Follow up to Technical Meeting held May 1st to May 3rd, 2012

Submitted May 15th, 2012

This document provides responses as a follow up to discussions had between Baffinland and regulatory agencies at the technical meetings held by the Nunavut Impact Review Board (NIRB) in Iqaluit on May 1st to May 3rd, 2012. This document broadly categorizes the requests and responses into four main categories. The information request number (IR #) is referenced, however, a brief summary of the request is provided as the request in most cases seeks additional clarity to responses provided by Baffinland on April 19th, 2012, prior to the technical meetings.

Air, freshwater, soils

1. NIRB IR # 3b - Indicate whether the Proponent intends to adjust the site layout based on the air quality modeling results and, if so, whether dispersion modeling will be re-run once the site layout has been reconfigured.

   Response: RWDI have generated information on the frequency of exceeding the federal acceptable level for 1-hr NO_2 (400 ug/m3) at the accommodations. For model grid points that were co-located with the building or near it, the number of hours above the threshold in the 1-year simulation ranged from 51 to 242, depending on the grid point. This corresponds to between 0.6% and 2.8% of the time.

   There were no exceedances for SO_2. There were exceedances of 24-hr particulate matter (PM2.5 and TSP) but these were more related to mining operations than the power plant stacks.

   RWDI are currently running frequency information on PM. Once the latest layout of power plant relative to accommodation camp is established dispersion modelling will be re-run. If necessary, mitigation measures will be taken to reduce NO_2 emissions to within acceptable limits.

2. EC IR # 10 – Environment Canada (EC) requests that the Proponent clarify the discrepancies between the results cited from the "Spill Response Gap Study for the Canadian Beaufort Sea and the Canadian Davis Strait" in the Final Environmental Impact Statement (FEIS) and those that are actually provided in the report.

   Response: The request refers to information presented in Volume 9, section 3.8.5, the 4th paragraph which references conclusions on the gap analysis conducted by S.L. Ross Environmental Research Limited.

Baffinland acknowledges the error in the FEIS document. The information quoted in the FEIS is for the wind data set which is only one of the parameters considered by the study. This section was meant to include additional text which was lost during the final edition/preparation of the documents. Baffinland regrets this omission. The following text should be added:

"In consideration of all four parameters (wind, wave, visibility and daylight) considered, for the central Davis Strait, the report concludes that for the months of August through December, response with at least one of three of the three countermeasures options would be possible:

- **From 16 to 65% of the time in this period for the West Central Davis Strait; and,**
- **From 15% to 63% of the time in this period for the Central Davis Strait."**

"Marginal" or "not possible" responses can either be due to wind, waves, visibility, daylight and/or partial ice coverage. The obvious conclusion of the report is that the countermeasures options for response are effective, or partly effective, only during the open water season. Baffinland did not undertake a similar gap analysis for the Foxe Basin.

The report presents interesting information and is useful in guiding decision making relative to the shipment of fuel to the Project area (either to Milne Port or Steensby Port). In order to maximize the effectiveness of the spill response countermeasures (should a spill event occur), it is preferable to schedule fuel shipment during the open water season. This is what Baffinland is planning to do.

3. EC IR # 11a – Provide monthly flow diagrams comparable to the annual flow diagrams found in Volume 3 Appendix 3B Attachment 5 Appendix 100-2 Figures 1 through 7.

Response: We discussed the assessment methodology with the EC hydrologist on May 3 and clarified questions, such that the monthly site water balances were no longer needed by EC to conduct their technical review.

4. EC IR # 11b – Complete the assessment of water diversion and withdrawal using the 1:10 year dry period to determine if the 10% threshold will be exceeded when the area is subject to typical dry conditions.

Response: Completed and provided directly to EC.

5. DFO IR # 5.1a– Using the recommended swimming distance correction (reduce distance by half) for Table 7-4.10, please provide an update on how this change will affect the fish passage and HADD assessments.

Response: Fisheries and Oceans (DFO) had not previously challenged Baffinland's use of velocities under average flow conditions or requested any change to our threshold velocities. Baffinland understands that DFO would like Baffinland to halve the culvert lengths that are associated with each incremental velocity category in the fish passage matrix (Table 7-4.10). Baffinland's interpretation is that the matrix in Table 7-4.10 therefore remains the same except that the culvert length values in the left column are all halved. Since almost all of the velocities for average flow conditions are <1.0 m/sec, there will not be any changes to the fish passage designations (i.e., Y, P or N as per Table 7-4.10). If there are no changes to fish passage designations, there will be no changes to the HADD assessments either.

DFO IR # 5.1b

Response: The velocity data that were used in the assessment were collected for a different purpose, but were the best data available as they reflected site-specific information. As part of the HADD process, Baffinland will provide greater detail on the methods used for the collection of flow data at culverts along the Tote Road, as well as a description of the method used to calculate average flows.

6. AANDC # 9 – AANDC requests the Proponent provide estimates of the quality of the future pit lake after closure including early closure scenarios.

Response: The current preliminary pit model will predict a continuing trend in declining pit water quality for a period of time following closure since some additional PAG rock is currently identified that would produce acid drainage a few years after closure.

However, there are two factors in particular that need to be considered in this respect for the current pit water quality model.

1) **The current pit model assumes rather aggressive acid drainage loading terms based on scaled NAG leachate results; and**
2) **There is presently limited sampling of rock from the periphery of the pit, so assumptions on the amount of PAG material at the final pit wall have been extrapolated from overall data from the pit volume that may not be representative.**

Both of these issues are presently being addressed. The first through operation of Carbonate NP depleted humidity cells and the second by a further drilling and sampling program planned for this summer. Baffinland can refine and update the current pit model and include post closure conditions with the addition of improved data when available.

7. EC IR# 25a, b, c. – (a) Clarify the treatment and fate of propylene glycol used in de-icing operations; (b) Provide more information on the design of the drainage system for collecting oil and propylene glycol from airstrips (for example it is unclear if the airport perimeter will be surrounded by a ditch and the ditch water reclaimed); and (c) Clarify what is meant by "interim treatment for propylene glycol", and whether recycling will be used.

   Response: TP312 does not include any standards on de-icing fluids. Aircraft de-icing will occur with aircraft parked on a paved surface, with run-off collected at single low-point catch basin. Originally design allowed for a valve chamber so that run-off could gravity-flow from catch basin to a below-ground spent-glycol storage tank. However, recent discussions with airlines indicate infrequent requirements for de-icing (due to minimal moisture in the air), and when de-icing does occur, low volumes are used (approximately 150L per Boeing 737 aircraft). The likely de-icing product will be Propylene Glycol, (for which Baffinland is providing two sample products, see Attachment 1), which is lower toxicity than ethylene glycol.

8. AANDC # 5 – Baffinland to provide additional information on explosives handling.

   Response: During the May 1st pre-technical meetings in Iqaluit AANDC requested Baffinland further describe additional provisions taken to reduce the increase in nitrate levels in pit water and the waste rock storage seepage resulting from the use of ammonia nitrate-fuel oil or ANFO. ANFO, the blasting agent, is water soluble therefore measures need to be taken to prevent elevated concentrations in the pit water and waste rock management seepage.

   The Mary River FEIS describes the management plans that apply at the explosives plant, during transportation and during construction. These Management Plans can be found in Volume 3, Appendix 3B, Attachment 8 particularly the Explosive Management Plan and Volume 3, Appendix 3B – Attachment 5: Environmental Protection Plan, section 5.2.20: Drilling Blasting and Crushing.

   As AANDC is aware, mining is subject to regulations limiting ammonia, nitrate and nitrite levels in mine effluents released into the environment. Some of these parameters are included in the Water License. While ammonia limits are not specified in the Metal Mines Effluent Regulations, there are acute toxicity requirements for undiluted effluent (acute lethality testing -as specified in Reference Method EPS1/RM/13) and Daphnia magna monitoring - see Reference Method EPS 1/RM/14). The proposed sampling locations are referenced in Volume 10 Appendix 10D-4, Table 2.

Ammonium nitrate releases are governed by such factors as the type of explosives used (including the ratio of ANFO:emulsions) explosive handling and blasting efficiency and practices.

The key measures taken to control the egress of water soluble ammonium nitrate into the mine pit water and waste rock storage seepage collection ponds are noted below:

ANFO use will be strictly controlled during use. Each employee handling explosive will be trained in the proper use and management of explosives. If any ANFO is spilled during blast hole loading or transportation to the blast site, under no circumstances will the spilled ANFO be flushed with water or brine solutions. ANFO will be collected, reused or returned to the explosives plant. A spill handling procedure will be revised if required.

Blast holes will be monitored to determine if dissolution is occurring by water in or flowing through the hole. If ANFO dissolution is detected, then the ANFO and emulsion mixture can be altered to reduce solubility, i.e. the greater the percent of emulsion, the lower the water solubility. If solubility persists, then a substitute blasting agent could be used or, if necessary waste water will be treated.

If any undetonated explosives are observed after blasting of either ore or waste rock then the blasting procedures will be reviewed to prevent excess explosive use. Some of the factors to be reviewed include: modifying the blasting pattern, evaluating the blast hole diameter, determining if dewatering of the blast hole is required, determining if the use of liners or tubing in the holes would be effective and preventing blowback during the pneumatic loading of the blast hole loading by not filling the blast holes to the brim.

The water monitoring program is used to determine if nitrate concentrations are increasing or excursions are occurring.

9. EC # 27 – EC requests that the Proponent clarify if the brine recovered from tunneling activities will be re-used for drilling purposes and provide a discussion of the alternatives available for brine disposal including the final disposal method.

Response: The driller will re-circulate the drilling water as much as possible, thus minimizing the brine used. A settling container near the borehole will be used. The fines will settle and will be collected and disposed of. The water will be reused and sometimes new brine will need to be added as additional water is added into the system over time.

10. EC # 28 and 29 – Please see the Information Request spreadsheet submitted in April 2012 for the full IR. During the technical meetings, Baffinland committed to advancing AEMP and reference sites and to include the QIA.

Response: Baffinland will endeavour to advance AEMP plans and planned work for reference site selection by early June 2012 and will keep QIA appraised of progress made.

Marine Mammals

1. QIA IR # 08 –During the technical meetings, the QIA requested Baffinland providing a measure of variance on 30 years.

   Response: QIA requested that the data on pack ice include information on variability, i.e. some measure of variance. Attachment 2 is a spread sheet for five transects along the shipping route where pack ice cover is calculated by month for the available observation period (28 years in most cases). The standard deviation of the calculated mean is presented as a measure of variance.

   See attachment 2 titled "Pack Ice Variability for the Hudson Strait and Foxe Basin Shipping Route."

2. DFO IR # 2.2 – DFO requests the Proponent provide the rationale for their use of each threshold level with evidence that they are selected appropriately and described adequately as per the commitment.

   Response: DFO has suggested that "Potential Biological Removal" can serve as a threshold. See DFO DEIS Technical Comment 4.3.1:

   "<u>DFO recommends that thresholds be measureable and based upon quantitative VEC descriptors, for which reasonably reliable information is available</u>. For example, DFO currently uses Potential Biological Removal (PBR) to examine sustainable anthropogenic-induced mortality rates for walrus (see Stewart 2008 and references therein) and some other marine mammal species. For walrus, PBR is approximately 1-2% of the minimum population estimate. Currently, the main sources of human-induced mortality of walrus are hunting and climate change (Garlich-Miller et al. 2011). Potential mortality arising from the proposed Project will be cumulative and additional to these sources of removals."

   Note that Stewart, 2008 concludes that there is inadequate data available for use of PBR for establishing walrus harvest levels. Baffinland has developed thresholds to measure magnitude of effects for a range of interactions. Each selected parameter and associated threshold level is described in the FEIS. Baffinland has found no examples in the literature where PBR has been employed

in environmental effects prediction. Where information is lacking, e.g. on population size, professional judgment has been employed to assess magnitude, and conservative assumptions made (e.g. consider only a portion of the total range of the affected species or population).

Baffinland has completed and reported on several recent Environmental Impact Statements. The results illustrate that The Mary River Project FEIS, in determining magnitude of effect, has employed conventional and accepted methods.

See also Response to QIA Supplemental IR response (QIA IR-D 06).

3. EC IR # 1 - EC requests that the Proponent provide a quantitative summary of the wave height data from the recovered wave sensor. The summary should be similar (e.g. mean, range, percentage of time waves are above different height categories) to that provided for wave sensors deployed in Milne Inlet described in the Draft EIS (OEIS).

Response: See Attachment 3 titled "Steensby Inlet 2008 Wave Measurement Statistics"

4. QIA Request - Density in ballast water model – was it used as a parameter? During the technical meetings, Baffinland committed to following up with QIA.

   Response: The density driven flow reflects a very localized phenomenon that occurs at the point of discharge. Consequently, while a density flow inclusion might be important to determining the initial mixing zone, the absence of this consideration in the model does not affect the ultimate dispersion/dilution that occurs (as confirmed by Coastal and Ocean Resources Inc.).

5. QIA # 06 – It is requested that the Proponent provide a comprehensive description of the decision-making process used to establish thresholds for significance of marine impacts, including discussion on which thresholds were based on determinations by regulatory bodies, which were developed based on professional judgement, the information and experience used to develop the thresholds based on professional judgement, and evidence that these thresholds are biologically appropriate. (Timeline: Prior to QIA submitting final written comments).

   Response: Clarification is required on the assessment methodology approach used in the FEIS. The FEIS (Volume 2, Section 3.5.2) notes that thresholds for measureable parameters are used to establish the magnitude of an effect (or indicate compliance with a formal standard). Exceedence of a threshold value is not a stand-alone criterion used to determine whether a potential effect of the Project on a VEC is significant, which is the key point that reviewers seem to be misinterpreting.

Reviewers are referred to Section 7.11 of the NIRB (2009) Final Guidelines. The guidelines state that:

"The following attributes defined by NIRB shall be taken into consideration in determining the significance of each impact:

- **Direction or nature of impact (i.e., positive/beneficial versus negative/adverse);**
- **Magnitude and complexity of effects;**
- **Geographic extent of effects;**
- **Frequency and/or duration of effects;**
- **Reversibility or irreversibility of effects; and**
- **Probability of effects."**

These attributes, which are defined in Volume 2, Section 3.8, Tables 2-3.3 and 2-3.4 of the FEIS (along with other attributes not specifically required by NIRB), were all considered when determining significance of a Project effect on a given VEC. See also Volume 2, Section 3.8.3 of the FEIS for a discussion of the overall evaluation of significance.

The reviewer(s) indicated that the thresholds used to inform the marine mammal effects assessment were "not linked to biological concerns". Baffinland disagrees with this statement—the entire approach used in Volume 8, Section 5, including the measureable parameters and thresholds for each Key Indicator species, is directly linked to the primary areas of biological concern. The key potential effects of the Project on marine mammals were identified, a means to measure or assess levels of direct or indirect biological change (measureable parameter) were identified, and threshold values were used to identify the need for follow-up monitoring.

With regard to marine mammals, there are no regulated threshold values. Therefore, threshold values were based on professional judgment and considerable experience in preparing environmental assessments in the Arctic and other areas of Canada. Appendix 5 (Threshold Table) to the Information Request submission on the FEIS made by Baffinland provides some examples of environmental assessments and associated threshold values used in other assessments. The threshold values used in the Mary River FEIS are in line with those used and approved in those assessments. Other examples include environmental assessments recently completed in the Canadian Beaufort Sea (see GXT and Upun-LGL 2011 and Upun-LGL 2012 on the Environmental Impact Screening Committees Registry Site at http://www.screeningcommittee.ca/). As noted above, thresholds associated with measureable parameters are one of many considerations in judging significance under the NIRB Final Guidelines. During the EIS process, Baffinland has undertaken to acquire community perspective on the significance of predicted effects on marine mammals (as well as other VECs). For example, the FEIS (Volume 2, Section 3.8.3) notes that a five-

day workshop was held at Mary River in September 2010 to discuss this topic (as well as others).

In summary, the assessment approach used in the FEIS follows NIRB Guidelines and is based on numerous environmental assessments conducted for projects in the Canadian Arctic. The measureable parameters and thresholds used to identify the magnitude of effects are reasonable and appropriate.

6. During the technical meetings, Baffinland committed to providing a Risk Assessment for overwintering of fuel vessel.

   Response: Please see Attachment 4 titled "Overwintering of Fuel Vessel Response and Project Risk Register"

7. BIM to engage NRI in the future with monitoring programs related to air, water, wildlife etc. to ensure permits are in place.

   Response: Baffinland is committed to engaging with NRI as required with regards to monitoring programs that will require permits for the intended work.

8. EC IR # 4a and b. – Baffinland will consider these requests.

   Response: In addition to the response provided on this IR on April 19th, 2012, Baffinland can keep EC appraised of additional information as ship design progresses.

9. Identify the formation of technical working groups with QIA and other agency's to address Marine monitoring and adaptive management plans/concerns.

   Response: The formation of a Marine Mammal Working group is well underway and the terms of reference are currently being drafted for the group. An initial meeting was held on May 3rd, 2012 (involving QIA, DFO, BIM and EC), after the technical meeting, to establish a path forward and key items to be addressed.

Terrestrial Environment

1. Identify the formation of technical working group with QIA and other agency on terrestrial and monitoring and adaptive management plans/concerns.

   Response: The formation of a Terrestrial Wildlife Working group is well underway and the terms of reference are currently being drafted for the group. An initial meeting was held on May 4th, 2012 (involving QIA and BIM), after the technical meeting, to get input from the QIA on revisions that could be made to the Terrestrial Environment Management and Monitoring Plan. Revisions based on QIA input has been completed, the revised plan has been circulated to EC, the GN

and QIA and a tentative meeting is set for May 23rd or 24th in order to review the revised plan.

2. GN IR# 21 – BIM to provide Habitat Suitability Map to GN with a numbered legend.

   Response: Please see Attachment 5 titled "Caribou Habitat Selection Maps."

Social and Economic Environment

1. GN # 29a, b, c and d – Please see the Information Request spreadsheet submitted in April 2012 for the full IR. During the technical meetings, Baffinland committed to the creation of a working group.

   Response: A working group has been formed with Transport Canada. Baffinland has added John Hawkins (Head of Iqaluit airport) to working group the working group. Please also see Baffinland's response to numbers 8 and 9 related to this working group.

2. GN # 30 a, b, c – Please see the Information Request spreadsheet submitted in April 2012 for the full IR response. During the technical meetings, Baffinland committed to a small working group with the GN to develop a monitoring framework and to present the priorities of the framework at the Final Hearings.

   Response: The follow-up to this line item is that the Department of Economic Development and Transportation has established a small working group and Baffinland representatives are actively participating in this group. Baffinland initally met with the Government of Nunavut (GN), AANDC, and the Qikiqtani Inuit Association (QIA) on May 3. A second follow-up meeting with Doug Brubacher (Baffinland) and this group was held on May 8th to advance work. Additional process is planned through May and June in an effort to identify common ground before the Final Hearing.

3. GN # 31 c, d, e – Please see the Information Request spreadsheet submitted in April 2012 for the full IR response. During the technical meetings, Baffinland committed to considering if we can present our data on overnight stays in Iqaluit and if there will be an impact.

