VEGETATION MONITORING: DUST FALL

The potential impacts of dust deposition on soil and vegetation are an issue of concern for the Project. In particular, other studies have shown dust deposition to have a detrimental effect on vegetation health, and dust deposition on caribou forage (i.e., lichen) has been suggested as a potential mechanism causing caribou to avoid habitat at a distance of up to 14 km (Boulager et al. 2012). The main sources of dust emissions are fugitive sources, specifically bulk handling operations, crushing, blasting, storage, and dust emissions from vehicle and equipment traffic, although natural sources of dust fall also exist (e.g. wind erosion). The largest amount of dust fall generated by the Project is expected to be associated with use of the existing Tote road linking the Mine site with the port at Milne Inlet; however, there will also be dust fall generation from the railway and from point source locations at both the Mine site and ports.

The Mary River dust fall monitoring program was initiated in the summer of 2013 with sampling stations set up at the Mine site, Milne Port, along the Tote road, and at reference sites within the RSA. At this time, the railway and Steensby Port are not included in the dust fall monitoring program, due to access issues. Future construction of the railway linking Steensby Port with the Mine site will initiate dust fall monitoring for the southern section of the RSA. In addition to dust fall, this program component includes tracking and enumeration of traffic on the Tote Road, recorded as ‘vehicle passes’. General traffic data are tracked via Baffinland security in a specially designed MS Excel form, and ore haul vehicle passes are tracked by Baffinland Mine Operations. All traffic data are compiled and reviewed as part of the dust fall monitoring program annual reports. The dust fall monitoring program was developed using knowledge gathered from other similar monitoring programs (Ekati Mine, High Lake Project, Rescan 2006), as well as applicable caribou research. Dust fall sampling is carried out in accordance with the American Society for Testing and Materials (ASTM) ASTM D1739-98 sampling method (ASTM 2004).

Objectives

The objectives of the dust fall monitoring program are to:

1. Quantify the extent and magnitude of dust fall generated by Project activities;
2. Determine seasonal variations in dust fall at all sampling locations; and
3. Determine if annual changes in dust fall at sampling locations exceed identified thresholds associated with isopleth dispersion models.

Thresholds

There are no known dust deposition thresholds specific to effects on vegetation. Health Canada/Environment Canada’s national ambient air quality objectives for particulate matter

(CEPA/FPAC Working Group 1998) state that for the lack of quantitative dose-effect information, it is not possible to define a reference level for vegetation and dust deposition. In the absence of published thresholds for dust effects on vegetation, the High Lake Project (Wolfden Resources Inc. 2006), a proposed base metal mine in western Nunavut, developed thresholds in consideration of effects to vegetation health ranging from 4.6 g/m²/year for a low magnitude effect to ≥50 g/m²/year for a high magnitude effect. These values were based on a combination of the Alberta (AB) and Ontario (ON) ambient air quality criteria for human health purposes, and values reported by Spatt and Miller (1981) specific to effects of road dust on vegetation.

In addition to the consideration of thresholds developed by the High Lake Project, isopleth dispersion models (CALPUFF dispersion models) were used to predict deposition patterns from all sources during the operations phase of the Project. The CALPUFF dispersion model was recommended by a number of regulatory agencies and has been the *de facto* standard for environmental assessments in Canada's North. To refer to activities that are included in the assessment of the operations phase refer to the ERP Addendum to FEIS Volume 5.

To align with results of the isopleth dispersion models and the thresholds described above, the following annual TSP depositions thresholds will be used for the Mary River Project (summarized in Table 1):

Low: 1–4.6 g/m²/year;

Moderate: 4.6–50 g/m²/year; and

High: ≥ 50 g/m²/year.

Table 1. Dust (TSP) Deposition Rates and Criteria for Potential Effects on Vegetation Health.

Source of Information	Dust (TSP) deposition rate	Equivalent annual dust deposition rate (g/m²/year)	Comments
High Lake Impact Assessment (Wolfden 2006)	1.0–4.6 g/m²/year	1.0–4.6	Predicted low magnitude effect on vegetation health
	4.6–50 g/m²/year	4.6–50	Predicted moderate magnitude effect on vegetation health
	50–200 g/m²/year	50–200	Predicted high magnitude effect on vegetation health
Spatt and Miller (1981)	0.07 g/ m²/ d	26	Some effects to Sphagnum species
	1.0-2.5 g/ m²/ d	365-913	Decline in Sphagnum species abundance

Table 1. Dust (TSP) Deposition Rates and Criteria for Potential Effects on Vegetation Health.

Source of Information	Dust (TSP) deposition rate	Equivalent annual dust deposition rate ($g/m^2/year$)	Comments
Alberta	5.3 $g/m^2/30$ d	64	Alberta Guidelines for Residential and Recreational Areas (human health)
Ontario	4.6 $g/m^2/year$	4.6	Ontario Ambient Air Quality Criteria (human health)

Methods

The dust fall monitoring program began in July 2013 with 26 dust fall monitoring sites across the RSA. An additional eight sites were added in August 2014. Dust fall sampling locations were chosen to represent areas of various expected dust fall concentrations based on isopleth dispersion models and considering the direction of prevailing winds within the RSA, excluding areas of future infrastructure development. The 26 dust fall sample sites for the 2013/14 season included:

- Five dust fall samplers located at the Mine Site (three within the Mine Site and two references sites; one to the northeast, and one to the south);
- Three dust fall samplers located at Milne Port (two within the port itself, and one northeast and upwind of the port);
- 16 dust fall samplers divided between two sites along the Tote Road. These two sites are organized into transects, each composed of eight dust fall samplers distributed both north and south of the Tote Road centerline at 30 m, 100 m, 1 km, and 5 km. The prevalent wind direction is roughly parallel to the roadway as opposed to perpendicular, therefore no 'upwind' and 'downwind' directions from the road are identified; and

Two reference dust fall samplers located 14 km southwest of the Tote Road.

