good indication that there were sufficient nutrients in the marine environment at the ore dock to support this production. It is probable that terrestrially derived nutrients, entering inner Milne Inlet to the west of the ore dock at Phillips Creek, are supporting biological productivity at the fish offset. Marine productivity in the Arctic is strongly dependent upon freshwater input, the presence of nutrients, and environmental conditions (i.e., light availability and water temperatures) and is highly seasonal with an extremely short period for biological production. The observation and abundance of krill or mysid shrimp was also significant as these taxa provide an increased food resource for Arctic char and Arctic cod, as well as other higher organisms including seabirds, whales and seals. The presence of Arctic cod, as juveniles and in great abundance, was also a key observation as this species is important forage for Arctic char, as well as other fish species, marine mammals and birds. The presence of the large schools of juvenile cod also suggested successful reproduction of the species in inner Milne Inlet or possibly in association with the ore dock.

The process of biological invasion and colonization, which is the basis for developing the productivity of the offset habitats, was expected to be slow. This was confirmed in the deployment of settlement baskets near the ore dock as a monitoring tool for aquatic invasive species (SEM 2015). These baskets were retrieved after one year of deployment and there was very limited colonization of the material by periphyton, algae or invertebrates. However, monitoring in 2016 has indicated a much more rapid process of biological colonization of the fish offset than expected with productivity evident at all trophic levels. This is very encouraging and supports the underlying offsetting concept that increasing overall habitat complexity and heterogeneity in areas of homogenous, low relief substrate, will lead to increased biological productivity.

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Appendix A
Fisheries Act Authorization for the Milne Ore Dock

DFO File No.: 14-HCAA-00525
Authorization No.:1

FISHERIES ACT 35 (2)(b)AUTHORIZATION

Authorization Issued to:

Baffinland Iron Mines Corporation (hereafter referred to as the "Proponent")
Attention: Oliver Curran
2275 Upper Middle Road East Suite 300
Oakville, ON
L6H 0C3

Location of Proposed Project

Nearest community : Pond Inlet
Territory: Nunavut
Name of waterbody: Milne Inlet
UTM Coordinates: NAD 83 UTM 17 503250E 7976508N

Description of Proposed Project

The proposed project of which the work, undertaking or activity authorized is a part involves:

The Early Revenue Phase of the Mary River Project will involve the mining and shipment of up to 4.2 million tonnes per annum of iron ore via the Tote Road to the port at Milne Inlet, for shipment to European markets during the open water season.

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

The works, undertakings, or activities 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 ore dock and mooring structures.

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

> Permanent destruction of 24, 847 m^2 (6015 Habitat Equivalent Units) of fish habitat.

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	To
Date of Issuance	December 31, 2020

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

The period during which other conditions of this authorization must be complied with are provided in their respective sections below.

2. **Conditions that relate to measures and standards to avoid and mitigate serious harm to fish resulting from the ore dock construction:**

2.1 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.

2.2 Measures and standards to avoid and mitigate serious harm to fish resulting from the construction of the ore dock shall be implemented prior to the commencement of in-water works.

2.3 While conducting vibratory pile driving, dredging and infilling a marine mammal exclusion zone of 200m radius will be established. Field measurements will be undertaken to verify that underwater noise levels are below the 100db threshold.

2.4 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 or approaching the exclusion zone and only recommence when the marine mammals have left the area.

2.5 If measured underwater noise levels exceed the 100db threshold the following contingency measures shall be considered for implementation: expansion of the marine mammal exclusion zone and the installation of bubble curtains.

2.6 Turbidity levels shall be monitored in waters adjacent to the work zone during vibratory pile driving, infilling and dredging activities. If turbidity levels exceed Canadian Council of Ministers of the Environment (CCME) guidelines the following contingency measures shall be considered for implementation: installation of additional turbidity curtains, changes in grain size gradation of infill material, altered methods of infilling and the suspension of in-water works until turbidity levels are within the CCME guidelines.