   Response: As a follow-up to this line item, Baffinland has since determined that data would be technically available through flight manifests. Baffinland could contribute to a broader collaborative effort if a group like the SEMC determined that overnight stays in Iqaluit should be monitored generally (i.e. data from others as well in order to generate a meaningful picture).

4. GN # 36 a, b and c – Please see the Information Request spreadsheet submitted in April 2012 for the full IR request. During the technical meetings, Baffinland committed to having BIM's CFO get in contact with Grant Hipfner and Francois Picotte to discuss and further clarify these requests prior to submission of final technical comments from GN.

   Response: An invitation to connect with Baffinland's CFO has been extended to Grant and Francois. Below is a note from Grant identifying that the at the present time the GN is satisfied with information provided by Baffinland:

   "We appreciate your invitation to discuss the corporate tax question that François presented during NIRB's technical hearing earlier this month.

   Following some internal discussion we've concluded that Baffinland's latest response regarding CIT is adequate for us to complete our review at this time. We take your point in the FEIS that Mary River will likely not generate CIT until several years after operations begin, and accept that accurately estimating CIT so far into the future is difficult and circumstance-dependant. With this in mind, we are satisfied that we can justify our medium-term internal revenue forecasts at this time.

   We also appreciate Baffinland's commitment to continuing to work with Finance on taxation issues. For example, we continue to be interested in better understanding the wages your project will generate. We expect to take you up on your offer to discuss or clarify this and other tax issues in the future, should the project go ahead. We look forward to developing a good working relationship with your firm on these issues.

   At this point we do not feel a meeting with Baffinland is necessary, and look forward to concluding the review process."

5. GN # 37 a and b – Please see the Information Request spreadsheet submitted in April 2012 for the full IR request. During the technical meetings, Baffinland committed to provide the contact details of the HAY group so the department can follow up on pay scales.

   Response: Baffinland has now provided the GN with contact details to Baffinland's client at the HAY Group.

6. GN # 39 a – Please see the Information Request spreadsheet submitted in April 2012 for the full IR response. During the technical meetings, Baffinland committed to have further discussion with the GN on this topic.

Response: The Department of Economic Development and Transportation has now established a small working group and Baffinland is actively participating. Monitoring related to migration effects can be done if this is identified as a priority issue. Project-specific data would be technically available through Baffinland Human Resources system. Data related to migration for other employment would be technically available from HR systems of other major employers such as Government of Nunavut.

7. GN # 40 a and b – BIM to speak to its family assistance provider regarding provision of data.

   Response: Baffinland plans to connect with the provider in mid-May to determine whether data could be technically and ethically provided with no harm to those seeking assistance on a confidential basis.

8. GN # 42 a, b and c - Please see the Information Request spreadsheet submitted in April 2012 for the full IR response. During the technical meetings, Baffinland committed to establishing a working with Transport Canada and will inform Transport Canada to add Mark Noreau with justice to working group regarding security issues at port. Mark N. to provide name of RCMP rep to be on working group.

   Response: This has been completed and conversations have been initiated.

9. GN # 43, 44, 45 a and b - Please see the Information Request spreadsheet submitted in April 2012 for the full IR response. During the technical meetings, Baffinland committed to establishing a working with Transport Canada and will inform Transport Canada to add Mark Noreau with justice to working group regarding SAR. Mark N. to provide name of RCMP rep to be on working group.

   Response: This has been completed and conversations have been initiated.

Appendix 1:

Sample Products for De-Icing

CRYOTECH POLAR PLUS® - 55/45 DILUTE
Type I Aircraft Deicing/Anti-icing Fluid
MATERIAL SAFETY DATA SHEET

1. PRODUCT NAME & DESCRIPTION

CRYOTECH POLAR PLUS® - 55/45 DILUTE
Ready to Use
(Consisting of 55% Polar Plus and 45% water)
Type I Aircraft Deicing/Anti-icing Fluid
Complies with Specification AMS 1424

MANUFACTURED AND SUPPLIED IN THE USA BY:

Cryotech Deicing Technology
6103 Orthoway
Fort Madison, IA 52627
United States

CRYOTECH CONTACT INFORMATION:

Telephone: (800)346-7237
FAX: (319)372-2662
email: deicers@cryotech.com
website: http://www.cryotech.com

2. CHEMICAL COMPOSITION

The percent compositions are given to allow for the various ranges of the components present in the whole product and may not equal 100%.

PERCENT	COMPONENT	CAS#
100%	Cryotech Polar Plus® 55/45 Dilute Type I	
CONTAINING		
48%	Propylene Glycol	57-55-6
<1%	Corrosion Inhibitors	
52%	Water	7732-18-5

CAS - Chemical Abstract Service Number

3. HAZARD IDENTIFICATION (also see Sections 11 and 12)
CAUTION! - MAY CAUSE EYE IRRITATION

EYE CONTACT:
This substance may be slightly irritating to the eyes.
SKIN IRRITATION:
This substance is not expected to cause prolonged or significant skin irritation.
RESPIRATORY/INHALATION:
This material does not present an inhalation hazard.
INGESTION:
If swallowed, this substance is considered practically non-toxic to internal organs.

4. FIRST AID MEASURES

Chemical Emergency: Spill, leak, fire, or accident call
Chemtrec day or night (800)424-9300;
Outside continental USA call (703)527-3887

EYE CONTACT:
Flush eyes immediately with fresh water for at least 15 minutes while holding the eyelids open. Remove contact lenses if worn. No additional first aid should be necessary. However, if irritation persists, see a doctor.
SKIN CONTACT:
No first aid procedures are required. As a precaution, wash skin thoroughly with soap and water. Remove and wash contaminated clothing.
INHALATION:
Since this material is not expected to be an immediate inhalation problem, no first aid procedures are required.
INGESTION:
If swallowed, give water or milk to drink and telephone for medical advice.
DO NOT make the person vomit unless directed to do so by medical personnel.
If medical advice cannot be obtained, then take the person and product container to the nearest medical emergency treatment center or hospital.

5. FIRE FIGHTING MEASURES

FLASH POINT (close cup):
None below boiling point.
AUTO IGNITION:
446°C
EXPOSURE LIMITS:
No data available.
EXTINGUISHING MEDIA:
Water, foam, Carbon Dioxide, dry powder.
FIRE FIGHTING PROCEDURES:
None
HAZARDOUS DECOMPOSITION PRODUCTS:
Incomplete combustion may produce Carbon Monoxide and other harmful gases/vapors.
UNUSUAL FIRE HAZARDS:
The product may become combustible after prolonged heating at the boiling point.
NFPA RATINGS:
Health 0; Flammability 1; Reactivity 0; Special NDA:
(Least - 0, Slight - 1, Moderate - 2, High - 3, Extreme - 4)
These values are obtained using the guidelines or published evaluations prepared by the National Fire Protection Association (NFPA) or the National Paint Coating Association.

6. ACCIDENTAL RELEASE MEASURES

Chemical Emergency: Spill, leak, fire, or accident call
Chemtrec day or night (800)424-9300;
Outside continental USA call (703)527-3887

SPILL/LEAK PRECAUTIONS:
Contain spillage and absorb on suitable material e.g. sawdust, sand or earth.
Transfer to a container for disposal.
See section 13.
Wash the spillage area with plenty of water.

7. HANDLING AND STORAGE

STORAGE:
Store in tightly sealed original containers, away from direct heat, sunlight and strong oxidizing agents.
SPECIAL PRECAUTIONS:
Avoid contact with skin and eyes.
Avoid breathing mists/vapors when spraying.
TEMPERATURE STORAGE LIMITS:
Minimum -28°C (-18°F)

Maximum 60°C (140°F)

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

EYE PROTECTION:
Wear eye protection if splashing is possible.
SKIN PROTECTION:
No special skin protection is usually necessary.
Avoid prolonged or frequently repeated skin contact with this material.
Skin contact can be minimized by wearing protective clothing.
RESPIRATORY PROTECTION:
No special respiratory protection is normally required.
VENTILATION:
No special ventilation is necessary.

CRYOTECH POLAR PLUS® - 55/45 DILUTE
Type I Aircraft Deicing/Anti-icing Fluid
MATERIAL SAFETY DATA SHEET

9. PHYSICAL AND CHEMICAL PROPERTIES

APPEARANCE:
Clear, orange fluid.
ODOR:
None
REFRACTIVE INDEX (20°C):
1.387 - 1.390
pH (20°C):
7.0 - 9.0
BOILING POINT:
~106°C
FLAMMABILITY DATA:
See Section 5.
VAPOR PRESSURE (20°C):
13 mm Hg
SPECIFIC GRAVITY (20°C):
1.039
VAPOR DENSITY (AIR = 1):
No data available.
FREEZING POINT:
-33.4°C (-28°F)
VISCOSITY (20°C):
6 cP
SOLUBILITY:
Completely miscible in water.

10. STABILITY & REACTIVITY

HAZARDOUS DECOMPOSITION PRODUCTS:
None known.
STABILITY:
Stable
HAZARDOUS POLYMERIZATION:
Polymerization will not occur.
INCOMPATIBILITY:
May react with strong acids or strong oxidizing agents, such as chlorates, nitrates, peroxides, etc.
SPECIAL PRECAUTIONS:
READ AND OBSERVE ALL PRECAUTIONS ON PRODUCT LABEL.
Store away from strong oxidizing materials.

11. TOXICOLOGICAL INFORMATION

Considered to have low oral toxicity.
See also section 3.

LD_{50}	Rat - oral	>10g/Kg (estimated)
LC_{50}	Pimephales Promelas	6,350 mg/L (96h) undiluted
LC_{50}	Daphnia Magnia	6,825 mg/L (48h) undiluted

12. ECOLOGICAL INFORMATION

COD (20°C):	0.86 kg O_2/kg fluid (calculated)
BOD_5 (20°C):	0.36 kg O_2/kg fluid (calculated)
5 day BOD/COD:	0.41 (calculated)

13. DISPOSAL CONSIDERATION

Based on information available to Cryotech Deicing Technology, this product is neither listed as a hazardous waste nor does it exhibit any of the characteristics that would cause it to be classified or disposed of as an RCRA hazardous waste. If product should spill or be otherwise unsuitable for normal deicing applications, it may be absorbed on suitable materials and disposed of in sanitary landfill unless state or local regulations prohibit such disposal.

14. TRANSPORT INFORMATION

Not restricted under any transport regulations.

15. REGULATORY INFORMATION

ALL OF THE COMPONENTS IN THIS PRODUCT ARE ON THE FOLLOWING INVENTORY LISTS:
U.S.A. (TSCA), Europe (EINECS), Canada (DSL/NDSL).
TSCA SECTION 12(b):
None of the chemicals in this product are listed under TSCA Section 12(b).
OSHA HAZARD CLASSIFICATION:
Hazardous Chemical (Irritant);
None of the chemicals in this product are considered highly hazardous by OSHA.
CERCLA HAZARDOUS SUBSTANCES:
There is no CERCLA Reportable Quantity for this material.
SARA 311 CATEGORIES:

Immediate (Acute) Health Hazard:	Yes
Delayed (Chronic) Health Hazard:	No
Fire Hazard:	Yes
Sudden Release of Pressure Hazard:	No
Reactivity Hazard:	No

SARA 313:
None of the chemicals in this product are subject to reporting requirements under SARA Section 313.
CLEAN WATER ACT:
None of the chemicals in this product are listed as Priority Pollutants under the CWA.
None of the chemicals in this product are listed as Toxic Pollutants under the CWA.
STATE RIGHT-TO-KNOW:
This product does not contain materials listed on the specific Toxic or Hazardous Substance Lists of the following states: PA, MA, NJ. This product may contain a chemical known to the State of California (Proposition 65) to cause cancer: Propylene Oxide (CAS 75-56-9). This product may contain a chemical known to the State of California (Proposition 65) to cause cancer and/or reproductive harm: Ethylene Oxide (CAS 75-21-8).
WHMIS (Canada) CLASSIFICATION:
Not controlled

16. OTHER INFORMATION

This Material Safety Data Sheet contains environmental, health and toxicology information for your employees. Please make sure this information is given to them. It also contains information to help you meet community right-to-know/emergency response reporting requirements under SARA Title III and many other laws. If you resell this product, this MSDS must be given to the buyer or the information incorporated in your MSDS. Discard any previous edition of this MSDS.
Latest version of this MSDS can be obtained from Cryotech.

The above information is accurate to the best of our knowledge. However, since data, safety standards, and government regulations are subject to change and the conditions of handling and use or misuse are beyond our control, **Cryotech Deicing Technology, a Division of General Atomics International Services Corporation makes no warranty, either express or implied, with respect to the completeness or continuing accuracy of the information contained herein and disclaims all liability for reliance thereon.** Cryotech Deicing Technology, a Division of General Atomics International Services Corporation assumes no responsibility for any injury or loss resulting from the use of the product described herein. User should satisfy himself that he has all current data relevant to his particular use.

CRYOTECH POLAR PLUS® - 63/37 DILUTE
Type I Aircraft Deicing/Anti-icing Fluid
MATERIAL SAFETY DATA SHEET

1. PRODUCT NAME & DESCRIPTION

CRYOTECH POLAR PLUS™ - 63/37 DILUTE
Ready to Use
(Consisting of 63% Polar Plus and 37% water)
Type I Aircraft Deicing/Anti-icing Fluid
Complies with Specification AMS 1424

MANUFACTURED AND SUPPLIED IN THE USA BY:
Cryotech Deicing Technology
6103 Orthoway
Fort Madison, IA 52627
United States

CRYOTECH CONTACT INFORMATION:
Telephone: (800)346-7237
FAX: (319)372-2662
email: deicers@cryotech.com
website: http://www.cryotech.com

2. CHEMICAL COMPOSITION

The percent compositions are given to allow for the various ranges of the components present in the whole product and may not equal 100%.

PERCENT	COMPONENT	CAS#
100%	Cryotech Polar Plus™ 63/37 Dilute Type I	
CONTAINING		
55%	Propylene Glycol	57-55-6
<1%	Corrosion Inhibitors	
45%	Water	7732-18-5

CAS - Chemical Abstract Service Number

3. HAZARD IDENTIFICATION (also see Sections 11 and 12)
CAUTION! - MAY CAUSE EYE IRRITATION

EYE CONTACT:
This substance may be slightly irritating to the eyes.
SKIN IRRITATION:
This substance is not expected to cause prolonged or significant skin irritation.
RESPIRATORY/INHALATION:
This material does not present an inhalation hazard.
INGESTION:
If swallowed, this substance is considered practically non-toxic to internal organs.

4. FIRST AID MEASURES

Chemical Emergency: Spill, leak, fire, or accident call
Chemtrec day or night (800)424-9300;
Outside continental USA call (703)527-3887

EYE CONTACT:
Flush eyes immediately with fresh water for at least 15 minutes while holding the eyelids open. Remove contact lenses if worn. No additional first aid should be necessary. However, if irritation persists, see a doctor.
SKIN CONTACT:
No first aid procedures are required. As a precaution, wash skin thoroughly with soap and water. Remove and wash contaminated clothing.
INHALATION:
Since this material is not expected to be an immediate inhalation problem, no first aid procedures are required.
INGESTION:
If swallowed, give water or milk to drink and telephone for medical advice. DO NOT make the person vomit unless directed to do so by medical personnel. If medical advice cannot be obtained, then take the person and product container to the nearest medical emergency treatment center or hospital.

5. FIRE FIGHTING MEASURES

FLASH POINT (close cup):
None below boiling point.
AUTO IGNITION:
446°C
EXPOSURE LIMITS:
No data available.
EXTINGUISHING MEDIA:
Water, foam, Carbon Dioxide, dry powder.
FIRE FIGHTING PROCEDURES:
None
HAZARDOUS DECOMPOSITION PRODUCTS:
Incomplete combustion may produce Carbon Monoxide and other harmful gases/vapors.
UNUSUAL FIRE HAZARDS:
The product may become combustible after prolonged heating at the boiling point.
NFPA RATINGS:
Health 0; Flammability 1; Reactivity 0; Special NDA:
(Least - 0, Slight - 1, Moderate - 2, High - 3, Extreme - 4)
These values are obtained using the guidelines or published evaluations prepared by the National Fire Protection Association (NFPA) or the National Paint Coating Association.

6. ACCIDENTAL RELEASE MEASURES

Chemical Emergency: Spill, leak, fire, or accident call
Chemtrec day or night (800)424-9300;
Outside continental USA call (703)527-3887

SPILL/LEAK PRECAUTIONS:
Contain spillage and absorb on suitable material e.g. sawdust, sand or earth.
Transfer to a container for disposal.
See section 13.
Wash the spillage area with plenty of water.

7. HANDLING AND STORAGE

STORAGE:
Store in tightly sealed original containers, away from direct heat, sunlight and strong oxidizing agents.
SPECIAL PRECAUTIONS:
Avoid contact with skin and eyes.
Avoid breathing mists/vapors when spraying.
TEMPERATURE STORAGE LIMITS:
Minimum -37°C (-34°F)

Maximum 60°C (140°F)

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

EYE PROTECTION:
Wear eye protection if splashing is possible.
SKIN PROTECTION:
No special skin protection is usually necessary.
Avoid prolonged or frequently repeated skin contact with this material.
Skin contact can be minimized by wearing protective clothing.
RESPIRATORY PROTECTION:
No special respiratory protection is normally required.
VENTILATION:
No special ventilation is necessary.

CRYOTECH POLAR PLUS® - 63/37 DILUTE
Type I Aircraft Deicing/Anti-icing Fluid
MATERIAL SAFETY DATA SHEET

9. PHYSICAL AND CHEMICAL PROPERTIES

APPEARANCE:
Clear, orange fluid.
ODOR:
None
REFRACTIVE INDEX (20°C):
1.395 - 1.398
pH (20°C):
7.0 - 9.0
BOILING POINT:
~106°C
FLAMMABILITY DATA:
See Section 5.
VAPOR PRESSURE (20°C):
13 mm Hg
SPECIFIC GRAVITY (20°C):
1.041
VAPOR DENSITY (AIR = 1):
No data available.
FREEZING POINT:
-42.2°C (-44°F)
VISCOSITY (20°C):
8 cP
SOLUBILITY:
Completely miscible in water.

10. STABILITY & REACTIVITY

HAZARDOUS DECOMPOSITION PRODUCTS:
None known.
STABILITY:
Stable
HAZARDOUS POLYMERIZATION:
Polymerization will not occur.
INCOMPATIBILITY:
May react with strong acids or strong oxidizing agents, such as chlorates, nitrates, peroxides, etc.
SPECIAL PRECAUTIONS:
READ AND OBSERVE ALL PRECAUTIONS ON PRODUCT LABEL.
Store away from strong oxidizing materials.

11. TOXICOLOGICAL INFORMATION

Considered to have low oral toxicity.
See also section 3.