Additional sites were added in August 2014 to increase sampling coverage of dust fall in the areas around Milne Port and the Mine Site:

- Four additional dust fall samplers at Milne Port (resulting in a total of seven dust fall samplers in that area); and
- Four additional dust fall samplers located at the Mine Site (resulting in a total of eight dust fall samplers in that area).

Each site is comprised of one sampling apparatus, which is made up of a hollow post (~ 2m long) and terminal bowl shaped holder for the dust collection vessel (Photo 1). The terminal bowl is topped with bird spikes to prevent contamination by bird fecal matter. The sampling apparatus was installed by pounding 5-foot rebar into the ground, placing the post over the rebar, and then stabilizing with guy wires. Dust collection vessels are placed in the holder, pre-charged with 250 mL of algaecide in summer and 250 mL of alcohol in winter. Collection vessels are changed out every month (28–31 days) and shipped to an accredited laboratory for analysis of total, fixed and volatile insoluble particulate matter.

Caribou present are present in the area of the Baffinland Mine Site year-round; therefore, sampling of the dust fall monitoring stations occurs on a year-round basis; however, during the winter, the sampling program is limited to a subset of the monitoring sites. Winter monitoring activities are restricted by safety consideration associated with accessing the more remote reference sites.

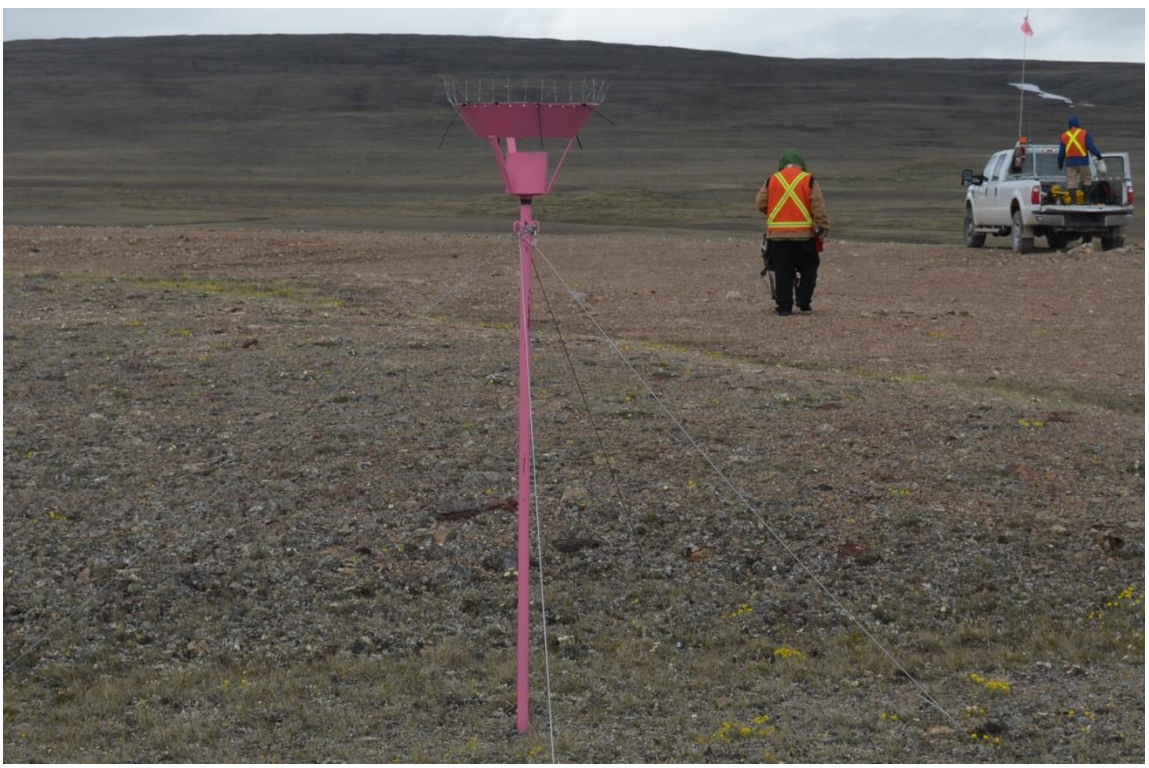


Photo 1. Dust fall collector sampling apparatus, July 10, 2013.

Annual dust fall results are analyzed against the predicted dust deposition thresholds for the Project to determine if dust fall exceeds the applicable indicator threshold. Results are also reviewed to investigate dust fall on a temporal and spatial scale relative to background with focus on seasonal differences in dust fall data.

References

American Society for Testing and Materials (ASTM). 2004. Standard Test Method for Collection and Measurement of Dustfall (Settleable Particulate Matter) Designation D 1739-98 Reapproved 2004, West Conshohocken, PA.

Boulanger J., Poole K.G., Gunn A., and J. Wierzchowski. 2012. Estimating the zone of influence of industrial developments on wildlife: a migratory caribou *Rangifer tarandus groenlandicus* and diamond mine case study. Wildlife Biology 18:2.

