Baffinland Iron Mines Corporation

SHIPPING AND MARINE WILDLIFE MANAGEMENT PLAN

BAF-PH1-830-P16-0024

Rev DRAFT FOR REVIEW

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1 INTRODUCTION

1.1 Purpose and Scope

The Shipping and Marine Wildlife Management Plan (SMWMP) has been developed to:

- Address the issues of concern to Inuit with respect to shipping associated with the Mary River Project (the Project).
- Establish rules and procedures applicable to shipping during the construction, operational and decommissioning phases of the Project.
- Outline the existing mitigation and management measures related to Project shipping designed to minimize potential effects of Project activities on the marine environment, marine mammals, and traditional hunting and harvesting activities.

The SMWMP is a part of the Baffinland Iron Mines Corporation (Baffinland) Environmental Management System (EMS) and reflects Baffinland commitments with respect to shipping activities associated with the Project. Specifically, the SMWMP:

- Describes the means whereby Baffinland ships, fuel and equipment to the site, and exports iron ore from the Milne Port Site.
- Describes the management of the shipping operation, including the commissioning and operation of iron ore carriers. The SMWMP also describes the specifications and procedures in place for charter and operation of suitable vessels to export iron ore on a seasonal basis.
- Addresses the management, routing and operation of ships and describes how the vessels will navigate through and in the vicinity of ice.
- Describes the monitoring and mitigation measures, and adaptive management procedures to be employed in addressing concerns related to marine wildlife, including mammals and birds.

It is noted that in all matters of marine transportation, the Master of the vessel has an overriding obligation to protect the safety of his vessel, crew and the environment for which he is ultimately responsible and, notwithstanding anything contained in this SMWMP, the Master will always be guided by this principle.

1.2 Relationship to Other Management Plans

This plan should be viewed in concert with the following additional relevant plans (including specific protocols and/or instructions) that have been prepared for the Project as summarized below in Table 1.1.

Table 1.1 Relevant Management Plans

Relevant Management Plans	Document Reference Number	Information Provided by Referenced Plan
Environmental Protection Plan (EPP)	BAF-PH1-830-P16-0008	Provides relevant environmental protection measures.
Adaptive Management Plan (AMP)	n/a	Formalize and consolidate the various aspects of adaptive management that are integral to ongoing operations, planned capital projects, and future planning;
Spill Contingency Plan	BAF-PH1-830-P16-0036	Describes mitigation and management measures in the event of a spill related to protecting marine environment including marine wildlife
Spill at Sea Response Plan	BAF-PH1-830-P16-0042	Describes mitigation, management and response measures related to marine environment
Emergency Response Plan	BAF-PH1-840-P16-0002	Describes mitigation, management and response measures related to emergencies
Oil Pollution Prevention Plan (OPPP) — Milne Port	BAF-PH1-830-P16-0058	Describes prevention, mitigation and management measures related to marine environment.
Oil Pollution Emergency Plan (OPEP) — Milne Port	BAF-PH1-830-P16-0013	Describes mitigation, management and response measures related to marine environment
Marine Monitoring Plan (MMP)	BAF-PH1-830-P16-0046	Describes how monitoring of the marine environment will be undertaken at the Project level
Narwhal Adaptive Management Response Plan (NAMRP)	BAF-Ph1-830-P16-0024	Developed to guide the implementation of Baffinland's shipping mitigations and marine mammal monitoring programs
Internal Communications Protocol for Shipping Activities	BAF-PH1-820-PRO-0001	Describes internal Baffinland communication procedures related to the shipping season
Interim Closure and Reclamation Plan	BAF-PH1-830-P16-0012	Describes interim Project closure and reclamation measures to be adopted
Ballast Water Management Plan	BAF-PH1-830-P16-0050	Describes mitigation and monitoring measures related to ballast water management
Standard Instructions to Masters (SITM)	n/a	Provides annual instructions to Masters for vessels loading at Milne Port

1.3 Corporate Policies

Baffinland has two corporate policies that apply to environmental management:

- **Sustainable Development (SD) Policy** - identifies Baffinland's commitment internally and to the public to operate in a manner that is environmentally responsible, safe, fiscally responsible and respectful of the cultural values and legal rights of Inuit.
- **Health, Safety and Environment (HSE) Policy** - describes the company's commitment to achieve a safe, healthy and environmentally responsible workplace.

All employees and contractors must comply with the contents of both above mentioned policies, which are included in Appendix A.

1.4 Regulatory Requirements

This Plan outlines the Project's policies and procedures to ensure compliance with the relevant terms, conditions and regulations outlined in the following regulatory instruments and Inuit agreements:

- Commercial Lease - Q13C301 (Commercial Lease) with the Qikiqtani Inuit Association (QIA)
- Project Certificate No. 005 issued by the Nunavut Impact Review Board (NIRB)

Canada is an active member of the International Maritime Organization (IMO) and is a signatory to IMO agreements such as the International Convention for the Safety of Life at Sea (SOLAS), the International Convention for the Prevention of Pollution from Ships (MARPOL), the International Convention on Load Lines, the International Safety Management Code (ISM), and the IMO International Convention for the Control and Management of Ships' Ballast Water and Sediment. The majority of operations described in this SMWMP are marine or port-related and are federally regulated by Transport Canada through the Canada Shipping Act and various International Regulations augmented by various Shipping Notices and Publications.

Up-to-date versions of these Acts and Regulations are available on Transport Canada's website available at: http://www.tc.gc.ca. The transportation of all cargoes between Canadian and international ports is regulated by the Government of Canada and the International Maritime Organization (IMO) through a variety of legislation. A list of relevant Acts and Regulations is included as Appendix B.

Project Certificate No. 005 Terms and Conditions relevant to the SMWMP, cross-referenced to where the terms are addressed in the SMWMP, are summarized in Appendix C.

1.4.1 Other Applicable Legislation

1.1.1.1 *Fisheries Act*

The federal *Fisheries Act* (1985, amended 2019), administered by Fisheries and Oceans Canada (DFO), includes provisions for the protection of fish[1] and their habitats, and is the principal federal statute to manage Canadian fisheries. The following sections and regulations of the Act outline prohibitions that require Authorizations and that are applicable to the proposed Project:

- Section 34 prohibits any work, undertaking or activity (other than fishing) that results in the death of fish.
- Section 35 prohibits any work, undertaking or activity that results in the harmful alteration, disruption or destruction of fish habitat.

[1] Under the Fisheries Act, 'fish' is defined as shellfish, crustaceans, marine animals and any part of the life history of the animal, including eggs, sperm, spat, larvae and juvenile stages (Government of Canada, 1985).

- Section 36 prohibits the deposit of deleterious substances into water frequented by fish or in any place under any conditions where the deleterious substance or any other deleterious substance that results from the deposit of the deleterious substance may enter any such water.
- The Marine Mammal Regulations (last amended November 2, 2018), pursuant to sections 8 and 43 and subsection 87(2) the Fisheries Act, prohibits:
  - under Section 7(1), the disturbance of marine mammals by any person except:
  - When carrying on a work, undertaking or activity that is authorized or permitted under the Fisheries Act;
  - When fishing for marine mammals under the authority of the Regulations;
  - In the manner set out in a licence issued under the Fishery (General) Regulations authorizing the licensee to fish for marine mammals for experimental, scientific, education or public display purposes; and
  - In the manner authorized under the Species at Risk Act
  - Under the Regulations Section 7(2), disturbance of a marine mammal is defined as 'to approach a marine mammal to, or to attempt to a) feed it, b) swim with it or interact with it, c) move it or entice or cause it to move from the immediate vicinity in which it is found, d) separate if from members of its group or go between it and a calf, e) trap it or its group between a vessel and the shore or between a vessel and one or more other vessels, or f) tag or mark it.
  - Under the Regulations Sections 7(3) through 7(5), disturb also includes approaching a marine mammal with a vehicle in all Canadian fisheries waters within 100 metres, unless the vessel is in transit.
- The Metal and Diamond Mining Effluent Regulations (SOR/2002-222) enabled under the Fisheries Act prescribe deleterious substances, and authorize the deposit of effluent containing deleterious substances if it is within applicable maximum authorized concentrations, requires that final discharge points be identified, and outlines monitoring conditions.

1.1.1.2 Species at Risk Act

The federal *Species at Risk Act* (SARA, the Act) is federal legislation that "provides for the legal protection of wildlife species and the conservation of the biological diversity" (SARA website). Under Section 32 of the SARA, once a species is listed as extirpated, endangered or threatened on Schedule 1, individuals of those species are protected from "killing, harming, harassing, capturing, taking, possessing, collecting, buying, selling or trading" (Government of Canada, 2023). Section 33 of the Act prohibits against "damaging or destroying the residence of individuals of a species listed as extirpated, endangered, or threatened". Of the ten species of marine mammals that potentially occur in the Project area during the shipping season, polar bear are the only species protected under SARA, where they are listed as Special Concern in Schedule 1.

1.1.1.3 Nunavut Land Claims Agreement

The Nunavut Land Claims Agreement (NLCA) is a modern treaty that was signed in 1993 by representatives of the Government of Canada, Tunngavik Federation of Nunavut, and the government of the Northwest Territories (CIRNAC, 2020). The NLCA provides the Tunngavik Federation of Nunavut with aboriginal title to the Nunavut settlement area—a land area of approximately 350,000 square kilometres (Nunavut Tunngavik, 2019). The Tunngavik Federation of Nunavut also has ownership of waters and land-fast ice that fall within their area of traditional use. The NLCA consists of 42 chapters that focus on a range of aspects, such as: wildlife management; harvesting rights; lands, water and environmental management regimes; public sector employment and contracting; and heritage resources. Some of the identified rights of Indigenous Peoples include the right to harvest wildlife, the right to negotiate with industries for social and economic benefits from non-renewable resources, as well as the right to have equal representation of Inuit in decision-making processes related to resource management and land use (CIRNAC, 2020). The NLCA guarantees Inuit federal royalties from resource-extraction projects and allows for Inuit to self-govern. The goals of the NLCA are to provide Inuit with financial compensation and economic opportunities related to development; to provide clarity of land ownership and the use of land and resources; to provide harvesting rights; to provide the rights to participate in decision-making concerning the harvesting of wildlife; to encourage the cultural preservation of Inuit; and to encourage self-reliance (Nunavut Tunngavik, 2019). The Government of Nunavut Department of Environment (GNDoE) is the lead Government of Nunavut (GN) Agency in fulfilling Government obligations concerning wildlife in Nunavut. Section 5.2.1 (i) of the Nunavut Agreement states that the government retains the ultimate responsibility for wildlife management.

1.1.1.4 Nunavut *Wildlife Act*

The Nunavut *Wildlife Act* (GN, 2005), and applicable regulations that came into effect in July 2015, is territorial legislation established for the management of wildlife and habitat in Nunavut, including the conservation, protection and recovery of species at risk. The *Nunavut Wildlife Act* applies to all terrestrial wildlife and their habitat. The GNDoE has a legislated mandate for the management of terrestrial species in Nunavut and is responsible for fulfilling the GN responsibilities under federal legislation, and national and international agreements and conventions. The relevant species related in this act related to the Project is the polar bear.

1.1.1.5 Nunavut Planning and Project Assessment Act (NuPPAA)

The Nunavut Planning and Project Assessment Act (NuPPAA) is a federal statute that was implemented in 2014 and adds to the environmental impact assessment regime outlined in Articles 11 and 12 of the NLCA (Dylan and Thompson, 2020). The NuPPAA contains provisions that regulators must follow during the environmental assessment process, including the incorporation of Inuit Qaujimajatuqangit (IQ). NuPPA allows for a single-window entry point, which means that all proposed projects must be submitted to the Nunavut Planning Commission (NPC) for review prior to any development (CIRNAC, 2015). As per the NuPPAA, the NPC must then determine whether the proposed developments conform with Nunavut land use plans (CIRNAC, 2015). If the NPC determines that the project plans conform with the land use plans, then a commercial production lease is granted and the project can begin compiling the necessary data to develop an environmental impact statement (EIS) (Dylan and Thompson, 2020).

1.4.2 Marine Environment Working Group

Baffinland has cooperated with government regulatory and resource management agencies to establish a MEWG for the Project. The group comprises membership from Environment Canada, Fisheries and Oceans Canada, Parks Canada, the Government of Nunavut, the Qikiqtani Inuit Association, and Makivik Corporation. The Terms of Reference for the Marine Environment Working Group are currently under revision and may include changes to member organizations serving on the MEWG, in addition to other modifications (still to be determined).

The MEWG provides advice to Baffinland in connection with mitigation measures for the protection of the marine environment, monitoring of effects on the marine environment and the consideration of adaptive management plans.

1.5 Management Plan Revision

The Shipping and Marine Wildlife Management Plan (SMWMP) will be updated as required on the basis of management reviews, incident investigations, regulatory changes or other Project-related changes, including the introduction of new adaptive management measures related to shipping as determined through the Marine Monitoring Plan and outcomes of the Trigger Action Response Plans (TARPs).

Baffinland will also update and modify its SITM and SMWMP as necessary to reflect the outcomes of annual engagements with the community of Pond Inlet and the Mittimatalik Hunter and Trappers Organization (MHTO), and input on adaptive management (as informed through implementation of the Marine Monitoring Plan (MMP) and mitigations measures provided by the Qikiqtani Inuit Association (QIA), Fisheries and Oceans Canada (DFO) and the Marine Environment Working Group (MEWG). The Terms of Reference for the Marine Environment Working Group are currently under revision (refer to Section 1.4 for further information). Any relevant changes will be incorporated into future revisions as required.

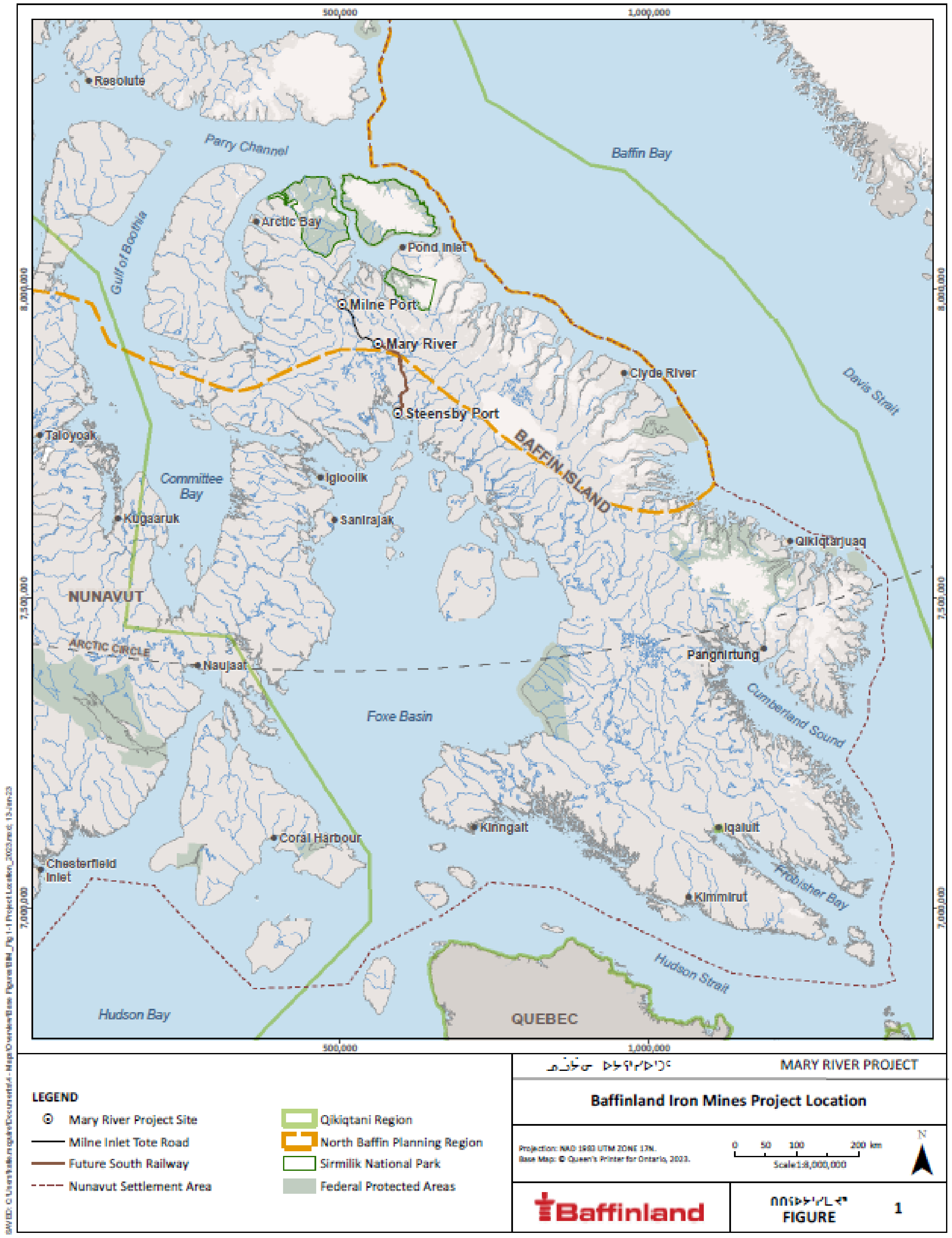

Figure 1.1 Project Location

2 PLANNING

2.1 Objectives

This is an activity management plan that focuses on outlining the operationalization of the ways Project shipping is managed to prevent or avoid adverse effects on the marine environment. It is closely related to the MMP, which describes the monitoring programs required to gather information necessary to assess environmental effects from the Project on the marine environment and identify if additional mitigation measures are necessary. If the results of monitoring programs outlined in the MMP identify a need for modifications to current mitigation and management measures or additional mitigation, the SMWMP would be updated accordingly. Accordingly, Table 2.1 provides the objectives and performance indicators for the MMP that would feed into the policies and procedures accounted for in the SMWMP.

Table 2.1 Objectives and Performance Indicators

VEC / Sub-VECs (Key Indicators)	Objective	Performance Indicator(s)
Marine Water and Sediment Quality • Marine Water Quality • Marine Sediment Quality	Monitor for adverse environmental effects from shipping operations (prop wash, ballast water discharges[2]) and port operations (effluent discharge, dust dispersion and deposition from ore stockpiles and ship loading) on marine water and sediment quality at Milne Inlet. Identify mitigation for avoiding and/or minimizing adverse effects that exceed FEIS predictions.	Marine Water Quality • Metals, TSS, hydrocarbons, nutrients Marine Sediment Quality • Particle size, nutrients, metals, hydrocarbons
Marine Habitat and Biota • Benthic Infauna • Substrate, Macroflora and Epifauna • Marine Fish Community • Marine Fish Health • Non-indigenous Species / Aquatic Invasive Species (NIS/AIS)	Monitor for adverse environmental effects from shipping operations (prop wash, ballast water discharges[3]) and port operations (effluent discharge, dust dispersion and deposition from ore stockpiles and ship loading) on marine habitat and biota at Milne Inlet. Identify mitigation for avoiding and/or minimizing adverse effects that exceed FEIS predictions.	Benthic Infauna • Density, taxa richness, Simpson's diversity and evenness indices Substrate, Macroflora and Epifauna • Relative abundance (% cover or density), Simpson's diversity and evenness indices Marine Fish Community • Total catch, relative abundance, catch-per-unit-effort (CPUE) Marine Fish Health • Tissue chemistry (metals) and body condition[4] NIS/AIS • Detection of NIS/AIS across multiple trophic groups (zooplankton, benthic infauna/epiflora/epifauna, fish)

[2] Refer to Baffinland's Ballast Water Management Plan (BAF-PH1-830-P16-0050) for ballast water monitoring requirements and testing protocols

[3] Refer to Baffinland's Ballast Water Management Plan (BAF-PH1-830-P16-0050) for ballast water monitoring requirements and testing protocols

[4] Effect indicators for body condition include: Wrinkled rock-borer clam (*Hiatella arctica)*: whole animal wet weight, relative gonad size (gonad weight against body weight) if observable, whole-animal dry weight, dry shell or soft tissue weight related to shell length, and length frequency analysis; Fourhorn sculpin (*Myoxocephalus quadricornis*): size at age/length (i.e., body weight against age/length), relative gonad size (gonad weight against body weight), body weight relative to length (i.e., condition), relative liver weight (liver weight against body weight) and length frequency analysis.

VEC / Sub-VECs (Key Indicators)	Objective	Performance Indicator(s)
Marine Mammals • Narwhal • Ringed Seal	Monitor for potential effects of ship traffic and ship noise on marine mammals in the Regional Study Area (RSA) (i.e., behavioural disturbance such as displacement, avoidance, change in abundance and/or distribution). Identify mitigation for avoiding and/or minimizing adverse effects that exceed FEIS predictions.	Narwhal • Change in stock abundance • Change in relative abundance and distribution • Change in group composition • Change in surface behaviour • Change in dive behaviour Ringed Seal • Change in regional density and/or distribution
Marine Mammals • Narwhal • Ringed Seal • Bowhead	Monitor for potential ship strikes on marine mammals in RSA. Identify mitigation for avoiding and/or minimizing adverse effects that exceed FEIS predictions.	• Occurrence of death or injury as a direct result of a ship strike
TBD	Inuit objectives TBD	The development of Inuit indicators will be jointly developed by Baffinland and the QIA.

Baffinland and the QIA are jointly implementing an adaptive management process into management plans developed for the Project (see Section 2.3), which includes the development of Inuit objectives and indicators noted in Table 2.1.

2.2 Consideration of Inuit Qaujimajatuqangit and Local Knowledge

Baffinland views Inuit Qaujimajatuqangit as central to the successful planning and operation of the Project. IQ is reflective of the Inuit knowledge transferred from generation to generation and captures knowledge of relationships and morality, core values and worldviews, as well as environmental knowledge. As identified in the Mary River Project Inuit Impact and Benefit Agreement (IIBA), IQ is beneficial for the Project and provides critical insights into the environmental, ecological, cultural and socioeconomic dimensions of the Project.

Given the importance of IQ, Baffinland developed an IQ Framework to guide its integration and use. The IQ Framework supports collaboration and decision-making throughout the life of the Project and is not limited to the approach or methods associated with an individual IQ study. The purpose of the IQ Framework is to identify procedures and provide guidance on the following;

- The processes through which IQ can be shared with Baffinland
- Schedule and timing for gathering and integration of IQ

- Roles and responsibilities of parties involved
- Processes and mechanisms through which IQ informs Project related decision-making

The IQ Framework also defines commonly used terms to support communication between parties and identifies the relationship between the IQ Framework and other management and monitoring plans, including the QIA's Inuit Stewardship Plan. For a greater understanding of the Projects general approach towards consideration of IQ, please refer to the IQ Framework.

In addition to the general pathways that IQ has and will inform this Plan, there are several initiatives with specific relevance to this Plan worth noting here:

- North Baffin Hunters and Trappers Organizations membership in the Marine Environment Working Group. Baffinland has agreed to resource the participation of 2 members of the MHTO and 1 member from each of the 4 remaining North Baffin HTO's in the Marine Environment Working Group, where marine monitoring programs and mitigation are discussed before being finalized and implemented.
- Project Certificate 005, Appendix B Commitments. Baffinland and QIA agreed to several commitments aimed at increasing the role of IQ in marine monitoring and mitigation. These include commitments by Baffinland to:
  - resource Inuit-led monitoring, updated Early Warning Indicator, Inuit Objectives, Thresholds, Responses
  - work with harvesters to gather samples, and observations on what they are experiencing and comparing to previous years with respect to narwhal body condition
  - Jointly approve with the QIA the adaptive management components of this Plan that relate to narwhal and seal through a bilateral Adaptive Management Plan Working Group

2.3 Principles of Adaptive Management

Adaptive management is a planned and systematic process for continuously improving environmental management practices by learning about their outcomes (Canadian Environmental Assessment Agency, 2016). Adaptive management provides flexibility to identify and implement new mitigation measures or to modify existing ones during the life of a project.

Adaptive strategies are implemented when unanticipated adverse effects are observed, or if effects exceed identified thresholds. The management and mitigation of unanticipated adverse effects are most effective when collaboration between Baffinland, local stakeholders and regulators is employed. If effects to the marine environment exceed identified thresholds, Baffinland will implement the commensurate response as outlined in the MMP TARP (Baffinland, 2023a).

2.3.1 Defining the Adaptive Management Process

Baffinland has developed a draft Adaptive Management Plan (AMP) that provides the framework by which adaptive management is to be incorporated into Project operations (Baffinland, 2020). The Project-wide adaptive management process outlined in Baffinland's AMP begins with a planning phase, followed by iterative phases of implementing and monitoring the actions included in the plan(s), evaluating the effectiveness of actions included in the plans based on results of monitoring and other feedback mechanisms, and adjusting management strategies and actions and responses based on monitoring. The cycle begins anew with implementation and monitoring of a revised plan, which integrates the outcomes of the previous cycle. This cycle can occur, in real-time or over an extended period according to the nature of the situation or area of focus. In this way, a properly designed and well-implemented adaptive management process progressively diminishes uncertainty, as management strategies and processes are refined throughout a project's operational lifecycle.

Implementation of the AMP will be informed by a Baffinland-QIA Adaptive Management Working Group. Ongoing inputs from the Inuit Stewardship Plan as well as other IQ sources and Baffinland's ongoing Project monitoring will also form the basis of amendments and refinements to the objectives, indicators, thresholds, and response requirements over time.

2.3.2 Adaptive Management Checklist for Environmental Management

Table 2.2 presents an adaptive management checklist developed for the SMWMP, identifying how adaptive management has been incorporated into the current revision of the Plan.

Table 2.2 Adaptive Management Checklist

Adaptive Management Phases	Components	Questions to Guide Decision-Making	Status of Management Plan (i.e., complete, in progress, undergoing revisions)
Plan	Objectives	Are objectives clear and key desired outcomes defined? Do they include Inuit objectives?	In Progress Interim Objectives from the Marine Monitoring Plan (MMP) are identified in Section 2.1
	Indicators	Are performance indicators adequately identified? Do they include Inuit defined indicators?	In Progress Interim Indicators from the Marine MMP are identified in Section 2.1.

Adaptive Management Phases	Components	Questions to Guide Decision-Making	Status of Management Plan (i.e., complete, in progress, undergoing revisions)
	Identification of Thresholds	Are thresholds for specific responses identified (e.g., early warning triggers, action levels, quantitative metrics or qualitative descriptions)?	In Progress Interim Thresholds from the MMP are identified in Section 5
	IQ Integration / Influence	Are mechanisms for IQ integration/influence identified?	In Progress Section 3.1.2.8 describes communication with MHTO about floe edge use, general community communication and shipping monitors. The AMP working group is integrating IQ, and later firmed up through inputs by the Inuit Committee as needed.
Implement and Monitor	Management Strategies and Responses	Are management strategies and response options clearly identified?	In Progress Mitigation relevant to shipping operations is presented throughout. Actions and management strategies are also presented in the MMP.
	Resourcing	Are all phases of the adaptive management cycle properly resourced (in accordance with Inuit Agreements) to be fully implemented?	In Progress Roles and responsibilities are described in Section . Resourcing in accordance with Inuit Agreements will need to be discussed through the AMP Working Group, with annual work plans and budgets developed. QIA positions will be incorporated into a new Roles and Responsibilities section.
	Monitoring	Does the monitoring program provide the information needed to determine the effectiveness of management strategies and responses?	In Progress A draft list of monitoring programs are described in the MMP.
	Timeline for implementation	Is the possibility that rapid response may be necessary, taken into account in the implementation plan/process?	In Progress Emergency Management and Response is described in Section 3.4. Other rapid response procedures are described in other plans, such as the Marine Management Plan and the Ballast Water Management Plan.
Evaluate and Learn	Review Data and Feedback	Is the process for reviewing and evaluating management effectiveness (based on monitoring data and feedback) articulated?	In Progress A new Review of Plan Effectiveness section will include mechanisms for reviewing and evaluating management effectiveness.
	Additional Mitigation	Are mechanisms for determining the need for additional mitigation described?	In Progress The MMP TARP identifies actions to be undertaken according to various triggers. Need for additional mitigation is

Adaptive Management Phases	Components	Questions to Guide Decision-Making	Status of Management Plan (i.e., complete, in progress, undergoing revisions)
			determined based on results of monitoring programs described in the MMP.
	Input of IQ Holders	Are opportunities identified for IQ holders to review results and provide input into adaptive management responses / mitigations?	In Progress To be discussed with the Inuit Committee.
Adjust	Unanticipated Effects or Issues	Is it apparent how unanticipated effects or issues will be actioned and resolved?	In Progress This information is presented in Section 3.4. Emergency Management and Response and Section 5.1 Environmental Monitoring and will be updated based on finalized text from other in-progress management or monitoring plans.
	Reporting	Are reporting mechanisms for new / revised strategies and response actions established?	In Progress Reporting requirements are described in Section 5.2. Additional reporting related to marine monitoring is described in the MMP.
	Scheduled Updates	Is the frequency of scheduled updates to the management plan identified?	Complete The new Review of Plan Effectiveness section (Section 6) describes the annual process of identifying issues and developing new or revised strategies and response actions.

3 IMPLEMENTATION

This section describes the requirements and procedures for shipping during the construction, operational and decommissioning phases of the Project, and details environmental management relevant to marine wildlife, and emergency management and response plans.

3.1 SHIPPING AND PORT OPERATIONS

Figure 3.2 shows the shipping route associated with the Mary River Project. This route has been established based on safe navigation, as well as environmental factors.

All iron ore carriers engaged with Baffinland will comply with current Canadian and applicable international legislation (See Section 1.4).

In order to ensure that all tonnage chartered for operation in Milne Inlet is in compliance with the Baffinland SMWMP, all vessels that utilize Milne Port must comply with Baffinland environment, health and safety policies and general site rules while on route to, and while anchored within the Port.

3.1.1 Charter Vessel Specifications

Baffinland has established a protocol for selecting chartered iron ore carriers. The standard is identical to the specifications for dedicated iron ore carriers and includes the requirement to have appropriate ice class, Canadian Arctic class (or equivalent) and familiarity with AIRSS to operate in the ice conditions forecast to be encountered during the projected periods of the voyages into Milne Inlet.

An Ice Information Contractor will be engaged to forecast ice condition at the time of the vessel's planned loading and will advise what, if any, ice class is required.

The shipping class and types of ore carriers proposed for use are provided below:

A. Ice class designs for ore carriers include (not an exhaustive list, butbased on current knowledge of market availability):

   i. Non Ice Class (Type E)

   ii. Ice Class 1C (Type D)

   iii. Ice Class 1B (Type C)

   iv. Ice Class 1A (Type B)

   v. Ice Class 1A Super (PC 7)

B. Types of ore carriers include (Table 3.1; not an exhaustive list, but based on current knowledge of market availability). Baffinland will charter no more than 84 carrier trips, based on market availability. The shipping class and types or ore carries proposed for use are provide in Table 3.1.

Table 3.1 Types of Ore Carriers on Current Knowledge of Market Availability

Vessel Type	Deadweight Tonnage (DWT; metric tonnes)	Carrying Capacity (metric tonnes)
Supramax	50,000-60,000	55,000
Panamax	60,000-70,000	73,500
Kamsarmax	80,000-85,000	82,000
Post Panamax	90,000-95,000	94,000
Baby Cape	100,000-120,000	100,000
Capesize*[1]	200,000-220,000	205,000

[1]All vessels ranging in size from Capesize to Newcastlemax will be collectively referred to as Capesize*, equivalent to vessel sizes of Deadweight Tonnage (DWT) range of 200,000 – 220,000, and carrying capacity range of approximately 200,000 to 215,000 metric tonnes.

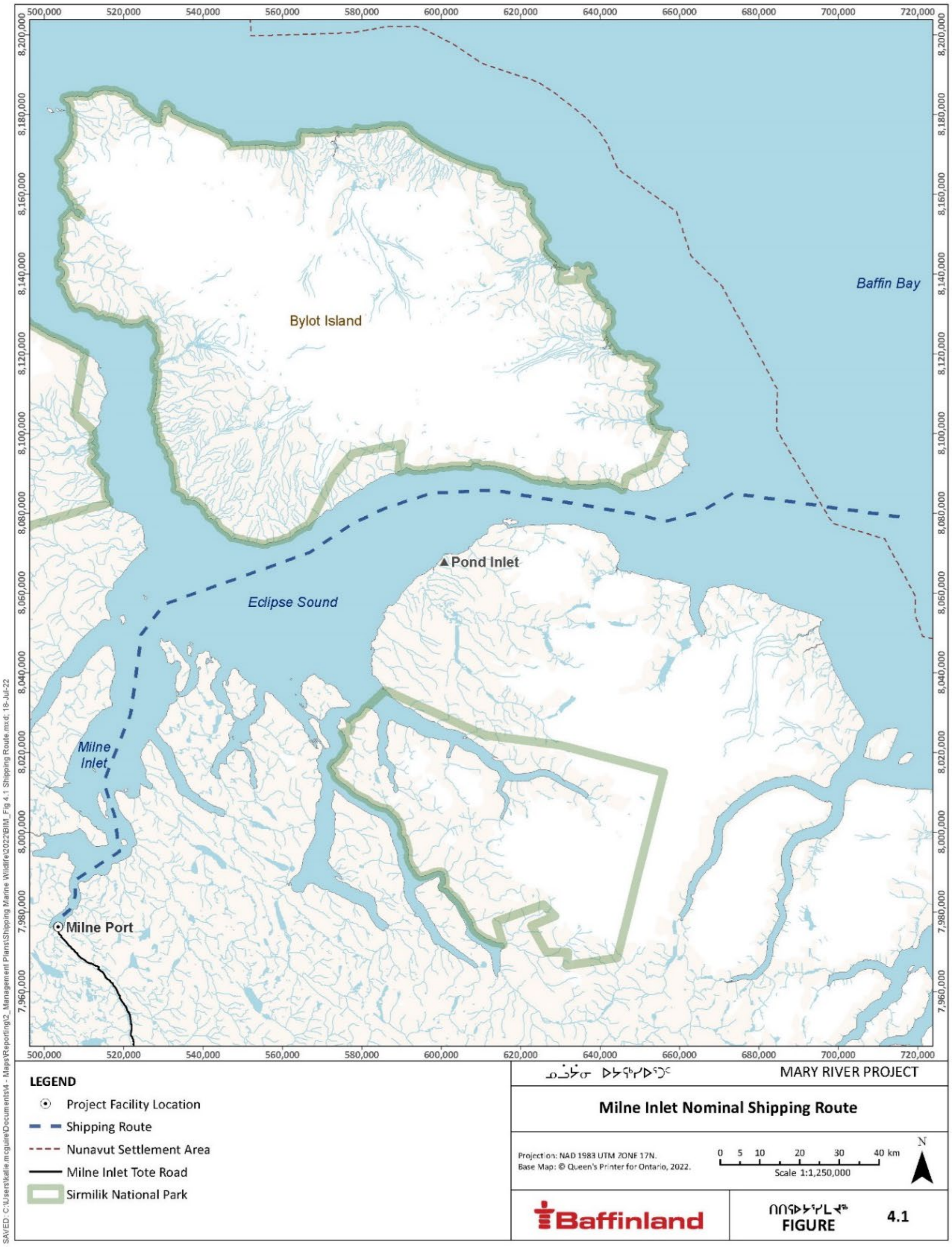

Figure 3.1 Milne Inlet Nominal Shipping Route

3.1.1.1 Pre-Charter Audit/Inspection of Iron Ore Carriers

All foreign-registered ships entering Canadian ports are liable to be inspected by Transport Canada to ensure compliance with the regulations and to confirm that the ships are safe for their crew and the environment when they proceed to sea. All of the major shipping countries have similar port state inspections. Ships failing to pass inspection can be held until they have been repaired and achieve compliance.

Baffinland will arrange for each candidate vessel (foreign and domestic) to be assessed before being placed on charter, to ensure that the vessel is capable of operating in the ice conditions that are forecast for Milne Inlet during the period of operation. Appendix D provides a copy of the Baffinland Pre-Charter Bulk Carrier Ice Capability Assessment. In order to ensure that the chartered vessel can load and carry the iron ores safely and efficiently, vessels that meet the required criteria for navigating in the forecast ice conditions will undergo a limited audit to ensure conformance with the ISM system before the vessel is chartered. This limited audit will be an adaptation of the ISM internal audit and the ship inspection will follow the Transport Canada port state inspection format. A copy of the Baffinland Pre-Charter Bulk Carrier Inspection Checklist and Limited Audit is provided in Appendix E.

3.1.2 Vessel Traffic Management

3.1.2.1 Navigation

Milne Inlet Port is located at latitude 71 53’ 23’’ North, longitude 80 54’ 13’’ West. For sake of clarification, a voyage constitutes a round trip between a load port (Milne Inlet) and the designated discharge port for that vessel. A transit is considered to be a one-way track either to or from Milne Inlet by any of the vessels. A voyage represents two transits through the Northern Transportation Corridor.

All Vessels will follow the nominal shipping route as described in the Standing Instructions to Masters (SITM) (see Figures 3.1 and 3.2). The Standing Instructions to Masters (SITM) is a document prepared and distributed to vessel owner/operators and Masters with detailed instructions regarding the shipping route, anchorage locations and Baffinland set restrictions to be followed when navigating through the Project area.

Specific information regarding vessel traffic management for icebreakers and shipping during shoulder seasons is outlined in Section 3.2 below.

3.1.2.2 Drifting / Anchoring

Project vessels will not anchor within the RSA along route to Milne Port except at one of the following anchorages near Ragged Island or at Milne Port (see Figure 3.1). The number of Project vessels allowed to wait, drift or anchor near Ragged Island is limited to three vessels. Drifting of vessels should be avoided to the extent possible unless warranted for safety to minimize effects on land users who may be hunting or traveling near Ragged Island. This will help to further minimize fuel consumption and noise generated from engines.

3.1.2.3 Routing

The nominal shipping route to Milne Inlet (Figure 3.2) was developed with guidance from experienced Vessel Masters retained by Baffinland to load at Milne Port. Ultimately deviations from the shipping route may occur and as dictated by the over-riding Master's authority and responsibility for safe navigation.

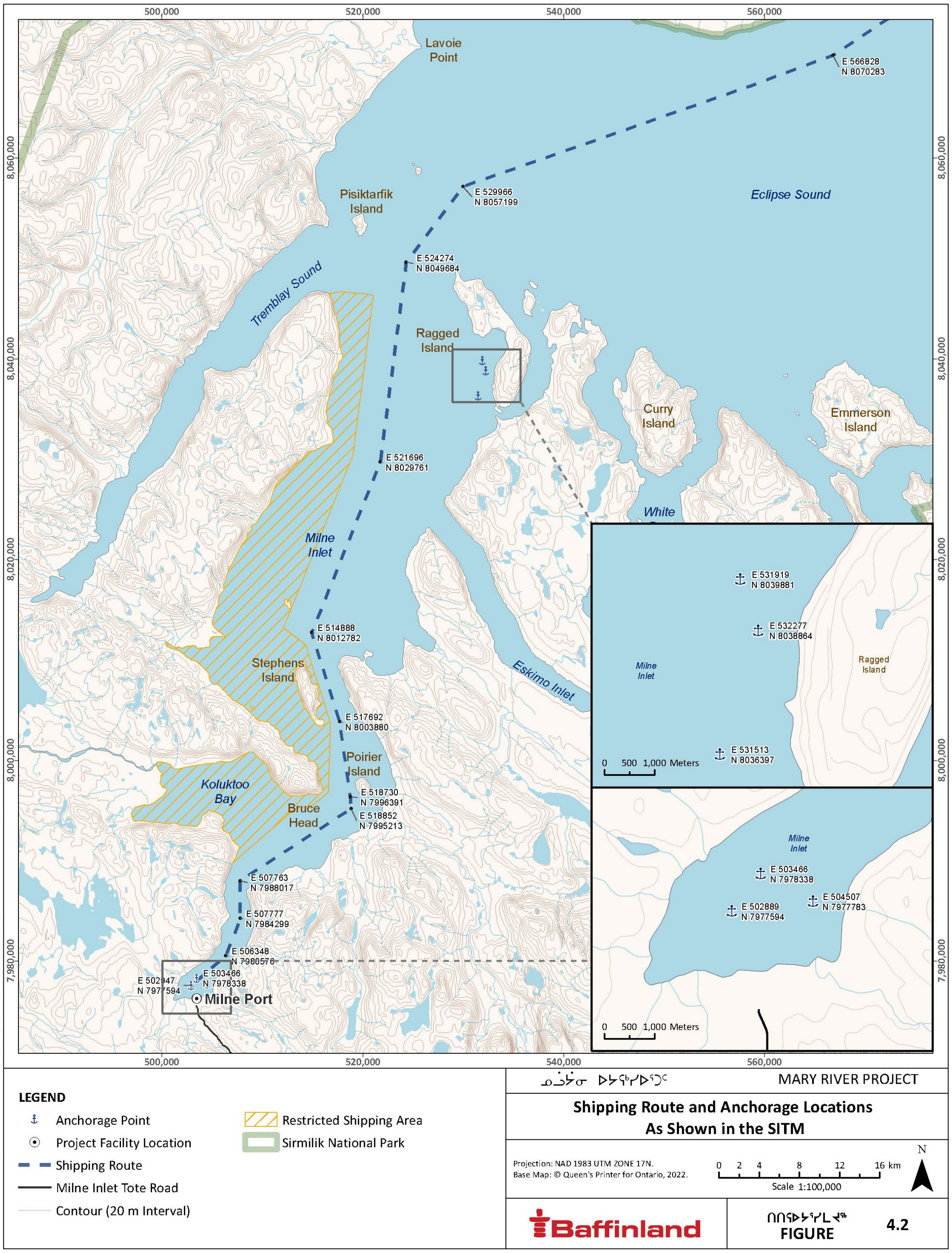

Figure 3.2 Shipping Route and Anchorage Locations as Shown in the SITM

3.1.2.4 Convoy System

Baffinland may operationalize a reduction in the number of independent transits in the marine Regional Study Area (RSA) by implementing a convoy system during the shipping season. The anticipated benefit of implementing convoys will be to reduce cumulative noise exposure for marine mammals (See Austin [2022]), and reduce the frequency of visual observations of vessels passing through and potentially interacting with land users and harvesters. Baffinland will implement target reductions based on guidance described in Baffinland's Operational Guide for Ore Carrier Convoys (See Appendix F for details)).

3.1.2.5 Tug Support

Tugs operate primarily in Milne Port assisting vessels to travel from their anchorage points in Milne Port to the ore dock for loading. However, tugs may occasionally escort ore carriers between Milne Port and Ragged Island.

3.1.2.6 Berthing

Ore carriers are berthed with the assistance of two tugs and a Docking Master on board the vessel. All vessels are brought alongside in a safe and efficient manner to avoid contact with the berth or other hazards. A person on the berth assists in properly positioning the vessel to ensure loading operations will be most effective. Linesmen ensure the vessel is properly tied up once in position.

3.1.2.7 Fueling

Fuel (diesel, gasoline and jet fuel) will be delivered to Milne port by tankers which will be off-loaded into holding tanks using the commonly-employed floating hose fuel transfer method. Milne Port maintains a Transport Canada approved OPEP which is reviewed and resubmitted annually.

Port contingency and vessel-specific response plans exist to address issues relating to:

- Appropriate fuel intake devices that prevent overflows.
- Spill fuel collection and recycling or destruction facilities, where applicable.
- Infiltration and other devices including porous pavement, soak-away pits or dry wells, seepage or infiltration trenches, percolation basins, catch basins, to contain spills.

3.1.2.8 Summary of Communications Protocol and Shipping Monitors

Baffinland has developed specific criteria to follow for determining the start of each shipping season (see Section 3.2.3 for specific details). Once it has been confirmed that no landfast ice remains along the Northern Shipping Route, Baffinland, as part of its internal shipping-related communication protocol, will obtain written confirmation (or evidence of verbal confirmation) from the Hamlet and the MHTO that sea ice overlapping the shipping route is not being used for travel or harvesting by harvesters or community members, and that the proposed shipping activity will not result in additional safety risks to hunters or the community that cannot be mitigated, for instance, by transiting through a path of less consolidated ice in Eclipse Sound and Milne Inlet confirms with the Mittimatalik Hunters and Trappers Organization (MHTO) or the Hamlet that the floe edge is no longer being used by hunters prior to having the first vessel enter the shipping corridor. It is further noted that no floe edge would we expected when ice concentrations have degraded to 3/10ths or less.

At least 72 hours prior to the start of the shipping season, Baffinland will also inform the MHTO, the Hamlet and the Qikiqtani Inuit Association (QIA) in writing the expected date on which the first vessel(s) may enter the RSA. Another notification will be sent at least 24 hours prior to commencement of the shipping season. Shipping will begin only once it is confirmed that there is a continuous path of 3/10ths ice concentrations along the nominal shipping route. Specific details are included in the Internal Communications Protocol for Shipping Activities (Baffinland, 2021e).

Should Baffinland meet the requirements for obtaining a variance to proceed prior to confirming a continuous path of 3/10ths or an exceptional circumstance has been identified, specific communication procedures will be followed. Baffinland will initiate direct engagement with the QIA, MHTO and the Hamlet, as described in Term and Condition 185 of the Project Certificate (see Appendix C for additional details).

Communications throughout the shipping season will be maintained with local harvesters and hunters throughout the season by supplying community members with a contact information for Baffinland staff that they can engage with if there are concerns regarding Project-shipping throughout the season.

Office-based Shipping Monitors working out of Baffinland's Pond Inlet office located on the second floor of the MHTO office building will also track Project shipping activities using both observational methods and tracking through AIS monitoring up to 24 hours a day (see Section 6.5). Ship Monitors will also serve as key communications liaisons between community members and Baffinland.

If any incidents require reporting (i.e. fuel spill) to federal or territorial agencies, Baffinland will also contact the Hamlet of Pond Inlet and the MHTO to ensure they are aware of the details of the incident, investigations being undertaken and any actions that will occur to resolve and address the incident.

Prior to the start of each shipping season, Baffinland will consult with the MHTO and the Hamlet of Pond Inlet on the protocol for communications, lessons learned from the past shipping season, and whether any modifications to the process are required.

3.1.3 Construction Shipping

To support construction activities of the Project, containerized equipment and materials may be shipped to Milne Inlet. Vessels will be required to follow the same instructions for navigating through Milne Port as they would for the Operations phase of the Project.

3.1.4 Operations Shipping

During operations, dedicated voyages carrying re-supply materials and equipment will travel to Milne Port. Fuel will be delivered by sealift tankers. Iron ore will be shipped from Milne port, using the routes presented in Figure 3.2.

Vessels are provided with specific guidance regarding their travel to site. In the SITM, vessel Masters are instructed to follow the shipping route and avoid areas such as Koluktoo Bay and the western shoreline near Bruce head to minimize effects on marine mammals and interference with hunting activities. The SITM also provide details regarding dedicated anchorage locations at Ragged Island and Milne Port and speed restrictions (9 knots) imposed by Baffinland to be followed while they are transiting the Northern Shipping Route. Under an approved SOP shipping scenario, a convoy system tailored to annual shipping activities will be developed in advance of the shipping season and implemented to the extent possible (See Appendix D for specific details on convoy implementation).

Vessels procured for the Project operate in accordance with two primary legal instruments regulating ship traffic in the Canadian Arctic: the *Canada Shipping Act*, and the *Arctic Waters Pollution Prevention Act*, and their associated regulations (See Section 1.4 and Appendix B).

3.1.4.1 Ship Loading and Unloading

Freight and Fuel Vessels

Ships loaded with equipment and supplies for a full year of Project operation are docked at the Milne Port freight dock and unloaded either directly or via lightering barges (see Figure 3.3). Goods are stored in Milne Inlet laydown areas for transfer to vehicles that transport the goods to the Mine Site along the Tote Road. Most goods are transported in containers that will limit spills and facilitate transfer from ship to shore and transport to the Mine Site. Fuel is transported in tankers and offloaded from the moored vessel by means of floating hoses.

Fuel for shipping is to be purchased only from accredited suppliers that can provide assurance that the fuel used for shipping conforms to Canadian regulations (*Benzene in Gasoline Regulations, 1997; Contaminated Fuels Regulations, 1991; Gasoline Regulations, 1990; Fuel Information Regulations, No. 1, 1999; Sulphur in Diesel Fuel Regulations, 2002; Sulphur in Gasoline Regulations, 1999*).

Ship Loading Fines Ore at the Milne Port Ore Dock

The ship loader for the Milne Dock ore dock is designed as a conveyance system used to fill the holds of the vessels with the ore, and has a capacity of 6,000 t/h.

3.1.5 Schedule

Annual shipping could occur seasonally over a period of extending up to approximately 72 and 92 days based on the number of constraints and historical ice conditions. This is based on historical ice conditions covering years 1997-2022, where shipping could be expected to start as early as July 21, based on the confirmation of no landfast ice and that there is a continuous path of no greater than 3/10ths ice concentrations along the nominal shipping route. A more likely scenario is to assume an average start date of July 31. In the Fall, there is uncertainly in when the shipping season may end, however unless the requirements for a variance or exceptional circumstance is granted under Term and Condition No. 185 of the Project Certificate, all shipping activity is to end no later than October 31 (refer to Appendix F for additional details). Chartered vessels will typically make one to three round trips per season. Each round trip of a ship from Milne Inlet to a port in Europe is estimated to take approximately 25 to 27 days. The vessels will travel at a speed of maximum 9 knots when transiting through Eclipse Sound and Milne Inlet.

3.1.6 Safety

Baffinland requires that the ship-owner/operator of candidate vessels will have as priorities safety of life, protection of the environment, and the preservation of ship and cargo.

While Baffinland and the vessel owner/operators wish to obtain the maximum efficiency in all of the company's chartered ship operations, it is recognized that the Master of a ship has sole responsibility for the safety of the ship, crew and cargo, and the protection of the environment. The Master has the authority to adjust speed, heave to, deviate, seek shelter or enter a port of refuge to re-stow cargo or seek medical assistance should environmental conditions or the condition of the vessel, the machinery, safety of the crew or cargo require such a precaution.

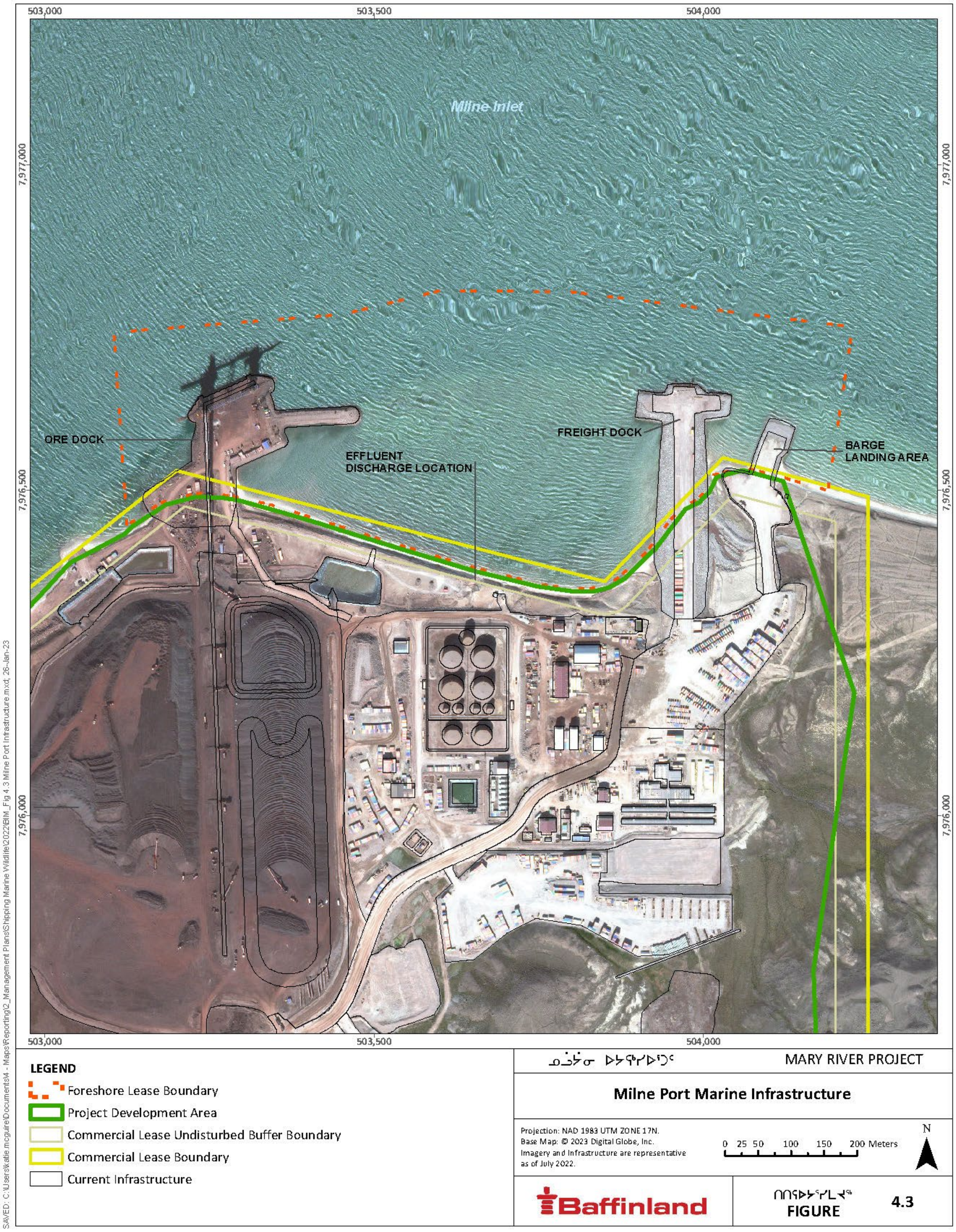

Figure 3.3 Milne Port Marine Infrastructure

Baffinland requires that candidate ship-owner/operators have a safety and operating management system based on the principles of the International Safety Management Code (ISM Code). The objective of the ISM Code is to ensure safety at sea, prevention of human loss of life or injury and avoidance of marine environment pollution. To achieve this objective, the Code requires that the ship-owner/operator share fully with the vessel personnel the responsibility to maintain a safe ship. The Code establishes a clear and concise safety management system, including, as examples, the following functional requirements:

- **A safety and environmental protection policy.** By considering the nature of the waters that vessels are to travel within, standards of watch keeping are reinforced with additional lookouts on the bridge and engineers in the machinery space. The manoeuvring ability of machinery and the operation of steering gear are tested prior to arrival or departing in a passage where navigation is restricted or where the route is close to shore. Strict measures regarding the handling and transfer of bunker and cargoes are established. Masters will be required to navigate within established channels.
- **Levels of authority and lines of communication defined.** This ensures that safety remains a high priority and that the lines of communication between shore and ship personnel remain open. Responsibilities are clearly defined and contacts to provide the ship with round the clock shore support are mandatory.
- **Procedures for reporting accidents and non-conformities with the Code.** The method of recording non-conformities, establishing corrective measures, and ensuring open dialogue between all parties is to be documented and reviewed.
- **Procedures to prepare for and respond to emergency situations.** Ships must have a set of operating manuals that supplement and support regulatory requirements and vendor instructions. These manuals evolve from standard practices and procedures, and they are to be tailored to individual ships. The objective is to document and provide guidance and instruction on the safe handling and operation of all shipboard equipment. Clear instruction is provided with regard to pre-arrival and departure check lists, navigation, handling of cargoes, bunkering, stability conditions, and the stresses imposed and acceptable to each concentrate carrier. The manuals are a concise guide for both ship and shore personnel to ensure safe operation, with emergencies considered and responses planned.

In addition, ship and shore personnel engaged in operations must be aware of hazards arising from cargo operations and from the materials and iron ores being handled. This includes the provision of Safety Data Sheets (SDS) information and any additional training required.

3.1.6.1 Safety of Persons Using Small Boats in the Shipping Route

Subject to ship and human safety considerations, mitigation measures to safeguard the safety of those in small boats will include the following:

- Barge-tugs or ships will restrict themselves to the recommended shipping route thereby not surprising any small boat travelling outside the shipping route;
- The ship will sound its horn if a small boat seems unaware of its presence; and
- Baffinland will inform communities of planned shipping transits both prior to the start of the shipping season and in real-time via AIS monitoring data available at the Shipping Monitor Office located on the second floor of the MHTO office building, and on the Baffinland website (www.baffinland.com). Baffinland also aims to regularly send to the MHTO and the Hamlet a 10-vessel rolling schedule of upcoming vessel activity.

3.2 ICE MANAGEMENT AND ICE BREAKING ACTIVITIES

3.2.1 Standard Definitions

For the purpose of management plan the following definitions of 'ice conditions' are applicable:

- **Landfast Ice (Fast ice)**: Ice that forms and remains fast along the coast.
- **Mobile ice/Mobile pack:** Ice that is not consolidated and may drift with winds and currents.
- **Concentration:** Ration expressed in tenths (/10) describing the area of water surface covered by ice as a fraction of the whole area.
- **Grey-White Ice:** Sea ice between 15 cm and 30 cm
- **Break-up**: Moment when ice starts to fracture in late spring or summer.
- **Freeze-up**: Moment when the freezing process begins in fall or early winter.
- **Open Water:** Are of freely navigable water in which ice can be seen in concentrations less that 1/10 (traces)

3.2.2 Ice Management and Icebreaking Activities

Ice management and icebreaking activities will generally not apply during the early shipping shoulder season unless the criteria for variances and/or exceptional circumstances set at Term and Condition No. 185 of the Project Certificate are met. A combination of ice management and icebreaking activities may be required to allow for the safe passage of vessels at the end of the shipping season, though as implemented since 2021, no icebreaking will be conducted at the start of the shipping season. Ice management is considered the act of preventing ice floes or icebergs from making contact with vessels and port infrastructure at Milne Port. Icebreaking activities will involve the use of a designated icebreaking vessel to facilitate the passage of lesser ice class vessels through prevailing ice conditions (i.e. ice escort services). Ice management will typically occur when there are icebergs or smaller ice floes in an area while icebreaking will be necessary to facilitate passage through much heavier ice concentrations.

Where utilized, icebreakers aim to avoid the heaviest ice concentrations areas during transits along the Northern Shipping Route. During the period of ice freeze-up during the Fall shoulder seasons (or if the start and end of the season is allowed to vary under an approved variance or exceptional circumstances pursuant to Project Certificate Term and Condition No. 185 of the Project Certificate), the Master or Ice Navigator on the icebreaker optimizes the use of leads in the ice to facilitate safe vessel passage and to limit fuel consumption. Interaction of the icebreaker with very close ice and compact ice is possible during the shoulder seasons but only if the ice is mobile (comprised of mobile ice floes as opposed to landfast ice). Ice thickness is another critical component of an icebreaker's ability to engage ice.

Where they are employed, refueling of icebreaker(s) will occur at Milne Port using ship-to-ship fuel transfer between the icebreaker and a fuel tanker. Once Project tug vessels arrive at Milne Port, they will remain there for the duration of the shipping season. In addition to ice management services, the tug vessels may escort Project vessels if needed between Milne Port and Ragged Island during the open water season as a precaution against other possible risks and malfunctions associated with shipping (e.g., vessel loss of power).

Should any icebreaking operations proceed under Term and Condition No. 185, it is expected that icebreakers could escort as a convoy between one and five Project vessels (i.e., tugs, ore carriers, freight vessels or fuel tankers) - subject to prevailing ice conditions and operational considerations including shipping schedule. Icebreaker escorts of the tugs would typically only occur at the beginning (should it be allowed to proceed under Term and Condition No. 185) and end of the shipping season when the tugs are either arriving or departing Milne Inlet. Shipping Routes during Shoulder Season

Along the Northern Shipping Route, the Icebreaker Master or Ice Navigator will determine the best travel route between the entrance of Pond Inlet and Milne Port based on local ice conditions at the time of transit. It is noted that since 2021, active icebreaking has not been undertaken by Baffinland at the start of the shipping season and would not be expected unless the criteria for variances and/or exceptional circumstances set at Term and Condition 185 of the Project Certificate are met. The start of the shipping season is determined through various criteria, including a confirmation that there is a continuous path of no greater than 3/10ths ice concentrations along the nominal shipping route (for further details on start of season criteria, refer to Section 3.2.3). Since ice conditions may vary from year to year, it is not possible to define a permanent route during the shoulder seasons with any level of accuracy. It is possible that transits during the shoulder seasons may deviate from the nominal open water shipping route (as defined in the Standing Instructions to Masters) by > 5 nautical miles (nm) if dictated by ice conditions. However, ships will not enter any restricted areas unless it is a matter of safety from extreme conditions (i.e. storms, large multi-year ice floes that become mobile and threaten navigational safety).Icebreaker Operations during Shoulder Season

Similar to years 2021 and 2022, timing for the start of 2023+ shipping seasons will be determined by confirmation that a continuous shipping path of 3/10ths ice concentrations or less is available along the Northern Shipping Route, unless criteria in Term and Condition 185 is met for a given year. Local ice conditions at the time of transits will dictate which vessels can enter the region, how many vessels can be escorted by icebreaker(s) if required, and how long a transit may take.

Icebreakers will maintain sustained travel speeds of no greater than nine (9) knots within the prescribed area, however, temporary and localized increases in speed may be required from time to time to break through larger ice floes and allow vessels under escort to safely follow. Icebreaker operations will be implemented in consideration of available ice condition data to ensure the safety of escorted vessels is not compromised. Icebreaker vessels will be sourced from the available market and could be either domestic or international.

Since ice conditions are expected to vary from year to year, it is not possible to predict an accurate number, frequency and duration of expected transits for the Fall shoulder season, though the maximum ore carriers in a season will be no greater than 84. However based on historical freeze-up data (see Fednav 2023), icebreaker services may be required at end of September/early October. Over the period where icebreaker escorts are required under regular operations with an expected end of shipping date of October 31, it is estimated that approximately 9 to 25 icebreaker transits may be needed over 9 to 25 days of sufficiently high ice coverage. This assumes that an icebreaker may complete approximately 1 escort transit every 24 hours, though this will vary according to ice conditions along the nominal shipping route.

3.2.3 Criteria Used by Baffinland to Initiate Shipping Season

Baffinland will rely on several criteria for determining the start of each annual shipping season, including information on prevalent ice conditions based local land use activities and several technical and environmental determinants, as defined further below:

3.2.3.1 Community

Baffinland's first priority is to confirm shipping activities will not pose a safety issue for local land users.

- Before commencing shipping operations, Baffinland (Sustainable Development) will obtain written confirmation (or evidence of verbal confirmation) from the Hamlet and the MHTO that sea ice overlapping the shipping route is not being used for travel or harvesting by harvesters or community members, and that the proposed shipping activity will not result in additional safety risks to hunters or the community that cannot be mitigated, for instance, by transiting through a path of less consolidated ice in Eclipse Sound and Milne Inlet.

3.2.3.2 Environmental

Each season's shipping activities will be governed by prevailing ice conditions and a commitment that landfast ice must have broken along the entire shipping corridor prior to commencement of icebreaking and ice management operations.

- As done since 2021, Baffinland Shipping Department must also confirm that a continuous path of 3/10ths ice concentrations along the Northern Shipping route is available. Baffinland's Shipping Department through advice provided by third-party ice analysts will use a combination of up-to-date ice charts, satellite imagery and aerial images to make this determination.

3.2.3.3 Vessel Safety

Navigation in waters under Canadian Jurisdiction north of 60° North Latitude is governed by the Arctic Shipping Safety and Pollution Prevention Regulations (ASSPPR), under the provision of the Arctic Waters Pollution Prevention Act (AWPPA). ASSPPR incorporates by reference the international Polar Code.

- ASSPPR includes the obligation to employ an approved risk assessment tool to validate the capability of a vessel to navigate safely in prevailing ice conditions. The Arctic Ice Regime Shipping System (AIRSS) and POLARIS were developed as tools to be used by each ship's Captain or Ice Navigator (i.e., ice pilot) to validate accessibility of a vessel through a given area based on prevailing sea ice conditions. This process is described in more detail in Section 3 of Fednav Ice Services, 2023).
- Define Regimes present along the Northern Shipping Route through review of satellite imagery, Canadian Ice Service's Daily Ice Charts, Canadian Coast Guard Ice Conditions reports, and ice observations conducted by Ice Navigators on board.
- Calculate the Ice Numerals for all Ice Regimes present along the Shipping Route by calculating the sum of the concentration in tenths of each Ice Regime and the Ice Multiplier associated with the ice type and the class or type of vessel.
- Vessel Captain transmits Ice Regime Routing Message to NORDREG to obtain permission for navigation along the route.
- Vessel Captain and Ice Navigator confirm passage with Port Captain and Vessel Captain of Ice Breaker escort.

3.2.4 Ecological

Even if criteria are met through Term and Condition 185, no icebreaking operations will occur during the ringed seal parturition, nursing, or breeding period (i.e. between March to April). As done since 2021, there will not be any icebreaking at the start of the shipping season since shipping will be delayed until ice conditions no greater than 3/10ths may be avoided, therefore no overlap between icebreaking operations and narwhal during their seasonal migratory movements (i.e. between early-July to mid-August) in the RSA. This is one of many mitigation measures that have been developed to reduce the potential effects of this overlap. In summary, to eliminate the potential pathway of temporal interactions of shipping activities with seal and narwhal, the following will be implemented:

- Baffinland will not break ice during the ringed seal parturition, pupping and nursing periods.
- As done since 2021, Baffinland will not break ice at the start of the shipping season, avoiding this activity during the Eclipse Sound narwhal summer stock spring migratory period. Should icebreaking be required under exceptional circumstances (refer Appendix C for details), transit restrictions will be applied as implemented during the 2019 shipping season (refer to Section 3.3 where details on transit restriction instructions may be implemented following approval by QIA, Hamlet of Pond Inlet and the Mittimatalik Hunters and Trappers Organization.

3.2.5 Additional Mitigation for 2023+ Shipping Seasons

As done since 2021, Baffinland will delay shipping in years 2023+ until there is a continuous path of 3/10ths or less ice concentration along the Northern Shipping Route, eliminating the need for an icebreaker at the start of the shipping season. Baffinland will also aim to implement a convoy procedure tailored to annual shipping activities to further reduce the number of transits completed over the duration of the shipping season. Specific guidance for convoy implementation is available in Appendix F.

3.2.5.1 Vessel Information

The suite of vessels for the shipping season will be a function of vessel commercial availability required for the anticipated ice conditions at different points of the shipping season and latest Transport Canada regulations. As such, an exact shipping schedule which outlines the number of vessels during each period of the shipping season year over year is not possible to provide. The shipping season will be maximized each year based on commercial availability of vessels and weather conditions, and to minimize the overall number of transits in the RSA over the length of the shipping season. The shipping class and types of icebreakers and ore carriers proposed for use are provided below:

- Ice class designs for ore carriers include (not an exhaustive list, but based on current knowledge of market availability):
    i. Non Ice Class (Type E)

ii. Ice Class 1C (Type D)

iii. Ice Class 1B (Type C)

iv. Ice Class 1A (Type B)

v. Ice Class 1A Super (PC 7)

- Types of ore carriers include (Table 4.2; not an exhaustive list, but based on current knowledge of market availability):

Table 3.2 Types of Ore Carriers on Current Knowledge of Market Availability

Vessel Type	Deadweight Tonnage (DWT; metric tonnes)	Carrying Capacity (metric tonnes)
Supramax	50,000-60,000	55,000
Panamax	60,000-70,000	73,500
Kamsarmax	80,000-85,000	82,000
Post Panamax	90,000-95,000	94,000
Baby Cape	100,000-120,000	100,000
Capesize*[1]	200,000-220,000	205,000

[1]All vessels ranging in size from Capesize to Newcastlemax will be collectively referred to as Capesize*, equivalent to vessel sizes of Deadweight Tonnage (DWT) range of 200,000 – 220,000, and carrying capacity range of approximately 200,000 to 215,000 metric tonnes.

3.2.6 Ice Navigation to Milne Port for Various Ship Ice Classes

In order to provide guidance on ice navigation to Milne Port, ice conditions along the Northern Shipping Route to Milne Inlet were summarized by Fednav Ice Services (2023). Ice navigation was subsequently evaluated based on the following considerations:

A. Methodology: Regional weekly ice charts from the Canadian Ice Service were used to evaluate ship access to Milne Inlet Port for various ship ice classes. A period of 15 years, from 2008 to 2022 was analyzed.

The POLARIS system was used for this analysis. Specifically, the existence of a route to Milne Inlet port yielding only positive Risk Index Outcomes (RIOs) was used as the criteria to determine whether a ship class could navigate at a specific time.

A decay factor was applied to RIO calculations from June 15 onwards when determining the start of the shipping windows.

The first and last dates of the shipping windows are presented in Figure 3.4 and Figure 3.5.

Shipping season lengths are presented in Figure 3.6.

Additional information is also taken from the Ice conditions and ship access to the Milne Inlet port report (Fednav Ice Services, 2023).