LD_{50}	Rat - oral	>10g/Kg (estimated)
LC_{50}	Pimephales Promelas	6,350 mg/L (96h) undiluted
LC_{50}	Daphnia Magnia	6,825 mg/L (48h) undiluted

12. ECOLOGICAL INFORMATION

COD (20°C):	0.99 kg O_2/kg fluid (calculated)
BOD_5 (20°C):	0.40 kg O_2/kg fluid (calculated)
5 day BOD/COD:	0.41 (calculated)

13. DISPOSAL CONSIDERATION

Based on information available to Cryotech Deicing Technology, this product is neither listed as a hazardous waste nor does it exhibit any of the characteristics that would cause it to be classified or disposed of as an RCRA hazardous waste. If product should spill or be otherwise unsuitable for normal deicing applications, it may be absorbed on suitable materials and disposed of in sanitary landfill unless state or local regulations prohibit such disposal.

14. TRANSPORT INFORMATION

Not restricted under any transport regulations.

15. REGULATORY INFORMATION

ALL OF THE COMPONENTS IN THIS PRODUCT ARE ON THE FOLLOWING INVENTORY LISTS:
U.S.A. (TSCA), Europe (EINECS), Canada (DSL/NDSL).
TSCA SECTION 12(b):
None of the chemicals in this product are listed under TSCA Section 12(b).
OSHA HAZARD CLASSIFICATION:
Hazardous Chemical (Irritant);
None of the chemicals in this product are considered highly hazardous by OSHA.
CERCLA HAZARDOUS SUBSTANCES:
There is no CERCLA Reportable Quantity for this material.
SARA 311 CATEGORIES:

Immediate (Acute) Health Hazard:	Yes
Delayed (Chronic) Health Hazard:	No
Fire Hazard:	Yes
Sudden Release of Pressure Hazard:	No
Reactivity Hazard:	No

SARA 313:
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CLEAN WATER ACT:
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This product does not contain materials listed on the specific Toxic or Hazardous Substance Lists of the following states: PA, MA, NJ. This product may contain a chemical known to the State of California (Proposition 65) to cause cancer: Propylene Oxide (CAS 75-56-9). This product may contain a chemical known to the State of California (Proposition 65) to cause cancer and/or reproductive harm: Ethylene Oxide (CAS 75-21-8).
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Appendix 2:

Pack Ice Variability for the Hudson Strait and Foxe Basin Shipping Route

Pack Ice variability for the Hudson Strait and Fox Basin shipping route

Pack ice variability for the shipping route was determined on a monthly basis over a period of 28 or 29 years (1982 or 1983 through 2010 depending on availability. Note: Five years for Foxe Basin and two years for Hudson Strait are missing for the month of December due Environment Canada's sampling schedule). The shipping route was broken into 5 separate sections based on latitude and longitude (Hudson Strait east, central, and west: Longitudes 65W-70W, 70W-75W, and 75W-80W, respectively, as well as, Foxe Basin north and south: Latitudes 68N-71N and 65N-68N, respectively).

The monthly variability (standard deviation) was based around the 28/29 year mean for each individual section. Pack ice cover was estimated by averaging the pack ice extent for each section which itself was calculated from Environment Canada's Ice Conditions charts (i.e., a chart displaying 50% of northern Foxe Basin having 90% pack ice cover and 50% with open water in October would be represented as having 45% pack ice cover for the month of October for that respective year).

The **overview** table provided displays the minimum, maximum, mean, and standard deviation over the 28 year period for each section of the shipping route for each month of the year.

In summary, the core winter and spring seasons had a very low variability (i.e., 0 to 6% variability January through May), and a higher variability for the summer and shoulder seasons (0 to 35% variability June through December).

Considering the variability of the calculated pack ice extent, there is no basis to alter EIS predictions, nor confidence levels related to those predictions with respect to the effects of shipping on pack ice and marine mammals.

Pack Ice extent as a percentage in Hudson Strait and Fox Basin

	January					February					March					April				
	N	Min	Max	Mean	StDev	N	Min	Max	Mean	StDev	N	Min	Max	Mean	StDev	N	Min	Max	Mean	StDev
Hudson Strait																				
Western	28	90	90	90	0.0	28	87	90	90	0.7	28	89	90	90	0.3	28	77	90	89	3.2
Central	28	81	90	90	1.7	28	89	90	90	0.2	28	88	90	90	0.4	28	74	90	89	3.4
Eastern	28	63	94	88	5.5	28	85	94	90	1.2	28	89	90	90	0.3	28	72	90	87	5.5
Foxe Basin																				
North	28	90	90	90	0.0	28	89	90	90	0.2	28	90	90	90	0.0	28	90	90	90	0.0
South	28	90	90	90	0.0	28	89	90	90	0.2	28	90	90	90	0.0	28	87	90	90	0.6

	May					June					July					August				
	N	Min	Max	Mean	StDev	N	Min	Max	Mean	StDev	N	Min	Max	Mean	StDev	N	Min	Max	Mean	StDev
Hudson Strait																				
Western	29	65	90	79	7.5	29	30	90	64	14.8	29	1	81	36	22.5	29	0	20	4	5.7
Central	29	63	90	80	8.8	29	1	90	60	22.0	29	0	69	30	20.8	29	0	10	1	2.8
Eastern	29	63	90	80	7.5	29	18	90	66	14.4	29	0	81	37	22.6	29	0	46	5	11.0
Foxe Basin																				
North	29	45	90	83	12.4	29	18	90	61	20.7	29	27	90	61	17.9	29	3	65	30	17.9
South	29	83	90	89	1.6	29	61	95	84	8.1	29	33	90	74	14.0	29	1	72	37	18.8

	September					October					November					December				
	N	Min	Max	Mean	StDev	N	Min	Max	Mean	StDev	N	Min	Max	Mean	StDev	N	Min	Max	Mean	StDev
Hudson Strait																				
Western	29	0	15	2	3.8	29	0	35	3	8.8	29	0	90	23	29.6	27	7	90	68	28.4
Central	29	0	0	0	0.0	29	0	5	0	1.1	29	0	76	12	20.7	27	0	90	56	35.2
Eastern	29	0	2	0	0.4	29	0	0	0	0.0	29	0	37	5	8.4	27	3	90	44	31.4
Foxe Basin																				
North	29	0	85	10	18.6	29	0	90	15	28.5	29	9	90	81	19.8	24	90	90	90	0.0
South	29	0	33	9	9.9	29	0	90	10	27.1	29	0	90	53	37.7	24	76	90	89	3.9

January Pack Ice Extent

Hudson Strait

	Western	Central	Eastern
1982			
1983	90	90	90
1984	90	90	90
1985	90	90	94
1986	90	90	90
1987	90	90	90
1988	90	90	90
1989	90	90	90
1990	90	90	90
1991	90	90	90
1992	90	90	90
1993	90	90	90
1994	90	90	90
1995	90	90	90
1996	90	90	90
1997	90	90	90
1998	90	90	90
1999	90	90	90
2000	90	90	90
2001	90	90	85
2002	90	90	81
2003	90	90	90
2004	90	81	63
2005	90	90	90
2006	90	90	90
2007	90	90	90
2008	90	90	89
2009	90	90	81
2010	90	90	87
Min	90	81	63
Max	90	90	94
Mean	90	90	88
StDev	0.0	1.7	5.5

Fox Basin

	North	South
1982		
1983	90	90
1984	90	90
1985	90	90
1986	90	90
1987	90	90
1988	90	90
1989	90	90
1990	90	90
1991	90	90
1992	90	90
1993	90	90
1994	90	90
1995	90	90
1996	90	90
1997	90	90
1998	90	90
1999	90	90
2000	90	90
2001	90	90
2002	90	90
2003	90	90
2004	90	90
2005	90	90
2006	90	90
2007	90	90
2008	90	90
2009	90	90
2010	90	90
Min	90	90
Max	90	90
Mean	90	90
StDev	0.0	0.0

February Pack Ice Extent

Hudson Strait

	Western	Central	Eastern
1982			
1983	90	90	90
1984	90	90	90
1985	90	90	94
1986	90	90	90
1987	88	90	90
1988	90	90	90
1989	90	90	90
1990	90	90	90
1991	90	90	90
1992	90	90	90
1993	90	90	90
1994	90	90	90
1995	90	90	90
1996	90	90	90
1997	90	90	90
1998	90	90	90
1999	90	90	90
2000	90	90	90
2001	90	90	90
2002	90	90	90
2003	89	90	90
2004	87	89	85
2005	90	90	90
2006	90	90	90
2007	90	90	90
2008	90	90	90
2009	90	90	90
2010	90	90	90
Min	87	89	85
Max	90	90	94
Mean	90	90	90
StDev	0.7	0.2	1.2

Fox Basin

	North	South
1982		
1983	90	90
1984	90	90
1985	90	90
1986	90	90
1987	90	90
1988	90	90
1989	90	90
1990	90	90
1991	90	90
1992	90	90
1993	90	90
1994	90	90
1995	90	90
1996	90	90
1997	90	90
1998	90	90
1999	90	90
2000	90	90
2001	90	90
2002	90	90
2003	89	89
2004	90	90
2005	90	90
2006	90	90
2007	90	90
2008	90	90
2009	90	90
2010	90	90
Min	89	89
Max	90	90
Mean	90	90
StDev	0.2	0.2

March Pack Ice Extent

Hudson Strait

	Western	Central	Eastern
1982			
1983	90	90	90
1984	90	90	90
1985	90	88	90
1986	89	90	89
1987	89	90	90
1988	90	90	90
1989	90	90	90
1990	90	90	90
1991	90	90	90
1992	90	90	90
1993	90	90	90
1994	90	90	90
1995	90	90	90
1996	90	90	90
1997	90	90	90
1998	90	90	90
1999	90	90	90
2000	90	90	90
2001	90	90	90
2002	90	90	90
2003	90	90	90
2004	89	90	89
2005	90	90	90
2006	90	90	89
2007	90	90	90
2008	90	90	90
2009	90	90	90
2010	90	90	90
Min	89	88	89
Max	90	90	90
Mean	90	90	90
StDev	0.3	0.4	0.3

Fox Basin

	North	South
1982		
1983	90	90
1984	90	90
1985	90	90
1986	90	90
1987	90	90
1988	90	90
1989	90	90
1990	90	90
1991	90	90
1992	90	90
1993	90	90
1994	90	90
1995	90	90
1996	90	90
1997	90	90
1998	90	90
1999	90	90
2000	90	90
2001	90	90
2002	90	90
2003	90	90
2004	90	90
2005	90	90
2006	90	90
2007	90	90
2008	90	90
2009	90	90
2010	90	90
Min	90	90
Max	90	90
Mean	90	90
StDev	0.0	0.0

April Pack Ice Extent

Hudson Strait

	Western	Central	Eastern
1982			
1983	90	90	90
1984	77	81	72
1985	90	74	81
1986	81	86	79
1987	84	87	75
1988	90	90	90
1989	90	90	90
1990	90	90	90
1991	90	90	90
1992	90	90	90
1993	90	90	90
1994	90	90	90
1995	90	90	90
1996	90	90	90
1997	89	90	90
1998	90	90	90
1999	83	88	83
2000	88	89	74
2001	90	90	90
2002	90	90	90
2003	90	90	90
2004	90	90	90
2005	90	90	90
2006	90	90	90
2007	86	88	88
2008	90	90	90
2009	90	90	90
2010	90	90	85
Min	77	74	72
Max	90	90	90
Mean	89	89	87
StDev	3.2	3.4	5.5

Fox Basin

	North	South
1982		
1983	90	90
1984	90	90
1985	90	90
1986	90	90
1987	90	90
1988	90	90
1989	90	90
1990	90	90
1991	90	90
1992	90	90
1993	90	90
1994	90	90
1995	90	90
1996	90	90
1997	90	87
1998	90	90
1999	90	90
2000	90	90
2001	90	90
2002	90	90
2003	90	90
2004	90	90
2005	90	90
2006	90	90
2007	90	90
2008	90	90
2009	90	90
2010	90	90
Min	90	87
Max	90	90
Mean	90	90
StDev	0.0	0.6

May Pack Ice Extent

Hudson Strait

	Western	Central	Eastern
1982	86	87	74
1983	88	84	84
1984	75	74	81
1985	77	72	81
1986	76	71	74
1987	65	63	63
1988	70	89	85
1989	90	90	90
1990	81	72	68
1991	81	72	81
1992	90	90	90
1993	90	90	90
1994	72	63	81
1995	78	87	65
1996	68	85	80
1997	77	85	86
1998	85	89	89
1999	82	82	75
2000	85	85	89
2001	81	85	78
2002	77	88	86
2003	78	72	76
2004	83	83	71
2005	77	74	82
2006	90	90	77
2007	67	65	74
2008	90	84	80
2009	74	84	87
2010	68	68	70
Min	65	63	63
Max	90	90	90
Mean	79	80	80
StDev	7.5	8.8	7.5

Fox Basin

	North	South
1982	81	88
1983	89	90
1984	63	90
1985	72	90
1986	59	90
1987	75	90
1988	90	90
1989	90	90
1990	90	90
1991	54	90
1992	90	90
1993	90	90
1994	45	90
1995	73	83
1996	90	90
1997	81	90
1998	90	90
1999	90	90
2000	90	90
2001	90	86
2002	88	90
2003	90	90
2004	90	90
2005	90	90
2006	90	90
2007	90	90
2008	90	90
2009	90	90
2010	86	86
Min	45	83
Max	90	90
Mean	83	89
StDev	12.4	1.6

June Pack Ice Extent

Hudson Strait

	Western	Central	Eastern
1982	48	38	44
1983	70	90	77
1984	75	81	81
1985	70	74	75
1986	62	81	79
1987	79	60	72
1988	60	86	82
1989	90	70	75
1990	85	90	59
1991	80	57	90
1992	64	33	81
1993	50	54	57
1994	83	45	73
1995	39	77	57
1996	72	54	80
1997	55	76	54
1998	77	64	57
1999	59	54	67
2000	62	78	84
2001	64	51	58
2002	61	23	71
2003	70	62	60
2004	72	76	51
2005	76	80	66
2006	39	1	64
2007	52	40	56
2008	76	83	78
2009	57	48	58
2010	40	21	60
2011	30	43	18
Min	30	1	18
Max	90	90	90
Mean	64	60	66
StDev	14.8	22.0	14.4

Fox Basin

	North	South
1982	63	88
1983	71	90
1984	26	90
1985	56	90
1986	68	90
1987	71	90
1988	25	95
1989	70	86
1990	81	90
1991	90	89
1992	23	86
1993	81	63
1994	18	90
1995	78	90
1996	46	84
1997	80	61
1998	75	87
1999	81	77
2000	80	82
2001	77	88
2002	33	85
2003	57	80
2004	75	85
2005	36	89
2006	45	80
2007	72	90
2008	54	77
2009	45	88
2010	85	86
2011	67	66
Min	18	61
Max	90	95
Mean	61	84
StDev	20.7	8.1

July Pack Ice Extent

Hudson Strait

	Western	Central	Eastern
1982	13	13	23
1983	67	60	63
1984	47	61	81
1985	52	39	55
1986	8	5	19
1987	63	42	56
1988	67	46	62
1989	63	65	26
1990	81	54	57
1991	50	23	54
1992	53	36	80
1993	64	60	50
1994	42	52	38
1995	20	34	36
1996	10	25	49
1997	55	69	64
1998	1	0	0
1999	16	23	18
2000	23	13	18
2001	26	10	8
2002	36	12	49
2003	30	9	5
2004	38	21	37
2005	52	28	24
2006	18	13	14
2007	20	31	34
2008	19	28	21
2009	3	2	10
2010	6	0	8
Min	1	0	0
Max	81	69	81
Mean	36	30	37
StDev	22.5	20.8	22.6

Fox Basin

	North	South
1982	49	55
1983	63	76
1984	62	78
1985	90	90
1986	59	69
1987	29	82
1988	52	90
1989	27	75
1990	48	90
1991	66	72
1992	45	84
1993	78	70
1994	35	73
1995	53	40
1996	38	84
1997	79	69
1998	55	33
1999	60	75
2000	90	73
2001	83	69
2002	54	90
2003	88	84
2004	71	85
2005	75	78
2006	33	81
2007	63	82
2008	81	82
2009	58	50
2010	72	66
Min	27	33
Max	90	90
Mean	61	74
StDev	17.9	14.0

August Pack Ice Extent

Hudson Strait

	Western	Central	Eastern
1982	12	9	4
1983	20	6	27
1984	2	1	46
1985	1	1	18
1986	1	0	1
1987	7	6	2
1988	2	0	4
1989	6	0	0
1990	12	1	0
1991	1	0	0
1992	19	10	30
1993	12	5	0
1994	2	0	0
1995	0	0	0
1996	0	0	0
1997	0	0	0
1998	1	0	0
1999	0	0	0
2000	7	0	1
2001	0	0	0
2002	1	0	0
2003	0	0	0
2004	7	0	1
2005	1	0	0
2006	0	0	0
2007	0	0	0
2008	3	0	0
2009	0	0	0
2010	0	0	0
Min	0	0	0
Max	20	10	46
Mean	4	1	5
StDev	5.7	2.8	11.0

Fox Basin

	North	South
1982	35	56
1983	48	72
1984	3	46
1985	33	28
1986	63	51
1987	47	28
1988	21	24
1989	14	71
1990	46	68
1991	41	54
1992	35	65
1993	9	13
1994	7	10
1995	49	38
1996	42	38
1997	35	29
1998	37	48
1999	36	48
2000	20	31
2001	65	39
2002	6	17
2003	10	6
2004	49	46
2005	14	36
2006	8	1
2007	10	34
2008	9	16
2009	46	36
2010	34	33
Min	3	1
Max	65	72
Mean	30	37
StDev	17.9	18.8

September Pack Ice Extent

Hudson Strait

	Western	Central	Eastern
1982	0	0	0
1983	15	0	2
1984	0	0	0
1985	0	0	0
1986	0	0	0
1987	0	0	0
1988	0	0	0
1989	2	0	0
1990	14	0	0
1991	0	0	0
1992	5	0	0
1993	7	0	0
1994	0	0	0
1995	3	0	0
1996	0	0	0
1997	0	0	0
1998	3	0	0
1999	3	0	0
2000	0	0	0
2001	1	0	0
2002	0	0	0
2003	0	0	0
2004	0	0	0
2005	0	0	0
2006	0	0	0
2007	0	0	0
2008	1	0	0
2009	0	0	0
2010	0	0	0
Min	0	0	0
Max	15	0	2
Mean	2	0	0
StDev	3.8	0.0	0.4

Fox Basin

	North	South
1982	14	16
1983	6	9
1984	2	15
1985	0	4
1986	33	2
1987	59	31
1988	5	23
1989	6	20
1990	9	14
1991	12	1
1992	85	24
1993	13	33
1994	6	8
1995	3	6
1996	2	0
1997	0	0
1998	0	0
1999	7	7
2000	0	0
2001	0	0
2002	0	18
2003	4	0
2004	13	15
2005	0	0
2006	0	0
2007	0	14
2008	4	8
2009	0	0
2010	0	0
Min	0	0
Max	85	33
Mean	10	9
StDev	18.6	9.9