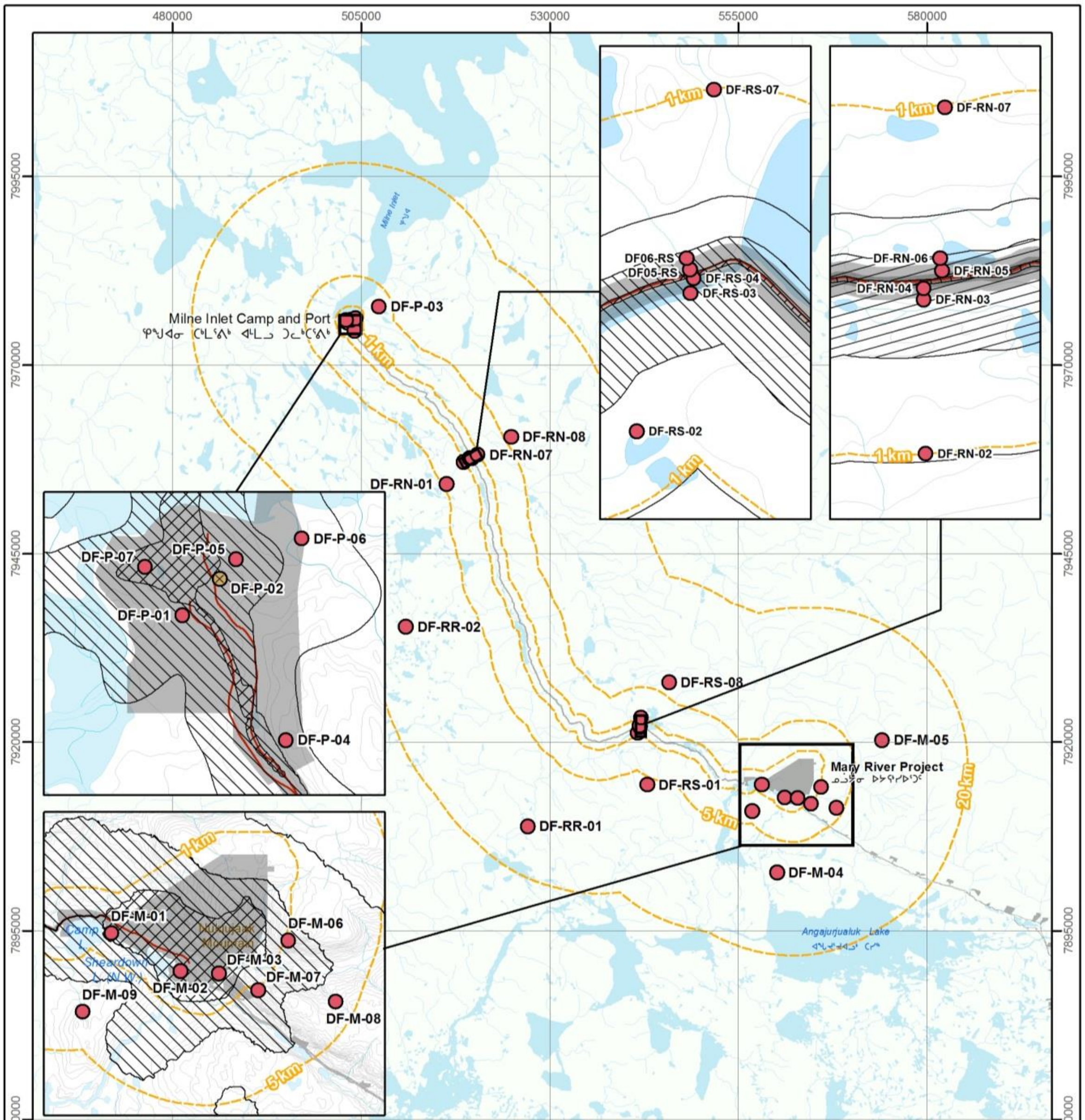
CEPA/FPAC Working Group on Air Quality Objectives and Guidelines. 1998. National ambient air quality objectives for particulate matter. Executive Summary. Part 1: Science assessment document. http://www.hc-sc.gc.ca/ewh-semt/alt_formats/hecs-sesc/pdf/pubs/air/naaqo-onqaa/particulate_matter_matieres_particulaires/summary-sommaire/98ehd220.pdf.

Rescan Environmental Services Ltd. 2012. Ekati Mine 2011 Air Quality Monitoring Program. Produced for: BHP Billiton Canada Inc.

Wolfden Resources Inc. 2006. High Lake Project Proposal. Volume 6: Terrestrial Environment, Section 2.0 - Vegetation. Project proposal submission the Nunavut Impact Review Board, November 2006.

Table 2. Dust fall sample sites within the Project RSA.