Figure 3.4 Beginning of Shipping Window to Milne Inlet Port for Various Ice Classes

Year		Type E	1C	1B	1A	PC7	1A Super	PC6	PC5	PC4
1	2022	2022-08-01	2022-08-01	2022-08-01	2022-08-01	2022-08-01	2022-08-01	2022-06-20	2022-03-21	#N/A
2	2021	2021-07-26	2021-07-26	2021-07-26	2021-07-26	2021-07-26	2021-07-26	2021-03-21	#N/A	#N/A
3	2020	2020-07-27	2020-07-27	2020-07-27	2020-07-27	2020-07-27	2020-07-27	2020-06-15	#N/A	#N/A
4	2019	2019-07-29	2019-07-29	2019-07-22	2019-07-22	2019-07-22	2019-07-22	2019-06-17	2019-03-11	#N/A
5	2018	2018-08-06	2018-08-06	2018-08-06	2018-07-30	2018-07-30	2018-07-30	2018-06-18	#N/A	#N/A
6	2017	2017-08-07	2017-08-07	2017-08-07	2017-07-31	2017-07-31	2017-07-31	2017-07-17	2017-06-19	#N/A
7	2016	2016-07-25	2016-07-25	2016-07-25	2016-07-25	2016-07-18	2016-07-18	2016-06-20	#N/A	#N/A
8	2015	2015-08-15	2015-08-15	2015-08-03	2015-08-03	2015-08-03	2015-08-03	2015-08-03	2015-06-15	#N/A
9	2014	2014-08-11	2014-08-11	2014-08-11	2014-08-11	2014-08-11	2014-08-11	2014-08-11	2014-08-11	2014-08-11
10	2013	2013-08-05	2013-08-05	2013-07-29	2013-07-29	2013-07-29	2013-07-29	2013-06-17	#N/A	#N/A
11	2012	2012-07-23	2012-07-23	2012-07-23	2012-07-23	2012-07-23	2012-07-23	2012-06-18	2012-03-19	#N/A
12	2011	2011-08-01	2011-08-01	2011-07-25	2011-07-25	2011-07-25	2011-07-25	2011-06-20	2011-06-06	#N/A
13	2010	2010-08-09	2010-08-09	2010-08-09	2010-08-09	2010-08-09	2010-08-09	2010-07-05	2010-06-21	2010-05-24
14	2009	2009-08-03	2009-08-03	2009-08-03	2009-08-03	2009-07-27	2009-07-27	2009-06-22	2009-03-30	2009-01-26
15	2008	2008-08-04	2008-08-04	2008-08-04	2008-08-04	2008-08-04	2008-08-04	2008-06-23	2008-04-28	#N/A
Average date		8-1	8-1	7-30	7-29	7-28	7-28	6-21	5-11	5-10
Number of unninterupted shipping seasons		0	0	0	0	0	0	0	5	12

Figure 3.5 End of shipping Window to Milne Inlet Port for Various Ice Classes

Year		Type E	1C	1B	1A	PC7	1A Super	PC6	PC5	PC4
1	2022	2022-10-03	2022-10-03	2022-10-03	2022-10-10	2022-10-24	2022-10-17	2022-10-24	2022-12-12	#N/A
2	2021	2021-11-08	2021-11-15	2021-11-22	2021-12-13	2021-12-13	2021-12-13	2021-12-13	2022-01-03	#N/A
3	2020	2020-11-09	2020-11-09	2020-11-09	2020-12-21	2020-12-21	2020-12-21	2020-12-28	#N/A	#N/A
4	2019	2019-11-04	2019-11-11	2019-11-25	2019-12-23	2019-12-23	2019-12-23	2020-02-17	#N/A	#N/A
5	2018	2018-10-08	2018-10-22	2018-10-22	2018-12-26	2018-12-26	2018-12-26	2018-12-24	2018-12-24	#N/A
6	2017	2017-10-23	2017-10-30	2017-10-30	2017-11-06	2017-11-06	2017-11-06	2017-11-06	#N/A	#N/A
7	2016	2016-10-10	2016-10-10	2016-10-10	2016-10-10	2016-10-10	2016-10-10	2016-10-10	2017-02-13	#N/A
8	2015	2015-10-26	2015-11-02	2015-11-02	2015-12-14	2015-12-14	2015-12-14	2016-02-08	#N/A	#N/A
9	2014	2014-11-03	2014-11-03	2014-11-10	2014-11-10	2014-11-10	2014-11-10	2014-11-10	2015-02-02	#N/A
10	2013	2013-11-04	2013-11-04	2013-11-04	2013-11-11	2013-12-09	2013-12-09	2013-12-09	2014-07-21	2014-07-28
11	2012	2012-11-05	2012-11-12	2012-11-12	2012-12-24	2012-12-31	2012-12-31	2012-12-31	#N/A	#N/A
12	2011	2011-10-31	2011-11-07	2011-11-14	2011-12-05	2011-12-05	2011-12-05	2011-12-05	2012-01-23	#N/A
13	2010	2010-10-25	2010-11-08	2010-11-08	2010-11-08	2010-11-08	2010-11-08	2010-11-08	2011-02-14	#N/A
14	2009	2009-10-26	2009-11-09	2009-11-09	2009-11-16	2009-11-23	2009-11-23	2009-11-23	2010-03-01	2010-04-19
15	2008	2008-10-27	2008-11-03	2008-11-10	2008-11-17	2008-11-24	2008-11-24	2008-12-01	2008-12-01	2008-12-08
Average date		10-25	10-31	11-3	11-23	11-27	11-27	12-5	2-3	4-6
Number of unninterupted shipping seasons		0	0	0	0	0	0	0	5	12

Figure 3.6 End of Shipping Window to Milne Inlet Port for Various Ice Classes

Year		Type E	1C	1B	1A	PC7	1A Super	PC6	PC5	PC4
1	2022	63	63	63	70	84	77	126	266	#N/A
2	2021	105	112	119	140	140	140	267	#N/A	#N/A
3	2020	105	105	105	147	147	147	196	#N/A	#N/A
4	2019	98	105	126	154	154	154	245	#N/A	#N/A
5	2018	63	77	77	149	149	149	189	#N/A	#N/A
6	2017	77	84	84	98	98	98	112	#N/A	#N/A
7	2016	77	77	77	77	84	84	112	#N/A	#N/A
8	2015	72	79	91	133	133	133	189	#N/A	#N/A
9	2014	84	84	91	91	91	91	91	175	#N/A
10	2013	91	91	98	105	133	133	175	#N/A	#N/A
11	2012	105	112	112	154	161	161	196	#N/A	#N/A
12	2011	91	98	112	133	133	133	168	231	#N/A
13	2010	77	91	91	91	91	91	126	238	#N/A
14	2009	84	98	98	105	119	119	154	336	448
15	2008	84	91	98	105	112	112	161	217	#N/A

B. Limitations: The analysis is based on 15 years of data. Although 15 years is a sufficient period to understand general patterns and to assess variability between years, it is not an extensive study period.

The ice charts used for the analysis are an interpretation made by ice analysts at the time the chart was published. Their analysis is based on remotely-sensed data, climate models and the interpretation skills of the analysts themselves. They are not free of inexactitudes and, therefore, may not accurately reflect the actual prevailing ice conditions at the time of publication.

Ice charts are also produced at a relatively coarse spatial scale and temporal resolution (the charts are published weekly). Consequently, there may exist valid routes that would allow access to a vessel of a specific ice class that are not visible from the charts.

The analysis uses RIO calculation, which are based on concentration, stage of development and decay. These calculations do not account for other factors that can seriously impact the ability of a vessel to progress through an ice pack, such as pressure and deformation. Indeed, pressure and deformation can significantly delay a transit. One such example is the shear zones which forms at the junction of Baffin Bay and Pond Inlet, and which may constitute, at times, a formidable obstacle for ships.

Also, when assessing the presence of a route for the purpose of this analysis, there were some instances where the route that was established was substantially intricate. In addition, there are times of the year when the portion of the voyage spent in ice is considerable. As a result, it is possible that outside of a purely theoretical exercise, a prudent ship owner would have, on some instances, shied away from a voyage for fear of developing ice conditions.

Based on the above methodology and assumptions, the following conclusions for navigation to Milne Port apply:

- The nominal open water season is from August 1st to October 15th (75 days).
- On some years, it is expected that a shoulder window will allow the shipping season to be extended beyond the high confidence shipping window for certain classes of ships. This will need to be assessed on a yearly basis as there is high variability in terms of length and timing of the shoulder period.
- Unless a variance or an exceptional circumstance is approved, Baffinland will cease all shipping to and from Milne Port on or before October 31.

- Provision for icebreaking services will be strongly recommended for all DNV 1C, 1B, 1A and 1A Super vessels as well Polar Class 6 and 7 ships during the Fall shoulder period, at the closing of the season. In comparison, Polar Classes 5 and higher can engage ice and face a certain amount of pressure on the ice cover
- Type E vessels (no ice class) are not meant to engage any significant amount of ice. The high confidence shipping window is August 1st to October 25th (85 days). Extending the season requires an icebreaker escort.
- The high confidence shipping window for DNV 1C is August 1st to October 31st (91 days). Extending the season requires an icebreaker escort.
- The high confidence shipping window for DNV 1B is July 30th to November 3rd (96 days). Extending the season requires an icebreaker escort.
- The high confidence shipping window for DNV 1A is July 29th to November 23rd (117 days). Extending the season requires an icebreaker escort.
- The high confidence shipping window for DNV 1A Super is July 28th to November 27th (122 days). Extending the season requires an icebreaker escort.
- The high confidence shipping window for PC7 is July 28th to November 27th (122 days). Extending the season requires an icebreaker escort.
- The high confidence shipping window for PC6 is June 21st to December 1st (122 days). Extending the season requires an icebreaker escort.
- PC5 and PC4 vessels can navigate in much more challenging ice conditions. Using POLARIS, these classes of vessels would have positive RIOs throughout the year for several years during the period analysed. It is the concentration of old ice in some ice regimes that dictates whether the vessels obtain negative RIOs or not.
- For PC5, vessels would have positive RIOs throughout the year for 5 seasons out of 15.
- For PC4 vessels, vessels would have positive RIOs throughout the year for 12 seasons out of 15.

3.2.6.1 Ice Navigators

When regulations and safe operation require an Ice Navigator will be placed aboard each vessel. An Ice Navigator is a qualified Officer who has several years of experience navigating vessels in ice infested waters, Canadian Arctic Waters, and elsewhere. Onboard the chartered ship, his duties are advisory only and his principal responsibility is to provide the Master with advice with regard to the navigation of the vessel into and outward from Milne Inlet, in the areas north of 60 degrees latitude, as well as anywhere sea ice can be present. It is intended that the Ice Navigator will join each chartered vessel at the last port of discharge, prior to the vessel's departure for Milne Inlet. The Ice Navigator will remain onboard for the duration of the voyage, leaving the vessel after the vessel arrives in the designated discharge port. Among the Ice Navigators duties is to ensure the chartered vessel is capable of entering/exiting and safely operating in Milne Inlet in the presence of ice.

After boarding, the Ice Navigator will convene a meeting with all watch keepers wherein they may wish to discuss various aspects of their role onboard and general information regarding navigating in potential ice. The Ice Navigator shall verify that the vessel has up to date charts and nautical publications required to be onboard in accordance with governing regulations. Ultimately, it is the Owners' responsibility to ensure the proper charts and publications are onboard. The Ice Navigator will witness the safe and reliable operation of the machinery and familiarize themselves with the manoeuvrability of the vessel, the change out of ballast, and will report any apparent deficiencies to Fednav. The Ice Navigator shall provide the Master with advice on safe navigation in ice covered Canadian waters, coastal navigation and environment protection procedures in Canadian Arctic Waters & loading at Milne Inlet.

Furthermore, an Ice Navigator may among other duties:

- Assist the Master to understand and complete the required environmental procedures.
- Verify that the vessel has the required Canadian Charts and Publications as specified by Canadian Regulations, and that all are the latest edition and corrected up to date.
- Advise the Master in the navigation of the vessel though ice prone areas en route to Milne Inlet.
- Coach and train the crew as necessary on detecting and avoiding glacial ice features, in a variety of sea and ice conditions.
- Assist the Master in completion of navigation safety and ice entry checklists; and
- Assist the Master in establishing communications with ECAREG and/or NORDREG and with the Milne Inlet site personnel.
- Advise/assist the Master in berthing the vessel alongside the Milne Inlet facility in the event the Milne Inlet Port Docking Master cannot attend on-board.
- Act as facilitator between ship and shore reloading procedures.
- Assist the Master in cargo, customs and immigration documentation for arrival and sailing from Milne Inlet.

3.2.6.2 Transiting In Ice-Infested Waters

It is expected that ice could be present on the approaches to Milne Inlet at any time during the season (especially at the beginning and at the end of the shipping season).

In the event of ice being present in the approaches to Milne Inlet, the vessel is to be navigated according to the principles defined in the *Arctic Ice Regime Shipping System (AIRSS).* The Ice Navigator will be conversant with this system and will provide information as to its application.

For the purpose of implementing Fall shoulder season icebreaking/ice navigation mitigation measures, ice conditions in the RSA will be verified by the Ice Navigators onboard vessels, on a daily basis, using up to date ice charts, satellite imagery and ice reconnaissance from the bridge. In addition, ice conditions in the RSA will be verified by Fednav on a daily basis using any available Canadian Ice Service's Daily Ice Charts and satellite imagery. For the avoidance of doubt and to ensure more timely information on ice conditions, the daily ice charts will be used as a guide, however the ultimate opinion of ice coverage will be made by Ice Navigator onboard vessel.

It should be noted that while there may be an Ice Navigator onboard who is familiar with the conditions the vessel might encounter, the responsibility for the safe prosecution of the voyage rests solely with the vessel's Master.

When landfast ice is present, operations will not be executed along the Northern Shipping Route, and ore carriers will be prevented from rendering a positive ice numeral.

3.2.7 In Instructions to Escort Vessels

The following instructions assume all the criteria Baffinland uses to initiate the shipping season have been met. Unless a variance or an exceptional circumstance warrants a deviation from normal operations that requires travel in ice conditions along the shipping route that exceed 3/10ths ice concentrations, and is approved by QIA, the Hamlet of Pond Inlet and the MHTO, items 1 and 2 will be applied at the start of the shipping season. Alternatively, should a variance or exception circumstance be agreed upon under Term and Condition No. 185, procedures defined under Item 3 will apply.

1. Once the concentration is assessed and confirmation that ice concentrations no greater than 3/10ths along the shipping route can be avoided, the on-board personnel will report real-time data to the Port Captain to enable the Port Captain to properly manage any upcoming vessel traffic.
2. Pending continued confirmation of a continuous path of ice concentrations no greater than 3/10ths along the nominal shipping route, and that a transit may occur without the breaking of ice, normal operations (i.e., unrestricted transit restrictions over a 24 hour period) may be implemented, in absence of any icebreaker escort.
3. Should criteria for establishing variance or exceptional circumstance be approved under Term and Condition No. 185 for earlier start of shipping operations requiring icebreaker escort, the following will apply:
    i. The Vessel Captain on-board the icebreaker will assess the concentrations of ice using best available resources to determine vessel escort limitations.

ii. If ice conditions are greater than 6/10ths concentration or more, with no possible avoidance of icebreaking during the transit, once an icebreaker has finished its transit, the vessel will wait until 24 hours has passed following start of transit before commencing a new transit.

iii. If the ice breaker encounters 4/10ths to 6/10ths ice concentrations along a transit but no greater, the ice breaker may complete the transit and start a second transit immediately thereafter. If both transits are completed in less than 24 hours, the icebreaker will wait until a period of 24 hours has passed since the first transit began before commencing a third transit. That third transit will be the first in a new cycle (i.e. a 24-hour period).

iv. If the vessel encounters 3/10 or less of ice, or is able to transit without breaking ice, normal operations (i.e., unrestricted transit restrictions over a 24 hour period) may be initiated, which may or may not include using the icebreaker to escort vessels (noting that no active icebreaking would be undertaken by the icebreaker).

v. The 24-hour period under these mitigation measures commences at the time the vessel crosses into the RSA and/or departs Milne Port.

4. Regardless of any start of season scenarios, unless criteria for a variance or an exceptional circumstance are met through Term and Condition No. 185 that may influence end of season operations, Baffinland is to plan for and cease all shipping from Milne Port by October 31.

3.2.8 Instructions to Vessels Entering/Exiting the RSA during Implementation of Mitigation Measures

The following instructions assume all the criteria Baffinland uses to initiate the shipping season have been met.

- The vessels will inform the Port Captain when they are permitted to enter the RSA based on the ice class of their respective vessels.
- The Port Captain will issue and adjust the vessel schedules and instructions depending on the ice concentrations and associated transit limitations.
- For the vessels being escorted when required, the Port Captain will notify them as to when and where to meet the icebreaker to begin escort operations.
- For the vessels sailing without icebreaker escort assistance, the Port Captain will notify them at which time they can enter the RSA or depart from Milne Inlet.

- When more than one vessel is entering or exiting the RSA at a given time (i.e., during implementation of a convoy), the vessels shall proceed in a single line-up, while aiming to keep a distance of no greater than 1 nautical mile, and keeping a safe distance between vessels. Refer to Appendix F for additional details.
- Vessels awaiting instructions from the Port Captain to enter the RSA, or vessels awaiting an icebreaker escort, or, will be instructed to wait in Baffin Bay at least 40 km east of the Nunavut Settlement Area when incoming, or in Milne Port when outgoing (see Figure 3.6). If an entrance delay is expected, vessel captains may anchor, at their own discretion, at a known anchorage location within Baffin Bay identified as Store Hellefiskebank (see Figure 3.7).

Figure 3.7 Shipping Route Buffer Zone

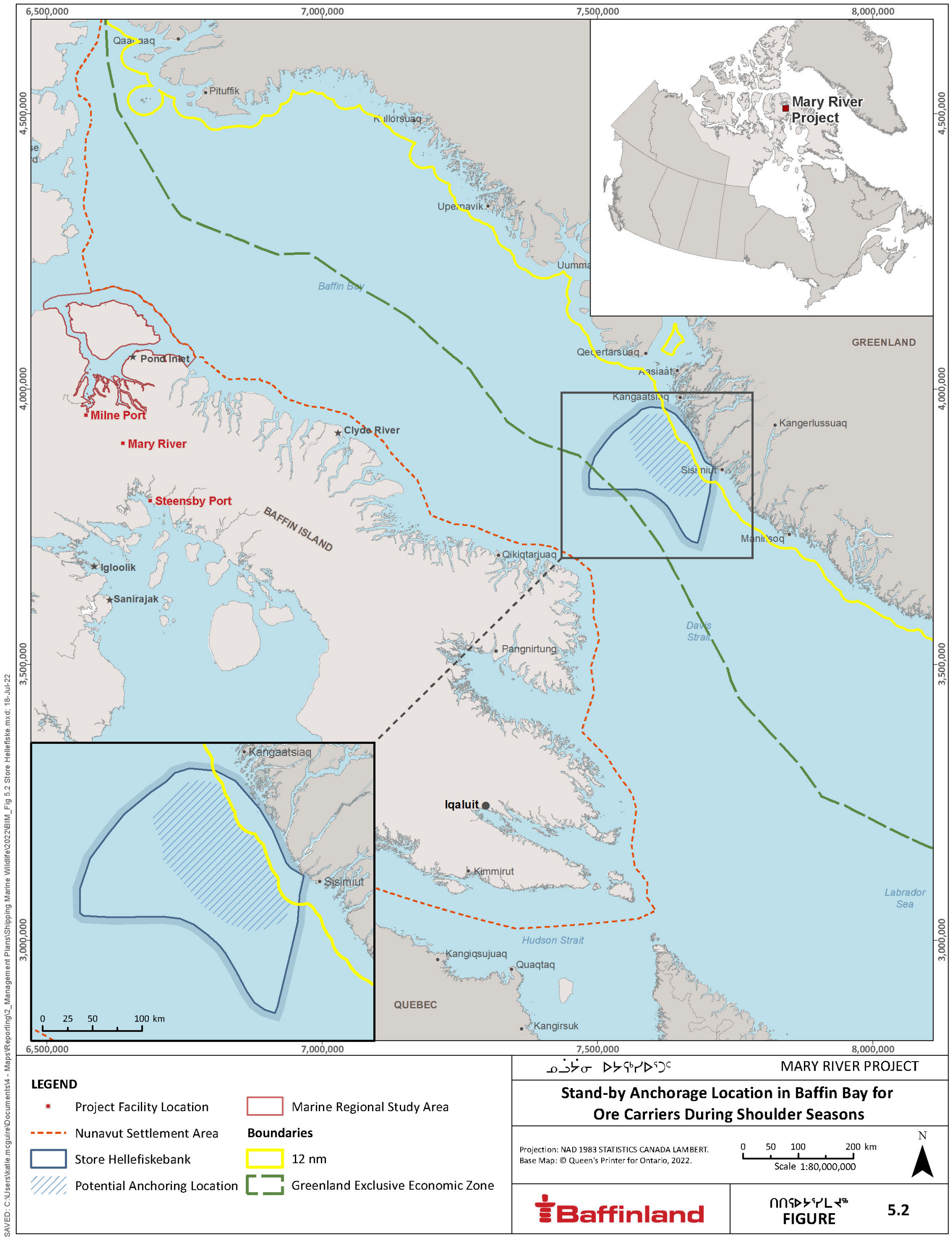

Figure 3.8 Store Hellefiskebank Anchorage Location

3.3 ENVIRONMENTAL MANAGEMENT

3.3.1 Fish Habitat Protection

The authority for the management and conservation of fish and fish habitat in Canada is contained in the federal *Fisheries Act*. DFO is the federal agency responsible for managing Canada's fisheries through the *Fisheries Act*. The fish and fish habitat protection provisions of the *Fisheries Act* are the authorities for the regulation of works, undertakings or activities that risk harming fish and fish habitat (see the Fisheries Protection Policy (Fisheries and Oceans Canada [DFO], 2019). The prohibitions include two prohibitions against persons carrying on works, undertakings or activities that result in the "death of fish by means other than fishing" (referred to as the death of fish; subsection 34.4(1)), and the "harmful alteration, disruption or destruction of fish habitat" (subsection 35(1)).

The fish and fish habitat protection provisions apply to all fish and fish habitat throughout Canada.

The prohibition in subsection 35(1) states that: 35. (1) No person shall carry on any work, undertaking or activity that results in harmful alteration, disruption or destruction of fish habitat. Under subsection 35(1) a person may carry on such works, undertakings or activities without contravening this prohibition, provided that they are carried on under the authority of one of the exceptions listed in subsection 35(2), and in accordance with the requirements of the appropriate exception. In most cases, this exception would be Ministerial authorizations granted to proponents in accordance with the Authorizations Concerning Fish and Fish Habitat Protection Regulations. This exception is provided for under paragraph 35(2)(b), described further in DFO (2019). The Fisheries Act includes a number of other exceptions, some of which have not yet been brought into force, which are also further described in DFO (2019).

3.3.2 Marine Mammals

Project shipping and port operations have the potential to interact with marine mammals and their habitats with potential for adverse effects on these receptors.

Project activities of concern include vessel discharges (ballast water), vessel movements, vessel noise and vibration, and accidental spills and releases. Vessel strikes on marine mammals have the potential to result in direct mortalities or injury. Specific details on the management of potential Project effects related to marine mammals is contained in the MMP. Detailed response actions related to potential Project effects are provided in the MMP (BAF-PH1-830_P16-0046), Tables 5.1 and 5.2.

A summary of applicable mitigation measures for marine mammals are outlined in Table 4.1, in addition to a summary of intended outcomes of mitigation measure implementation with respect to potential effects provided in Table 4.2.

All vessels are to follow the nominal shipping route (See Figure 3.1) to the fullest extent possible and avoid such areas such as Koluktoo Bay and the western shoreline near Bruce Head (see Figure 3.2) to minimize effects on marine mammals and interference with hunting activities.

All Project vessels will restrict speed to 9 knots when transiting along the established shipping corridor, and will be operated in such a way as to avoid separating an individual member(s) of a group of marine mammals from other members of the group. When marine mammals appear to be trapped or disturbed by vessel movements, the vessel will implement appropriate measures to mitigate disturbance, including stoppage of movement until wildlife move away from the immediate area.

Table 3.3 Mitigation Measures for Marine Mammals

Project Activity	Mitigation Measure(s)	Species
Vessel traffic to/from Milne Port	• Maintain constant speed and course when possible. • Reduce vessel speed to 9 knots. • Reduce vessel idling • No more than 3 ore carriers anchoring at Ragged Island and/or drifting in Eclipse Sound. Drifting to be avoided unless warranted for safety reasons. • No icebreaking to commence the shipping season unless Term and Condition No. 185 are met. Ore carriers will not begin their transit to Milne Port until 3/10ths or less ice is present along the entire shipping route through the Nunavut Settlement Area (NSA) from the entrance of Eclipse Sound and Milne Port. • No breaking of landfast ice will occur in the spring or fall shoulder season. • When marine mammals appear to be trapped or disturbed by Project vessel movements, the vessel will implement appropriate measures to mitigate disturbance, including stoppage of movement until wildlife move away from the immediate area (as safe navigation allows). • All Project vessels will be provided with standard instructions to operate their vessel in a manner that avoids separating an individual member(s) of a group of marine mammals from other members of the group; • All Project vessels will be provided with standard instructions to not approach within 300 m of a walrus or polar bear observed on sea ice; • Vessels awaiting instructions from the Port Captain to enter the RSA will be instructed to wait in Baffin Bay at least 40 km east of the Nunavut Settlement Area. • No more than 84 ore carriers (ranging in sizes up to Capesize*[1], dependent on market availability; no annual tonnage limits) will be chartered during the shipping season, pending approval of the SOP. • Use of convoys throughout the shipping season to further reduce total sound exposure. Acoustic monitoring data indicates that if ore carriers transit in convoys with inter-vessel separation less than 10 km, there is an overall reduction of the total sound exposure in the Regional Study Area compared to multiple individual transits of an equivalent number	Ringed Seal, Bearded Seal, Walrus, Beluga, Narwhal, Bowhead Whale, Polar Bear

Project Activity	Mitigation Measure(s)	Species
	of vessels. Slight increases of instantaneous sound levels in the regions between the vessels are compensated for by shorter exposure duration, resulting in a net decrease of noise exposure (See Austin [2022] in Attachment 1 in Appendix F). Baffinland proposes to set annual targets of approximately 5-10% reduction in overall independent one-way transits by implementing convoys, which effectively combines individual transits into single 'effective transits' (refer to Appendix D for additional details on convoy implementation)	

[1]All vessels ranging in size from Capesize to Newcastlemax will be collectively referred to as Capesize*, equivalent to vessel sizes of Deadweight Tonnage (DWT) range of 200,000 – 220,000, and carrying capacity range of approximately 200,000 to 215,000 metric tonnes.

Table 3.4 Intended Outcomes of Mitigation Measures for Marine Mammals to Address Potential Effects

Potential Effect	Mitigation	Intended Outcome of Mitigation	
Ship Strike	• 9 knot speed restriction • Placement of Marine Wildlife Observers on icebreaking vessels • Commitment to not break landfast ice • All icebreaking activities (if Term and Condition 185 criteria are met) will be conducted outside of sensitive life cycle periods for ringed seal (pupping, nursing and mating periods) • All Project vessels will maintain constant speed and course (as safe navigation allows) • When marine mammals appear to be trapped or disturbed by Project vessel movements, the vessel will implement appropriate measures to mitigate disturbance • All Project vessels are provided with standard instructions to not approach within 300m of a walrus or polar bear observed on sea ice • All Project vessels are provided with standard instructions to operate their vessel in a manner that avoids separating an individual member(s) of a group of marine mammals from other members of the group. • Establishment of restricted "no-go" zones to avoid key sensitive areas (Koluktoo Bay, Tremblay Sound, western shore of Milne Inlet).	Avoid marine mammal mortality or injury as a result of Project operations	• Section 3.1.2 • Section 3.1.4 • Section 3.2.2 • Section 3.2.4 • Section 3.2.6 • Section 3.3.2 • Appendix C
Ice Entrapment	• Commitment to not break landfast ice • Avoidance of ice if and when safe to do so • When marine mammals appear to be trapped or disturbed by Project vessel movements, vessels will implement appropriate management measures to mitigate disturbance.	To avoid ice entrapment events as a result of icebreaking activities.	• Section 3.1.4 • Section 3.2.2 • Section 3.2.4 • Section 3.2.6 • Appendix C

Potential Effect	Mitigation	Intended Outcome of Mitigation	
Hearing Impairment	• Not required as marine mammal acoustic injury thresholds were not exceeded in any of the modelling scenarios. This was subsequently confirmed through passive acoustic monitoring program.	N/A	N/A
Acoustic Disturbance	• Establishment of a 40-km 'buffer zone' at entrance of RSA • Avoidance of ice if and when safe to do so • Establishment of restricted "no-go" zones to avoid key sensitive areas (Koluktoo Bay, Tremblay Sound, western shore of Milne Inlet).	Reduce the acoustic disturbance zone (spatial area) in the RSA.	• Section 3.1.4 • Section 3.2.2 • Section 3.2.2.1 • Section 3.2.6.3.2 • Section 3.3.2
	• Restriction of transits in heavier ice conditions (only if early shoulder season activities permitted under Term and Condition 185)	To minimize the amount of time narwhal will be exposed to noise levels that would onset disturbance and avoidance behaviours.	• Section 3.2.2
	• 9 knot speed restriction	Reduce the noise output of all Project vessels	• Section 3.1.4
	• Commitment to not break landfast ice	Reduce the noise output of icebreaker operations, and therefore reduce acoustic disturbance zone and daily exposure period.	• Section 3.1.4 • Section 3.2.2 • Section 3.2.4 • Section 3.2.6
	• All Project vessels will maintain constant speed and course (as safe navigation allows)	Reduce the acoustic disturbance zone (spatial area) in the RSA	• Appendix C
	• No drifting of Project vessels in Eclipse Sound (as safe navigation allows)	Reduce the acoustic disturbance zone (spatial area) and daily exposure period	• Section 3.1.2.2
	• Maximum of 3 vessels anchored at Ragged Island	Reduce the acoustic disturbance zone (spatial area)	• Section 3.1.2.2

Potential Effect	Mitigation	Intended Outcome of Mitigation	
	• No more than 84 ore carriers (ranging in sizes up to Capesize*[1], dependent on market availability; no annual tonnage limits) will be chartered during the shipping season, pending approval of the SOP	To minimize the amount of time narwhal will be exposed to noise levels that would onset disturbance and avoidance behaviors.	• Section 3.2.2
	• Use of convoys throughout each shipping season	To minimize the amount of time narwhal will be exposed to noise levels that would onset disturbance and avoidance behaviors.	• Section 3.1.2.4 • Appendix F
Acoustic Masking	• Establishment of a 40-km 'buffer zone' at entrance of RSA • Establishment of restricted "no-go" zones to avoid key sensitive areas (Koluktoo Bay, Tremblay Sound, western shore of Milne Inlet).	Reduce the acoustic disturbance zone (spatial area) in the RSA.	• Section 3.1.4 • Section 3.2.2.1 • Section 3.2.6.3.2 • Section 3.3.2
	• Restriction of transits in heavier ice conditions (only if early shoulder season activities permitted under Term and Condition 185)	To minimize the amount of time narwhal will be exposed to noise levels that would onset disturbance and avoidance behaviors.	• Section 3.2.2
	• 9 knot speed restriction	Reduce the noise output of all Project vessels	• Section 3.1.4
	• Commitment to not break landfast ice	Reduce the noise output of icebreaker operations, and therefore reduce acoustic disturbance zone and daily exposure period	• Section 3.1.4 • Section 3.2.2 • Section 3.2.4 • Section 3.2.6
	• All Project vessels will maintain constant speed and course (as safe navigation allows)	Reduce the acoustic disturbance zone (spatial area) in the RSA	• Appendix C

Potential Effect	Mitigation	Intended Outcome of Mitigation	
	• No drifting of Project vessels in Eclipse Sound (as safe navigation allows)	Reduce the acoustic disturbance zone (spatial area) and daily exposure period	• Section 3.1.2.2
	• Maximum of 3 vessels anchored at Ragged Island	Reduce the acoustic disturbance zone (spatial area)	• Section 3.1.2.2
	• No more than 84 ore carriers (ranging in sizes up to Capesize*[1], dependent on market availability; no annual tonnage limits) will be chartered during the shipping season, pending approval of the SOP	To minimize the amount of time narwhal will be exposed to noise levels that would onset disturbance and avoidance behaviors.	• Section 3.2.2
	• Use of convoys throughout each shipping season	To minimize the amount of time narwhal will be exposed to noise levels that would onset disturbance and avoidance behaviors.	• Section 3.1.2.4 • Appendix F

[1]All vessels ranging in size from Capesize to Newcastlemax will be collectively referred to as Capesize*, equivalent to vessel sizes of Deadweight Tonnage (DWT) range of 200,000 – 220,000, and carrying capacity range of approximately 200,000 to 215,000 metric tonnes.

It is important to note that none of the aforementioned mitigations related to vessel movement, should be read in any way as over-riding the Vessel Master's authority and responsibility for safe navigation and management of the vessel.

The above measures shall be revisited each shipping season with changes captured in annual updates to the SMWMP should additional actions be identified through implementation of the Marine Monitoring Plan and relevant Trigger Action Response Plan (TARP) applicable to marine mammals.

3.3.3 Onboard Waste Management

All vessels are to have Waste Management Plans for sewage and solid waste.

3.3.3.1 Sewage and Grey Water

All ore carriers are to be fitted with a holding tank with sufficient capacity to meet the grey and black water requirements of the ship for the duration of its time in the RSA. Ore carriers are not to discharge effluent from treated or untreated sewage or grey water while in the RSA.

3.3.3.2 Solid Waste

In accordance with MARPOL and the *Arctic Waters Pollution Prevention Act*, no solid waste materials or garbage is to be disposed of in Canadian waters. As no facility exists to dispose of foreign or Canadian ship waste materials or garbage at Milne Port, such materials will either be incinerated or retained on-board and later disposed of in accordance with Canadian and International regulations.

3.3.4 Invasive Species Management

3.3.4.1 Ballast Water Management

In order to reduce or eliminate the risk of invasive aquatic species and pathogens being introduced into Canadian waters as a result of shipping, all ships will exchange ballast water in accordance with the *Ballast Water Regulations SOR/2021-120* (Transport Canada, 2001). The regulations require that ships transiting to Canadian ports exchange ballast water at sea in deep water away from coastal zones. This measure limits the potential for foreign harmful aquatic organisms or pathogens to be released in Canadian waters where they may colonize. Vessels are required to adhere to the Ballast Water Control and Management Regulations and will follow their own Ballast Water Management Plan). Additionally, chartered vessels will be required to follow protocols for ballast water management and discharge as outlined in Baffinland's Ballast Water Management Plan (BWMP). As done since 2020, Baffinland requires all ore carrier vessels with treatment systems to perform both a ballast water exchange (D1 standard) and treatment (D2 standard) as part of ongoing management and mitigation measures aimed at reducing/eliminating the potential risk of introduction of aquatic invasive species at Milne Port.

3.3.4.2 Anti-Fouling Management

In order to reduce or eliminate the risk of invasive aquatic species and pathogens being introduced into Canadian waters as a result of ship hull biofouling, an anti-fouling coating will be in applied to the hulls of all Project vessels that will arrive and depart from Milne Port. The anti-fouling coating used will comply with the anti-fouling convention as well as be approved under the Pest Management Regulatory Agency of Canada and Regulations for the Prevention of Pollution from Ships and for Dangerous Chemicals (2007-86). This convention prohibits the use of dangerous organotin chemicals in anti-fouling systems. Any anti-fouling system that has a component listed under Annex I of the convention will not be used. The potential anti-fouling systems include:

- Organotin-free polishing type paint
- Organotin-free ablative type paint
- Organotin free conventional type paint
- Biocide-free silicon type paint
- Other biocide-free paints

As the iron ore carriers commissioned for operations will exceed 400 gross tonnes and will be undertaking international voyages, these vessels will require an international anti-fouling system certification. Baffinland is committed to ensuring all vessels procured for the Project meet the IMO International Convention on the Control of Harmful Anti-fouling Systems on Ships. As per Annex I of the convention (and Schedule 6 of the Regulations for the Prevention of Pollution from Ships and for Dangerous Chemicals [2007-86]), the anti-fouling system will:

- Not bear organotin compounds on their hulls or external parts or surfaces; or
- Bear a coating that forms a barrier to such compounds leaching from the underlying non-compliant anti-fouling systems.

3.3.5 Automatic Identification System (AIS) Vessel Tracking

Project vessel transits along the Northern Shipping Route are tracked and recorded using a combination of shore-based and satellite-based Automated Identification System Data. Automated Identification System transponders are mandatory on all commercial vessels >300 gross tonnes and on all passenger ships. Information provided by the AIS includes vessel name and unique identification number, vessel size and class, position and heading, course, speed of travel, and destination port.

Satellite-based Automatic Identification System data is acquired through Spire (previously known as exactEarth Ltd.) is used to track Project vessel movements along the shipping corridors in real-time. In 2018 Baffinland also installed a shore-based real-time satellite-based Automatic Identification System vessel tracking system at the Pond Inlet Baffinland office located on the second floor of the MHTO Building.

3.3.6 Community-based Ship Monitoring

Ship locations are posted on the Baffinland Iron Mines website (www.baffinland.com) and available at the Baffinland office in Pond Inlet located on the second floor of the MHTO office building.

Additionally, Baffinland employs up to four (4) full-time and six (6) part-time land-based shipping monitors to work in Pond Inlet who are responsible for conducting live monitoring throughout the shipping season and has established communication protocols and designate contact information to respond to community concerns. This is in addition to the full-time Community Environment Coordinator also based in Pond Inlet who is available year-round to address any community concerns.

These processes will help to increase response time to correct vessel movement or speed in the event of non-adherence to vessel management protocols.

3.4 EMERGENCY MANAGEMENT AND RESPONSE

3.4.1 Spill Prevention and Management

Vessels procured by Baffinland and Baffinland staff will ensure the following is in place to prevent and respond to spills, in the unlikely even they occur:

- Comply with the *Oil Pollution Prevention Regulations* and maintain an approved Shipboard Oil Pollution Emergency Plan (SOPEP).
- Conduct exercises with the Terminal staff at regular intervals to ensure ship and shore can co-operate to minimize the damage from any spill of fuel.
- Maintain an up-to-date oil transfer record book covering the disposal of engine room sludge and the discharge of oily water through a separator.
- Maintain a separate record book for oil cargo and the treatment and disposal of cargo slops.
- Conduct exercises to test the ship and shore joint capability to handle an oil pollution incident in accordance with the provisions of the Ships' Oil Spill Response Plan and the Oil Pollution Emergency Plan – Milne Inlet (OPEP).
- Ensure that all hazardous materials are stored and handled as per information provided in Safety Data Sheets (SDS).
- Ensure that all dangerous goods are transported as per requirements under the *Transportation of Dangerous Goods Act and Regulations.*

Management plans for the Project related to spill response and management include the following:

- Spill Contingency Plan
- Spill at Sea Response Plan
- Environmental Protection Plan
- Emergency Response Plan
- Oil Pollution Emergency Plan – Milne Inlet (OPEP)
- Oil Pollution Prevention Plan – Milne Inlet (OPPP)
- Shipboard Oil Pollution Emergency Plan[5].

Copies of Baffinland's latest management plans for the Project are available at www.baffinland.com.

[5] SOPEPs are developed by and for the Master of the vessel. The SOPEP is not a Baffinland Management plan. SOPEPs must meet external standards as dictated by IMO under MARPOL 73/78.

3.4.2 Extreme Weather Conditions

The Vessel Master (the Master) is responsible at all times for the safe navigation and operation of the vessel within the applicable laws of Canada, having special responsibility for the safety of life, the safety of the ship and the preservation of the environment. In order to meet these responsibilities, the Master has full authority to take whatever action considered necessary to successfully complete the voyage. This includes responding to extreme weather conditions and taking actions to adjust speed, seek shelter, accept assistance or deviate to save lives, as required.

3.4.3 Accidental Events during Shipping and Reporting Procedures

In the event of a malfunction or other incident during shipping operations within Milne Inlet, the Master will immediately inform the port emergency control system requesting such assistance as may be practical. Outside of Milne Inlet, the Master shall immediately report the incident verbally and later in writing to the nearest Transport Canada reporting station.

In the event any accidental contact occurs between a Project vessel and a marine mammal or an aggregation of seabirds, with resulting death or serious injury, the regional office of Fisheries and Oceans Canada (marine mammals) or Environment and Climate Change Canada (seabirds) is to be notified and supplied with information documenting the incident (date/time/location, affected species and condition, circumstances of the incident, weather and sea conditions, location/travel direction of the affected animal(s)). The Vessel Master will inform Baffinland Site personnel, who will contact the appropriate government agency. Annually, Baffinland will summarize any such incidents in its report to NIRB.

3.4.4 Unforeseen Events

During shipping operations, unforeseen events or unanticipated interactions with the environment may occur that may require intervention by the Ship's Master. Baffinland has adopted a response management strategy for all phases of the Project that will prepare Project personnel to identify, resolve and learn from any unforeseen events. One of the main principles of an effective response management strategy is to expect the unexpected and to be prepared to act quickly and decisively when it occurs. Examples of unforeseen events associated with Project shipping activities might include unanticipated startle reactions by marine mammals or unexpected attraction to ship's lighting by seabirds. If an unforeseen event were to occur, corrective actions would be taken by the Master of the vessel to avoid or reduce any adverse effects. In the case of the examples provided, these actions might include adjusting ships speed to reduce noise, or to maintain essential lighting only, in sensitive areas. Any such events, the subsequent corrective action taken and the degree of success will be documented to allow others to learn from these experiences to ensure continual improvement.

4 ROLES AND RESPONSIBILITIES

Baffinland's Shipping Team and Contractors are responsible for achieving compliance with applicable regulations and permit requirements. To meet these requirements, Baffinland is committed to working with only the best in class ship operators. Compliance is achieved through continuous monitoring, development and implementation of operational standards and procedures in addition to vessel owner/operator communication and awareness raising strategies.

General responsibilities include:

- To manage and schedule shipments of cargoes in and out of Project ports;
- To ensure, prior to chartering a vessel, that a pre-charter audit and/or document inspection is carried out on the vessel to confirm the condition of the vessel and that it is managed and operated in accordance with the International Safety Management (IMS) system with all certificates up to date, including any relevant foreign program equivalent to Transport Canada's Marine Safety Delegated Statutory Inspection Program.
- To provide vessel owner/operators and masters with a copy of the SITM and to maintain these documents to ensure they contain up-to-date commitments regarding operation of vessels while travelling along Project Shipping Routes;
- To review environmental monitoring and management practices and identify, as required, adaptive management measures to achieve environmental compliance.

Specific responsibilities related to shipping operations are as follows are provided below in Table 4.1.

Table 4.1 Roles and Responsibilities

Position	Responsibilities
Vessel Owners and Operators (External)	• Ensure Project-vessels chartered to perform Baffinland trade meet all federal and international regulations. • Subject to safety considerations, follow all instructions from Baffinland and or/it's contractors for operating the vessel along the Northern Shipping Route.
Head of Shipping	• Communicate requirements of and distribute copies of relevant management plans, including Baffinland's SMWMP to all vessel owners and operators and any contractors hired by Baffinland to support shipping operations. • Conduct audit and inspections of vessel documents to ensure they meet Baffinland's internal requirements and federal and international regulations, as needed.
Port Captain (Contractor)	• The Port Captain oversees and organizes efficient operation of the assigned fleet at Milne Port. • The Port Captain will contact the Head of Shipping if vessels are not following protocols and instructions as outlined in the Standing Instructions to Masters.
Shipping Monitors (Baffinland Employee–	• Track Project-related vessels travelling along the Northern Shipping Route via AIS monitoring and live monitoring stationed out of Pond Inlet.

Position	Responsibilities
Resident of Pond Inlet)	• Track, record and provide communications to residents of Pond Inlet on the use of convoys over the entire duration of the shipping season. • Record events where ships have made significant deviations from shipping routes. • Record environmental conditions, sighting of marine mammals and vessel interactions with hunters, when information is available. • Act as a community liaison between Baffinland and residents and hunters from Pond Inlet to address community concerns related to Project-shipping, if any when these arise.
Marine Environment Working Group	The MEWG's primary function is to consult with and provide advice to Baffinland with respect to its monitoring programs and mitigation measures, including its efforts to collect baseline data, monitor effects of the Project, and determine any adaptive management measures that may be required during the construction, operations, closure and reclamation of the Project. In fulfilling its role the MEWG may: • Make recommendations and provide advice to Baffinland on any aspects of the MMP which require the adoption of additional or revised monitoring programs and mitigation measures in order to comply with applicable regulatory requirements and/or to mitigate adverse Project effects; • Collaborate on research programs, activities, or initiatives relating to the marine environment; • Review the SMWMP, its implementation, and suggest recommended changes; • Review and provide technical advice and directions for improvements relating to the following: o monitoring reports and results provided to the MEWG by Baffinland; o the assessment of potential impacts of the Project on the marine environment and marine wildlife; o the effectiveness of mitigation measures implemented by Baffinland; and o Baffinland's plans for the development and implementation of adaptive management and/or mitigation measures.
QIA Regulatory Manager (IIBA)	• Directs QIA's onsite environmental resources • Liaise with Baffinland's Permitting and Compliance Manager and/or Environmental Superintendents • Reviews regulatory submissions on behalf of the QIA • Member of the QIA-Baffinland Adaptive Management Working Group
QIA (Adaptive Management - Position TBD)	• Establish the Adaptive Management Working Group with Baffinland • Provide timely results of relevant monitoring programs carried out under the Inuit Stewardship Plan, to inform the adaptive management system • Engage in additional investigations in circumstances where adverse changes merit adaptive management interventions, for relevant management plans, as required • Support the monitoring and reporting of effectiveness of remedial actions, as per the adaptive management feedback loop, through the Inuit Stewardship Plan's mechanisms • Review updates to the Adaptive Management Plan, and adaptive management components including relevant management plans and portions of these plans (i.e., objectives)
BIM-QIA Adaptive Management Working Group	• Evaluate relevant management plans within the EMS system against the Adaptive Management Checklist (Appendix B) • Develop and approve (which will be informed by but may go beyond those required by regulatory approvals) objectives, indicators, thresholds and appropriate response requirements for all relevant management plans within the EMS system • Oversee the implementation of approved adaptive management plans

Position	Responsibilities
	• Review results of Adaptive Management responses completed by Baffinland on an annual and as needed basis

5 MONITORING

The Plan focuses on the managing shipping and interactions with marine wildlife. Given this is an activity management plan, its primary purpose is to speak to the safe and efficient operation of shipping activities and to incorporate all relevant mitigation measures for responsible shipping operations that meet requirements outlined in Terms and Condition of Project Certificate No. 005. This plan therefore does not identify shipping-specific indicators and thresholds related to environmental protection. This plan is closely linked with the MMP, Spill at Sea Management Plan and Ballast Water Management Plan.

5.1 Environmental Monitoring

Baffinland is committed to implementing marine-based monitoring programs for the Mary River Project to monitor for possible Project-related impacts to the marine environment as identified in the FEIS (Baffinland 2012) and Addendums (Baffinland 2013; 2018; 2020; 2022) and to meet requirements outlined in Terms and Conditions of Project Certificate No. 005. The main objectives of the monitoring programs are to:

- Verify effects predictions described in the Approved Project;
- Evaluate the effectiveness of Project mitigation measures;
- Identify unforeseen environmental effects;
- Provide an early warning of an adverse change in the environment; and
- Improve the understanding of cause-and-effect relationships.

Baffinland's marine-based monitoring programs are primarily focused on the interaction between Project activities and the receiving marine environment, and in the establishment of cause-effect relationships that flow from these interactions. Monitoring results provide information that serve to modify, add, or eliminate mitigation measures which will then be incorporated into future of the SMWMP as required. Additional monitoring programs may be developed, if required, and could lead to the implementation of adaptive environmental management measures (which would subsequently lead to changes in the SMWMP).

In accordance with Condition 77 of the Project Certificate, a Marine Environment Working Group (MEWG) has been established to provide advice and recommendations related to marine environmental monitoring and implementation of mitigation measures for the protection of the marine environment. The Terms of Reference for the Marine Environment Working Group are currently under revision (refer to Section 1.4 for further information).

More specifically, environmental monitoring is conducted at three levels:

- Research – studies to establish basic monitoring parameters (e.g. natural variability; potential for project-environment interaction), or to establish a baseline for future monitoring;
- Surveillance – studies to record natural environment phenomena and act as an "early warning" of changes, which, while not attributable to the Project, could require attention and possible design of a specific EEM program;
- EEM –environmental effects monitoring (EEM) based on a statistically robust study design capable of accepting or rejecting a Null Hypothesis, and focused on establishing a cause/effect relationship between environmental phenomena and Project attributes.

Environmental compliance monitoring is also carried out to demonstrate that the conditions of applicable permits and approvals (e.g. with respect to limits on concentrations of discharges) have been met during in-water or near-water marine-based Project works.

Detailed information on Baffinland's monitoring programs are outlined in Baffinland's MMP. The MMP is intended to provide detailed information on program design and monitoring procedures for all of Baffinland's monitoring programs. The MMP is intended to be regularly updated based on program design modifications that are required based on annual monitoring results and/or recommendations provided by the MEWG and the NIRB.

In design and execution of its monitoring programs, Baffinland is committed to applying rigorous standards for study design, analysis and reporting. All study designs are provided to the MEWG for review and comment. All monitoring data are analyzed rigorously by experienced analysts, and all final monitoring reports are circulated to the NIRB for comment. Additionally, affected communities will continue to be consulted on study design and provided opportunities to participate in implementation of the monitoring programs. Monitoring results are regularly presented to community advisory groups for discussion. In all monitoring programs, Baffinland engages direct Inuit participation in study planning, execution and interpretation of results.

A Trigger Action Response Plan (TARP) has been developed in order to identify monitoring objectives and the adaptive management framework for each of Baffinland's marine-based monitoring programs, including performance indicators, effects thresholds and pre-defined actions (i.e., responses) that are implemented if or when established thresholds are exceeded. The TARP for the Marine Environment component (water and sediment quality, benthic infauna, fish health and fish tissue chemistry; Table 5.1) and for Marine Mammals (Table 5.2) were developed as part of the MMP and included below for reference. Specific details are in included in Baffinland (2023a).

Should the need for new or modified mitigation measures be triggered through TARP, the SMWMP will be amended to incorporate these changes for implementation during the next upcoming shipping season.

Table 5.1 Marine Environment Trigger Action Response Plan (TARP)

Monitoring Program / Key Indicator	Objective	Performance Indicators	Project Activity Monitored	Condition Status / Threshold			Pre-defined Response(s)		
				Low Risk	Moderate Risk	High Risk	Low Risk	Moderate Risk	High Risk
Marine Environmental Effects Monitoring Program (MEEMP) / Marine Water Quality	• Monitor for adverse environmental effects from shipping operations (propeller wash) and port operations (effluent discharge, dust dispersion and deposition from ore stockpiles and ship loading) on marine water quality at Milne Inlet. • Identify mitigation for avoiding and/or minimizing adverse effects that exceed FEIS predictions	• Metals • TSS • Hydrocarbons • Nutrients	• Propeller wash • Effluent Discharge • Ore dust dispersion and deposition from stockpiles and ship loading	Refer to Table 5.1 of the Marine Monitoring Plan					
MEEMP / Marine Sediment Quality	• Monitor for adverse environmental effects from shipping operations (propeller wash) and port operations (effluent discharge, dust dispersion and deposition from ore stockpiles and ship loading) on marine sediment quality at Milne Inlet. • Identify mitigation for avoiding and/or minimizing adverse effects that exceed FEIS predictions.	• Particle Size • Nutrients • Metals • Hydrocarbons	• Propeller wash • Effluent Discharge • Ore dust dispersion and deposition from stockpiles and ship loading	Refer to Table 5.1 of the Marine Monitoring Plan					
MEEMP / Benthic Infauna	• Monitor for adverse environmental effects from shipping operations (propeller wash, ballast water discharges) and port operations (effluent discharge, dust dispersion and deposition from ore	• Density • Taxa Richness • Simpson's Diversity Index • Simpson's Evenness Index	• Propeller wash • Effluent Discharge • Ballast water discharge • Ore dust dispersion and deposition from stockpiles and ship loading	Refer to Table 5.1 of the Marine Monitoring Plan					

Monitoring Program / Key Indicator	Objective	Performance Indicators	Project Activity Monitored	Condition Status / Threshold			Pre-defined Response(s)		
				Low Risk	Moderate Risk	High Risk	Low Risk	Moderate Risk	High Risk
	stockpiles and ship loading) on benthic infauna at Milne Inlet. • Identify mitigation for avoiding and/or minimizing adverse effects that exceed FEIS predictions.								
MEEMP / Fish Health	• Monitor for adverse environmental effects from shipping operations (propeller wash) and port operations (effluent discharge, dust dispersion and deposition from ore stockpiles and ship loading) on fish health in Milne Port. • Identify mitigation for avoiding and/or minimizing adverse effects that exceed FEIS predictions.	• Body condition[6]	• Propeller wash • Effluent Discharge • Ore dust dispersion and deposition from stockpiles and ship loading	Refer to Table 5.1 of the Marine Monitoring Plan					
MEEMP / Fish Health	• Monitor for adverse environmental effects from shipping operations (propeller wash) and port operations (effluent discharge, dust dispersion and deposition from ore stockpiles and ship loading) on fish health in Milne Port. • Identify mitigation for avoiding and/or minimizing adverse effects that exceed FEIS predictions.	• Fish Tissue Chemistry[7] • Metals •	• Propeller wasEffluent Discharge • Ore dust dispersion and deposition from stockpiles and ship loading	Refer to Table 5.1 of the Marine Monitoring Plan					

[6] Effect indicators include: *Hiatella arctica*: whole animal wet weight, relative gonad size (gonad weight against body weight) if observable, whole-animal dry weight, dry shell or soft tissue weight related to shell length, and length frequency analysis; Fourhorn sculpin: size at age/length (i.e., body weight against age/length), relative gonad size (gonad weight against body weight), body weight relative to length (i.e., condition), relative liver weight (liver weight against body weight) and length frequency analysis.

[7] The Fish Tissue Chemistry program may not always be undertaken as a regular monitoring component (i.e., mercury and selenium monitoring are only required under the MDMER if effluent concentrations trigger a fish tissue study); therefore, the Risk Status/ Thresholds described herein will be implemented as and when a tissue chemistry program is implemented.

Monitoring Program / Key Indicator	Objective	Performance Indicators	Project Activity Monitored	Condition Status / Threshold			Pre-defined Response(s)		
				Low Risk	Moderate Risk	High Risk	Low Risk	Moderate Risk	High Risk
NIS/AIS Monitoring Program (integrated in MEEMP)	• Monitor for potential introductions of an NIS or AIS as a result of Project activities. • Identify mitigation for avoiding and/or minimizing adverse effects that exceed FEIS predictions	• Occurrence of an NIS/AIS	• Ballast water discharge • Hull biofouling	Refer to Table 5.1 of the Marine Monitoring Plan					
TBD	Placeholder for Inuit OITRS	TBD	TBD	Refer to Table 5.1 of the Marine Monitoring Plan					

Table 5.2 Marine Mammal Trigger Action Response Plan (TARP)

Monitoring Programs (Key Indicator)	Objective	Performance Indicators	Project Activity Monitored	Condition Status / Threshold			Pre-defined Response(s)		
				Low Risk	Moderate Risk	High Risk	Low Risk	Moderate Risk	High Risk
Marine Mammal Aerial Survey Program (MMASP) Bruce Head Shore-based Monitoring Program Narwhal Tagging Program (Narwhal)	• Monitor for potential effects of shipping (vessel noise, vessel presence) on narwhal in the RSA and identify responses for avoiding and/or minimizing adverse effects that exceed FEIS predictions.	• Decrease in stock abundance • Change in relative abundance • Change in proportion of immatures relative to observed population • Change in surface or dive behaviour[8]	• Shipping operations • Icebreaking operations during fall shoulder season	Refer to Table 5.2 of the Marine Monitoring Plan					
Ringed Seal Aerial Survey Program (RSASP) (Ringed Seal)	• Monitor for potential effects of shipping on ringed seal density and/or distribution in the RSA. • Identify mitigation for avoiding and/or minimizing adverse effects that exceed FEIS predictions.	• Change in seal density	• Shipping operations	Refer to Table 5.2 of the Marine Monitoring Plan					
Ship-based Observer (SBO) Program (All Marine Mammal Species in RSA)	• Monitor for potential ship strikes on marine mammals in RSA, and potential changes in relative abundance and behaviour due to Project shipping. • Identify mitigation for avoiding and/or minimizing adverse effects that exceed FEIS predictions.	• Ship strike occurrence	• Shipping operations • Icebreaking operations during fall shoulder season.	Refer to Table 5.2 of the Marine Monitoring Plan					
TBD	Placeholder for Inuit OITRS	TBD		Refer to Table 5.2 of the Marine Monitoring Plan					

[8] Application of certain behavioural response indicators are contingent on securing necessary permits and MHTO support for running a tagging/telemetry program with concurrent AIS data.

Detailed information on relevant monitoring programs is outlined in Baffinland's MMP. This Plan is intended to be regularly updated based on program design modifications that are required based on annual monitoring results and/or recommendations provided by the MEWG and the NIRB.

In design and execution of its monitoring programs, Baffinland is committed to applying rigorous standards for study design, analysis and reporting. All study designs are provided to the MEWG for review and comment. All monitoring data are analyzed rigorously by experienced analysts, and all draft monitoring reports are circulated to the MEWG for comment prior to issuance as final documents. Additionally, affected communities will continue to be consulted on study design and provided opportunities to participate in implementation of the monitoring programs. Monitoring results are regularly presented to community advisory groups for discussion. In all monitoring programs, Baffinland engages direct Inuit participation in study planning, execution and interpretation of results.

5.2 ENVIRONMENTAL REPORTING

5.2.1 Reporting Requirements

All marine and Project operations monitoring activities and reports pursuant to the Project Certificate and various regulatory requirements of the Project will be submitted annually to the NIRB. All results are to be kept and maintained throughout the life of the Project and EIS and EEM predictions will be updated as new baseline information is collected. A Project-specific web page (www.baffinland.com) has been developed as a means of making all non-confidential monitoring and reporting information available to the general public. To the fullest extent possible, all results will be available in English and Inuktitut (through inclusion of an executive summary for every marine monitoring report). As described and pursuant to Term and Condition 183, Baffinland shall, every six months, provide to DFO a tracking table of (i) collective recommendation of the other members of the working group, and (ii) any directions from DFO. For each, the table must show the Proponent's means of implementation. Where any direction or recommendations are not fully implemented, the Proponent shall include the rationale.

In the event a need for variance or an exceptional circumstance arises as described and pursuant to Term and Condition 185 of the Project Certificate (see Appendix C for additional details), Baffinland will provide a detailed written description to the NIRB, QIA, Hamlet of Pond Inlet and MHTO clearly demonstrating how it will meet specific criteria before continuing with operations.

Additionally, prior to the start of each shipping season, Baffinland will provide to the NIRB a Marine Shipping and Vessel Management Report informing the Board of the following:

- Anticipated number of ship transits along the approved shipping route;
- Convoy target reduction levels;

- Identification of specific areas to be used for drifting and anchorage of vessels with details of how community feedback and comments from the MEWG has been used to inform the selection of suitable areas;
- Timelines for organizing pre- and post-shipping meetings with the community;
- Plans for preventing or mitigating vessel interference with marine mammals and traditional hunting activities pursuant to Term and Condition 125(as) of the Project Certificate;
- Evidence of community involvement to review preliminary results of the monitoring programs, and to compare results with experiences of community members and hunters with respect to the marine environment and marine mammals during the shipping season; and
- Evidence of reporting new or non-native species identified as a result of Aquatic Invasive Species Monitoring to the MHTO and DFO with confirmation of whether or not this species had been observed in the past or through other community or regional monitoring initiatives.

6 REVIEW OF PLAN EFFECTIVENESS

An important element of Baffinland's management system is reviewing the continued suitability, adequacy and effectiveness of each management plan. This will occur through an annual review process as well as scheduled updates.

6.1 Annual Review of Compliance and Unanticipated Effects

Baffinland conducts internal inspections and audits throughout the year. Throughout the year, immediate corrective actions are taken as appropriate to address instances of non-compliance, as well as unanticipated effects observed. Follow-up corrective actions may also be required. These immediate and follow-up corrective actions are documented in the annual report.

One follow-up corrective action may be to revise mitigation measures or monitoring programs described in the applicable management plans. During the annual reporting cycle, Baffinland staff will review instances of non-compliance as well as unanticipated effects and determine if a review of plan effectiveness is appropriate. Should there be a significant unanticipated effect, determined by the Inuit Committee and/or community observations, a review of plan effectiveness will be completed. This process is articulated on Figure 6.1.

Part of this annual review cycle is the incorporation of IQ, which may include feedback from the Inuit Committee, and other sources of IQ outlined in Section 2.2, and/or community observations. This process may occur annually whether repeat non-compliance and/or unanticipated effects are identified (Figure 6.1).

6.2 Scheduled Updates

The SMWMP is a "living" document and will be revised regularly as new information becomes available, methods are further developed, refined or replaced, and/or to account for adaptive management measures, with particular consideration of outcomes of annual monitoring described in the MMP and any triggered actions requiring changes to shipping activities including mitigation measures. Further details will continually be developed following discussions with the Qikiqtani Inuit Association (QIA), community Hunters and Trappers Organizations (HTOs), the Marine Environment Working Group (MEWG) and other involved parties. In addition to the annual review cycle described above, scheduled Plan reviews will occur according to the schedule presented in Table 6.1.

Plan updates will be recorded in the Document Revision Record located at the front of the Plan. Each plan update will be provided to the QIA for review and approval before being finalized for implementation.

Table 6.1 Plan Review Schedule

Review Event	Description
Prior to construction and/or operations[1]	Incorporate any additional requirements as required through updates to applicable legislation and amended Project Certificate
Every 3 years during operation	Mandatory management review

NOTE:

1. This is a generic term that applies to Project expansions or other major sustaining capital works.

Plan updates will be recorded in the Document Revision Record located at the front of the Plan. Each plan update will be shared with the MEWG which includes DFO and QIA as members for review and input before being finalized for implementation.

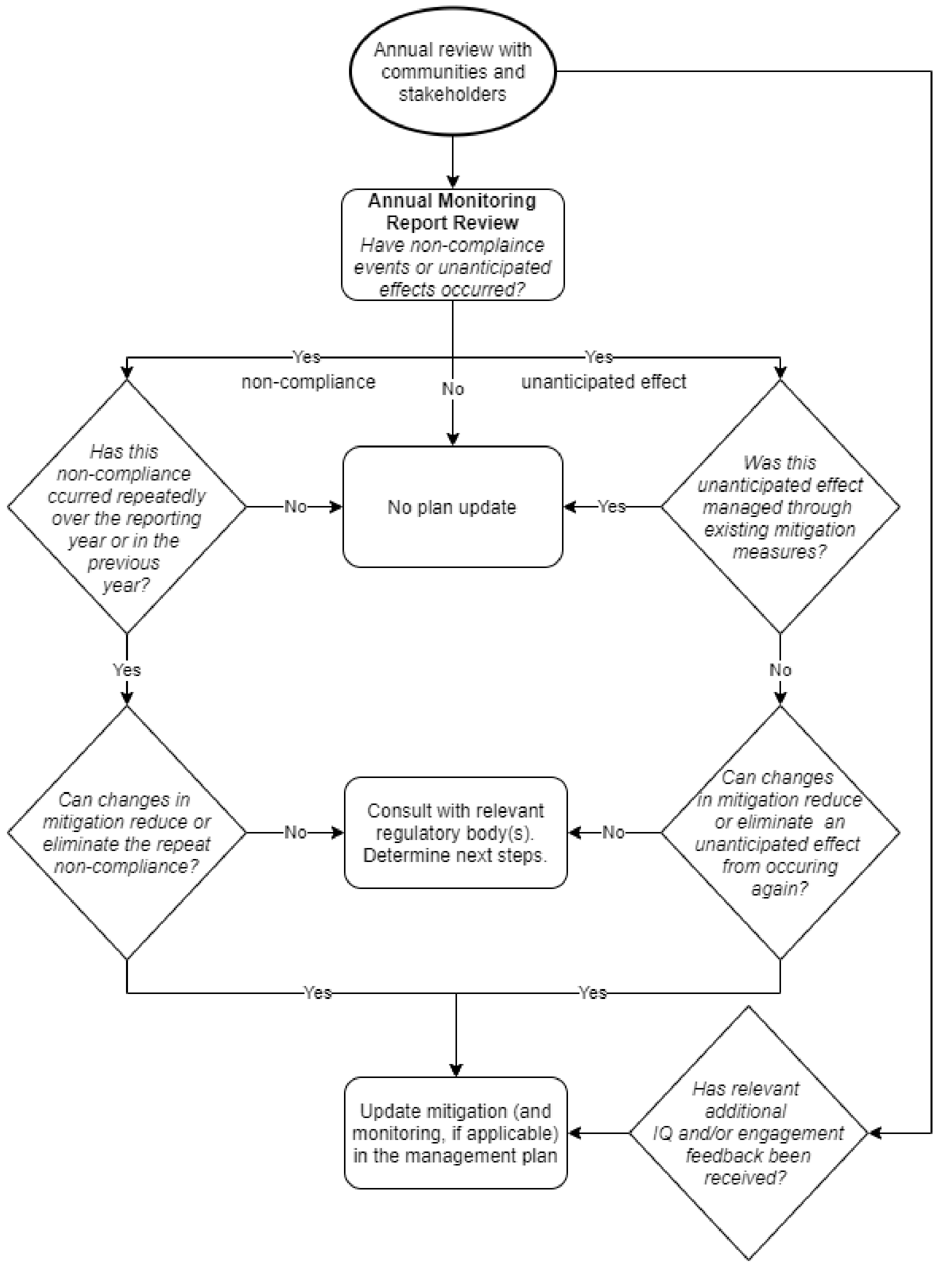

Figure 6.1 Annual Review of Plan Effectiveness

7 REFERENCES

Austin. 2022. Baffinland 2022 Underwater Acoustic Monitoring: Preliminary analysis of noise from vessel convoys. Version 1.0. Technical report by JASCO Applied Sciences for Baffinland Iron Mines.

Baffinland Iron Mines Corporation (Baffinland), 2012. Mary River Project – Final Environmental Impact Statement. Volume 8: Marine Environment. Appendix 8A-2. Marine Mammal Baseline. February 2012.

Baffinland Iron Mines Corporation (Baffinland), 2013. Mary River Project – Addendum to the Final Environmental Impact Statement.

Baffinland Iron Mines Corporation (Baffinland), 2015. Spill at Sea Response Plan. August 7. Document # BAF PH1 830 P16 0042, Rev. 0.

Baffinland Iron Mines Corporation (Baffinland), 2018a. Interim Closure and Reclamation Plan. 30 October 2018. Document # BAF-PH1-830-P16-0012.

Baffinland Iron Mines Corporation (Baffinland), 2018b. Mary River Project – Addendum to the Final Environmental Impact Statement for the Phase 2 Proposal. August 2018. Revised September 2018.

Baffinland, 2020. Baffinland Iron Mines Corporation – Adaptive Management Plan (Revised Draft) - Jointly approved draft between Baffinland and the Qikiqtani Inuit Association in relation to the Inuit Certainty Agreement. June 15.

Baffinland Iron Mines Corporation (Baffinland), 2021a. Environmental Protection Plan. April 30. Document # BAF-PH1-830-P16-0008, Rev. 2.

Baffinland Iron Mines Corporation (Baffinland), 2021b. Spill Contingency Plan. February 28. Document # BAF-PH1-830-P16-0036, Rev. 6.

Baffinland Iron Mines Corporation (Baffinland), 2021c. Oil Pollution Emergency Plan – Milne Inlet (OPEP) Emergency Response Plan. May 11. Document # BAF-PH1-830-P16-0013, Rev. 8.

Baffinland Iron Mines Corporation (Baffinland), 2021d. Oil Pollution Prevention Plan – Milne Inlet (OPPP) Emergency Response Plan. May 11. Document # BAF-PH1-830-P16-0002, Rev. 1.

Baffinland Iron Mines Corporation (Baffinland), 2021e. Internal Communications Plan for Shipping Activities. July 14. Document # BAF-PH1-820-PRO-0001, Rev. 0

Baffinland Iron Mines Corporation (Baffinland), 2021f. Emergency Response Plan. 8 December 2020. Document # BAF PH1 840 P16 0002, Rev. 5.

Baffinland Iron Mines Corporation (Baffinland), 2023a. Draft Marine Monitoring Plan (MMP). Date XX Document # BAF-PH1-830-P16-0046 Rev 1.

Baffinland Iron Mines Corporation (Baffinland), 2023b. DRAFT Ballast Water Management Plan. Date xx. Document # BAF-PH1-830-P16-0050, Rev. xx.

Crown of Indigenous Relations and Northern Affairs Canada (CIRNAC), 2015. Nunavut Planning and Project Assessment Act (NuPPAA) – Before and After Coming Into Force. Available at:

https://www.rcaanc-cirnac.gc.ca/eng/1436361043458/1547482937046 (accessed on March 3, 2023).

CIRNAC, 2020. Treaties and Agreements. Available at: https://www.rcaanc-cirnac.gc.ca/eng/1100100028574/1529354437231 (accessed on March 3, 2023).

Dylan, D. and S. Thompson, 2020. NIRB's inchoate incorporation of Inuit Qaujimajatuqangit in recommendation-making under Nunavut's impacts assessment regime. The McGill International Journal of Sustainable Development Law and Policy, 15(1), 53–84.

Fednav Ice Services, 2023. Ice conditions and ship access to the Milne Inlet Port. Prepared by Fednav Ice Services for Baffinland Iron Mines Corporation.

Fisheries and Oceans Canada (DFO), 2019. Fish and Fish Habitat Protection Policy Statement. August 2019. Available online at https://waves-vagues.dfo-mpo.gc.ca/Library/40971193.pdf (accessed March 3, 2022).

Government of Nunavut (GN), 2005. Consolidation of Wildlife Act (Current to: November 6, 2012). S.Nu. 2003,c.26. S.Nu. 2003,c.26.

Government of Canada, 2022. Species at Risk Act. Available at: Species at Risk Act (justice.gc.ca) (accessed March 3, 2023).

Nunavut Impact Review Board (NIRB). 2022. NIRB Project Certificate No. 005 (Amendment no. 04) for development of the Mary River Project Proposal in the Qikiqtani Region of Nunavut. November 3, 2022.

Nunavut Tunngavik, 2019. The Nunavut Agreement. Available at: https://nlca.tunngavik.com/. Accessed on 14 January 2023.

Transport Canada, 2019. A Guide to Canada's Ballast Water Regulations. TP 13617E. Environmental Protection. 10.

Appendix A: Corporate Policies

Baffinland Iron Mines Corporation

Health, Safety and Environment Policy

BAF-PH1-800-POL-0001

Rev 3

Approved by: Brian Penney

Title: Chief Executive Officer

Date: May 3rd, 2019

Signature:

DOCUMENT REVISION RECORD

Issue Date MM/DD/YY	Revision	Prepared By	Approved By	Issue Purpose
05/07/15	0	EM	TP	For Use
03/07/16	1	JS	BP	Minor edits
04/20/18	2	TS	SA/BP	Minor edits
05/03/19	3	TS	BP	Minor edits

This Baffinland Iron Mines Corporation Policy on Health, Safety and Environment is a statement of our commitment to achieving a safe, healthy and environmentally responsible workplace. We will not compromise this policy for the achievement of any other organizational goals.