3. Conditions that relate to measures and standards to avoid and mitigate serious harm to fish resulting from project related shipping activity (Terms and Conditions (T&C) adapted from Nunavut Impact Review Board's Project Certificate No 5 May 28, 2014):

3.1 The Proponent shall develop and implement a monitoring program to evaluate changes to marine fish, fish habitat and aquatic organisms as well as to monitor for non-native species introductions resulting from ballast water discharges. Baseline data collection shall commence prior to any ballast water discharge into Milne Inlet and monitoring shall continue for the life of the project. (NIRB T&C 87).

3.2 The Proponent shall develop and implement a monitoring program to confirm the predictions made in the Final Environmental Impact Statement – Addendum, with respect to disturbance impacts of shipping noise on the distribution of marine mammals. The survey shall be designed to monitor effects during the shipping season and include locations in Milne Inlet, Eclipse Sound and Pond Inlet. The survey shall continue over a sufficiently lengthy period of time to determine the extent to which habituation occurs for Narwhal and Bowhead whales. (NIRB T&C 109)

3.3 The Proponent shall develop and implement a monitoring protocol that includes but is not limited to acoustic monitoring, to assess the potential short term, long term and cumulative effects of vessel noise on marine mammals and marine mammal populations.(NIRB T&C 110)

3.4 The Proponent shall provide sufficient marine mammal observer coverage on project vessels to monitor marine mammal interactions with project vessels and report any accidental contact of marine mammals. (NIRB T&C 121)

3.5 The Proponent shall identify and implement measures to reduce the potential for interactions with marine mammals throughout the life of the project. These measures may include; a) changes in frequency and timing (including periodic shipping suspensions) when the likelihood of negative interactions with marine mammals are greatest or during sensitive life stages b) reduced shipping speeds where ship-marine mammal interactions are most likely to occur. (NIRB T&C 105)

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

4.1 The Proponent shall undertake monitoring and report to DFO annually by December 31st whether measures and standards to avoid and mitigate serious harm to fish were conducted according to the conditions of this Authorization, by:

4.1.1 Providing dated photographs and inspection reports to demonstrate effective

.../4

implementation and functioning of mitigation measures and standards described above to limit the serious harm to what is covered by this authorization.

4.1.2 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.

5. **Conditions that relate to monitoring and reporting of measures and standards to avoid and mitigate serious harm to fish from project related shipping:**

5.1 The Proponent shall undertake monitoring and report to DFO annually. The submission of monitoring reports shall coincide with the Proponent's submission of their Annual Monitoring Report to the Nunavut Impact Review Board.

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

6.1 Course rock substrate will be placed around the perimeter of the ore dock and moorings at Milne Inlet to provide 6003 HEU of fish habitat.

6.2 All fish habitat offsetting measures shall be completed and functioning according to the criteria below by December 31, 2020.

6.2.1 Coarse rock substrate will provide additional habitat for benthic invertebrates and fish species in Milne Inlet.

6.2.2 Colonization of the rock substrate by algae and aquatic vegetation to provide a food source for benthic invertebrates and fish.

6.3 If the results of monitoring as required in condition 7 indicate that the offsetting measures are not completed by the date specified in condition 6.2, the Proponent shall give written notice to DFO and put in place contingency measures specified in condition 6.5 and associated monitoring measures, as contained within their approved offsetting plan, to ensure the offsetting is completed and functioning as required by this authorization.

6.4 If monitoring identifies deterioration in the structure, plans will be developed to repair and reinforce these areas. Annual monitoring (drop camera) will be adjusted to include repaired locations and will continue for a period of three years following any repairs.

6.5 If no quantifiable increase in use of the rock substrate by fish, benthic invertebrates or aquatic vegetation is detected by year 6 the following contingency measures will be undertaken.

6.5.1 The Proponent will create an additional 6005 HEU of artificial reefs outside the zone of influence of the ore dock within Milne Inlet.

6.6 To ensure that the above offsetting contingency measures are functioning as intended the monitoring program described in Condition 7 shall be carried out.

6.7 Offsetting measures shall be left undisturbed, and the Proponent shall not carry on any work, undertaking or activity that will adversely disturb or impact the offsetting measures.