Site ID	Location	Sample period	Distance to PDA (m)	Dust isopleth zone	Latitude	Longitude
DF-M-01	Mine Site	year round	Within PDA	High	71.3243	-79.3747
DF-M-02	Mine Site	year round	Within PDA	High	71.3085	-79.2906
DF-M-03	Mine Site	year round	Within PDA	High	71.3072	-79.2433
DF-M-04	Mine Site	summer only	9,000	Nil	71.2197	-79.3277
DF-M-05	Mine Site	summer only	9,000	Nil	71.3731	-78.9230
DF-M-06	Mine Site	year round	1,000	Moderate	71.3196	-79.1560
DF-M-07	Mine Site	year round	1,000	Moderate	71.3000	-79.1953
DF-M-08	Mine Site	year round	4,000	Moderate	71.2945	-79.1002
DF-M-09	Mine Site	year round	2,500	Low	71.2936	-79.4127
DF-RS-01	Tote Road - south	summer only	5,000	Nil	71.3275	-79.8001
DF-RS-02	Tote Road - south	summer only	1,000	Low	71.3893	-79.8324
DF-RS-03	Tote Road - south	year round	100	Moderate	71.3967	-79.8228
DF-RS-04	Tote Road - south	year round	30	Moderate	71.3975	-79.8222
DF-RS-05	Tote Road - south	year round	30	Moderate	71.3980	-79.8228
DF-RS-06	Tote Road - south	year round	100	Moderate	71.3986	-79.8234
DF-RS-07	Tote Road - south	summer only	1,000	Nil	71.4077	-79.8182
DF-RS-08	Tote Road - south	summer only	5,000	Nil	71.4489	-79.7106
DF-RN-01	Tote Road - north	summer only	5,000	Nil	71.6883	-80.5363
DF-RN-02	Tote Road - north	summer only	1,000	Low	71.7145	-80.4704
DF-RN-03	Tote Road - north	year round	100	Moderate	71.7186	-80.4473
DF-RN-04	Tote Road - north	year round	30	Moderate	71.7189	-80.4456
DF-RN-05	Tote Road - north	year round	30	Moderate	71.7185	-80.4414
DF-RN-06	Tote Road - north	year round	100	Moderate	71.7189	-80.4397
DF-RN-07	Tote Road - north	summer only	1,000	Nil	71.7226	-80.4165
DF-RN-08	Tote Road - north	summer only	5,000	Nil	71.7435	-80.2898
DF-P-01	Milne Port	year round	Within PDA	Moderate	71.8802	-80.9072
DF-P-02	Milne Port	decommissioned	Within PDA	Moderate	71.8850	-80.8912
DF-P-03	Milne Port	year round	3,000	Nil	71.8996	-80.7884
DF-P-04	Milne Port	year round	Within PDA	Low	71.8710	-80.8828
DF-P-05	Milne Port	year round	Within PDA	Moderate	71.8843	-80.8945
DF-P-06	Milne Port	year round	Within PDA	Low	71.8858	-80.8790
DF-P-07	Milne Port	year round	Within PDA	High	71.8838	-80.9160
DF-RR-01	Reference – Road	summer only	14,000	Nil	71.2805	-80.2450
DF-RR-02	Reference – Road	summer only	14,000	Nil	71.5189	-80.6923



LEGEND ᑐᑭᒋᔾᖏᑦ

- Active Dust Fall Monitoring Site
- Decommissioned Dust Fall Monitoring Site
- Milne Tote Road
- Potential Development Area ᓄᓇ ᐊᑐᕐᑕᐅᔪᐃᓇᓂᐊᓕᖅ ᓴᐱᕆᓯᕐᓯᐅᕐᑐᖕᓂᑦ

TSP Annual Deposition

- High
- Moderate
- Low

Dust Fall Sample Locations for the Project Area

NOTES ᖃᐅᔨᒪᔭᕆᐊᖃᕐᑦ

TSP isopleths provided by RWDI Air Inc (2010/2014). These data were modified by EDI for the purpose of map display.

Updated PDA provided by Hatch (25 April 2013).

Scale ᐊᖏᓂᖓ

0 5 10 20 30

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Map Scale ᐊᖏᓂᖓ: 1:750,000 (printed on 8.5 x 11)
Map Projection: NAD 1983 UTM Zone 17N

Drawn:	Checked:	Date:	
MP	MAS/DH	23/02/2016	**MAP 1**

Baffinland EDI

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Appendix I

Initial Stream Diversion Barrier Study

Knight Piésold
CONSULTING

www.knightpiesold.com

MEMORANDUM

To:	Mr. Oliver Curran	Date:	June 25, 2014
Copy To:		File No.:	NB102-181/34-A.01
From:	Dale Klodnicki	Cont. No.:	NB14-00160
Re:	Initial Stream Diversion Barrier Study - Rev. 0 Mary River Project - Aquatic Effects Monitoring Program		

1 – INTRODUCTION

A stream diversion barrier study was identified as a follow-up program in the Final Environmental Impact Statement (FEIS) for the Mary River Project (Baffinland, 2012). The primary objectives of the study are to monitor the effects of both increases and reductions in streamflow at several mine site streams and to further understand how Project-related reductions in streamflow may result in the creation of fish barriers that have the potential to occur at low flows. The monitoring program may identify the need for mitigation measures to address Project-related fish stranding.

The stream diversion barrier study is a “targeted study”, which forms part of Baffinland’s Aquatic Effects Monitoring Program (AEMP). This memorandum describes the initial study that was focussed on obtaining a better understanding for existing flow conditions and, in particular, the frequency and duration of the occurrence of fish barriers and fish stranding that was identified in five (5) mine site streams (North/South Consultants Inc. - NSC, 2008; Knight Piésold Ltd. - KP, 2012).