We implement this Policy through the following commitments:

- Continual improvement of safety, occupational health and environmental performance
- Meeting or exceeding the requirements of regulations and company policies
- Integrating sustainable development principles into our decision-making processes
- Maintaining an effective Health, Safety and Environmental Management System
- Sharing and adopting improved technologies and best practices to prevent injuries, occupational illnesses and environmental impacts
- Engaging stakeholders through open and transparent communication.
- Efficiently using resources, and practicing responsible minimization, reuse, recycling and disposal of waste.
- Reclamation of lands to a condition acceptable to stakeholders.

Our commitment to provide the leadership and action necessary to accomplish this policy is exemplified by the following principles:

- As evidenced by our motto "Safety First, Always" and our actions Health and Safety of personnel and protection of the environment are values not priorities.
- All injuries, occupational illnesses and environmental impacts can be prevented.
- Employee involvement and active contribution through courageous leadership is essential for preventing injuries, occupational illnesses and environmental impacts.
- Working in a manner that is healthy, safe and environmentally sound is a condition of employment.
- All operating exposures can be safeguarded.
- Training employees to work in a manner that is healthy, safe and environmentally sound is essential.
- Prevention of personal injuries, occupational illnesses and environmental impacts is good business.
- Respect for the communities in which we operate is the basis for productive relationships.

We have a responsibility to provide a safe workplace and utilize systems of work to meet this goal. All employees must be clear in understanding the personal responsibilities and accountabilities in relation to the tasks we undertake.

The health and safety of all people working at our operation and responsible management of the environment are core values to Baffinland. In ensuring our overall profitability and business success every Baffinland and business partner employee working at our work sites is required to adhere to this Policy.

Brian Penney
Chief Executive Officer
May 2019

Sustainable Development Policy

Baffinland

At Baffinland Iron Mines Corporation (Baffinland), we are committed to conducting all aspects of our business in accordance with the principles of sustainable development & corporate responsibility and always with the needs of future generations in mind. Baffinland conducts its business in accordance with the Universal Declaration of Human Rights.

Everything we do is underpinned by our responsibility to protect the environment, to operate safely and fiscally responsibly and with utmost respect for the cultural values and legal rights of Inuit. We expect each and every employee, contractor, and visitor to demonstrate courageous leadership in personally committing to this policy through their actions. The four pillars of our corporate responsibility strategy are:

1. Health and Safety
2. Environment
3. Upholding Human Rights of Stakeholders
4. Transparent Governance

Health and Safety

- We strive to achieve the safest workplace for our employees and contractors; free from occupational injury and illness, where everyone goes home safe everyday of their working life. Why? Because our people are our greatest asset. Nothing is as important as their health and safety. Our motto is "Safety First, Always"
- We report, manage and learn from injuries, illnesses and high potential incidents to foster a workplace culture focused on safety and the prevention of incidents
- We foster and maintain a positive culture of shared responsibility based on participation, behaviour, awareness and promoting active courageous leadership. We allow our employees and contractors the right to stop any work if and when they see something that is not safe

Environment

- Baffinland employs a balance of the best scientific and traditional Inuit knowledge to safeguard the environment
- We apply the principles of pollution prevention, waste reduction and continuous improvement to minimize ecosystem impacts, and facilitate biodiversity conservation
- We continuously seek to use energy, raw materials and natural resources more efficiently and effectively. We strive to develop more sustainable practices. We strive to develop more sustainable practices
- Baffinland ensures that an effective closure strategy is in place at all stages of project development to ensure reclamation objectives are met

Upholding Human Rights of Stakeholders

- We respect human rights, the dignity of others and the diversity in our workforce. Baffinland honours and respects the unique cultural values and traditions of Inuit
- Baffinland does not tolerate discrimination against individuals on the basis of race, colour, gender, religion, political opinion, nationality or social origin, or harassment of individuals freely employed
- Baffinland contributes to the social, cultural and economic development of sustainable communities in the North Baffin Region

Sustainable Development Policy

- We honour our commitments by being sensitive to local needs and priorities through engagement with local communities, governments, employees and the public. We work in active partnership to create a shared understanding of relevant social, economic and environmental issues, and take their views into consideration when making decisions
- We expect our employees and contractors, as well as community members, to bring human rights concerns to our attention through our external grievance mechanism and internal human resources channels. Baffinland is committed to engaging with our communities of interest on our human rights impacts and to reporting on our performance

Transparent Governance

- Baffinland will take steps to understand, evaluate and manage risks on a continuing basis, including those that may impact the environment, employees, contractors, local communities, customers and shareholders.
- Baffinland endeavours to ensure that adequate resources are available and that systems are in place to implement risk-based management systems, including defined standards and objectives for continuous improvement.
- We measure and review performance with respect to our safety, health, environmental, socio-economic commitments and set annual targets and objectives.
- Baffinland conducts all activities in compliance with the highest applicable legal & regulatory requirements and internal standards.
- We strive to employ our shareholder’s capital effectively and efficiently and demonstrate honesty and integrity by applying the highest standards of ethical conduct.

Brian Penney
Chief Executive Officer
March 2016

Appendix B: International and Federal Shipping Regulations and Acts

Federal and/or International Acts and Regulations	Reference
Aids to Navigation Protection Regulations	https://laws-lois.justice.gc.ca/eng/regulations/C.R.C.,_c._1403/index.html
Arctic Waters Pollution Prevention Act and Regulation	http://www.tc.gc.ca/eng/marinesafety/debs-arctic-acts-regulations-awppa-494.htm
Ballast Water Control and Management Regulations.	https://laws-lois.justice.gc.ca/eng/regulations/sor-2011-237/
Canada Labour Code	https://laws-lois.justice.gc.ca/eng/acts/L-2/
Canada Shipping Act	https://laws-lois.justice.gc.ca/eng/acts/c-10.15/
Canadian Transportation Accident Investigation and Safety Board Act	https://laws-lois.justice.gc.ca/eng/acts/c-23.4/
Canadian Transportation Act	https://laws-lois.justice.gc.ca/eng/acts/c-10.4/
Canadian Transportation of Dangerous Goods Act	http://www.tc.gc.ca/eng/tdg/act-menu-130.htm
Cargo, Fumigations and Tackle Regulations	https://laws-lois.justice.gc.ca/eng/regulations/sor-2007-128/
Charts and Nautical Publications Regulations	https://laws-lois.justice.gc.ca/eng/regulations/sor-95-149/
Classed Ships Inspection Regulations	https://laws-lois.justice.gc.ca/eng/regulations/SOR-89-225/
Collision Regulations	https://laws-lois.justice.gc.ca/eng/regulations/c.r.c.,_c._1416/
Crew Accommodation Regulations	https://laws-lois.justice.gc.ca/eng/regulations/C.R.C.,_c._1418/
Dangerous Bulk Materials Regulations	https://laws-lois.justice.gc.ca/eng/regulations/SOR-87-24/index.html
Dangerous Chemicals and Noxious Liquid Substances Regulations	https://laws-lois.justice.gc.ca/eng/regulations/sor-93-4/page-1.html
Department of Transport Act	https://laws-lois.justice.gc.ca/eng/acts/T-18/
Fire and Boat Drills Regulations	https://laws-lois.justice.gc.ca/eng/Regulations/SOR-2010-83/index.html
Fire Detection and Extinguishing Equipment Regulations	https://laws-lois.justice.gc.ca/eng/Regulations/C.R.C.,_c._1422/index.html
Fisheries Act	https://laws-lois.justice.gc.ca/eng/acts/f-14/
Garbage Pollution Prevention Regulations	https://laws-lois.justice.gc.ca/eng/regulations/C.R.C.,_c._1424/index.html
Home-Trade, Inland and Minor Waters Voyages Regulations	https://laws-lois.justice.gc.ca/eng/regulations/C.R.C.,_c._1430/
Hull Inspection Regulations	https://laws-lois.justice.gc.ca/eng/Regulations/C.R.C.,_c._1432/index.html
International Convention for the Control and Management of Ships' Ballast Water and Sediment	https://www.imo.org/en/About/Conventions/Pages/International-Convention-for-the-Control-and-Management-of-Ships%27-Ballast-Water-and-Sediments-(BWM).aspx
International Convention for the Prevention of Pollution from Ships (MARPOL)	https://www.imo.org/en/About/Conventions/Pages/International-Convention-for-the-Prevention-of-Pollution-from-Ships-

Federal and/or International Acts and Regulations	Reference
	(MARPOL).aspx#:~:text=The%20International%20Convention%20for%20the,2%20November%201973%20at%20IMO
International Convention on Load Lines	https://www.imo.org/en/About/Conventions/Pages/International-Convention-on-Load-Lines.aspx
International Maritime Dangerous Goods (IMDG) Code	https://www.imo.org/en/OurWork/Safety/Pages/DangerousGoods-default.aspx#:~:text=The%20IMDG%20Code%20was%20developed,prevent%20pollution%20to%20the%20environment
International Maritime Solid Bulk Cargoes (IMSBC) Code	https://www.imo.org/en/OurWork/Safety/Pages/CargoesInBulk-default.aspx#:~:text=The%20primary%20aim%20of%20the,shipment%20of%20certain%20types%20of
International Safety Management Code	http://www.tc.gc.ca/eng/marinesafety/dvro-4066.htm
Life Saving Equipment Regulations	https://laws-lois.justice.gc.ca/eng/Regulations/C.R.C.,_c._1436/index.html
Marine Certification Regulations	https://laws-lois.justice.gc.ca/eng/regulations/SOR-97-391/index.html
Marine Liability Act	https://laws-lois.justice.gc.ca/eng/acts/M-0.7/
Marine Machinery Regulations	https://laws-lois.justice.gc.ca/eng/regulations/sor-90-264/
Marine Transportation Security Act	https://laws-lois.justice.gc.ca/eng/acts/m-0.8/
Marine Transportation Security Regulations	https://laws-lois.justice.gc.ca/eng/regulations/sor-2004-144/
Navigation Protection Act	https://laws-lois.justice.gc.ca/eng/acts/n-22/
Oceans Act	https://laws-lois.justice.gc.ca/eng/acts/o-2.4/
Oil Pollution Prevention Regulations	https://laws-lois.justice.gc.ca/eng/regulations/SOR-93-3/index.html
Response Organizations and Oil Handling Facilities	https://laws-lois.justice.gc.ca/eng/regulations/SOR-95-405/index.html
Safe Containers Convention Act	https://laws-lois.justice.gc.ca/eng/acts/S-1/
Safe Working Practices Regulations	https://laws-lois.justice.gc.ca/eng/Regulations/C.R.C.,_c._1467/index.html
Safety Management Regulations	https://laws-lois.justice.gc.ca/eng/regulations/SOR-98-348/
Ship Station Radio Regulations	https://laws-lois.justice.gc.ca/eng/regulations/SOR-2000-260/
Shipping Casualties Reporting Regulations	https://laws-lois.justice.gc.ca/eng/Regulations/SOR-85-514/index.html
Shipping Inquiries and Investigations Rules	https://laws-lois.justice.gc.ca/eng/regulations/C.R.C.,_c._1479/index.html
Ships' Elevator Regulations	https://laws-lois.justice.gc.ca/eng/regulations/C.R.C.,_c._1482/
Standards for navigating Appliances and Equipment	http://www.tc.gc.ca/eng/marinesafety/tp-tp3668-menu-391.htm
Steering Appliances and Equipment Regulations	https://laws-lois.justice.gc.ca/eng/Regulations/SOR-83-810/index.html
Transportation of Dangerous Goods Program	http://www.tc.gc.ca/eng/tdg/safety-menu.htm

Federal and/or International Acts and Regulations	Reference
Vessel Traffic Services Zones Regulations	https://laws-lois.justice.gc.ca/eng/regulations/SOR-89-98/
VHF Radiotelephone Practices and Procedures Regulations	https://laws-lois.justice.gc.ca/eng/regulations/SOR-81-364/

Appendix C: Project Terms and Conditions Relevant to the SMWMP

Project Certificate No. 005 Terms and Conditions

The Plan addresses Project Certificate No. 005 Terms and Conditions including commitments provided in Appendix B (NIRB 2022) as outlined in Table F.1.

Table F.1: Project Certificate (PC) No. 005 (Amendment No. 04) Conditions Relevant to the SMWMP Including Appendix B Commitments

PC Condition #	Term or Condition Description	Applicable to Active Phase of the Project
90	The Proponent shall incorporate into its Shipping and Marine Mammals Management Plan provisions to achieve compliance with the requirements under the International Convention for the Control and Management of Ship's Ballast Water and Sediment (2004) or its replacement and as implemented by the *Canadian Ballast Water and Control Regulations* as may be amended from time to time.	Yes
100	The Proponent shall update its Shipping and Marine Wildlife Management Plan to include avoidance of polynyas and mitigation measures designed for potential fuel spills along the shipping lane during winter months, with consideration for the impact of spilled fuel on marine mammals when the might be less mobile or able to avoid contact with spilt fuel or fumes.	No
104	Subject to safety considerations and potential for conditions as determined by the crew of transiting vessels, to result in route deviations: A. The Proponent shall require, for shipping to/from Steensby Port, project vessels to maintain a route to the south of Mill Island to prevent disturbance to walrus and walrus habitat on the northern shore of Mill Island. Where project vessels are required to transit to the north of Mill Island owing to environmental or other conditions, an incident report is to be provided to the Marine Environment Working Group and the NIRB within 30 days, noting all wildlife sightings and interactions as recorded by Shipboard Marine Wildlife Observers. B. The Proponent shall summarize all incidences of significant deviations from the nominal shipping routes for traffic to/from Milne Port and Steensby Port as presented in FEIS and FEIS Addendum to the NIRB annually, with corresponding discussion regarding justification for deviations and any observed environmental impacts.	Part A: No Part B: Yes
105	The Proponent shall ensure that measures to reduce the potential for interaction with marine mammals, particularly in Hudson Strait and Milne Inlet, are identified and implemented prior to commencement of shipping operations. These measures could include, but are not limited to: A. Changes in the frequency and timing (including periodic suspensions) of shipping during winter months in Hudson Strait and during the open water season in Milne Inlet, i.e., when interactions with marine mammals are likely to be the most problematic;	Part A: Yes Part B: Yes Part C: No

PC Condition #	Term or Condition Description	Applicable to Active Phase of the Project
	B. Reduced shipping speeds where ship-marine mammal interactions are most likely; and C. Identification of alternate shipping routes through Hudson Strait for use when conflicts between the proposed routes and marine mammals could arise. Repeated winter aerial survey results showing marine mammal distribution and densities in Hudson Strait would greatly assist in this task.	
120	The Proponent shall ensure that, subject to vessel and human safety considerations, all project shipping adhere to the following mitigation procedures while in the vicinity of marine mammals: • Wildlife will be given right of way; • Ships will when possible, maintain a straight course and constant speed, avoiding erratic behavior; and • When marine mammals appear to be trapped or disturbed by vessel movements, the vessel will implement appropriate measures to mitigate disturbance, including stoppage of movement until wildlife have moved away from the immediate area.	Yes
121	The Proponent shall immediately report any accidental contact by project vessels with marine mammals or seabird colonies to Fisheries and Oceans Canada and Environment Canada, respectively, by notifying the appropriate regional office of the: • Date, time and location of the incident; • Species of marine mammal or seabird involved; • Circumstances of the incident; • Weather and sea conditions at the time; • Observed state of the marine mammal or sea bird colony after the incident; and • Direction of travel of the marine mammal after the incident, to the extent that it can be determined.	Yes
125 (a)	The Proponent shall consult with potentially-affected communities and groups, particularly Hunters' and Trappers' Organizations regarding the identification of project vessel anchor sites and potential areas of temporary refuge for project vessels along the shipping routes within the Nunavut Settlement Area. Feedback received from community consultations shall be incorporated into the most appropriate mitigation or management plans.	Yes
175	The Proponent shall, in coordination and consultation with the Qikiqtani Inuit Association and the Hunters and Trappers Organizations of the North Baffin communities and Coral Harbour, provide updates to its Shipping and Marine Mammals Management Plan to include adaptive management measures it proposes to take should the placement of reflective markers along the ship track in winter months not prove to be a feasible method of marking the track to ensure the safety of ice-based travelers.	No
177	The Proponent shall enroll any foreign flagged vessels commissioned for Project-related shipping within Canadian waters into the relevant foreign	Yes

PC Condition #	Term or Condition Description	Applicable to Active Phase of the Project
	program equivalent to Transport Canada's Marine Safety Delegated Statutory Inspection Program.	
179	179(a). The total number of ships transporting iron ore via Milne Inlet may not exceed 84 ore carriers per year.	Pending Sustaining Operations Proposal (SOP)
183	The Proponent shall collaborate with the Marine Environment Working Group (MEWG) to develop impact avoidance or mitigation strategies for the protection of the marine environment, and shall implement these strategies. The Proponent shall implement any direction from the Department of Fisheries and Oceans (DFO), issued in furtherance of their mandate, for any avoidance or mitigation measures, including cessation of any activity, for the protection of the marine environment. The Proponent shall, every six months, provide to DFO a tracking table of (i) collective recommendation of the other members of the working group, and (ii) any directions from DFO. For each, the table must show the Proponent's means of implementation. Where any direction or recommendations are not fully implemented, the Proponent shall include the rationale.	Yes
185	All project related shipping associated with the Northern Shipping route shall observe the following conditions, subject to the variances and/or exceptions below: a. The Proponent must avoid breaking landfast ice at all times during the shipping season. b. The Proponent shall confirm a continuous path of 3/10ths ice concentrations along the Northern Shipping route is available prior to commencement of the shipping season. c. The Proponent is required to plan for and cease all shipping from Milne Port by October 31. The Proponent may proceed with a variance to condition (b) above, or under exceptional circumstances that may occur from time to time seek an exception to condition (c). Variances and exceptional circumstances require the direct engagement of Qikiqtani Inuit Association (QIA), as well as the written confirmations obtained from the Hamlet of Pond Inlet, the Mittimatalik HTO (MHTO) and QIA as described below. Examples of a variance may include: sea ice coverage changing from 3/10th or less to greater than 3/10th due to changes in environmental conditions such as wind, or a generally later forecast for ice break up. Exceptional circumstances include events that are unforeseen and occur outside of Baffinland's control but will not include contingencies that the Proponent should reasonably have planned for. Examples of unforeseen events may include: a breakdown in loading equipment, weather disruptions to shipping schedules, or a later than expected ice break up past July 15.	Yes

PC Condition #	Term or Condition Description	Applicable to Active Phase of the Project
	In the event a need for variance or an exceptional circumstance arises, the Proponent is required to provide a detailed written description to the NIRB, QIA, Hamlet of Pond Inlet and MHTO clearly demonstrating how it will meet each of the following criteria before continuing with operations: i. a description of the rationale for variation or exceptional circumstances and anticipated duration of the extended shipping season; ii. a description as to whether the anticipated ice conditions during the shipping period are consistent with Appendix B commitments and the Shipping and Marine Wildlife Management Plan; iii. a description confirming that shipping will proceed in full compliance with all Project Certificate terms and conditions and Appendix B commitments (including but not limited to the limits described in Terms and Conditions 179(a) and (b) and the requirement not to break landfast ice); iv. a description of any additional mitigation or monitoring efforts being undertaken as a result of the variation or exceptional circumstance; v. a description of how the Proponent has made best efforts to meet with the Hamlet, MHTO and the QIA to discuss and consider the variation or exceptional circumstance; vi. copies of all public communications relating to the variation or exceptional circumstance; vii. written confirmation (or evidence of verbal confirmation) from the Hamlet and the MHTO that sea ice overlapping the shipping route is not being used for travel or harvesting by harvesters or community members, and that the proposed shipping activity will not result in additional safety risks to hunters or the community that cannot be mitigated, for instance, by transiting through a path of less consolidated ice in Eclipse Sound and Milne Inlet The Qikiqtani Inuit Association, Hamlet of Pond Inlet and Mittimatalik HTO agree to review and respond to requests of the Proponent within a reasonable timeframe that will not unduly delay shipping activities. The Proponent is required to review and respond to items raised by QIA, Hamlet of Pond Inlet and MHTO including requested changes to monitoring, mitigation and compensation associated with the variance or exceptional circumstance. All determinations related to variances and exceptional circumstances will be communicated to NIRB. For greater clarity, this condition applies to all ships supporting the Mary River Project including ore carriers and supply ships.	
Appendix B Commitments		
001	Baffinland will continue to implement the following mitigation measures to reduce or avoid impacts to marine mammals (Relevant species: Ringed Seal, Bearded Seal, Walrus, Beluga, Narwhal, Bowhead Whale, Polar Bear) as a result of shipping:	Yes

PC Condition #	Term or Condition Description	Applicable to Active Phase of the Project
	• Maintain constant speed and course when possible. • Reduce vessel speed to 9 knots. • Reduce vessel idling. • When marine mammals appear to be trapped or disturbed by Project vessel movements, the vessel will implement appropriate measures to mitigate disturbance, including stoppage of movement until wildlife move away from the immediate area (as safe navigation allows). • All Project vessels will be provided with standard instructions to operate their vessel in a manner that avoids separating an individual member(s) of a group of marine mammals from other members of the group; • All Project vessels will be provided with standard instructions to not approach within 300 m of a walrus or polar bear observed on sea ice; • Vessels awaiting instructions from the Port Captain to enter the RSA will be instructed to wait in Baffin Bay at least 40 km east of the Nunavut Settlement Area. Baffinland will implement the following additional mitigation measures to reduce or avoid impacts to marine mammals (Relevant species: Ringed Seal, Bearded Seal, Walrus, Beluga, Narwhal, Bowhead Whale, Polar Bear) as a result of shipping: • Use of convoys throughout the season to further reduce total sound exposure. Acoustic monitoring data indicates that if ore carriers transit in convoys with inter-vessel separation less than 10 km, there is an overall reduction of the total sound exposure in the Regional Study Area compared to multiple individual transits of an equivalent number of vessels. Slight increases of instantaneous sound levels in the regions between the vessels are compensated for by shorter exposure duration, resulting in a net decrease of noise exposure. Target reduction levels will be communicated through Baffinland annual shipping reports.	

Appendix D: Baffinland Pre-Charter Bulk Carrier Ice Capability Assessment

D.1 Baffinland Pre-Charter Bulk Carrier Ice Capability Assessment

D.1.1 GENERAL

The Baffinland pre-charter bulk carrier ice capability assessment will be carried out prior to finalization of any charter.

D.1.2 APPLICATION OF THE VESSEL SELECTION PROTOCOL

The vessel selection protocol applies to vessels engaged in the export of iron ore according to the season during the planned period of the charter.

D.1.3 MINIMUM SPECIFICATIONS FOR VESSEL SELECTION

These are the minimum requirements for vessel selection according to the season during the planned period of the charter.

D.1.4 CRITERIA FOR DETERMINING VESSEL PERFORMANCE IN ICE

This is based on the Arctic Ice Regime Shipping System (AIRSS) calculation of ice numerals and Canadian Arctic Class or equivalent.

D.1.5 MINIMUM REQUIREMENTS FOR CARRIERS AND ALTERNATE IRON ORE CARRIERS

The minimum requirements will be specified in the Baffinland original request to brokers for proposals for vessels, taking account of the season and projected ice conditions during the period of the charter.

D.1.6 VESSEL ICE CAPABILITY ASSESSMENT

The main concern is to ensure that the carriers and alternate iron ore carriers selected are capable of operating in the ice conditions which are forecast for the period when the vessel will be operating in the approaches to Milne Inlet or within Milne Inlet.

The ice capability requirement is dependent on updated ice forecasting, based on current radar satellite information, related to the vessel's design, construction, ice performance, and operating procedures. The calculation is based on the following:

i. The ice numerals of a vessel being considered for operations into Milne Inlet ice, which will be calculated under the Arctic Ice Regime Shipping System (AIRSS).
ii. The vessel's Class and Type in accordance with Canadian Regulations (i.e., Canadian Arctic Class or equivalent).
iii. The thickness and character of the ice in Milne Inlet during the period of the charter.

D.1.7 ICE CONDITIONS FORECASTS AND ICE CAPABILITY ASSESSMENT

The following summary is provided as an aid to understanding Baffinland's vessel selection process for selecting vessels for operation into Milne Inlet.

1. An Ice Information Contractor, with expertise in ice measurement, forecasting and routing, will be contracted to provide a forecast of the ice conditions expected in the Milne Inlet area at the time of the proposed shipping.
2. The Owner and Managers of a vessel being considered for a charter shall be required to provide full details of the vessel's design, ice construction, machinery, class, etc. to the Baffinland Independent Contractor responsible for assessing the vessel's ice capability.
3. The Independent Contractor engaged by Baffinland shall consider the vessel's ice design and construction, ice performance and certificates to confirm if the vessel's ice numerals are positive and sufficient to enable the vessel to safely transit the forecast ice conditions in Milne Inlet during the projected time frame.

This contract shall be established well in advance of the first charter vessel assessment to enable the Independent Contractor to provide Baffinland with a list of information required to carry out their assessment of the proposed vessel's ice capability.

4. Providing the vessel meets all of the required criteria for navigating in the forecast ice conditions, the Independent Contractor shall determine that the vessel under consideration is structurally and mechanically capable of safely completing the contemplated voyage and will provide that determination to Baffinland.
5. Providing the vessel meets all of the above requirements for the charter, the vessel shall be subject to a general inspection to confirm that the vessel remains in good condition, meeting all of the equipment requirements and operating procedures necessary for vessels operating into Canadian ports. The Surveyor will also ensure that the equipment requirements and operating procedure requirements listed out in the Baffinland Inuit Impacts and Benefits Agreement (IIBA) are satisfied. These equipment requirements and operating procedure requirements are all included in the Baffinland pre-charter bulk carrier inspection checklist (refer to Appendix C).

The above inspection will be coupled with a limited audit to ensure that the vessel is operated in conformance with the International Safe Management regulations.

Providing that the vessel satisfies all of the above inspections and the limited audit, the vessel may be placed on charter.

Note: Surveyors conducting the pre-charter inspection will be informed of any special inspection requirements related to ice procedures and route planning not otherwise included in the Baffinland IIBA. The provision of a Berthing Master provides the necessary source of information and advice to a Master unfamiliar with the conditions in Milne Inlet.

6. Twenty-four hours before the chartered vessel enters the ice outside Milne Inlet, the Ice Information Contractor shall provide an updated estimate and forecast of the ice conditions which the vessel will encounter in and outside of Milne Inlet. The vessel's AIRSS ice numerals will again be calculated.

If the ice numerals remain positive for the updated ice report, the vessel may enter Milne Inlet.

If the ice numerals are negative, the vessel may not enter port until ice conditions improve and positive numeral results.

Appendix E:
Baffinland Pre-Charter Inspection Checklist and Limited Audit

E.1 BAFFINLAND PRE-CHARTER BULK CARRIER INSPECTION CHECKLIST AND LIMITED AUDIT

E1.1 INTRODUCTION

Baffinland Iron Mines Corp. has developed an Iron Ore mine at Mary River, Baffin Island, and shipping terminals at Steensby Port Site and Milne Inlet on Baffin Island in Nunavut.

In order to preserve the environment and the Inuit way of life, Baffinland have signed the Inuit Impacts and Benefits Agreement (IIBA) which, among other things, provides for the shipment of Iron Ore.

E.1.2 SHIPPING OPERATIONS

Carriers and alternate Iron Ore Carriers (should these be required) must be classed for ice navigation according to the expected ice conditions.

E.1.3 COMPLETION OF PRE-CHARTER BULK CARRIER INSPECTION AND LIMITED AUDIT

It is not the intention that the Baffinland inspector/surveyor inspect a bulk carrier and carry out a complete ISM Type audit in the course of the vessel's normal turn-around in port.

However, an experienced surveyor can examine the vessel's documentation or computerized safety and maintenance programs in sufficient depth to satisfy themselves as to the standard of operation and management of the vessel. This information coupled with a visual inspection of the hull and superstructure, machinery spaces, deck and safety equipment is normally sufficient for the Charter to decide whether the vessel is capable of working safely in Canada or otherwise. In order to save time we suggest that the surveyor uses a digital camera to photograph points of interest, general layout of the vessel, hull condition, etc., or any items which cause concern.

The following pre-charter bulk carrier inspection checklist is a combination of a Transport Canada Ship Safety Checklist, which is the standard required for all foreign ships entering Canada, to which we have added the requirements as identified by Baffinland as the outcome of the Environmental Assessment Process.

The limited audit outlined is sufficient to confirm that the vessel is maintaining ISM Standards.

PART 1 — PRE-CHARTER BULK CARRIER (INSPECTION AS PER THE FOLLOWING CHECKLISTS)

Section 1: General Information

Section 1: General Information		
1.1	Date this document completed	
1.2	Name of ship	
1.3	LR/IMO No.	
1.4	Date of name changes	
1.5	Flag	

1.6	Call sign	
1.7	INMARSAT number	
1.8	Ship's fax number	
1.9	Ship's telex number	
1.10	Ship's e-mail address	
1.11	Type of hull: (1) Single Hull, (2) Double Hull, (3) Double Bottom (4) Double Side, (5) Other (if Other, Specify)	
Section 1.2: Ownership and Operation		
1.12	Registered Owner	
1.13	Full Address Office telephone number	
1.14	Name of Operator (if different from above)	
1.15	Full Address	
	Office telephone number	
	Office fax number	
	Office email address	
	Contact person	
1.16	Contact person after hours telephone number	
	Emergency callout number	
	Emergency callout pager number	
	Contact details for person responsible for oil spill response.	
1.17	Total number of ships operated by this Operator	
Section 1.3: Builder		
1.18	Builder	
1.19	Date delivered	
1.20	If applicable, date of completion of major hull changes	
1.21	If major hull changes, what changes were made?	
Section 1.4: Classification		
1.22	Classification Society	LLOYDS REGISTER
1.23	Class Notation	
1.24	Date of last dry-dock	
1.25	Date next dry-dock due	
1.26	Date of last special survey	
1.27	Was last special survey an enhanced special survey?	
1.28	Date next special survey due	
1.29	If ship has Condition Assessment Programme (CAP) rating, what is the latest rating?	
1.30	Date of last annual survey	

1.31	Date of last boiler survey - port boiler	
1.32	Date of last boiler survey – starboard boiler	
1.33	If machinery on Continuous Survey are any item overdue or	
1.33.1	If Yes give details:	
1.34	Is ship subject to any conditions of class, class extensions, outstanding Memorandums or class recommendations?	
1.34.1	If Yes, give details:	
Section 1.4: Dimensions		
1.35	Length overall (LOA)	
1.36	Length between perpendiculars (LBP)	
1.37	Extreme breadth	
1.38	Moulded breadth	
1.39	Moulded depth	
1.40	Does ship have a bulbous bow?	
Section 1.5: Tonnages		
1.41	Net Registered Tonnage	
1.42	Gross Tonnages	
1.43	Moulded depth	

Section 1.6: Loadline Information

		Freeboard	Draft	Deadweight	Displacement
1.44	Summer				
1.45	Winter				
1.46	Lightship				
1.47	Normal Ballast Condition				
1.48	Segregated Ballast Condition				

Section 1.7: Recent Operational History

1.49	Has ship been involved in a pollution incident during the past 12 months?	
1.50	Has ship been involved in a grounding incident during the past 12 months?	
1.51	Has ship been involved in a collision during the past 12 months?	

Section 2: Certification and Documentation

	Certificates	Issue Date	Expiry	Last Annual
2.1	CERTIFICATE OF REGISTRY			
2.2	SAFETY EQUIPMENT CERT			
2.3	SAFETY RADIO CERTIFICATE			
2.4	SAFETY CONSTRUCTION CERTIFICATE			
2.5	LOAD LINE CERTIFICATE			
2.6	IOPP			
2.7	ISM			
2.8	INTERNATIONAL SEWAGE POLLUTION			

2.9	USCG (LETTER OF COMPLIANCE) CFR			
2.10	UNATTENDED MACHINERY SPACE CERTIFICATE			
2.11	INTERNATIONAL TONNAGE CERTIFICATE			
2.12	MINIMUM SAFE MANNING CERTIFICATE			
Documentation - Are the latest editions of the following publications t·ted on board?				
2.13	IMO *Safety of Life at Sea Convention (SOLAS 74)*			
2.14	IMO *International Code of Signals (SOLAS V-Reg 21)*			
2.15	IMO *international Convention for the Prevention of Pollution from Ships (MARPOI. 73/78)*			
2.16	IMO *Ships Routing*			
2.17	IMO *International Regulations for Preventing Collisions at* Sea *(COLREGS)*			
2.18	IMO *Standards of Training, Certification and* Watch Keeping *(STCW Convention)*			
2.19	Does the Vessel carry a SOLAS Safety Manual available to Crew?			
2.20	ICS *Guide to Helicopter/Ship Operations*			

Section 3: Crew Management

Date of Minimum Manning Certificate			
	Minimum Manning	Officers	Rating
3.1	Minimum manning required		
3.2	Actual required		
3.3	Nationality		
	Nationality		
	Nationality		
3.4	Common language used		

Section 4: Navigation Equipment

4.1	Is the vessel equipped With the following equipment?	Yes/No	Type	No Of Units
4.2	Standard Magnetic Compass			
4.3	Steering Magnetic or Periscope compass			
4.4	Gyro Compass			
4.5	Gyro Repeaters			
4.6	Radar 1 X Band (9 GHz)			
4.7	Radar 2 S Band (4 GHz)			
4.8	Are radars gyro stabilized?			
4.9	Radar plotting equipment			
4.10	ARPA			
4.11	Depth sounder with recorder			
4.12	Speed/distance indicator			
4.13	Doppler log			
4.14	Docking approach Doppler			
4.15	Rudder angle indicator			
4.16	RPM indicator			
4.17	Controllable pitch propeller indicator			
4.18	Bow thruster indicator			
4.19	Rate of turn indicator			
4.20	Radio direction finder			

4.21	Navtex receiver			
4.21	Satellite navigation receiver			
4.22	GPS			
4.23	Differential GPS			
4.24	ECDIS (Electronic Chart Display and Information System)			
4.25	EPIRB			
4.26	GMDSS Installation			
4.26	VHF Dual Installation			
4.28	VHF Portable hand Sets			
4.29	MFIHF Installation			
4.30	Inmarsat Installation			
4.31	Loran C receiver			
4.32	Course recorder			
4.33	Off — course alarm — gyro			
4.34	Off — course alarm — magnetic			
4.35	Engine order printer			
4.36	Anemometer			
4.37	Several pairs of binoculars			
4.38	Weather fax			
	Other Equipment			
4.40	Does vessel carry sextant(s)?			
4.41	Does vessel carry a signal lamp?			
4.42	Are steering and machinery controlled from the bridge?			
4.43	Are bridge controls available on bridge wings?			
4.44	Internal communications system?			
4.45	P.A. system?			
4.46	Sound signals, whistle, and fog horn?			
4.47	Navigation lights?			
4.48	Two powerful searchlights?			
4.49	Does the vessel have properly equipped pilot ladder clw manropes?			
4.50	Does the vessel have a substantial accommodation ladder either side?			
4.51	Does the vessel have a short light weight gangway with side ropes?			
4.52	Does the vessel have current navigational charts for the port and route?			

Section 5: Pollution Prevention

5.1	Is spill containment fitted under the cargo manifold?	
5.2	Is spill containment fitted under all bunker manifolds?	
5.3	Is containment fitted under the bunker tank vents?	
5.4	Is containment fitted around the deck machinery?	
5.5	Specify type of scupper plugs	
5.6	Are means provided for draining or removing oil from deck area/containment?	
5.7	Does the vessel have on board the equipment, procedures and resources for use in event of an oil spill?	
5.8	Does the vessel have a shipboard oil pollution emergency plan (SOPEP) that complies with the requirements of the MARPOL convention?	

5.9	Is the following pollution control equipment available to clean up oil spilled on deck?	
5.9.1	Sorbents?	
5.9.2	Non-sparking hand scoops/shovels?	
5.9.3	Containers?	
5.9.4	Emulsifiers?	
5.10	Does the vessel have a certified sewage system?	
5.11	Does the vessel have a sewage storage tank?	
5.12	Does the vessel have on board holding of bilge water?	
5.13	Does the vessel have on board holding of oily waste?	
5.14	Does the vessel have on board holding of solid wastes?	
5.15	is a garbage incinerator fitted?	

Part 2: LIMITED AUDIT OF THE OUTBOARD OPERATION OF THE ISM SYSTEM

International Safety Management Certificate	
Issued By Classification Society Name	
Last 5 year renewal	Date:
Intermediate audit	Date:
Internal audit	Date:
Name of Designated Person Ashore (DPA)	
Contact Phone Number Contact email address	

General	**Yes /No**
Are the ISM system manuals available to the crew?	
Are the Master, officers and crew familiar with the ISM system?	
Are crew familiar with the Ship's Contingency Plans & their responsibilities?	
Are crew familiar with safe working practices required onboard?	
Are crew wearing Personal Protective Equipment and Clothing as appropriate?	
Are safety signs exhibited throughout the vessel?	
Are ear defenders/plugs used in the machinery spaces?	
Are eye protectors available near burning and grinding gear?	
Is the Safety Officer named and familiar with his responsibilities?	
Are minutes of safety meetings kept and forwarded to Safety Officer/DPA?	
Are concerns raised at meetings dealt with effectively onboard?	
Are concerns beyond the ship's capacity attended to promptly by the ship's management?	
Is the secondary emergency control center maintained?	
Does the vessel have a Material Safety Data System (MSDS) in place?	
Accommodation	
Are the ship's accommodations clean, tidy and hygienic?	
Are lifejackets and survival suits stored in each cabin?	
Are fire extinguishers, alarms, etc. in place and in date?	
Are public rooms, mess rooms etc. clean, tidy and hygienic?	
Are the galley and food stores clean with refrigerators operational?	
Is proper food handling and food hygiene in effect?	
General Exterior Inspection	
Is the ship's hull in good external condition & well coated?	
Is the visible lower hull free from fouling?	
Is an organotin, tributalin or biocide based anti-fouling coating used?	

Machinery Spaces						
Machinery Space						
Main Engines						
Generators						
Boilers						
Inert Gas System			Nitrogen		CO_2	Yes
General Cleanliness	Good					
Bilge Cleanliness	Good					
Oily Water Separator						
Oil Sludge Tank			Capacity	21.7 m3		
Ballast Pumps			Capacity	cu. metres/Hr		
Sewage Pumps	Type					
Sewage Holding Tank	Capacity		m^3		Days	

Engine Rooms Records	
Engine Room Log Book (Note engine/generator/bolier breakdowns in port or shut downs at sea during the last two voyages)	
Fuel consumption per day	Mt/Day
Lube oil consumption	Ltrs/Day
Planned Maintenance System (Note if up to date and any outstanding work)	
Oil record book (Must be up to date and signed by C/E and Master)	

Deck Log Book – For Last Voyages	
Average Speed	kts
Weather	
Are charts and publications corrected up to date?	
Has the Master been provided with a Port Information Book?	
Is the Master aware that he must carry all the necessary Canadian charts and publications before arrival in Canada?	
Are ballast transfer/changes recorded in a ballast log book records (Last Voyage)?	

Life Saving Appliances						
Lifeboats	Total No		Open/Enclosed			
	Type		Motor		Enclosed	
Davits	Type					
No. of Survivors	Capacity					
Rescue Boat	Condition					
Davits						
Life Rafts	Date		Capacity:			
Life Raft Davits for above						
Survival/Immersion Suits	Total					
SARTS						
Records of Lifeboat Drills, Fire Drills, etc.						
Are post exercise debriefings held after each exercise and are all crew invited to comment as to how to improve the effectiveness of the fire team, first aid teams, etc.?						

CREW CERTIFICATION

Requirements:

All crew to have Certificate of Training in Emergency Duties and Fire Fighting issued by an accredited institution. The Master, 1^{St} Mate and two Senior Engineers shall be certified for all Emergency Command and Control Issues. At least two Officers shall be qualified GMDSS operators.

All new crew shall be provided with an orientation of the ship on joining. This will include an introduction to his duties, the emergency signals and his emergency station under the various contingencies.

A booklet setting out details of the vessel should be provided in each cabin along with notices showing how to don a lifejacket and or survival/immersion suit.

Every vessel shall have a SOLAS manual onboard available to all crew members. This manual describes in the common language(s) of the crew, each piece of safety equipment, its position onboard and how to operate it.

Check make up and qualifications of all watch-keeping Officers and Engineers.

Can the vessel operate with the machinery spaces unmanned (UMS)? If so, the machinery space must be manned by at least one watch-keeping engineer when the vessel is reduced to manoeuvring speed for entering or leaving port.

Qualification of Master and Watch Keepers

Crew First Aid Training: Numbers:

Advanced First Aid Training: Numbers:

Rescue Craft Training: Numbers:

Crew	Certificate of Competency			Basic Safety Certificate		Adv. Safety Certificate	
	Level	State	Date	State	Date	State	Date
Master							
1st Mate							
2nd Mate							
3rd Mate							
Chief Eng.							
1st Eng.							
2nd Eng.							
3rd Eng.							
4th Eng.							
Seamen							

Other Information	Yes/No	Comments
The suitability of the winterization of the vessel's onboard systems and equipment, including deck and cargo equipment, evacuation craft, etc. for operation in cold temperatures and icing according to all expected conditions.		
The provision of clear vision systems for unimpaired forward and astern vision in cold temperatures, icing, etc		
The suitable of the vessel's navigation equipment and appliances for safe navigation through ice in all expected conditions.		
The suitable of key safety-related and survival equipment for cold temperatures, ice and icing conditions – including survival kits and immersion suits.		
Confirmation that the vessel's officers and crew are familiar with cold weather survival procedures and the environmental conditions which they can expect to encounter.		
Confirm that the vessel's ice navigation history has established that the vessel has a record of successful navigation in ice conditions comparable to those expected in Anaktalak Bay during the voyage.		
Confirm that the vessel's operating manuals include a clear statement of the operating limitations for the vessel and its essential systems in all anticipated ice conditions, temperatures and other environmental conditions.		
Confirm that the vessel's operating manuals include passage planning procedures accounting for anticipated ice and other environmental conditions and transit speeds having due regard to the vessel's class and type in the anticipated conditions.		
Confirm that the vessel's operating manuals include deviations from standard operating procedures when navigating in ice-covered waters, including the operation of machinery systems, remote control and warning systems, electric and electronic systems.		
Confirm that the vessel has appropriate escape and evacuation procedures into cold water and ice, etc		
Confirm that the vessel is adequately equipped and its crews are properly trained to provide effective damage control and minor hull repair under all expected conditions.		

Appendix F:
Operational Guide for Ore Carrier Convoys

Baffinland Iron Mines Corporation

OPERATIONAL GUIDE FOR ORE CARRIER CONVOYS

FOR REVIEW PURPOSES ONLY

Prepared By:
Department:
Title:
Date:
Signature:

Approved By:
Department:
Title:
Date:
Signature:

DOCUMENT REVISION RECORD

Issue Date MM/DD/YY	Revision	Prepared By	Approved By	Issue Purpose
01/27/23	0			Refining guide in context of 2023+ operations using target reduction examples of 5-10%

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1 PURPOSE

This implementation guide serves to provide an overview of how Baffinland may operationalize a reduction in the number of independent transits in the marine Regional Study Area (RSA) by implementing a convoy system during the shipping season. Through the implementation of a convoy system in years 2023+, Baffinland aims to reduce the number of transits needed based on the setting of transit reduction targets (ranging between 5-10%) determined annually in comparison to a system without convoying. The use of convoys will reduce the frequency of individual vessel transits calling to Milne Port, which will have a similar effect to reducing overall ship traffic. The anticipated benefit of this program will be to reduce cumulative noise exposure for marine mammals to the extent possible without compromising shipment targets, and reduce the frequency of visual observations of vessels passing through and potentially interacting with land users and harvesters. As additional learnings are gained through implementation of convoys over the years, Baffinland will endeavor to increase the percentage of convoys if operationally possible.

This convoy system is a novel approach to noise reduction for the benefit of marine mammals and has not been implemented at the proposed scale at Mary River or at any other Port in Canada, but was first piloted in 2022 for the Mary River Project. Based on the results from 2022, Baffinland is confident it can implement a successful convoy system and achieve target reduction levels between 5-10%, however it is expected that the operational guidance may change annually as direct experience is gained over each implementation year. Baffinland expects lessons to be learned and relayed in annual reporting efforts to the NIRB, which will inform future versions of this operational guide.

2 SCOPE

This operational guide includes details related to the use of convoys in order to minimize the total number of transits completed by Baffinland ore carriers over the entire duration of the shipping season within the marine RSA (Figure 2.1). This guide also covers the obligations and commitments made under regulatory or social license that require input and oversight from Baffinland's Shipping Department, its shipping agents and vessel owner partners. This guide does not abdicate any departments' responsibilities for understanding and following all legal requirement under permits and authorizations issued to the Company.

It is further noted that in all matters of marine transportation, the Captain of the vessel (the Vessel Master) has an overriding obligation to protect the safety of their vessel, crew, and environment for which they are ultimately responsible for. Notwithstanding anything contained in this Convoy System Operational Guide (the Guide), the Vessel Master will always be guided by this principle.

This Guide covers transits completed over the entire duration of the shipping season, for which the start and end of shipping operations is defined through a specific set of requirements allowing for safe passage in the marine RSA. It does not apply to vessels transiting outside the RSA.

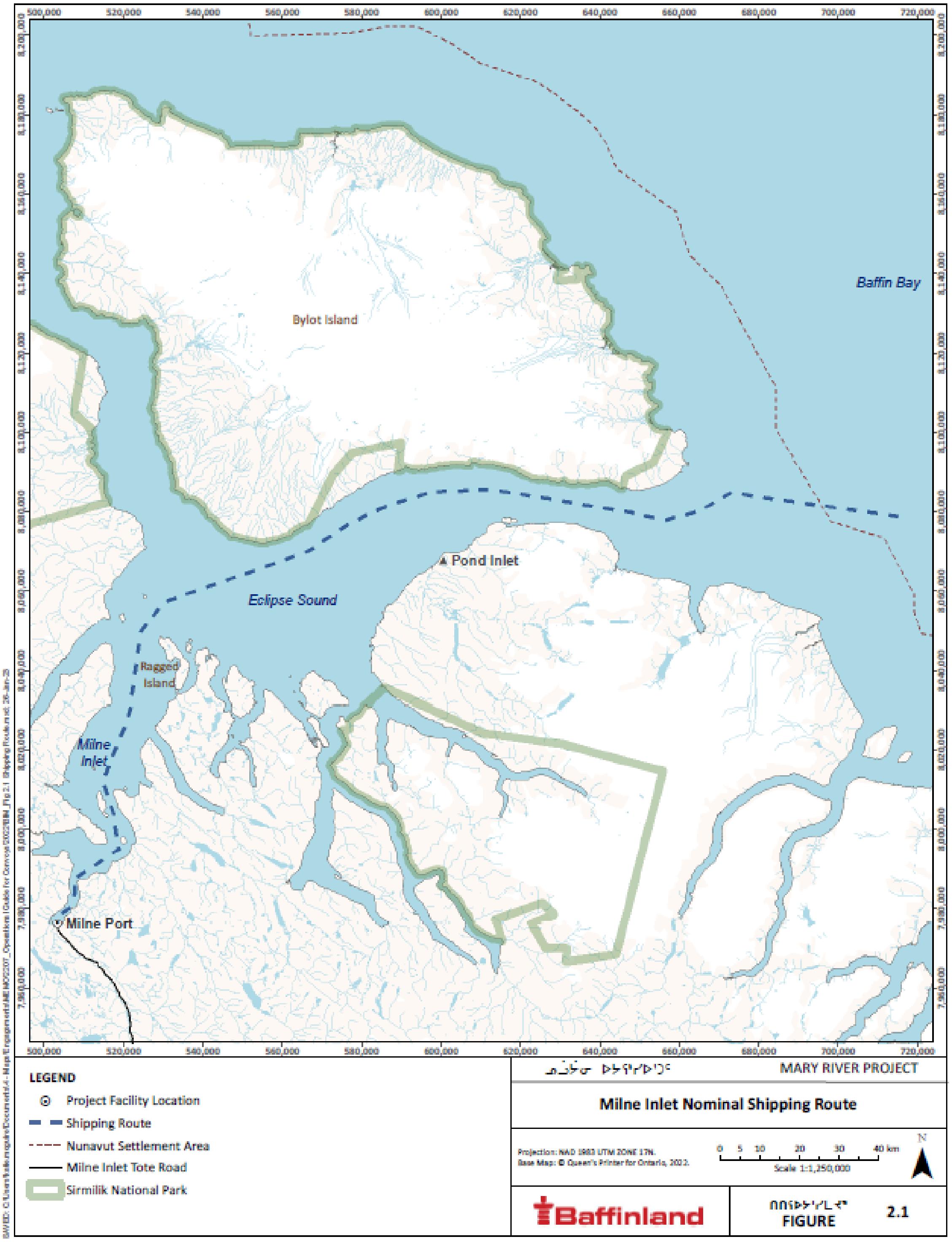

FIGURE 2.1: SHIPPING ROUTE BUFFER ZONE

3 RESPONSIBILITIES

To safely and effectively reduce the number of transits through the RSA over the entire duration of the shipping season, Baffinland and its shipping agents will work with best-in-class vessel owners. A description of the roles and responsibilities for individuals executing on the convoy system are as follows:

Baffinland Shipping Department (including Baffinland Head of Shipping and Vice President Sales and Logistics): Responsible for overall shipping operations including understanding and overseeing any requirements related to the regulatory and social licenses that requires actions from the Shipping Departments, its shipping agents and vessel owner partners. The Baffinland Shipping Department will provide a shipping schedule to the Port Captains on a daily basis, which among other things, consider where vessels are in their approach to the staging area in Baffin Bay at 73 W longitude, and their ability to travel in convoy. In addition to other factors (see 4.2 Criteria used for Convoys), this schedule will determine the feasibility of a convoy. The Baffinland Shipping Department, will report all planned vessel movements to Sustainable Development for external communications and reporting.

Baffinland Sustainable Development:

Manager Environmental, Social and Governance (ESG): Manager ESG will provide oversight to the Shipping Monitors by informing them of incoming convoys. This information will be provided by the Shipping Department and its shipping agents. Direct engagement with community representatives (e.g., the Hamlet of Pond Inlet, the Mittimatalik Hunters and Trappers Organization) will be engaged prior to, during and after the shipping season is complete on convoy system implementation. At the end of the season, a summary report will be provided to the Marine Environment Working Group, the Hamlet, and the MHTO on the resulting convoy implementation.

Shipping Monitors: Shipping Monitors will be responsible for tracking, recording and providing communications using various formats (e.g., Facebook, VHF radio) to residents of Pond Inlet on Baffinland's use of convoys over the duration of the shipping season. Baffinland Manager ESG will aim to provide advance notice of incoming convoy system prior to their entry into the RSA and/or prior to when ore carriers leave Ragged Island anchorage.

Baffinland Shipping Department and its Agents

Vessel Captain/Vessel Master: The Captains of the vessels calling to Milne Port are highly qualified, with years of experience in polar waters. They will be responsible for the actual implementation and performance of the convoy. All Captains performing in convoy will communicate via ship radio throughout the transit. Based on their experience and prevailing weather and ice conditions, the Captains will choose a safe distance between their vessel and the vessel ahead of them in the convoy and, if required, report any necessary deviations from the nominal shipping lane to all other vessels in convoy. It should be noted that all previously applied shipping mitigations will continue to apply in years 2023+ in addition to the new convoy system (i.e. 9 knot speed limit, use of nominal shipping route, anchoring limits at Ragged Island, etc.). The vessels will provide their expected time of arrival (ETA) during the voyage.

Port Captain: The Port Captain's office situated at Milne Port will be the focal point for ship to shore communications and coordination of all marine shipping movements. The Port Captain will establish and communicate the shipping schedule, advising Vessel Captains on when to enter the marine RSA. The Port Captain will manage the implementation of the convoy system and will dictate the timing of departure and size of convoy. The Port Captain's office will issue orders as required to all vessels under Baffinland's ultimate authority and will report all planned vessel movements to the Shipping Department via Head of Shipping.

4 DEFINITIONS

4.1 GENERAL DESCRIPTIONS

For the purpose of this operational guide the following definitions of 'convoys' are applicable:

TABLE 4.1: Definitions

Term	Definition
Convoy	2 or more vessels traveling in proximity that provides inter-vessel separation less than 10 km (Note that vessels in a convoy are instructed to maintain no more than 1 nautical mile between each vessel, provided it is safe to do so)
Full Transit	A convoy from Baffin Bay to Milne Port or Milne Port to Baffin Bay (243 km) (Note that vessels do not stop at Ragged Island when leaving Milne Port)
Partial Transit	A convoy from Baffin Bay to Ragged Island (173 km) or Ragged Island to Milne Port (70 km) (Note that vessels do not stop at Ragged Island when leaving Milne Port)
Convoy Target	The distance of ore carrier transits completed in convoy divided by the total distance of transits for all ore carriers
Effective Transits	The total number of transits for a segment or all segments where individual transits and convoys are accounted for as single transits, regardless of the number of vessels
Effective Distance	The total distance travelled for a segment or all segments where the distances of individual transits and convoys are accounted for equally, regardless of the number of vessels

4.2 TYPES OF CONVOYS

Convoys will occur throughout the shipping season as ore carriers travel in groups of two or more and maintain inter-vessel separation of less than 10 km, a distance demonstrated to reduce total sound exposure in the marine RSA (Austin 2022; Attachment 1). Baffinland acknowledges that the closer the vessels travel together, the greater the benefits in noise reduction. As a result, Baffinland will endeavour to maintain distances between vessels at 1 nautical mile or less, however, operational realities not yet experienced may challenge our ability to satisfy this condition in all circumstances and some deviations should be expected.

Convoys will either occur as full transits or a partial transit. The former occur when a convoy of ore carriers travel the entire distance from Baffin Bay to Milne Port, or Milne Port to Baffin Bay, whereas the latter occur when a convoy of vessels travel the distance from Baffin Bay to Ragged Island, or Ragged Island to Milne Port (Note that ore carriers do not typically stop of Ragged Island when outbound).

Since Ragged Island is not an exact midway point along the shipping route within the marine RSA, the total distance of ore carrier transits within the marine RSA must be considered when setting the Convoy Target for each shipping season. This process is explained further in Section 5.3.

5 PROTOCOL

5.1 CONVOY IMPLEMENTATION CRITERIA

The ability to execute a convoy will depend on the following factors:

5.1.1 VESSEL SAFETY

- The use of a convoy system for ore carriers calling to be Milne Port will be dependent on a number of risk factors that may affect the safe passage of vessels in the marine RSA including:
  - Ice conditions (i.e., what could prevent a convoy? e.g., bergy bits, growlers, Fall freeze up);
  - Timing of incoming and outgoing vessels and the potential to meet in the no passing zone established Bruce Head and Poirier Island;
  - Presence of other vessels in the RSA (Baffinland and non-Baffinland vessels);
  - Weather;
  - Other factors as identified in practice

5.1.2 AVAILABILITY OF ANCHORAGES AT RAGGED ISLAND AND MILNE PORT

- The size of convoy will depend on available anchorage capacity at either Ragged Island and/or Milne Port to accept ore carriers that have not been cleared for berthing at the ship loading dock. Ragged Island and Milne Port each have three designated anchoring points (for a single vessel at each), however, two of the three anchorages at Milne Port are relatively deep, which can cause safety concerns in bad weather as vessels can drift even at anchor. As a result, the third anchorage is only ever occupied on an emergency basis.

5.1.3 NUMBER OF VESSELS IN STAGING TO THE EAST OF 73 W LONGITUDE OR RAGGED ISLAND

- The deployment and size of convoy will be dependent on the number of available ore carriers which are staging to the East of 73 W longitude (See Figure 52.1) or anchored at Ragged Island (Figure 5.1).

5.1.4 THE SHIPPING SCHEDULE

- Deployment schedule and frequency of convoys will depend on the need for individual vessels to commence sailing inbound and outbound. This will in turn be determined by factors including but not limited to: safety at all times, the ice-class of the vessel, the vessel's location prior to commencement of convoying, crew and fuel status on each vessel, the utilization of the ore loading dock at Milne port, safety stock levels at customers' discharge ports, changes in the loading sequence of vessels at Milne port, product availability at Milne Port amongst others. Baffinland's Shipping Department will coordinate the Shipping Schedule.

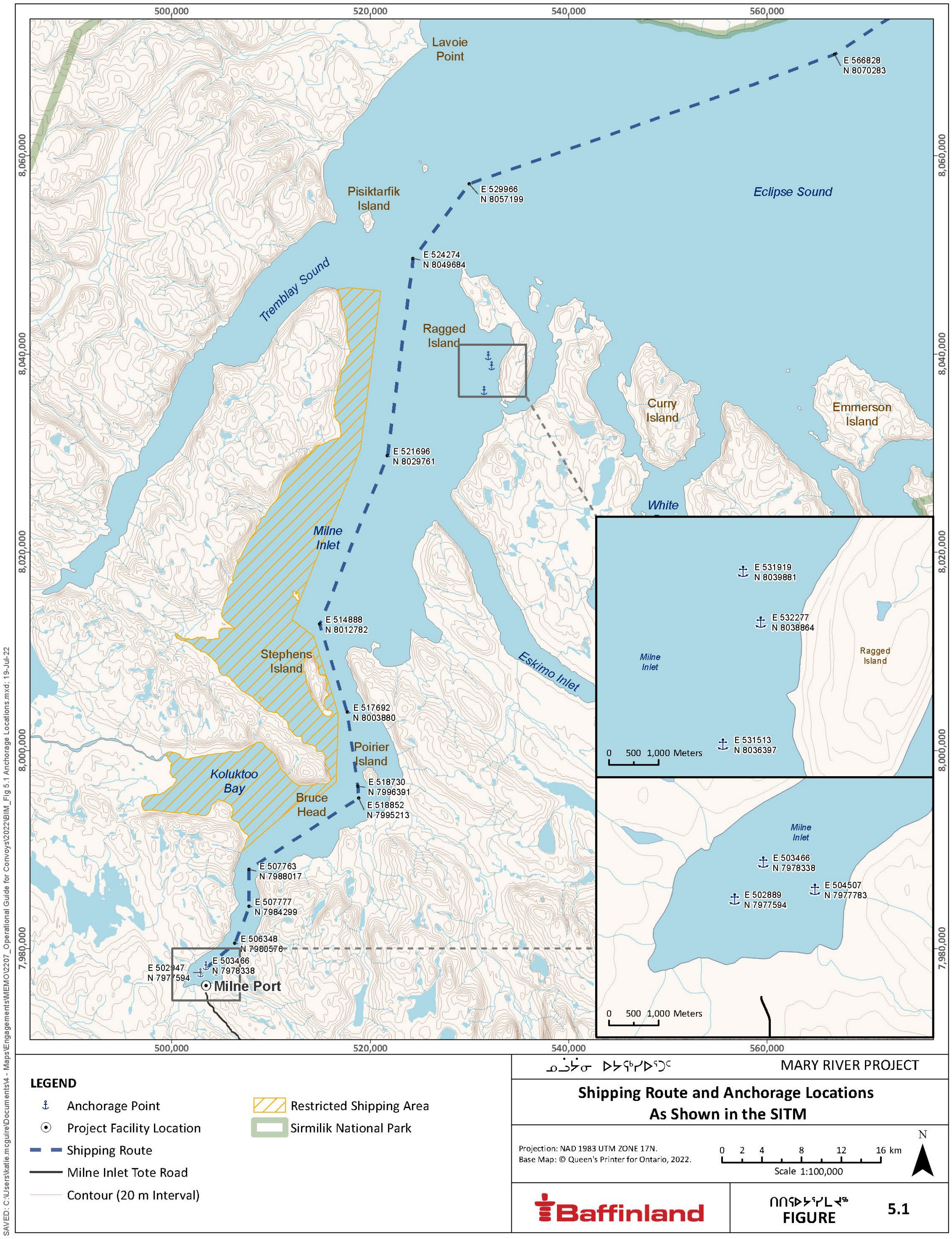

FIGURE 5.1: SHIPPING ROUTE AND ANCHORAGE LOCATIONS AS SHOWN IN THE SHIPPING INSTRUCTIONS TO MASTERS

5.2 INSTRUCTIONS TO VESSELS TRANSITIONS IN A CONVOY

This section presents instructions to Vessel Masters when deploying a convoy.

1. The Port Captain will communicate with Baffinland vessels to coordinate daily vessel scheduling. Vessels standing by for clearance from Port Captain to enter the marine RSA and proceed to Milne Port will wait at the designated staging area to the east of 73 W longitude, or other established safe anchorage locations in Baffin Bay.
2. When feasible for the shipping project and safety permitted, vessels may enter the RSA under a convoy when instructed to do so by the Port Captain.
3. The Port Captain, with support from Baffinland Shipping Department and Vessel Captains, will determine the size and sequence of convoy.
4. Vessels will convoy in a single file line-up.
5. The Port Captain will provide instructions on where each vessel should complete their convoy (i.e., anchorage location).
6. Vessels performing a convoy will maintain a safe distance from one another, which will vary based on present conditions.
7. Vessels in convoy will be in constant communication via ship radio and can reach Port Captains by telephone or radio.
8. All vessels calling Milne Port must follow all instructions provided in the Standing Instructions to Masters (SITMs) and General Information for Masters of Vessels Loading at Milne Inlet Port, in addition to any additional instructions provided by the Port Captains.
    - All Project vessels operating in the RSA will maintain a maximum speed of nine knots.
    - Project vessels will maintain a constant course along the nominal shipping route and speed when in transit (as safe navigation allows).
    - Vessels entering the RSA will report ice conditions or presence of ice to Port Captain who will inform all vessels sailing throughout the RSA.
    - When marine mammals appear to be trapped or disturbed by vessel movements, the vessels will implement appropriate measures to mitigate disturbance, including stoppage of movement until wildlife move away from the immediate area (as safe navigation allows).
    - All vessels will be provided with standard instructions to not approach within 300 m of a walrus or polar bear observed on sea ice.
    - All vessels will be provided with standard instructions to operate their vessel in a manner that avoids separating an individual member(s) of a group of marine mammals from other members of the group.
    - Vessels leading a convoy will report any change in course to other vessels in convoy to mitigate disturbance to marine mammals or wildlife.
9. Nothing contained herein should be read in any way as over-riding the Vessel Master’s authority and responsibility for safe navigation and management of the vessel.

10. These instructions shall be revisited every shipping season with changes captured in annual updates to the SITMs and General Information for Masters of Vessels Loading at Milne Inlet Port.

An example of a shipping schedule is provided as Attachment 2, which outlines how vessels may travel to Milne Port in segments independently and in convoy with other vessels.

5.3 CALCULATION OF REDUCTION OF TRANSITS

Since in some cases convoys may only be carried out over a portion of the nominal shipping route, and the point at which some convoys may end or begin at Ragged Island is closer to Milne Port than Baffin Bay, the overall implementation of convoys cannot be effectively measured by a simple accounting of full and half transits. The most accurate accounting must consider the overall distance travelled in convoy as a proportion of total distance otherwise travelled as individual transits.

In the calculation of the convoy target, the following distances are used for the potential inbound transits:

- The full transit from Baffin Bay to Milne Port is approximately: 243 km
- The partial transit from Baffin Bay to Ragged Island is approximately: 173 km
- The partial transit from Ragged Island to Milne Port is approximately: 70 km

Unlike inbound transits, outbound vessels do not anchor at Ragged Island and the only distance to be traveled is equivalent to a full transit from Milne Port to Baffin Bay, which is approximately: 243 km.

To illustrate how Baffinland will report on its performance against a pre-determined annual Convoy Target (e.g., 5-10%) for 2023+, two illustrative scenarios are provided that break down different combinations of individual versus full and partial convoy transits as Attachment 3.

5.4 CONVOY-RELATED COMMUNICATIONS AND REPORTING

5.4.1 INTERNAL

The Baffinland Shipping Department will provide regular updates to the Sustainable Development Department throughout the shipping season on potential upcoming implementation of a convoy system. As part of these updates, a number of details will be provided at minimum, including: potential for an upcoming convoy system within the next 7 days, and upon coordination of such a convoy. These communications will come via the shipping-dedicated email that is available to Shipping Monitors and Manager ESG.

5.4.2 EXTERNAL

Shipping monitors will track and record each convoy occurrence as part of their daily tracking duties and reporting. Convoys, when implemented, will be announced on the marine VHF radio in advance of the convoy formation to the extent possible. Shipping Monitors will announce convoy systems on Facebook upon their entry into the RSA. Wherever possible, a screenshot will be taken of the vessels when underway; this will be posted along with the messaging of an incoming convoy system.

5.4.3 END OF SEASON REPORTING

Baffinland will submit a summary of convoying activities within 90 days of the close of the shipping season to the Marine Environment Working Group (MEWG), the Hamlet of Pond Inlet and the Mittimatalik Hunters and Trappers Organization (MHTO). Input received from Pond Inlet residents, as received through various media, will be incorporated to the extent possible. This summary will include information such as the following (which may be change once convoy systems are implemented):

- Dates on which convoys were implemented;
- Start and end locations of each convoy system;
- Summary of distance travelled for individual and convoy system transits;
- Achieved percentage for the full season;
- Any reported concerns.

6 REFERENCES

Austin, M. 2022. Baffinland 2022 Underwater Acoustic Monitoring: Preliminary analysis of noise from vessel convoys. Version 1.0. Technical report by JASCO Applied Sciences for Baffinland Iron Mines.

Attachment 1
Baffinland 2022 Underwater Acoustic Monitoring - Preliminary Analysis of Noise from Vessel Convoys

Underwater Noise Modelling for the Mary River Project – Sustaining Operations Proposal

Acoustic modelling of noise from vessels at Milne Port and along the Northern Shipping Route

JASCO Applied Sciences (Canada) Ltd

8 March 2023

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Executive Summary

JASCO Applied Sciences, under contract to WSP Canada, performed an underwater acoustic modelling study to predict underwater sound propagation and calculate noise footprints from commercial shipping operations associated with the Mary River Project, an iron ore mine located in the Qikiqtani Region of North Baffin Island, Nunavut. Modelling was undertaken to aid in the assessment of potential acoustic impacts (i.e., injury and/or behavioural disturbance) on marine mammals as a result of exposure to Project shipping. Project vessels considered in the model included Post-Panamax and Capesize bulk carriers, tugs, fuel tankers and icebreakers. Operational scenarios considered in the model included vessels mooring in Milne Port and Ragged Island, active berthing of vessels at Milne Port, and vessels transiting along the Northern Shipping Route under open-water conditions and in heavy and light ice conditions. Aggregate shipping scenarios were also considered and included occurrence of simultaneous sound sources and one or more vessels transiting together in a convoy formation.

Source levels in decidecade bands for each source type were obtained from JASCO's measurements of Project vessel noise in the Regional Study Area (RSA). When Project-specific vessel measurements were not available (i.e., for tug-assisted berthing and for moored ore carriers), surrogate sources levels were obtained from JASCO's in-house database of vessel measurements from other regions. Underwater sound propagation from the various Project vessel noise sources was undertaken using JASCO's Marine Operations Noise Model (MONM). The modelling predicted the acoustic footprint from the various Project vessel activities, and considered the effects of bathymetry, water sound speed profiles, seabed geoacoustic parameters, and vessel characteristics. We computed instantaneous sound pressure level (SPL), maximized over depth in the water, as well as 24-hour sound exposure levels (SEL_{24h}) and compared these to established thresholds for marine mammal acoustic injury (variable by marine mammal hearing group) and behavioural disturbance (120 dB re 1 µPa broadband SPL for non-impulsive sound sources such as vessel noise). For assessing potential for acoustic injury, auditory weighting was applied to the modelled sound fields to estimate received levels relative to hearing sensitivities of marine mammal hearing groups according to the National Marine Fisheries Service (NMFS) guidelines (NMFS 2018) for non-impulsive sounds.

The loudest SEL_{24h} corresponded to tug-assisted berthing scenarios for Capesize and Post-Panamax bulk carriers. None of the transiting carriers exceeded any of the SEL_{24h} injury thresholds for the different marine mammal hearing groups. Berthing scenarios also yielded large radii to the 120 dB re 1 µPa SPL disturbance threshold, although long-range sound propagation was limited by the surrounding land at Milne Port. The largest disturbance ranges for transiting vessels were associated with vessels transiting along the Northern Shipping Route at 9 knots (kn).

Summarized threshold criteria and results:

- Shipping operations in Milne Port: The loudest vessel activities were those involving tug-assisted berthing at the ore dock, with exceedances of the injury threshold predicted to occur at distances up to 1.84 km (R_{max}) for high-frequency cetaceans (HFC), 0.06 km (R_{max}) for mid-frequency cetaceans (MFC), 0.07 km for low-frequency cetaceans (LFC), and 0.06 km for phocid pinnipeds (PPW). Tug-assisted berthing activities had the potential to cause exceedance of the 120 dB re 1 µPa SPL disturbance threshold for all marine mammal hearing groups at distances up to 11.2 km (R_{max}). Sound from ore carriers transiting at 5 kn within Milne Port exceeded the 120 dB re 1 µPa SPL disturbance threshold at distances up to 0.3 km (R_{max}) for Post-Panamax carriers and up to 0.4 km (R_{max}) for Capesize carriers. When ore carriers were escorted by tugs at 5 kn, the disturbance threshold was exceeded at distances up to 4.6 km (R_{max}).

- Shipping operations outside Milne Port: ranges to the 120 dB re 1 µPa SPL disturbance threshold were as follows:
  - 3.2 km < R_{max} < 5.2 km for Capesize carriers transiting at 9 kn
  - 2.9 km < R_{max} < 4.0 km for Post-Panamax carriers transiting at 9 kn
  - 14.2 km < R_{max} < 28.5 km for tankers transiting at 9 kn
  - 5.6 < R_{max} < 9.5 km when the icebreaker was transiting alone in compact ice (4.1 < R_{max} < 6.8 km in very open drift ice)
  - 5.9 < R_{max} < 9.3 when the icebreaker was transiting with one Capesize carrier in compact ice (4.2 < R_{max} < 7.6 in very open drift ice)
  - 6.1 < R_{max} < 9.1 when the icebreaker was transiting with two Capesize carriers in compact ice (5.4 < R_{max} < 8.1 in very open drift ice)
  - 6.1 < R_{max} < 9.1 when the icebreaker was transiting with one tanker in compact ice (15.7 < R_{max} < 19.9 in very open drift ice)
  - 6.6 < R_{max} < 8.7 when the icebreaker was transiting with two Capesize carriers and two tugs in compact ice (15.4 < R_{max} < 21.3 in very open drift ice)

1. Introduction

1.1. Project Background

The Mary River Project (hereafter, "the Project") is an operating open-pit iron ore mine located in the Qikiqtani Region of North Baffin Island, Nunavut. Baffinland Iron Mines Corp. (Baffinland) is the owner and operator of the Project. The operating mine site is connected to a port at Milne Inlet (Milne Port) via the 100 km long Milne Inlet Tote Road. Future, but yet undeveloped, components of the Project include a South Railway connecting the mine site to a future port at Steensby Inlet (Steensby Port).