6.8 DFO may draw upon funds set aside by the Proponent through the letter of credit provided as

.../5

part of the application for this authorization, in order to ensure conditions of this authorization related to offsetting measures, including monitoring and reporting, are met.

7. **Conditions that relate to monitoring and reporting of offsetting measures (described above in section 6:**

7.1 The Proponent shall conduct monitoring of the offsetting measures according to the approved schedule and criteria below:

7.1.1 During Year 1, 3 and 5 the integrity of the coarse rock substrate will be monitored using video surveys (drop camera). All information will be geo-referenced and any slumping or other deterioration will be documented and repaired as necessary.

7.1.2 During Year 2, 4 and 6 video surveys (drop camera) of the coarse rock substrate will be used to document the types and percent coverage of the aquatic vegetation colonizing the substrate. Benthic invertebrates and fish recoded in the video will be identified and quantified.

7.1.3 The production of benthic invertebrates and the occurrence of fish larva will be monitored by setting artificial and natural substrate collection baskets in the vicinity of the coarse substrate.

7.1.4 Continuous video monitoring of the rock substrate shall be undertaken to demonstrate the association of fish with the rock substrate.

7.2 The Proponent shall report to DFO that the offsetting works were conducted according to the conditions of this Authorization by providing the following:

7.2.1 Monitoring report shall be submitted to the DFO-Yellowknife Office by December 31 of each year monitoring is carried out.

DFO File No. : 14-HCAA-00525
Authorization No. :1

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 works, undertakings and/or activities 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.

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. In the event that any such individuals are identified in this area, or in the event that an aquatic species found in this same area is listed under the SARA after this Authorization is issued, this Authorization does not permit the killing, harming, capture or taking of individuals of any such species (section 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).]

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: JUN 3 0 2014

Approved by: David Burden

Dave Burden
Regional Director General
Central and Arctic Region
Fisheries and Oceans Canada

Appendix B

Licence to Fish for Scientific Purposes
And Animal Use Protocol

Fisheries and Oceans Canada | Pêches et Océans Canada

Licence #: S-16/17-1014-NU

David Scruton
2nd Floor, 70 Mews Place
St. John's, NU, CA A1B 4N2

Dear David Scruton,

Enclosed is your Licence to Fish for Scientific Purposes issued pursuant to Section 52 of the Fishery (General) Regulations.

Failure to comply with any of the conditions specified on the attached licence may result in a contravention of the Fishery (General) Regulations.

Please be advised that this licence only permits those activities stated on your licence. Any other activity may require approval under the Fisheries Act or other legislation. It is the Project Authority's responsibility to obtain any other approvals.

Please ensure that you include the licence number and project title in any future correspondence and that you complete the Summary Harvest Report upon completion of activities under this licence.

Yours truly,

June 22, 2016

For Jenna Kayakjuak
License Delivery Officer
Northern Operations
Central and Arctic Region
Fisheries and Oceans Canada

Date

Enclosure

LICENCE TO FISH FOR SCIENTIFIC PURPOSES

S-16/17-1014-NU

Pursuant to Section 52 of the Fishery (General) Regulations, the Minister of Fisheries and Oceans hereby authorizes the individual(s) listed below to fish for scientific purposes, subject to the conditions specified.

Project Authority: David Scruton — Sikumiut Environmental Management Limited
2nd Floor, 70 Mews Place
St. John's, NU, CA A1B 4N2

Other Personnel: Grant Vivian; Claire Moor-Gibbons; Jason Lewis
Additional field staff from Pond Inlet will be hired, names to be determined. These individuals will be under the supervision of the above staff.

Objectives:
1. To collect data from Milne Inlet for Environmental Effects Monitoring
2. To assess the effectiveness of fish offsetting in relation to the construction of the Milne ore dock.

CONDITIONS

Specified Conditions:

Other gear types: Fukui traps (a live trapping technique).

Total number of live samples are unknown; purpose is to gather information on distribution, relative abundance, size distribution, and other biological characteristics.