October Pack Ice Extent

Hudson Strait

	Western	Central	Eastern
1982	0	0	0
1983	34	3	0
1984	0	0	0
1985	0	0	0
1986	35	0	0
1987	2	5	0
1988	0	0	0
1989	0	0	0
1990	4	0	0
1991	0	0	0
1992	9	0	0
1993	4	0	0
1994	0	0	0
1995	1	0	0
1996	0	0	0
1997	0	0	0
1998	0	0	0
1999	0	0	0
2000	0	0	0
2001	0	0	0
2002	0	0	0
2003	0	0	0
2004	0	0	0
2005	0	0	0
2006	0	0	0
2007	0	0	0
2008	0	0	0
2009	0	1	0
2010	0	1	0
Min	0	0	0
Max	35	5	0
Mean	3	0	0
StDev	8.8	1.1	0.0

Fox Basin

	North	South
1982	24	4
1983	21	15
1984	0	0
1985	0	0
1986	2	0
1987	6	8
1988	0	0
1989	87	88
1990	90	90
1991	4	0
1992	0	1
1993	0	0
1994	0	0
1995	90	90
1996	0	0
1997	0	0
1998	8	0
1999	0	0
2000	0	0
2001	0	0
2002	0	0
2003	0	0
2004	49	0
2005	0	0
2006	0	0
2007	0	0
2008	0	0
2009	51	0
2010	0	0
Min	0	0
Max	90	90
Mean	15	10
StDev	28.5	27.1

November Pack Ice Extent

Hudson Strait

	Western	Central	Eastern
1982	0	5	9
1983	21	0	1
1984	1	3	3
1985	1	6	3
1986	44	2	0
1987	6	6	0
1988	90	63	14
1989	90	76	24
1990	54	18	9
1991	22	9	0
1992	14	0	0
1993	29	9	6
1994	88	65	16
1995	63	14	3
1996	0	0	0
1997	5	4	1
1998	2	2	0
1999	0	0	0
2000	31	20	10
2001	27	5	9
2002	0	0	0
2003	0	0	0
2004	0	0	0
2005	0	0	0
2006	0	0	0
2007	62	38	37
2008	7	1	0
2009	1	0	1
2010	0	2	1
Min	0	0	0
Max	90	76	37
Mean	23	12	5
StDev	29.6	20.7	8.4

Fox Basin

	North	South
1982	90	90
1983	90	90
1984	90	90
1985	90	90
1986	90	90
1987	90	62
1988	86	9
1989	90	90
1990	90	90
1991	80	90
1992	90	90
1993	72	0
1994	36	0
1995	90	23
1996	90	18
1997	90	78
1998	48	40
1999	90	52
2000	90	90
2001	90	90
2002	45	14
2003	81	0
2004	86	9
2005	89	0
2006	90	34
2007	90	90
2008	90	29
2009	90	90
2010	9	0
Min	9	0
Max	90	90
Mean	81	53
StDev	19.8	37.7

December Pack Ice Extent

Hudson Strait

	Western	Central	Eastern
1982	89	88	57
1983	88	89	81
1984	90	90	90
1985	78	36	26
1986	90	90	90
1987			
1988	90	72	32
1989	90	10	9
1990	86	77	55
1991	90	90	90
1992	90	90	90
1993	90	90	90
1994			
1995	83	83	58
1996	74	72	32
1997	71	51	24
1998	23	1	9
1999	41	15	23
2000	84	84	23
2001	88	88	66
2002	21	6	21
2003	23	0	3
2004	90	90	90
2005	18	17	18
2006	7	3	7
2007	88	72	36
2008	42	40	21
2009	90	90	84
2010	45	12	10
Min	7	0	3
Max	90	90	90
Mean	69	57	46
StDev	28.1	35.1	31.6

Fox Basin

	North	South
1982	90	90
1983	90	90
1984	90	90
1985	90	90
1986	90	90
1987	90	90
1988	90	90
1989	90	90
1990		
1991		
1992	90	90
1993	90	90
1994	90	90
1995		
1996		
1997	90	90
1998	90	86
1999	90	90
2000	90	90
2001		
2002	90	90
2003	90	76
2004	90	90
2005	90	76
2006	90	90
2007	90	90
2008	90	90
2009	90	90
2010	90	90
Min	90	76
Max	90	90
Mean	90	89
StDev	0.0	3.9

Appendix 3:

Steensby Inlet 2008 Wave Measurement Statistics

Steensby Inlet Wave Measurements Statistics
6 September – 8 October 2008
Mary River Project

Submitted to:

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April 2012

AMEC Job Number: TN12103603

Date	Prepared	Reviewed
April 2012	P. Roussel	B. Batstone

Steensby Inlet 2008 Wave Measurements Statistics

A Waves Array ADCP was deployed in Steensby Inlet and successfully recorded wave data between 6 September and 8 October 2008 at Site 5 (Figure 1) in a water depth of about 30m. The wave height detection limit was 0.1 m.

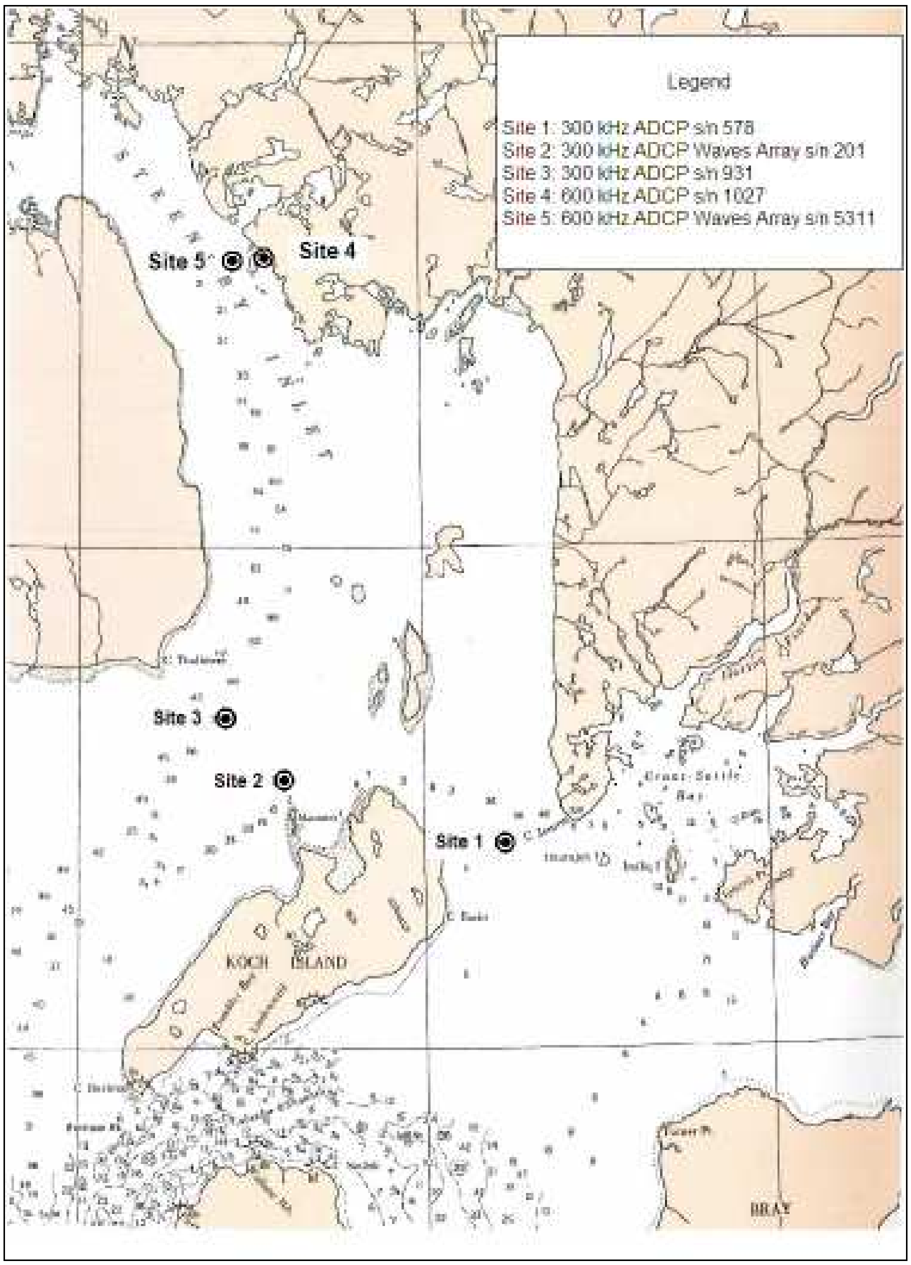


Figure 1 Sites of ADCPs deployed In Steensby Inlet in 2008

Figure 2 shows time series of significant wave height, peak period and peak direction between 6 September and 8 October 2008. Recorded significant wave heights always exceeded the detection threshold of 0.1m. The highest wave height measured was 0.93 m during on 27 and 28 September. A second episode took place on 7 and 8 October, when significant wave height reached 0.75 m. The waves were from the northwest and the southeast respectively, both directions corresponding to the longest fetch along Steensby Inlet more favorable to the development of sea states. Associated peak periods were about 4 and 5 seconds respectively.

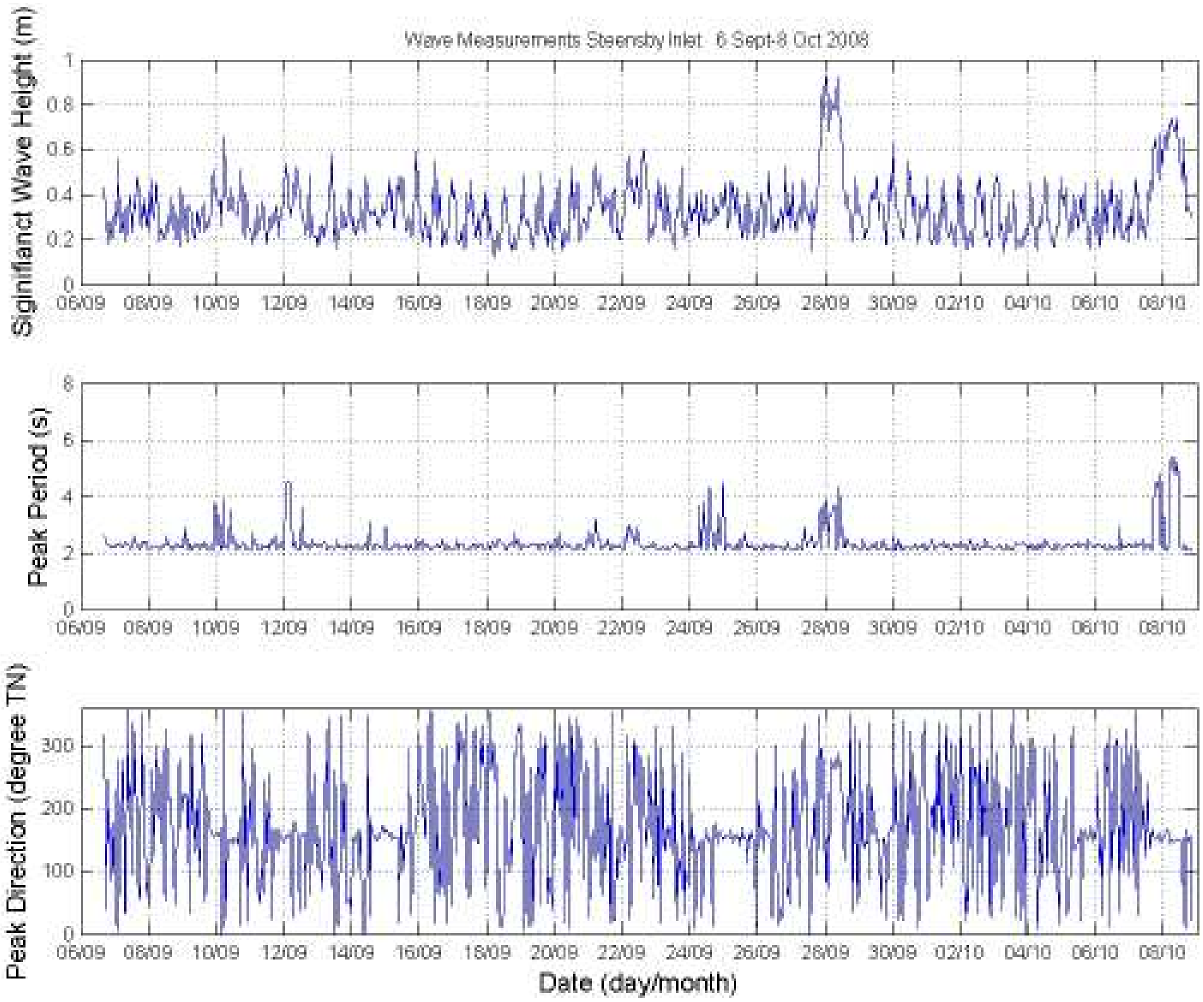


Figure 2 Significant Wave Height, Peak Period and Peak Direction Steensby Inlet Site 5, 2008

The minimum significant wave height during the deployment was 0.12 m and the mean was 0.33 m. Peak periods range from 2.1 to 5.4 seconds, with a mean of 2.35 seconds.

Wave heights were between 0.2 m and 0.35 m almost 60% of the time (Figure 3).
Wave heights exceeded 0.2 m 90% of the time, 0.3 m 50% of the time, and exceeded 0.5 m 8% of the time (Fig. 4).

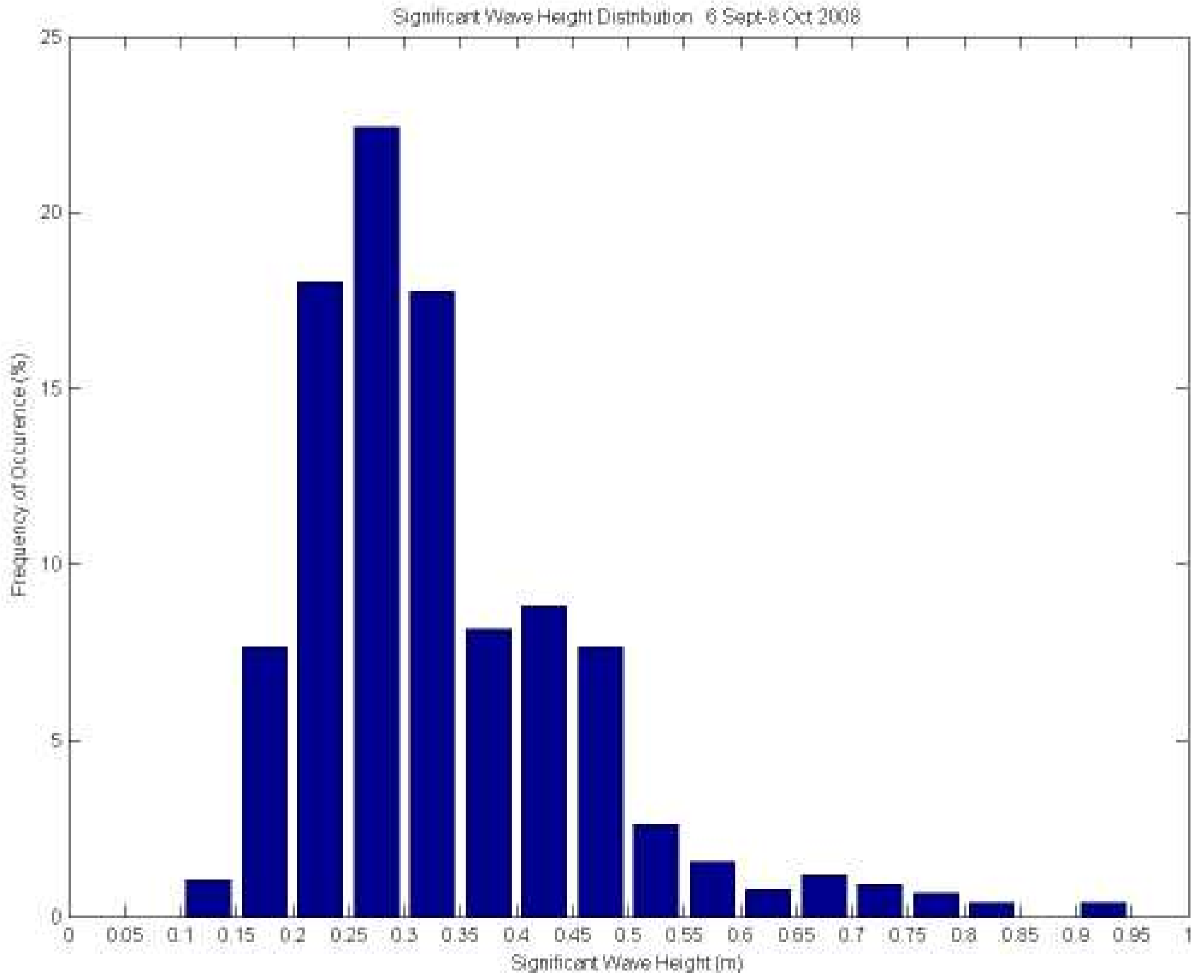


Figure 3 Distribution of significant wave height Steensby Inlet Site 5, 2008

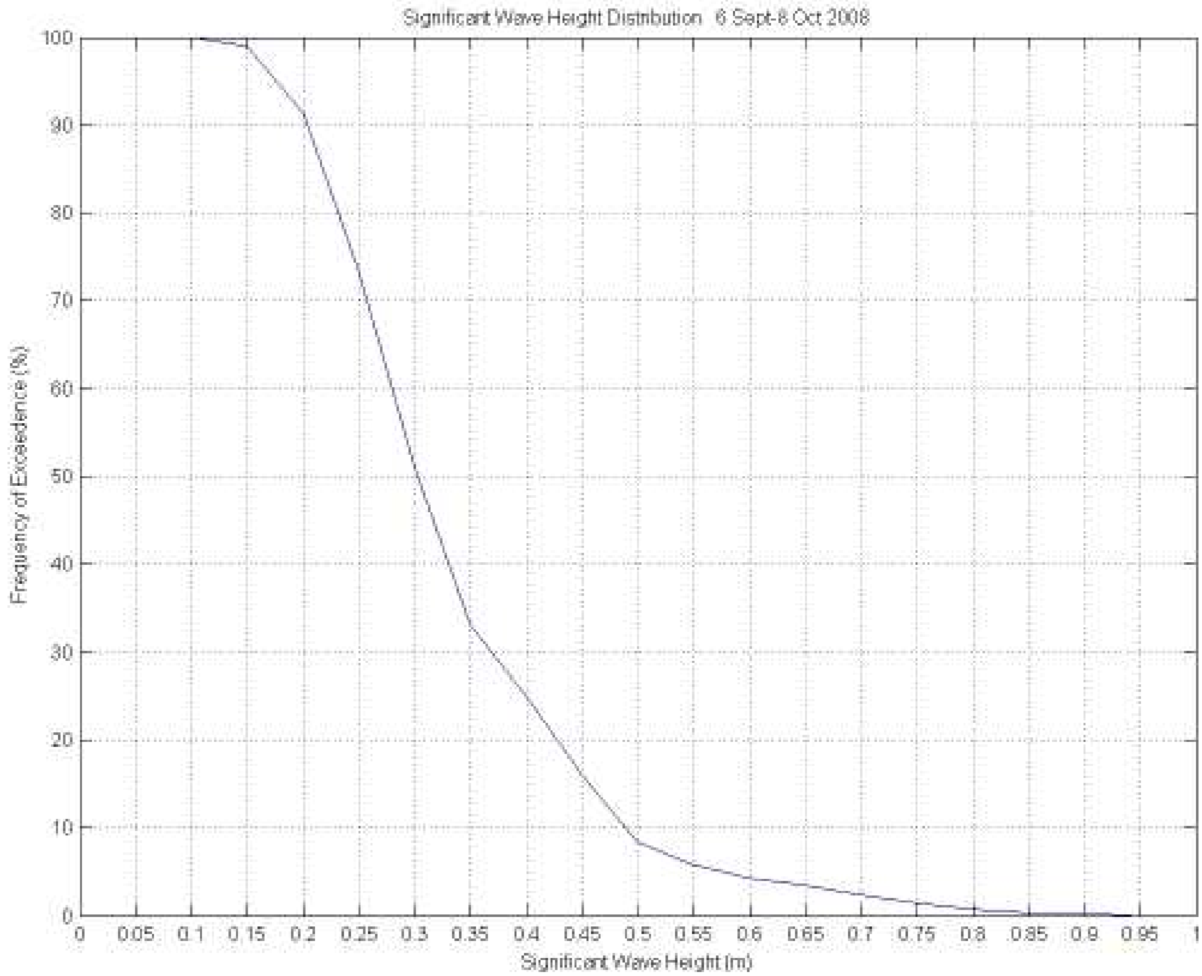


Figure 4 Probability of exceedence of significant wave height Steensby Inlet Site 5, 2008

Appendix 4:

Overwintering of Fuel Vessel Risk Assessment

OVERWINTERING OF FUEL VESSEL – STEENSBY INLET WINTER 2013-2014

PROJECT OVERVIEW AND RISK ASSESSMENT

Foreword

As part of Baffinland Iron Mines Corporation's (BIM) Mary River Iron Ore development, the project outlines plans to overwinter a fuel vessel at Steensby Inlet during the first year of construction.