To date, Baffinland has been operating in the Early Revenue Phase (ERP) of the Project and is authorized to transport 4.2 Mtpa of ore by truck to Milne Port for shipping through the Northern Shipping Route using chartered ore carrier vessels. A production increase to ship 6.0 Mtpa from Milne Port was approved for 2018-2022 and shipping is expected to continue for the life of the Project (20+ years). During the first year of ERP operations in 2015, Baffinland shipped ~900,000 tonnes of iron ore from Milne Port involving 13 return ore carrier voyages. In 2016, the total volume of ore shipped out of Milne Port reached 2.6 million tonnes involving 37 return ore carrier voyages. In 2017, the total volume of ore shipped out of Milne Port reached 4.1 million tonnes involving 56 return ore carrier voyages. Following approval to increase production to 6.0 Mtpa, a total of 5.1 Mtpa of ore was shipped via 71 return voyages in 2018, 5.9 Mtpa of ore was shipped via 81 return voyages in 2019, 5.5 Mtpa was shipped via 72 return voyages in 2020, and 5.6 Mtpa via 73 return voyages in 2021. In 2022, a total of 4.7 Mtpa of iron ore was shipped via 62 return voyages. Baffinland is currently requesting approval for a further amendment to Project Certificate No. 005, for Sustaining Operations, allowing the continued transport of iron ore via the Tote Road and marine shipping along the Northern Shipping Route at the nominal levels previously approved from 2018–2022, exporting nominally 6 Mtpa.

1.2. Acoustic Modelling

JASCO Applied Sciences (JASCO) performed an acoustic modelling study to predict underwater sound propagation and calculate noise footprints resulting from commercial shipping operations at Milne Port and along the Northern Shipping Route. Project vessels considered in the modelling included Post-Panamax bulk carriers, Capesize[1] bulk carriers, tugs, tankers and icebreakers. Shipping scenarios were modelled under open-water conditions and in both light and heavy ice conditions. The current Project Description does not involve icebreaking operations during the early shoulder season (June/July) or open-water season (Aug/Sept). As such, modelling of icebreakers was limited to the fall shoulder season (October), the only period during the shipping season when icebreaking operations would be required to escort ore carriers along the Northern Shipping Route. All shipping scenarios involving icebreaker escorts were selected to represent the worst-case (i.e., loudest) of all possible vessel configurations considered in the model. Aggregate shipping scenarios were also considered in acoustic model including occurrence of simultaneous vessel noise sources and events when one or more vessels would transit together in a convoy formation.

Baffinland's shipping extends from Milne Port to the entrance to Baffin Bay, passing by Koluktoo Bay and through Milne Inlet, Eclipse Sound, and Pond Inlet. Descriptions of the modelled scenarios and

[1] all vessels ranging in size from Baby Cape to Newcastlemax will be collectively referred to as Capesize in this report, equivalent to vessel sizes of Deadweight Tonnage (DWT) range of 100,000 – 220,000, and carrying capacity range of approximately 100,000 to 215,000 metric tonnes

corresponding modelled locations are presented in Table 2. Figure 1 shows the modelled locations along the Northern Shipping Route and in Milne Port.

Section 2 details the methodology for estimating the source levels, obtaining environmental parameters, and modelling the sound propagation of the various shipping scenarios. Modelling results are presented in Section 3., including summary tables in Section 3.2 showing the maximum and 95% distances to the sound level thresholds of interest, and a representative example of the SEL_{24h} due to transiting vessels. Sound field maps, which show predicted sound levels and the various sound level threshold contours for all scenarios, are presented in Appendix D.

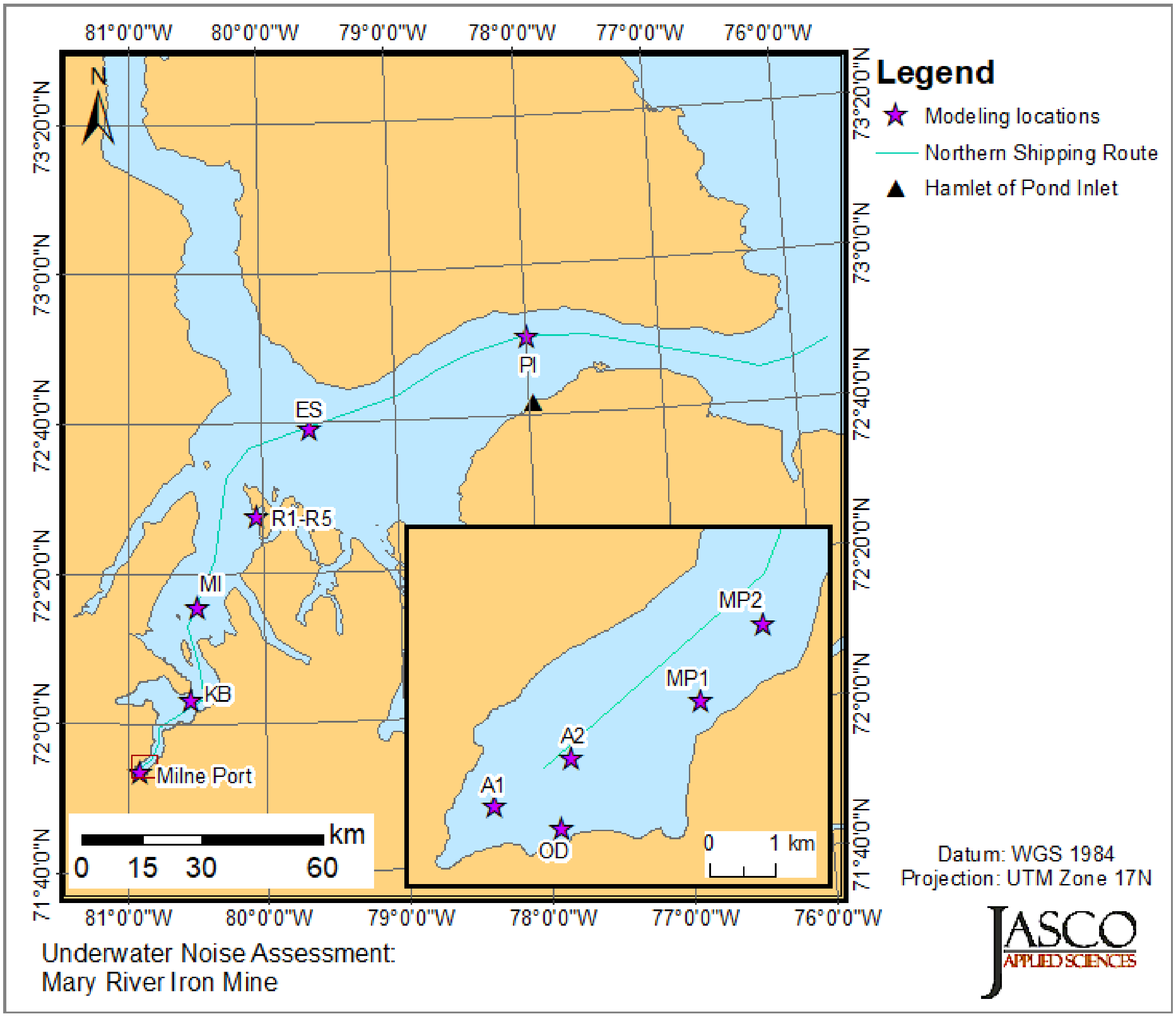

Figure 1. Northern Shipping Route: Modelled locationsincluded Pond Inlet (PI), Eclipse Sound (ES), anchorages near Ragged Island (R1-R5), Milne Inlet (MI), and Koluktoo Bay (KB). The inset of Milne Port shows the ore dock (OD) as well as anchorages in Milne Port (A1 and A2). Ship transit scenarios within Milne Port were modelled at representative locations, MP1 and MP2.

Table 1 Locations of modelled sites shown in Figure 1

Site name	Abbreviation	Easting / Northing (m)	Latitude (°N) / Longitude (°W)
Pond Inlet	PI	599356.334 / 8085143.771	72.84010000° N / 77.98176666° W
Eclipse Sound	ES	545328.308 / 8062140.922	72.65170016° N / 79.63793058° W
Milne Inlet	MI	517770.270 / 8017831.791	72.25839444° N / 80.47751836° W
Koluktoo Bay	KB	515937.593 / 7994772.836	72.05181030° N / 80.53661963° W
Ragged Island, anchor point 1	R1	532263.779 / 8040401.093	72.45911008° N / 80.04085311° W
Ragged Island, anchor point 2	R2	531200.649 / 8039343.807	72.44978254° N / 80.07293765° W
Ragged Island, anchor point 3	R3	530816.533 / 8040793.156	72.46282686° N / 80.08369237° W
Ragged Island, anchor point 4	R4	530133.593 / 8038290.401	72.44048510° N / 80.10510406° W
Ragged Island, anchor point 5	R5	529756.216 / 8039732.989	72.45346621° N / 80.11567915° W
Milne Port, anchor point 1	A1	502231.272 / 7977014.290	71.89313879° N / 80.93567637° W
Milne Port, anchor point 2	A2	503416.923 / 7977765.164	71.89985629° N / 80.90146082° W
Ore dock	OD	503264.591 / 7976676.380	71.89009714° N / 80.90590286° W
Milne Port 1	MP1	505394.235 / 7978641.963	71.90767970° N / 80.84437289° W
Milne Port 2	MP2	506348.106 / 7979798.782	71.91802690° N / 80.81675183° W

Table 2. Modelled scenarios for shipping operations involving Post-Panamax (PP) carriers, Capesize (CS) carriers and tankers. Figure 1 and Table 2 have site names that correspond to location abbreviations from Table 1. Scenarios were modelled for the month of October when environmental/marine conditions expected to result in the greatest amount of sound propagation. The aggregate scenario (22) was modelled during August, when higher levels of vessel activity are most likely to occur along the Northern Shipping Route.

<table>
<tr><th>Scenario</th><th>Operation(s) and location abbreviation</th><th>Month used for basis of model</th><th>Daily duration (s)</th><th>Other details</th></tr>
<tr><td>1</td><td>Moored PP at OD</td><td rowspan="21">October</td><td>86,400</td><td></td></tr>
<tr><td>2</td><td>Berthing PP at OD</td><td>12,960</td><td></td></tr>
<tr><td>3</td><td>Moored PP at R1</td><td>86,400</td><td></td></tr>
<tr><td>4</td><td>Transiting PP at MP1</td><td>NA</td><td>Transit speed = 5 kn</td></tr>
<tr><td>5</td><td>Transiting PP with tug escorts at MP1</td><td>NA</td><td>Transit speed = 5 kn</td></tr>
<tr><td>6</td><td>Transiting PP at KB</td><td>NA</td><td rowspan="4">Transit speed = 9 kn</td></tr>
<tr><td>7</td><td>Transiting PP at MI</td><td>NA</td></tr>
<tr><td>8</td><td>Transiting PP at ES</td><td>NA</td></tr>
<tr><td>9</td><td>Transiting PP at PI</td><td>NA</td></tr>
<tr><td>10</td><td>Moored PP at R1 and CS at R4</td><td>86,400</td><td></td></tr>
<tr><td>11</td><td>Moored CS at A2</td><td>86,400</td><td></td></tr>
<tr><td>12</td><td>Transiting CS at MP2</td><td>NA</td><td>Transit speed = 5 kn</td></tr>
<tr><td>13</td><td>Transiting CS with tug escorts at MP2</td><td>NA</td><td>Transit speed = 5 kn</td></tr>
<tr><td>14</td><td>Transiting CS at KO</td><td>NA</td><td rowspan="4">Transit speed = 9 kn</td></tr>
<tr><td>15</td><td>Transiting CS at MI</td><td>NA</td></tr>
<tr><td>16</td><td>Transiting CS at ES</td><td>NA</td></tr>
<tr><td>17</td><td>Transiting CS at PI</td><td>NA</td></tr>
<tr><td>18</td><td>Transiting tanker at KO</td><td>NA</td><td rowspan="4">Transit speed = 9 kn</td></tr>
<tr><td>19</td><td>Transiting tanker at MI</td><td></td></tr>
<tr><td>20</td><td>Transiting tanker at ES</td><td></td></tr>
<tr><td>21</td><td>Transiting tanker at PI</td><td></td></tr>
<tr><td>22</td><td>Aggregate scenario including:
• Berthing CS at OD
• Transiting CS with tug escorts at MP
• Moored PP at A1</td><td>August</td><td>As described above per activity</td><td></td></tr>
</table>

Table 3. Modelled scenarios for shipping operations involving an icebreaker transiting independently (i.e., solo) and when escorting Capesize (CS) carriers, tugs, and tankers. Site names correspond to location abbreviations in Table 1. Scenarios were modelled for the month of October when sea ice was most likely to be present along the Northern Shipping Route.

Scenario	Site	Operation(s) and location abbreviation	Transit speed (kn)	Month used for basis of model
23	MI	1 Icebreaker transiting solo in compact ice	5	October
24	MI	1 Icebreaker transiting solo in very open drift ice	9	
25	ES	1 Icebreaker transiting solo in compact ice	5	
26	ES	1 Icebreaker transiting solo in very open drift ice	9	
27	PI	1 Icebreaker transiting solo in compact ice	5	
28	PI	1 Icebreaker transiting solo in very open drift ice	9	
29	MI	1 Icebreaker transiting with 1 CS, in compact ice	5	
30	MI	1 Icebreaker transiting with 1 CS, in very open drift ice	9	
31	ES	1 Icebreaker transiting with 1 CS, in compact ice	5	
32	ES	1 Icebreaker transiting with 1 CS, in very open drift ice	9	
33	PI	1 Icebreaker transiting with 1 CS, in compact ice	5	
34	PI	1 Icebreaker transiting with 1 CS, in very open drift ice	9	
35	MI	1 Icebreaker transiting with 2 CS, in compact ice	5	
36	MI	1 Icebreaker transiting with 2 CS, in very open drift ice	9	
37	ES	1 Icebreaker transiting with 2 CS, in compact ice	5	
38	ES	1 Icebreaker transiting with 2 CS, in very open drift ice	9	
39	PI	1 Icebreaker transiting with 2 CS, in compact ice	5	
40	PI	1 Icebreaker transiting with 2 CS, in very open drift ice	9	
41	MI	1 Icebreaker transiting with 1 CS and 1 tanker, in compact ice	5	
42	MI	1 Icebreaker transiting with 1 CS and 1 tanker, in very open drift ice	9	
43	ES	1 Icebreaker transiting with 1 CS and 1 tanker, in compact ice	5	
44	ES	1 Icebreaker transiting with 1 CS and 1 tanker, in very open drift ice	9	
45	PI	1 Icebreaker transiting with 1 CS and 1 tanker, in compact ice	5	
46	PI	1 Icebreaker transiting with 1 CS and 1 tanker, in very open drift ice	9	
47	MI	1 Icebreaker transiting with 2 tugs and 2 CS, in compact ice	5	
48	MI	1 Icebreaker transiting with 2 tugs and 2 CS, in very open drift ice	9	
49	ES	1 Icebreaker transiting with 2 tugs and 2 CS, in compact ice	5	
50	ES	1 Icebreaker transiting with 2 tugs and 2 CS, in very open drift ice	9	
51	PI	1 Icebreaker transiting with 2 tugs and 2 CS, in compact ice	5	
52	PI	1 Icebreaker transiting with 2 tugs and 2 CS, in very open drift ice	9	

2. Methods

Sound levels for all sources were obtained either from direct measurements of Baffinland Project vessels made by JASCO during its 2018-2022 acoustic monitoring programs, or from JASCO's in-house database of available surrogates (for tugs during berthing and for moored ore carriers). Sound levels as a function of distance from the source were computed using JASCO's Marine Operations Noise Model (MONM). MONM is a frequency-dependent model that computes propagation loss (PL) via the parabolic-equation approximation of the acoustic wave equation (Appendix B.2), which accounts for the effects of environmental parameters such as bathymetry, sound speed in the water column, and sediment geoacoustics. In this study, MONM was used to obtain PL in decidecade bands from 10 Hz to 2 kHz. The frequency range for the PL was then extended to 25 kHz following the procedure described in Appendix B.2, which accounts for energy attenuation by molecular absorption in seawater and scattering due to surface ice. Modelling was performed for the frequency range 10–25000 Hz. Modelling results are presented in different forms suitable for further noise impact assessment. For each modelled scenario (Table 1 and Table 2), the following output was produced:

- Maps of Sound Pressure Level (SPL) isopleths (110–200 dB re 1 µPa, in 10 dB steps).
- Maps of frequency-weighted 24-h SEL (SEL_{24h}) for each source and location, representing injury thresholds according to the National Marine Fisheries Service (NMFS) guidelines (NMFS 2018).
- Tables of distances to the marine mammal impact thresholds of interest.

Marine mammal species with potential to occur along the Northern Shipping Route include narwhal, beluga whale, killer whale, bowhead whale, harp seal, ringed seal, bearded seal and walrus. The potential effects of Project shipping noise on these species are presented in this report using marine mammal functional hearing group designations and associated impact criteria (Appendix A.2 and A.3) for acoustic injury (NMFS 2018) and disturbance.

Table 4 presents the representative functional hearing groups for each marine mammal indicator species considered in this modelling study. All noise exposure criteria in NMFS (2018) are identical to those in the more recent Southall et al. (2019); however, the mid- and high-frequency cetacean groups from NMFS (2018) were renamed high- and very high-frequency cetaceans, respectively, in Southall et al. (2019). This report uses the hearing group names from NMFS (2018) for consistency with previous modelling conducted for the Project.

Table 4. Representative functional hearing groups for each marine mammal indicator species considered in the modelling study.

Species	Functional Hearing Group NMFS criteria (NMFS 2018)
Narwhal Beluga whale	Mid-frequency cetaceans (MFC)
Bowhead whale	Low-frequency cetaceans (LFC)
Harp seal Ringed seal Bearded seal (also applied for Walrus)	Phocid pinnipeds in water (PPW)

2.1. Acoustic Source Parameters

2.1.1. Transiting Vessel Scenarios

Source levels for all transiting vessel scenarios were estimated by examining spectral sound levels from data collected by JASCO during acoustic monitoring programs undertaken in the RSA between 2018 and 2022. Measurements corresponded to multiple transits of vessels with varying ship lengths, transit speeds, and deadweight tonnage. The analysis considered measurements of 172 bulk carrier transits, 12 tanker transits, two icebreaker transits in compact ice, four icebreaker transits in open ice, and four tug transits. In all cases, the measured levels were adjusted to account for the vessel speed, adjusted to the modelled speeds of 9 and 5 kn using Equation C-1. For ore carriers, measured levels were also adjusted to account for the vessel length, and scaled for the modelled vessel lengths in Table 5, also using Equation C-1.

Once the speed- and length-adjusted spectra were determined for all measurements, the decidecade source levels used in this work were determined by taking the mean among all available measurements for each vessel type. Figure 2 shows the source levels in decidecade bands for all vessels transiting at 9 kn (outside Milne Port area) and at 5 kn (at Milne Port, while approaching the ore docks). The modelled source depths were obtained by applying the relation between source depth, propeller diameter, and draft (Table 5) as described in Appendix C.

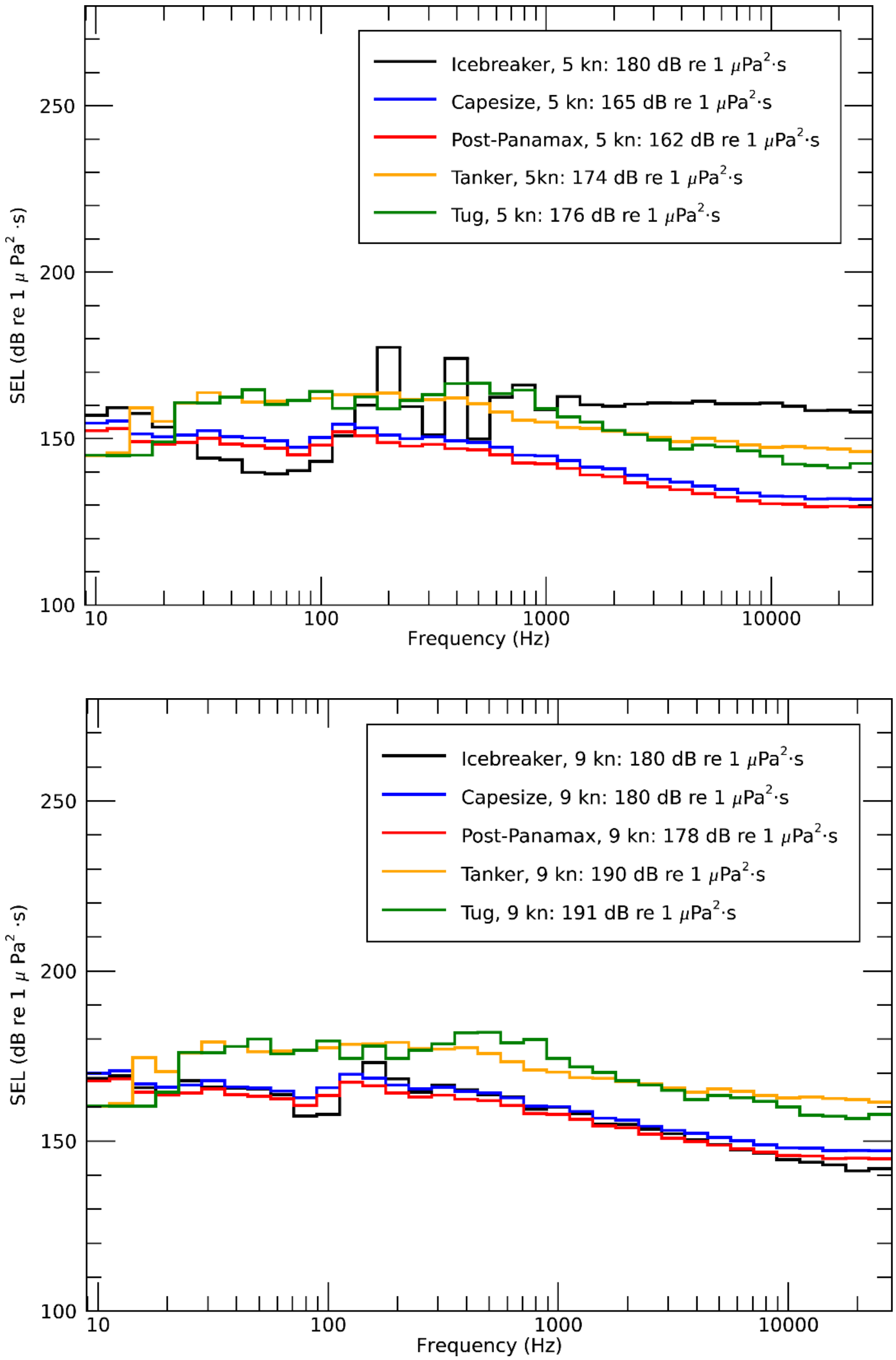

Figure 2. Monopole source levels for transiting vessels used for modelling. Scenarios with transit speeds at 5kn (top) and scenarios with a transit speed of 9kn (bottom). The model for the icebreaker transiting at 5 kn corresponds to noise during travel through compact ice, while that for the icebreaker transiting at 9 kn corresponds to noise during travel through very open drift ice.

Table 5. Vessel specifications for the modelled vessels.

Specification	Capesize	Post-Panamax	Tug	Icebreaker	Tanker
Deadweight tonnage (DWT)	220,000	94,000	190	2,890	18,000
Length overall (m)	300	230	30.8	97	147.5
Beam (m)	50	38	11.1	24	23
Fully laden draft (m)	18	15	5.2	8	9.5
Propeller diameter (m)	8.4	8	3.8	4	3.4
Vessel speeds (kn)	5 and 9				
Source depth (Z_s) (m)	11.3	8.2	2.0	4.8	6.6

2.1.2. Moored Ore Carriers

For scenarios involving moored ore carriers, the source levels in Figure 3 are based on measurements of the bulk carrier *Nelvana* at standby at Sechelt, British Columbia (MacGillivray et al. 2004). The *Nelvana* has a length of 243 m and a breadth of 32.3 m, similar to the dimensions of Post-Panamax carriers. For the purposes of the modelling, sound from a moored Capesize ore carrier was assumed to be the same as that from a moored Post-Panamax ore carrier.

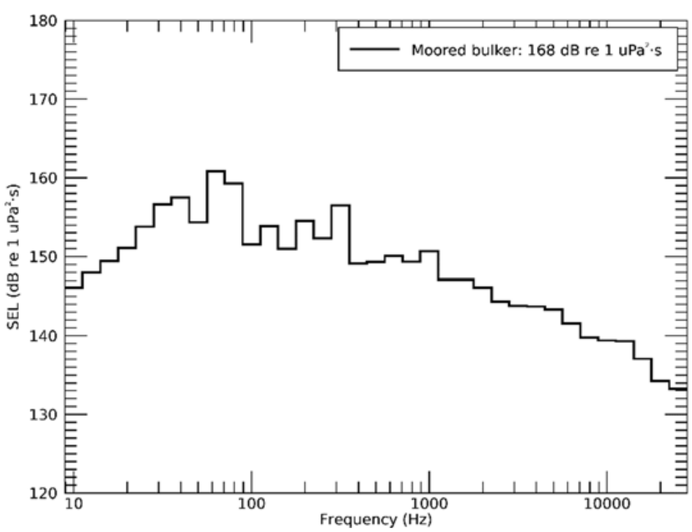

Figure 3 Source levels for a moored ore carrier. Legend: Broadband SEL.

2.1.3. Tugs During Berthing

For berthing scenarios, tug source levels (Figure 4) were based on measurements of the *Seaspan Resolution* performing a berthing simulation by positioning the two propellers toward the sides of the tug (pushing against each other) with engines at full power (Warner et al. 2014).

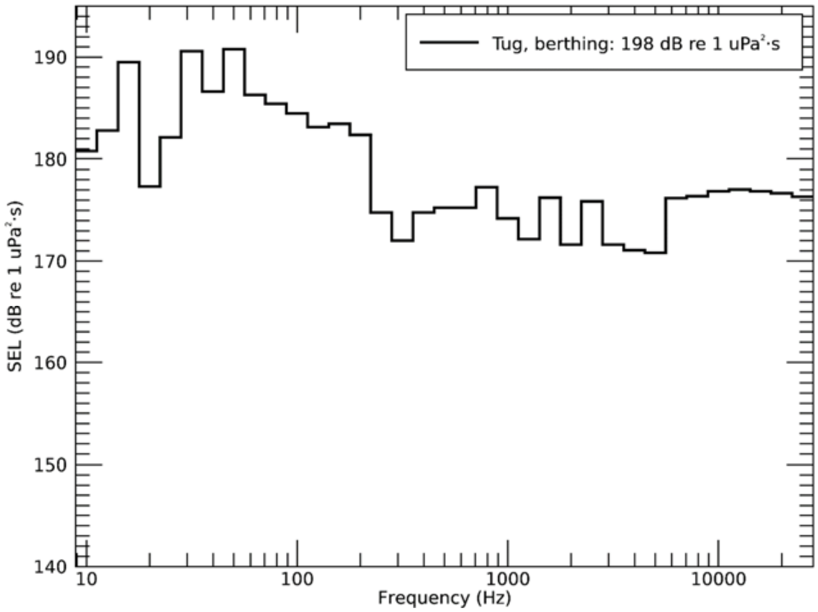

Figure 4. Source levels for a tug assisting berthing. Legend: Broadband SEL.

2.2. Environmental Parameters

2.2.1. Bathymetry

The accuracy of sound propagation model results depends on the quality of bathymetry data used. In this work, the bathymetry was a combination of two sources:

- SRTM 30+ dataset (Becker et al. 2009), with resolution of 300 × 900 m. This data set was used to construct the bathymetry for areas east of Eclipse Sound.
- Data provided by Golder Associates Ltd. at a resolution of 20 × 20 m, which was obtained from Canadian Hydrographic Surveys 4012380, 4013439, 4013646, 4013647, 4013648, 1200024, 2301836, 28956, 28962, 3380, 3395, 3477, and 66215. These data are a combination of multi-beam surveys, single-beam surveys, and hand-annotated paper charts corresponding to areas west of the Eclipse Sound modelled location.

The final bathymetry grid (Figure 5) was adjusted to represent higher high water mean tide (HHWMT).

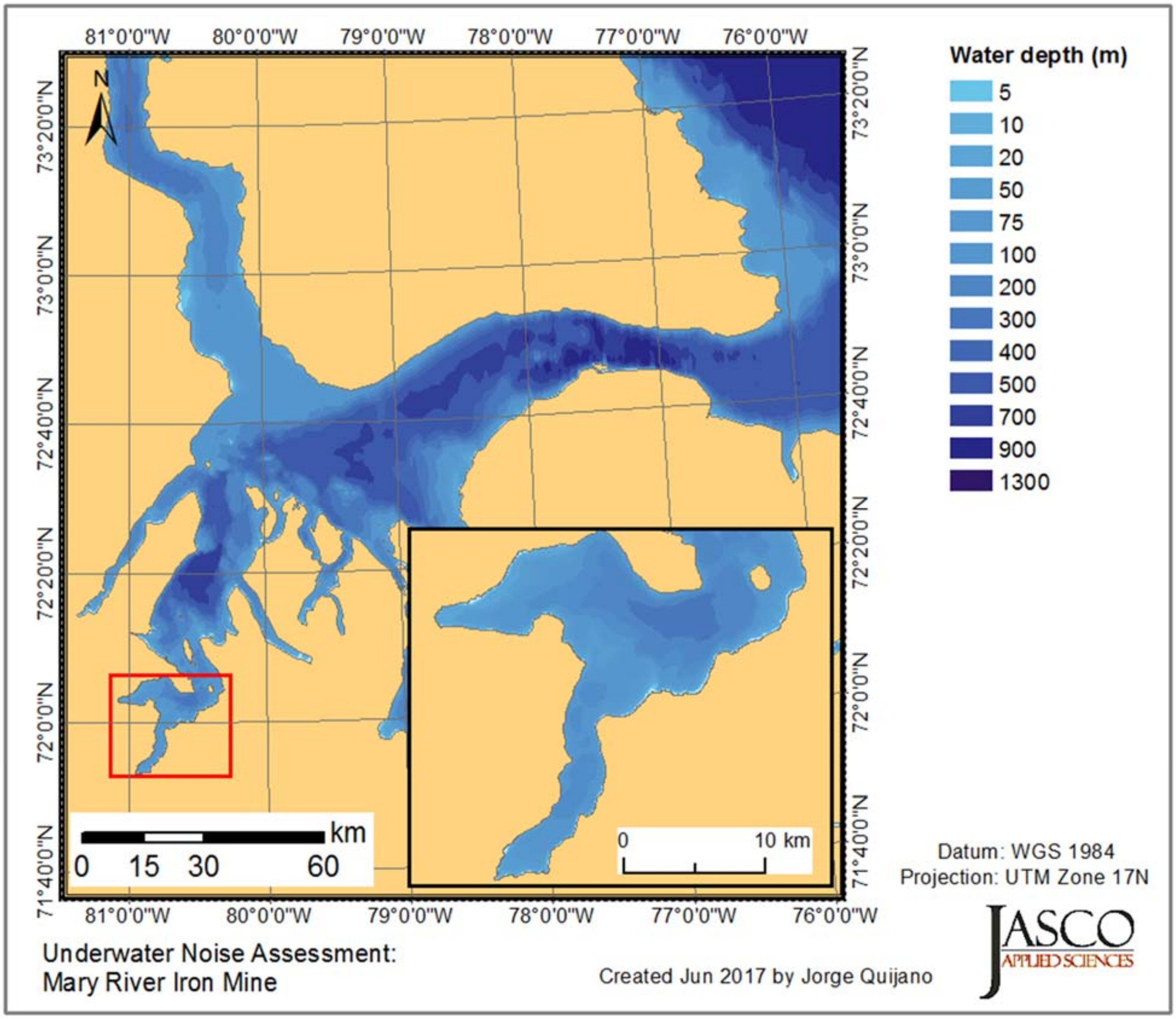

Figure 5. Bathymetry used in the models. Inset: bathymetry at Milne Port.

2.2.2. Sediment geoacoustics

Similar to acoustic modelling conducted the approved project (Zykov and Matthews 2010), modelling was carried out using generic geoacoustic profiles representative of the modelled area. As such, silt content in the top sediment layer was assumed to increase with increasing water depth and increasing distance from Milne Port. The resulting geoacoustic profiles in Tables 6, 7, and 8 correspond to geographic areas south of Ragged Island, at Eclipse Sound, and at Pond Inlet, respectively.

Table 6. Geoacoustic properties for all scenarios south of Ragged Island (i.e., Milne Port, Milne Inlet, and Koluktoo Bay). Within each depth range, each parameter varies linearly within the stated range.

Depth below seafloor (m)	Material	Density (g/cm3)	P-wave speed (m/s)	P-wave attenuation (dB/λ)	S-wave speed (m/s)	S-wave attenuation (dB/λ)
0–20.0	Compact sand	2.07-2.10	1,700-2,050	0.24-1.30	300	0.024
20.0–350.0	Cobbles to granitic gneiss	2.10-2.40	2,050-3,500	1.30-0.35		
> 350.0	Pre-Cambrian basement	2.60	5,500	0.28		

Table 7. Geoacoustic properties for scenarios at Eclipse Sound. Within each depth range, each parameter varies linearly within the stated range.

Depth below seafloor (m)	Material	Density (g/cm3)	P-wave speed (m/s)	P-wave attenuation (dB/λ)	S-wave speed (m/s)	S-wave attenuation (dB/λ)
0–20.0	Silty sand to compact sand	2.04-2.10	1,670-2,050	0.19-1.30	225	0.014
20.0–350.0	Cobbles to granitic gneiss	2.10-2.40	2,050-3,500	1.30-0.35		
> 350.0	Pre-Cambrian basement	2.60	5,500	0.28		

Table 8. Geoacoustic properties for scenarios at Pond Inlet. Within each depth range, each parameter varies linearly within the stated range.

Depth below seafloor (m)	Material	Density (g/cm3)	P-wave speed (m/s)	P-wave attenuation (dB/λ)	S-wave speed (m/s)	S-wave attenuation (dB/λ)
0–20.0	Silty sand to compact sand	1.80-2.10	1,550-2,050	0.11-1.30	150	0.004
20.0–350.0	Cobbles to granitic gneiss	2.10-2.40	2,050-3,500	1.30-0.35		
> 350.0	Pre-Cambrian basement	2.60	5,500	0.28		

2.2.3. Water sound speed

The depth-dependent water sound speed profiles (SSP) for August and October, used to model underwater noise (Table 2), were obtained as follows:

- October (for activities at Milne Port, Koluktoo Bay, and Ragged Island): Conductivity, temperature and depth (CTD) data provided to JASCO by Golder Associates Ltd. were used to obtain an averaged SSP up to 100 m depth. The averaged SSP was extended to 500 m depth with data from the GDEM database.
- October (for activities at all other locations): A single SSP up to 500 m was obtained from the GDEM database.

For all cases above, SSPs were calculated from CTD data using the formula from Coppens (1981), and SSPs were extrapolated to the maximum depth found in the modelled area, using this empirical formula (Medwin and Clay 1997):

$$c = 1449.2 + 4.6T - 0.055T^2 + 0.00029T^3 + (1.34 - 0.01T)(S - 35) + 0.016z \quad (1)$$

where T is the temperature (°C), S is the salinity (parts per thousand), and z is the depth (m). The formula was applied assuming constant temperature and salinity at all depths beyond the last data point available from measurements.

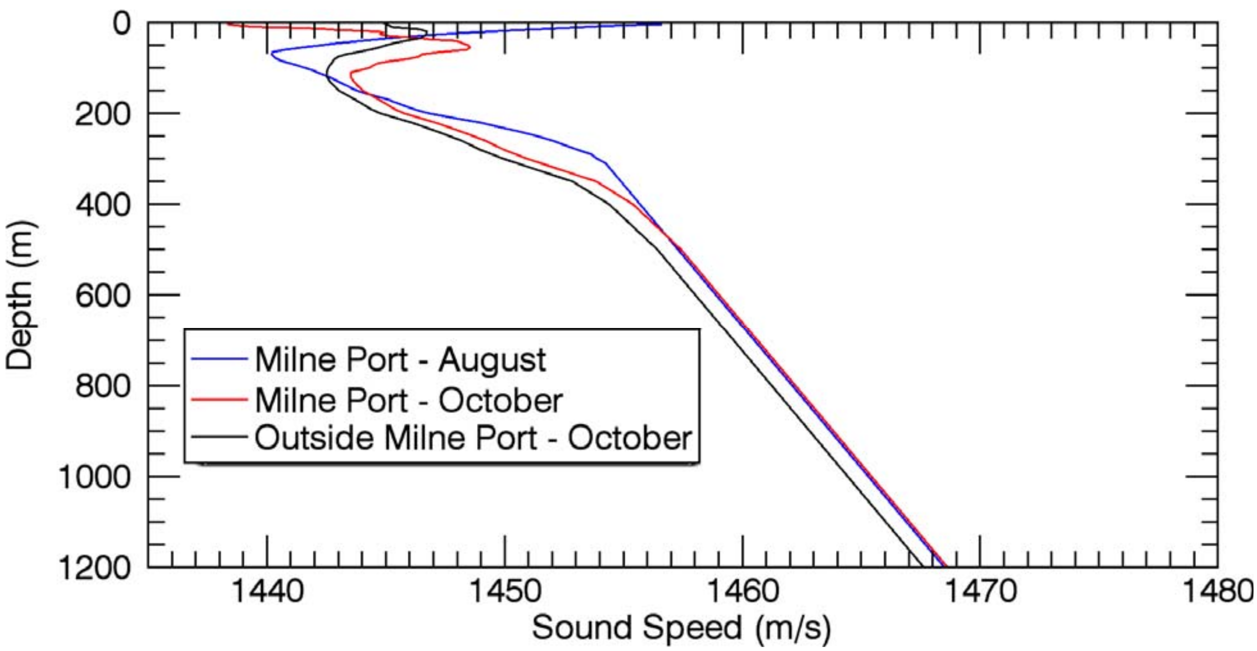

Figure 6. Sound speed profiles for study area used for underwater noise modelling.

2.3. Estimating Distances to Threshold Levels

Sound level contours were calculated based on the underwater sound fields predicted by the propagation models, sampled by taking the maximum value over all modelled depths above the sea floor for each location in the modelled region. The predicted distances to specific levels were computed from these contours. Two distances relative to the source are reported for each sound level: 1) R_{max}, the maximum range to the given sound level over all azimuths, and 2) $R_{95\%}$, the range to the given sound level after the 5% farthest points were excluded (see examples in Figure 7).

The $R_{95\%}$ is used because sound field footprints are often irregular in shape. In some cases, a sound level contour might have small protrusions or anomalous isolated fringes. This is demonstrated in the image in Figure 7(a). In cases such as this, where relatively few points are excluded in any given direction, R_{max} can misrepresent the area of the region exposed to such effects, and $R_{95\%}$ is considered more representative. In strongly asymmetric cases such as shown in Figure 7(b), on the other hand, $R_{95\%}$ neglects to account for significant protrusions in the footprint. In such cases R_{max} might better represent the region of effect in specific directions. Cases such as this are usually associated with bathymetric features affecting propagation. The difference between R_{max} and $R_{95\%}$ depends on the source directivity and the non-uniformity of the acoustic environment.

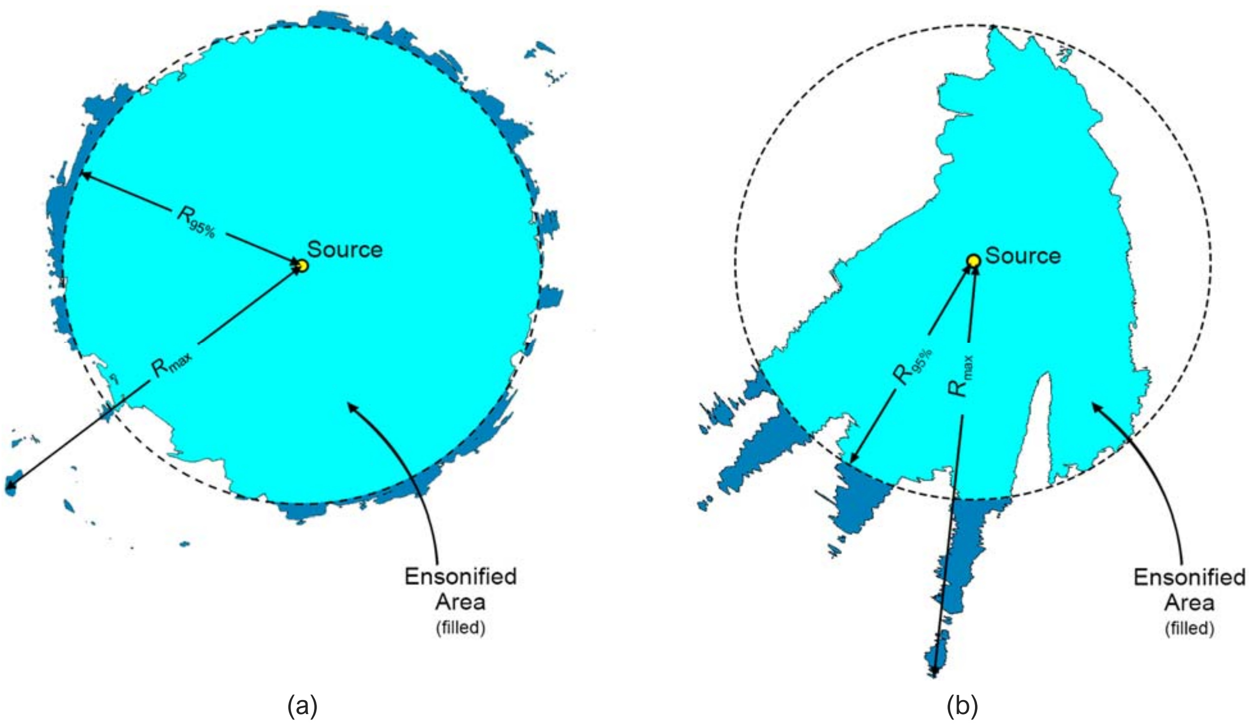

Figure 7. Sample areas ensonified to an arbitrary sound level with R_{max} and $R_{95\%}$ ranges shown for two different scenarios. (a) Largely symmetric sound level contour with small protrusions. (b) Strongly asymmetric sound level contour with long protrusions. Light blue indicates the ensonified areas bounded by $R_{95\%}$; darker blue indicates the areas outside this boundary which determine R_{max}.

2.4. Modelling Assumptions

Where uncertainties in operating conditions existed, modelling parameters were chosen to yield realistically conservative noise levels. We applied several such conservative assumptions to the methods used in this study so the results would not underestimate potential effects on marine life:

- Because marine mammals swim through an extensive depth range, all the distances to thresholds (R_{max}, $R_{95\%}$) and the noise level contour maps represent the maximum sound levels over all depths.
- Modelling was performed by considering the spectral content corresponding to vessel operations up to 25 kHz.
- The modelled locations were selected based on maximizing line-of-sight of the acoustic propagation into water channels along the shipping route.
- The bathymetry used for modelling was adjusted to represent higher high water mean tide.
- Scenarios with moored carriers were modelled assuming they were in place for 24 hours.

3. Results

Section 3.1 presents tables of distances to SPL isopleths in Table 9 and Table 10. Modelled results that correspond to SEL_{24h} for transiting vessels are presented in Section 3.2. Maps of SPL isopleths for all scenarios are in Appendix D.1.

3.1. SPL for Transiting Vessel Scenarios

3.1.1. Transiting Vessel Scenarios Without Icebreaker Escorts

Table 9. Distances to broadband SPL (10 Hz–25 kHz) of 120 re 1 µPa.

Scenario	Scenario Description	SPL = 120 dB re 1 µPa	
		R_{max} (km)	$R_{95\%}$ (km)
1	Moored PP at OD	2.3	1.7
2	Berthing PP at OD	11.2	9.8
3	Moored PP at R1	1.4	1.0
4	Transiting PP at MP1	0.3	0.3
5	Transiting PP with tug escorts at MP1	4.6	3.4
6	Transiting PP at KB	4.0	2.3
7	Transiting PP at MI	3.1	1.6
8	Transiting PP at ES	3.1	1.8
9	Transiting PP at PI	2.9	1.4
10	Moored PP at R1 and CS at R4	2.6	2.3
11	Moored CS at A2	1.6	1.1
12	Transiting CS at MP2	0.4	0.3
13	Transiting CS with tug escorts at MP2	4.5	3.5
14	Transiting CS at KO	5.0	3.5
15	Transiting CS at MI	5.0	2.9
16	Transiting CS at ES	5.2	3.2
17	Transiting CS at PI	3.2	2.2
18	Transiting tanker at KO	14.2	10.9
19	Transiting tanker at MI	19.3	13.0
20	Transiting tanker at ES	28.5	18.7
21	Transiting tanker at PI	28.0	14.2

3.1.2. Transiting Vessel Scenarios With Icebreaker Escorts

Table 10. Distances to broadband SPL (10 Hz–25 kHz) of 120 dB re 1 µPa.

Scenario	Scenario Description	SPL 120 dB re 1 µPa	
		R_{max} (km)	$R_{95\%}$ (km)
23	1 Icebreaker transiting, in compact ice, Milne Inlet	9.5	4.3
24	1 Icebreaker transiting, in very open drift ice, Milne Inlet	6.8	3.3
25	1 Icebreaker transiting, in compact ice, Eclipse Sound	7.8	4.3
26	1 Icebreaker transiting, in very open drift ice, Eclipse Sound	4.1	2.9
27	1 Icebreaker transiting, in compact ice, Pond Inlet	5.6	3.2
28	1 Icebreaker transiting, in very open drift ice, Pond Inlet	4.1	2.9
29	1 Icebreaker transiting with 1 CS, in compact ice, Milne Inlet	9.3	4.2
30	1 Icebreaker transiting with 1 CS, in very open drift ice, Milne Inlet	6.6	4.2
31	1 Icebreaker transiting with 1 CS, in compact ice, Eclipse Sound	7.8	4.3
32	1 Icebreaker transiting with 1 CS, in very open drift ice, Eclipse Sound	7.6	4.2
33	1 Icebreaker transiting with 1 CS, in compact ice, Pond Inlet	5.9	3.3
34	1 Icebreaker transiting with 1 CS, in very open drift ice, Pond Inlet	4.2	3.3
35	1 Icebreaker transiting with 2 CS, in compact ice, Milne Inlet	9.1	4.1
36	1 Icebreaker transiting with 2 CS, in very open drift ice, Milne Inlet	7.8	4.9
37	1 Icebreaker transiting with 2 CS, in compact ice, Eclipse Sound	7.9	4.3
38	1 Icebreaker transiting with 2 CS, in very open drift ice, Eclipse Sound	8.1	5.4
39	1 Icebreaker transiting with 2 CS, in compact ice, Pond Inlet	6.1	3.5
40	1 Icebreaker transiting with 2 CS, in very open drift ice, Pond Inlet	5.4	3.7
41	1 Icebreaker transiting with 1 CS and 1 tanker, in compact ice, Milne Inlet	9.1	4.2
42	1 Icebreaker transiting with 1 CS and 1 tanker, in very open drift ice, Milne Inlet	17.1	11.2
43	1 Icebreaker transiting with 1 CS and 1 tanker, in compact ice, Eclipse Sound	7.9	4.6
44	1 Icebreaker transiting with 1 CS and 1 tanker, in very open drift ice, Eclipse Sound	19.9	13.7
45	1 Icebreaker transiting with 1 CS and 1 tanker, in compact ice, Pond Inlet	6.1	3.5
46	1 Icebreaker transiting with 1 CS and 1 tanker, in very open drift ice, Pond Inlet	15.7	9.8
47	1 Icebreaker transiting with 2 tugs and 2 CS, in compact ice, Milne Inlet	8.7	4.3
48	1 Icebreaker transiting with 2 tugs and 2 CS, in very open drift ice, Milne Inlet	16.2	11.9
49	1 Icebreaker transiting with 2 tugs and 2 CS, in compact ice, Eclipse Sound	8.1	4.9
50	1 Icebreaker transiting with 2 tugs and 2 CS, in very open drift ice, Eclipse Sound	21.3	15.3
51	1 Icebreaker transiting with 2 tugs and 2 CS, in compact ice, Pond Inlet	6.6	3.9
52	1 Icebreaker transiting with 2 tugs and 2 CS, in very open drift ice, Pond Inlet	15.4	11.5

3.2. SEL_{24h} for Transiting Vessel Scenarios

We analyzed the cumulative noise footprint for transiting vessels by modelling the SEL for each vessel type at a single location, and by transposing this footprint along 3-km segments of the route to emulate vessel movement. Figure 8 shows an example of the noise footprint resulting from transposing the unweighted SEL for a Capesize carrier transiting at 9 kn in Eclipse Sound (Scenario 16) following this method. The noise footprint concentrates around the transit route resembling a thin swath, with levels that decay sharply as a function of range perpendicular to the track.

As a conservative assessment of the sound exposure that a marine mammal would receive due to exposure from a passing vessel, we calculated the cumulative SEL for a fixed receiver located 20 m off the vessel's track. It is expected that within any 24-h period, on average two ore carriers would transit along the Northern Shipping Route (Figure 1) (one inbound and one outbound). It is very unlikely that the same marine mammal would come within 20 m of a passing vessel and even less unlikely that this would happen more than once in a single day. As such, the present analysis only considered the accumulated SEL from a single transit. As an example, Figure 9 shows weighted SEL at a fixed receiver located 20 m off the track followed by a transiting Capesize ore carrier in Eclipse Sound, as a function of distance between the ore carrier and the fixed receiver. Negative distances indicate the range of the approaching vessel, and positive distances indicate the range from the vessel as it continues past the fixed receiver. Where the inbound vessel heads toward the simulated receiver (indicated by negative distances on the horizontal axis), a monotonic increase in sound exposure occurs. At the vessel's closest point of approach (CPA) to the receiver (0 m on the horizontal axis), sound exposure was shown to sharply increase. Once the vessel passed the CPA (indicated by positive distances), sound exposure quickly leveled off. This illustrates that sound exposure was greatest when the vessel passed the CPA, and that the total sound exposure was minimally affected by contributions of noise from the vessel at distances far from the CPA. That is, that the total sound exposure from a vessel passing a fixed point can be reasonably estimated by considering only a small section of the transit track as has been done here. In scenarios with more than two vessels in convoy, additional SEL steps are observed as the subsequent vessels passed the fixed receiver. An example of this is in Figure 10, which represents the worst-case (i.e., loudest) shipping scenario.

None of the injury thresholds (shown as horizontal dashed lines) were reached for the transiting Capesize carrier in Figure 9 or for the multi-vessel convoy in Figure 10, or for any of the transiting scenarios considered. In reality, a marine mammal would be unlikely to remain at a fixed location within such close proximity to the vessels and these calculations are a very precautionary estimate of the expected marine mammal sound exposure. These results indicate that there is no feasible risk of acoustic injury due to transiting vessel noise associated with the Project.

Appendix D.2 presents maps of the modelled SEL_{24h} for all scenarios that did not involve transiting vessels (Scenarios 1, 2, 3, 10, 11, and 22). Tug-assisted berthing had the potential to exceed the SEL_{24h} injury thresholds at distances up to 1.84 km for HFC, 0.06 km for MFC (e.g., narwhal and beluga), 0.07 km for LFC (e.g., bowhead whale), and 0.06 km for PPW (e.g., ringed seal, bearded seal, harp seal and walrus). Underwater noise levels generated by moored ore carriers did not exceed the SEL_{24h} injury thresholds for any of the function hearing groups at distances > 20 m (R_{max}).

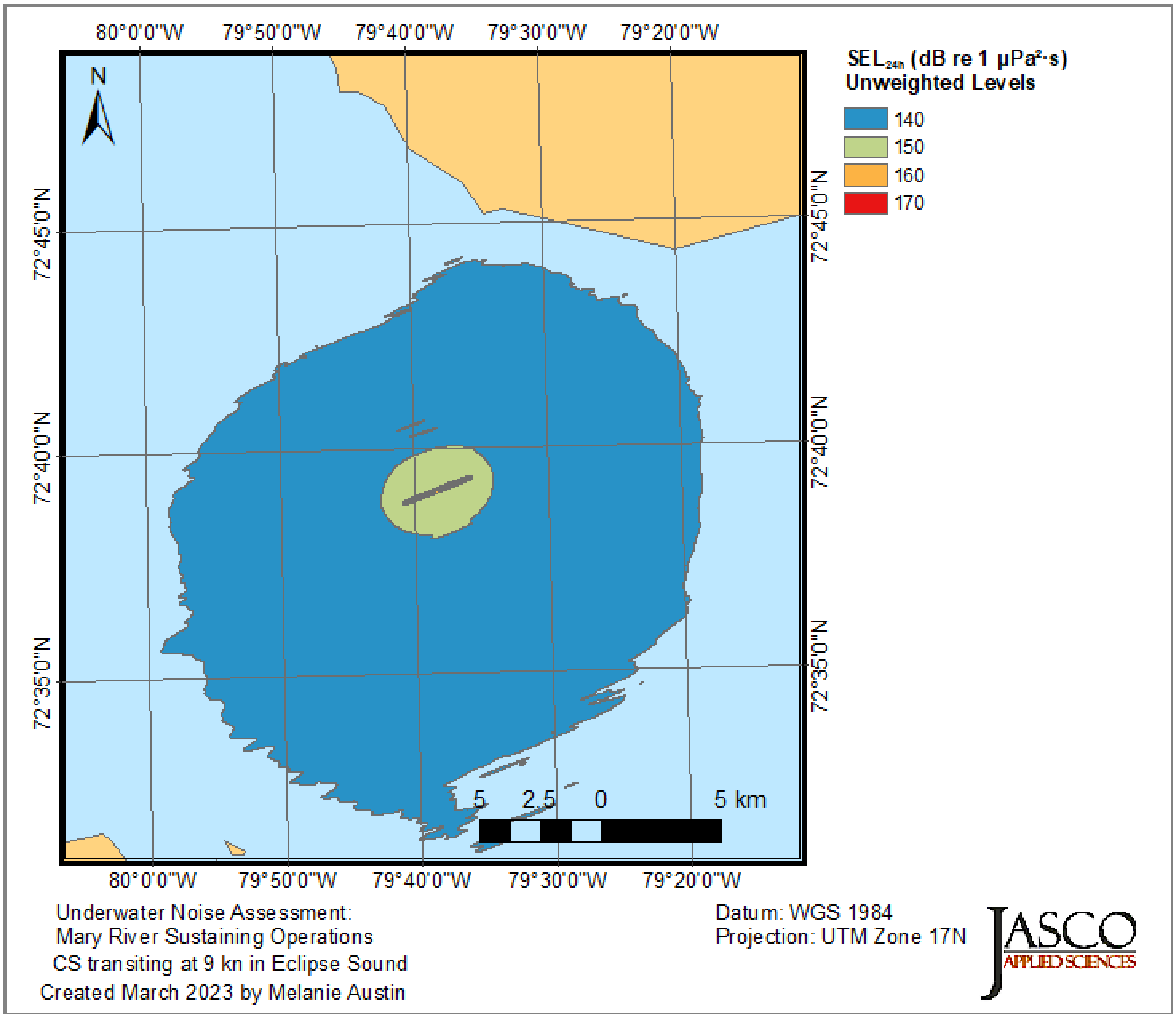

Figure 8. Scenario 16: Modelled unweighted SEL_{24h} for a CS carrier transiting at 9 kn at the Eclipse Sound (ES) location along a 3 km track. Sound exposure at a modelled receiver located 20 m off the middle of the vessel's track is shown in Figure 9.

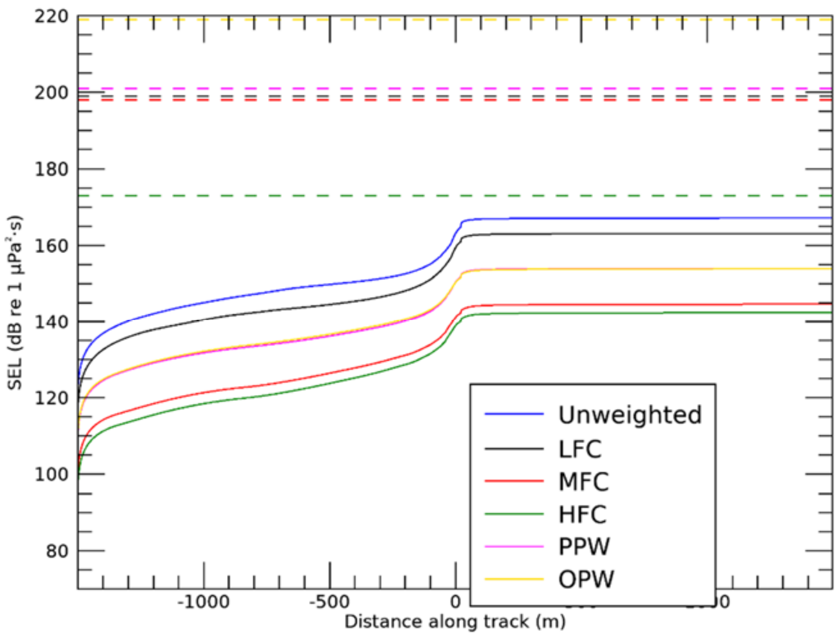

Figure 9. Weighted SEL_{24h} corresponding to a Capesize ore carrier transiting at 9 kn at Eclipse Sound (Figure 8), at a modelled receiver located 20 m off the vessel's track. Negative and positive distances along track indicate the inbound vessel position before and after passing the CPA, respectively. Weighting functions correspond to the NMFS criteria (NMFS 2018); the corresponding thresholds are indicated by horizontal colour-coded dashed lines..

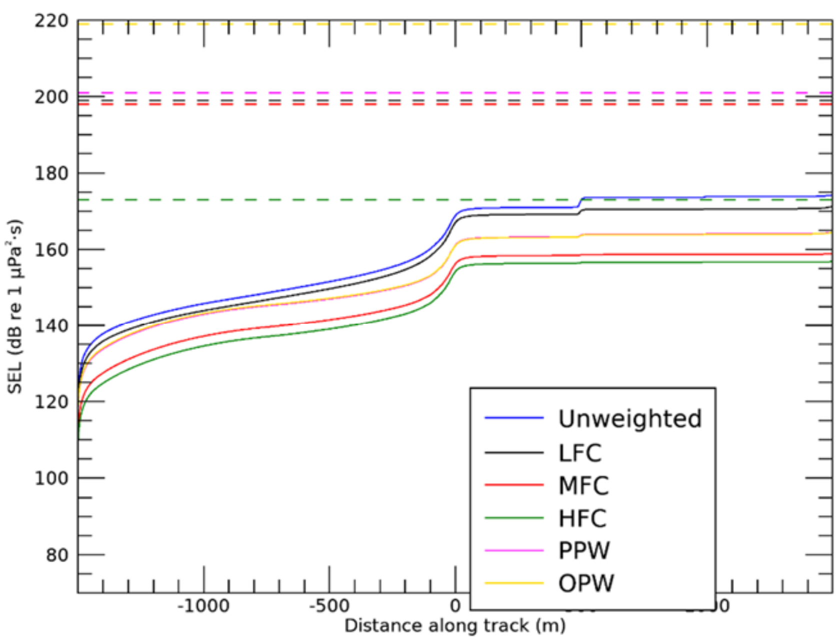

Figure 10. Weighted SEL_{24h} corresponding to an icebreaker, two tugs, and two Capesize ore carriers transiting at 5 kn through compact ice at Pond Inlet, at a modelled receiver located 20 m off the vessel's track. Negative and positive distances along track indicate the inbound vessel position before and after passing the CPA, respectively. Weighting functions correspond to the NMFS criteria (NMFS 2018); the corresponding thresholds are indicated by horizontal colour-coded dashed lines.

4. Discussion and Conclusion

The extent over which marine mammal species could be affected by Project shipping noise was assessed by considering:

- Shipping scenarios involving individual Project vessel sound sources such as transiting ore carriers (with and without tug escorts), tankers, and icebreakers.
- Aggregate shipping scenarios that combined individual sound sources. These were used to determine the total noise footprint of port operations such as tug-assisted transiting and berthing of bulk carriers, and vessel transits within a 24 h period.

Modelling results were processed to obtain maps of SPL isopleths (110–200 dB re 1 µPa, 10 dB steps) and of SEL_{24h} representing injury thresholds according to established NMFS thresholds.

From shipping operations in Milne Port, scenarios involving active berthing activities were associated with the largest ensonification areas due to the contribution of the tug noise (broadband levels of 198 dB re 1 µPa²·s, Figure 4), which was the loudest non-impulsive noise source considered in this study. During tug-assisted berthing, noise levels had the potential to exceed the 120 dB re 1 µPa SPL disturbance threshold at distances up to 11.2 km for all marine mammal hearing groups (R_{max}). Tug-assisted berthing had the potential to exceed the SEL_{24h} injury thresholds at distances up to 1.84 km for HFC, 0.06 km for MFC (e.g., narwhal and beluga), 0.07 km for LFC (e.g., bowhead whale), and 0.06 km for PPW (e.g., ringed seal, bearded seal, harp seal and walrus). Underwater noise levels generated by moored ore carriers had the potential to exceed the 120 dB re 1 µPa SPL disturbance threshold at distances up to 2.3 km (R_{max}) for all functional hearing groups, and did not exceed the SEL_{24h} injury thresholds for any of the function hearing groups at distances > 20 m (R_{max}).

For shipping operations in Milne Port, where vessel transit speeds decreased to 5 kn, the 120 dB re 1 uPa SPL disturbance threshold was predicted to be exceeded at distances up to 0.4 km (R_{max}) for Capesize carriers (Figure D-12) and 0.3 km (R_{max}) for Post-Panamax carriers (Figure D-4) based on Scenarios 12 and 4, respectively, for which carriers were modelled without tug escorts. When tugs escorted the ore carriers in Milne Port, the distance to the 120 dB re 1 µPa SPL was shown to increase to 4.6 km (R_{max}) – irrespective of the ore carrier class involved.

For shipping operations outside of Milne Port, underwater noise levels generated by transiting Project vessels did not exceed any of the SEL_{24h} injury thresholds for any of shipping scenario (Section 3.2). For vessels transiting in open-water conditions at 9 kn, the 120 dB re 1 µPa SPL disturbance threshold was predicted to be exceeded at distances up to 5.2 km (R_{max}) for Capesize carriers, 4.0 km (R_{max}) for Post-Panamax carriers, and 28.5 km (R_{max}) for fuel tankers.

During the late shoulder season, underwater noise generated by icebreakers escorting vessels along the Northern Shipping Route resulted in the following ranges to the 120 dB re 1 µPa SPL disturbance threshold:

- $5.6 < R_{max} < 9.5$ km when the icebreaker was transiting alone in compact ice ($4.1 < R_{max} < 6.8$ km in very open drift ice)
- $5.9 < R_{max} < 9.3$ when the icebreaker was transiting with one Capesize ore carrier in compact ice ($4.2 < R_{max} < 7.6$ in very open drift ice)
- $6.1 < R_{max} < 9.1$ when the icebreaker was transiting with two Capesize ore carriers in compact ice ($5.4 < R_{max} < 8.1$ in very open drift ice)

- 6.1 < R_{max} < 9.1 when the icebreaker was transiting with one tanker in compact ice (15.7 < R_{max} < 19.9 in very open drift ice)
- 6.6 < R_{max} < 8.7 when the icebreaker was transiting with two Capesize ore carriers and two tugs in compact ice (15.4 < R_{max} < 21.3 in very open drift ice)

Modelling results presented in this report are consistent with in-field measurements (Austin and Dofher 2020) of the ranges from Project vessels where sound levels fell below the 120 dB re 1 µPa SPL disturbance threshold (Table 11). The present modelling results therefore provide conservative estimations of the underwater noise fields generated by Project vessels under the SOP, relative to the median of measured sound levels of Project vessels currently operating in the RSA as part of the approved Project.

Table 11 Summary statistics of the maximum distances where sound levels were measured to be at or above 120 dB re 1 µPa in the forward and aft aspects based on measurements JASCO collected in the regional study area in 2018 and 2019 (source: Austin and Dofher, 2020).

Vessel Class	Forward Distance to 120 dB re 1 µPa (m)				Aft Distance to 120 dB re 1 µPa (m)			
	Max	Min	Average	Median	Max	Min	Average	Median
Cargo Vessel (n = 22)	9,575	674	3,881	2,345	8,486	826	4,573	5,297
Icebreaker (n = 3)	8,743	3,260	6,273	6,815	9,311	7,128	8,346	8,599
Ore Carrier (n = 166)	4,497	313	1,313	1,162	7,306	532	2,730	1,969
Research Vessel (n = 2)	989	684	837	837	596	596	596	596
Fuel Tanker (n = 11)	9,625	1,489	6,847	7,376	9,706	5,235	8,397	8,846
Tug (n = 6)	8,565	1,749	4,943	4,515	6,813	1,527	3,561	2,343

Glossary

absorption

The conversion of sound energy to heat energy. Specifically, the reduction of sound pressure amplitude due to particle motion energy converting to heat in the propagation medium.

acoustic impedance

The ratio of the sound pressure in a medium to the volume flow rate of the medium through a specified surface due to the sound wave. It is a measure of how well sound propagates through a particular medium.

acoustic noise

Sound that interferes with an acoustic process.

attenuation

The gradual loss of acoustic energy from absorption and scattering as sound propagates through a medium. Attenuation depends on frequency—higher frequency sounds are attenuated faster than lower frequency sounds.

auditory frequency weighting

The process of applying an auditory frequency-weighting function. An example for marine mammals are the auditory frequency-weighting functions published by Southall et al. (2007).

auditory frequency-weighting function

Frequency-weighting function describing a compensatory approach accounting for a species' (or functional hearing group's) frequency-specific hearing sensitivity.

azimuth

A horizontal angle relative to a reference direction, which is often magnetic north or the direction of travel. In navigation it is also known as bearing.

background noise

Combination of ambient noise, acoustic self noise, and, where applicable, sonar reverberation (ISO 18405:2017) that is detected, measured, or recorded with a signal

bandwidth

A range within a continuous band of frequencies. Unit: hertz (Hz).

broadband level

The total level measured over a specified frequency range. If the frequency range is unspecified, the term refers to the entire measured frequency range.

cetacean

Member of the order Cetacea. Cetaceans are aquatic mammals and include whales, dolphins, and porpoises.

compressional wave

A mechanical vibration wave in which the direction of particle motion is parallel to the direction of propagation. Also called a longitudinal wave. In seismology/geophysics, it's called a primary wave or P-wave. Shear waves in the seabed can be converted to compressional waves in water at the water-seabed interface.

conductivity-temperature-depth (CTD)

Measurement data of the ocean's conductivity, temperature, and depth; used to compute sound speed profiles and salinity.

continuous sound

A sound whose sound pressure level remains above the background noise during the observation period and may gradually vary in intensity with time, e.g., sound from a marine vessel.

decade

Logarithmic frequency interval whose upper bound is ten times larger than its lower bound (ISO 80000-3:2006). For example, one decade up from 1000 Hz is 10,000 Hz, and one decade down is 100 Hz.

decibel (dB)

Unit of level used to express the ratio of one value of a power quantity to another on a logarithmic scale. Especially suited to quantify variables with a large dynamic range.

decidecade

One tenth of a decade. Approximately equal to one third of an octave (1 ddec ≈ 0.3322 oct), and for this reason sometimes referred to as a 1/3-octave band.

decidecade band

Frequency band whose bandwidth is one decidecade. *Note*: The bandwidth of a decidecade band increases with increasing centre frequency.

delphinid

Member of the family of oceanic dolphins (Delphinidae), composed of approximately 35 extant species, including dolphins, porpoises, and killer whales.