Waters:

Water Body: Milne Inlet
Point A: 72° 20' N, 80° 30' W

Species: Sculpin, Fourhorn

Gear: 10 MM Mesh Gillnets and Larger
Angling
Hand Line
See Conditions

Total Weight	Weight Live	Weight Dead	Number Alive	Number Dead	Number Tows	Number Sets	Hours	Minutes
			500	50				

Water Body: Milne Inlet
Point A: 72° 20' N, 80° 30' W

Species: Sculpin, Shorthorn

Gear: 10 MM Mesh Gillnets and Larger
Angling
Hand Line
See Conditions

Total Weight	Weight Live	Weight Dead	Number Alive	Number Dead	Number Tows	Number Sets	Hours	Minutes
			500	50				

Water Body: Milne Inlet
Point A: 72° 20' N, 80° 30' W

Species: Sculpin, Ribbed

Gear: 10 MM Mesh Gillnets and Larger
Angling
Hand Line
See Conditions

Total Weight	Weight Live	Weight Dead	Number Alive	Number Dead	Number Tows	Number Sets	Hours	Minutes
			500	50				

Water Body: Milne Inlet
Point A: 72° 20' N, 80° 30' W

Species: Sculpin, Arctic Staghorn

Gear: 10 MM Mesh Gillnets and Larger
Angling
Hand Line
See Conditions

Total Weight	Weight Live	Weight Dead	Number Alive	Number Dead	Number Tows	Number Sets	Hours	Minutes
			500	50				

Water Body: Milne Inlet
Point A: 72° 20' N, 80° 30' W

Species: Spiny Lumpsucker

Gear: 10 MM Mesh Gillnets and Larger
Angling
Hand Line
See Conditions

Total Weight	Weight Live	Weight Dead	Number Alive	Number Dead	Number Tows	Number Sets	Hours	Minutes
			500	50				

Water Body: Milne Inlet
Point A: 72° 20' N, 80° 30' W

Species: Cod, Greenland

Gear: 10 MM Mesh Gillnets and Larger
Angling
Hand Line
See Conditions

Total Weight	Weight Live	Weight Dead	Number Alive	Number Dead	Number Tows	Number Sets	Hours	Minutes
			500	50				

Water Body: Milne Inlet
Point A: 72° 20' N, 80° 30' W

Species: Cod, Arctic

Gear: 10 MM Mesh Gillnets and Larger
Angling
Hand Line
See Conditions

Total Weight	Weight Live	Weight Dead	Number Alive	Number Dead	Number Tows	Number Sets	Hours	Minutes
			500	50				

Water Body: Milne Inlet
Point A: 72° 20' N, 80° 30' W

Species: Invertebrates

Gear: See Conditions

Total Weight	Weight Live	Weight Dead	Number Alive	Number Dead	Number Tows	Number Sets	Hours	Minutes
						300		

Water Body: Milne Inlet
Point A: 72° 20' N, 80° 30' W

Species: Arctic Charr (SR OR LL)

Gear: 10 MM Mesh Gillnets and Larger
Angling
Hand Line
See Conditions

Total Weight	Weight Live	Weight Dead	Number Alive	Number Dead	Number Tows	Number Sets	Hours	Minutes
			500	50				

Fishing Period: July 15, 2016 to September 15, 2016

A copy of this licence must be available at the study site and produced at the request of a fishery officer.

Live fish may not be retained unless specified in the conditions of this licence.

The licence holder shall immediately cease fishing when the total fish killed or live sampled reaches any of the maximums set for any of the species listed.

Transportation:

Other approvals/permits may be necessary to collect or transport certain species, such as Marine Mammal Transportation Permits. For marine mammal parts, products and derivatives a Marine Mammal Transportation Licence is required for domestic transport and, for international transport a Canadian CITES Export Permit is also required.

Disposal of Fish Caught:

Fish not required for the purpose of dead sampling and/or retention MUST be returned to the water at the site of capture. Retained fish may be made available to the nearest settlement for domestic consumption or sold commercially within the Territory. Any dead fish for commercial sale beyond the Territory in which it was caught requires authorization under the Fish Inspection Regulations. Disposal of any fish remains must be in accordance with local land use regulations.