Shipment of fuel by ship in the Arctic is highly regulated and BIM is diligent in ensuring that fuel contractors ensure compliance with all regulations and guidelines in force. However, it is noted that there are no specific permits or approvals that are required for the overwintering of fuel vessels in Arctic ports. Transport Canada has developed the draft *Arctic Waters Guidelines/Standards for lay up of Petroleum Barges in Land Fast Ice* to address the practice and each project is reviewed and evaluated on a case by case basis. The safe lay-up, in land-fast ice, of petroleum barges and other offshore units has been successfully achieved for many years in Canadian Arctic Waters. Close cooperation between regulatory agencies (Transport Canada, Canadian Coast Guard) with the marine and offshore industries has greatly contributed to this success. Going forward, BIM wishes to ensure that the approach taken in regards to overwintering of fuel vessels is contemplated using best industry practice which meets all of the standards as set out in the current guidelines.

Recently, BIM conducted a workshop which was designed to carefully define the scope of such an operation and also to conduct a qualitative risk assessment of the overwintering operation and the planned fuel transfers that would occur during the overwintering period. During the risk assessment process, a project operations risk register was compiled with inputs from key stakeholders. Operational risks were collectively identified and ranked according to probability of occurrence and impact. Mitigation actions were defined for each risk by the stakeholder groups from each specific area of operations. The resulting risk registers are included herewith and the mitigation actions were clearly defined and are outlined within this document in some detail.

Contents

1.0 Statement of Proposed Activity and Purpose

1.1 Purpose

Adequate supply of fuel meeting the requirements of Baffinland Iron Mine's proposed work plan for the 2013 and 2014 season is an essential element to the success of the project. The regular open water sealift planned for summer of 2013 will permit BIM to transfer approximately 8ML of petroleum product to temporary shore tanks. The overwintering of a fuel vessel will be imperative in order for Baffinland Iron Mines to continue construction activities until such time as permanent shore tankage is completed during the 2014 construction program.

1.2 Volume of fuel required for winter season

At the onset of 2013 Work Plan activities, seven (7) prefabricated, one hundred thousand litre (100,000 L) ISO doubled walled tanks fuel tanks will be placed on site. Two (2) of the ISO fuel tanks will be designed to contain Ultra Low sulphur Diesel (P50) and five (5) will be designed to contain Jet A 1 fuel. In addition, it is expected that up to 5 ML storage capacity will be installed on shore during the 2013 construction period. To supplement the fuel requirement required for the 2013-2014 period, a 20 ML fuel vessel will be anchored near shore and overwinter in Steensby Port.

1.3 Overview of Climatic Conditions

There is currently no Environment Canada meteorological station at Steensby Port, the closest being Pond Inlet. Extensive data exists for Pond Inlet, and data has been collected over a shorter period of time at the Steensby site.

Baffinland established an on-site meteorological station at Mary River Camp on June 13, 2005. The station has been collecting hourly data since being established, except for an interruption in the winter of 2005. Two additional meteorological stations were installed by Baffinland in June 2006 at Milne Port and Steensby Port. These stations have the same sensors as the Mary River station.

The north Baffin Island region is located within the Northern Arctic Ecozone, as delineated in the National Ecological Framework for Canada (Agriculture and Agri-Food Canada, 2000). Northern Baffin Island has a semi-arid climate with relatively little precipitation. The region experiences near 24-hour darkness with less than two hours of twilight from approximately November 12th to January 29th. During winter months (December to April), the treeless topography and fine powdery snow produce blowing snow conditions resulting in restricted visibility. Steam fog may occur in areas of open water, but does not persist more than a few miles downwind. Ice fog is infrequent, due to the lack of moisture in the air, but may occur more frequently if settlements become larger and sufficient moisture is added to the air through fuel combustion.

Frost-free conditions are short and occur from late June to late August. There is continuous sunshine from approximately May 5th to August 7th. The months of July and August bring maritime influences and are usually the wettest (snow may still occur). Fog increases at this time due to arrival of moist air from southern Canada.

During September to November, temperature and the number of daylight hours start to decrease, and by mid-October the mean daily temperature is well below 0°C. The highest amount of snowfall typically occurs during this period. A condition called "Arctic white out" often occurs during this time, where diffuse white clouds blend into the white snow-covered landscape, reducing visibility and increasing the likeliness of disorientation. This condition can also occur in April and May.

During the overwintering period for the fuel vessel, the inlet is ice covered with first year land-fast ice for approximately nine months. Freeze-up occurs in mid- to late- October and clearing not being complete until late July. The cold climate and predictable temperatures ensure a period of stable land fast ice that is favorable to the overwintering project. Challenges in dealing with cold weather operations and exposure to cold, wind and the elements are dealt with on a daily basis by Baffinland Iron Mines personnel and procedures and safeguards are in place for dealing with these conditions. The climatic conditions expected to be encountered during the overwintering have been examined in the risk assessment and several additional mitigating actions have been contemplated to reduce the likelihood, consequences and therefore the severity of an incident.

BIM and the fuel contractor will monitor current and forecasted weather conditions. Assessments of the implications of weather deterioration on personnel safety and operational effectiveness will be intensified during periods of inclement weather. If BIM in conjunction with the fuel contractor determine that weather conditions are expected to adversely affect the fuel transfer operation, a decision will be made to delay the operation until conditions abate ("Go/no go" considerations). A key factor in such a determination is whether or not critical emergency prevention and response measures are compromised.

1.3.1 Winds

Specific data accumulated indicate that winds from the northwest occur most frequently (24% of the time), followed by winds from the east (nearly 12% of the time). The wind data also indicates that "gentle breeze" conditions (3.4 to 5.5 m/s) occur most frequently at 32% of the time, followed by "light breeze " conditions (1.6 to 3.4 m/s), which occur 25% of the time. The data indicates that strong breezes (10.8 to 13.9 m/s) occur only 4% of the time.

1.3.2 Currents

The absence of existing tidal measurements in Steensby Inlet led to a study of water levels in the southern part of the inlet. Tides are mainly semidiurnal and have a pronounced fortnightly cycle. The maximum observed tidal range was approximately 4 m during spring tides and 1.5 to 2 m during neap tides.

Currents in the immediate port area have also been extensively studied, however tidal action is by far the most dominant current action observed at the port. Winds influence surface currents and would contribute to spill migration if an incident occurs in open water.

As winds would not be a factor in relation to currents due to the shore fast ice that will be present during the overwintering period, the tidal currents present would be of most influence on spills that would penetrate or originate under the ice.

The currents expected to be encountered during the overwintering have been examined in the risk assessment and several additional mitigating actions have been contemplated to reduce the likelihood, consequences and therefore the severity of an incident. Monitoring to prevent or quickly detect and minimize the volumes of any unlikely incident is the best method of mitigating the effects of currents and potential transport of oil from the area of the vessel mooring.

1.3.3 Ice

The Steensby Port will eventually be a year-round shipping operation with planned vessel arrivals every few days. Such a continuous operation this far north will be unprecedented in Canada, all previous such undertakings being seasonal only, examples being the mining operations at Nanisivik (northern Baffin Island) and at Little Cornwallis Island to the west. The current most northerly year-round operations in Canada are the Raglan Mines, which ships ore from Deception Bay in northern Quebec and the Voisey's Bay Mine in northern Labrador, both of which, however, operate at reduced shipping frequency during winter. To this end, ice conditions in the port and along the shipping route have been the focus of intense scrutiny throughout project development. Extensive data has been analyzed and extensive studies carried out to characterize the ice conditions at Steensby inlet.

With regards to overwintering a fuel vessel at Steensby, Transport Canada draft guidelines suggest a thorough historical analysis and assessment of ice conditions at the proposed overwintering location to ensure that land-fast (non pressured) ice conditions are assured throughout the lay-up period.

The overwintering proposed for the Baffinland Iron Mines (BIM) Mary River project on northern Baffin Island are to be located at the Steensby port site. Steensby Inlet is an approximately 15 km wide by 40 km long water body located to the north of Foxe Basin and about 140 km south of the mine site, at approximately 65º N. latitude (Figure 1-1). The inlet is ice covered with first year land-fast ice for approximately nine months of the year, freeze-up occurring in mid- to late- October and clearing not being complete until late July.

Typical sea ice conditions in Steensby Inlet and along the proposed shipping route were identified from literature sources (Markham, 1981; Prinsenberg, 1986) and an ice and marine shipping assessment conducted in support of the Project. The ice study supported the selection of Steensby Port as a viable location, helped define the proposed shipping route to Steensby Inlet, and determined the appropriate ice class of vessels.

Data used in the detailed Enfotec Ice and Marine Shipping Assessment included CIS data (1990 to 2010), as well as synthetic aperture radar (SAR) imagery from aircraft (1990-1995) and RADARSAT satellite (1998-2010). Additional CIS ice data (1982-2010) was analyzed by Sikumiut Environmental Management Ltd. The 30 year baseline review used the most recent and up-to-date data available for the RSA. Other data such as the Hall Beach ice thickness data and on-site sampling was used for modeling purposes.

Foxe Basin and Hudson Strait undergo an annual pattern of ice formation and ablation. Through most of the year, marine waters in the region are covered by land-fast and mobile drift or pack ice. Only during September is Foxe Basin largely ice-free. The Foxe Basin/Steensby Inlet area has a longer ice season than other areas at similar or even higher latitudes (Markham, 1981; Prinsenberg, 1986).

Ice formation in northern Foxe Basin begins in mid- to late October. New ice expands southward from north-western Foxe Basin (Markham, 1981). Freeze-up begins in the western portion of Hudson Strait during November and proceeds eastward until most of the Strait is covered, generally in mid-December. Shore lead systems frequently form along the southern coast of Baffin Island, while ice tends to accumulate along the southern shore of Hudson Strait and Ungava Bay. Landfast ice forms along coastline areas of Foxe Basin and Hudson Strait. Most inlets and bays across northern Foxe Basin, including Steensby Inlet and Murray Maxwell Bay, are characterized by large extents of landfast ice. Each year, Steensby Inlet is completely covered by landfast ice that can extend as far south as Koch Island in some years.

To capture maximum ice thickness values in Steensby Inlet, sampling was conducted in May and June. This field sampling period was chosen based on 50 years of ice thickness data from nearby Hall Beach and the results were consistent with expected values from that location. Sampling effort was equally divided between the Steensby port site and the entrance to Steensby Inlet. In May, Steensby port site median ice thickness was 1.90 m while the mean (± standard deviation) ice thickness was 1.93 ± 0.36 m. In June the median ice thickness was 1.85 cm and the mean (± standard deviation) ice thickness was 1.94 ± 0.37 m. The sampling stations across the entrance of Steensby Inlet were spaced 5 to 10 km apart and in the month of June had a mean of 1.85 m and a median ice thickness of (± standard deviation) 1.87 ± 0.16 m. Even though the stations were spaced farther apart, the spread of measurements was tighter than that of the port site.

Examination of satellite imagery and historical winter atlases suggests that landfast ice in Steensby Inlet is characterized by few ridges and leads. However, during a shipping-focused thematic workshop held at Mary River during September 2010, Igloolik community members indicated that a recurring lead occurs between one of the small islands in central Steensby Inlet and the eastern shore. This is not deemed to potentially interfere with the overwintering of the vessel.

From the extensive study of the data and the analysis BIM has determined that the overwintering site provides secure and stable land-fast conditions favorable for the safety of the vessel throughout the overwintering period.

Ice freeze up occurs during period of low temperature and calm sea state (no winds). Under these conditions, ice forms quickly and newly formed ice then acts as a buffer to retard wind-induced wave formation. During this period of rapid ice formation, high winds or other phenomena can act to break up the newly formed ice and cause it to raft and otherwise break up. Eventually, the low air temperature and even brief periods of calm water will result in formation of an ice cover that is thick enough to resist these disruptive forces and the ice continues to grow both in thickness and aereal extent. At the outer edge of land-fast ice, the dynamics of air temperature and wave/current conditions can affect the sina and this area of interaction between landfast and pack ice can result in an area of ice build-up and a moving edge. In mild winters the sina will be closer to shore; in colder winters the sina will extend seaward.

The knowledge gained from the study of the ice formation and conditions at Steensby allow the overwintering of the fuel vessel to take place in a stable, controlled and planned fashion. The capability of the ship in maintaining position during the shoulder periods and the stability of the shore fast ice, once formed, ensure the safety of the mooring operation.

1.3.4 Waves

As the area of the shore fast ice is extensive once freeze up has occurred, wave action is not deemed to be a factor during the overwintering period.

1.3.5 Wildlife

Wildlife is active in the vicinity of Steensby Inlet during the entire winter, including the planned time frame of the fuel transfer operation. The people that will be involved in the execution of the fuel transfer operation 24 hours per day are therefore subject to encounters with dangerous wildlife. Worker safety will be addressed through a requirement to give notification of sightings and/or evidence of wildlife, a wildlife deterrent training program and protocols for responding to wildlife-related emergencies. Standard BIM wildlife protocol applies.

1.4 Fuel Vessel Selection

The choice of a ship as opposed to unpowered barge was carefully considered by BIM. The choice of a ship of appropriate ice class will ensure not only integrity of construction, but also will provide for vessel management during the freeze up and break up shoulder periods. Ice management vessels will not be required as the vessel will be able to accomplish mooring independently during the shoulder periods before and after the shore-fast ice season. The details in relation to vessel selection, mooring and other considerations are discussed herewith.

1.4.1 Vessel Specifications

The vessel selection shall be carried out with mitigation of risk as the primary goal. BIM recognizes that the selection of the type of vessel, the performance of the vessel operations, crewing standards and other operational parameters influence the safety of the operation to a high degree.

The choice of the vessel will be subject to commercial negotiations conducted at a future date. Baffinland Iron Mines will award an Engineering Procurement Construction Management contract (EPCM) however Baffinland Mines shall oversee and ensure that the criteria for vessel selection shall be developed to include but not be limited to:

Essential characteristics:

- Ice class 1A or higher
- Double hulled, Segmented compartments
- Vessel must carry full complement of spill control gear and the crew must be trained in its use

The vessel ice class and hull construction ensure that risk of damage to the external hull under any circumstance is very low. The double hulled construction acts as further prevention against a spill. In order for a spill to the marine environment to occur, not only would the outside hull of the tanker have to be compromised, but the cargo tank (which is significantly inward from the hull) would need to be compromised as well.

Several other criteria shall be evaluated and are all deemed as risk mitigating and as an enhancement to suitability of a potential vessel:

- Bunker, slop and lube oil tanks having a void space between tank and ship skin.
- The carrier must demonstrate a comprehensive monitoring capability for all double hull void spaces to detect any ingress of cargo into these spaces. They also must have onboard tank

volume monitoring capabilities capable of detecting small changes of volumes within the cargo tanks.

- Seabays , firefighting systems capable of remaining operational throughout and extended overwinter period in arctic temperatures.
- Have sufficient heating capacity to remain fully operational throughout the winter months.
- Carriers able to demonstrate that the proposed ship and fleet is approved by a number of oil majors and are able to present a trading history for the previous 6 months given precedence.
- Adequate crew as to not exceed hours of work and rest during winter lay-up.
- Crew should be familiar with cold weather/winter operations.
- Crew should be familiar with Arctic ship to shore discharge and meet SOTO requirements.
- Carrier must advise vessel class society and have a plan to deal with certificates that may become due for renewal during overwintering.
- Have a plan for vessel provisioning throughout the overwintering period.
- Plan for crew changes throughout the overwintering period.
- Provide details of the vessel fuel consumption over the period, stack emissions and other environmental impacts.
- Have performed a complete risk assessment of the operation from the ship operator's perspective and provide a plan for mitigation of risks. The risk assessment shall be reviewed by Baffinland Iron Mines.

1.4.2 On board Emergency Response Personnel and Equipment

The vessel must carry on board a complete inventory of spill equipment meeting the requirements of the Arctic Waters Oil Transfer Guidelines - TP 10783 E. This equipment must include but is not limited to:

Containment Equipment

Sufficient containment equipment to completely encircle the vessel complete with accessories to deploy and maintain in a workable condition.

Skimming equipment

Sufficient skimming capabilities to recover, within 48 hours, a volume equivalent to the largest tank of the vessel.

Sorbent materials

Sufficient sorbent materials to maintain operations for a period equivalent to the lead time expected for replacement stock to arrive on site or 48 hours, whichever is greater.

1.4.3 SOPEP

The fuel contractor will have a Shipboard Oil Pollution Emergency Plan (SOPEP) in place on the ship in accordance with applicable regulations. BIM also will outline activity-specific protocols relating to ship to shore fuel transfer in its Oil Pollution Emergency Plan ("OPEP"), which has been prepared by BIM to meet requirements under the *Canada Shipping Act, 2001* and its *Response Organizations* *and Oil Handling Facilities Regulations*. The vessel SOPEP shall be reviewed by BIM as part of the vessel selection process.

1.4.4 Vessel Anchoring Location and Mooring

The vessel will be safely moored at the end of the navigation season just prior to freeze up. Once freeze up is complete and the ice is solid and land fast cargo discharge can commence from the ship to the BIM tanks on shore throughout the winter. Upon spring break up the vessel will then be able to depart once safe navigation conditions permit.