Fourier transform, Fourier synthesis

A mathematical technique which, although it has varied applications, is referenced in a physical data acquisition context as a method used in the process of deriving a spectrum estimate from time-series data (or the reverse process, termed the inverse Fourier transform). A computationally efficient numerical algorithm for computing the Fourier transform is known as the fast Fourier transform (FFT).

frequency

The rate of oscillation of a periodic function measured in cycles per unit time. The reciprocal of the period. Unit: hertz (Hz). Symbol: f. 1 Hz is equal to 1 cycle per second.

frequency weighting

The process of applying a frequency-weighting function.

frequency-weighting function

The squared magnitude of the sound pressure transfer function (ISO 18405:2017). For sound of a given frequency, the frequency-weighting function is the ratio of output power to input power of a specified filter, sometimes expressed in decibels. Examples include the following:

- *Auditory frequency-weighting function*: compensatory frequency-weighting function accounting for a species' (or functional hearing group's) frequency-specific hearing sensitivity.

functional hearing group

Category of animal species when classified according to their hearing sensitivity, hearing anatomy, and susceptibility to sound. For marine mammals, initial groupings were proposed by Southall et al. (2007), and revised groupings are developed as new research/data becomes available. Revised groupings proposed by Southall et al. (2019) include low-frequency cetaceans, high-frequency cetaceans, very high-frequency cetaceans, phocid carnivores in water, other carnivores in water, and sirenians. See auditory frequency-weighting functions, which are often applied to these groups. Example hearing groups for fish include species for which the swim bladder is involved in hearing, species for which the swim bladder is not involved in hearing, and species without a swim bladder (Popper et al. 2014).

geoacoustic

Relating to the acoustic properties of the seabed.

hearing threshold

For a given species or functional hearing group, the sound level for a given signal that is barely audible (i.e., that would be barely audible for a given individual in the presence of specified background noise during a specific percentage of experimental trials).

hertz (Hz)

Unit of frequency defined as one cycle per second. Often expressed in multiples such as kilohertz (1 kHz = 1000 Hz).

high-frequency (HF) cetaceans

See functional hearing group. *Note*: The mid- and high-frequency cetaceans groups proposed by Southall et al. (2007) were renamed high- and very-high-frequency cetaceans, respectively, by Southall et al. (2019).

intermittent sound

A sound whose level abruptly drops below the background noise level multiple times during an observation period.

impulsive sound

Qualitative term meaning sounds that are typically transient, brief (less than 1 s), broadband, with rapid rise time and rapid decay. They can occur in repetition or as a single event. Sources of impulsive sound include, among others, explosives, seismic airguns, and impact pile drivers.

isopleth

A line drawn on a map through all points having the same value of some specified quantity (e.g., sound pressure level isopleth).

knot (kn)

Unit of vessel speed equal to 1 nautical mile per hour.

level

A measure of a quantity expressed as the logarithm of the ratio of the quantity to a specified reference value of that quantity. For example, a value of sound pressure level with reference to 1 μPa^2 can be written in the form *x* dB re 1 μPa^2.

low-frequency (LF) cetaceans

See functional hearing group.

masking

Obscuring of sounds of interest by other sounds at similar frequencies.

median

The 50th percentile of a statistical distribution.

mid-frequency (MF) cetaceans

See functional hearing group. *Note*: The mid-frequency cetaceans group proposed by Southall et al. (2007) was renamed high-frequency cetaceans by Southall et al. (2019).

monopole source level (MSL)

A source level that has been calculated using an acoustic model that accounts for the effect of the sea-surface and seabed on sound propagation, assuming a point source (monopole). Often used to quantify source levels of vessels or industrial operations from measurements. See also radiated noise level.

mysticete

Member of the Mysticeti, a suborder of cetaceans. Also known as baleen whales, mysticetes have baleen plates (rather than teeth) that they use to filter food from water (or from sediment as for grey whales). This group includes rorquals (Balaenopteridae, such as blue, fin, humpback, and minke whales), right and bowhead whales (Balaenidae), and grey whales (*Eschrichtius robustus*).

non-impulsive sound

Sound that is not an impulsive sound. Not necessarily a continuous sound.

octave

The interval between a sound and another sound with double or half the frequency. For example, one octave above 200 Hz is 400 Hz, and one octave below 200 Hz is 100 Hz.

odontocete

Member of Odontoceti, a suborder of cetaceans. These whales, dolphins, and porpoises have teeth (rather than baleen plates). Their skulls are mostly asymmetric, an adaptation for their echolocation. This group includes sperm whales, killer whales, belugas, narwhals, dolphins, and porpoises.

otariid

Member of the family Otariidae, one of the three groupings of pinnipeds (along with phocids and walrus). These eared seals, commonly called fur seals and sea lions, are adapted to semi-aquatic life; they use their large fore flippers for propulsion underwater and can walk on all four limbs on land.

otariid pinnipeds underwater (OW)

See functional hearing group.

other marine carnivores in water (OCW)

See functional hearing group.

parabolic equation method

A computationally efficient solution to the acoustic wave equation that is used to model propagation loss. The parabolic equation approximation omits effects of backscattered sound (which are negligible for most ocean-acoustic propagation problems), simplifying the computation of propagation loss.

peak sound pressure level (PK), zero-to-peak sound pressure level

The level (L_{pk}) of the squared maximum magnitude of the sound pressure (p^2_{pk}) in a stated frequency band and time window. Defined as $L_{\text{pk}} = 10\log_{10}(p^2_{\text{pk}}/p^2_0) = 20\log_{10}(p_{pk}/p_0)$. Unit: decibel (dB). Reference value (p^2_0) for sound in water: 1 μPa².

peak-to-peak sound pressure

The difference between the maximum and minimum sound pressure over a specified frequency band and time window. Unit: pascal (Pa).

permanent threshold shift (PTS)

An irreversible loss of hearing sensitivity caused by excessive noise exposure. Considered auditory injury. Compare with temporary threshold shift.

phocid

Member of the family Phocidae, one of the three groupings of pinnipeds (along with otariids and walrus). These true/earless seals are more adapted to in-water life than are otariids, which have more terrestrial adaptations. Phocids use their hind flippers to propel themselves underwater.

phocid pinnipeds underwater (PW), phocid carnivores in water (PCW)

See functional hearing group.

pinniped

Member of the superfamily Pinnipedia, which is composed of phocids (true seals or earless seals), otariids (eared seals or fur seals and sea lions), and walrus.

point source

A source that radiates sound as if from a single point.

power spectral density

Generic term, formally defined as power in a unit frequency band. Unit: watt per hertz (W/Hz). The term is sometimes loosely used to refer to the spectral density of other parameters such as squared sound pressure. Ratio of energy spectral density**Error! Reference source not found.**, E_f, to time duration, Δt, in a specified temporal observation window. In equation form, the power spectral density P_f is given by $P_f = E_f/\Delta t$. Power spectral density can be expressed in terms of various field variables (e.g., sound pressure).

propagation loss (PL)

Difference between a source level (SL) and the level at a specified location, $\mathrm{PL}(x) = \mathrm{SL} - L(x)$.
Unit: decibel (dB). See also transmission loss.

radiated noise level (RNL)

A source level that has been calculated assuming sound pressure decays geometrically with distance from the source, with no influence of the sea-surface or seabed. Often used to quantify source levels of vessels or industrial operations from measurements. See also monopole source level.

received level

The level of a given field variable measured (or that would be measured) at a given location.

reference value

Standard value of a quantity used for calculating underwater sound level. The reference value depends on the quantity for which the level is being calculated:

Quantity	Reference value
Sound pressure	$p_0{}^2$ = 1 μPa^2 or p_0 = 1 μPa
Sound exposure	E_0 = 1 μPa^2 s
Sound particle displacement	$\delta_0{}^2$ = 1 pm^2
Sound particle velocity	$u_0{}^2$ = 1 nm^2/s^2
Sound particle acceleration	$a_0{}^2$ = 1 μm^2/s^4

shear wave

A mechanical vibration wave in which the direction of particle motion is perpendicular to the direction of propagation. Also called a secondary wave or S-wave. Shear waves propagate only in solid media, such as sediments or rock. Shear waves in the seabed can be converted to compressional waves in water at the water-seabed interface.

sound

A time-varying disturbance in the pressure, stress, or material displacement of a medium propagated by local compression and expansion of the medium. In common meaning, a form of energy that propagates through media (e.g., water, air, ground) as pressure waves.

sound exposure

Time integral of squared sound pressure over a stated time interval in a stated frequency band. The time interval can be a specified time duration (e.g., 24 h) or from start to end of a specified event (e.g., a pile strike, an airgun pulse, a construction operation). Unit: pascal squared second (Pa^2 s). Symbol: E.

sound exposure level (SEL)

The level (L_E) of the sound exposure (E) in a stated frequency band and time window: $L_E = 10\log_{10}(E/E_0)$ (ISO 18405:2017). Unit: decibel (dB). Reference value (E_0) for sound in water: 1 µPa² s.

sound field

Region containing sound waves.

sound intensity

Product of the sound pressure and the sound particle velocity (ISO 18405:2017). The magnitude of the sound intensity is the sound energy flowing through a unit area perpendicular to the direction of propagation per unit time. Unit: watt per metre squared (W/m²). Symbol: I.

sound pressure

The contribution to total pressure caused by the action of sound (ISO 18405:2017). Unit: pascal (Pa). Symbol: p.

sound pressure level (SPL), rms sound pressure level

The level (L_p) of the time-mean-square sound pressure (p^2_{rms}) in a stated frequency band and time window: $L_p = 10\log_{10}(p^2_{\mathrm{rms}}/p^2_0) = 20\log_{10}(p_{rms}/p_0)$, where rms is the abbreviation for root-mean-square. Unit: decibel (dB). Reference value (p^2_0) for sound in water: 1 µPa². SPL can also be expressed in terms of the root-mean-square (rms) with a reference value of p_0 = 1 µPa. The two definitions are equivalent.

sound speed profile

The speed of sound in the water column as a function of depth below the water surface.

source level (SL)

A property of a sound source equal to the sound pressure level measured in the far field plus the propagation loss from the acoustic centre of the source to the receiver position. Unit: decibel (dB). Reference value: 1 µPa² m².

spectrum

Distribution of acoustic signal content over frequency, where the signal's content is represented by its power, energy, mean-square sound pressure, or sound exposure.

temporary threshold shift (TTS)

Reversible loss of hearing sensitivity caused by noise exposure. Compare with permanent threshold shift.

transmission loss (TL)

The difference between a specified level at one location and that at a different location: $\mathrm{TL}(x_1,x_2) = L(x_1) - L(x_2)$ (ISO 18405:2017). Unit: decibel (dB). See also propagation loss.

unweighted

Term indicating that no frequency-weighting function is applied.

wavelength

Distance over which a wave completes one cycle of oscillation. Unit: metre (m). Symbol: λ.

Literature Cited

[ANSI] American National Standards Institute and [ASA] Acoustical Society of America. S1.1-2013. *American National Standard: Acoustical Terminology*. NY, USA. https://webstore.ansi.org/Standards/ASA/ANSIASAS12013.

[HESS] High Energy Seismic Survey. 1999. *High Energy Seismic Survey Review Process and Interim Operational Guidelines for Marine Surveys Offshore Southern California*. Prepared for the California State Lands Commission and the United States Minerals Management Service Pacific Outer Continental Shelf Region by the High Energy Seismic Survey Team, Camarillo, California. 98 pp.

[ISO] International Organization for Standardization. 2006. *ISO 80000-3:2006. Quantities and units -- Part 3: Space and time*. https://www.iso.org/standard/31888.html.

[ISO] International Organization for Standardization. 2017. *ISO 18405:2017. Underwater Acoustics – Terminology*. Geneva. https://www.iso.org/standard/62406.html.

[NMFS] National Marine Fisheries Service. 1998. *Acoustic Criteria Workshop*. Dr. Roger Gentry and Dr. Jeanette Thomas Co-Chairs.

[NMFS] National Marine Fisheries Service. 2013. *Marine Mammals: Interim Sound Threshold Guidance* (webpage). National Marine Fisheries Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce. http://www.westcoast.fisheries.noaa.gov/protected_species/marine_mammals/threshold_guidance.html.

[NMFS] National Marine Fisheries Service. 2016. *Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing: Underwater Acoustic Thresholds for Onset of Permanent and Temporary Threshold Shifts*. U.S. Department of Commerce, NOAA. NOAA Technical Memorandum NMFS-OPR-55. 178 pp.

[NMFS] National Marine Fisheries Service. 2018. *2018 Revision to: Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (Version 2.0): Underwater Thresholds for Onset of Permanent and Temporary Threshold Shifts*. U.S. Department of Commerce, NOAA. NOAA Technical Memorandum NMFS-OPR-59. 167 pp. https://www.fisheries.noaa.gov/webdam/download/75962998.

[NOAA] National Oceanic and Atmospheric Administration. 2013. *Draft guidance for assessing the effects of anthropogenic sound on marine mammals: Acoustic threshold levels for onset of permanent and temporary threshold shifts*, December 2013, 76 pp. Silver Spring, Maryland: NMFS Office of Protected Resources. http://www.nmfs.noaa.gov/pr/acoustics/draft_acoustic_guidance_2013.pdf.

[NOAA] National Oceanic and Atmospheric Administration. 2015. *Draft guidance for assessing the effects of anthropogenic sound on marine mammal hearing: Underwater acoustic threshold levels for onset of permanent and temporary threshold shifts*, July 2015, 180 pp. Silver Spring, Maryland: NMFS Office of Protected Resources. http://www.nmfs.noaa.gov/pr/acoustics/draft%20acoustic%20guidance%20July%202015.pdf.

[ONR] Office of Naval Research. 1998. *ONR Workshop on the Effect of Anthropogenic Noise in the Marine Environment*. Dr. R. Gisiner Chair.

Aerts, L., M. Blees, S. Blackwell, C. Greene, K. Kim, D.E. Hannay, and M. Austin. 2008. *Marine mammal monitoring and mitigation during BP Liberty OBC seismic survey in Foggy Island Bay, Beaufort Sea, July-August 2008: 90-day report*. Document Number LGL Report P1011-1. Report by LGL Alaska Research Associates Inc., LGL Ltd., Greeneridge Sciences Inc. and JASCO Applied Sciences for BP Exploration Alaska. 199 pp. http://www.nmfs.noaa.gov/pr/pdfs/permits/bp_liberty_monitoring.pdf.

Austin, M. and T. Dofher. 2020. *Technical Memorandum - Vessel Source Level Estimates for the 2018 and 2019 Shipping Seasons: Baffinland Mary River Project. Document 02235, Version 2.0. Technical Memorandum by JASCO Applied Sciences for Golder Associates Ltd.*

Babushina, Y.S., G.L. Zaslavskii, and L.I. Yurkevich. 1991. Air and underwater hearing characteristics of the northern fur seal: Audiograms, frequency and differential thresholds. *Biophysics* 39: 900-913.

Becker, J.J., D.T. Sandwell, W.H.F. Smith, J. Braud, B. Binder, J. Depner, D. Fabre, J. Factor, S. Ingalls, et al. 2009. Global Bathymetry and Elevation Data at 30 Arc Seconds Resolution: SRTM30_PLUS. *Marine Geodesy* 32(4): 355-371.

Collins, M.D. 1993. A split-step Padé solution for the parabolic equation method. *Journal of the Acoustical Society of America* 93(4): 1736-1742.

Collins, M.D., R.J. Cederberg, D.B. King, and S. Chin-Bing. 1996. Comparison of algorithms for solving parabolic wave equations. *Journal of the Acoustical Society of America* 100(1): 178-182.

Coppens, A.B. 1981. Simple equations for the speed of sound in Neptunian waters. *Journal of the Acoustical Society of America* 69(3): 862-863. http://dx.doi.org/10.1121/1.385486.

Ellison, W.T. and P.J. Stein. 1999. *SURTASS LFA High Frequency Marine Mammal Monitoring (HF/M3) Sonar: Sustem Description and Test & Evaluation*. Under U.S. Navy Contract N66604-98-D-5725.

Finneran, J.J. and A.K. Jenkins. 2012. *Criteria and thresholds for U.S. Navy acoustic and explosive effects analysis*. SPAWAR Systems Center Pacific, San Diego, California.

Finneran, J.J. 2015. *Auditory weighting functions and TTS/PTS exposure functions for cetaceans and marine carnivores*. Technical report by SSC Pacific, San Diego.

Finneran, J.J. 2016. *Auditory weighting functions and TTS/PTS exposure functions for marine mammals exposed to underwater noise*. Technical Report for Space and Naval Warfare Systems Center Pacific, San Diego, U.S. . 49 pp. http://www.dtic.mil/dtic/tr/fulltext/u2/1026445.pdf.

François, R.E. and G.R. Garrison. 1982a. Sound absorption based on ocean measurements: Part I: Pure water and magnesium sulfate contributions. *Journal of the Acoustical Society of America* 72(3): 896-907.

François, R.E. and G.R. Garrison. 1982b. Sound absorption based on ocean measurements: Part II: Boric acid contribution and equation for total absorption. *Journal of the Acoustical Society of America* 72(6): 1879-1890.

Funk, D., D.E. Hannay, D. Ireland, R. Rodrigues, and W. Koski (eds.). 2008. *Marine mammal monitoring and mitigation during open water seismic exploration by Shell Offshore Inc. in the Chukchi and Beaufort Seas, July–November 2007: 90-day report*. LGL Report P969-1. Prepared by LGL Alaska Research Associates Inc., LGL Ltd., and JASCO Research Ltd. for Shell Offshore Inc., National Marine Fisheries Service (US), and US Fish and Wildlife Service. 218 pp.

Gray, L.M. and D.S. Greeley. 1980. Source level model for propeller blade rate radiation for the world's merchant fleet. *Journal of the Acoustical Society of America* 67(2): 516-522. http://dx.doi.org/10.1121/1.383916.

Hamson, R.M. 1997. The modelling of ambient noise due to shipping and wind sources in complex environments. *Applied Acoustics* 51: 251-287. https://doi.org/10.1016/S0003-682X(97)00003-0.

Hannay, D.E. and R.G. Racca. 2005. *Acoustic Model Validation*. Document Number 0000-S-90-04-T-7006-00-E, Revision 02. Technical report for Sakhalin Energy Investment Company Ltd. by JASCO Research Ltd. 34 pp.

Ireland, D.S., R. Rodrigues, D. Funk, W. Koski, and D.E. Hannay. 2009. *Marine mammal monitoring and mitigation during open water seismic exploration by Shell Offshore Inc. in the Chukchi and Beaufort Seas, July–October 2008: 90-Day Report*. Document Number LGL Report P1049-1. 277 pp.

Kastak, D. and R.J. Schusterman. 1998. Low-frequency amphibious hearing in pinnipeds: Methods, measurements, noise, and ecology. *Journal of the Acoustical Society of America* 103: 2216-2228.

Kastelein, R.A., R. van Schie, W.C. Verboom, and D. de Haan. 2005. Underwater hearing sensitivity of a male and a female Steller sea lion (*Eumetopias jubatus*). *Journal of the Acoustical Society of America* 118(3): 1820-1829. http://dx.doi.org/10.1121/1.1992650.

MacGillivray, A.O., H. Sneddon, and D.E. Hannay. 2004. *Underwater Acoustic Noise Level Measurements from Gravel Loading Facility, Sechelt, British Columbia*. JASCO Research Ltd. for Dillon Consulting. 26 pp.

Malme, C.I., P.R. Miles, C.W. Clark, P. Tyak, and J.E. Bird. 1983. *Investigations of the Potential Effects of Underwater Noise from Petroleum Industry Activities on Migrating Gray Whale Behavior*. Report Number 5366. http://www.boem.gov/BOEM-Newsroom/Library/Publications/1983/rpt5366.aspx.

Malme, C.I., P.R. Miles, C.W. Clark, P. Tyack, and J.E. Bird. 1984. *Investigations of the Potential Effects of Underwater Noise from Petroleum Industry Activities on Migrating Gray Whale Behavior. Phase II: January 1984 migration*. Report Number 5586. Report prepared by Bolt, Beranek and Newman Inc. for the U.S. Department of the Interior, Minerals Management Service, Cambridge, MA (USA). 357 pp. https://www.boem.gov/BOEM-Newsroom/Library/Publications/1983/rpt5586.aspx.

Martin, B., K. Broker, M.-N.R. Matthews, J. MacDonnell, and L. Bailey. 2015. *Comparison of measured and modeled air-gun array sound levels in Baffin Bay, West Greenland. OceanNoise 2015*, 11-15 May, Barcelona, Spain.

Medwin, H. and C.S. Clay. 1997. *Fundamentals of Acoustical Oceanography*. Academic Press.

Moore, P.W.B. and R.J. Schusterman. 1987. Audiometric assessment of northern fur seals, *Callorhinus ursinus*. *Marine Mammal Science* 3: 31-53.

Mulsow, J. and C. Reichmuth. 2007. Electrophysiological assessment of temporal resolution in pinnipeds. *Aquatic Mammals* 33: 122-131.

Mulsow, J., J.J. Finneran, and D.S. Houser. 2011a. California sea lion (*Zalophus californianus*) aerial hearing sensitivity measured using auditory steady-state response and psychophysical methods. *Journal of the Acoustical Society of America* 129: 2298-2306.

Mulsow, J., C. Reichmuth, F.M.D. Gulland, D.A.S. Rosen, and J.J. Finneran. 2011b. Aerial audiograms of several California sea lions (*Zalophus californianus*) and Steller sea lions (*Eumetopias jubatus*) measured using single and multiple simultaneous auditory steady-state response methods. *Journal of Experimental Biology* 214: 1138-1147.

Nedwell, J.R. and A.W. Turnpenny. 1998. The use of a generic frequency weighting scale in estimating environmental effect. *Workshop on Seismics and Marine Mammals*. 23–25th June 1998, London, U.K.

Nedwell, J.R., A.W.H. Turnpenny, J. Lovell, S.J. Parvin, R. Workman, and J.A.L. Spinks. 2007. *A validation of the* dB_{ht} *as a measure of the behavioural and auditory effects of underwater noise*. Report No. 534R1231 prepared by Subacoustech Ltd. for the UK Department of Business, Enterprise and Regulatory Reform under Project No. RDCZ/011/0004. www.subacoustech.com/information/downloads/reports/534R1231.pdf.

O'Neill, C., D. Leary, and A. McCrodan. 2010. Sound Source Verification. (Chapter 3) *In* Blees, M.K., K.G. Hartin, D.S. Ireland, and D. Hannay (eds.). *Marine mammal monitoring and mitigation during open water seismic exploration by Statoil USA E&P Inc. in the Chukchi Sea, August-October 2010: 90-day report*. LGL Report P1119. Prepared by LGL Alaska Research Associates Inc., LGL Ltd., and JASCO Applied Sciences Ltd. for Statoil USA E&P Inc., National Marine Fisheries Service (US), and US Fish and Wildlife Service. 1-34.

Payne, R. and D. Webb. 1971. Orientation by means of long range acoustic signaling in baleen whales. *Annals of the New York Academy of Sciences* 188: 110-142. https://doi.org/10.1111/j.1749-6632.1971.tb13093.x.

Popper, A.N., A.D. Hawkins, R.R. Fay, D.A. Mann, S. Bartol, T.J. Carlson, S. Coombs, W.T. Ellison, R.L. Gentry, et al. 2014. *Sound Exposure Guidelines for Fishes and Sea Turtles: A Technical Report prepared by ANSI-Accredited Standards Committee S3/SC1 and registered with ANSI*. ASA S3/SC1.4 TR-2014. SpringerBriefs in Oceanography. ASA Press and Springer. 76 pp. https://doi.org/10.1007/978-3-319-06659-2.

Racca, R.G., A. Rutenko, K. Bröker, and M. Austin. 2012a. A line in the water - design and enactment of a closed loop, model based sound level boundary estimation strategy for mitigation of behavioural impacts from a seismic survey. *11th European Conference on Underwater Acoustics 2012*. Volume 34(3), Edinburgh, United Kingdom.

Racca, R.G., A. Rutenko, K. Bröker, and G. Gailey. 2012b. *Model based sound level estimation and in-field adjustment for real-time mitigation of behavioural impacts from a seismic survey and post-event evaluation of sound exposure for individual whales*. *Acoustics 2012 Fremantle: Acoustics, Development and the Environment*, Fremantle, Australia. http://www.acoustics.asn.au/conference_proceedings/AAS2012/papers/p92.pdf.

Richardson, W.J., B. Würsig, and C.R. Greene, Jr. 1986. Reactions of bowhead whales, *Balaena mysticetus*, to seismic exploration in the Canadian Beaufort Sea. *Journal of the Acoustical Society of America* 79(4): 1117-1128. https://doi.org/10.1121/1.393384.

Richardson, W.J., B. Würsig, and C.R. Greene, Jr. 1990. Reactions of bowhead whales, *Balaena mysticetus*, to drilling and dredging noise in the Canadian Beaufort Sea. *Marine Environmental Research* 29(2): 135-160. https://doi.org/10.1016/0141-1136(90)90032-J.

Richardson, W.J., C.R. Greene, Jr., C.I. Malme, and D.H. Thomson. 1995. *Marine Mammals and Noise*. Academic Press, San Diego, California. 576.

Ross, D. 1976. *Mechanics of Underwater Noise*. Pergamon Press, New York. 375 pp.

Schusterman, R.J., R.F. Balliet, and J. Nixon. 1972. Underwater audiogram of the California sea lion by the conditioned vocalization technique. *Journal of the Experimental Analysis of Behavior* 17: 339-350.

Scrimger, P. and R.M. Heitmeyer. 1991. Acoustic source-level measurements for a variety of merchant ships. *Journal of the Acoustical Society of America* 89(2): 691-699. https://doi.org/10.1121/1.1894628.

Southall, B.L., A.E. Bowles, W.T. Ellison, J.J. Finneran, R.L. Gentry, C.R. Greene, Jr., D. Kastak, D.R. Ketten, J.H. Miller, et al. 2007. Marine Mammal Noise Exposure Criteria: Initial Scientific Recommendations. *Aquatic Mammals* 33(4): 411-521. https://doi.org/10.1080/09524622.2008.9753846.

Southall, B.L., J.J. Finneran, C.J. Reichmuth, P.E. Nachtigall, D.R. Ketten, A.E. Bowles, W.T. Ellison, D.P. Nowacek, and P.L. Tyack. 2019. Marine Mammal Noise Exposure Criteria: Updated Scientific Recommendations for Residual Hearing Effects. *Aquatic Mammals* 45(2): 125-232. https://doi.org/10.1578/AM.45.2.2019.125.

Spence, J., R. Fischer, M. Bahtiarian, L. Boroditsky, N. Jones, and R. Dempsey. 2007. *Review of Existing and Future Potential Treatments for Reducing Underwater Sound from Oil and Gas Industry Activities*. Report Number NCE REPORT 07-001. Report prepared by Noise Control Engineering, Inc., for Joint Industry Programme on E&P Sound and Marine Life.

Thiele, L., A. Larsen, and O.W. Nielsen. 1990. *Underwater noise exposure from shipping in Baffin Bay and Davis Strait*. Report by Odegaard & Danneskiold-Samsoe ApS for Greenland Environmental Research Institute, Copenhagen, Denmark. 99 pp.

Warner, G., C. Erbe, and D.E. Hannay. 2010. Underwater Sound Measurements. (Chapter 3) *In* Reiser, C.M., D.W. Funk, R. Rodrigues, and D. Hannay (eds.). *Marine Mammal Monitoring and Mitigation during Open Water Shallow Hazards and Site Clearance Surveys by Shell Offshore Inc. in the Alaskan Chukchi Sea, July-October 2009: 90-Day Report*. LGL Report P1112-1. Report by LGL Alaska Research Associates Inc. and JASCO Applied Sciences for Shell Offshore Inc., National Marine Fisheries Service (US), and US Fish and Wildlife Service. 1-54.

Warner, G., C. O'Neill, A. McCrodan, H. Frouin-Mouy, J. Izett, and A.O. MacGillivray. 2014. Underwater Acoustic Measurements in Haro Strait and Strait of Georgia. Appendix A. *In Hemmera, SMRU Canada, and JASCO Applied Sciences. 2014 (b) Roberts Bank Terminal 2 Technical Data Report-Underwater Noise. Ship Sound Signature Analysis Study*. Technical Report for Port Metro Vancouver. http://www.robertsbankterminal2.com/wp-content/uploads/RBT2-Ship-Sound-Signature-Analysis-Study-TDR.pdf.

Zhang, Y. and C. Tindle. 1995. Improved equivalent fluid approximations for a low shear speed ocean bottom. *Journal of the Acoustical Society of America* 98(6): 3391-3396. https://doi.org/10.1121/1.413789.

Zykov, M.M. and M.-N.R. Matthews. 2010. *Assessment of Underwater Noise for the Mary River Iron Mine: Construction and Operation of the Milne Inlet Port Facility. Version 2.1*. Mary River Project Environmental Impact Statement, Volume 8, Marine Environment. Technical report prepared for LGL Ltd. by JASCO Applied Sciences. 25 pp. http://www.nwb-oen.ca/public/registry/2%20MINING%20MILLING/2A/2AM%20-%20Mining/2AM-MRY1325%20BIMC/1%20APPLICATION/Final%20Environmental%20Impact%20Statement/Volume%2008/Appendix%208C%20-%20Underwater%20Noise%20Modelling/03-Appendix%208C-2%20%20-%20Underwater%20Noise%20Modelling%20for%20Milne%20Inlet%20and%20Eclipse%20Sound.pdf.

Appendix A. Underwater Acoustics

This section provides a detailed description of the acoustic metrics relevant to the modelling study and the modelling methodology.

A.1. Acoustic Metrics

Underwater sound pressure amplitude is quantified in decibels (dB) relative to a fixed reference pressure of p_0 = 1 μPa. Because the perceived loudness of sound, especially pulsed sound such as from seismic airguns, pile driving, and sonar, is not generally proportional to the instantaneous acoustic pressure, several sound level metrics are commonly used to evaluate sound and its effects on marine life. Here we provide specific definitions of relevant metrics used in the accompanying report. Where possible, we follow International Organization for Standardization definitions and symbols for sound metrics (e.g., ISO 18405:2017, ANSI S1.1-2013).

The sound pressure level (SPL or L_p; dB re 1 μPa) is the root-mean-square (rms) pressure level in a stated frequency band over a specified time window (T; s):

$$L_p = 10\log_{10}\frac{p_{\text{rms}}^2}{p_0^2} = 10\log_{10}\left(\frac{1}{T}\int_T p^2(t)\,dt \Big/ p_0^2\right) . \quad \text{(A-1)}$$

It is important to note that SPL always refers to an rms pressure level (i.e., a quadratic mean over a time interval) and therefore not instantaneous pressure at a fixed point in time. The SPL can also be defined as the *mean-square* pressure level, given in decibels relative to a reference value of 1 μPa^2 (i.e., in dB re 1 μPa^2). The two definitions of SPL are numerically equivalent, differing only in reference value.

The sound exposure level (SEL or L_E; dB re 1 μPa^2 s) is the time-integral of the squared acoustic pressure over a duration (T):

$$L_E = 10\log_{10}\left(\int_T p^2(t)\,dt \Big/ T_0 p_0^2\right) \text{dB} , \quad \text{(A-2)}$$

where T_0 is a reference time interval of 1 s. SEL continues to increase with time when non-zero pressure signals are present. It is a dose-type measurement, so the integration time applied must be carefully considered for its relevance to impact to the exposed recipients. SEL can be calculated over a fixed duration, such as the time of a single event or a period with multiple acoustic events.

SEL can be calculated over periods with multiple acoustic events or over a fixed duration. For a fixed duration, the square pressure is integrated over the duration of interest. For multiple events, the SEL can be computed by summing (in linear units) the SEL of the N individual events:

$$L_{E,N} = 10\log_{10}\left(\sum_{i=1}^{N} 10^{\frac{L_{E,i}}{10}}\right) . \quad \text{(A-3)}$$

Because the SPL and SEL are both computed from the integral of square pressure, these metrics are related numerically by the following expression, which depends only on the duration of the time window T:

$$L_p = L_E - 10\log_{10}(T) . \quad \text{(A-4)}$$

If applied, the frequency weighting of an acoustic event is always specified, as in the case of weighted SEL (e.g., $L_{E,\mathrm{LF},24\mathrm{h}}$; see Appendix A.3) or auditory-weighted SPL ($L_{p,\mathrm{ht}}$).

A.1.1. Decidecade Band analysis

The distribution of a sound's power with frequency is described by the sound's spectrum. The sound spectrum can be split into a series of adjacent frequency bands. Splitting a spectrum into 1 Hz wide bands, called passbands, yields the power spectral density of the sound. This splitting of the spectrum into passbands of a constant width of 1 Hz, however, does not represent how animals perceive sound.

Animals perceive exponential increases in frequency rather than linear increases, so analyzing a sound spectrum with passbands that increase exponentially in size better approximates real-world scenarios. In underwater acoustics, a spectrum is commonly split into decidecade bands, which are one tenth of a decade wide. A decidecade is sometimes referred to as a "1/3-octave" because one tenth of a decade is approximately equal to one third of an octave. Each decade represents a factor of 10 in sound frequency. Each octave represents a factor of 2 in sound frequency. The centre frequency of the ith decidecade band, $f_c(i)$, is defined as:

$$f_\mathrm{c}(i) = 10^{\frac{i}{10}}\,\mathrm{kHz}\,, \tag{A-5}$$

and the low (f_{lo}) and high (f_{hi}) frequency limits of the ith decidecade band are defined as:

$$f_{\mathrm{lo},i} = 10^{\frac{-1}{20}} f_\mathrm{c}(i) \text{ and } f_{\mathrm{hi},i} = 10^{\frac{1}{20}} f_\mathrm{c}(i)\,. \tag{A-6}$$

The decidecade bands become wider with increasing frequency, and on a logarithmic scale the bands appear equally spaced (Figure A-1).

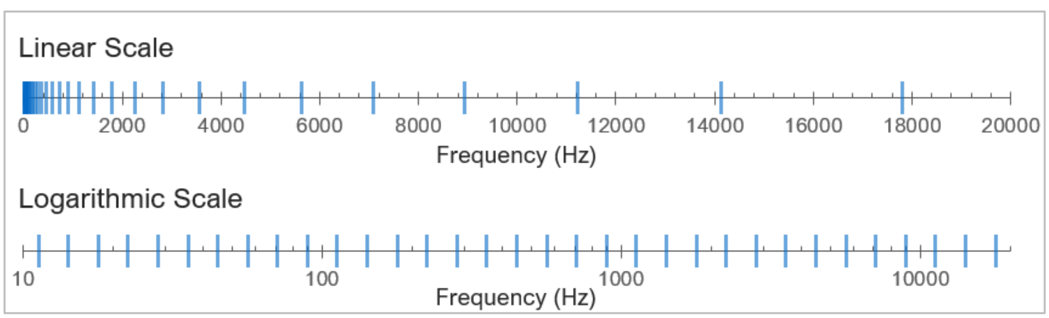

Figure A-1. Decidecade frequency bands (vertical lines) shown on (top) a linear frequency scale and (bottom) a logarithmic scale. On the logarithmic scale, the bands are equally spaced.

The sound pressure level in the ith band ($L_{p,i}$) is computed from the spectrum $S(f)$ between $f_{lo,i}$ and $f_{hi,i}$:

$$L_{p,i} = 10\log_{10} \int_{f_{\mathrm{lo},i}}^{f_{\mathrm{hi},i}} S(f)\,\mathrm{d}f\ \mathrm{dB}\,. \tag{A-7}$$

Summing the sound pressure level of all the bands yields the broadband sound pressure level:

$$\text{Broadband SPL} = 10\log_{10}\sum_i 10^{\frac{L_{p,i}}{10}}\ \text{dB}\,. \tag{A-8}$$

Figure A-2 shows an example of how the decidecade band sound pressure levels compare to the sound pressure spectral density levels of an ambient sound signal. Because the decidecade bands are wider than 1 Hz, the decidecade band SPL is higher than the spectral levels at higher frequencies. Decidecade band analysis can be applied to continuous and impulsive sound sources. For impulsive sources, the decidecade band SEL is typically reported.

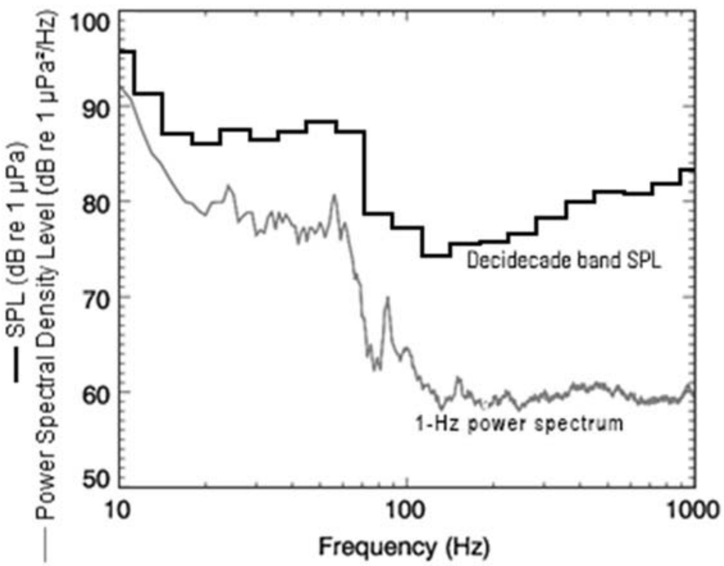

Figure A-2. Sound pressure spectral density levels and the corresponding decidecade band sound pressure levels of example ambient sound shown on a logarithmic frequency scale. Because the decidecade bands are wider with increasing frequency, the decidecade band SPL is higher than the power spectrum, which is based on bands with a constant width of 1 Hz.

A.2. Impact Criteria

A.2.1. Marine mammals

It has been long recognized that marine mammals can be adversely affected by underwater anthropogenic noise. For example, Payne and Webb (1971) suggested that communication distances of fin whales are reduced by shipping sounds. Subsequently, similar concerns arose regarding effects of other underwater noise sources and the possibility that impulsive sources—primarily airguns used in seismic surveys—could cause auditory injury. This led to a series of workshops held in the late 1990s, conducted to address acoustic mitigation requirements for seismic surveys and other underwater noise sources (NMFS 1998, ONR 1998, Nedwell and Turnpenny 1998, HESS 1999, Ellison and Stein 1999). In the years since these early workshops, a variety of thresholds have been proposed for both injury (Section A.2.1.1) and disturbance (Section A.2.1.2). The following sections summarize the development of the current thresholds relevant to this study; this remains an active research topic, however.

A.2.1.1. Injury

The U.S. National Oceanic and Atmospheric Administration's (NOAA) National Marine Fisheries Service (NMFS) considered recommendations from the workshops of the 1990s and adopted a set of interim thresholds for assessing injury due to both impulsive and non-impulsive types of noise sources. These NMFS SPL criteria for acoustic exposure injury to marine mammals were set according to recommendations for cautionary estimates of sound levels leading to onset of permanent hearing threshold shift (PTS). These criteria prescribed injury thresholds of 190 dB re 1 µPa SPL for pinnipeds and 180 dB re 1 µPa SPL for cetaceans (NMFS 2013) for most noise sources. These injury thresholds are applied to individual noise pulses and do not consider the overall duration of the noise or its acoustic frequency distribution.

Criteria that do not consider exposure duration or noise spectra are generally insufficient for assessing hearing injury. Human workplace noise assessments consider the SPL as well as the duration of exposure and sound spectral characteristics. For example, the International Institute of Noise Control Engineering (I-INCE) and the Occupational Safety and Health Administration (OSHA) suggests thresholds in C-weighted peak pressure level and A-weighted time-average sound level (dB(A)^2 L_{eq}).[3] They also suggest exchange rates that increase the allowable thresholds for each halving or doubling of exposure time. This approach assumes that hearing damage depends on the relative loudness perceived by the human ear. It also assumes that the ear might partially recover from past exposures, particularly if there are periods of quiet nested within the overall exposure.

In recognition of shortcomings of the SPL-only based injury criteria, in 2005 NMFS sponsored the Noise Criteria Group to review literature on marine mammal hearing to propose new noise exposure criteria. Some members of this expert group published a landmark paper (Southall et al. 2007) that suggested assessment methods similar to those applied for humans. The resulting recommendations introduced dual acoustic injury criteria for impulsive sounds that included peak pressure level thresholds and SEL_{24h} thresholds, where the subscripted 24h refers to the accumulation period for calculating SEL. The peak pressure level criterion is not frequency weighted whereas the SEL_{24h} is frequency weighted according to one of four marine mammal species hearing groups: Low-, Mid- and High-Frequency Cetaceans (LFC, MFC, and HFC respectively) and Pinnipeds in Water (PINN). These weighting functions are referred to as M-weighting filters (analogous to the A-weighting filter for human; Appendix A.3). The SEL_{24h} thresholds were obtained by extrapolating measurements of onset levels of Temporary Threshold Shift (TTS) in belugas by the amount of TTS required to produce Permanent Threshold Shift (PTS) in chinchillas. The Southall et al. (2007) recommendations do not specify an exchange rate, which suggests that the thresholds are the same regardless of the duration of exposure (i.e., it infers a 3 dB exchange rate).

Also in 2012, the US Navy recommended a different set of criteria for assessing Navy operations (Finneran and Jenkins 2012). Their analysis incorporated new dolphin equal-loudness contours[4] to update weighting functions and injury thresholds for LFC, MFC, and HFC. They recommended separating the pinniped group into otariids (eared seals) and phocids (earless seals) and assigning adjusted frequency thresholds to the former based on several sensitivity studies (Schusterman et al. 1972, Moore and Schusterman 1987, Babushina et al. 1991, Kastak and Schusterman 1998, Kastelein et al. 2005, Mulsow and Reichmuth 2007, Mulsow et al. 2011a, Mulsow et al. 2011b).

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[3] The "A" refers to a specific frequency-dependent filter shaped according to a human equal loudness contour.
[4] An equal-loudness contour is the measured sound pressure level (dB re 1 µPa for underwater sounds) over frequency, for which a listener perceives a constant loudness when exposed to pure tones.

The latest National Oceanic and Atmospheric Administration (NOAA) criteria for auditory injury (NMFS 2018) and its earlier iterations (NOAA 2013, 2015, NMFS 2016) have been scrutinized by the public, industrial proponents, and academics. This study applies the specific methods and thresholds for auditory injury summarized by NMFS (2018). We have also included results based on the current NMFS SPL criteria to help readers compare criteria among most other assessments performed since 1999. Table 12 lists the applied marine mammal auditory injury thresholds.

Table 12. Marine mammal auditory injury (PTS onset) thresholds based on NMFS (2018). peak sound pressure level (PK) in dB re 1 µPa; weighted SEL_{24h} in dB re 1 µPa²·s.

Hearing group	Impulsive sounds		Non-impulsive sounds
	PK [2]	Weighted SEL (24 h)	Weighted SEL (24 h)
Low-frequency cetaceans	219	183	199
Mid-frequency cetaceans	230	185	198
High-frequency cetaceans	202	155	173
Phocid pinnipeds in water	218	185	201
Otariid pinnipeds in water	232	203	219

A.2.1.2. Disturbance

Unlike auditory injury thresholds, no recent guidance has been published on disturbance thresholds for marine mammals. The NMFS currently uses SPL thresholds for behavioural response of 160 dB re 1 µPa for impulsive sounds and 120 dB re 1 µPa for non-impulsive sounds for all marine mammal species (NMFS 2016), based on observations of mysticetes (Malme et al. 1983, Malme et al. 1984, Richardson et al. 1986, Richardson et al. 1990). As of present, NMFS applies these disturbance thresholds as a default, but makes exceptions on a species-specific and sub-population specific basis where warranted.

It is helpful to assess an animal's zone of audibility for marine construction noise; animals outside this zone are unlikely to be affected by noise because they cannot hear it. Still, masking effects can occur beyond the audibility zone boundary. The maximum distance at which an animal can hear sounds from a source is limited either by its hearing threshold or by ambient noise. The ear has the ability to perform frequency filtering when interfering noises are present. It can detect quiet signals even when interfering noise levels are higher than those of the signal of interest. This filtering requires, however, the signal and noise to be sufficiently separated in frequency. The zone of audibility must therefore be determined by considering the ambient noise spectral distribution relative to the sound source's noise spectra. Although the zone of responsiveness, the region within which the animal reacts behaviourally or physiologically, is often smaller than the zone of audibility, some species can detect certain signals slightly below ambient levels, i.e., outside the defined zone of audibility (Richardson et al. 1995). In most instances, however, the zone of audibility approximates the region outside of where noise effects are normally insignificant.

A.3. Marine Mammal Frequency Weighting

The potential for noise to affect animals depends on how well the animals can hear it. Noises are less likely to disturb or injure an animal if they are at frequencies that the animal cannot hear well. An exception occurs when the sound pressure is so high that it can physically injure an animal by non-auditory means (i.e., barotrauma). For sound levels below such extremes, the importance of sound components at particular frequencies can be scaled by frequency weighting relevant to an animal's sensitivity to those frequencies (Nedwell and Turnpenny 1998, Nedwell et al. 2007).

A.3.1. NMFS (2018) Frequency Weighting Functions

A US Navy technical report by Finneran and Jenkins (2012) defined two types of auditory frequency weighting functions for marine mammals. The Navy Type I functions are identical to the M-weighting functions of Southall et al. (2007) with the following exceptions: the weighting pinnipeds function became the Type I phocids function, and a new Type I function was defined for otariid pinnipeds (based on estimated functional hearing limits, which span a smaller range than those of phocids).

To better account for the increased susceptibility of marine mammals to noise at high frequencies (>1 kHz), the US Navy developed Type II weighting functions for cetaceans, derived from equal loudness contours for bottlenose dolphins (Finneran and Jenkins 2012). These Type II functions incorporate a component based on the Type I functions at frequencies below 3 kHz and an equal-weighting component at frequencies above 3 kHz for the MF and HF cetaceans functions and less weighting at frequencies above 200 Hz for the LF cetaceans function.

In 2015, a US Navy technical report by Finneran (2015) recommended new auditory weighting functions. These auditory weighting functions for marine mammals are applied in a similar way as A-weighting for noise level assessments for humans in air. The new frequency-weighting functions are expressed as:

$$G(f) = K + 10\log_{10}\left\{\frac{(f/f_1)^{2a}}{[1+(f/f_1)^2]^a[1+(f/f_2)^2]^b}\right\}. \quad \text{(A-9)}$$

Finneran (2015) proposed five functional hearing groups for marine mammals in water: low-, mid- and high-frequency cetaceans (LF, MF, and HF cetaceans, respectively), phocid pinnipeds, and otariid pinnipeds. The parameters for these frequency-weighting functions were further modified the following year (Finneran 2016) and were adopted in NOAA's technical guidance that assesses acoustic impacts on marine mammals (NMFS 2018). The updates did not affect the content related to either the definitions of the weighting functions or the threshold values. Table A-1 lists the frequency-weighting parameters for each hearing group. Figure A-3 shows the resulting frequency-weighting curves.

Table A-1. Parameters for the auditory weighting functions recommended by NMFS (2018).

Functional hearing group	a	b	f_1 (Hz)	f_2 (Hz)	K[1] (dB)
Low-frequency cetaceans	1.0	2	200	19,000	0.13
Mid-frequency cetaceans	1.6	2	8,800	110,000	1.20
High-frequency cetaceans	1.8	2	12,000	140,000	1.36
Phocid pinnipeds in water	1.0	2	1,900	30,000	0.75
Otariid pinnipeds in water	2.0	2	940	25,000	0.64

[1] In NMFS (2018), this constant is symbolized by C.

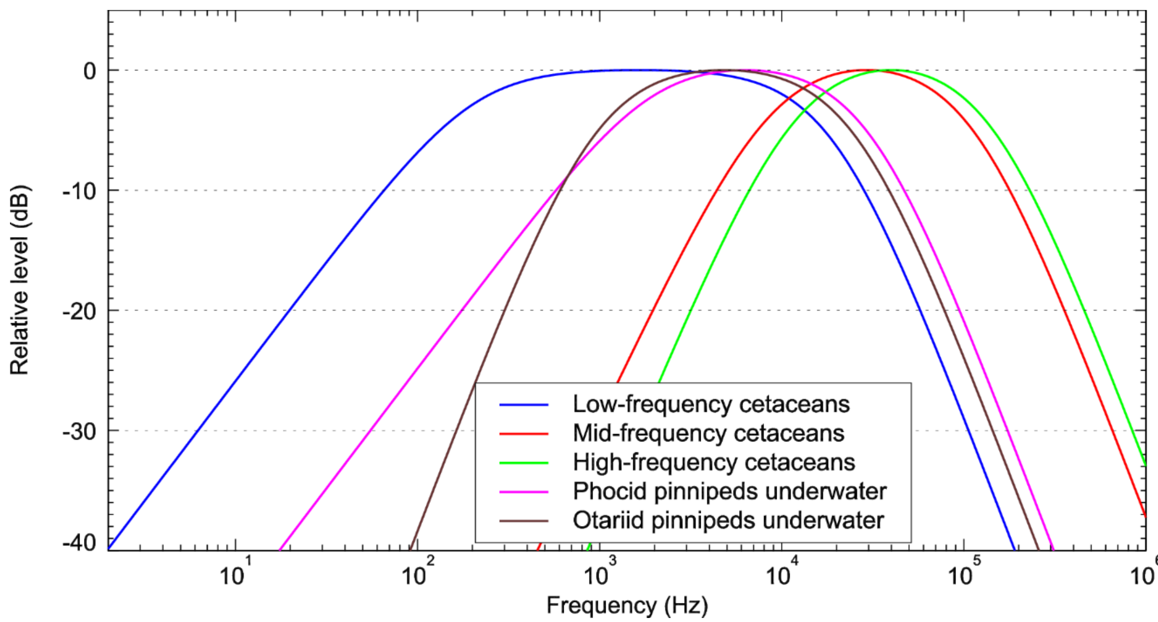

Figure A-3. Auditory weighting functions for the functional marine mammal hearing groups as recommended by NMFS (2018).

Appendix B. Sound Propagation Model

B.1. Propagation Loss

The propagation of sound through the environment was modelled by predicting the acoustic propagation loss—a measure, in decibels, of the decrease in sound level between a source and a receiver some distance away. Geometric spreading of acoustic waves is the predominant way by which propagation loss occurs. Propagation loss also happens when the sound is absorbed and scattered by the seawater, and absorbed scattered, and reflected at the water surface and within the seabed. Propagation loss depends on the acoustic properties of the ocean and seabed; its value changes with frequency.

If the acoustic source level (SL), expressed in dB re 1 µPa @ 1 m, and propagation loss (PL), in units of dB, at a given frequency are known, then the received level (RL) at a receiver location can be calculated in dB re 1 µPa @ 1 m by:

$$\mathrm{RL} = \mathrm{SL} - \mathrm{PL}. \tag{B-1}$$

B.2. Noise Propagation with MONM

Underwater sound propagation (i.e., propagation loss) at frequencies of 10 Hz to 2 kHz was predicted with JASCO's Marine Operations Noise Model (MONM). MONM computes received per-pulse SEL for directional impulsive sources, and SEL over 1 s for non-impulsive sources, at a specified source depth.

MONM computes acoustic propagation via a wide-angle parabolic equation solution to the acoustic wave equation (Collins 1993) based on a version of the U.S. Naval Research Laboratory's Range-dependent Acoustic Model (RAM), which has been modified to account for a solid seabed (Zhang and Tindle 1995). The parabolic equation method has been extensively benchmarked and is widely employed in the underwater acoustics community (Collins et al. 1996). MONM accounts for the additional reflection loss at the seabed, which results from partial conversion of incident compressional waves to shear waves at the seabed and sub-bottom interfaces, and it includes wave attenuations in all layers. MONM incorporates the following site-specific environmental properties: a bathymetric grid of the modelled area, underwater sound speed as a function of depth, and a geoacoustic profile based on the overall stratified composition of the seafloor.

MONM computes acoustic fields in three dimensions by modelling propagation loss within two-dimensional (2-D) vertical planes aligned along radials covering a 360° swath from the source, an approach commonly referred to as N×2-D. These vertical radial planes are separated by an angular step size of $\Delta\theta$, yielding $N = 360°/\Delta\theta$ number of planes (Figure B-1).

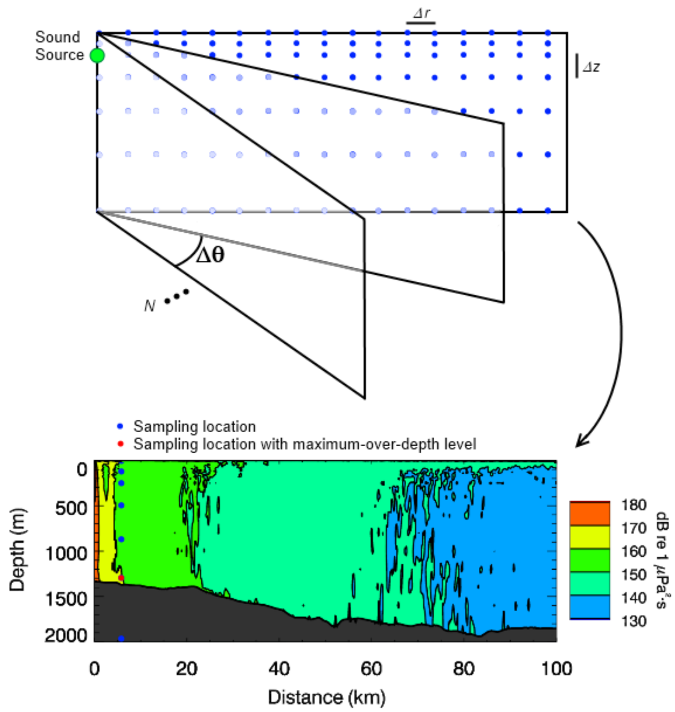

Figure B-1. The N×2-D and maximum-over-depth modelling approach used by MONM.

MONM treats frequency dependence by computing acoustic propagation loss at the centre frequencies of decidecade bands. Sufficiently many decidecade bands, starting at 10 Hz, are modelled to include the majority of acoustic energy emitted by the source. At each centre frequency, the propagation loss is modelled within each of the N vertical planes as a function of depth and range from the source. The decidecade band received SELs are computed by subtracting the band propagation loss values from the directional source level in that frequency band. Composite broadband received SELs are then computed by summing the received decidecade band levels.

The frequency-dependent propagation loss computed by MONM can be corrected to account for the acoustic energy attenuation by molecular absorption in seawater. The volumetric sound absorption is quantified by an attenuation coefficient, expressed in units of decibels per kilometre (dB/km). The absorption coefficient depends on the temperature, salinity, and pressure of the water as well as the sound frequency. In general, the absorption coefficient increases with the square of the frequency. The absorption of acoustic wave energy has a noticeable effect (> 0.05 dB/km) at frequencies above 1 kHz. For example, at 10 kHz the absorption loss over 10 km distance can exceed 10 dB. The coefficient for seawater can be computed according to the formulae of François and Garrison (1982a, b):

$$
\begin{aligned}
&a = \frac{A_1 f_1 f^2}{f_1^2 + f^2} + \frac{A_2 P_2 f_2 f^2}{f_2^2 + f^2} + A_3 P_3 f^2, \\
&\textit{where} \\
&A_1 = \frac{8.86}{c} \times 10^{(0.78\,pH - 5)}, \\
&f_1 = 2.8 \times \left(\frac{S}{35}\right)^{0.5} 10^{(4 - 1245/(T+273))}, \\
&A_2 = 21.44 \times \left(\frac{S}{c}\right)(1 + 0.025T), \\
&f_2 = 8.17 \times \frac{10^{(8-1990/(T+273))}}{[1 + 0.0018(S-35)]}, \\
&P_2 = 1 - 1.37 \times 10^{-4} z + 6.2 \times 10^{-9} z^2, \\
&A_3 = \begin{cases} 4.937 \times 10^{-4} - 2.59 \times 10^{-5} T + 9.11 \times 10^{-7} T^2 - 1.50 \times 10^{-8} T^3, & T \le 20^o C \\ 3.964 \times 10^{-4} - 1.146 \times 10^{-5} T + 1.45 \times 10^{-7} T^2 - 6.5 \times 10^{-10} T^3, & T > 20^o C \end{cases} \\
&\textit{and} \\
&P_3 = 1 - 3.83 \times 10^{-5} z + 4.9 \times 10^{-10} z^2.
\end{aligned}
\qquad \text{(B-2)}
$$

where, f is the frequency in kHz, T is the temperature in degrees centigrade, S is the salinity in parts per thousand (ppt) or practical salinity unit (PSUs), c is the water sound speed, and z is the water depth in meters. The formulae apply to all oceanic conditions and frequencies from 200 Hz to 1 MHz. For this project, absorption coefficients were computed and applied for all modelled frequencies.

Because of the computational expense associated with parabolic equation modelling at frequencies at or above several kHz and the relative importance of absorption at such frequencies, the propagation loss in each frequency band between 2.5 and 25 kHz was approximated from the propagation loss computed at 2 kHz by applying the correct frequency-dependent absorption coefficient in each band.

To account for acoustic loss in ice-covered seawater, the equation from (Thiele et al. 1990) was applied:

$$a = \frac{0.235 f^3}{0.0023 + f^3} + \frac{0.11 f^2}{1.0 + f^2} + \frac{43.7 f^2}{4100 + f^2} \qquad \text{(B-3)}$$

where a is the attenuation coefficient (dB/km) and f is the frequency in kHz.

Similar to the open-water scenarios, the propagation loss in each frequency band between 2.5 and 25 kHz was approximated from the propagation loss computed at 2 kHz and adjusted for losses due to scattering and absorption of sound propagation by applying Equation B-3.

The received per-pulse SEL sound field within each vertical radial plane is sampled at various ranges from the source, generally with a fixed radial step size. At each sampling range along the surface, the sound field is sampled at various depths, with the step size between samples increasing with depth below the surface. The step sizes are chosen to provide increased coverage near the depth of the source and at depths of interest in terms of the sound speed profile. The received per-pulse SEL at a surface sampling location is taken as the maximum value that occurs over all samples within the water column, i.e., the maximum-over-depth received per-pulse SEL. These maximum-over-depth per-pulse SELs are presented as colour contours around the source.

MONM's predictions have been validated against experimental data from several underwater acoustic measurement programs conducted by JASCO (Hannay and Racca 2005, Aerts et al. 2008, Funk et al. 2008, Ireland et al. 2009, O'Neill et al. 2010, Warner et al. 2010, Racca et al. 2012a, Racca et al. 2012b, Martin et al. 2015).

Appendix C. Vessel Noise

Underwater sound that radiates from vessels is produced mainly by propeller and thruster cavitation (Ross 1976, §8.6), with a smaller fraction of noise produced by sound transmitted through the hull, such as by engines, gearing, and other mechanical systems. Sound levels thus tend to be the highest when propulsion systems are used at high power, for example during transiting at high speeds. A vessel's sound signature depends on the vessel's size, power output, and propulsion system characteristics (e.g., blade shape and size). It produces broadband acoustic energy with most of the energy emitted below a few kilohertz. Sound from onboard machinery, particularly sound below 200 Hz, dominates the sound spectrum before cavitation begins—normally around 8 to 12 kn on many commercial vessels (Spence et al. 2007).

Source levels for a carrier of length L_T transiting at speed V_T can be estimated from measured spectral levels $S_T(f)$ of a similar carrier of length L_M and speed V_M, by using the relationship based on (Scrimger and Heitmeyer 1991) and (Hamson 1997):

$$S_T(f) = S_M(f) + 60\log(V_T / V_M) + 20\log(L_T / L_M), \tag{C-1}$$

where S_T (f) is the adjusted source level at the decidecade band of frequency *f* (Hz).

Since the dominant source of underwater noise from transiting vessels is generally propeller cavitation, the source depth used for acoustic modelling was estimated based on the draft (*D*) and propeller diameter (*d*). The source of radiated noise was assumed to be at a point partway between the shaft and the top of the propeller disk; we used the following equation (Gray and Greeley 1980) to estimate the source depth, Z_s:

$$Z_s = D - 0.85\,d \tag{C-2}$$

Appendix D. Modelled Sound Fields

D.1. SPL Isopleth Maps

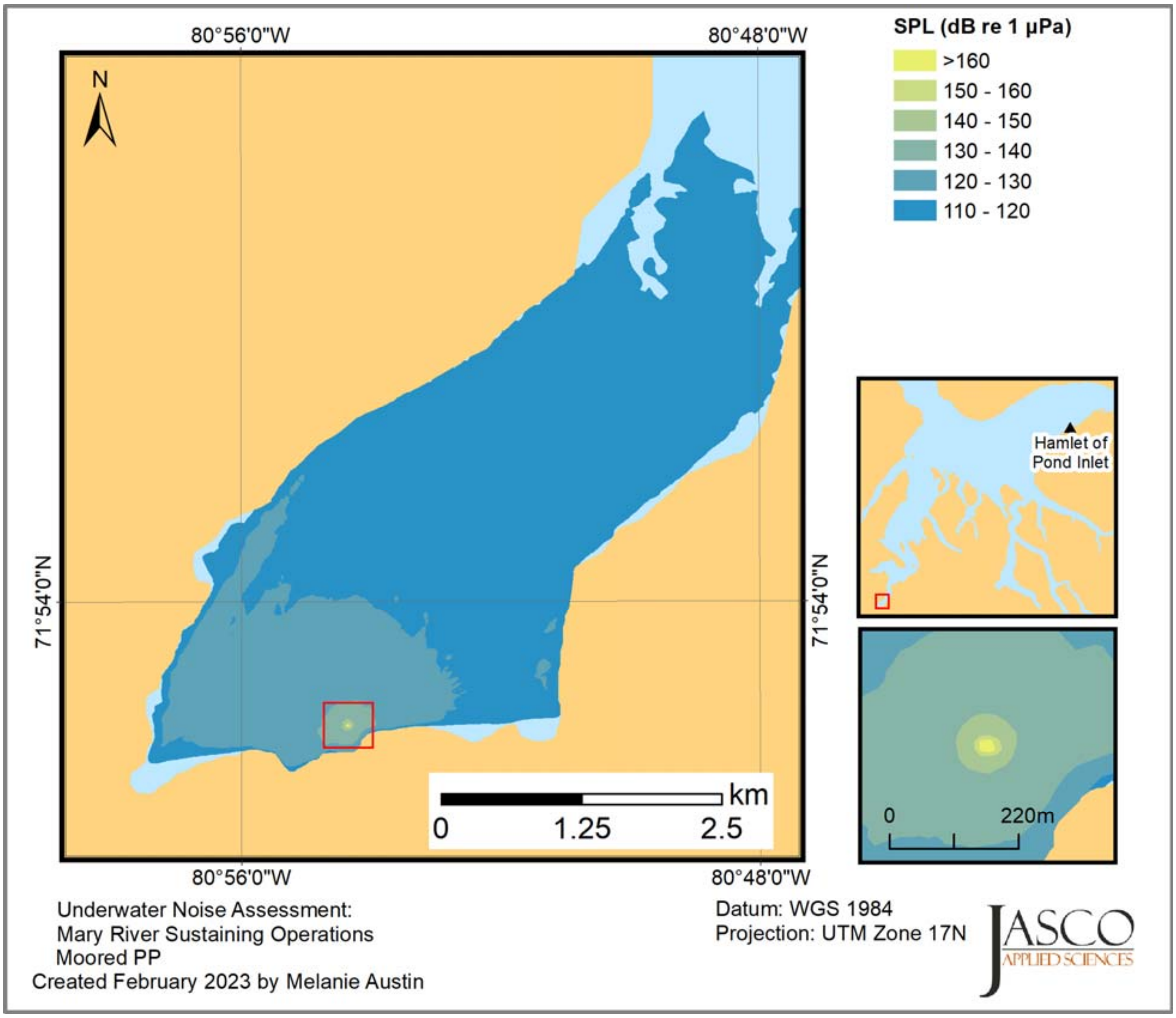

Figure D-1. Scenario 1: Map of SPL isopleths in 10 dB steps corresponding to a Post-Panamax (PP) ore carrier moored at the ore dock at Milne Port.

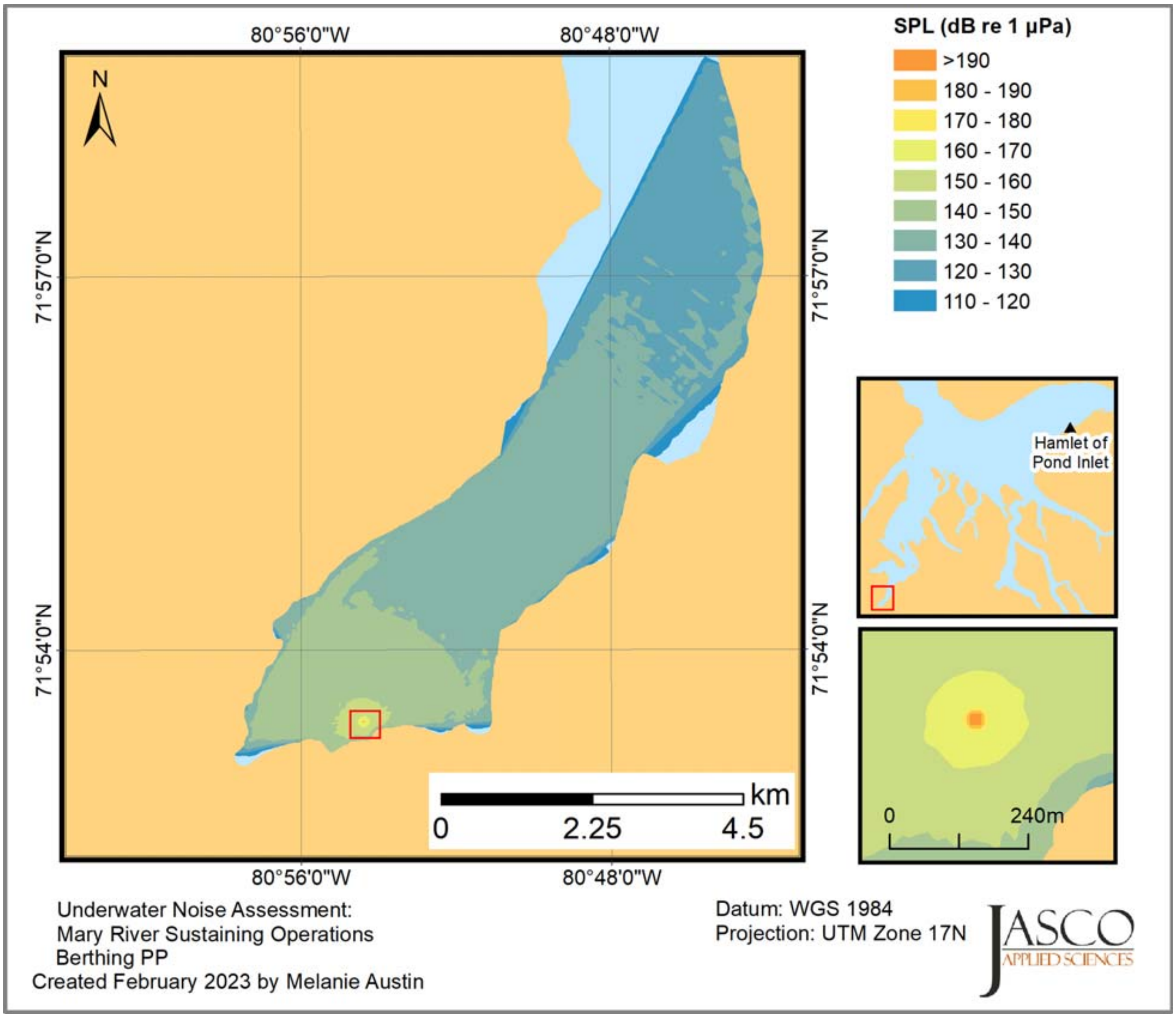

Figure D-2. Scenario 2: Map of SPL isopleths in 10 dB steps corresponding to the tug-assisted berthing of a Post-Panamax (PP) ore carrier at the ore dock at Milne Port.

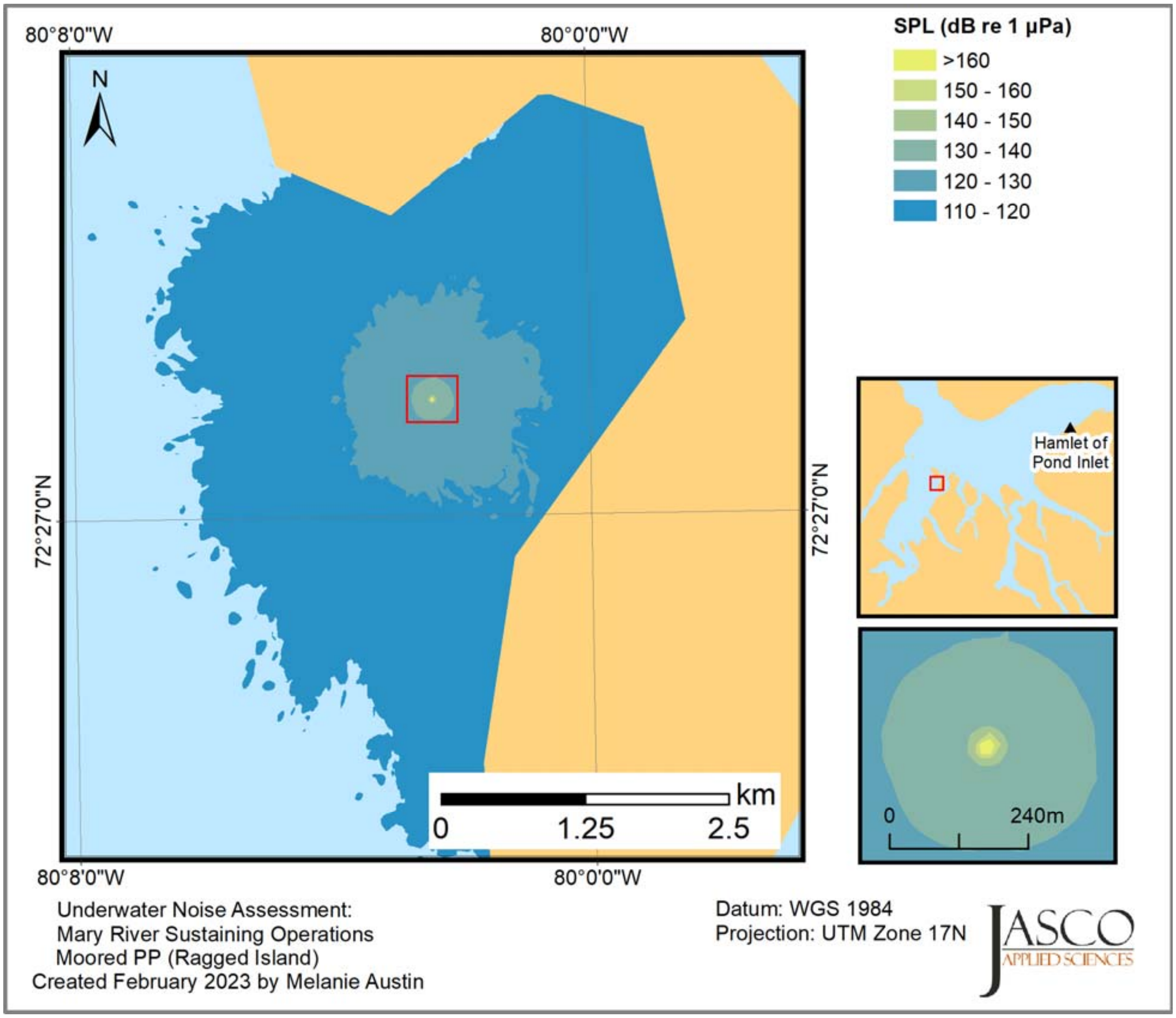

Figure D-3. Scenario 3: Map of SPL isopleths in 10 dB steps corresponding to a Post-Panamax (PP) ore carrier moored at Ragged Island.