Since the stream diversion barrier study was identified in the FEIS, Baffinland has developed plans that are now in the final stages of approval to initiate an Early Revenue Phase (ERP) of the Project (Baffinland, 2013). The ERP will involve mining 3.5 million tonnes per annum (Mt/a) of iron ore. The iron ore will be transported year-round by truck to Milne Port and then to market by ship during the open water season. Baffinland has contemplated a 5-year operating plan for the ERP, after which time the full-scale railway project would also be brought on-line. This development schedule is subject to a commercial decision by Baffinland to proceed and will be influenced by both market conditions and available financing.

The reduced production rate associated with the ERP will result in a considerably smaller mining footprint (open pit and waste rock stockpile) than was originally envisioned. As such, Project-related stream diversions will be negligible. The absence of diversions provides Baffinland with an opportunity to better understand existing flow conditions as it relates to fish passage. This initial study is exploratory in nature with the following objectives (which contribute to the primary objectives stated above):

- Develop an understanding of low-flow conditions that may result in barriers to fish passage within two tributaries of Camp Lake and three tributaries of Sheardown Lake (Figure 1).
- Document fish presence throughout the stream length under various flow conditions. It is important to document upstream access during spring freshet, since high water velocities in the spring can prevent fish passage. It is also important to document the downstream passage of fish in the fall, when they are returning to overwintering habitat in the lakes.

Stream gauging stations are seasonally operated on three of the five targeted streams (Figure 1). The conditions observed throughout each season and between years can be related to the calculated flows in the streams. An understanding of the relationship between flow conditions and the presence of fish barriers and fish presence, understanding that streams are dynamic systems that change over time.

2 – PROJECT EFFECTS AND PROPOSED MONITORING

2.1 GENERAL

The Project footprint (including water management features) will reduce flows in five mine site streams. The resulting flow reduction will result in a loss of fish habitat that was assessed to be minor (low magnitude) in the FEIS. The flow reductions also have the potential to affect the ability of Arctic Char (primarily juveniles) to access small tributaries in the mine site area, particularly in the spring as fish move into the streams and in fall when fish return to the lakes to overwinter. The creation of barriers (or increased frequency or changed timing of existing barriers) due to reduced flows could impede fish passage upstream or downstream in the tributaries. Although considered unlikely, mortalities are possible in the event fish became stranded in the streams in fall.

The development of the open pit, a waste rock stockpile, and associated water management facilities (ditches, berms and settling ponds) will divert and redirect runoff away from certain watercourses during the operational phase of the Mary River Project (Baffinland, 2012). Five tributary streams are anticipated to be affected by diversions in the Mine Area (Figure 1).

2.2 CAMP LAKE TRIBUTARY 1 (CLT-1)

CLT-1 provides approximately 5.7 km of probable or confirmed fish-bearing habitat within the main channel and its smaller tributaries. This habitat is generally shallow (typically < 0.5 m deep), with predominantly cobble substrates (NSC, 2012; see Figure 2). Habitat in the upper reaches of the tributaries typically consists of a shallow series of cascades and riffles, with intermittent flow that provides only small amounts of habitat for aquatic life. The L1 branch of CLT-1 extends from the north-eastern shore of Camp Lake for approximately 1,400 m before reaching an impassable barrier (waterfall). It consists predominantly of riffle/pool habitat with cobble substrata. Undercut banks, deep pools and boulders provide ample cover in this stream. The utilization of the L1 branch of CLT-1 by Arctic Char is high. During surveys by Knight Piésold and NSC, one area on the L1 branch of CLT-1 between the lake and the falls was identified as a potential fish barrier under low flow conditions (Figures 1 and 2). Baffinland has continued to operate a seasonal stream gauge on the L1 branch of CLT-1 since 2006 (Figure 1).

A secondary channel (L2, referred to in NSC (2012) as Tributary 1b), continues an additional 1.25 km from downstream of the impassable falls into a series of broad and shallow ponds. This channel runs parallel to the airstrip along the base of the mountain. This channel is a low gradient area where several large, shallow (0.5 m) pools with cobble bottoms where limited in-stream cover is present. Limited sampling in the L2 stream suggests a much lower level of fish utilization compared with the L1 branch.

The west pond will collect runoff from the west half of the waste rock stockpile area and discharge it to the L1 stream of the Camp Lake Tributary 1 (CLT-1). This will result in an overall increase in flows in the L1 stream of CLT-1 that will be not be typical of the natural hydrograph. The L2 branch (CLT-1 L2 stream) will not receive flows from the west pond and will experience a flow reduction.

Flow regimes in CLT-1 for the FEIS predicted (Page 225 in Volume 7; Baffinland, 2012):

- An 8% reduction in flows during July
- A 25 to 39% increase in flows during June, August and September during operation and closure
- A 7 to 22% increase in flows throughout the open water period during post-closure

These predictions considered the total flow of CLT-1, including the L1 and L2 streams. A section of CLT-1 L1 was identified as a potential barrier under low flow conditions. Increased flow in CLT-1 L1 has the potential to create a barrier to upstream movement during the spring.

A detailed survey of L2 stream was not conducted. Anticipated effects from flow diversion are different between these streams. The L2 stream of CLT-1 flows parallel to the airstrip, and experiences a net reduction in flow as a result of west pond discharges being directed solely into the L1 stream. The L2 stream is identified as Arctic Char habitat, though it is lower quality habitat compared with the main channel of CLT-1 (L1 stream).

Monitoring within CLT-1 will initially include the potential barrier location on the L1 branch under low flow conditions and support a better understanding of the flow conditions and fish utilization of the L2 branch under different flow conditions (i.e., in spring and fall).