The choice of mooring location has been carefully considered and is based on several factors. The selected location provides a secure land fast ice environment as soon as freeze up occurs and throughout the overwintering period. Also, the location is in close proximity to the shore reservoir storage facility. Sufficient water depth to ensure a 25% of draft minimum under keel clearance shall be ensured to mitigate any effects of cold sink from potential ice buildup under the hull. In addition, as the cold sink effect is more probable under empty tank conditions, a careful tank inventory control shall be implemented to avoid this condition as long as possible into the layup period thus delaying onset of any cold sink effect.

It is not anticipated that ice management vessels shall be required as the vessel will be moored (anchored) until such time as sufficient freeze in is achieved. Once secure, anchors shall be raised and stowed so as to avoid potential damage or loss of anchors and windlass should the ice shift at break up. Ongoing ice monitoring shall be carried out throughout the freeze in and break up period. Vessel position shall be carefully monitored and logged throughout the overwintering period. As the vessel is crewed and self propelled, immediate action can be taken to reposition the vessel during the shoulder seasons if required.

1.4.5 Ship to Shore Fuel Transfer Method

No fuel transfer shall occur during the shoulder seasons at freeze up and break up. BIM has sufficient on shore fuel storage capacity for these periods so that no transfer by hose in partially ice covered waters will be required (over 5 ML storage capacity to be erected on land during the 2013 open water season).

BIM has established standard operating procedures that dictate conditions where ice thickness permits work on the ice surface. Until these conditions are met and weather conditions permit, no deployment of transfer equipment shall be made.

Two methods of product transfer have been contemplated:

- Bulk transfer by hose over the ice
- Periodic transfers by tanker truck along the ice

Regardless of the transfer method, all product transfers shall be made in accordance with all regulatory requirements which include but are not limited to:

1. Arctic Shipping Pollution Prevention Regulations (ASPPR) under the Arctic Waters Pollution Prevention Act.

2. Regulations for the Prevention of Pollution from Ships and for Dangerous Chemicals (RPPSDC) under the Canada Shipping Act, 2001

3. Arctic Waters Oil Transfer Guidelines (TP10783)

4. Transport Canada Draft Guidelines for Lay-Up of petroleum Barges/Vessels in Land Fast Ice

In addition the following regulations relating to the Steensby Oil Handling facility also apply:

The *Canada Shipping Act*, 2001*,* stipulates that operators of designated oil handling facilities must have an on-site oil pollution emergency plan.

The Steensby Inlet Fuel Storage Facility, Oil Pollution Emergency Plan takes into account the requirements of the Canada Shipping Act, 2001, part 8, subsections 168. (1), 168. (2) and 168. (3). Although the subsection 168 (2) is applicable, as the Milne inlet site is located North of 60', therefore the subsections 168. (1) (a), 168. (1) (b) (ii), 168. (1) (b) (iii) do not apply.

The Canada Shipping Act Response Organizations and Oil Handling Facilities Regulations (SOR/95-405) applies.

The Oil Handling Facilities Standards, TP12402 applies.

Bulk transfer through hose:

BIM will develop strict standard operating procedures (SOP) which will dictate requirements for work on ice. These SOP's shall be in effect at all times. Prior to any work being undertaken on the shore fast ice, all conditions within the SOP must be met and the work performed in strict accordance with the procedures.

For the bulk transfers, it is anticipated that approximately 2500 feet of arctic grade hose shall be deployed between the ship and the shore receiving facility. The hose shall be a suitable height above the ice surface secured to and supported by an engineered hose support system. Elevating the hose will ensure that the hose does not become buried in blowing snow and also to permit continued monitoring, inspection and any maintenance to the hose conduit.

BIM has identified Arctic grade hoses that are specially suited to the harsh environment, temperatures and exposure that is anticipated. All hoses shall be tested and certified. Hoses are to be fitted with flange style couplings with gaskets that are suited to the temperatures and service anticipated. The hose shall be fully pressure tested after installation and shall be air tested and fully visually inspected prior to each petroleum transfer. Although the couplings are highly reliable, as an additional spill mitigation measure, portable berms shall be installed under each hose coupling to contain any possible drips or leaks from couplings. An ice road shall be maintained along the hose length to ensure access at all times. During transfer operations the line will be periodically visually inspected by BIM crews to ensure integrity.

A complete BIM fuel transfer procedure shall address all elements of the operation. The fuel transfer procedure shall contain similar elements as the BIM bulk fuel transfer procedure for the marine transfer but shall also include all of the additional elements related to the specifics of transfer over the ice. Strict operating limits which shall include temperature, visibility and other “go/no go” factors shall be established. No transfers shall take place where conditions do not meet the operating limits established.

To limit operational risks, each package to be pumped would be a relatively sizeable volume i.e. minimum 1000m^3. Following the cargo transfer the hose would be pigged and left empty to prevent any possible pollution incident.

Prior to each transfer operation the temporary pipeline would be pressure tested with air and physically inspected.

During transfer operations the shore manifold is manned at all times. A low pressure alarm is installed at the shore manifold which is highly sensitive to differences in pressure during pumping. Any loss in the system will cause a drop in manifold pressure and results in an audible alarm which is immediately reported by the manifold personnel.

The tank farm shall be monitored at all times by Baffinland personnel during the transfer.
Spill response equipment shall be placed at strategic and easily accessible locations to ensure rapid response, containment and recovery in the event of any spill occurrence.

Spill mitigation during the ship to shore transfer by hose has been considered carefully in the risk assessment process. Several spill mitigation measures have been considered including:

- Regular inspection and monitoring, proper equipment specification, gaskets for arctic conditions, flanges on hoses rather than cam locks, secondary containment under all couplings.
- Spill response immediately on hand during transfers
- Pre-testing prior to transfer commencing
- Equipment specification for arctic conditions
- SOP for fuel to shore transfers
- Monitoring/personnel on deck keeping watch
- Drip trays under manifold, fish-plate around perimeter of ship, scupper plugs
- Continuous pressure monitoring both at ship’s manifold and at shore manifold (low pressure alarm)
- Standard pumping procedures to address weather/elements
- Bear monitors and adherence to polar bear management plan
- Hose flagging, traffic restrictions during transfers, access track separated of hose alignment, inspection and monitoring regularly
- Spill response immediately on hand during transfers
- Pre-testing prior to transfer commencing
- Pressure monitoring at shore receiving line
- Define environmental conditions (GO/NO GO) acceptable for transfer
- Inspection of shore tank vent and monitoring
- Pigging procedure to prevent over pressurization of tank

- Fire prevention (no smoking, vehicle distance), pipeline monitoring, proper grounding procedures

Transfer by tanker truck:

Bulk transfers through the hose are deemed the most desirable method of fuel transfer. Truck transfers shall be considered as a secondary practice should they be required for operational reasons or should bulk hose transfers be precluded for any operational or logistical reason.

All BIM standard operating procedures (SOP) in place which dictate requirements for work on ice remain in force.

The fuel will be transferred from the ship to the trucks using 4-inch diameter, 4-ply Arctic Grade flexible hoses connected to a manifold on the tanker and an inflow valve on the bottom of each truck. Details on the fuel transfer components shall be detailed in the fuel transfer procedures that shall be developed prior to actual operations.

The fuel tanker truck shall be positioned beside the ship in a totally bermed and contained area. Trucks shall only be filled to 85% capacity in order to minimize the risk of accidental overfilling.

As the receiving facility (trucks and shore tanks) and shore representative, BIM provides support in the form of pre-fuel transfer preparations and verifications, including gauging shore, truck and tanker tanks, providing equipment and personnel to assist the transfer in the form of trained tank/valve/hose/pipeline monitors, stand-by equipment operators, restricting activities in the fuel transfer area, and emergency response personnel and equipment.

In the event of an oil handling emergency, BIM will also assist by activating its internal emergency response plans and personnel, and with notifying of regulatory agencies, as needed. The ship would also be responsible for activating its emergency response plan (SOPEP).

Emergency response pertaining to the bulk fuel offload is a coordinated responsibility between the fuel contractor and BIM. However, in the event of a spill during transfer, BIM's Onshore Co-ordinator would coordinate the response.

2.0 **Methodology for Risk Assessment**

Risk management on Baffinland Iron Mines projects is a core function that supports the achievement of business and project objectives through proactive rather than reactive management at all stages of the project life cycle. Sound risk management processes also support effective communication amongst key stakeholders and is integrated into the decision making and change management processes on projects. The risk management process that Baffinland Iron Mines has used in support of the overwintering project is the model detailed in the internationally recognized Australian Risk Management Standard, AS/NZS 4360.

The process followed a five step approach:

1) Establishing the context, objectives and criteria;

2) Collectively identifying risks by project area;
3) Collectively analyzing the risks from a likelihood and consequence perspective;
4) Ranking the risks by their resulting combined score;
5) Treating the risk by identifying mitigation actions.

2.1 Classification of Likelihood and Consequences

After establishing the context and then identifying the risks by project area, step three of the risk management process involved classifying each risk in terms of likelihood and consequence using a 5-point scale. Table 1 below shows the likelihood ratings and corresponding probabilities, whilst Table 2 below shows the consequence ratings and descriptions of how each rating pertains to technical performance and operating costs, project cost, project schedule, health and safety, reputation, legal/regulatory and environmental. For the first three categories, the approximate monetary and schedule impact ranges, specifically related to the Mary River Project, are shown in brackets.

Table 1: Likelihood Table

Rating	Likelihood Description and Indicative Frequency	Indicative Probability
A - 5	Almost Certain: Very high probability of occurrence could occur several times per year or several times during project execution. Has occurred several times on similar projects.	>0.8
B - 4	Likely: High probability, likely to occur approximately once per year or once during project execution. Similar event has occurred once per year on similar projects.	0.5 to 0.8
C - 3	Moderate: Possible, reasonable probability that it may occur at least once in a 1 to 10 year period or at least once during every three project executions. A similar event has occurred at the above times on other similar projects.	0.1 to 0.5
D - 2	Unlikely: Plausible, unlikely to occur during the project, could likely occur over the next 10 to 40 years or once during every 10 project executions. A similar event has occurred at the above times on other similar projects.	0.02 to 0.1
E - 1	Rare: Very low likelihood but not impossible, unlikely to occur during the next 40 years or during at least 10 project executions. A similar event has occurred at the above times on similar projects.	<0.02

Table 2: Consequence Table

Rating	Technical Performance	Project Cost	Project Schedule	Health & Safety	Reputation	Legal/Regulatory	Environment
E - 5 (Catastrophic)	60% of design capacity not achieved. Increase in operating costs >50% ***[> 204 M/yr]***	Greater than a year of lost production / shipping ***[>1.2 bn]***	Greater than 30% cost overrun ***[>1.5 bn]***	Fatality	Adverse global media coverage Govt inquiry Major public concerns Major loss of shareholder support	Very significant fines and prosecutions Multiple litigations	Long term environmental damage – 5 years or more requiring > $5M to remediate, study and/or penalties
D - 4 (Major)	Cannot achieve 80% of design capacity without significant capital expenditure. 30% to 50% Increase in operating costs ***[122-204 M/yr]***	6 to 12 months of lost production / shipping ***[0.6-1.2 bn]***	15% to 30% cost overrun ***[0.75-1.5 bn]***	Serious or multiple Injury resulting in permanent disabilities	Adverse national media coverage Govt member involved Senior mgt changed Significant shareholder support	Significant fines and prosecution. Very serious litigation, including class actions	Medium term – 1 to 5 years environmental damage requiring $1 to $5M to remediate, study and/or penalties
C - 3 (Significant)	Cannot achieve 100% design cap. without significant capital expenditure. 10% to 30% increase in operating costs ***[41-122 M/yr]***	2 to 6 months of lost production / shipping ***[200-600M]***	5% to 15% cost overrun ***[0.25-0.75 bn]***	Serious injuries Extended lost time	Adverse media coverage Board involved Significant decrease in Shareholder support	Major breach of regulation. Major litigation	Short-term < 1 year environmental damage requiring up to $1M to remediate, study and/or penalties
B - 2 (Moderate)	Cannot achieve 100% design cap. without some capital expenditure. <10% increase in OPEX ***[< 41 M/yr]***	Between a week and 2 months of lost production ***[23-200M]***	0.5% to 5% overrun ***[25-250 M]***	Significant injury Limited lost time	Adverse local media coverage Report to Board Shareholder concerns raised	Serious breach of regulation with investigation or report to authority with prosecution and/or moderate fine possible.	Environmental damage requiring up to $250K to remediate, study and/or penalties
A - 1 (Minor)	Minor Difficulties	Less than a week of lost production ***[<23M]***	Less than 0.5% Within budgeted costs ***[<25M]***	Minor injuries or near miss – no lost time	No media attention Issue raised by workers	Low level legal or approval issue	Negligible environmental impact, managed within budgets

2.2 Severity Definition

Risk ratings were presented in the form of a colored risk matrix to highlight the key risks to the project team (refer to Figure 1 below). Depending on the risk rating, the risk was classified as low (green zone, with a resulting rating from 1 to 6), medium (yellow zone, with a resulting rating from 7 to 19) or high (red zone, with a resulting rating from 20 to 25). At the end of the risk management assessment, the risk ratings were tallied and displayed in the risk matrix.

Figure 1: Severity Definition

CONSEQUENCE

LIKELIHOOD	Minor	Moderate	Significant	Major	Catastrophic
Almost Certain	11	16	20	23	25
Likely	7	12	17	21	24
Moderate	4	8	13	18	22
Unlikely	2	5	9	14	19
Rare	1	3	6	10	15

3.0 Risk Assessment Participants

The risk assessment workgroup consisted of various key stakeholders in the project including management, construction, environmental, operations, spill response planning and shipping.

Participant	Title / Organization	Discipline
Fernand Beaulac	Senior Consultant, Environmental Management Specialist EIS	Project oversight
David McCann	Operations Manager, Mary River Project – Baffinland Iron Mines Corp.	Project and site management
Jim Millard	Environmental Superintendent, Mary River Project – Baffinland Iron Mines Corp.	Environmental management, project and site
Shawn Tucker	Construction Manager, Mary River Project, Hatch	Site construction, Mary River and Steensby and Milne Inlet
Jamie Keech	Environmental Coordinator, Hatch	Environmental Management
Adam Grzegorczyk	Environmental Analyst, Hatch	Environmental Management
Todd Mitchell	Navenco Marine Inc., Spill Specialist	Spill mitigation and response planning
Christopher King	Petro-Nav Inc. – Vice President, Operations	Fuel shipment – Tanker operations specialist
Dan Methe	Safety Superintendent, Baffinland Iron Mines Corp.	Safety

4.0 Overview of Available Information

4.1 Experience at Hope Bay (Newmont 2011)

During the winter of 2011, Hope Bay Mining Ltd. (Newmont) undertook the delivery of approximately 8ML of Ultra-Low Sulphur Diesel (“ULSD”) from Trafigura Canada General Partnership (“Trafigura”) to Hope Bay Mining Limited (“HBML”) at Roberts Bay in Melville Sound, Nunavut Territory.

The operation involved the M/T Primula tanker which was frozen in the bay approximately 2.2 kilometres north of HBML’s jetty to a series of fuel trucks operated by HBML. The trucks then delivered the fuel to large shore tanks located near the jetty and throughout HBML’s project site.

The project was undertaken after significant review by stakeholders and was in conformity to Transport Canada guidelines. The operation met all regulatory requirements.

Careful planning and cooperation between all of the agencies involved contributed to the success and safety of the operation.

4.2 Experience in other Arctic Regions

The safe lay-up, in land-fast ice, of petroleum barges and other offshore units has been successfully achieved for many years in Canadian Arctic Waters. Close cooperation between regulatory agencies (Transport Canada, Canadian Coast Guard) with the marine and offshore industries has greatly contributed to this success.

In the past large tankers/OBO's or barges have been safely/successfully utilized as "Offshore Floating Tank Farms" (OFTF) in support of offshore drilling in the Canadian Arctic. Large barges and drill units have been frozen in at McKinley Bay, Herschel Basin, Wise Bay and Summers Harbour. Some notable examples are:

- OBO GULF BEAUFORT (150,000 dwt)
- OBO SKAUVANN (120,000 dwt)
- Barge ARCTIC KIGGIAK (10,000 dwt)
- Barge PETER KOMINGAK (7,000 dwt)
- Barge CANMAR SEA SHUTTLE (30,000 dwt)
- Barge ARCTIC TUK (9,700 dwt)
- Barge ARCTIC BREAKER (8,929 dwt)
- Barge ARCTIC IMMERK KAMOTIK (11,295 dwt)

Small barges have been and continue to be frozen in as a matter of course over much of the Western Arctic and in Baker Lake in the Eastern Arctic.

Transport Canada has recognized the feasibility of the practice and has produced draft guidelines for the safe lay up of vessels in land fast ice. They have noted that the safe storage/lay-up of oil cargo or fuel under all reasonable circumstances is possible using sound, well rehearsed practices, adequate numbers of trained/experienced and alert personnel, appropriate/sufficient materials and well maintained, thoroughly tested equipment.

It is also notable that the overwintering of fuel vessels is also practiced on a regular basis in other areas including Alaska, Russia and elsewhere in Arctic regions around the world, however the focus of this project is to provide for safe operating practices tailored to the Canadian Arctic environment and the concerns associated with the stakeholders in the target area.

5.0 Baffinland Emergency Preparedness and Response

5.1 Emergency Response Team

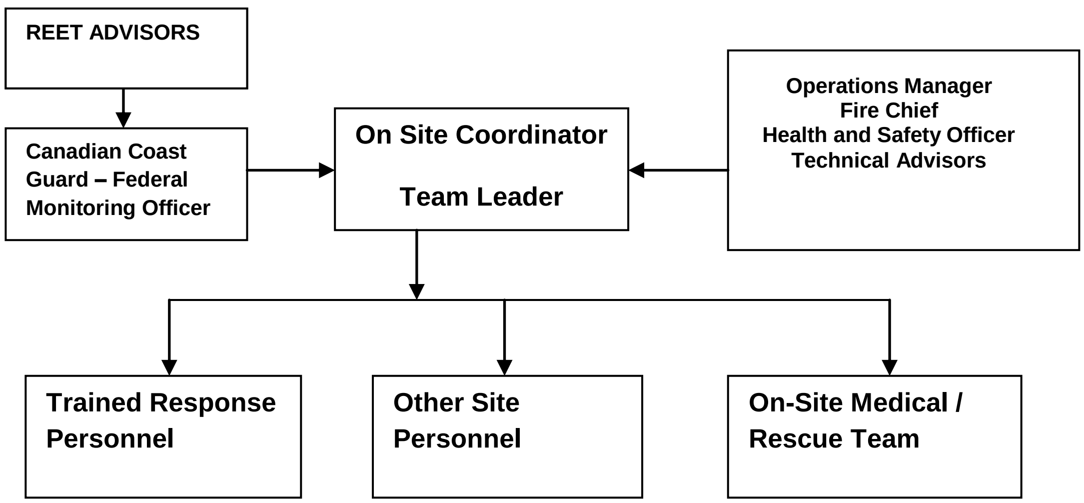
In the event of a spill, procedures and response functions are to be implemented through the spill management team. The structure of this management team is shown in table 3 and the organizational chart figure 2.