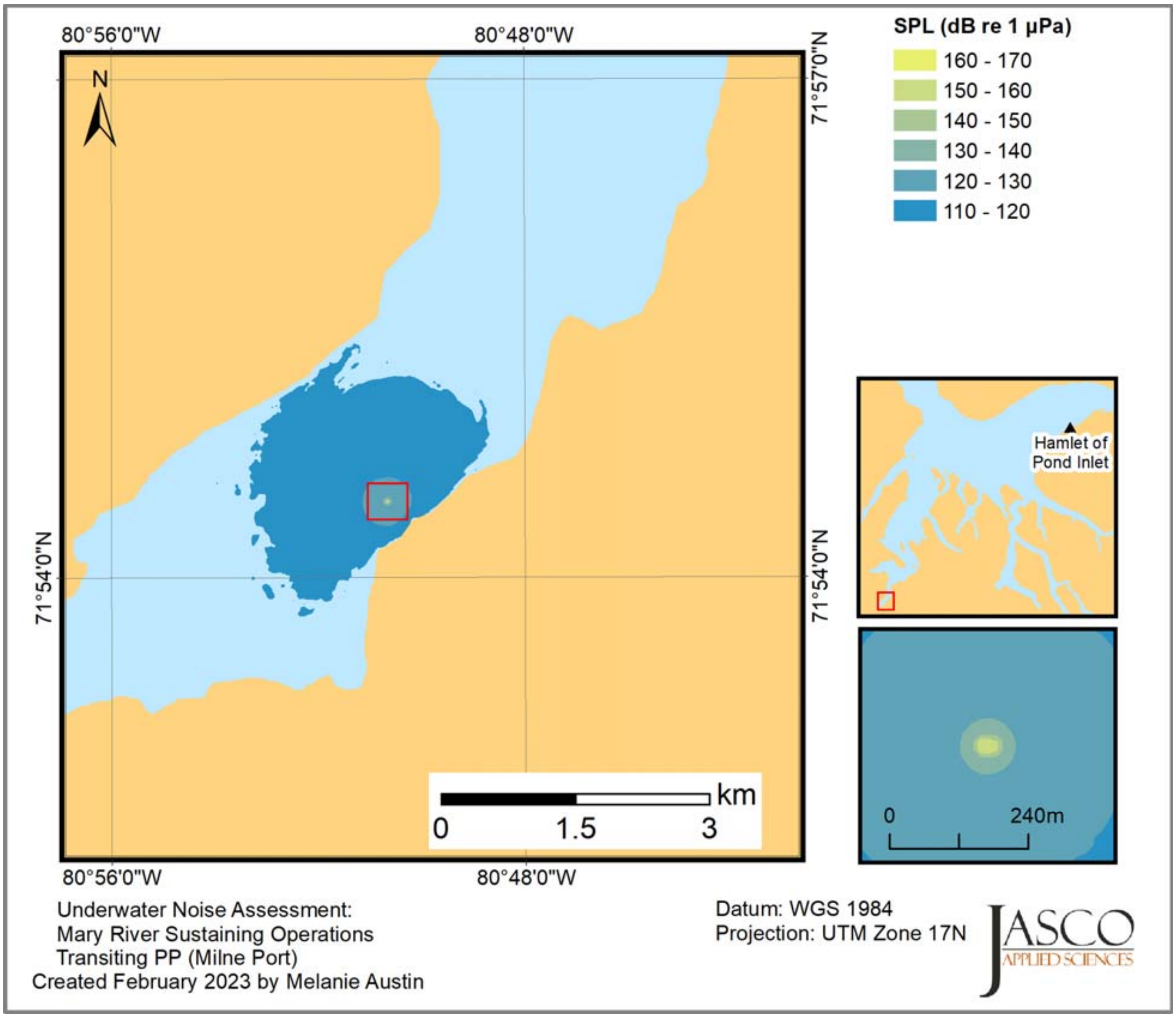

Figure D-4. Scenario 4: Map of SPL isopleths in 10 dB steps corresponding to a Post-Panamax (PP) ore carrier transiting at 5 kn within Milne Port without tug escorts.

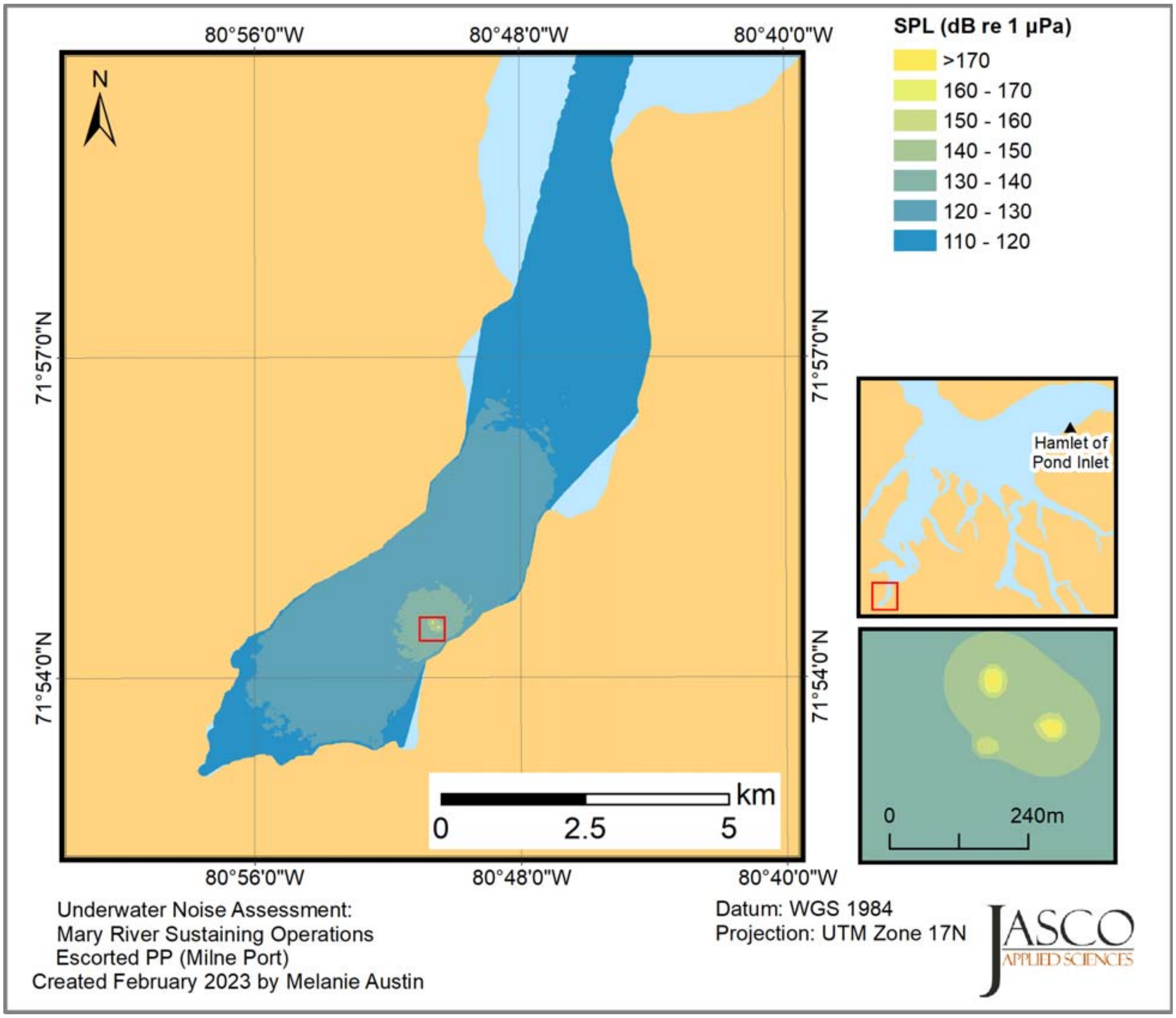

Figure D-5. Scenario 5: Map of SPL isopleths in 10 dB steps corresponding to a Post-Panamax (PP) ore carrier transiting at 5 kn within Milne Port while escorted by two tugs.

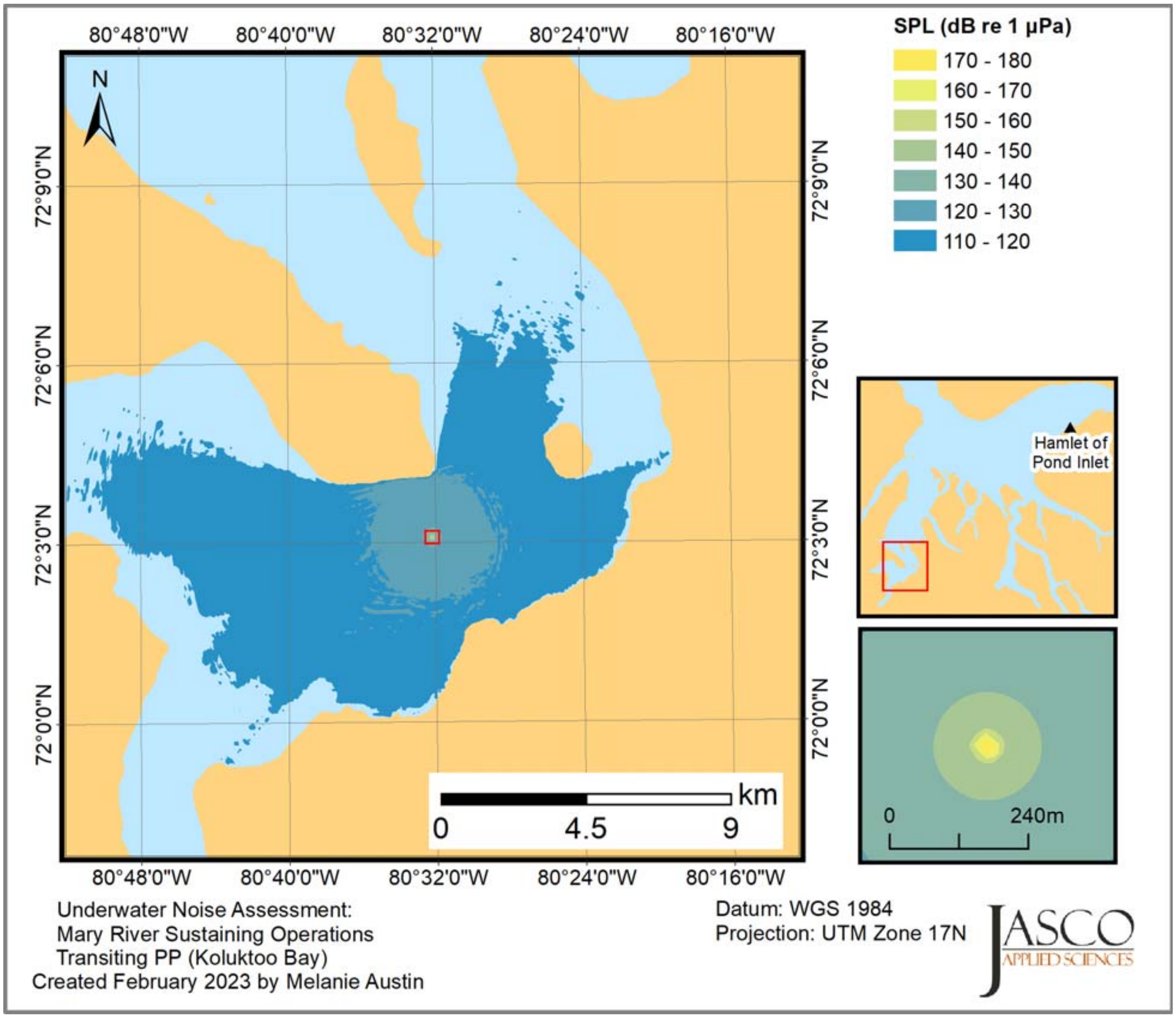

Figure D-6. Scenario 6: Map of SPL isopleths in 10 dB steps corresponding to a Post-Panamax (PP) ore carrier transiting at 9 kn at Koluktoo Bay.

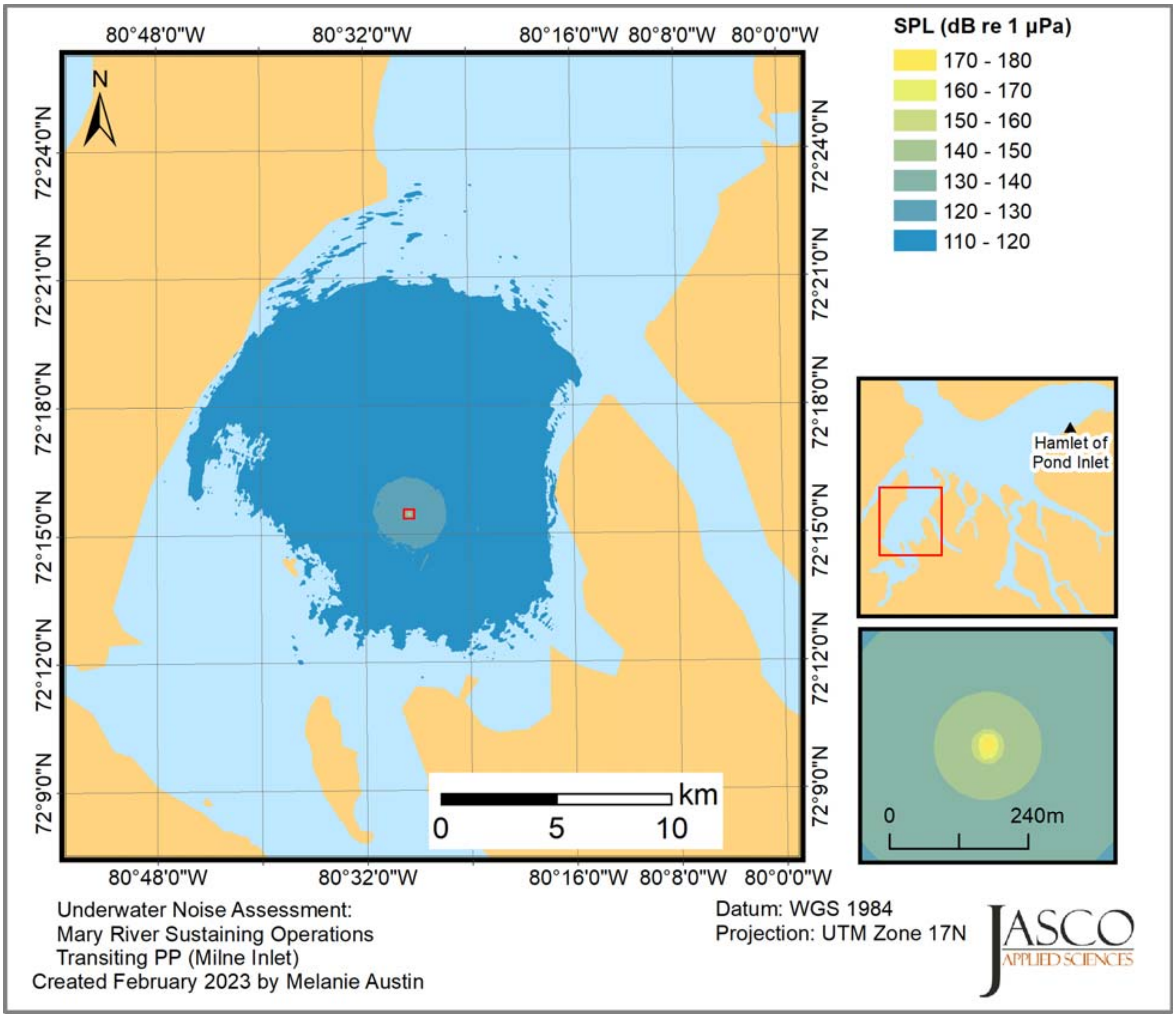

Figure D-7. Scenario 7: Map of SPL isopleths in 10 dB steps corresponding to a Post-Panamax (PP) ore carrier transiting at 9 kn at Milne Inlet.

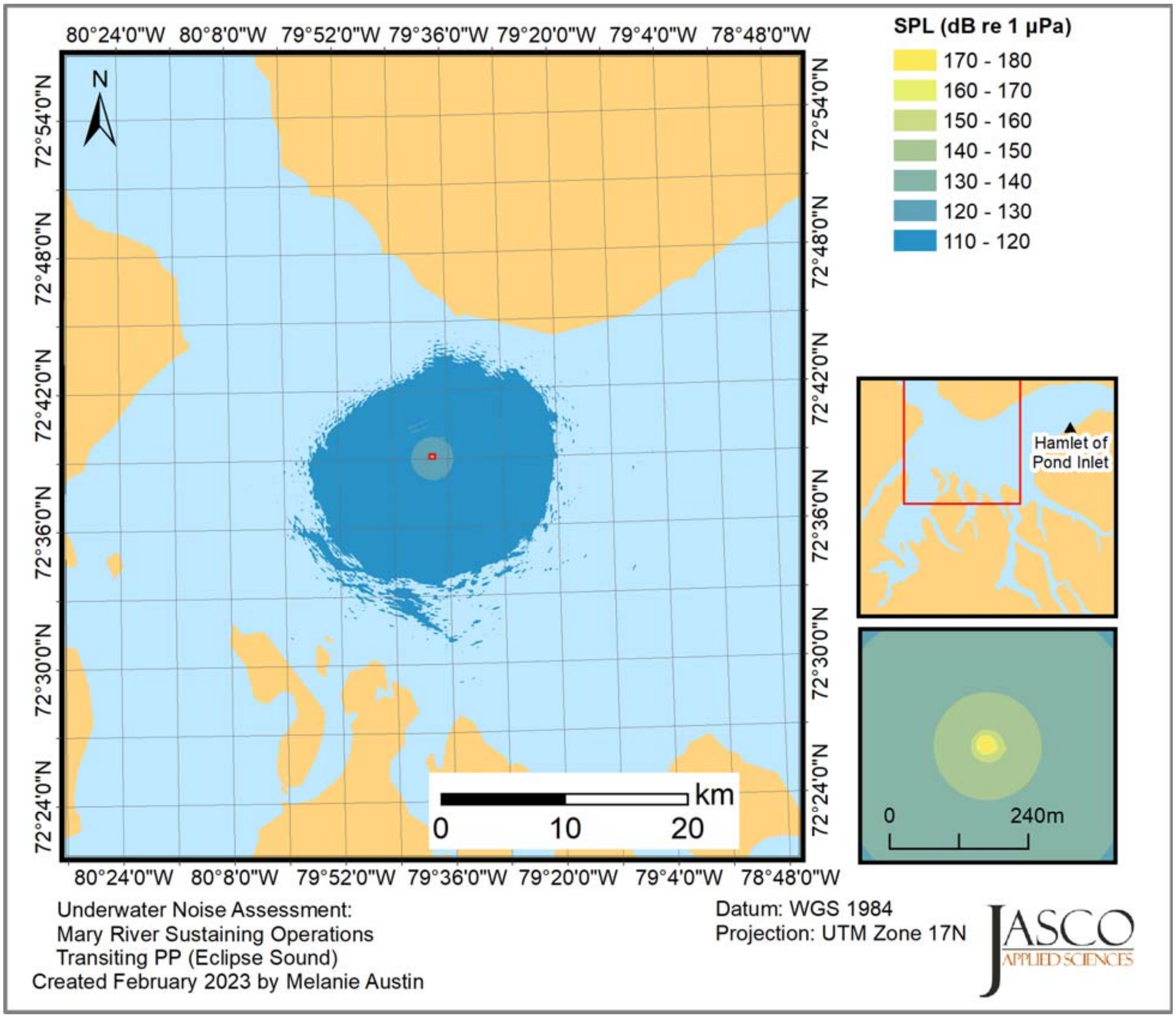

Figure D-8. Scenario 8: Map of SPL isopleths in 10 dB steps corresponding to a Post-Panamax (PP) ore carrier transiting at 9 kn at Eclipse Sound.

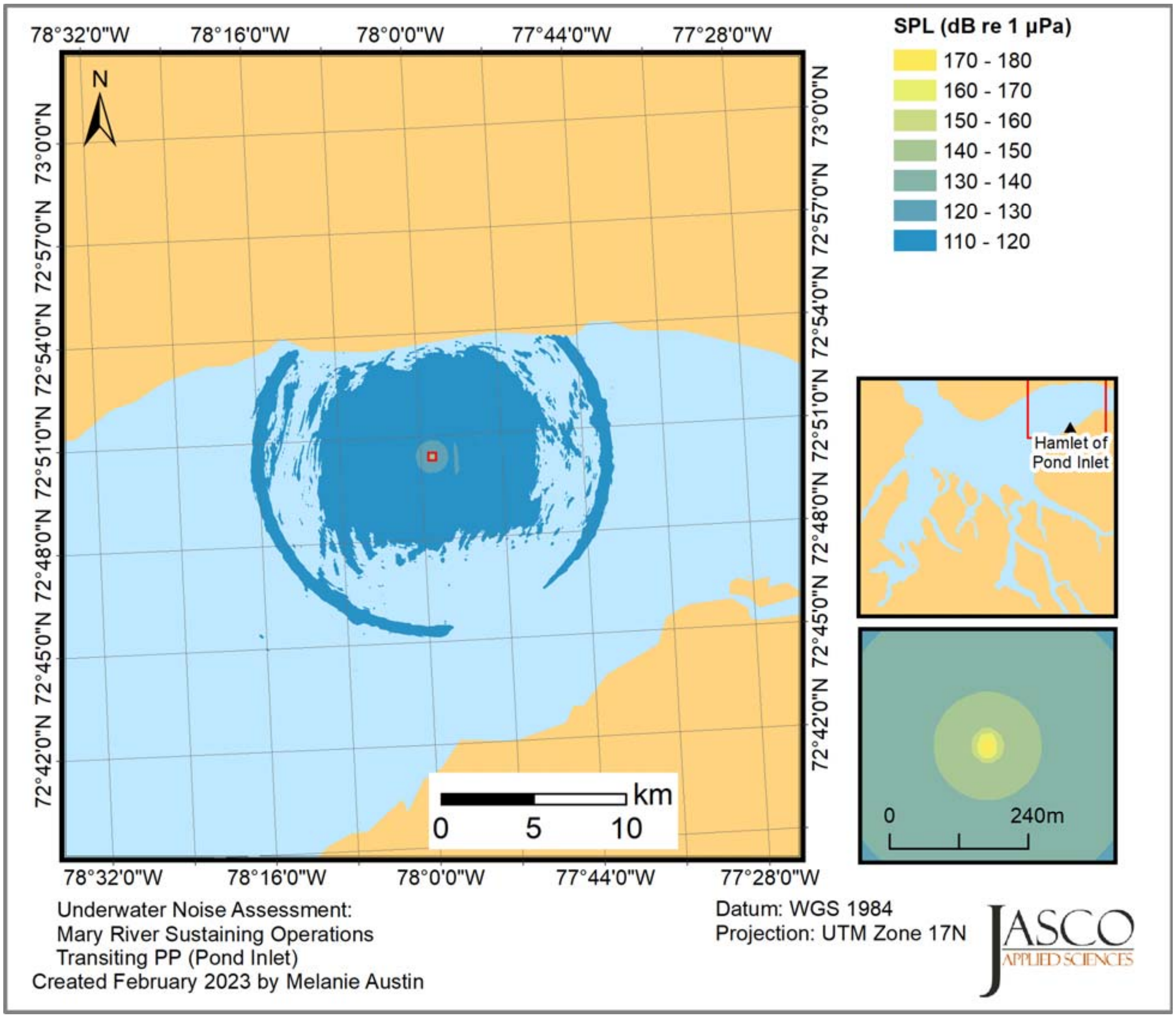

Figure D-9. Scenario 9: Map of SPL isopleths in 10 dB steps corresponding to a Post-Panamax (PP) ore carrier transiting at 9 kn at Pond Inlet.

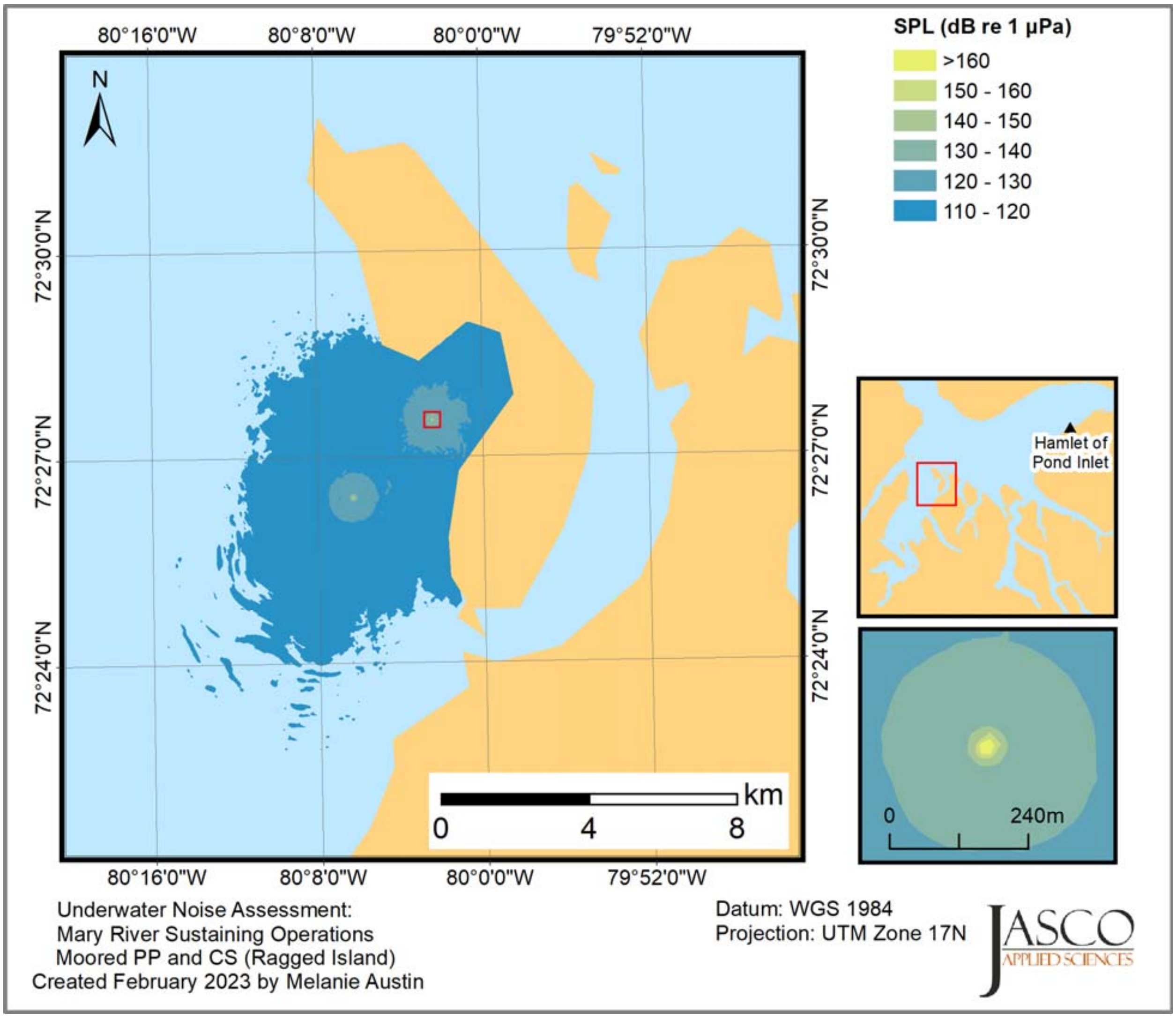

Figure D-10. Scenario 10: Map of SPL isopleths in 10 dB steps corresponding to a Post-Panamax (PP) and a Capesize (CS) ore carrier moored at Ragged Island.

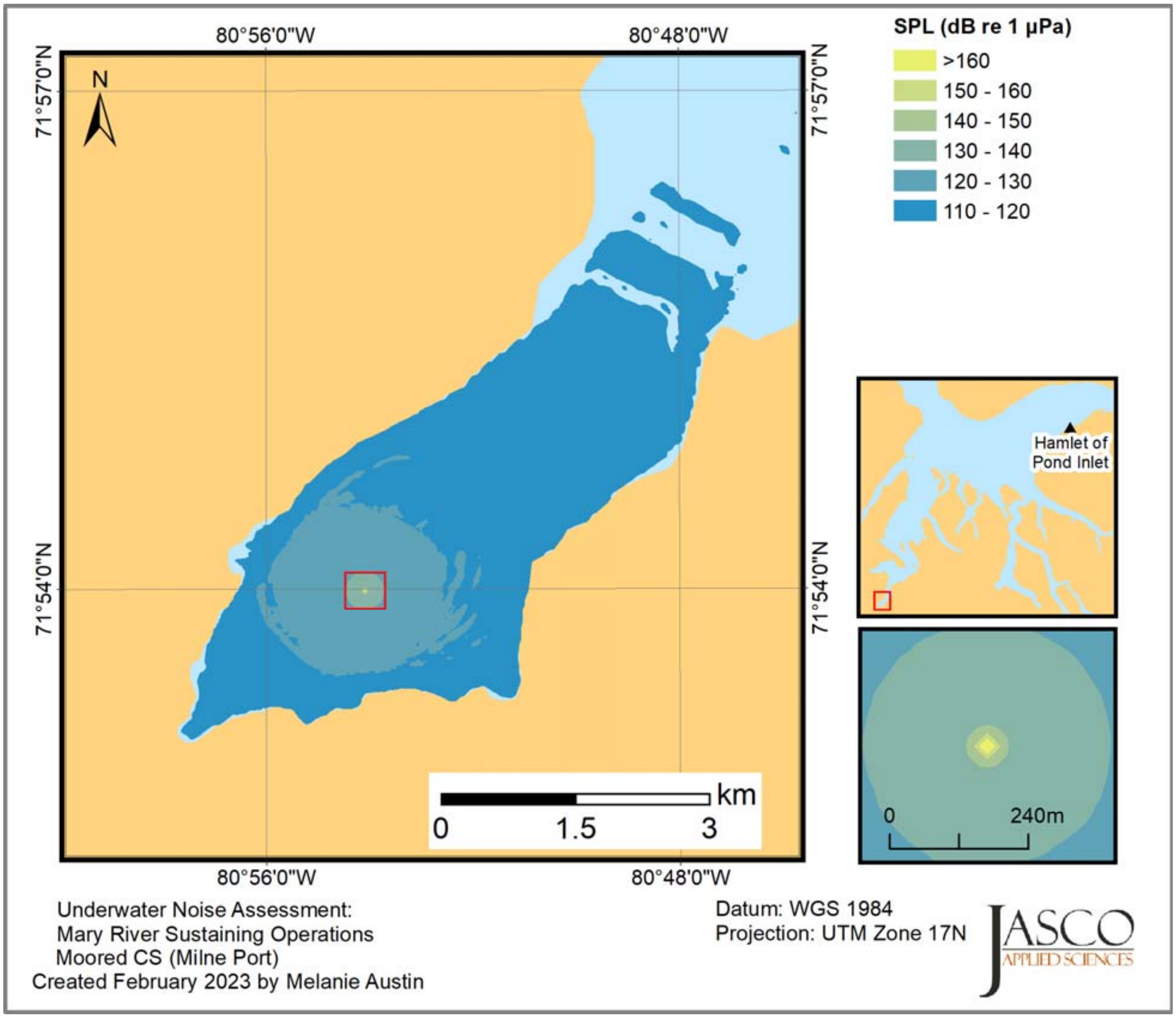

Figure D-11. Scenario 11: Map of SPL isopleths in 10 dB steps corresponding to a Capesize (CS) ore carrier moored at the anchor point A2 at Milne Port.

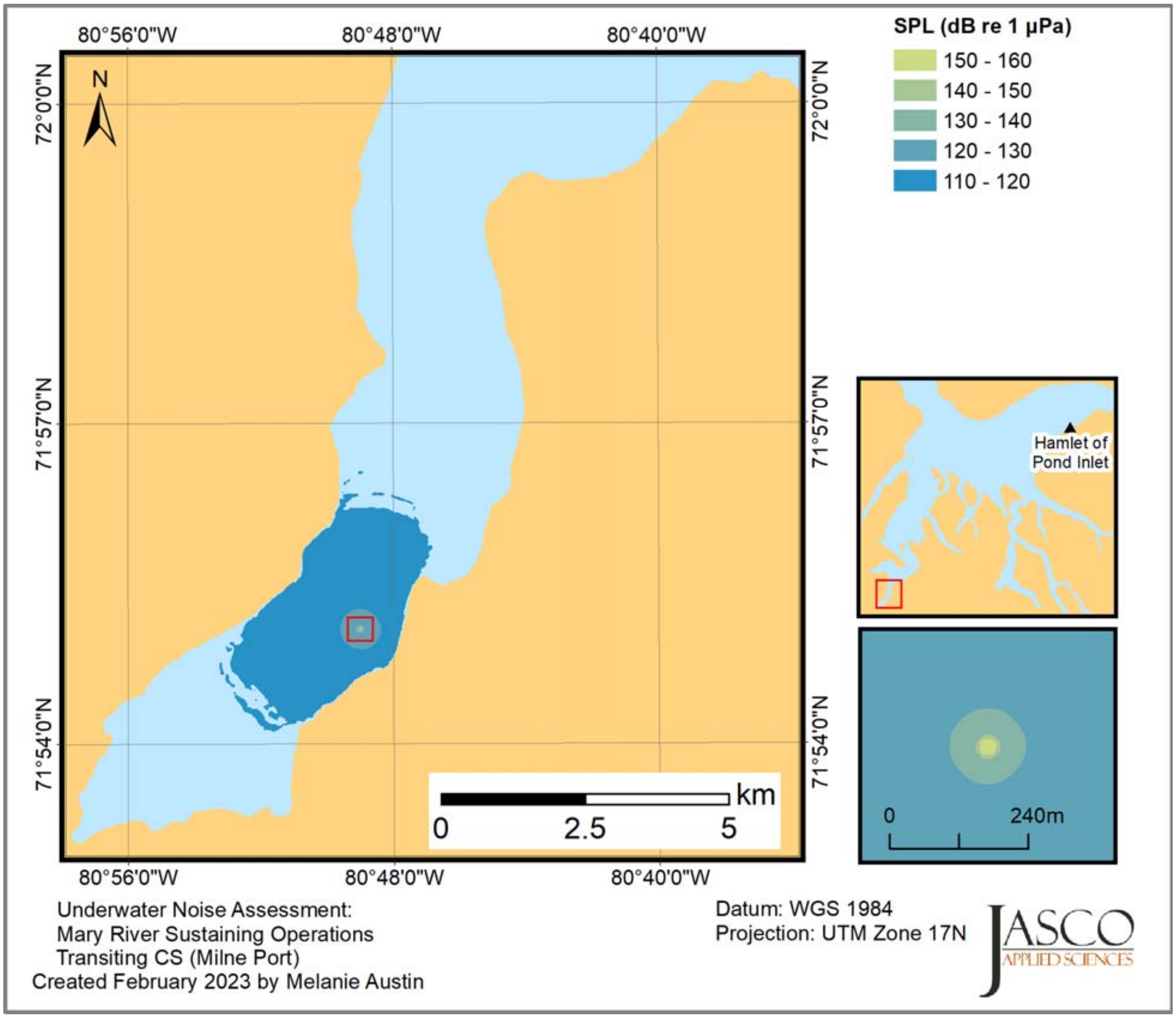

Figure D-12. Scenario 12: Map of SPL isopleths in 10 dB steps corresponding to a Capesize (CS) ore carrier transiting at 5 kn within Milne Port without tug escorts.

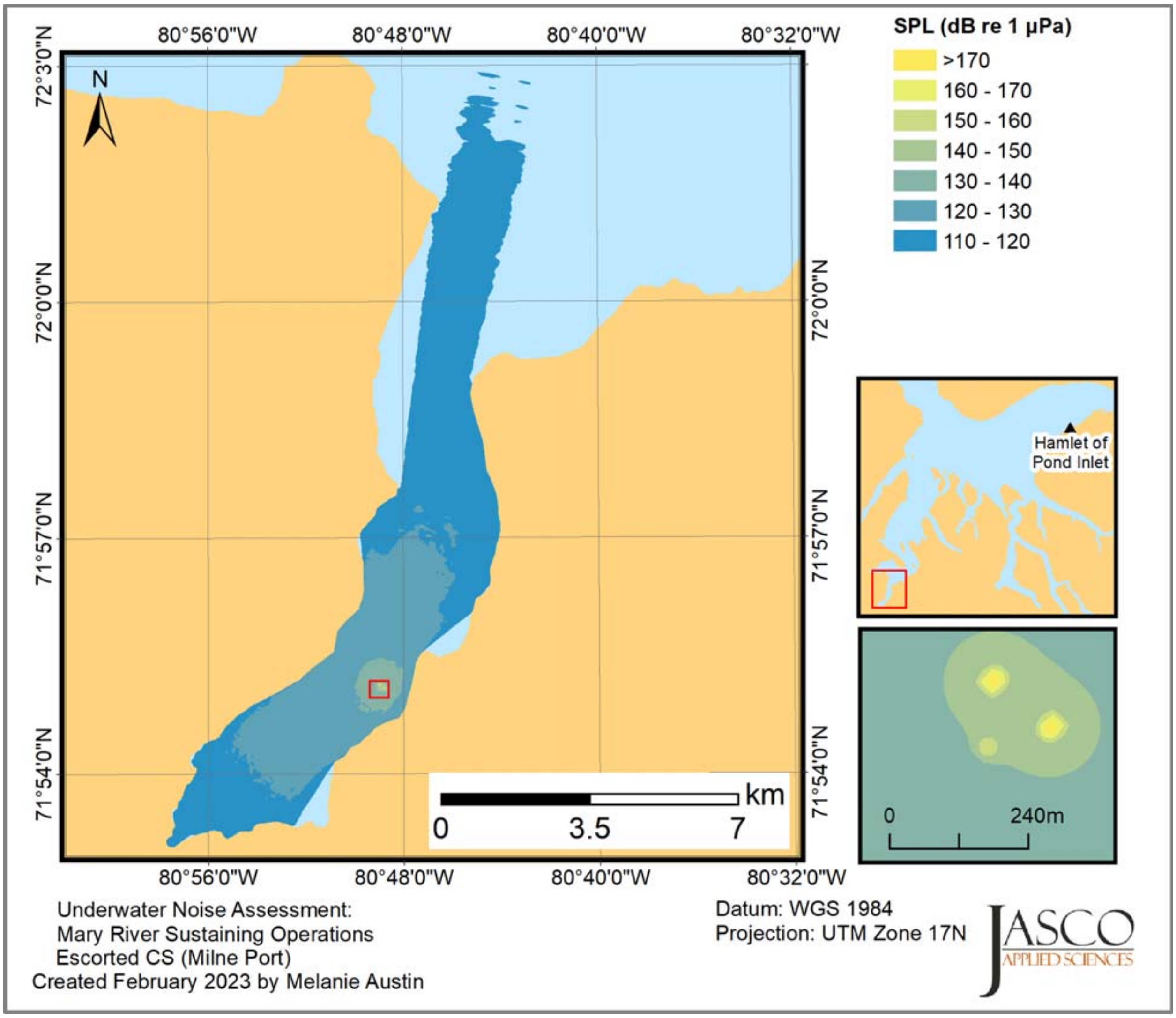

Figure D-13. Scenario 13: Map of SPL isopleths in 10 dB steps corresponding to a Capesize (CS) ore carrier transiting at 5 kn within Milne Port while escorted by two tugs.

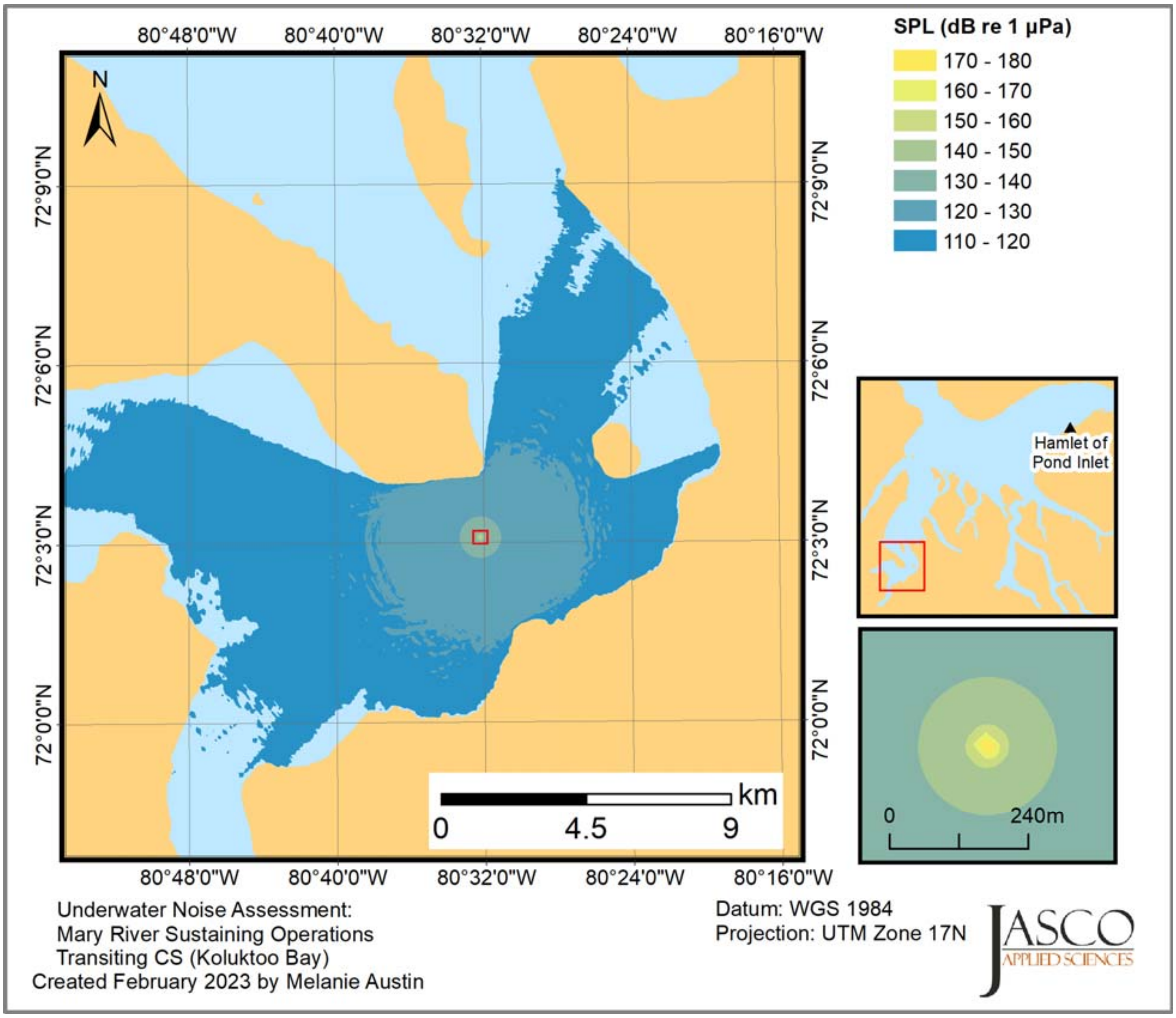

Figure D-14. Scenario 14: Map of SPL isopleths in 10 dB steps corresponding to a Capesize (CS) ore carrier transiting at 9 kn at Koluktoo Bay.

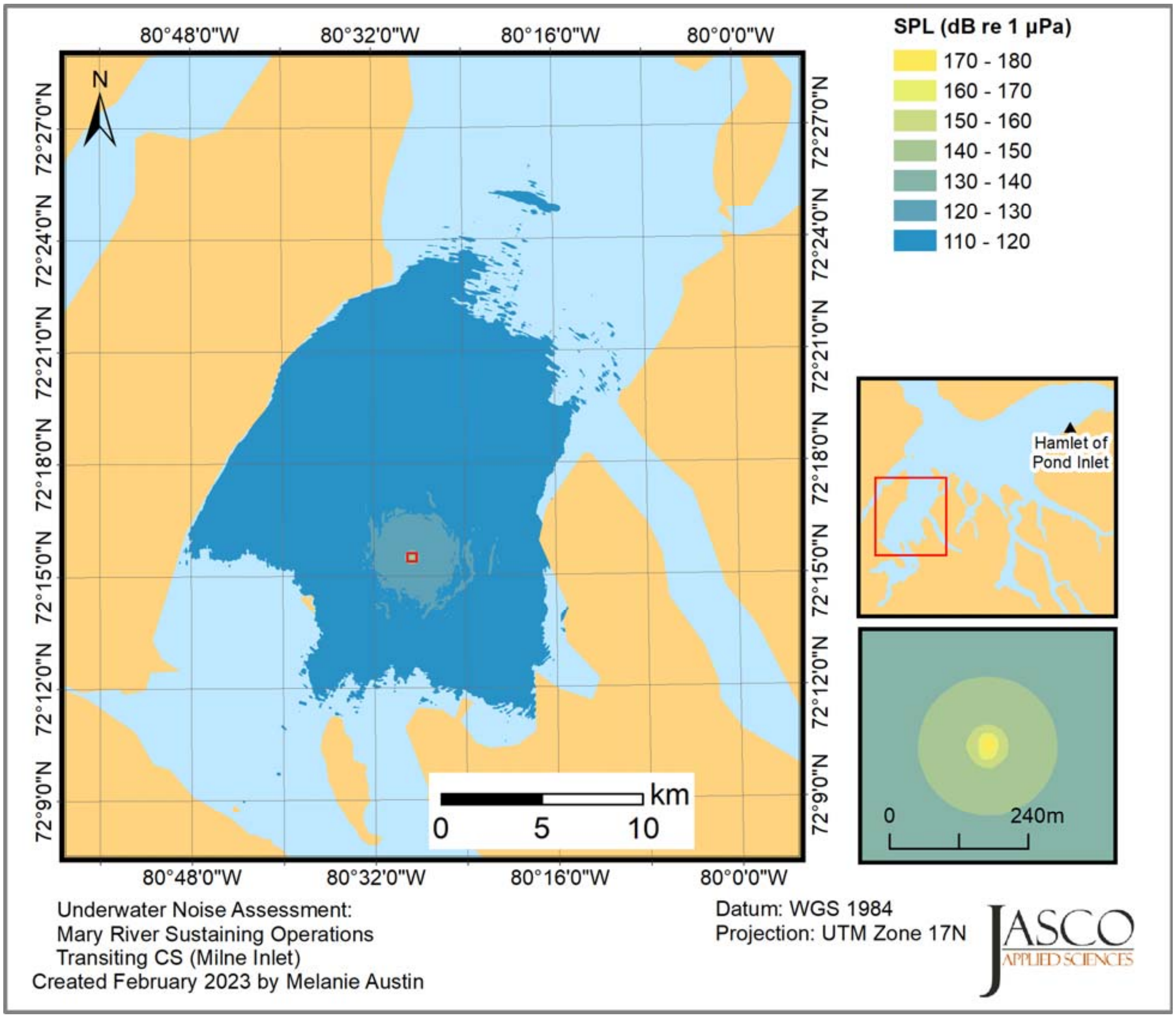

Figure D-15. Scenario 15: Map of SPL isopleths in 10 dB steps corresponding to a Capesize (CS) ore carrier transiting at 9 kn at Milne Inlet.

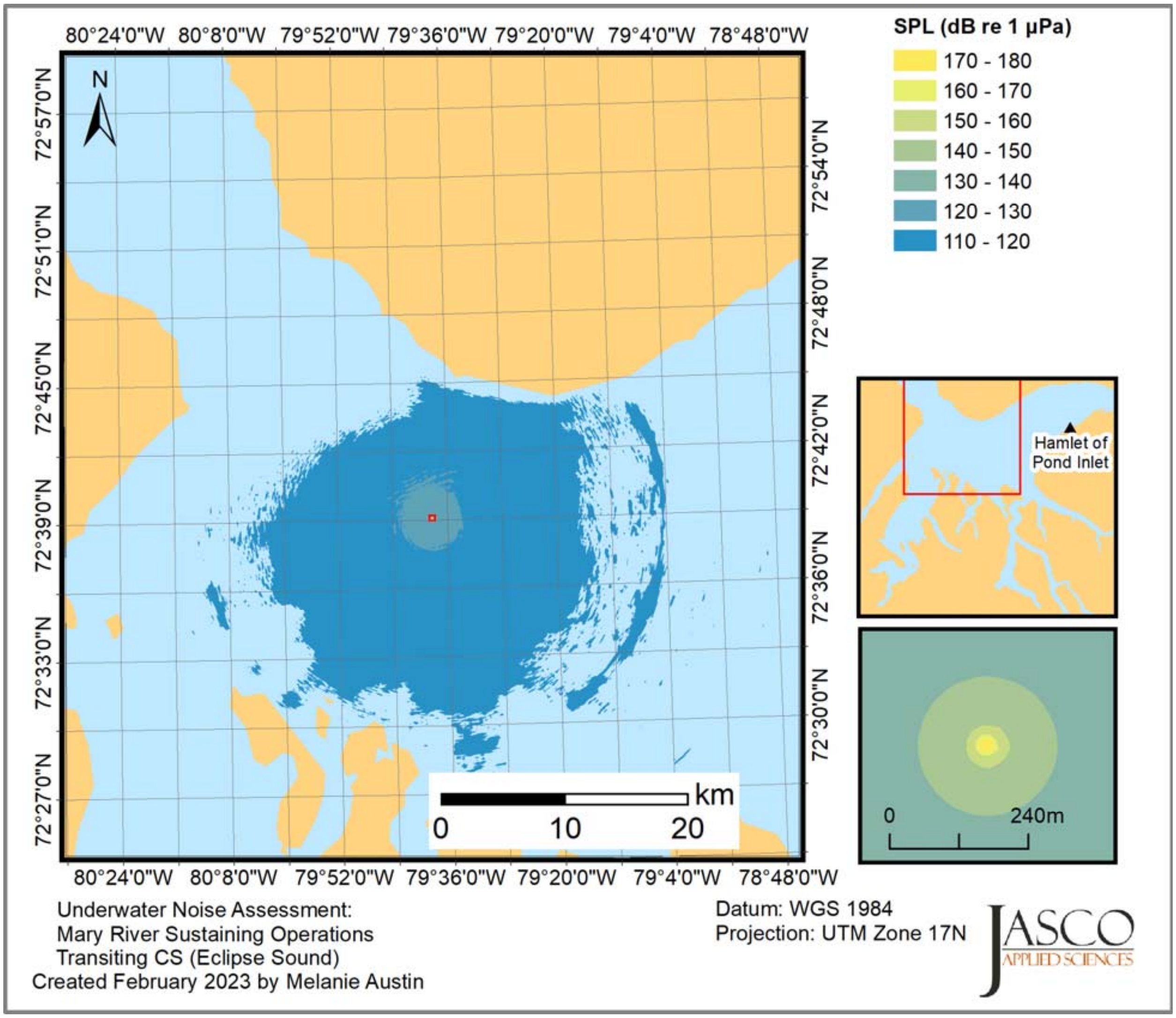

Figure D-16. Scenario 16: Map of SPL isopleths in 10 dB steps corresponding to a Capesize (CS) ore carrier transiting at 9 kn at Eclipse Sound.

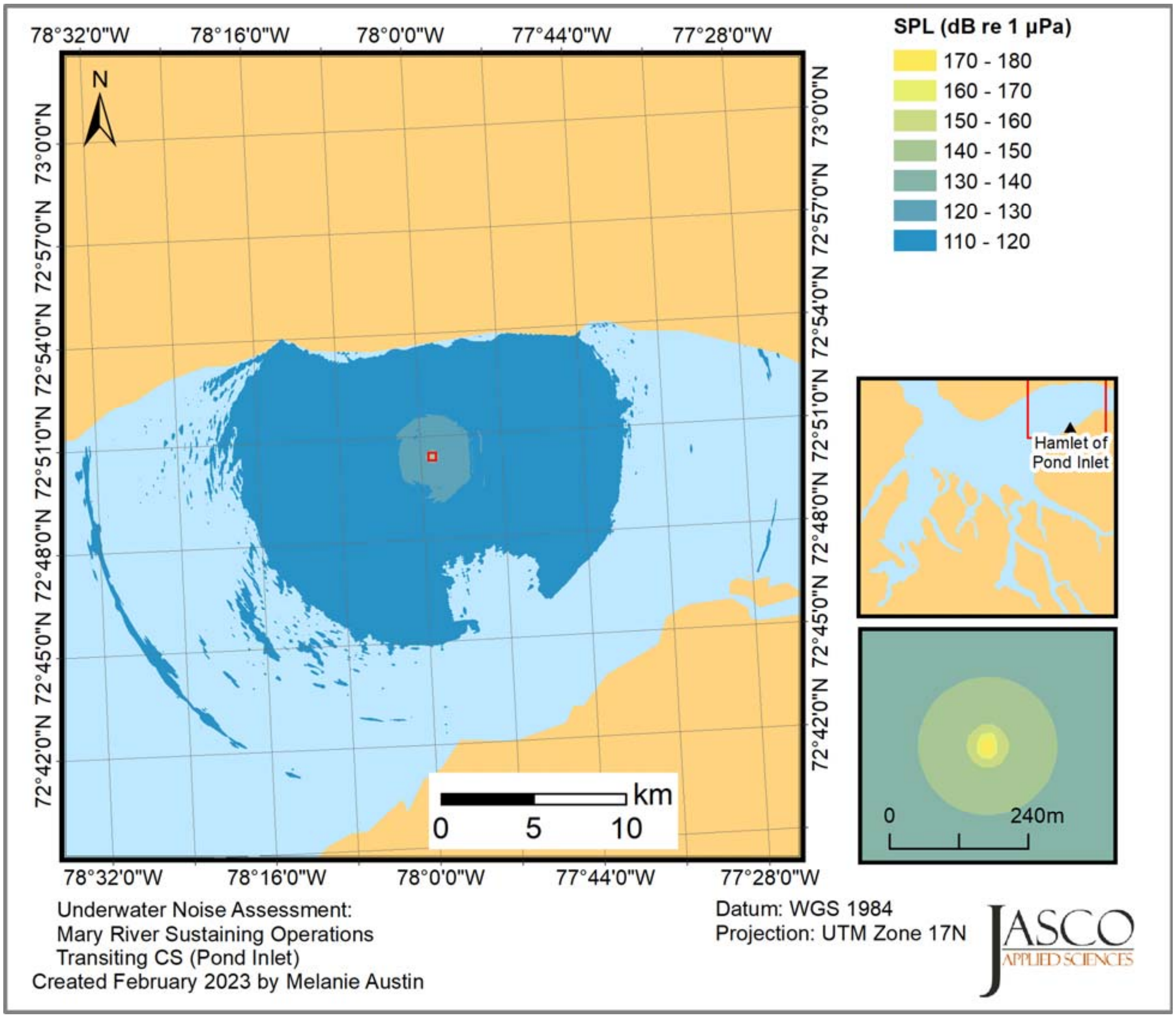

Figure D-17. Scenario 17: Map of SPL isopleths in 10 dB steps corresponding to a Capesize (CS) ore carrier transiting at 9 kn at Pond Inlet.

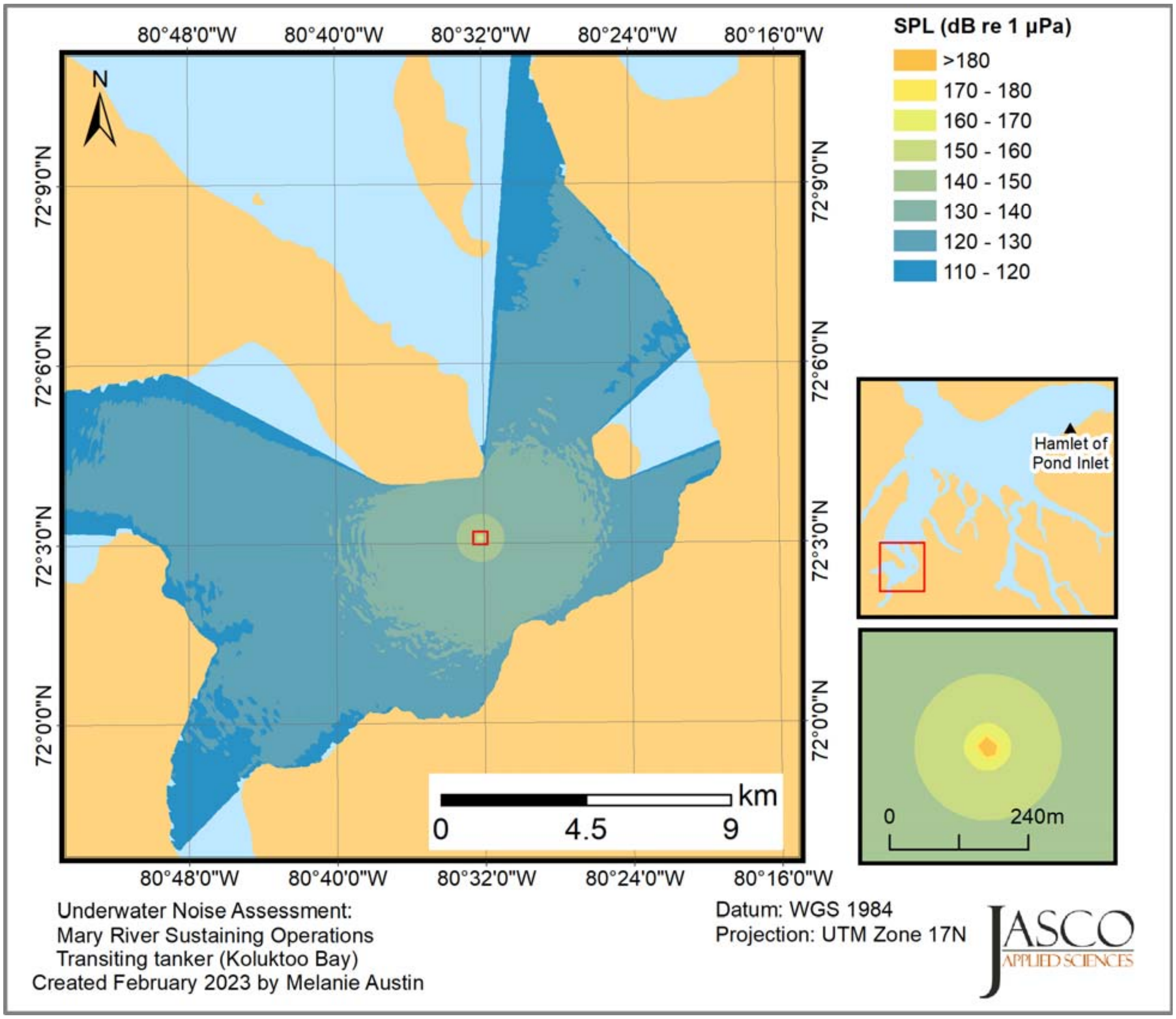

Figure D-18. Scenario 18: Map of SPL isopleths in 10 dB steps corresponding to a tanker transiting at 9 kn at Koluktoo Bay.

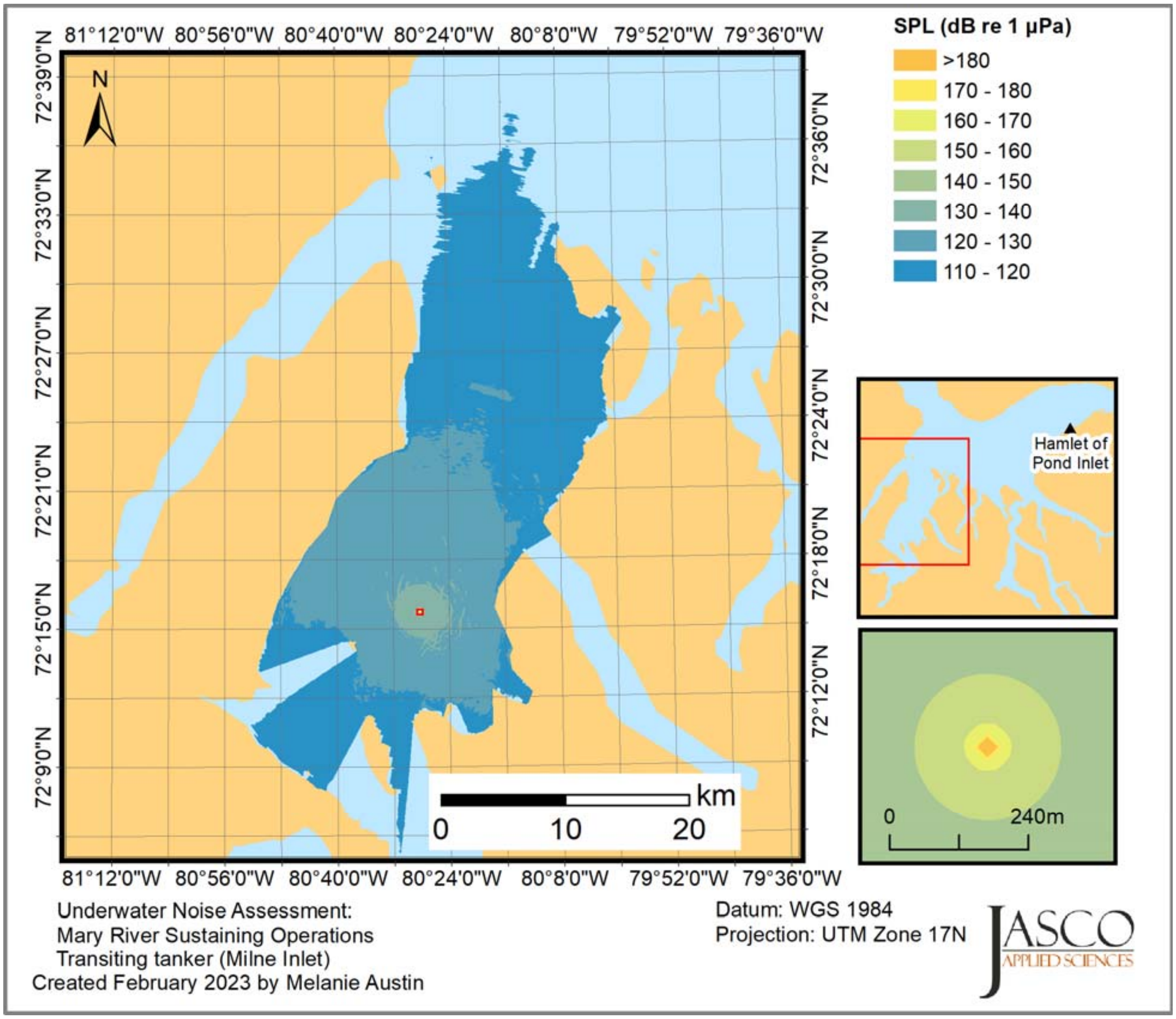

Figure D-19. Scenario 19: Map of SPL isopleths in 10 dB steps corresponding to a tanker transiting at 9 kn at Milne Inlet.

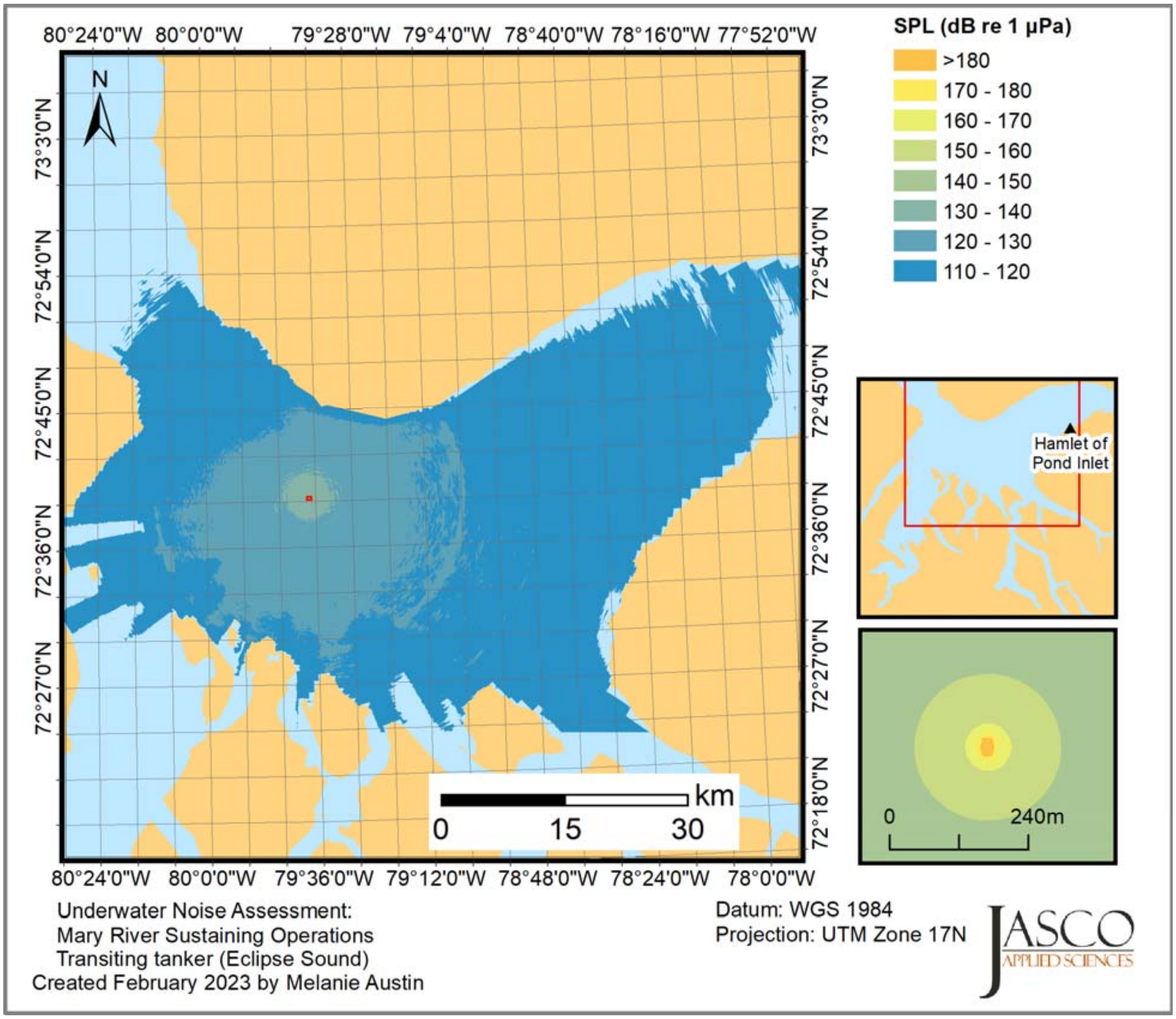

Figure D-20. Scenario 20: Map of SPL isopleths in 10 dB steps corresponding to a tanker transiting at 9 kn at Eclipse Sound.

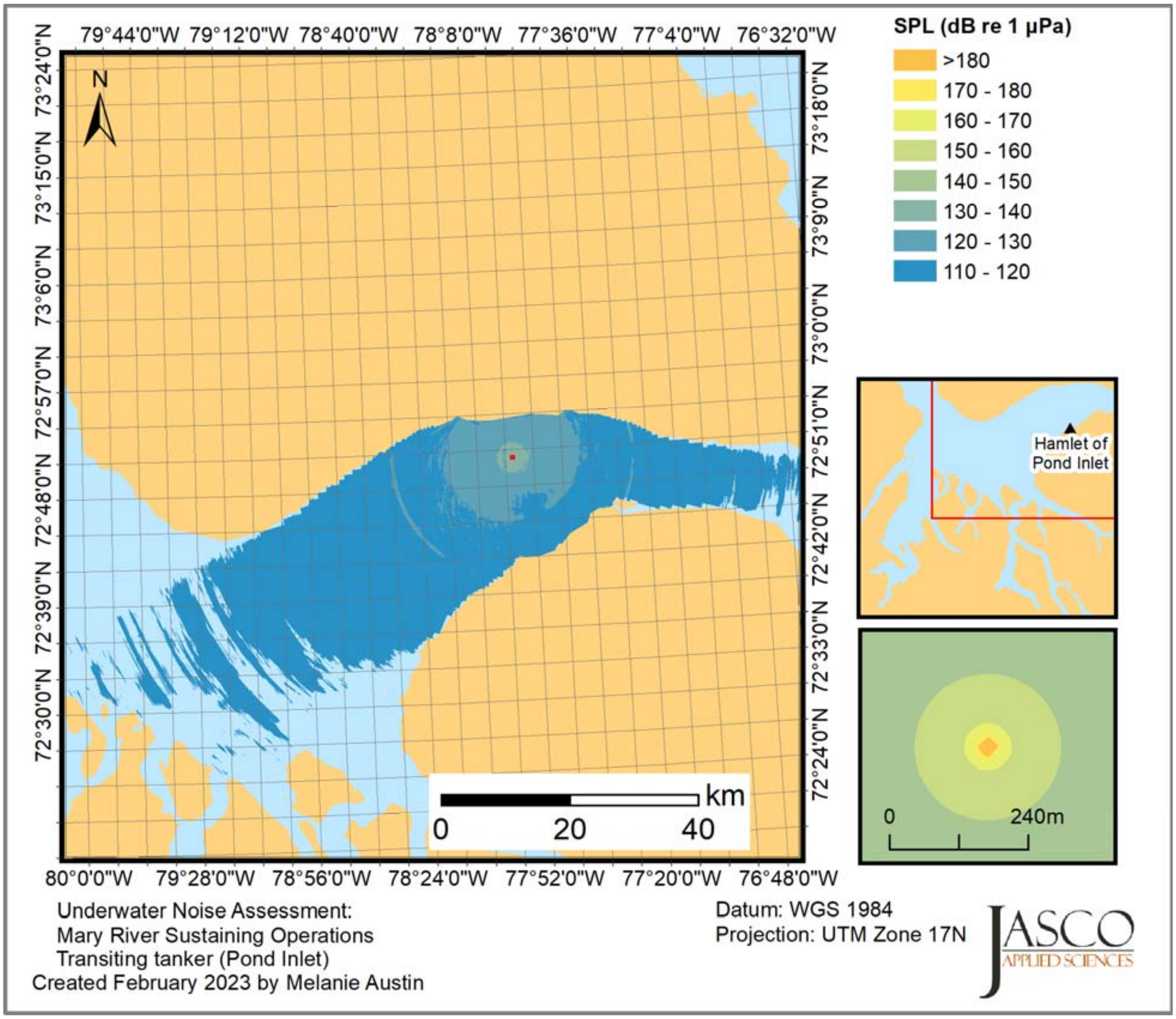

Figure D-21. Scenario 21: Map of SPL isopleths in 10 dB steps corresponding to a tanker transiting at 9 kn at Pond Inlet.