2.3 CAMP LAKE TRIBUTARY 2 (CLT-2)

CLT-2 is characterized by moderate to steep gradient, coarse bed material and a channel that tends to be braided (multiple channels, split by unvegetated islands and bars). Falls are located approximately 600 m from the mouth of the tributary (Figures 1 and 2). This tributary is heavily utilized by Arctic Char. During surveys by Knight Piésold and NSC, one area between the mouth and the falls on CLT-2 was identified as a potential fish barrier under low flow conditions (KP, 2011 and 2012; NSC, 2012).

Diversion of runoff from the west waste rock stockpile area and open pit will also alter discharge to CLT-2. The reduction in mean monthly flows is predicted to be 15 to 32% throughout the open-water period during operation, closure and post-closure (Page 225 in Volume 7; Baffinland, 2012). This reduction is predicted for the fish barrier location. Due to the apparent absence of any substantial inflows between the fish barrier and Camp Lake, the 15 to 32% reduction in flows is expected to be a fairly accurate estimate at its confluence with Camp Lake. No significant depth reduction was predicted within the fish-bearing section between Camp Lake and the upstream barrier that would impede fish access to habitat in CLT-2.

Since no barriers are expected under baseline flow conditions, limited “baseline” monitoring of CLT-2 will be undertaken during this initial study to validate predictions made in the FEIS. The stream will be visited opportunistically in the spring and fall during low flow years. More detailed monitoring of the fish-bearing section of CLT-2 will be undertaken once the Project has advanced to full-scale mining and the potential flow reductions identified in the FEIS have been realized.

2.4 SHEARDOWN LAKE TRIBUTARY 1 (SLDT-1)

Only four tributaries of Sheardown Lake support fish, and, of these, only one is of substantial size (SLDT-1). Three of the four fish-bearing tributaries (SDLT 1, SLDT 9, and SLDT 12) will be affected by a combination of open pit mining, ore stockpile placement and the associated water management practices during the Project’s operations and closure phases (Page 226 in Volume 7; Baffinland, 2012).

SDLT-1 (Tributary 1) and its main branch (Tributary 1b) flow into the northwest basin of Sheardown Lake and provide approximately 3 km of fish-bearing stream channel before reaching parts of the tributary that would not be passable to fish (Figure 3). Much of the stream is riffle or riffle/pool habitat over a predominantly cobble substrate and it is shallow (<0.1 m deep). The stream depth increases in the mid-section (up to 0.5 m) and both riffles and pools are present. Further upstream, the tributary forms a series of broad shallow pools. Stream habitat upstream of these pools is limited, consisting of a shallow (<0.1 m) stream with a cobble/boulder substrate and little cover. Cover in Tributary 1 varies with position, but is provided by boulders, undercut banks, and deep pools. SDLT-1 is the largest tributary of Sheardown Lake, providing important open water habitat for juvenile Arctic Char. Two potential barriers were identified within SDLT-1 (Figure 3).

The SDLT-1 stream contains stream gauge station H11 (established in 2011). Discharge hydrographs and rating curves have been developed for this stream.

During the operating and closure phases of the Project, SDLT-1 will experience flow reductions in the range of 21 to 35%. Post-closure, SDLT-1 will continue to experience a reduction in flows of 6 to 20% throughout the open-water period due to diversion of water around the open pit.

Monitoring within SDLT-1 will include the identified potential barrier locations within the lower reach near the outlet to the northwest lake basin and the other reach near the mine access road upstream. The proposed monitoring program will improve the mine's understanding of the flow and fish utilization conditions under different flow regimes (i.e., in the spring and fall).

2.5 SHEARDOWN LAKE TRIBUTARY 9 (SDLT-9)

SDLT-9 is characterized by cascade/pool habitat over cobble with varying amounts of boulder, gravel and/or sand (NSC, 2012). SDLT-9 drains a small fish-bearing lake with sufficient depth for overwintering, but an impassable barrier prevents upstream access from Sheardown Lake. Use of Tributary 9 habitat downstream of the barrier can also be limited due to lack of connectivity to Sheardown Lake under low flow conditions.

During operation of the railway project, SDLT-9 will experience an estimated 29% reduction in open-water season flows during operation and closure. Ore stockpiles will be removed at closure, so SDLT-9 flows will only be impacted during operations and closure. No Project-related reduction in flows is anticipated in SDLT-9 during the ERP, since there are no ERP facilities within this catchment.

SDLT-9 will be monitored during this initial program to understand the frequency and duration of fish barriers between Sheardown Lake and the small lake during low flow conditions (Figure 3). The presence and/or absence of fish will also be noted during low flow conditions.

2.6 SHEARDOWN LAKE TRIBUTARY 12 (SDLT-12)

SDLT-12 is similar to SDLT-9 and characterized by cascade/pool habitat over cobble with varying amounts of boulder, gravel and/or sand. Fish use of SDLT-12 is limited by an impassable waterfall and low flows during much of the open-water season.

SDLT-12 will experience an estimated 15% reduction in open-water season flows during operation and closure. Ore stockpiles will be removed at closure, so SDLT-12 flows will only be impacted during operations and closure. No Project-related reduction in flows is anticipated in SDLT-12 during the ERP, since there are no ERP facilities within this catchment.

SDLT-12 will be monitored during this initial program to understand the frequency and duration of fish barriers between Sheardown Lake and the permanent fish barrier (waterfall) during low flow conditions. The presence and/or absence of fish will also be noted during low flow conditions.