Table 3: Baffinland Emergency Response Management Personnel

Baffinland Emergency Response Management Personnel	
Position (Owner's Representative)[1]	**Contact**
Cliff Pilgrim or Jeff Bush On-site Co-Coordinator	**Emergency After Hours Tel: 403-450-8844** Email: cliff.pilgrim@baffinland.com Mary River Site Tel: 403-450-7312 Email: jeff.bush@baffinland.com Mary River Site Tel: 403-450-7316 Milne Inlet Site Tel: 647-723-2077 (24 hours)
Dalton Head or David McCann On-site Co-Coordinator (alternates)	**Emergency After Hours Tel: 403-450-8844** Email: dalton.head@baffinland.com Mary River Site Tel: 403-450-8838 Email: david.mccann@baffinland.com Mary River Site Tel: 403-450-8843
Jim Millard or Brian Larson Environmental Health & Safety Superintendant	Mary River Site Tel: 403-450-8843 Email : jim.millard@baffinland.com Off-Site Cell: 902-403-1337 Email : brian.larson@baffinland.com Mary River Site Tel : 403-450-1589
Dave McCann Operations Manager	Mary River Site Tel: 403-450-8843 Cell: 416-616-8860 Email: david.mccann@baffinland.com
Erik Madsen Corporate Contact – VP Sustainable Develop.	Office Tel: 416-8143980 Cell: 416-996-5523 Email: erik.madsen@baffinland.com
Note: The contact information for the EPCM contract representatives will be added once the Project Certificate is issued and the Project is approved.	

Once a spill event is reported, the On-Site Coordinator establishes a specific strategy for containing and controlling the spill and to initiate the cleanup activities. Other site personnel such as the Fire chief, Health and Safety Officer, and Operations Manager may act as technical advisers prior to and during the response. The trained Spill Response Team will conduct all emergency spill response operations under the leadership of the On-Site Coordinator. During the cleanup phase of the response other site personnel (e.g., heavy equipment operators, laborers, etc.) may be involved.

Figure 2: Spill Response Team Organization Chart



5.2 Response Equipment on Site

Table 4: Response equipment on site

Quantity	Description
1	Oil containment boom 300 meters – Aquaguard “Liteflex” 24
4	Anchor kits for anchoring boom in place
4	Towing bridal for oil boom
8	Spill response unit – X Large Land
4	Overpack spill kit
500	12 kg. Bags Multizorb granular
1	Custom pump skid for emergency fuel transfers from one tank to another
8	2 inch diameter x 8 meter transfer hose for emergency transfer pump
12	0.5m X 0.5m x 15 cm Arctic mini berm for under fittings
12	1m x 1m x 15 cm Arctic mini berm for under fittings

2	Insta berm 3m x 3m x .4m Arctic
300	Oil sheets for replenishing spill kits
1	Aluminium workboat with outboard engine, equipped with towing post and related equipment for boom deployment
1	Drum skimmer and diesel driven power pack, suitable for recovery of distillates – Capacity 7.5 tonnes per hour
1	Vacuum truck, 13,500 L capacity
20	200 litre (45 gallon) steel drums
12	Asphalt type rakes for beach cleaning
12	Perforated shovels for sorbent recovery
12	Pitch forks with screens for sorbent and debris recovery
12	Approved flotation devices

5.3 Training Requirement and Field Exercises

Baffinland Iron Mines ensures that personnel involved during a response receive training for their own safety, public safety, and that they have the required skills to minimize the impact of a spill on the environment.

The personnel directly linked to spill response operations will receive training to familiarize themselves with the environmental emergency plan. These personnel will also reexamine the manual of the Environmental Emergency Plan on a yearly basis according to their duties and responsibilities. All training is recorded in the training register and kept up to date in the Oil Pollution Emergency Plan binder.

The personnel directly linked to spill response operations, contract employees and the other responders identified in the environmental emergency plan should take part in the yearly training program.
All workboat operators and crews shall possess a Pleasure Craft Operator Competency Card.

Training Content

Spill training shall be provided on site prior to transfer operations for all personnel to be involved in the management and response to possible spills.

Baffinland Iron Mines On Site Co-ordinator shall possess accredited spill management training to a level commensurate to the duties required of the position.
Responder training is to be of a combined theoretical presentation (classroom) and also of a hands on nature (equipment deployment exercise).

The major components of this training program shall include:

Classroom Training:

- Introduction and overview of marine spill response
- Review of Baffinland general spill response plan and integration of same to marine response
- Review of Marine Oil Pollution Emergency Plan elements

- Short review of oil spill behavior and operational parameters / limitations for marine spill response operations
- Spill assessment
- Basic safety for spill responders to marine oil spills, presentation of video – small craft safety practices
- Basic oil boom deployment, presentation of video and booming techniques / guidelines
- Marine and shoreline recovery operations

Hands on Training and Deployments:

- Hands on review with participants of Baffinland inventory of spill equipment
- Hands on instruction - boom connections, tow bridles, rope handling, basic knots and attachment of deployment accessories
- Simulated deployment of booms and related gear on water using appropriate vessels
- Debriefing and lessons learned

Short Notice Training

In the event of a large spill the personnel requirements may exceed those that have received the specific responder training as outlined above. Due to the remoteness of the site, volunteers are not anticipated. Milne Inlet site services personnel shall be employed as additional responders.

Although all site services personnel possess WHMIS training additional short notice training shall be carried out for these new responders on an as needed basis. Certain modules of the responder training shall be delivered on site to these personnel selected specifically from the training outlined above. The operations manager shall determine which modules are pertinent to each group of additional responders and shall be responsible for assuring adequate training for each group.

Cold Weather Response Training:

Response during the overwintering period has been carefully considered and a special training shall be carried out for all personnel that may be present during this period.

Training for the cold weather response shall include but not be limited to:

- Cold Weather Oil Spill Response PPE
- Ice Characteristics
- Source Containment Techniques
- Surface and Subsurface Oil Removal
- Spill Trajectory Analysis - Ice and Snow
- Decontamination - Cold Weather Operations
- Ice Slotting
- Ice/Snow Decontamination
- Surface Removal Techniques (Skimmers, Augers, Chainsaws)

Exercises

Following the annual delivery of the spill training as outlined above a comprehensive spill exercise shall be undertaken. The exercise is structured to test the readiness of management, responders and to practice and validate the logistics of the deployment of spill gear. The exercise content shall be different from year to year so that it can validate the various elements of the plan and the response over a three year period. Some of the factors that shall be evaluated include but are not limited to:

- Activation of the emergency plan
- Management response
- Site safety
- Communications
- Equipment deployment to a specific scenario
- Reporting and co-ordination with outside agencies
- Exercise coordination with Canadian Coast Guard,
  Exercise coordination with ship

5.4 Monitoring

In order to assure minimal loss of product and to mitigate to the extent possible the impact of any spills, constant monitoring of the fuel vessel, the transfer operation and the receiving tank will be implemented.

Fuel Vessel Cargo and Void Space Tank Monitoring:

Baffinland Iron Mines has developed detailed and stringent criteria for the selection of the fuel vessel. The ships that shall be specified will have significant onboard monitoring capabilities that ensure that no product can leak from cargo tanks into the double bottom and side void tanks without immediately being detected. The volumes of the cargo tanks are electronically measured via tank radar or float system and the status of the tank volumes are constantly monitored from the ship's cargo control room. Taking into account temperature/volume fluctuations and other factors a small volume change in cargo can be detected. Manual measurements of tank volumes are also routinely carried out to provide redundancy.

The ships that are specified shall have onboard vapor detection systems that measure LEL (combustible gas) levels within the double bottom and side tanks. This is either a continuous monitoring system that relays data back to the cargo control room or the monitoring is accomplished manually on a regular schedule by measuring LEL's in all of the tanks using equipment specific to the task (explosimeters). This measure of LEL or combustible gas is an immediate indicator of even a minute ingress of cargo into the void spaces.

In addition to the above, additional monitoring is outlined in the OHF "OPEP". Other monitoring shall be implemented including but not limited to as follows:

- After freeze up, bore holes in ice around and in the vicinity of the vessel shall be drilled and constant monitoring of these sample sites shall be undertaken to ensure that any loss of product is immediately detected

- Constant monitoring of discharge operation while in progress, crew member available at ship's manifold at all times
- Constant pressure monitoring of the vessel manifold discharge pressure to detect any leaks through pressure drop
- Vessel crew member at shore receiving manifold at all times during discharge operation
- Low pressure alarm at shore receiving manifold preset to minimal detection variance to ensure immediate alarm should loss of pressure occur from leak along the hose

Baffinland Fuel Transfer Personnel

- Thorough inspection along hose length at regular intervals during discharge operations
- Constant communication between shore crew and vessel, established protocol for monitoring between vessel and shore facility
- Constant monitoring at shore receiving tank
- Wildlife monitors present along hose length and at shore facility at all times during transfer operations

6.0 Identification and Description of Risks Scenarios by Category

6.1 Ship to Shore Fuel Transfer Procedures or Malfunctions

A very comprehensive assessment of risks involved with the ship to shore transfer operation has been carried out.

6.1.1 Leaks at ship's manifold

The potential of leaks at the ship's manifold are considered to be infrequent. Several safeguards are built into the process to mitigate spills originating at the manifold. The ship manifold is designed with full drip trays underneath and is a fully confined area designed for source recovery of any spillage that may occur at a coupling to the manifold itself.

In the unlikely event of a hose rupture or fitting malfunction, product could potentially spray some distance from the event location. The duration of the event would be very short as pressure is constantly monitored by ship's personnel at all times. Volumes would be minimal. The vessel itself has a fully isolated deck with fish plates all around which act as a containment area for the entire deck of the vessel. Plugs and stoppers are fitted to all drains of the deck during transfer operations. Any spillage that evades the manifold drip trays would likely be contained on deck. Spill response gear is mandatory on the vessel and is available on standby for immediate recovery of any lost product.

6.1.2 Hose rupture

The most important spill prevention measure related to hose rupture is the selection of the hose itself. BIM has identified special Arctic Grade discharge hoses that are suitable for the extreme environment in which it is intended to operate. In addition, the hoses are completely tested and certified to a pressure far exceeding the anticipated working pressure during the discharge operation. On installation of the hoses between the ship and the shore facility, a complete air test to full working pressure shall be carried out. After each discharge operation, or if the operation is halted for a significant length of time, the hose shall be pigged and left empty. The hose is air tested again at the beginning of each discharge cycle to ensure integrity along its entire length. Both pressure and visual inspection is carried out to ensure operational safety.

The pressure monitoring at both the ship's manifold and shore receiving manifold are carried out on a continuous basis. A low pressure alarm at the shore receiving manifold will sound should any pressure drop due to leakage along the hose occur. In such an instance, pumping is immediately stopped so as to minimize volume loss.

Spill response equipment will be stationed at the ship, along the hose length, at the shore manifold and also at the receiving tank. Additional equipment is available at the Steensby facility and on the ship. Additional resources at Milne Inlet and at Mary River can also be accessed should the need arise.

It would be anticipated that any spillage can be contained on the ice using berms and contaminated material subsequently removed and moved to secondary containment that will be available on site at Steensby Port.

6.1.3 Leaks at connections

Spills at couplings are very unlikely due to highly reliable flange style couplings that are specified for the cold weather use. Thorough testing of the hose and couplings as outlined above further reduces the likelihood of any discharge.

Each coupling will have a portable berm installed beneath it in case of any accidental release or drips. Spill equipment along the hose route is in place to mitigate the effects of any potential spillage.

6.1.4 Level control in receiving tank

The receiving tank is monitored at all times by BIM personnel. Predetermined volumes are established for each product transfer and constant communication is maintained between ship and the shore based crews. The receiving tank is situated within an engineered bermed area so any potential spillage can be contained and recovered accordingly.

6.1.5 Vehicle accidents

BIM has strict policies and Standard Operating Procedures (SOP) in place in relation to all vehicle activities. Detailed fuel transfer procedures shall severely restrict access to the ice road during transfer operations. BIM procedures for working on ice (SOP) are in effect and therefore no transfers shall take place before ice conditions are safe for vehicle traffic.

BIM emergency procedures are in place and ready to respond to any incident involving vehicle accidents. Spill response equipment is situated along the hose route as above noted and responders available in case of any incident.

6.2 Ship Anchorage Problems and Collisions

Ice management vessels will not be required as the vessel will be able to accomplish mooring independently during the shoulder periods before and after the shore-fast ice season.

6.2.1 Collision with other vessels

The initial mooring of the vessel at the anchorage location is a normal marine operation of the kind that is normally carried out in any open water season in the Arctic. No other vessel traffic is anticipated during the positioning of the vessel at the discharge site overwintering location so there would be no risk of collisions with other vessels.

6.2.2 Loss of anchorage

Grounding or other marine emergencies are mitigated through the vessel selection process, crewing criteria and selection of an anchorage that provides minimum under keel clearance as discussed previously in this document. Vessel positioning is monitored by ship crew at all times before, during and after the mooring process to avoid any risk of groundings. As the vessel is self propelled, repositioning to ensure vessel stays on station is possible at all times.

It is anticipated that vessel mooring shall be accomplished solely through anchoring. As freeze up occurs and shortly after vessel is securely positioned in the shore fast ice, anchors shall be hoisted and stowed as to ensure damage to anchor chains, windlass or other related gear cannot occur. The anchors shall be redeployed at break up as needed to maintain ship station position as required.

6.3 Integrity of Fuel Vessel

The choice of a ship of appropriate ice class will ensure not only integrity of construction, but also will provide for vessel management during the freeze up and break up shoulder periods. The criteria for ship selection are fully discussed previously in this document.

Risk mitigation is provided mainly through the ship selection process. The selection of a proven vessel of appropriate class, design, crewing and configuration is the best spill mitigation means available.

6.3.1 Structural deformation of vessel in sea ice

The vessel is of appropriate ice class to withstand the type of ice that will be encountered during the overwintering period. Vessels of this class are routinely laid up in areas of shore fast ice when out of service for extended periods of time. The design of the hull, thicknesses and ice class ensure the integrity of the vessel.

Extensive ice history and data has been consulted in the selection of the Steensby overwintering site so as to ensure that only shore fast (unpressurized) ice is present at the location selected.

6.4 Catastrophic Event on Ship

6.4.1 Explosion or fire on board

The fuel vessel shall have extensive fire suppression and firefighting equipment commensurate with its class on board. Regulations dictate very specific fire fighting capabilities and crew certifications in regards to fire on board vessels. In addition, BIM has developed specific SOP's relating to fire fighting and emergency response.

During all transfer operations additional fire suppression equipment will be made available at the loading site, especially for the ship to truck transfer option. Proper grounding and fire prevention procedures shall form an integral part of the fuel transfer procedures.

7.0 Environmental Assessment

7.1 Description of Steensby Inlet Environment and Sensitive Habitat

A 2007 coastal habitat survey was conducted to document coastal and near shore habitats in the proposed development area. In that oil spills are a potential development issue, the survey extended several hundred kilometres from the proposed port sites so as to encompass habitats in the far field as well as the near field of the possible port sites.

Steensby Inlet is a large inlet at the northern end of Foxe Basin. Terrestrial relief around the Inlet is low, resulting in flat plains with very high concentrations of ponds and wetlands. The Inlet can be considered in terms of three general coastal regions: the coastal plain along the western shore, the northern lagoon complex and the rocky east coast. As spill scenarios developed for the purposes of this plan are focused on the immediate Steensby Port area, the local shoreline types found in this area are the focus here.
The eastern shore of Steensby Inlet is dominated by granitic bedrock and much of the coastal morphology is bedrock controlled. Rock headlands, rock cliffs and pocket beaches are interspersed with a few estuaries and lagoons to make this shore the most diverse in terms of coastal morphology. Steeper offshore gradients allow higher wave exposures, and ice movement along the shores has contributed to the formation of series of intertidal boulder ridges. Accretional landforms are relatively rare. Salt marshes are primarily located in delta flat complexes.

The shoreline characteristics in the immediate Steensby Port area are approximately composed of 10% rocky cliffs, 55% rocky cliffs with beaches, 30% alluvial fans with a small percentage (5%) lagoon complexes present.

Rock cliff beaches intertidal areas are primarily composed of poorly sorted sand gravel beaches. Boulder ridges in this intertidal zone are common. Intertidal widths are generally less than 30 meters. Biological description includes upper intertidal zone mostly bare of attached macrobiota. Lower intertidal commonly has rockweed type algae, in particular associated with boulder lag or at boulder ridges. Near shore subtidal often shows narrow band of understory kelp complex.

Alluvial fans are areas of till and glacial outwash. Backshore slopes are moderate and usually include a tundra vegetation cover. Associated intertidal areas are usually moderate to narrow coarse sediment beaches of boulder, cobble, and pebble sand. Bounder ridging tends to be common. Biological description shows intertidal generally bare of attached macrobiota on mobile sediments. Some lower intertidal rockweed type algae associated with boulder ridges.

In addition, extensive spill trajectory modeling for spills originating at Steensby Port has also been undertaken. The advection or transport of spilled fuel on the sea surface was modelled using wind and ocean current data. A 30-year time-series of gridded winds from the NCEP/NCAR reanalysis project were selected for use. These data are near-surface modelled winds and were found to compare favourably with measured winds from the nearby Steensby met station from 2006 to 2009. The NCAR/NCEP winds long time-series length ensures good statistical reliability in the predicted spill probability distributions. Estimation of ocean currents in Steensby Inlet were made following analysis of Acoustic Doppler Current Profiler (ADCP) measurements from field programs in September 2008. Based on the results of this study, and as the spill scenarios developed for the purposes of this plan are relatively small in volume (i.e. $5m^3$), impacts to the immediate area surrounding the port and fuel dock area only have been considered in this plan.

Spill trajectory modelling which takes into account the vast majority of trajectories, have shown that 86%, reach shore in the port site area, as soon as 15 minutes and on average in two hours. Considering the spill response mechanism in place and a high probability of containment of potential spills the likelihood of migration of minor spills beyond the port confines is considered a low risk.

Besides the Baffinland complex, there is no permanently settled community or habitation in the area. Cultural use of the coastal zone in Steensby inlet is limited. During coastal habitat surveys, only a single active hunting camp (wall tent) was observed in all of Steensby Inlet and tent rings were rare. A few locations of man-made materials were associated with the hunting camp. There was no cultural use observed in the immediate Steensby Port area considered in the plan.

7.2 Fuel spills in open water

For the purposes of this risk assessment, only spills during the overwintering period have been considered. Spills in open water during bulk fuel transfer operations are detailed in the Steensby Inlet OPEP.

7.3 Fuel spills during freeze up and break up periods

The likelihood of spills during the shoulder seasons is remote as no transfer operations would take place during these periods.

7.4 Fuel spills on ice

Response to spills on ice has been considered in detail in the risk assessment. Spill response equipment will be stationed at the ship, along the hose length, at the shore manifold and also at the receiving tank. Additional equipment is available at the Steensby facility and on the ship. Additional resources at Milne Inlet and at Mary River can also be accessed should the need arise.

It would be anticipated that any spillage can be contained on the ice using berms and contaminated material subsequently removed and moved to secondary containment that will be available on site at Steensby Port.