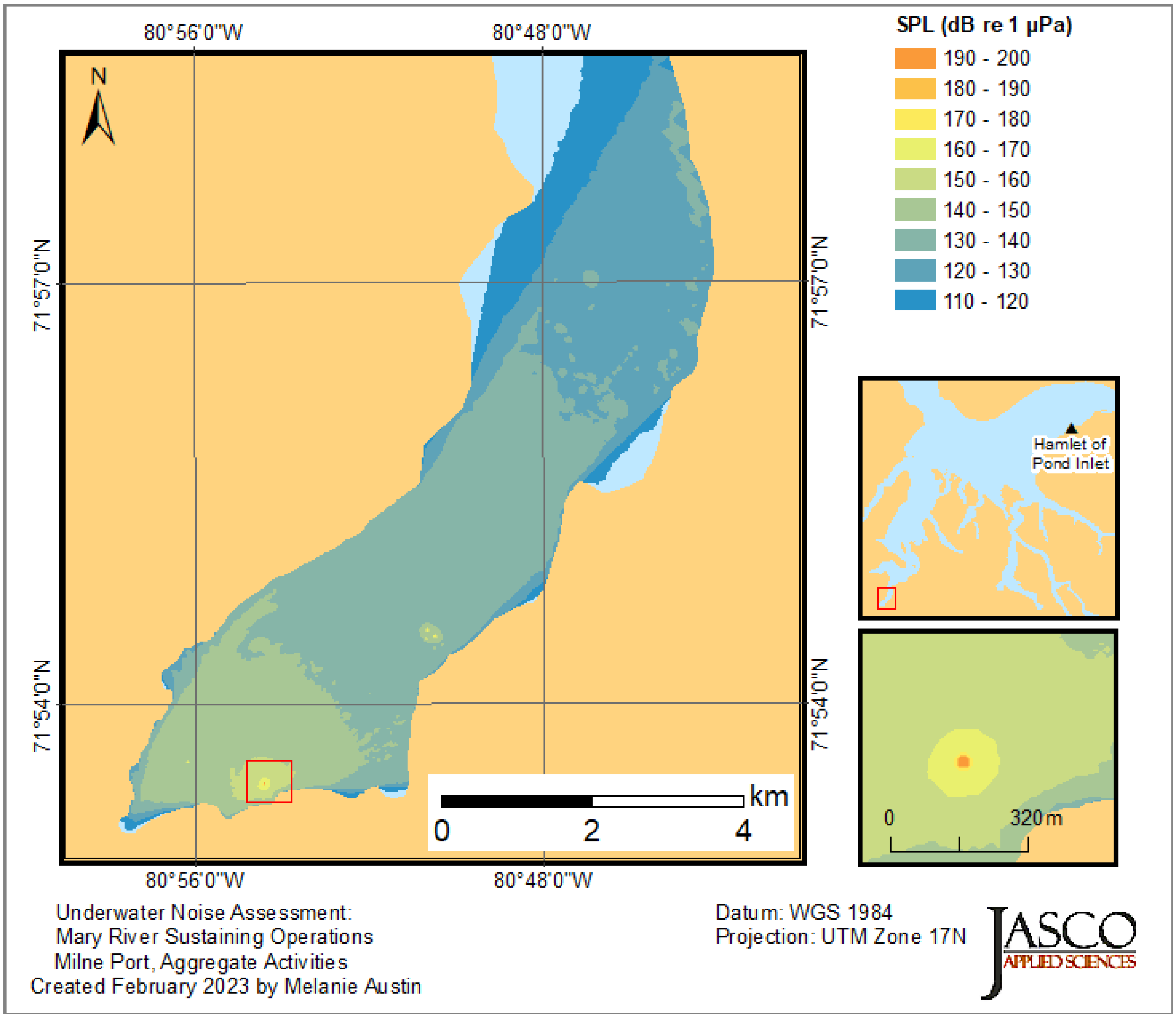

Figure D-22. Scenario 22: Map of SPL isopleths in 10 dB steps corresponding to a scenario with a Post-Panamax (PP) ore carrier berthing at the ore dock with tug assistance, a Cape Size (CS) ore carrier anchored in Milne Port, and a CS ore carrier transiting at 5 kn at Milne Port with tug escorts.

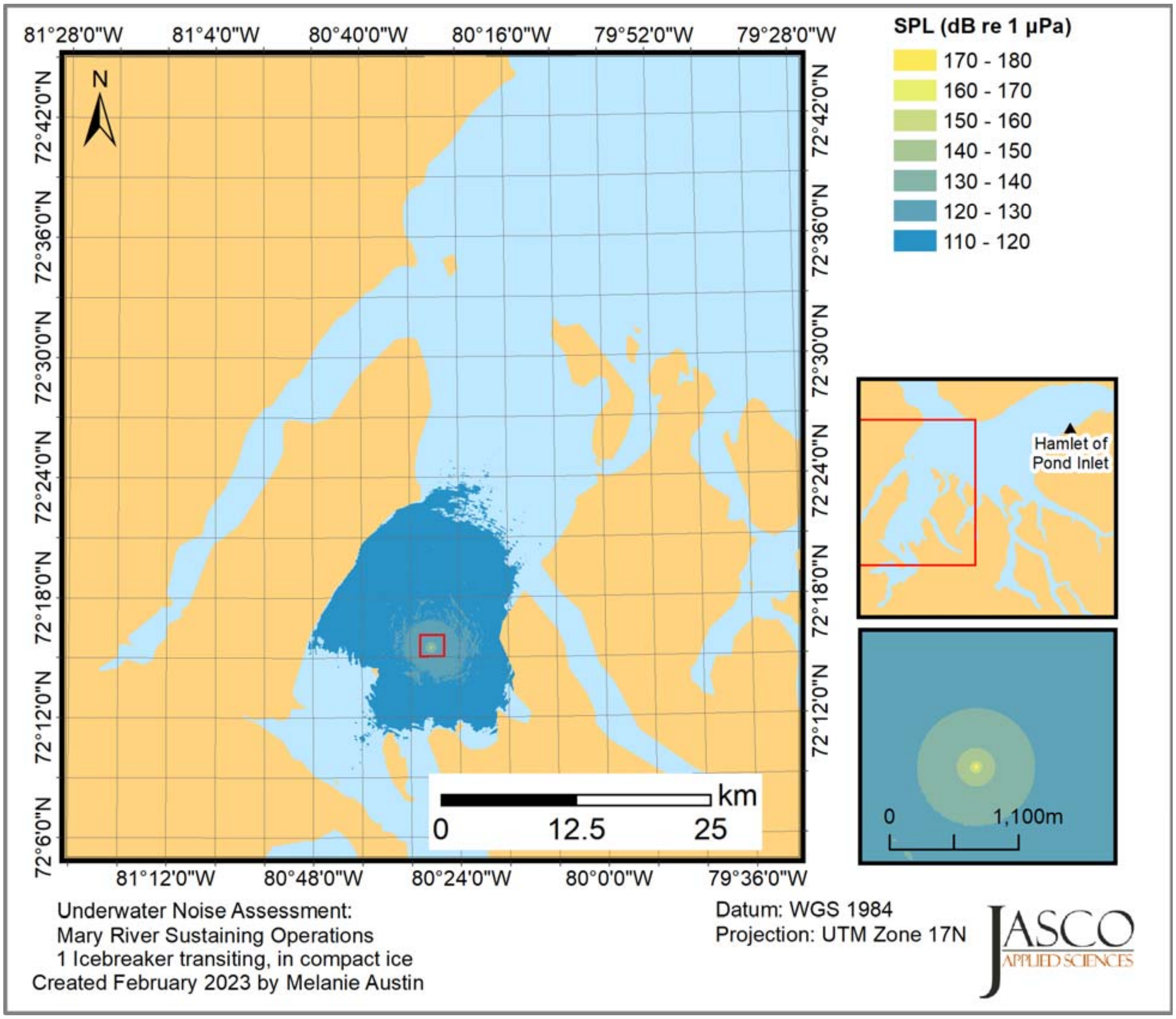

Figure D-23. Scenario 23: Map of SPL isopleths in 10 dB steps corresponding to an icebreaker transiting at 5 knots in compact ice in Milne Inlet.

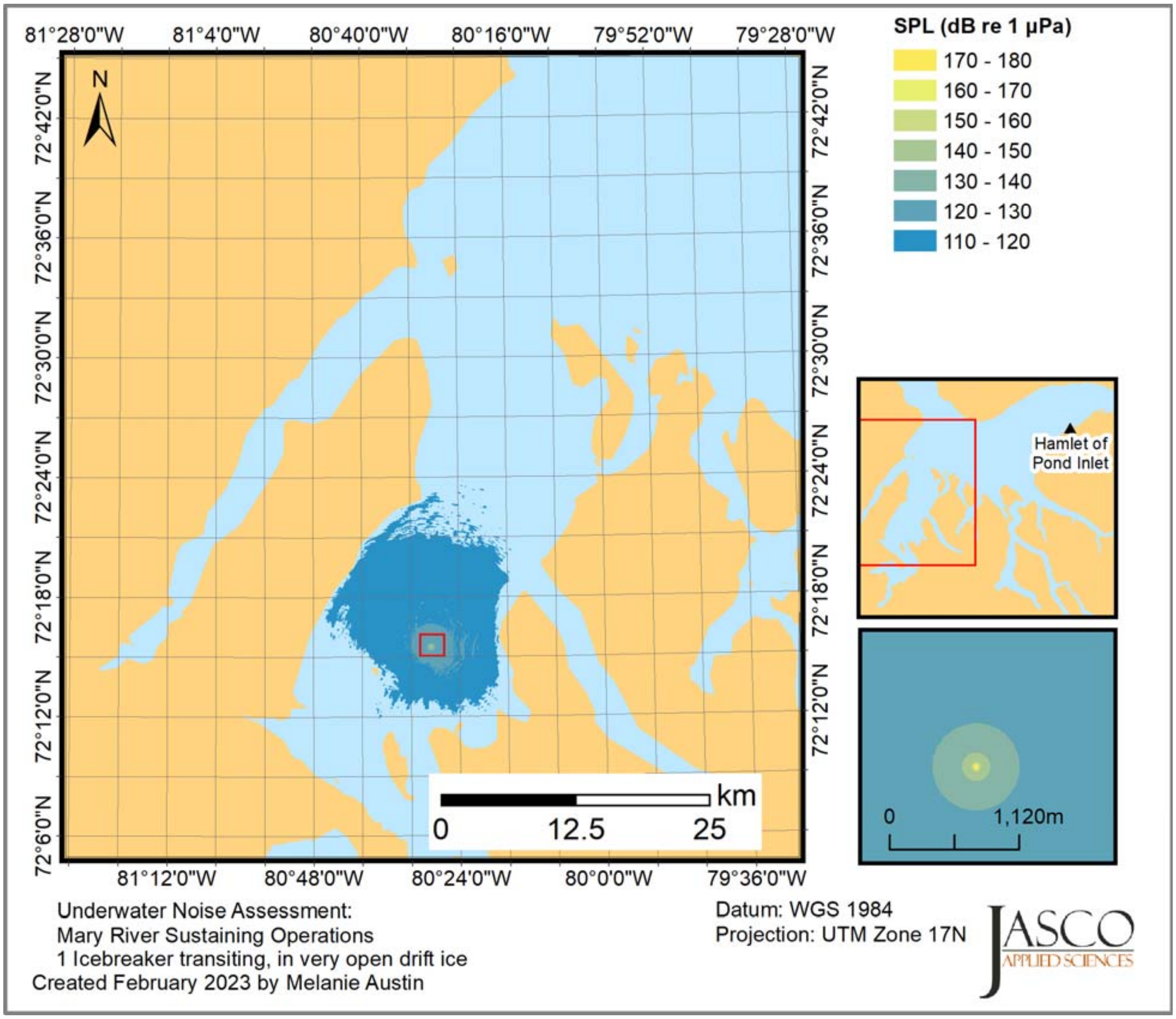

Figure D-24. Scenario 24: Map of SPL isopleths in 10 dB steps corresponding to an icebreaker transiting at 9 knots in very open drift ice in Milne Inlet.

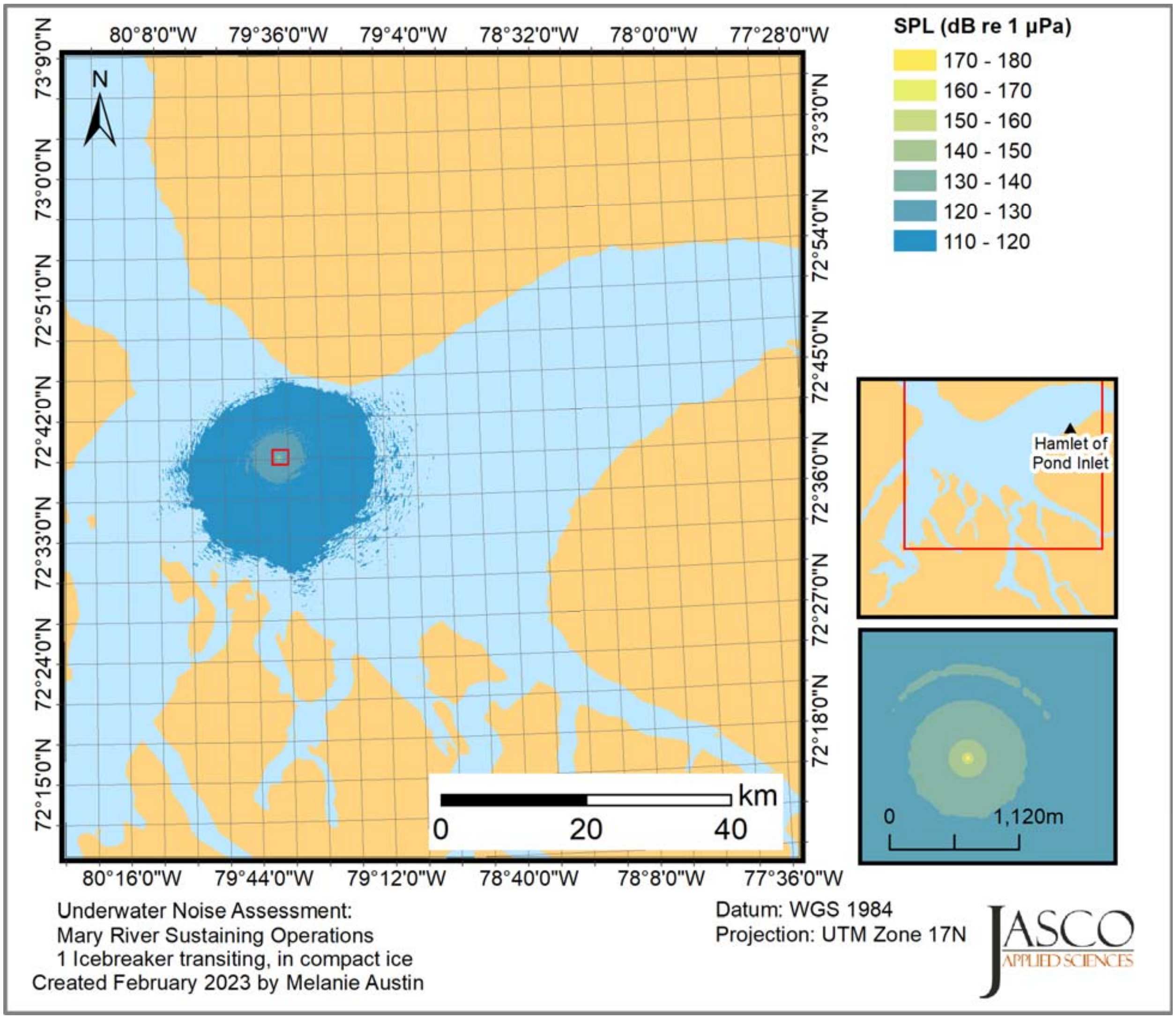

Figure D-25. Scenario 25: Map of SPL isopleths in 10 dB steps corresponding to an icebreaker transiting at 5 knots in compact ice in Eclipse Sound.

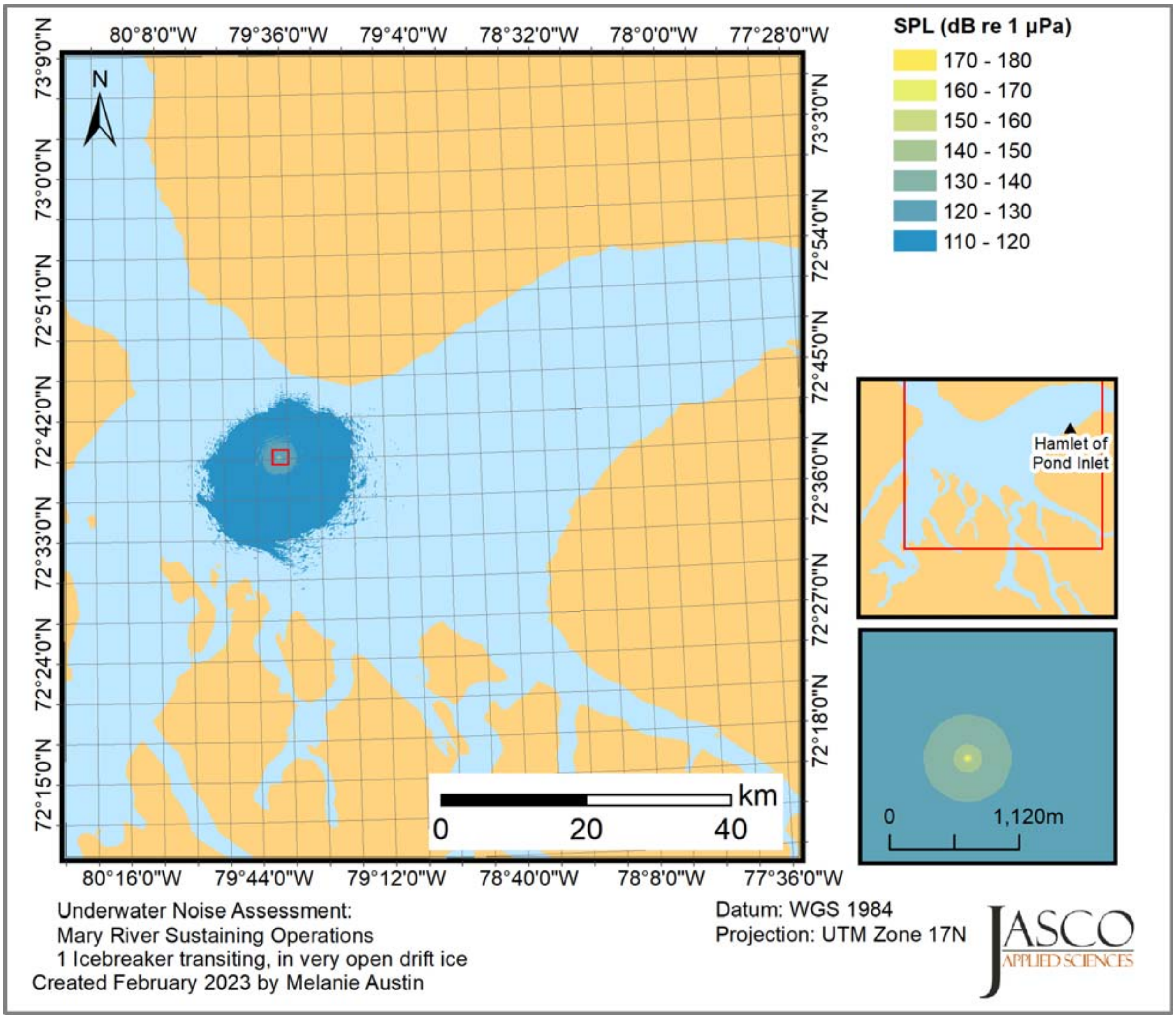

Figure D-26. Scenario 26: Map of SPL isopleths in 10 dB steps corresponding to an icebreaker transiting at 9 knots in very open drift ice in Eclipse Sound.

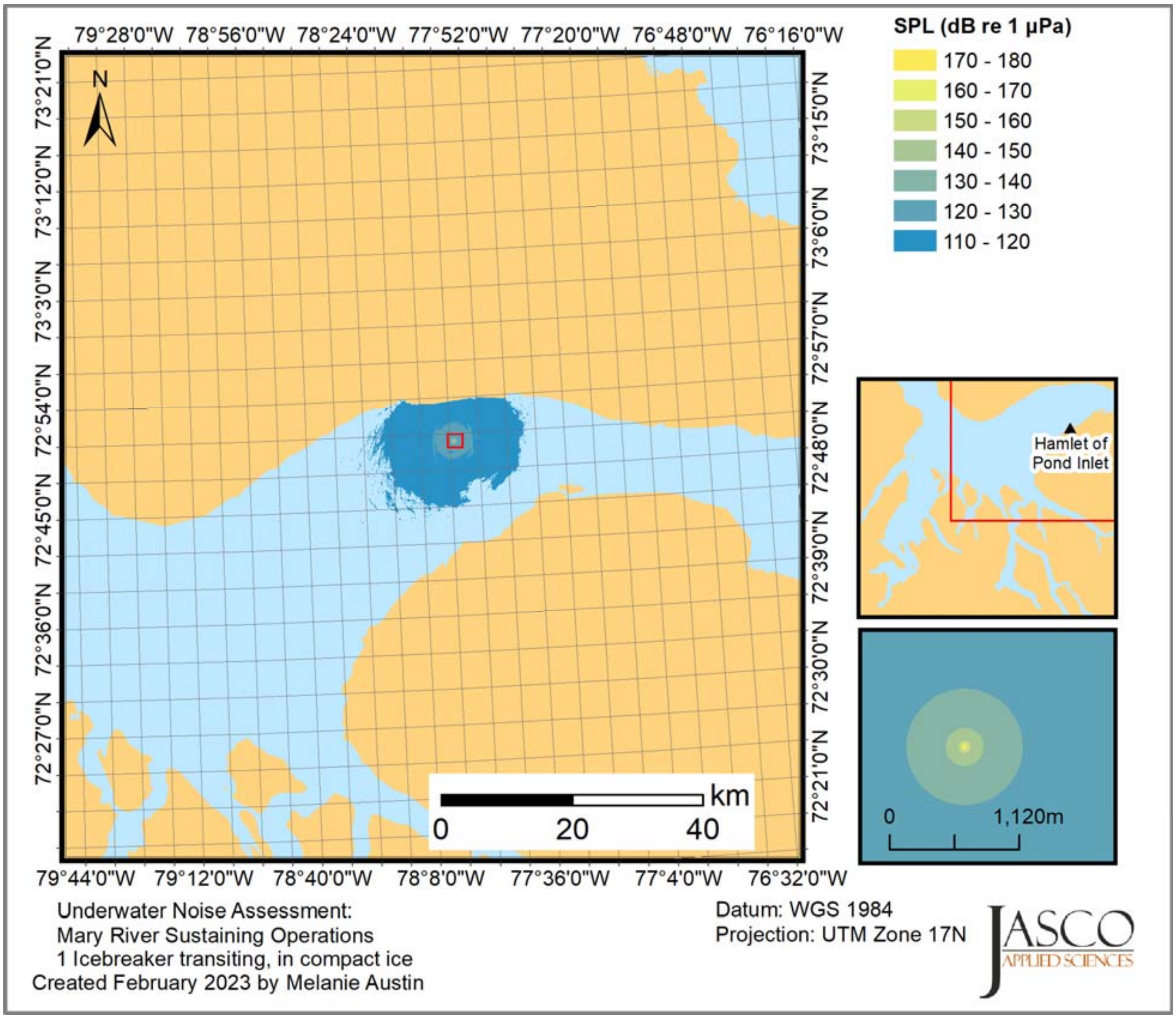

Figure D-27. Scenario 27: Map of SPL isopleths in 10 dB steps corresponding to an icebreaker transiting at 5 knots in compact ice in Pond Inlet.

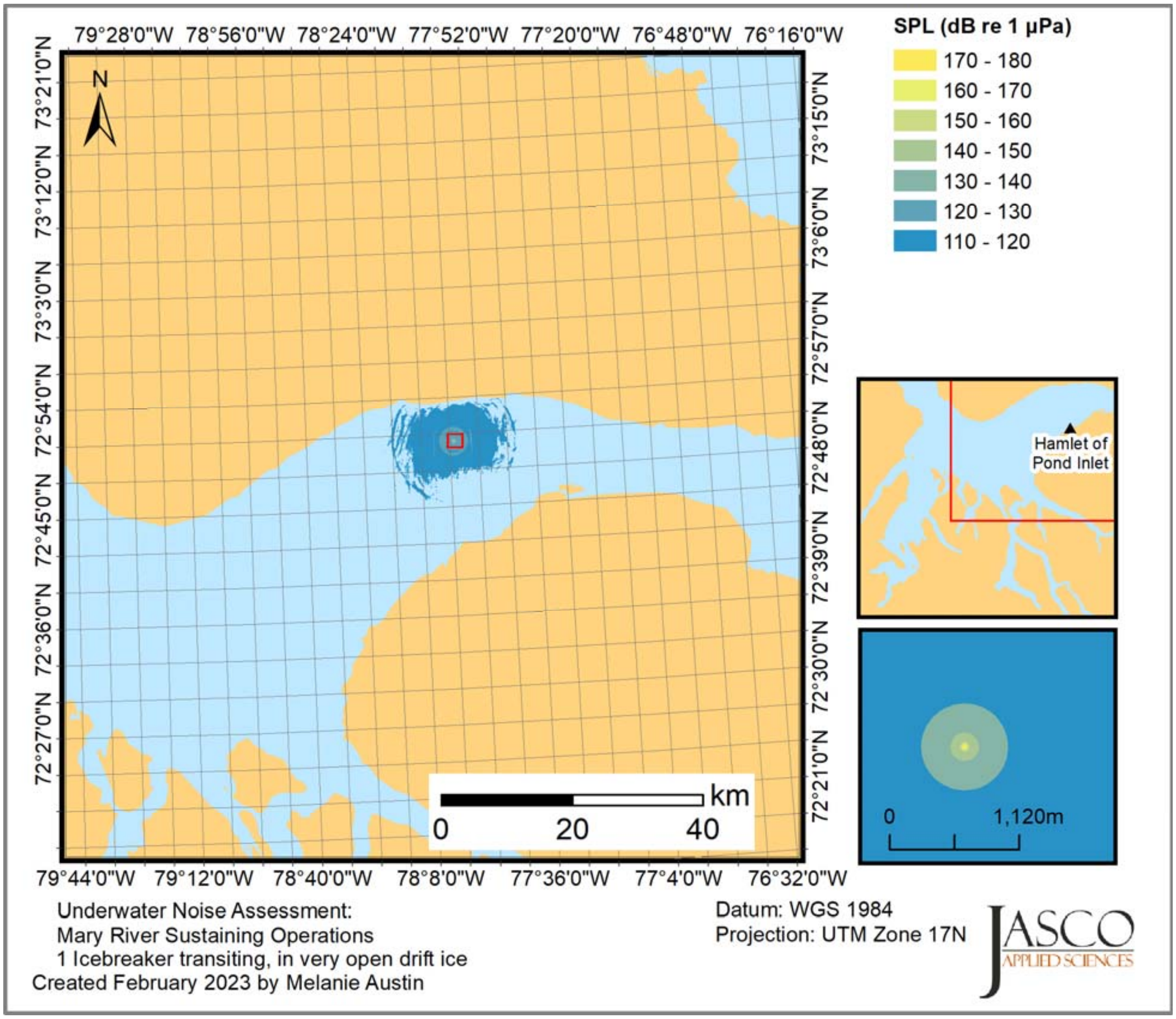

Figure D-28. Scenario 28: Map of SPL isopleths in 10 dB steps corresponding to an icebreaker transiting at 9 knots in very open drift ice in Pond Inlet.

Figure D-29. Scenario 29: Map of SPL isopleths in 10 dB steps corresponding to an icebreaker and a Capesize (CS) ore carrier transiting at 5 knots in compact ice in Milne Inlet.

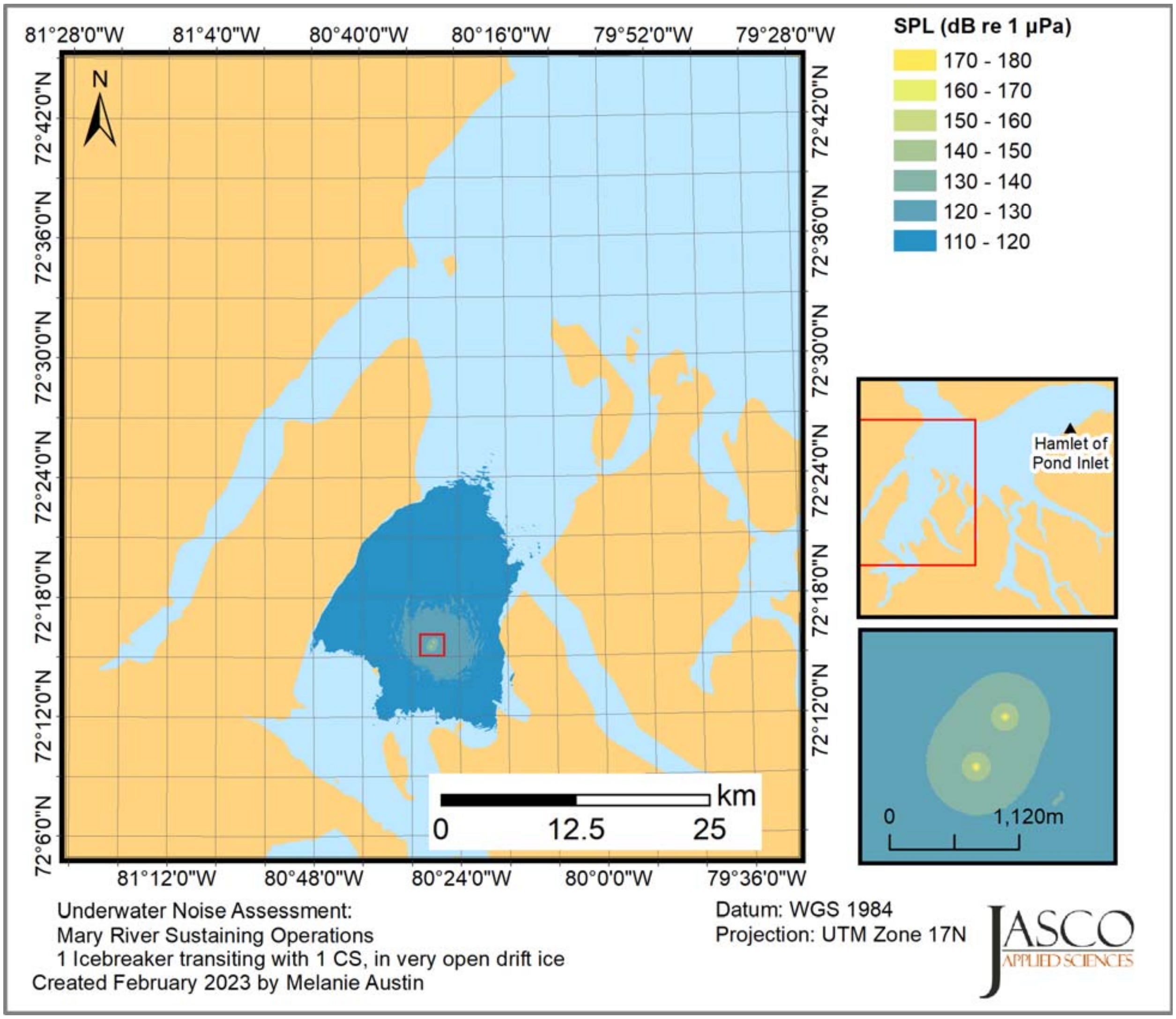

Figure D-30. Scenario 30: Map of SPL isopleths in 10 dB steps corresponding to an icebreaker and a Capesize (CS) ore carrier transiting at 9 knots in very open drift ice in Milne Inlet.

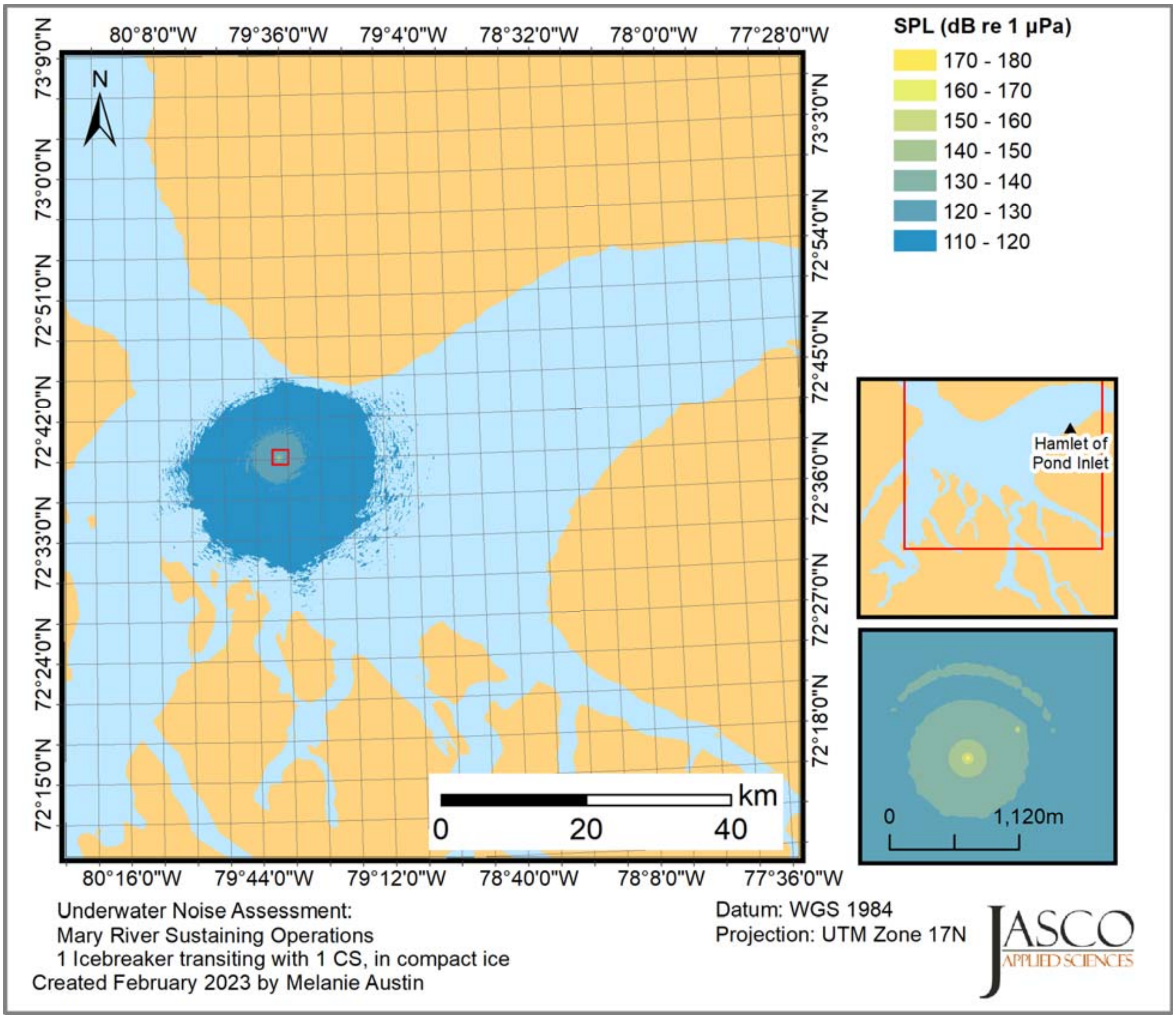

Figure D-31. Scenario 31: Map of SPL isopleths in 10 dB steps corresponding to an icebreaker and a Capesize (CS) ore carrier transiting at 5 knots in compact ice in Eclipse Sound.

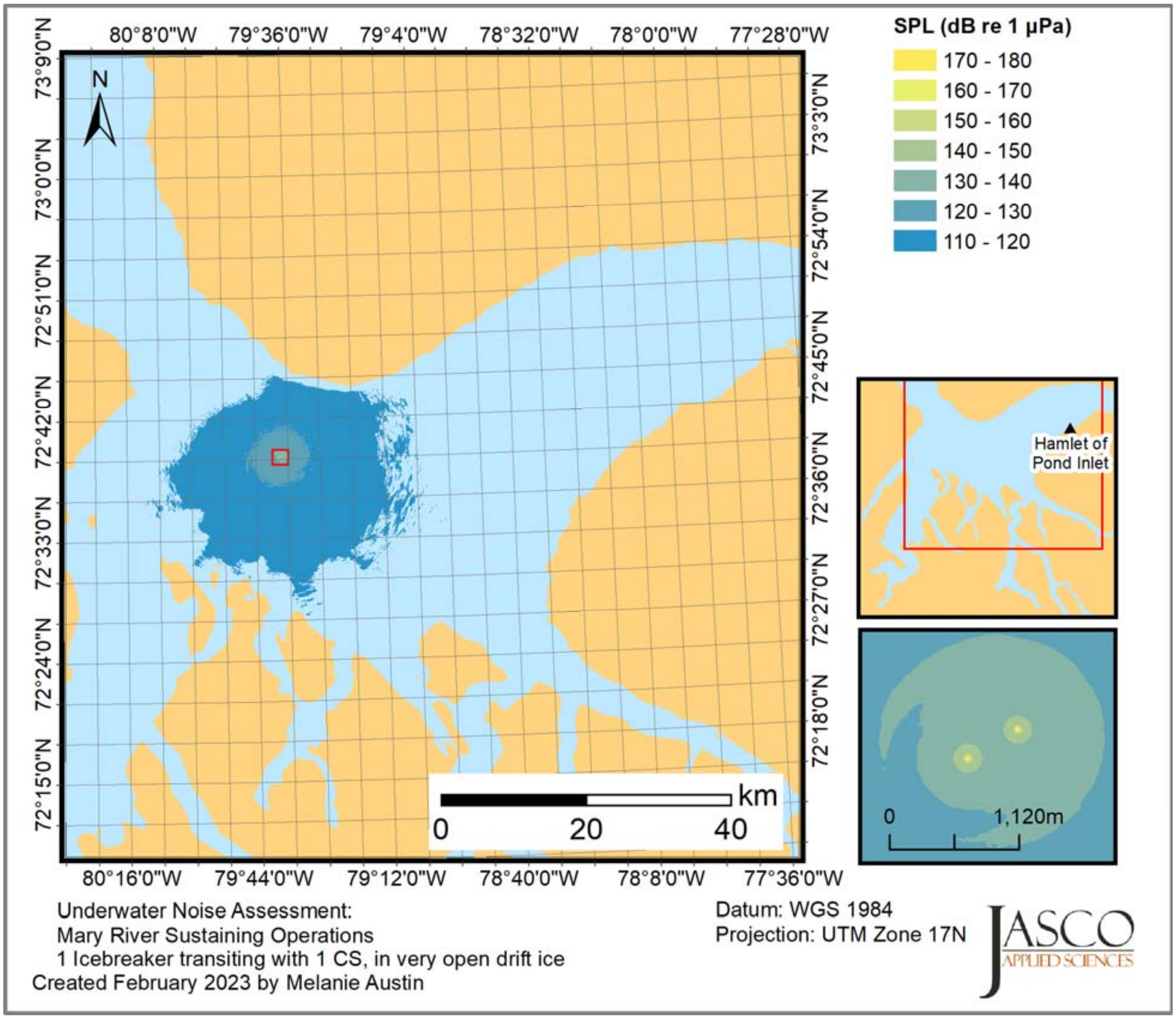

Figure D-32. Scenario 32: Map of SPL isopleths in 10 dB steps corresponding to an icebreaker and a Capesize (CS) ore carrier transiting at 9 knots in very open drift ice in Eclipse Sound.

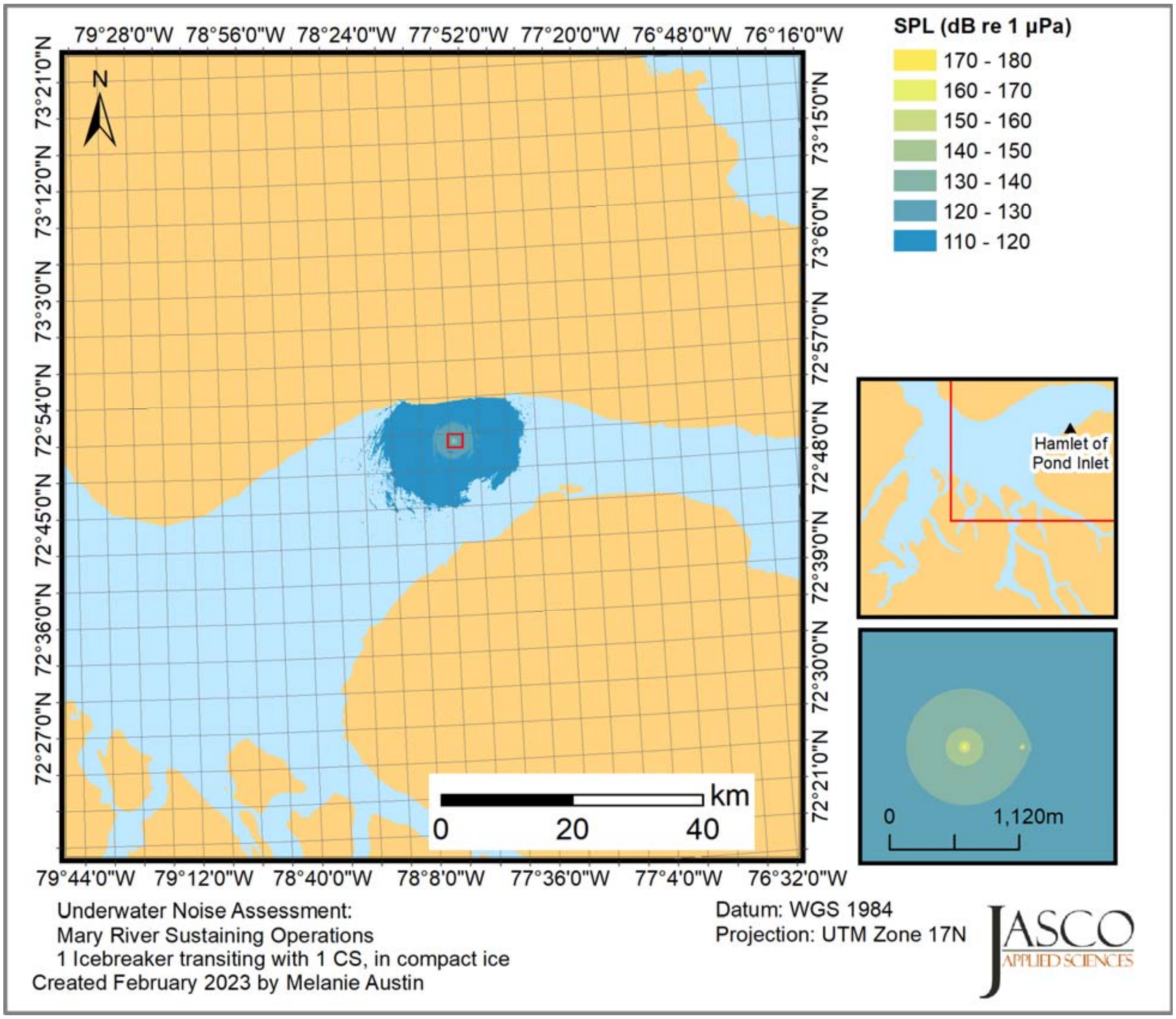

Figure D-33. Scenario 33: Map of SPL isopleths in 10 dB steps corresponding to an icebreaker and a Capesize (CS) ore carrier transiting at 5 knots in compact ice in Pond Inlet.

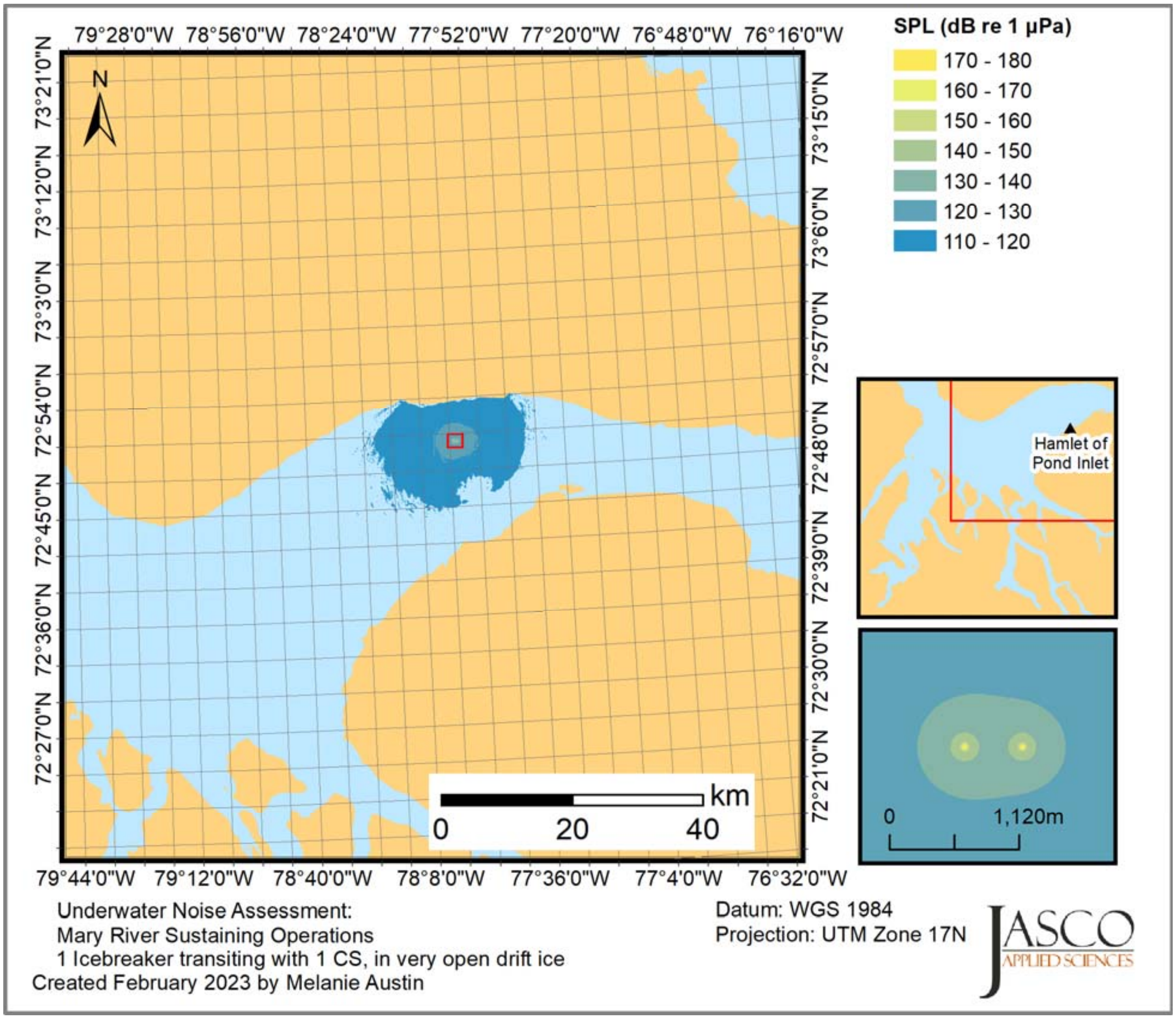

Figure D-34. Scenario 34: Map of SPL isopleths in 10 dB steps corresponding to an icebreaker and a Capesize (CS) ore carrier transiting at 9 knots in very open drift ice in Pond Inlet.

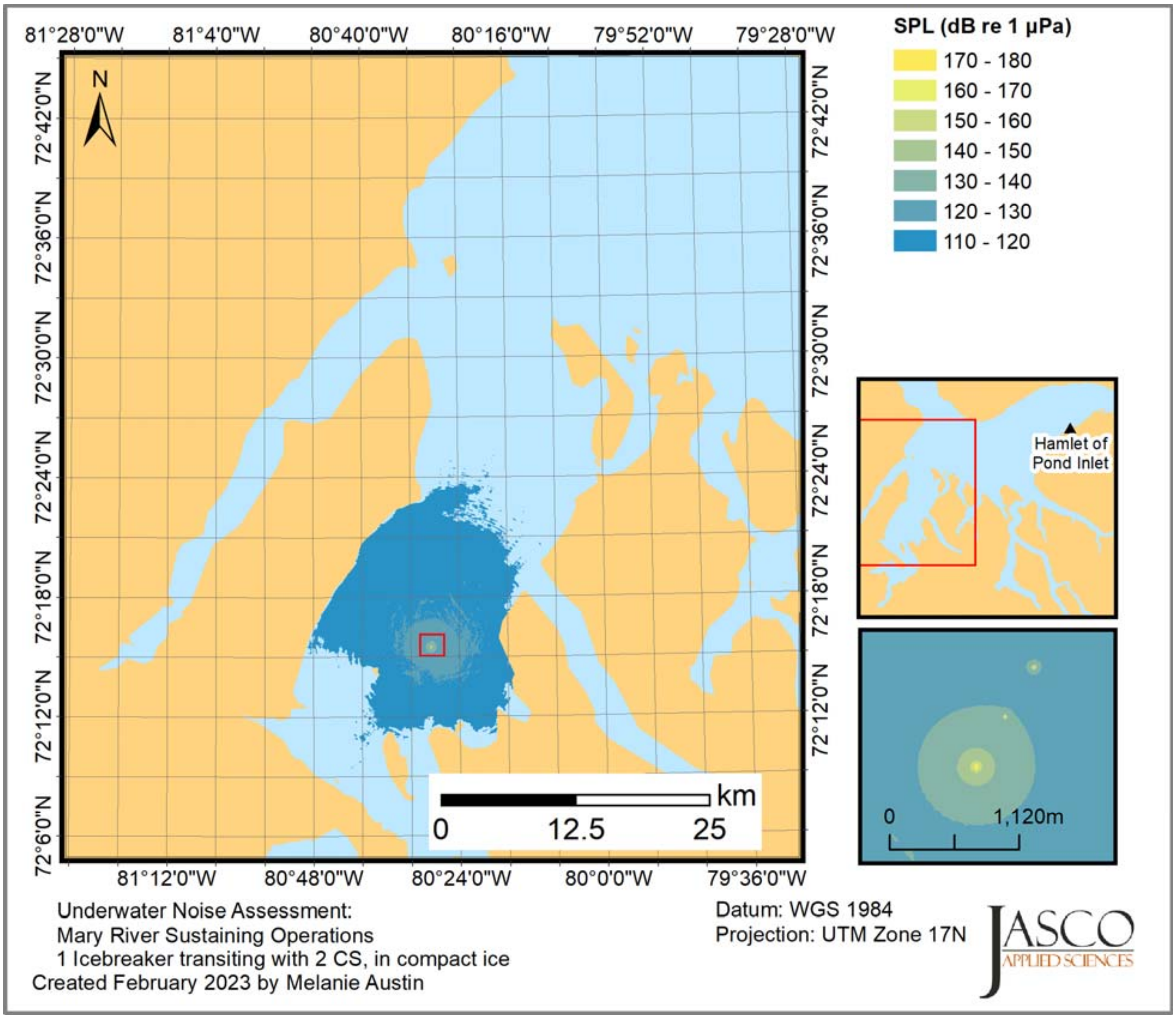

Figure D-35. Scenario 35: Map of SPL isopleths in 10 dB steps corresponding to an icebreaker and two Capesize (CS) ore carriers transiting at 5 knots in compact ice in Milne Inlet.

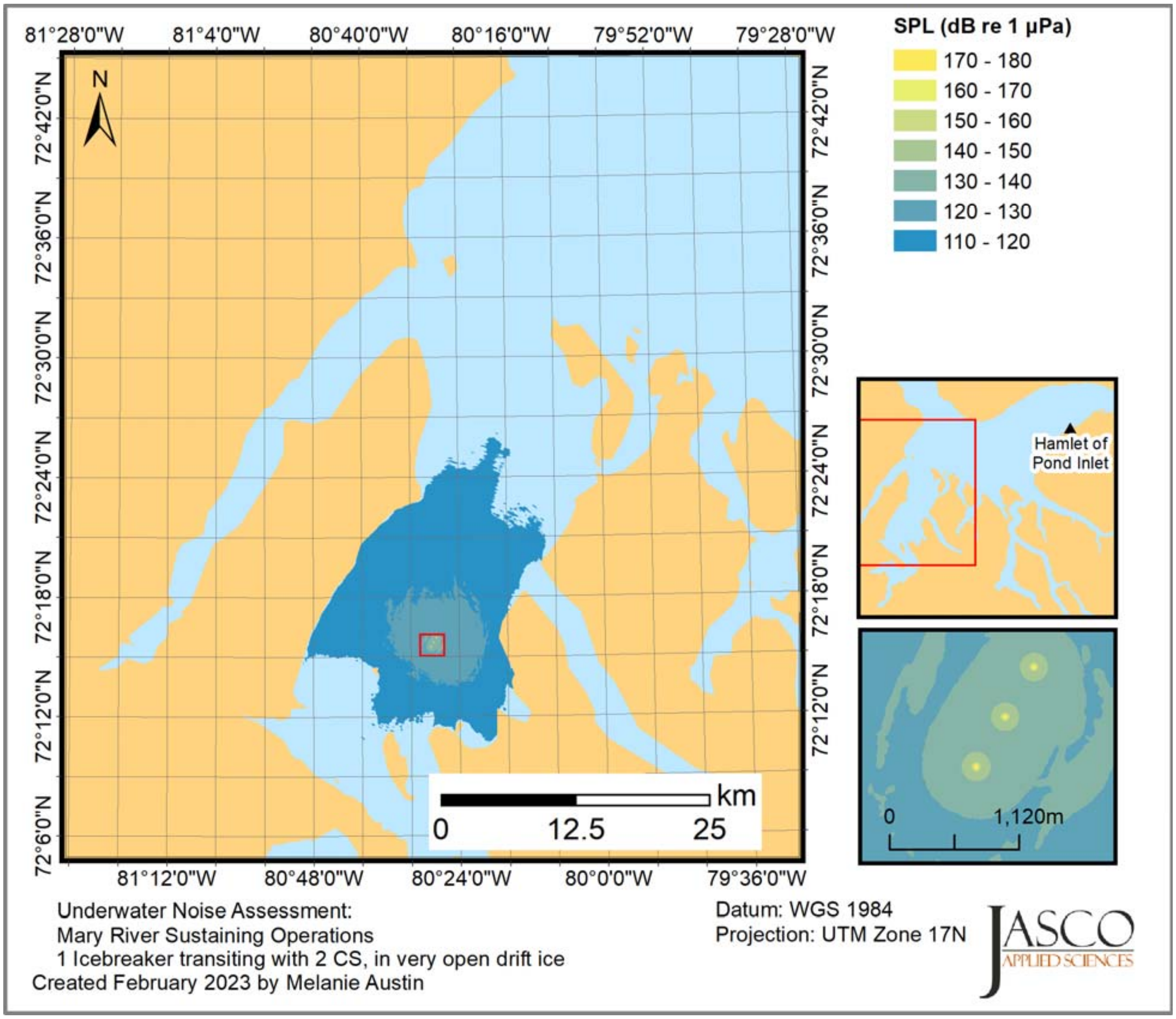

Figure D-36. Scenario 36: Map of SPL isopleths in 10 dB steps corresponding to an icebreaker and two Capesize (CS) ore carriers transiting at 9 knots in very open drift ice in Milne Inlet.

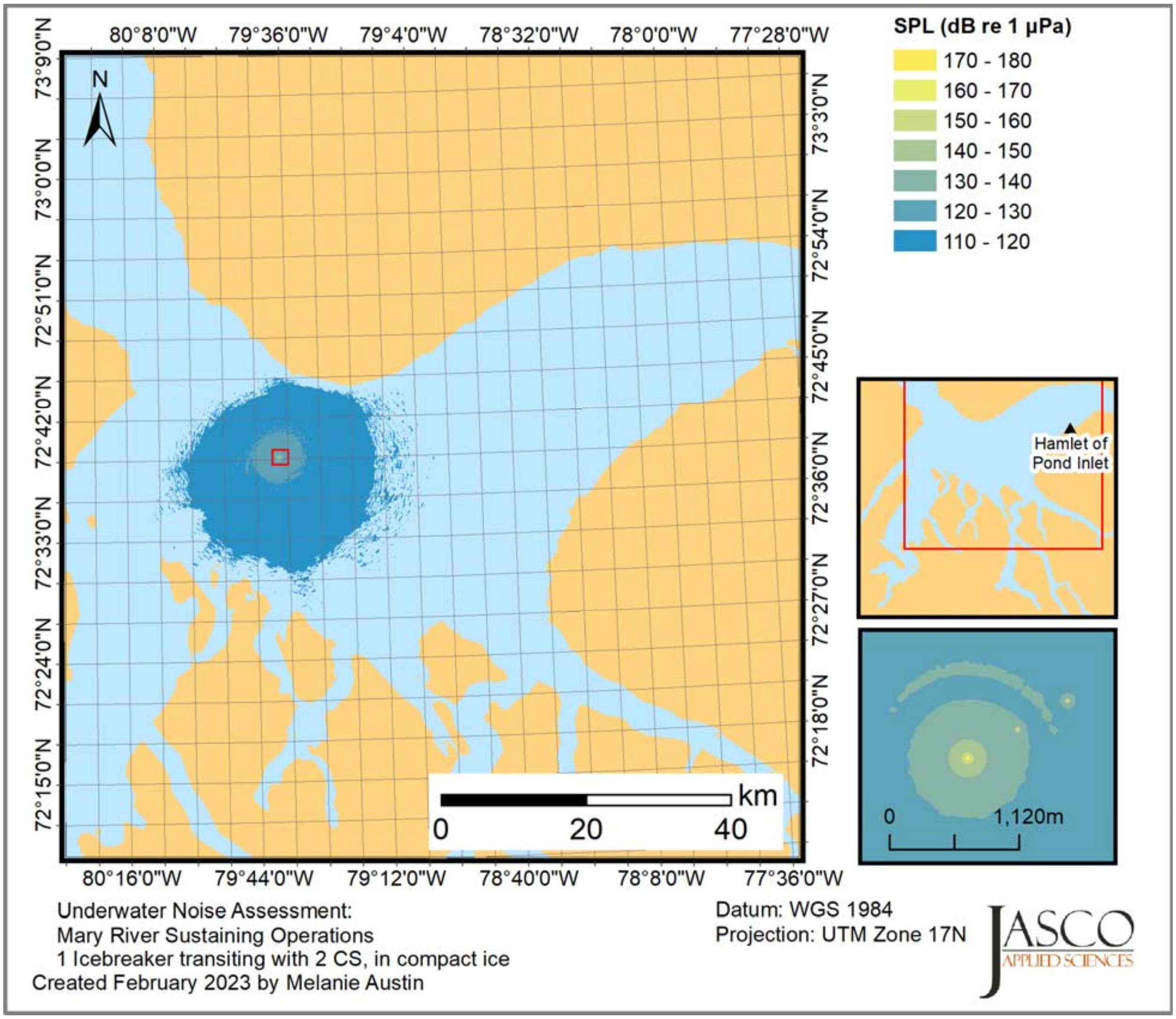

Figure D-37. Scenario 37: Map of SPL isopleths in 10 dB steps corresponding to an icebreaker and two Capesize (CS) ore carriers transiting at 5 knots in compact ice in Eclipse Sound.

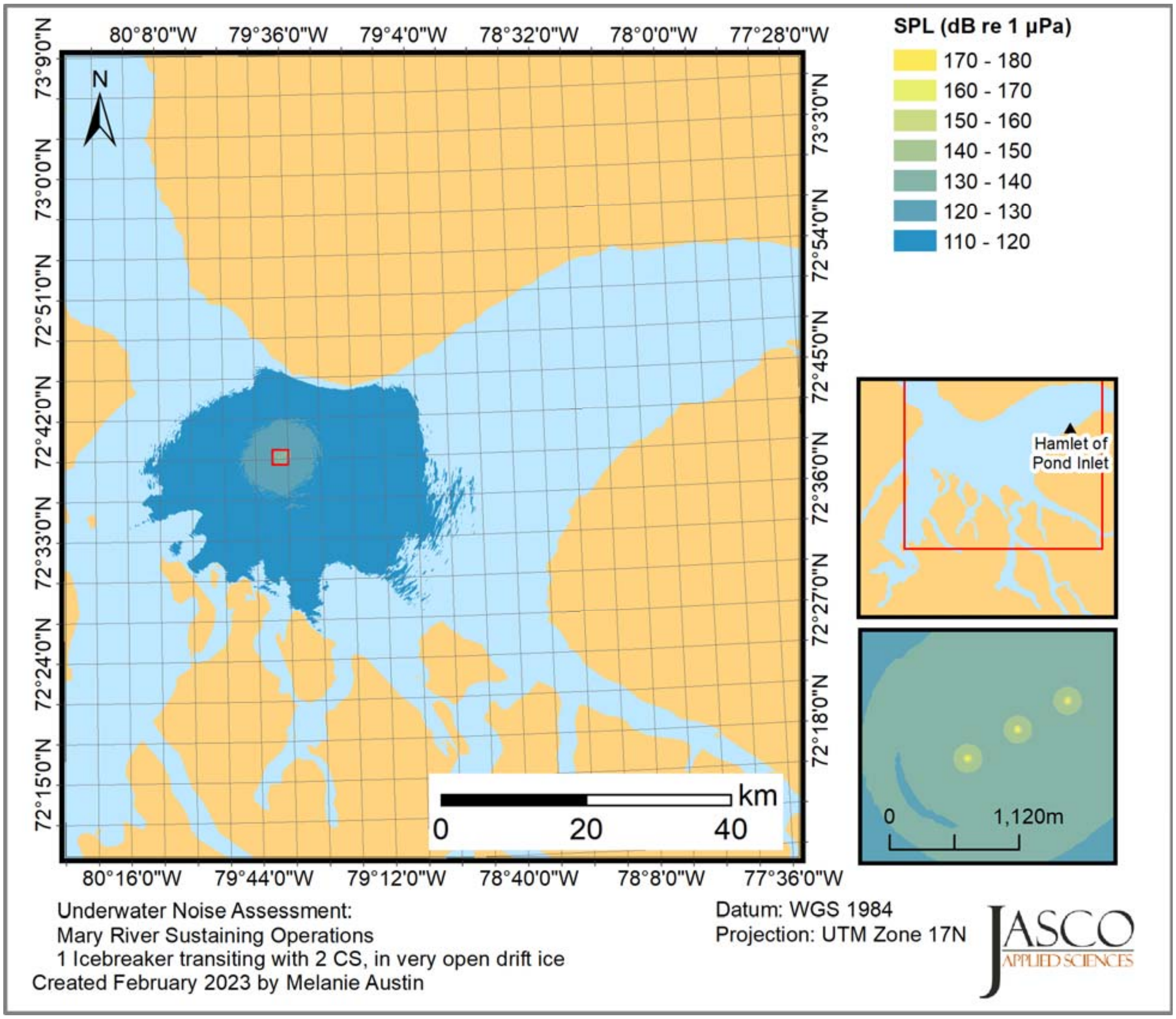

Figure D-38. Scenario 38: Map of SPL isopleths in 10 dB steps corresponding to an icebreaker and two Capesize (CS) ore carriers transiting at 9 knots in very open drift ice in Eclipse Sound.

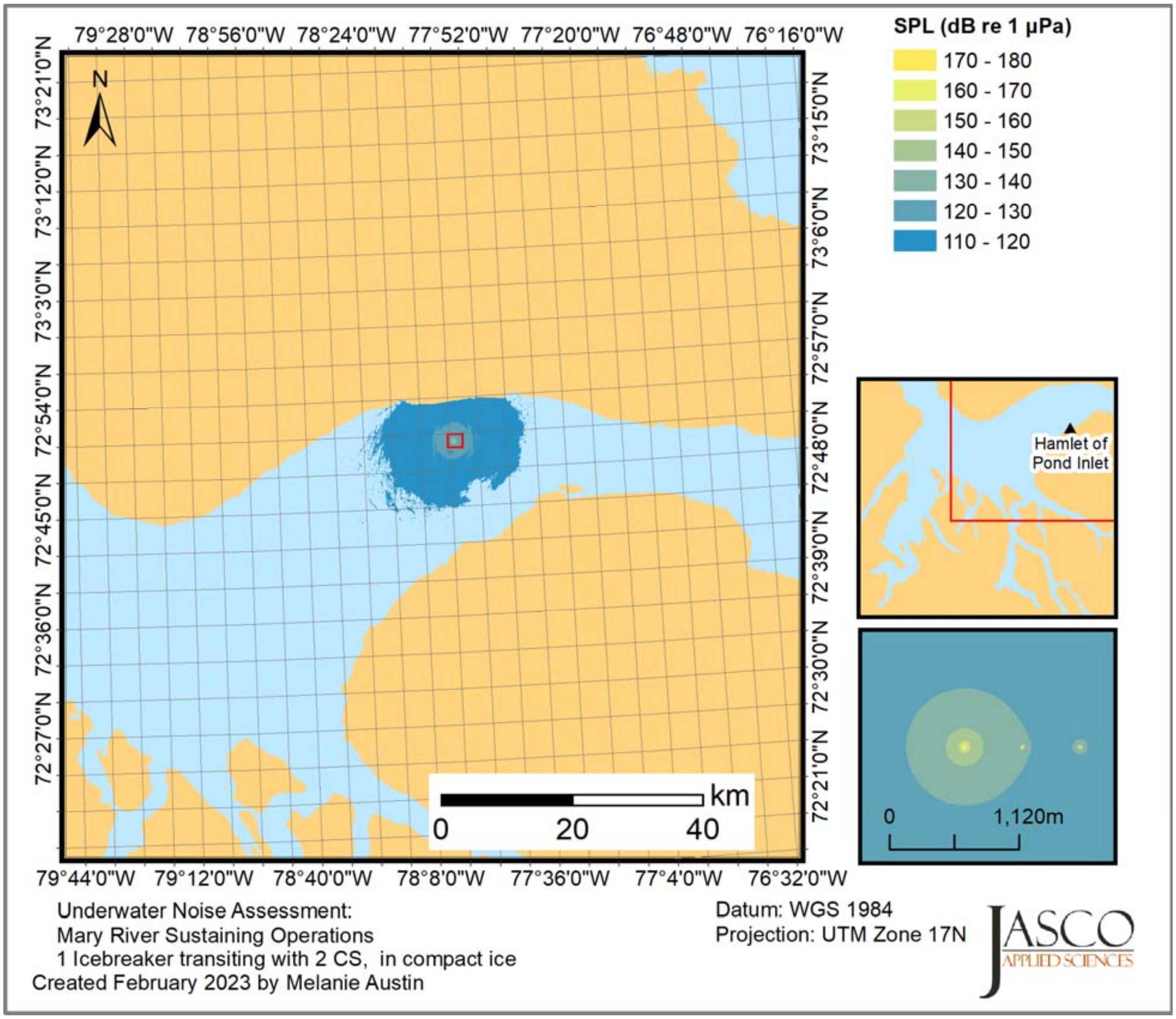

Figure D-39. Scenario 39: Map of SPL isopleths in 10 dB steps corresponding to an icebreaker and two Capesize (CS) ore carriers transiting at 5 knots in compact ice in Pond Inlet.

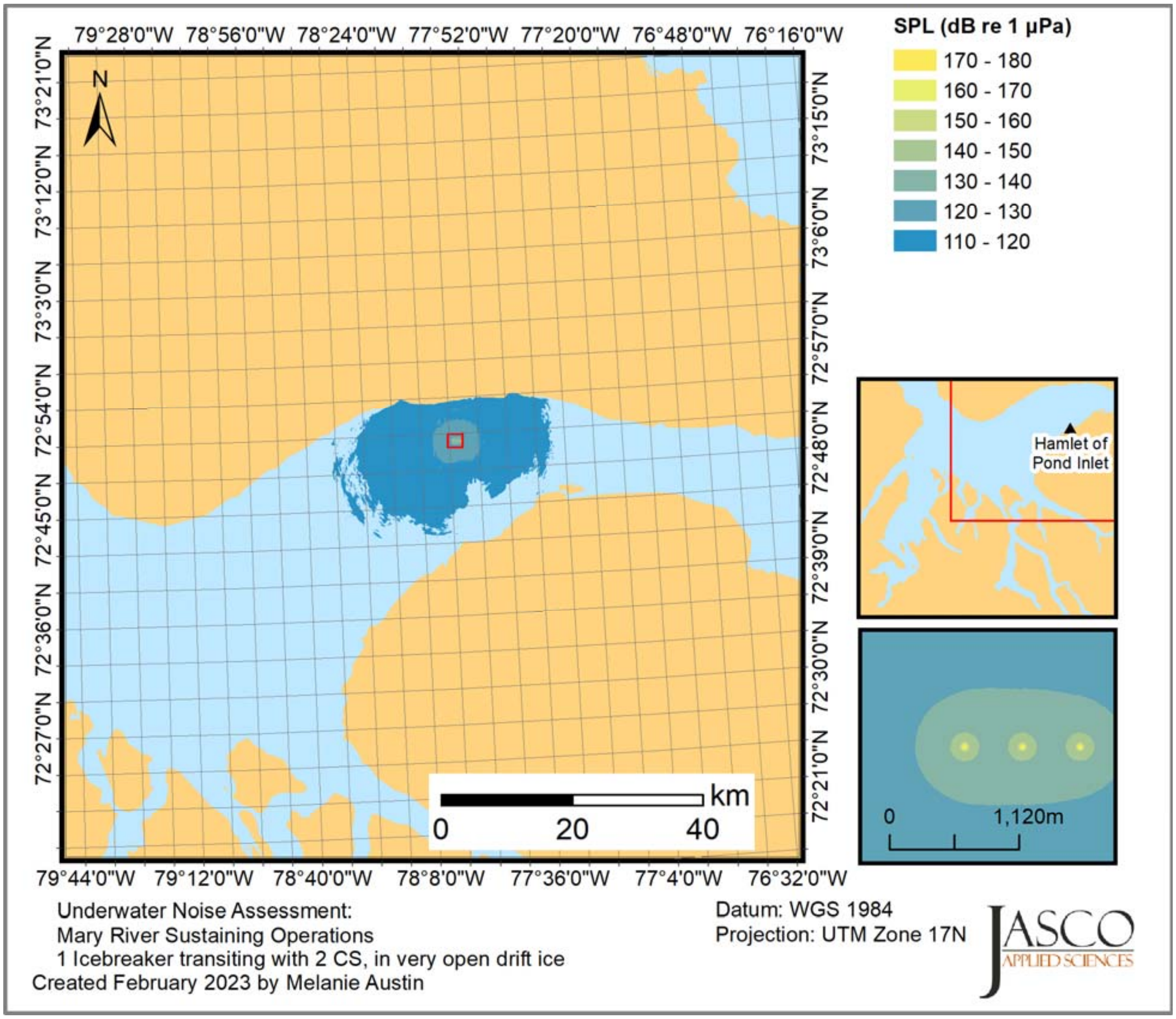

Figure D-40. Scenario 40: Map of SPL isopleths in 10 dB steps corresponding to an icebreaker and two Capesize (CS) ore carriers transiting at 9 knots in very open drift ice in Pond Inlet.