3 – MONITORING PROGRAM METHODOLOGY

The five streams of interest will be monitored in spring and fall during the initial years of operation. Low and high flow periods will be targeted where possible. Results of this initial monitoring will be reviewed to determine whether mitigation and/or ongoing monitoring is required. In spring, all five streams will be visually assessed to monitor for potential barriers and obstructions to upstream fish passage.

Surveys will document conditions within the monitoring streams between the upstream fish barriers and their outlets into Camp Lake and Sheardown Lake. The survey will utilize a field sheet (Appendix A) to document in situ conditions, including:

- A visual inspection along the targeted stream reaches
- Measurements of total water depth and point velocities at locations that may pose barriers to fish passage
- Instantaneous flow measurements within the SDLT-9 and SDLT-12 tributaries (not currently gauged)
- Photographing the potential natural barriers (facing upstream, downstream and the left and right banks). A minimum of 4 photos will be taken at each location.
- Documenting the presence and location of fish during the stream inspections

A target of two (2) spring surveys and three (3) fall surveys has been set. The number of surveys completed will be subject to on-site resource availability.

Other monitoring programs will contribute data relevant to this study. For example, Baffinland`s hydrology monitoring program includes stream gauges on three streams monitored under this program, and the freshwater biota monitoring will be undertaken as part of the Core Receiving Environment Monitoring Program (CREMP). Monitoring data from both these programs will be used in the analysis of data from this initial stream diversion monitoring study.

4 – ANALYSIS OF MONITORING RESULTS

The proposed Initial Stream Diversion Study will be completed annually over the next three years (2014, 2015 and 2016) followed by a review at the end of 2016. At the end of the three-year initial program, a report will be produced that summarizes the monitoring data and presents an analysis of results, including:

- Hydrographs from the existing stream gauging stations - The hydrograph results for the three years will be compared to historical hydrology records to better understand how flows varied throughout the year and how the flow rates compared to historical norms.
- The flow and water depths will also be compared to the values presented in support of the FEIS (KP, 2011 and 2012).
- Presentation of fish barrier identification information - This information will be summarized in tabular format and will most likely be organized by fish barrier or transect location. Comments will be provided on how the presence of specific fish barriers relate to flow conditions. This may help identify when specific sections of the streams become barriers to fish passage.
- Fish stranding information - A discussion on the frequency, timing and duration of current fish stranding. Comments will be provided on whether these events are likely to result in fish mortalities.

The 3-year initial stream diversion study monitoring report will be presented with the AEMP Annual Monitoring Report in the first half of 2017. The report will also include recommendations on potential mitigation measures and future monitoring.

Continuation of the monitoring program will depend upon the schedule and size of the Project. The Approved Project (18 Mt/a) will result in meaningful reductions in streamflow and monitoring will be required to identify Project-related fish barriers and fish stranding. If the ERP were to continue beyond 2017 and the 3-year study has met the stated objectives, then this targeted study may be discontinued until such time as the Approved Project proceeds. If possible, monitoring for the Approved Project will start one year prior to the start of larger scale mining.

5 – POTENTIAL MITIGATION MEASURES

A number of mitigation measures have been identified in the FEIS (Baffinland, 2012) and the Updated AEMP Framework (Baffinland, 2013), including:

- Monitoring and salvage fisheries
- Channel improvements
- Exclusion of Arctic Char from streams

Since the ERP will result in minimal to no changes in flows, implementation of mitigation measures will not be required within the initial three year study period. These mitigation options will be carried forward for consideration when the Project has reached full scale and the Project-related changes in flow can be expected to occur.

6 – REFERENCES

Baffinland Iron Mines Corporation, 2012. *Mary River Project Final Environmental Impact Statement*. February 2012.