Report on Activities:

The Project Authority will submit to the License Delivery Officer, Department of Fisheries and Oceans, within one month of the expiry date, a report stating:

i) whether or not the field work was conducted; and if conducted

ii) waterbody location, fishing coordinates, gear types used at each coordinate, numbers or amount of fish (by species) collected and/or marked and the date or period of collection.

A Summary Harvest Report template is provided by the License Delivery Officer at time of issuance of this licence .

The Project Authority also will provide a copy of any published or public access documents which result from the project . Information supplied will be used for population management purposes by the Department of Fisheries and Oceans and becomes part of the public record.

All documents should be sent to:

Fisheries and Oceans Canada
Northern Operations
Central and Arctic Region
P.O. Box 358
Iqaluit, NU X0A 0H0

Attention: License Delivery Officer

Telephone: (867) 979-8005
Fax: (867) 979-8039
E-mail: XCNA-NT-NUpermit@dfo-mpo.gc.ca

Notification of Commencement:

Prior to the commencement of fishing the Project Authority will contact:

Fisheries and Oceans Canada
Northern Operations
Central and Arctic Region
P.O. Box 358
Iqaluit, NU X0A 0H0

Attention: License Delivery Officer

Telephone: (867) 979-8005
Fax: (867) 979-8039
E-mail: XCNA-NT-NUpermit@dfo-mpo.gc.ca

For Larry Dow
Director, Northern Operations
Central and Arctic Region
Fisheries and Oceans Canada

June 22, 2016
Date

For the Minister of Fisheries and Oceans.

Pursuant to Section 52 of the Fishery (General) Regulations.

Canada

Date: June 14, 2016

To: David Scruton
Sikumiut Environmental Management Limited (SEM)
2nd Floor, 79 Mews Place
St. John's, NL, A1B 4N2

Subject: Animal Use Protocol - Letter of Approval

Dear David,

Your 2015 Animal Use Protocol (AUP), number FWI-ACC-2016-013 entitled "Mary River Project – 2016 Marine Environmental Effects Monitoring – Milne Inlet ", has been reviewed and approved by the Freshwater Institute Animal Care Committee. This AUP will expire on October 01, 2016.

Please note: Section 21 For Euthanasia a dose of 250 mg/L of buffered MS222 is sufficient. More is not better in this case as MS222 is an acid and can damage the gills and cause distress while the fish is euthanized.

Keep this signed letter of approval as well as the signed AUP approval form for your records. Please be advised that should there be a need to revise the protocol you are requested to contact the Freshwater Institute Animal Care Committee and obtain approval prior to proceeding.

In addition, you are required to submit a brief report within 30 days of completion of the project outlining the unexpected changes to the protocol, the number of animals used and any unanticipated results or mortalities. The report form is attached in your approval email.

Feel free to contact me if you have any questions or concerns.

Sincerely,

Kerri Pleskach

Kerri Pleskach *FWISL-ACC Acting Chairperson*

Freshwater Institute Science Laboratories Animal Care Committee
Arctic Aquatic Research
Central & Arctic / Région du Centre et de l'Arctique
Fisheries and Oceans Canada / Pêches et Océans Canada
501 University Crescent
Winnipeg, Manitoba R3T 2N6
Phone:204 984-2532
Fax:204 984-2403

Enclosure

Canada

APPROVAL BY ANIMAL CARE COMMITTEE MEMBERS

AUP#: ACC-2016-013 Date: June 14, 2016

Signatures of ACC Members

Kerri Pleskach, Chair	Theresa Carmichael
Dr. Ericka Anseeuw D.V.M.	Bob Artes
Kerry Wautier	Jack Orr

Interim Approval ☐ **Final Approval** ☒

APPROVAL BY THE FWI ANIMAL CARE COMMITTEE IS FOR THE PERIOD STATED ON YOUR ANIMAL USE PROTOCOL.

Pêches et Océans Canada Fisheries and Oceans Canada