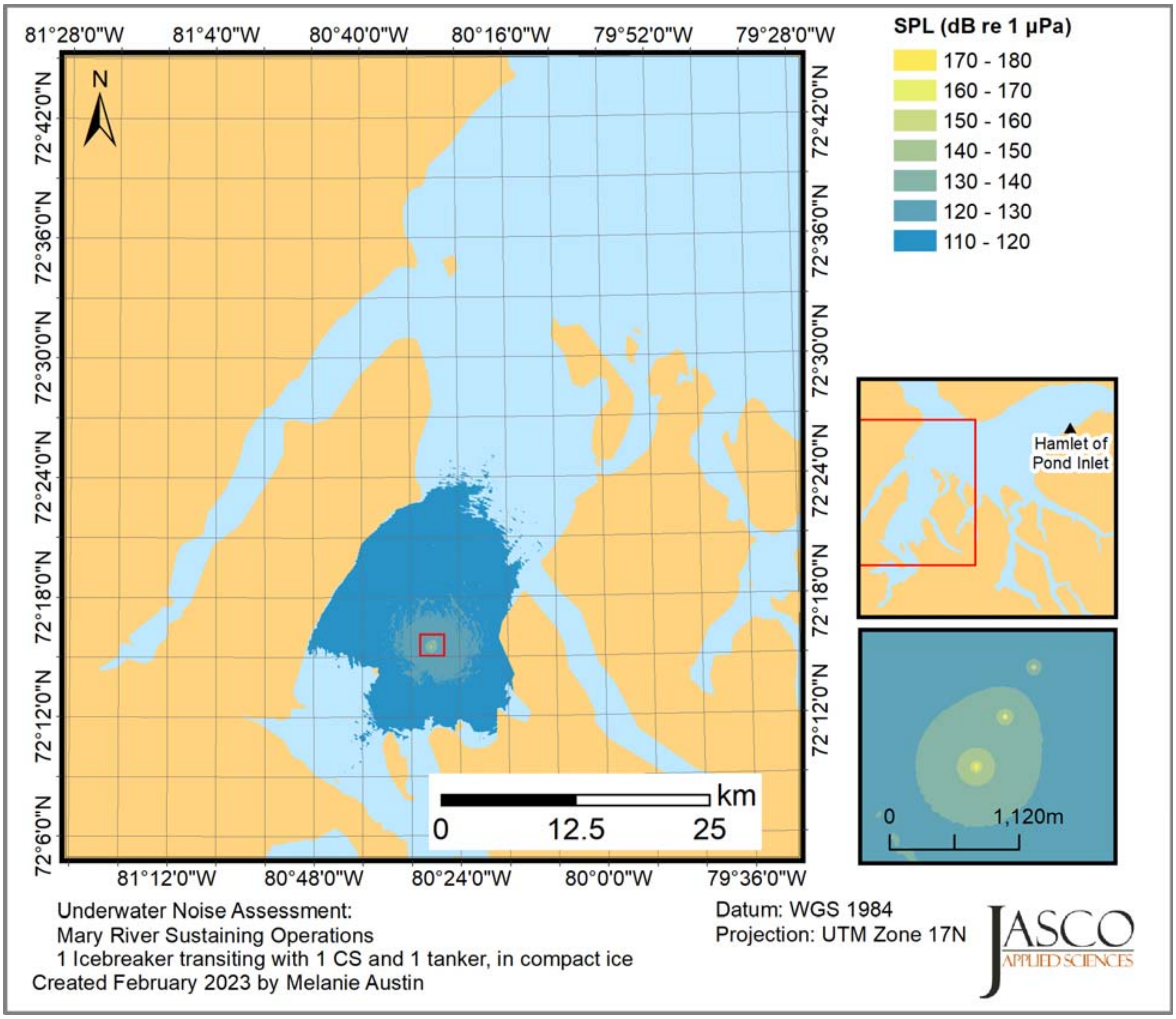

Figure D-41. Scenario 41: Map of SPL isopleths in 10 dB steps corresponding to an icebreaker, a tanker, and a Capesize (CS) ore carrier transiting at 5 knots in compact ice in Milne Inlet.

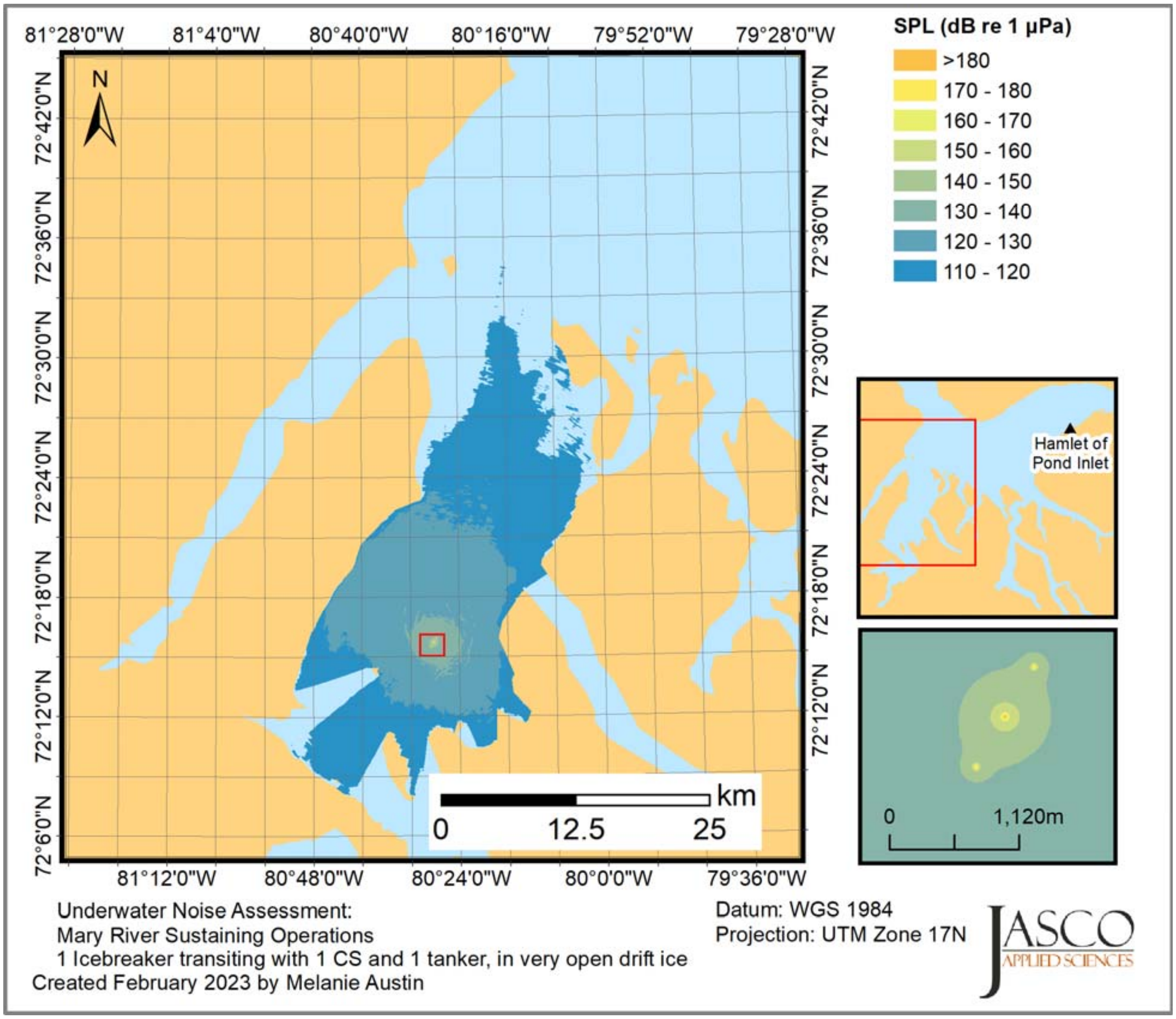

Figure D-42. Scenario 42: Map of SPL isopleths in 10 dB steps corresponding to an icebreaker, a tanker, and a Capesize (CS) ore carrier transiting at 9 knots in very open drift ice in Milne Inlet.

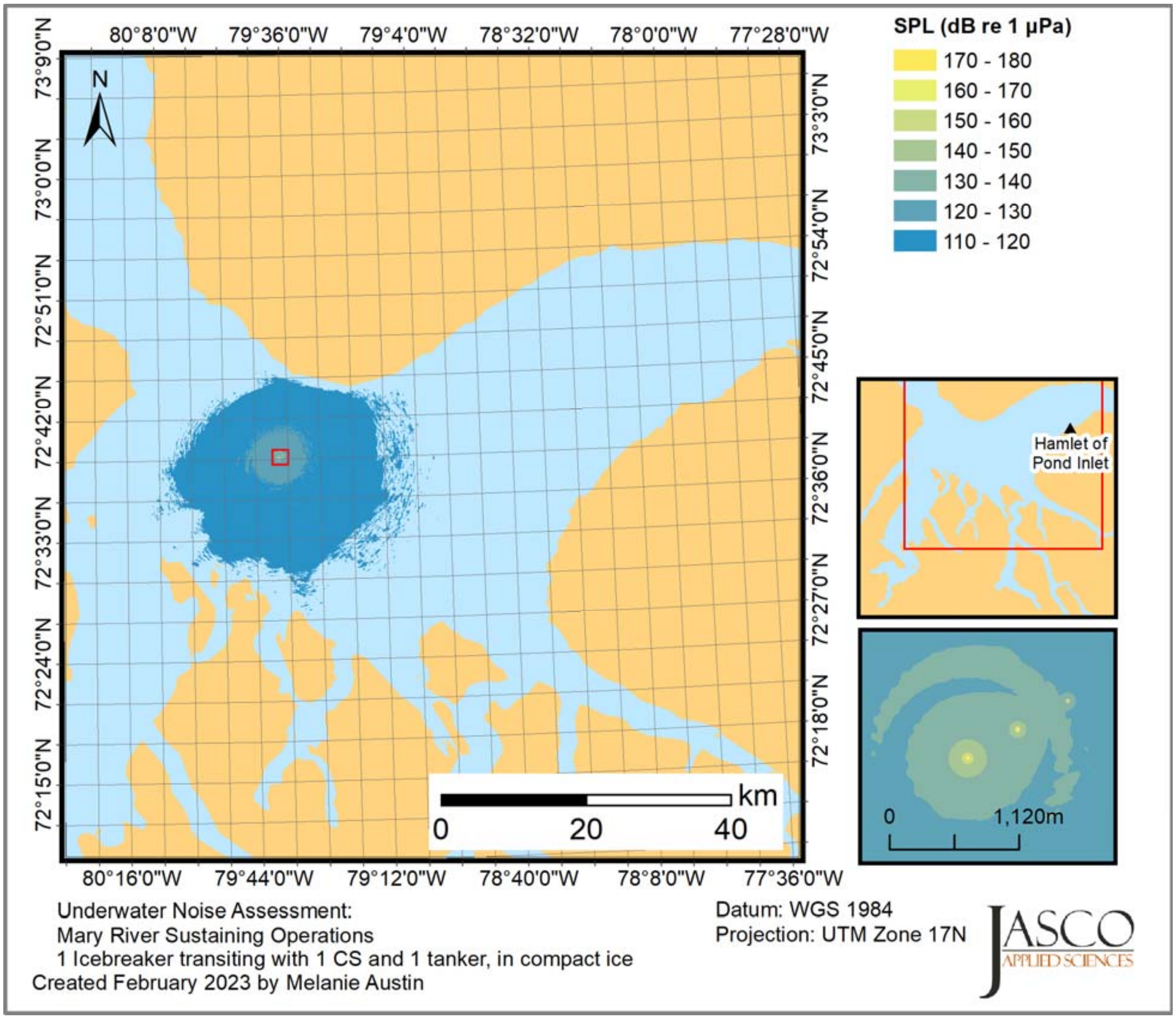

Figure D-43. Scenario 43: Map of SPL isopleths in 10 dB steps corresponding to an icebreaker, a tanker, and a Capesize (CS) ore carrier transiting at 5 knots in compact ice in Eclipse Sound.

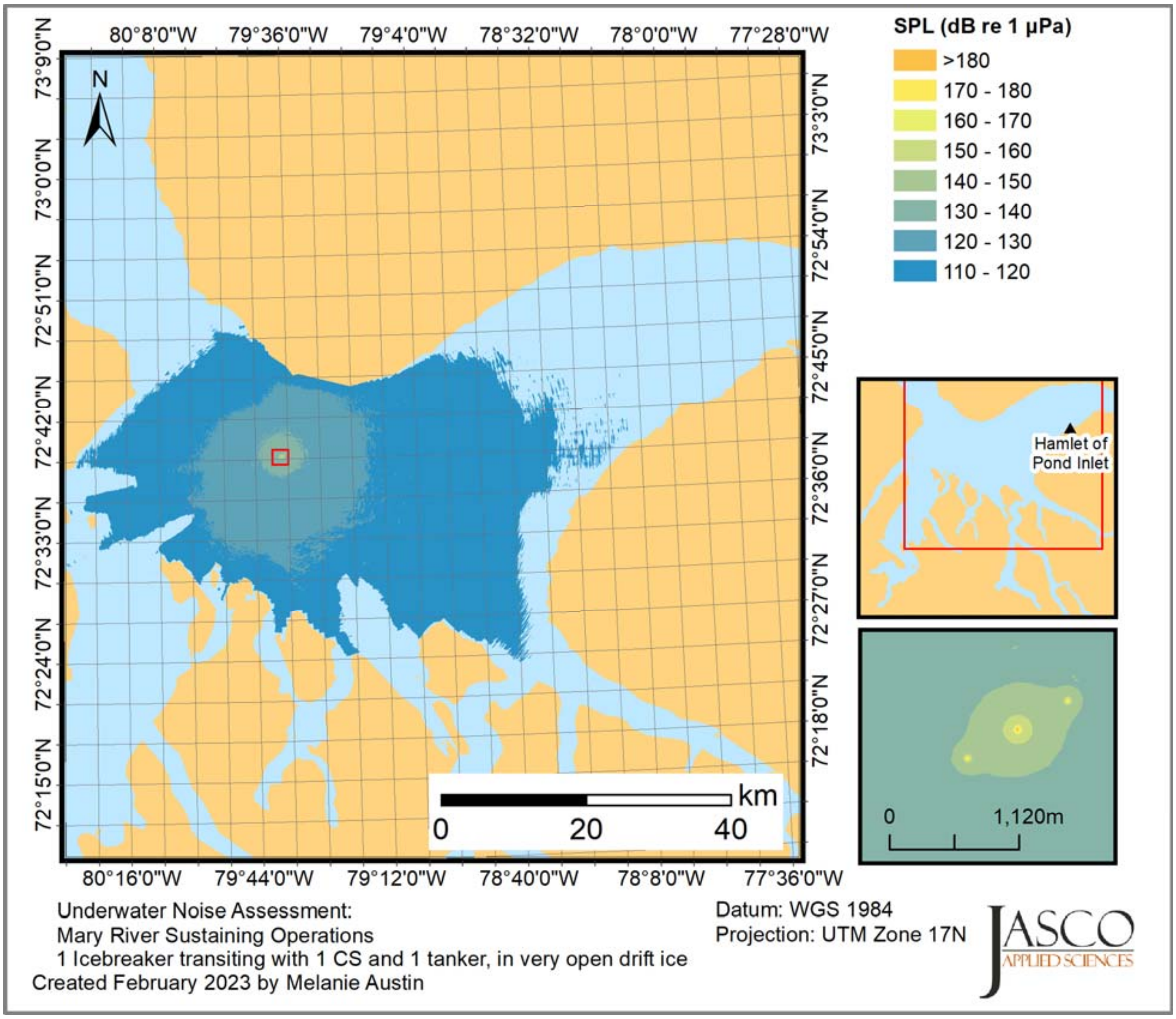

Figure D-44. Scenario 44: Map of SPL isopleths in 10 dB steps corresponding to an icebreaker, a tanker, and a Capesize (CS) ore carrier transiting at 9 knots in very open drift ice in Eclipse Sound.

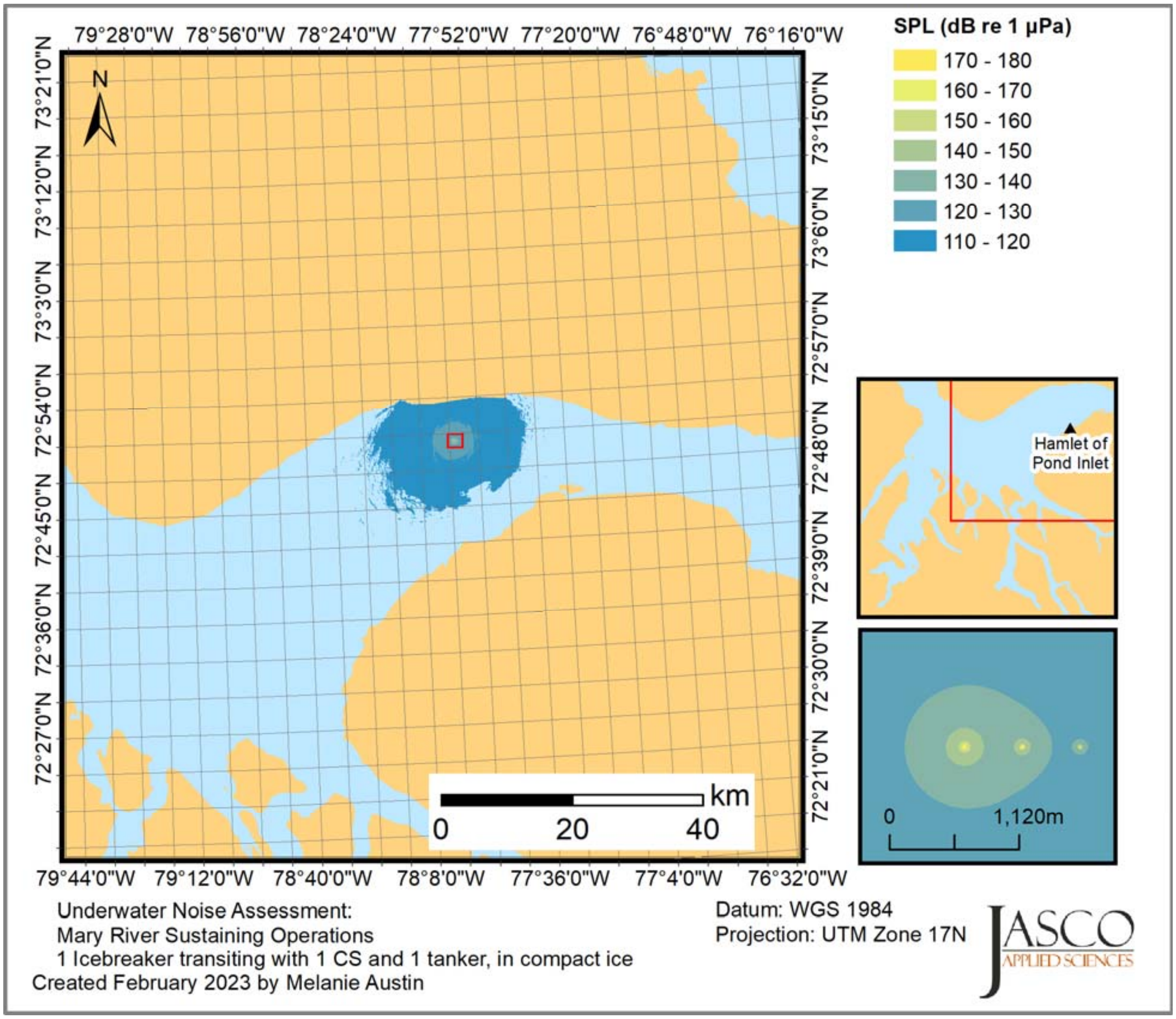

Figure D-45. Scenario 45: Map of SPL isopleths in 10 dB steps corresponding to an icebreaker, a tanker, and a Capesize (CS) ore carrier transiting at 5 knots in compact ice in Pond Inlet.

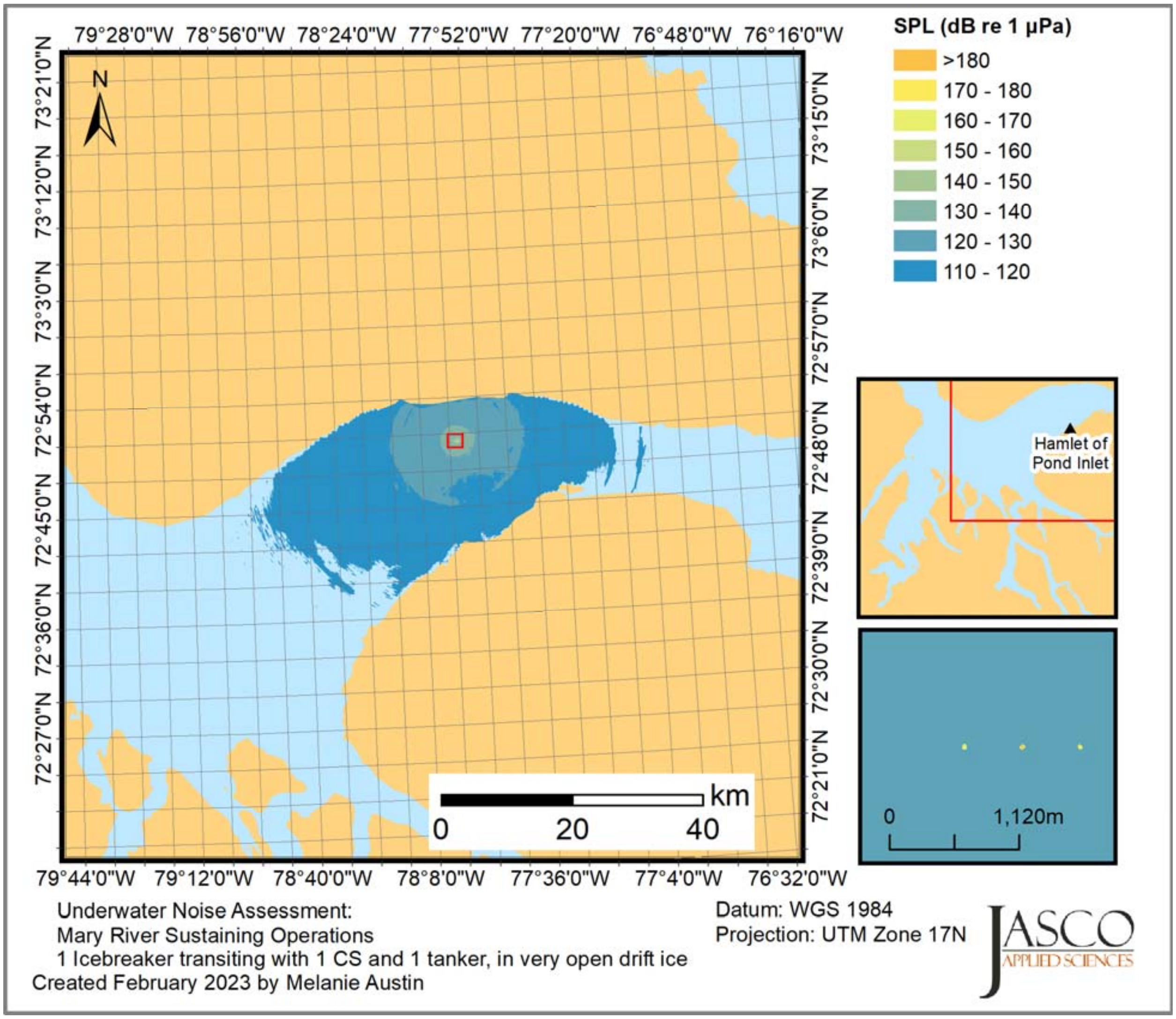

Figure D-46. Scenario 46: Map of SPL isopleths in 10 dB steps corresponding to an icebreaker, a tanker, and a Capesize (CS) ore carrier transiting at 9 knots in very open drift ice in Pond Inlet.

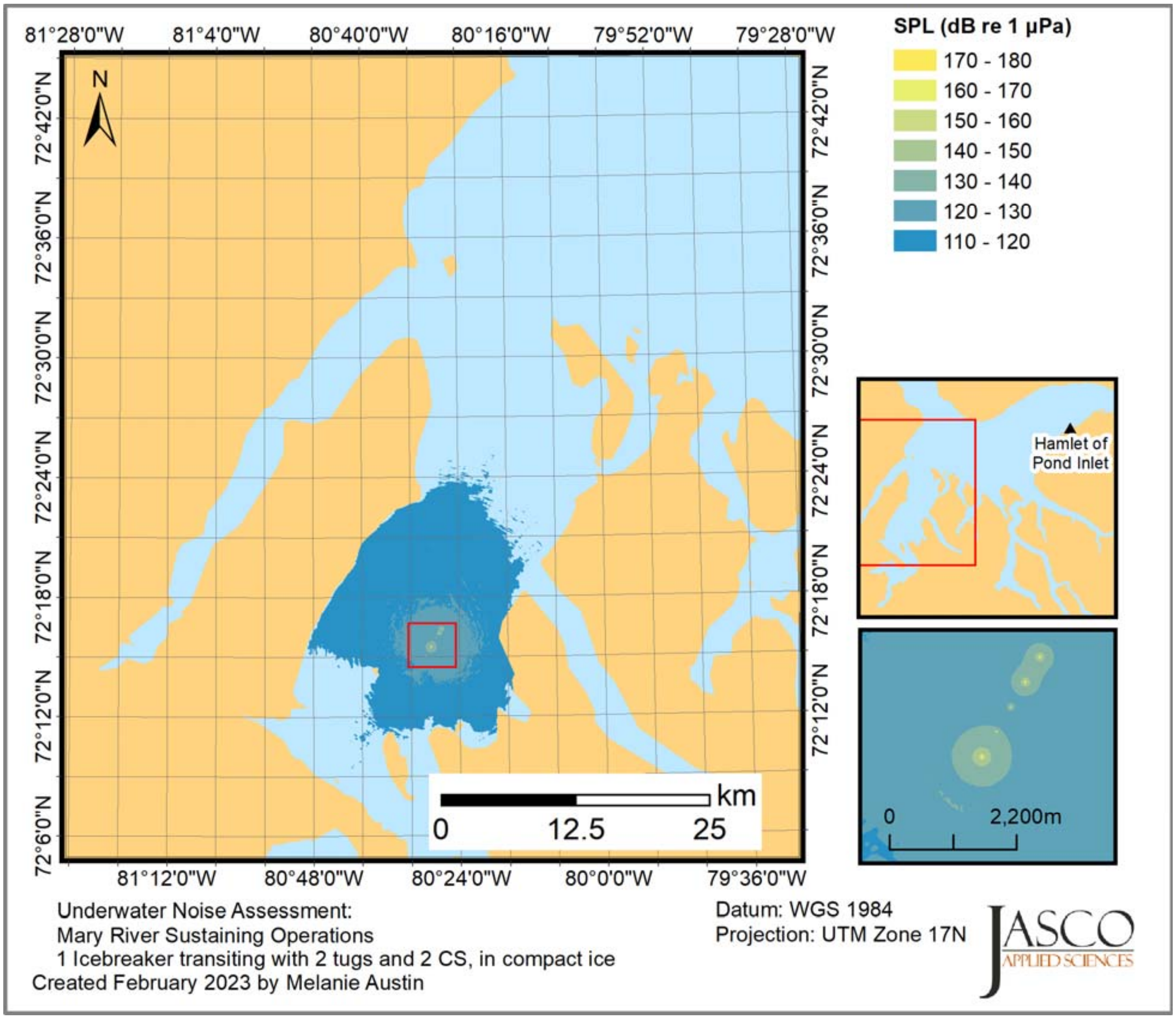

Figure D-47. Scenario 47: Map of SPL isopleths in 10 dB steps corresponding to an icebreaker, two tugs, and two Capesize (CS) ore carriers transiting at 5 knots in compact ice in Milne Inlet.

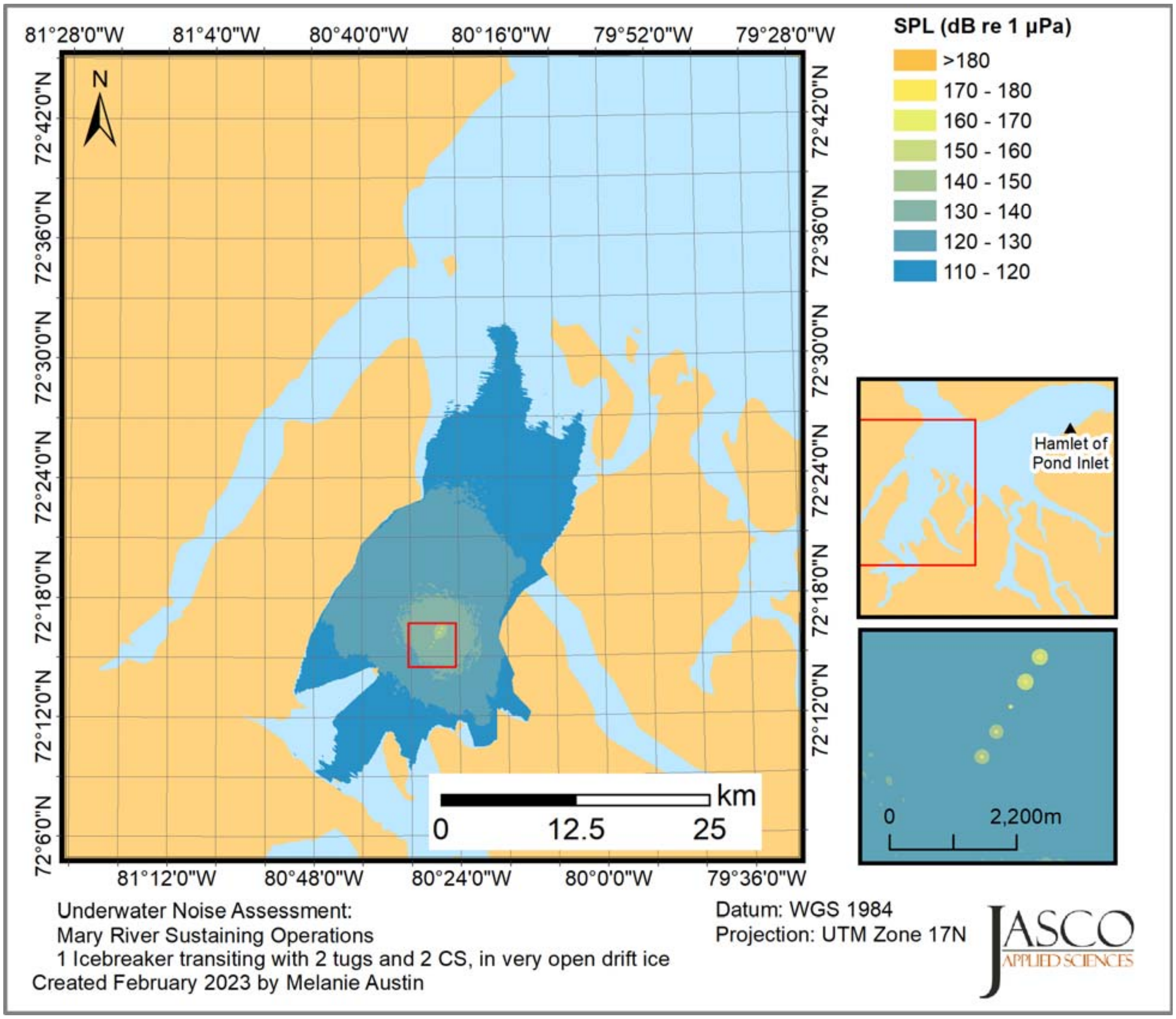

Figure D-48. Scenario 48: Map of SPL isopleths in 10 dB steps corresponding to an icebreaker, two tugs, and two Capesize (CS) ore carriers transiting at 9 knots in very open drift ice in Milne Inlet.

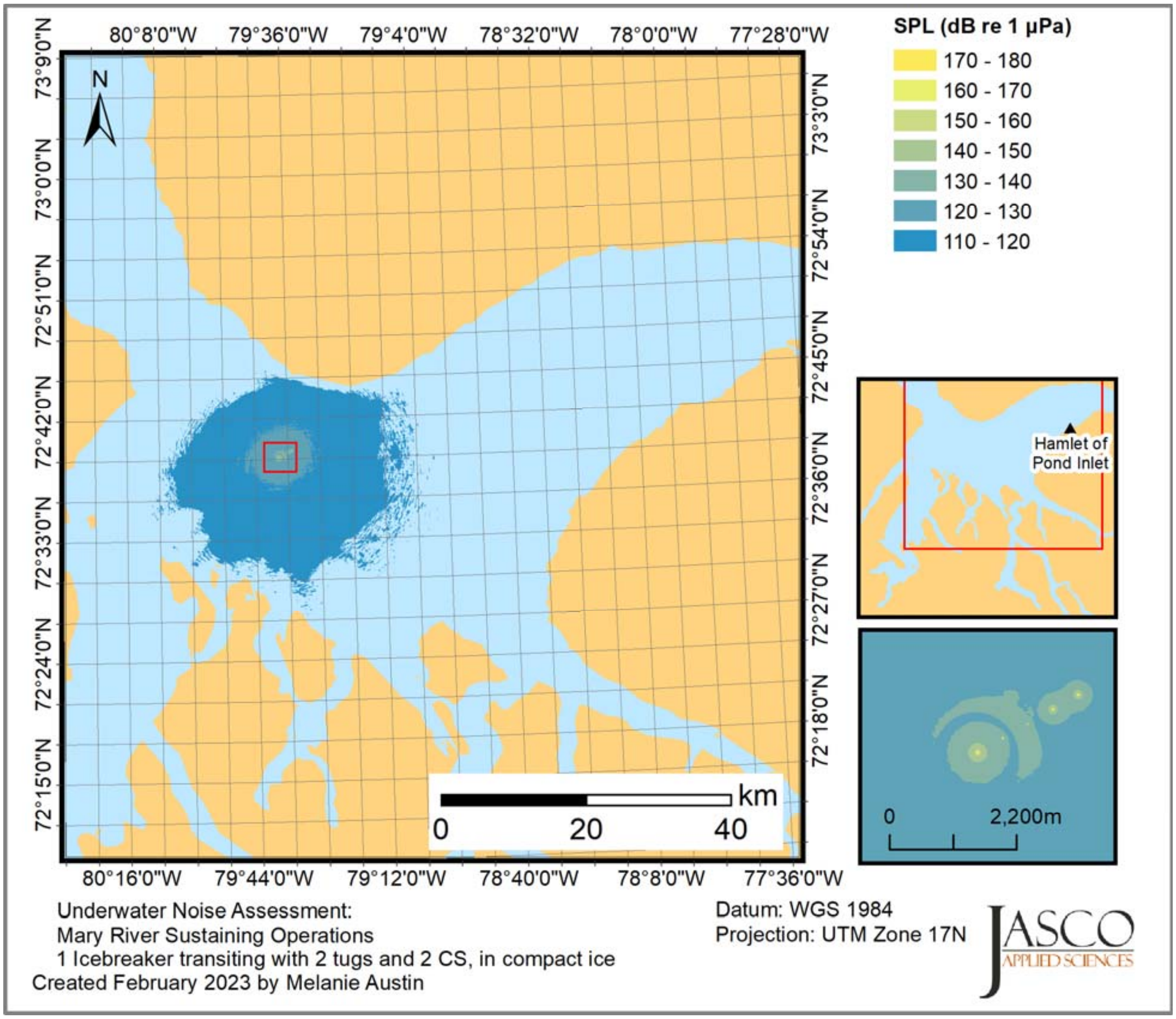

Figure D-49. Scenario 49: Map of SPL isopleths in 10 dB steps corresponding to an icebreaker, two tugs, and two Capesize (CS) ore carriers transiting at 5 knots in compact ice in Eclipse Sound.

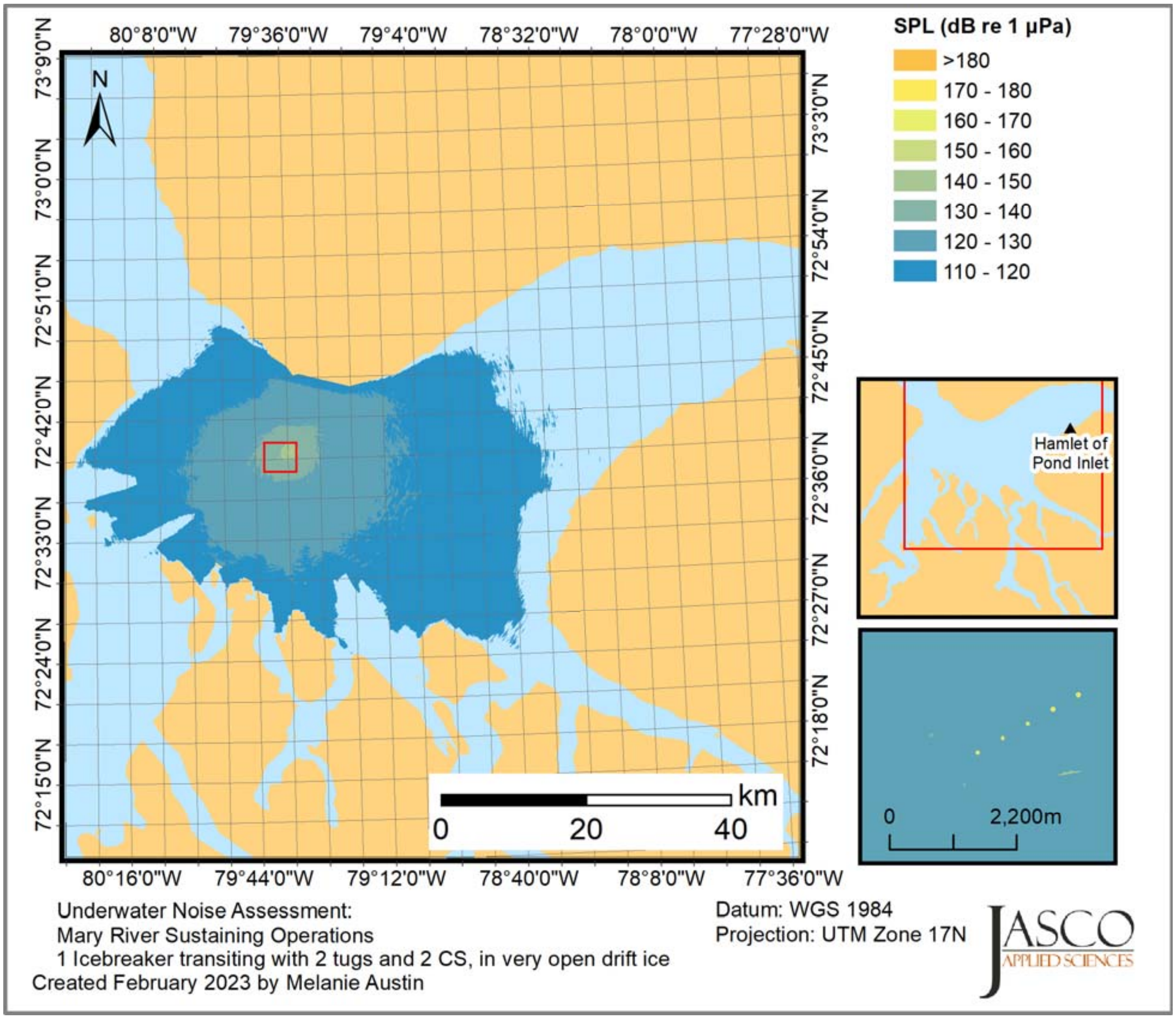

Figure D-50. Scenario 50: Map of SPL isopleths in 10 dB steps corresponding to an icebreaker, two tugs, and two Capesize (CS) ore carriers transiting at 9 knots in very open drift ice in Eclipse Sound.

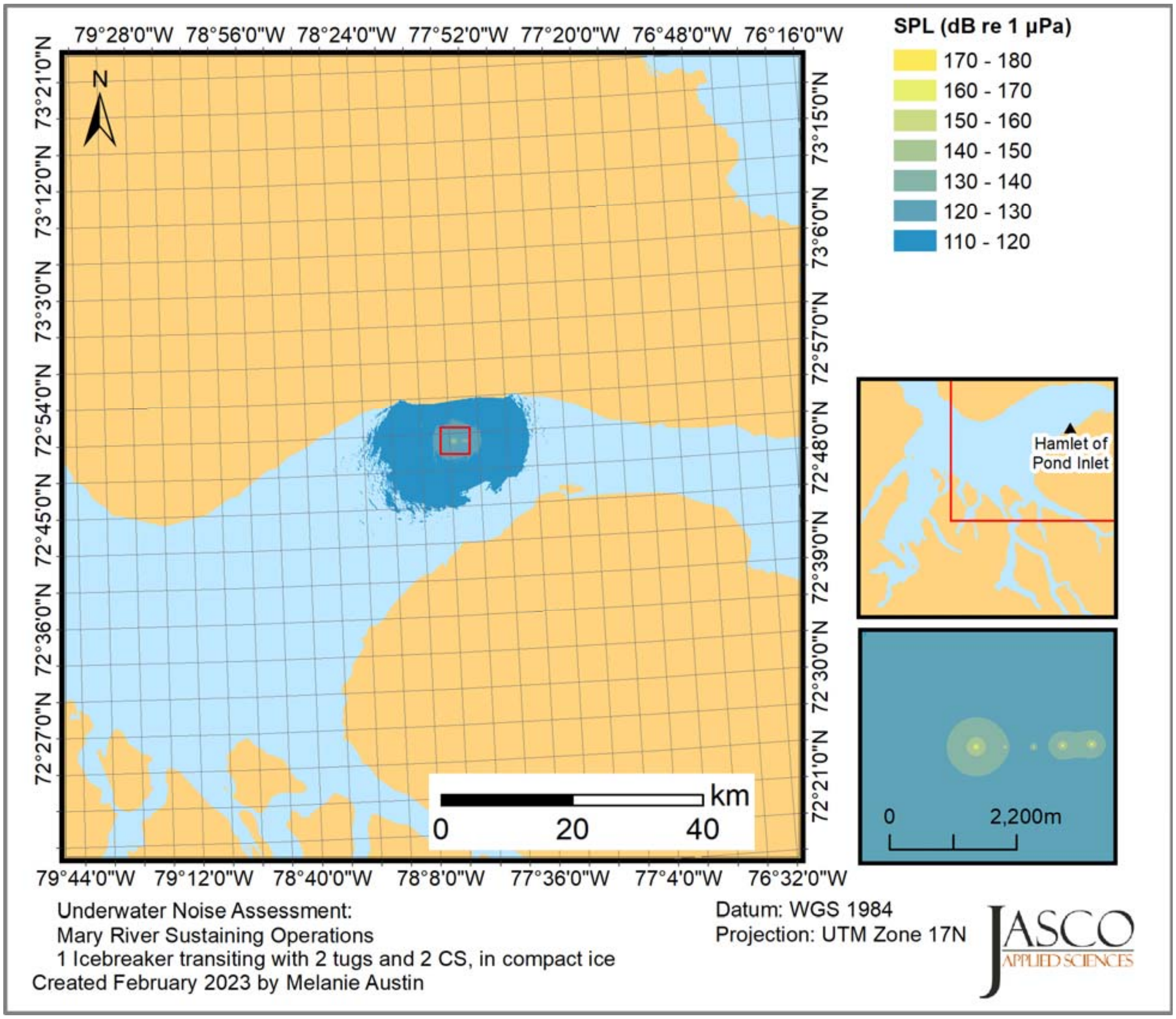

Figure D-51 Scenario 51: Map of SPL isopleths in 10 dB steps corresponding to an icebreaker, two tugs, and two Capesize (CS) ore carriers transiting at 5 knots in compact ice in Pond Inlet.

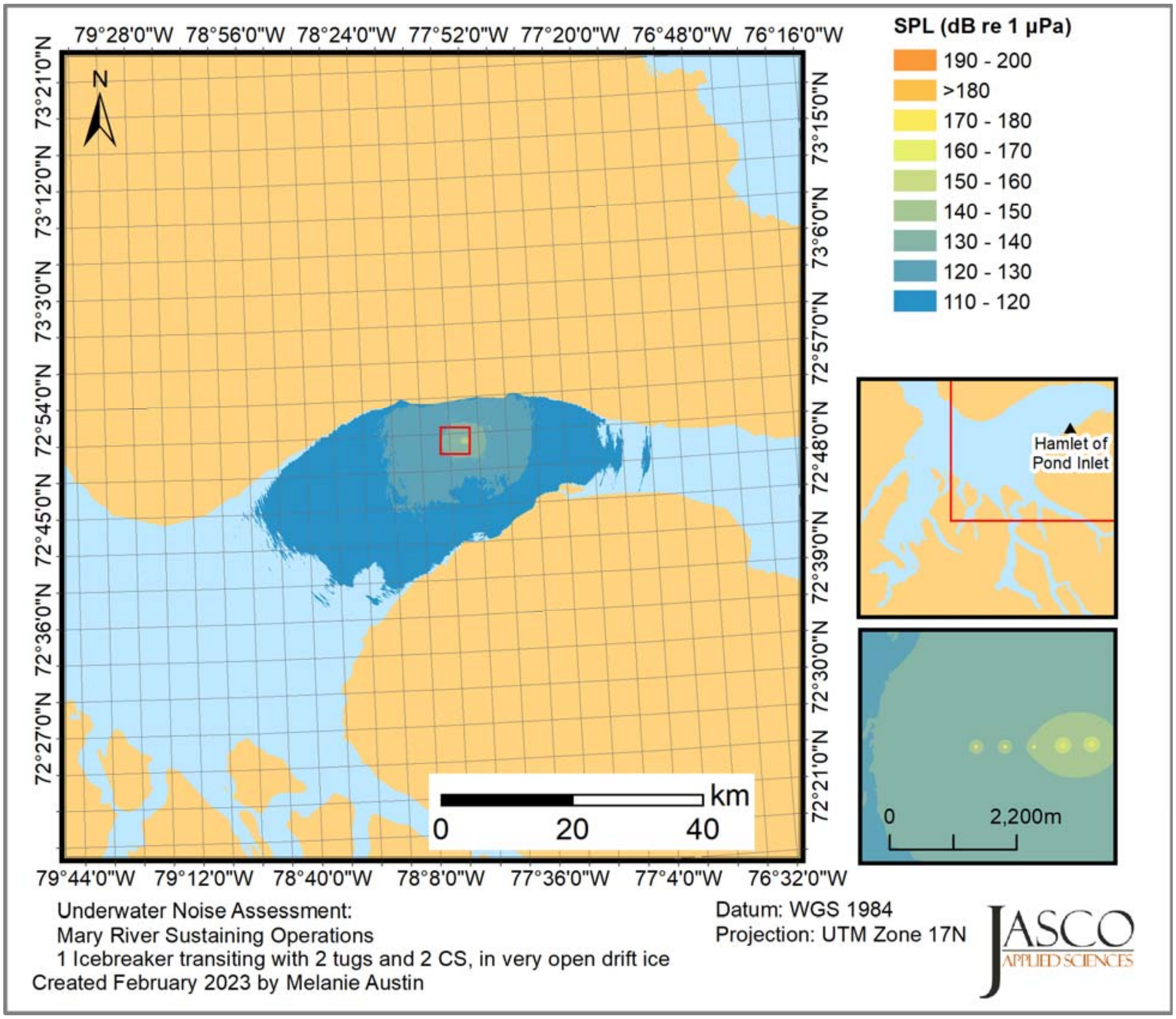

Figure D-52. Scenario 52: Map of SPL isopleths in 10 dB steps corresponding to an icebreaker, two tugs, and two Capesize (CS) ore carriers transiting at 9 knots in very open drift ice in Pond Inlet.

D.2. SEL$_{24h}$ Maps

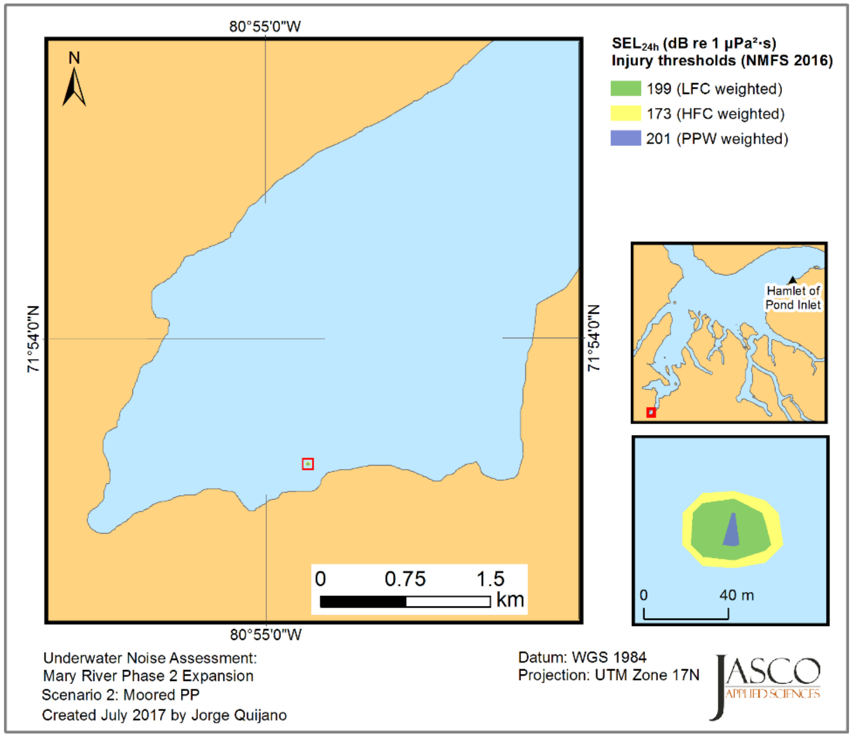

Figure D-53. Scenario 1: Map of SEL$_{24h}$ distances to injury thresholds according to NMFS 2018 corresponding to a Post-Panamax (PP) ore carrier moored at the ore dock at Milne Port.

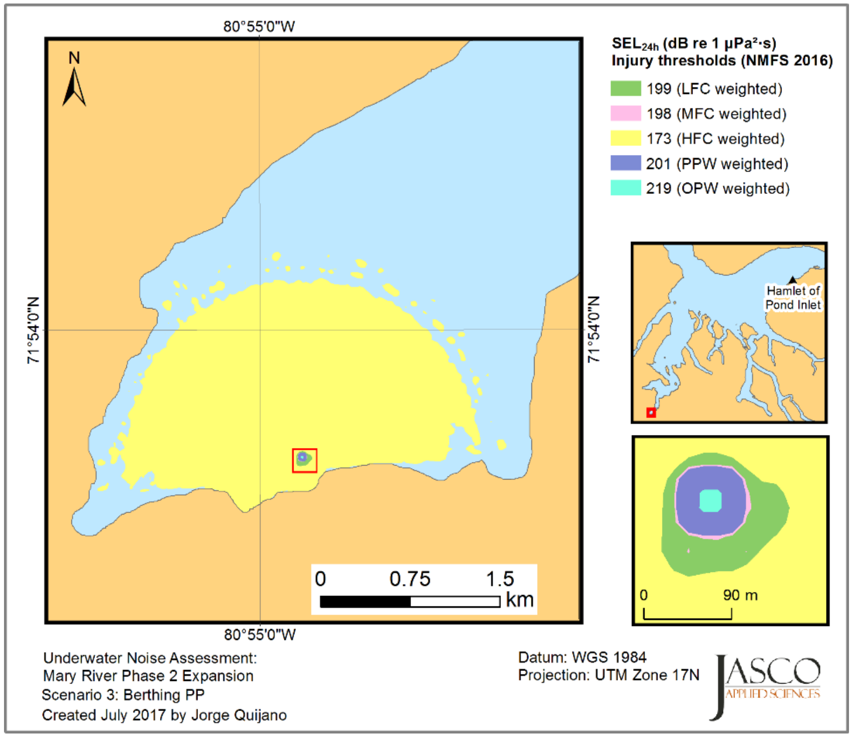

Figure D-54. Scenario 2: Map of SEL_{24h} distances to injury thresholds according to NMFS 2018 corresponding to the tug-assisted berthing of a Post-Panamax (PP) ore carrier at the ore dock at Milne Port.

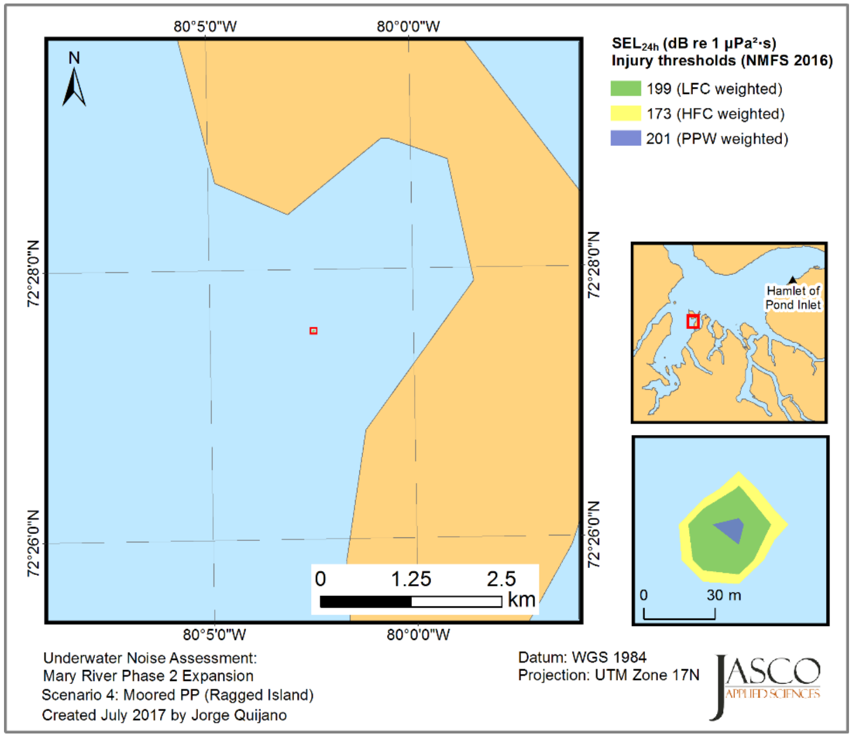

Figure D-55. Scenario 3: Map of SEL_{24h} distances to injury thresholds according to NMFS 2018, corresponding to a Post-Panamax (PP) ore carrier moored at Ragged Island.

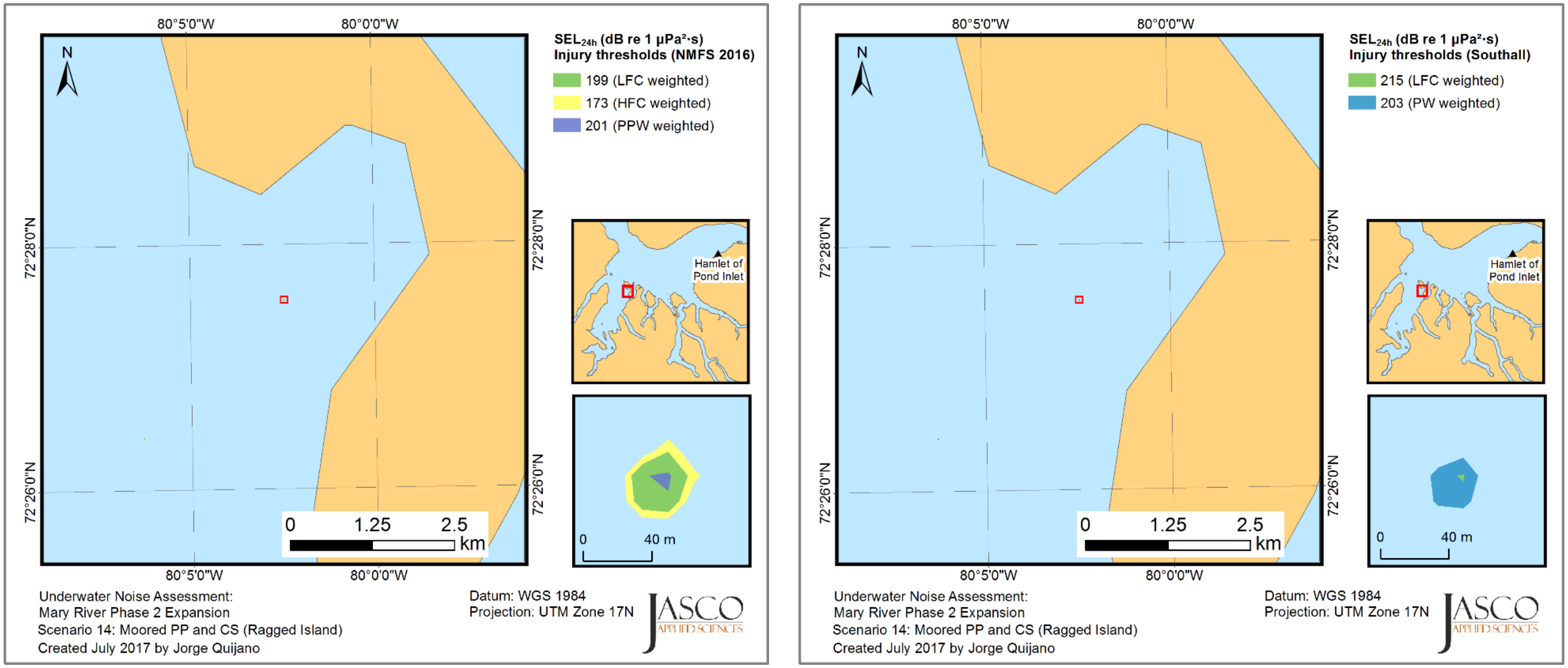

Figure D-56. Scenario 10: Map of SEL_{24h} distances to injury thresholds according to NMFS 2018, corresponding to a Post-Panamax (PP) and a Capesize (CS) ore carrier moored at Ragged Island.

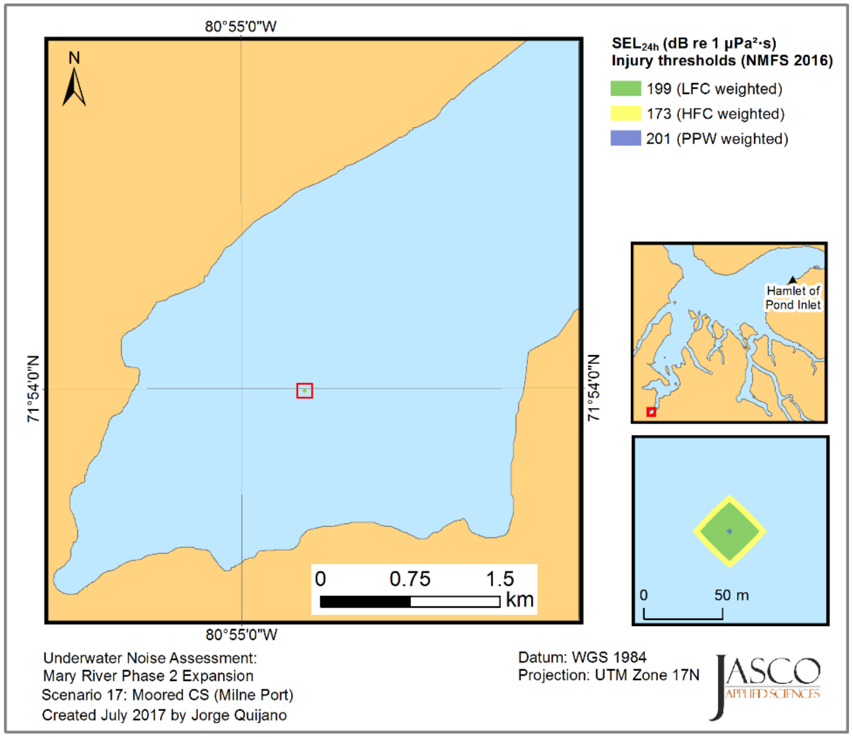

Figure D-57. Scenario 11: Map of SEL_{24h} distances to injury thresholds according to NMFS 2018, corresponding to a Capesize (CS) ore carrier moored at the anchor point A2 at Milne Port.

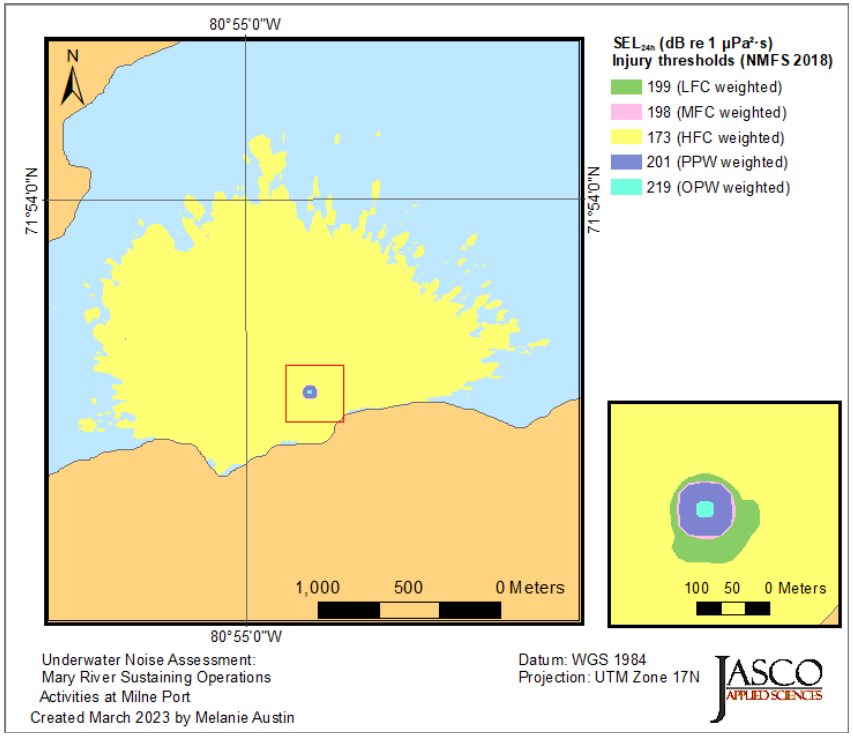

Figure D-58. Scenario 22: Map of SEL_{24h} distances to injury thresholds according to NMFS 2018, corresponding to a scenario with a Post-Panamax (PP) ore carrier berthing at the ore dock with tug assistance, a Cape Size (CS) ore carrier anchored in Milne Port, and a CS ore carrier transiting at 5 kn at Milne Port with tug escorts.

Attachment 2
Example Shipping Season

Table 1. Example shipping season

Transit	Convoy	Vessel	From	To	Vessel	From	To	Vessel	From	To	Distance (km)
1	X	Ship A	Baffin Bay	Milne Inlet	Ship B	Baffin Bay	Milne Inlet	Ship C	Baffin Bay	Milne Inlet	243
2		Ship D	Baffin Bay	Milne Inlet							243
3		Ship A	Milne Inlet	Baffin Bay							243
4	X	Ship E	Baffin Bay	Milne Inlet	Ship F	Baffin Bay	Ragged Island				243
5		Ship B	Milne Inlet	Baffin Bay							243
6		Ship C	Milne Inlet	Baffin Bay							243
7	X	Ship G	Baffin Bay	Ragged Island	Ship H	Baffin Bay	Ragged Island				173
8		Ship D	Milne Inlet	Baffin Bay							243
9		Ship F	Ragged Island	Milne Inlet							70
10		Ship E	Milne Inlet	Baffin Bay							243
11		Ship F	Milne Inlet	Baffin Bay							243
12	X	Ship G	Ragged Island	Milne Inlet	H	Ragged Island	Milne Inlet				70
13		Ship G	Milne Inlet	Baffin Bay							243
14		Ship H	Milne Inlet	Baffin Bay							243
										Total Distance covered:	2,986km

Table 2. Example Reporting Structure

Date	Transit	Vessel	Inbound/Outbound	Departure Position	Arrival Position	Distance KM)	Total Distance	Convoy #
30/07/2022	Convoy 1	Nordic Olympic	Inbound	73W	Berth		243	
30/07/2022	Convoy 1	Nordic Siku	Inbound	73W	Milne Anchorage 1	243	243	1
30/07/2022	Convoy 1	Nordic Odin	Inbound	73W	Milne Anchorage 2		243	
31/07/2022	Convoy 2	Nordic Sanngijug	Inbound	73W	Ragged Anchorage 3	173	173	2
31/07/2022	Convoy 2	Nordic Odyssey	Inbound	73W	Ragged Anchorage 1		173	
01/08/2022	Single	Nordic Olympic	Outbound	Berth	73W	243	243	
01/08/2022	Single	Nordic Sanngijug	Inbound	Ragged Anchorage 3	Milne Anchorage 1	70	70	
02/08/2022	Convoy 3	Arkadia	Inbound	73W	Ragged Island	173	173	3
02/08/2022	Convoy 3	Nordic Qinngua	Inbound	73W	Ragged Anchorage 3		173	
02/08/2022	Single	Nordic Siku	Outbound	Berth	73W	243	243	
03/08/2022	Single	Arkadia	Inbound	Ragged Island	Milne Anchorage 1	70	70	
03/08/2022	Convoy 4	Golden Ice	Inbound	73W	Ragged Island	173	173	4
03/08/2022	Convoy 4	Golden Brillaint	Inbound	73W	Ragged Anchorage 2		173	

Attachment 3
Example Convoy Target Calculations

The following tables demonstrate how the effective distances are calculated by transit segment (i.e. Baffin Bay to Ragged Island) and as a total for the season. Ultimate performance is measured by comparing the total effective distance travelled by the base case, which is the total distance travelled by all vessels without consideration for convoys. For simplicity, in both scenarios 80 ore carriers are chartered, where in absence of convoy implementation, an overall distance of 38,880 km would be travelled (Table 1). Under an approved Sustaining Operations Proposal (SOP) a maximum of up to 84 ore carriers could be chartered in years 2023+, which is can be variable year over year given the types of vessels available on the market). Estimated transit reductions were calculated using convoy targets of 5% (Scenario 1) and 10% (Scenario 2).

Table 1. Distance of transits based on number of ore carriers

Number of Ore Carriers (A)	Individual Transits (B)	Distance of Transits (km) (C)	Overall Distance Travelled (km) (B x C)
80	160 (80x2)	243	38,880

Scenario 1: 5% reduction target

In this first scenario where a target of 5% has been set as an example, 59 vessels transit direct from Baffin Bay to Milne Port during the shipping season, 46 travel individually, and 13 travel in convoys between two and three in size (Table 2). The remaining 21 vessels must anchor at Ragged Island en-route to Milne Port, 13 of which travel individually and 8 travel in convoys of two in size. Once at Ragged Island, 19 travel independently to Milne Port while the remaining 2 ore carriers travel in one convoy of two. All outbound vessels from Milne Port to Baffin Bay travel independently.

While a total of 80 vessels travelled between Baffin Bay and Milne Port and back, convoying combines individual transits to produce ‘effective transits’, in this case it’s 52 for the Baffin Bay to Milne Port segment, 17 for the Baffin Bay to Ragged Island segment, and 20 for the Ragged Island to Milne Port segment. The total effective distance per transit segment is calculated by multiplying the number of total effective transits for the transit segment by the corresponding transit distance (km). The total effective distance for the shipping season is calculated by adding each of the total transit segment distances together. In this case, convoying provides a total effective distance for the season of 36,417 km, which represents a 6% reduction from the base case. The target of 5% for the given shipping year would be met.

Table 2. Scenario 1 showing transit reduction calculations based on a 5% target

	INBOUND			OUTBOUND
Transit Segment	**Baffin Bay to Milne Port**	**Baffin Bay to Ragged Island**	**Ragged Island to Milne Port**	**Milne Port to Baffin Bay**
Transit Distance (km)	**243**	**173**	**70**	**243**
Individual Transits	46	13	19	80
Convoy Transit - 2	5	4	1	0
Convoy Transit - 3	1	0	0	0
Convoy Transit - 4	0	0	0	0
Convoy Transit - 5	0	0	0	0
Total Vessels	*59*	*21*	*21*	*80*
Total Effective Transits	52	17	20	80
Effective Distance per Transit Segment (km)	12,636	2,941	1,400	19,440
Total Effective Distance for the Shipping Season (km)	36,417			
Total Estimated Reduction from Base (%)	6			
Base (no convoy target; km)	38,880			
Effective Target Distance with Annual Target (km)	36,936			
Annual Target (%) Set	5			
Total Trips to Milne Port	80			

Scenario 2: 10% reduction target

In this second scenario where a target of 10% has been set, 37 vessels transit direct from Baffin Bay to Milne Port during the shipping season, 30 travel individually, and 7 travel in convoys between two and three in size (Table 3). The remaining 43 vessels must anchor at Ragged Island en route to Milne Port, 11 of which travel individually and 32 travel in convoys between 2 and 3 in size. Once at Ragged Island, 35 travel independently to Milne Port while the remaining 8 travel in a convoy of two in size. All outbound vessels from Milne Port to Baffin Bay travel independently.

While a total of 80 vessels travelled between Baffin Bay and Milne Port and back, convoying combines individual transits to produce 'effective transits', in this case it's 33 for the Baffin Bay to Milne Port segment, 27 for the Baffin Bay to Ragged Island segment, and 39 for the Ragged Island to Milne Port segment. The total effective distance for the shipping season is calculated by adding each of the total transit segment distances together. In this case, convoying provides a total effective distance for the season of 34,860 km, which represents a 6% reduction from the base case. The target of 10% for the given shipping year would be met.

Table 3. Scenario 2 showing transit reduction calculations based on a 10% target

	INBOUND			OUTBOUND
Transit Segment	**Baffin Bay to Milne Port**	**Baffin Bay to Ragged Island**	**Ragged Island to Milne Port**	**Milne Port to Baffin Bay**
Transit Distance (km)	243	173	70	243
Individual Transits	30	11	35	80
Convoy Transit - 2	2	16	4	0
Convoy Transit - 3	1	0	0	0
Convoy Transit - 4	0	0	0	0
Convoy Transit - 5	0	0	0	0
Total Vessels	37	43	43	80
Total Effective Transits	33	27	39	80
Effective Distance per Transit Segment (km)	8,019	4,671	2,730	19,440
Total Effective Distance for the Shipping Season (km)	34,860			
Total Estimated Reduction from Base (%)	10			
Base (no convoy target; km)	38,880			
Effective Target Distance with Annual Target (km)	34,992			
Annual Target (%) Set	10			
Total Trips	80			

Appendix G:
Narwhal Adaptive Management Response Plan (to be amended as required) *Latest version is 2022