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Signed: for

Dale Klodnicki, C.E.T. - Environmental Technologist

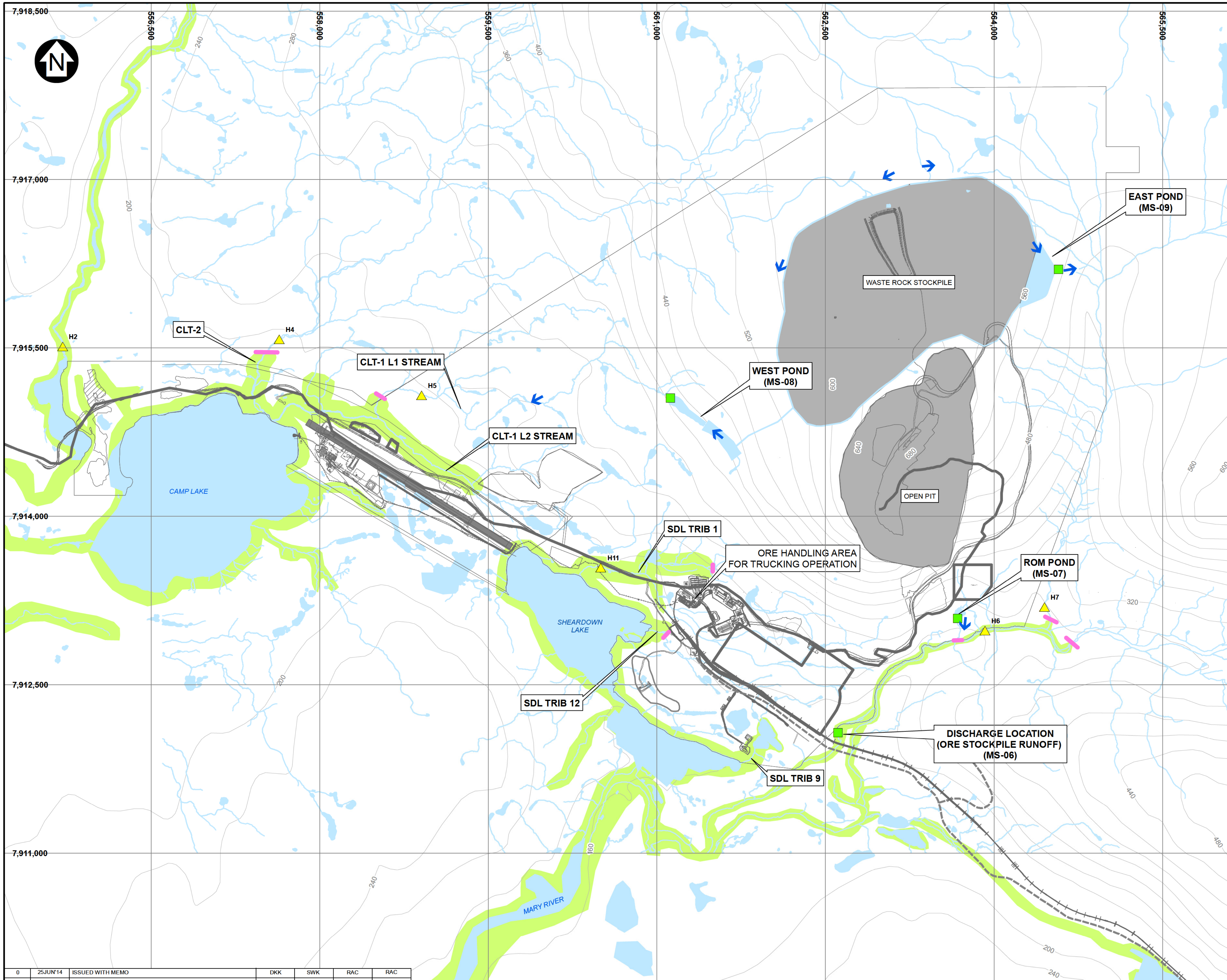
Reviewed and Approved:

Richard Cook, B.Sc. - Senior Scientist

Attachments:

Figure 1 Rev 0	Diversion Study Area Streams
Figure 2 Rev 0	Camp Lake Tributaries Subject to Monitoring
Figure 3 Rev 0	Sheardown Lake Tributaries Subject to Monitoring
Appendix A	Stream Diversion Field Data Sheet

/dkk



LEGEND:

- FINAL DISCHARGE POINT
- STREAM FLOW GAUGING STATION
- FISH BARRIER
- EXISTING TOTE ROAD
- PROPOSED RAILWAY ALIGNMENT
- PROPOSED CONSTRUCTION ACCESS ROAD
- PROPOSED SITE INFRASTRUCTURE
- RIVER/STREAM/DRAINAGE
- WATER
- CONFIRMED ARCTIC CHAR HABITAT

NOTES:

1. BASE MAP: © HER MAJESTY THE QUEEN IN RIGHTS OF CANADA, DEPARTMENT OF NATURAL RESOURCES (2004). ALL RIGHTS RESERVED.
2. COORDINATE GRID IS UTM NAD83 ZONE17.
3. CONTOURS ARE IN METRES. CONTOUR INTERVAL VARIES.
4. INFRASTRUCTURE INFORMATION PROVIDED BY HATCH ON JANUARY 31, 2014.
5. ARCTIC CHAR HABITAT (PRESENCE) FROM NSC, 2012 MARY RIVER PROJECT FRESHWATER AQUATIC BASELINE SYNTHESIS. REPORT: 2005-2011.

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	CHK'D	APP'D
0	25JUN'14	ISSUED WITH MEMO	DKK	SWK	RAC	RAC

SAVED: I:\102\00181\34\A\GIS\Figs\B50_r0.mxd; Jun 25, 2014 2:50 PM; skozmick

BAFFINLAND IRON MINES CORPORATION

MARY RIVER PROJECT

DIVERSION STUDY AREA STREAMS

Knight Piésold CONSULTING

P/A NO.	REF NO.
NB102-181/34	NB14-00160

FIGURE 1 REV 0

LEGEND:

- STREAM FLOW GAUGING STATION
- FISH BARRIER
- PREVIOUS TRANSECT LINE (KNIGHT PIESOLD, 2011)
- MILNE INLET TOTE ROAD
- CONTOUR

NOTES:

1. TOPOGRAPHY AND ORTHOPHOTOS PROVIDED BY EAGLE MAPPING (2005).
2. COORDINATE GRID IS IN METRES.
   COORDINATE SYSTEM: NAD 1983 UTM ZONE 17N.
3. CONTOUR INTERVAL IS 10 METRES.

SCALE 100 50 0 100 200 300 400 500 m

BAFFINLAND IRON MINES CORPORATION

MARY RIVER PROJECT

CAMP LAKE TRIBUTARIES SUBJECT TO MONITORING

Knight Piésold CONSULTING

P/A NO.	REF NO.
NB102-181/34	NB14-00160

FIGURE 2 REV 0

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	CHK'D	APP'D
0	25JUN'14	ISSUED WITH MEMO	DKK	SWK	RAC	RAC