7.5 Fuel spills under ice

The potential for spills under the ice are evaluated as being very low. After freeze up, bore holes in ice around and in the vicinity of the vessel shall be drilled and constant monitoring of these sample sites shall be undertaken to ensure that any loss of product is immediately detected.

Buoyant oil under ice will migrate to the underside of a floating ice sheet, which typically has an uneven surface. A current of 0.4 m/s is usually required to move oil along the underside of the ice. Under-ice pockets of oil tend to accumulate in naturally occurring surface depressions. Trenches or holes can be cut using an ice auger, chain saw, Ditch Witch®, bulldozer or backhoe to gain access to oil that has accumulated underneath the ice. Pumps and skimmers can be used to remove the oil. In many cases, burning can be attempted.

Slots cut in ice at an angle to the current can be used to divert or contain oil in a manner similar to angling booms in open water to divert slicks. Boom can be positioned in the slots and left to freeze in place when the trench and boom are only used for deflection/containment. Vacuum systems and pumps are used to transfer oil from collection points to storage.

Methodology for recovery of oil from under ice has been extensively studied and detailed response techniques have been developed for cold weather environments. Response techniques have been well documented and a large body of publications exists on the subject. Arctic response field guides have been produced, one of the most notable being the “Field Guide for Oil Spill Response in Arctic Waters” which was funded by eight participating circumpolar countries. In addition, support required to complete the project was provided by the following agencies:

- Indian & Northern Affairs Canada, Contaminated Sites Office, Yellowknife, NT
- Office of Emergency Management, US Department of Energy, Washington, DC
- Oil Spill Recovery Institute, Prince William Sound Science Center, Cordova, AK

In some cases, a deferred response until the return of open water conditions may also be considered or required. Careful monitoring through inspection bores is necessary to track movement of spills under ice where possible. Other effective methods of tracking oil under ice also exist and additional 3rd party experts may be retained to provide additional expertise, equipment and advice should this be required.

8.0 Summary of Findings and Risk Profile

A total of 50 operational risks were identified by the project team. Of the total risks identified, 20 (40%) were classified as low risks, 30 (60%) as medium risks, and none as high risks.

The highest ranking operations risks include the transiting of the fuel truck during oil transfer operations and the risks relating to a spill of residual fuel oil originating from ship’s bunker tanks. The mitigation of each of these risks has been addressed in detail during the risk assessment process. Through the application of standard operating procedures and stringent vessel selection, the likelihood of each of the risks is reduced to very low in all cases.

Follow up recommendations will include assignment of responsibilities to the identified mitigation actions, and constant update of the risk register throughout project execution in order to identify new risks, modify the rating of existing risks, and eliminate risks that are no longer valid.

9.0 Conclusion

The overwintering of a fuel vessel at Steensby Inlet represents acceptable practice and is comparable to other overwintering operations that are carried out in the Canadian Arctic on a yearly basis. Careful consideration of the project risk and appropriate mitigation representing best practices provide for an acceptable degree of safety for all aspects of the operation. The operational parameters also meet all the current regulations and are in conformity with existing Transport Canada draft "Guidelines/Standards for Lay Up of Petroleum Barges in Land Fast Ice".

Vessel selection, positioning and mooring are all accomplished taking into account multi-year studies of the ice, climatic and sensitivities found at the site. The fuel transfers are to be carried out with comprehensive safeguards in place as to avoid spills and to provide for swift and effective mitigation in the unlikely event of an occurrence.

Client Name: Baffinland Iron Mines Ltd.
Project Name: Mary River Project
Project Risk Register - Fuel Vessel
Overwintering - Steensby Inlet
Date: May, 2012

		RISK IDENTIFICATION AND ANALYSIS			TREATMENT RISK RATING				MITIGATION PLAN	
Area - Subarea	Risk ID	Risk Issue (Source/Event, time window)	Causes (drivers or triggers)	Impacts or Consequences	Consequence Rating	Likelihood Rating	Residual Risk Rating	Priority	Risk Treatments	Accountable Manager for Action
THREATS										
Fuel Barge Risks										
Mooring & Freeze up										
		Grounding pre-freeze up/break up - Minor	improper moorings	Minor Damage, no spill	B	E	3		ensure mooring equipment maintained. - vessel anchored in correct position. - availabilty bathymetry data. - ice data. - geotechnical info of bottom. - proper ship procedures. - BIM to perform ship seletion vetting and review risk assesment by shipper. - Ship / shipper wil be competent and meet stringent requirments.	
			high winds	Minor Damage, no spill	B	E	3		reliable/relevant weather forecast availability for Steensby Inlet. - establish collaboration with Environment Canada on weather forecasts. -identification of fall back / refuge anchorage points.	
			poor site selection	Minor Damage, no spill	B	E	3		access to bathymetry, bottom conditions, historical ice conditions, climatic conditions, waves/current conditions. - coordination with ship traffic.	
			anchor chain failure / windlass	Minor Damage, no spill	B	E	3		proper inspection. -close bridge watch. - ice conditions. - monitoring turning circle of vessel. - take corrective action	
			Damage to prop	Minor Damage, no spill	B	E	3		ensure mooring equipment maintained. - anchored in correct position. - availabilty bathymetry data. - ice data. - geotechnical info of bottom. - proper ship procedures. - BIM to perform ship seletion vetting and review risk assesment by shipper. - Ship / shipper wil be competent and meet stringent requirments.	
			Damage to hull	Minor Damage, no spill	B	E	3		ensure mooring equipment maintained. - anchored in correct position. - availabilty bathymetry data. - ice data. - geotechnical info of bottom. - proper ship procedures. - BIM to perform ship seletion vetting and review risk assesment by shipper. - Ship / shipper wil be competent and meet stringent requirments.	
			Engine break down/failure	Minor Damage, no spill	B	E	3		ensure proper maintenance carried out. - appropriate ship/shipper selection.	
		Grounding pre-freeze up/break up - Major	improper moorings	Damage or loss of maneuverability resulting in a Cargo Diesel spill.	D	E	10		ensure mooring equipment maintained. - anchored in correct position. - availabilty bathymetry data. - ice data. - geotechnical info of bottom. - proper ship procedures. - BIM to perform ship seletion vetting and review risk assesment by shipper. - Ship / shipper wil be competent and meet stringent requirments.	
				Damage or loss of maneuverability resulting in a residual oil spill.	E	E	15		RFP favoring no risidual fuel to be carried in double bottom tanks	
			high winds	Damage or loss of maneuverability resulting in a Cargo Diesel spill.	D	E	10		reliable/relevant weather forecast availability for Steensby Inlet. - establish collaboration with Environment Canada on weather forecast. - identification of fall back / refuge anchorage points.	
				Damage or loss of maneuverability resulting in a residual oil spill.	E	E	15		RFP for no risidual fuel ot be carried in double bottom tanks (if available)	
			poor site selection	Damage or loss of maneuverability resulting in a Cargo Diesel spill.	D	E	10		access to bathymetry, bottom conditions, historical ice conditions, climatic conditions, waves/current conditions. - coordination with ship traffic.	
				Damage or loss of maneuverability resulting in a residual oil spill.	E	E	15		RFP favoring no risidual fuel to be carried in double bottom tanks	
			anchor chain failure / windlass	Damage or loss of maneuverability resulting in a Cargo Diesel spill.	D	E	10		proper inspection. -Close bridge watch. - ice conditions. - monitoring turning circle of vessel. - take corrective action	
				Damage or loss of maneuverability resulting in a residual oil spill.	E	E	15		RFP favoring no risidual fuel to be carried in double bottom tanks	
			Mechanical failure	Damage or loss of maneuverability resulting in a Cargo Diesel spill.	D	E	10		ensure mooring equipment maintained. - anchored in correct position. - availabilty bathymetry data. - ice data. - geotechnical info of bottom. - proper ship procedures. - BIM to perform ship seletion vetting and review risk assesment by shipper. - Ship / shipper wil be competent and meet stringent requirments.	
				Damage or loss of maneuverability resulting in a residual oil spill.	E	E	15		RFP favoring no risidual fuel to be carried in double bottom tanks	
		Excessive ice pressure on hull	Ice movement, poor anchorage practice		A	E	1		Ice studies do not indicate a problem. - proper site selection, do not anchor near multi-year ice. - vigilant bridge watch. ensure appropriate ice class. leave anchor down until sufficient ice has formed. ensure ice strength quality hull. ensure proper maintenance carried out. - appropriate ship/shipper selection, ensure ice strength	
		Ice pan containing vessel break free	Ice fracture	Ship a drifting without mobiltiy	B	E	3		Ice studies do not indicate a problem. - proper site selection, do not anchor near multi-year ice.	

		RISK IDENTIFICATION AND ANALYSIS			***TREATMENT RISK RATING***				***MITIGATION PLAN***	
Area - Subarea	**Risk ID**	**Risk Issue** (Source/Event, time window)	**Causes** (drivers or triggers)	**Impacts or Consequences**	**Consequence Rating**	**Likelihood Rating**	**Residual Risk Rating**	**Priority**	**Risk Treatments**	***Accountable Manager for Action***
		Cold sink	Temperature differential between empty compartment and water allowing ice formation on ship hull	Damage or loss of maneuverability resulting in a spill.	A	B	7		ensure sufficient under keel clearence. - proper unloading procedures, tanks should remain with product in as long as possible.	
		Hull Damage	Lack of experince in ice	Minor Damage to ship	B	E	3		Experienced in ice ship captains only, SOP for when ship can operate in ice/thickness	
		Malfunction during internal transfer of hydrocarbons (during over wintering) - Minor	mechanical failure/procedural breakdown	Spill contained on deck	A	B	7		proper winterization of vessel. adequate procedures and training of personnel. Pre-transfer operational checklists.	
		Malfunction during internal transfer of hydrocarbons (during over wintering) - Major	mechanical failure/procedural breakdown	Spill overflow on ice	B	D	5		proper winterization of vessel. adequate procedures and training of personnel. Pre-transfer operational checklists.	
		Fire on ship - Minor Fire	mechanical failure/procedural breakdown	health and safety for crew, loss of operation (short term)	A	D	2		Fire supression system meeting all standards, ship fire fighting plan, appropriate selection of vessel, fire drills on board, crew trained, SOP to prevent fire, shore based emergency response available, minimum safe manpower for emergencies	
		Fire on ship - Major Fire/Explosion	mechanical failure/procedural breakdown	loose hull integrity causing spill & health and safety for crew, loss of operation (long term)	E	E	15		Fire supression system meeting all standards, ship fire figting plan, appropriate selection of vessel, fire drills on board, crew trained, SOP to prevent fire, shore based emergency response available, minimum safe manpower for emergencies	
Fuel Transfer		***Fuel Transfer by hose over ice***								
		Leak at coupling	Equipment malfuntction, human error	minimal spill on ice	A	B	7		Regular inspection and monitoring, proper equipment specification, gasketing for arctic conditions, flanges not camlocks, secondary containment under all couplings. Spill response immediately on hand during transfers, pre-testing prior to transfer commencing	
		Leak at ships manifold	Equipment malfuntction, human error	minimal spill on ice	A	B	7		Equipment specification for arctic conditions, SOP for fuel to shore transfers, monitoring/personnel on deck keeping watch, drip trays under manifold, fish-plate around perimeter of ship, scupper plugs, continous pressure monitoring	
		Leak along hose length	bears, vehical/snowmobile collison, defective hose, poor hose spec. ice/ship movement, hose support malfunction, shore interface, exposure to elements, lack of access.	minimal spill on ice	A	C	4		notify communities, bear monitors, standard pumping procedures to adddress weather/elements, adhearence to polar bear mgmt plan, hose flagging, traffic restrictions during transfers, access track seperated of hose alignment, regular inspection and monitoring, proper hose specification, Spill response immediately on hand during transfers, pre-testing prior to transfer commencing, pressure monitoring at shore receiveing manifold, define environmental conditions (GO/NO GO) acceptable for transfer	
		Leak at receiving shore manifold	Equipment malfuntction, human error	minimal spill on ice	A	B	7		inspection and monitoring during transfer by personnel on hand, pressure alarm, equipment spec for arctic condtions, pressure tested prior to cargo transfer operations	
		Sabotage on transfer hose	Undetermined	minimal spill on ice	A	E	1		Regualar inspection, pressure testing prior to transfer, perimeter security	
		Failure of receiving tank	vent plugging, instrumentation failure, over pressurization from pigging	spill in secondary containment, over pressurizing of tank (compromise tank integrity), loss of tank operation	C	C	13		inspection of vent and monitoring, tank spec for arctic conditions, pigging procedure to prevent overpressurization of tank	
		Hose causing wildlife/human barrier	Raised hose across ice	collision with hose, human harm, limiting wildlife movement, wildlife damage to hose	A	B	7		communication with communities, wildlife monitoring,	
		Fire along hose	smoking, sparks, engine exhaust, poor grounding procedures.	short term delay	A	E	1		SOP to prevent fire (no smoking, vechile distance), pipeline monitoring, proper grounding procedures	
Fuel Transfer by truck over ice										
		breaking through ice	thin ice	up to 30,000 L spill	E	D	19		BIM SOP for working on ice (min thickness, speed limits etc), spill response equipment on hand	
		spill during loading	human error, improper loading procedure, equipment malfunction	~ 1000 L spill	A	B	7		BIM SOP for fuel transfers, on hand monitoring, spill prevention equipment in place (liners), operator training, communications protocol, spill response equipment on hand	
		spill during unloading	human error, improper loading procedure, equipment malfunction	~ 1000 L spill	A	B	7		BIM SOP for fuel transfers, on hand monitoring, spill prevention equipment in place (liners), operator training, communications protocol,spill response equipment on hand	
		truck/vehicle accident/malfunction	human error, equipment malfunction	up to 30,000 L spill	C	C	13		Preventive maintaince, training, work schedule protoco (avoid sleep deprevation), speed limit, spill response equipment on hand	
		fire/explosion during loading/unloading	lack of grounding, spray/spill on hot surfaces (e.g. engine)	up to 30,000 L spill	E	E	15		grounding procedures, SOP (no smoking), fire supression/spill response equipment on hand	
Ice Issues										
		Inability to access hose (service/monitoring)	Weather, Ice conditions	~ 1000 L spill	A	D	2		No tranfer during shoulder season, proper monitoring and working on ice procedures	
Health and Saftey										
		unable to access vessel in emergency	unsafe ice conditions	isolation of personel, serious injury	C	C	13		Helicopter access for emergecy only (basket), Medic on-board	
		Personal Injury - temp exposure	weather condtions	serious injury	B	B	12		SOP for working in cold climate,	
		Personal Injury - Snow blindness	weather condtions	minor injury	A	C	4		SOP for working in cold climate, PPE requirement	

		RISK IDENTIFICATION AND ANALYSIS			TREATMENT RISK RATING					MITIGATION PLAN	
Area - Subarea	**Risk ID**	**Risk Issue** (Source/Event, time window)	**Causes** (drivers or triggers)	**Impacts or Consequences**	**Consequence Rating**	**Likelihood Rating**	**Residual Risk Rating**	**Priority**		**Risk Treatments**	***Accountable Manager for Action***
		wildlife (bears) interaction	attraction of wildlife, random event	possible injury/negitive interaction	C	C	13			BIM Polar Bear Management in place	
		Lost/disorentation	weather condtions	injury	D	D	14			marked route, buddy system, no operations in unfavroable weather conditions (Go/No Go), communication	
		vehicle collision	weather condtions, human error	injury	A	D	2			Exsisting SOP implemenation of light vehicle operation - 15 km/hr	
		Personal Injury - Walking	Travel over ice shore interface	injury	A	B	7			maintain fixed access in desginated crossings	
		Injury - Vechicle	Travel over ice shore interface	injury	B	D	5			maintain fixed access in desginated crossings	
		slips/trips/falls during loading/unloading of tankers	dipping tankers, improper protection (handrail etc), poor training.	injury	A	D	2			Job saftey analysis to be conducted on all tasks associated with bulk fuel transfer	
		Personal Injury - Falling through thin ice	overloading ice bearing capacity with personnel or equipment	serious injury/loss of equipment	D	C	18			Exsisting SOP implemenation for working on ice	
		Product exposure	sprays and spill, human error, equipment malfunction	minor injury	A	A	11			job saftey analysis to be conducted on all tasks associated with bulk fuel transfer to determine PPE and eye wash station requirements	

Appendix 5:

Caribou Habitat Selection Maps

LEGEND

Mary River Project

Potential Disturbance Area

Caribou Calving Habitat Selection Probability

High Probability (0.26)

Low Probability (0.00)

NOTES

Map Projection: North American Datum UTM Zone 17N

Ferguson, M. 1989. Baffin caribou. Pp. 142 in Hall, E. (ed). People and caribou in the Northwest Territories. Department of Renewable Resources, Government of the Northwest Territories. Yellowknife, NT. 190 pp.

This document is not an official land survey and the spatial data presented is subject to change without notice.

Scale 0 10 20 40 60 80 100 Km

Baffinland Iron Mines Corporation

Mary River Project: Caribou Habitat Selection During the Calving Season.

EDI

REVISED 5/11/2012

FIGURE 21

Whitehorse, YT: J:\Yukon\Projects\2012\12_Y_0093_Baffinland_MaryRiverProject\Mapping\Fig21_RSPF_Caribou_Calving_Revised11May2012.mxd

LEGEND

Mary River Project

Potential Disturbance Area

Caribou Calving Habitat Selection Probability

High Probability (0.48)

Low Probability (0.00)

NOTES

Map Projection: North American Datum UTM Zone 17N

Ferguson, M. 1989. Baffin caribou. Pp. 142 in Hall, E. (ed). People and caribou in the Northwest Territories. Department of Renewable Resources, Government of the Northwest Territories. Yellowknife, NT. 190 pp.

This document is not an official land survey and the spatial data presented is subject to change without notice.

Scale 0 10 20 40 60 80 100 Km

Baffinland Iron Mines Corporation

Mary River Project: Caribou Habitat Selection During the Summer Season.

EDI

REVISED 5/11/2012

FIGURE 22

Whitehorse, YT: J:\Yukon\Projects\2012\12_Y_0093_Baffinland_MaryRiverProject\Mapping\Fig22_RSPF_Caribou_Summer_Revised11May2012.mxd

LEGEND

Mary River Project

Potential Disturbance Area

Caribou Winter Habitat Selection Probability

High Probability (0.45)

Low Probability (0.00)

NOTES

Map Projection: North American Datum UTM Zone 17N

Ferguson, M. 1989. Baffin caribou. Pp. 142 in Hall, E. (ed). People and caribou in the Northwest Territories. Department of Renewable Resources, Government of the Northwest Territories. Yellowknife, NT. 190 pp.

This document is not an official land survey and the spatial data presented is subject to change without notice.

Scale 0 10 20 40 60 80 100 Km

Baffinland Iron Mines Corporation

Mary River Project: Caribou Habitat Selection During the Winter Season.

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REVISED 5/11/2012

FIGURE 23

Whitehorse, YT: J:\Yukon\Projects\2012\12_Y_0093_Baffinland_MaryRiverProject\Mapping\Fig23_RSPF_Caribou_Winter_Revised11May2012.mxd