APPENDIX C

2014 WATER AND SEDIMENT QUALITY CREMP MONITORING REPORT

BAFFINLAND IRON MINES CORPORATION
MARY RIVER PROJECT



2014 WATER AND SEDIMENT CREMP MONITORING REPORT

PREPARED FOR:

Baffinland Iron Mines Corporation
#300 - 2275 Upper Middle Road East
Oakville, Ontario, L6H 0C3

PREPARED BY:

Knight Piésold Ltd.
1650 Main Street West
North Bay, ON   P1B 8G5 Canada
p. +1.705.476.2165 | f. +1.705.474.8095

NB102-181/34-6
Rev 0
March 19, 2015

Knight Piésold
CONSULTING
www.knightpiesold.com

ISO 9001 - FS 64925
ISO 14001 - EMS 550121
OHSAS 18001 - OHS 550122

BAFFINLAND IRON MINES CORPORATION
MARY RIVER PROJECT

2014 WATER AND SEDIMENT CREMP MONITORING REPORT
NB102-181/34-6

Rev	Description	Date
0	Issued in Final	March 19, 2015

Knight Piésold Ltd.
1650 Main Street West
North Bay, Ontario Canada P1B 8G5
Telephone: (705) 476-2165
Facsimile: (705) 474-8095
www.knightpiesold.com

Knight Piésold
CONSULTING

EXECUTIVE SUMMARY

Background

The Core Receiving Environment Monitoring Program (CREMP) is a key element of Baffinland Iron Mines Corporation's (Baffinland's) Aquatic Effects Monitoring Plan (AEMP; Baffinland 2014) for the Mary River Project (the Project). This report presents the results of water and sediment quality monitoring conducted in 2014 as part of the water and sediment quality CREMP.

2014 Project Activities

Construction of mine infrastructure for the 3.5 million tonne per annum (Mt/a) Early Revenue Phase Project was initiated in mid-2013 and continued through 2014. In mid-September 2014, Baffinland initiated mining activities, including the development of preliminary pit benches, and the haulage, stockpiling, crushing and screening of ore, and subsequent transport over the Milne Inlet Tote Road to Milne Port. Water and sediment quality monitoring in 2014 was undertaken following and during construction activities, but prior to the production (drill, blast, haul, crush and stockpile) of ore.

Monitoring Objectives

The objective of monitoring of the water and sediment quality CREMP is to detect mine-related changes in contaminant concentrations within mine site lakes and streams. An additional objective of the 2014 monitoring program was to collect additional data that, subject to analysis and validation in this report, could potentially be added to the pre-mining baseline. Sediment quality monitoring in 2014 is intended to supplement the baseline dataset upon which final sediment benchmarks may be derived.

Data Analysis

The CREMP study design and data assessment procedures (KP, 2014) were used for the 2014 baseline data collection programs. The steps for monitoring and data analysis are briefly summarized below.

Step 1: Initial Data Analysis

Step 1 consists of data management, quality assurance/quality control (QA/QC) review, compilation of summary statistics, comparison of results to AEMP reference values (benchmarks and midpoints), and determination of whether or not a change is evident, relative to the baseline water quality. The evaluation of sediment quality data has the added step of excluding any samples not meeting the cut-offs for total organic carbon (TOC) and fines content established in the CREMP study design.

Step 2: Determine if Change is Mine-Related

Step 2 involves determining if the changes in water or sediment quality parameters of concern are due to the Project or due to natural variability or other causes. In some instances, results may be identified that are considered potentially indicative of change, but for which a mine-related linkage is absent, or the weight of evidence (i.e., other elevated parameters) does not suggest a mine-related change.

Step 3: Determine Action Level

Results that indicate a potential mine-related change are subject to low or moderate action if below or above the benchmark. Alternatively, if the weight of evidence suggests that a change (above or below the benchmark) is not mine-related, Step 3 is not carried out. With this approach, it is expected that benchmarks will be exceeded periodically for those parameters that are naturally elevated and for which benchmarks have been established based on the 97.5^{th} percentile of the baseline dataset.

Results

Evidence of Mine-related Change - Water Quality

Evidence of mine-related change was observed in Camp Lake Tributary, Camp Lake, and in Sheardown Lake NW and SE. Table 1 summarizes waterbody, parameter(s), potential sources and recommended actions to mitigate or confirm determination of a mine-related change.

Table 1 Evidence of Mine-Related Change - Water Quality

Waterbody	Parameter(s)	Potential Source(s)
Camp Lake Tributary	Total Aluminum Total Iron Ammonia Nitrate	• QMR2 quarry operations upstream (explosives residue). • Fill material for tote road and pad construction (explosives residue).
Camp Lake	Ammonia	• QMR2 quarry operations upstream via Camp lake Tributary • Fill material for tote road and bridge construction activities (Tom River bridge, 2014). • Nearby borrow area activities.
Sheardown Lake NW	Ammonia	• Fill material used at mine site development area.
Sheardown Lake SE	Ammonia	• Fill material used at mine site development area (explosives residue).

Each of Camp Lake, its tributary 1 and both basins of Sheardown Lake appeared to show a slight increase in concentrations of nitrogen compounds, including ammonia, which although elevated, remained well below the benchmarks. Nitrate exceeded the benchmark in Camp Lake Tributary downstream of QMR2. Within the Camp Lake Tributary the elevated nitrogen compounds are clearly attributable to runoff from the quarry. Aluminum and iron also exceeded the benchmarks in Camp Lake Tributary, and these exceedances have been attributed to quarry activities as well.

Evidence of Mine-related Change - Sediment Quality

The lake-wide sample sizes of the 2014 sediment quality dataset were greater than the baseline datasets for some lakes. As such, it was not unexpected that the 2014 results included concentrations higher than previously detected. In many cases the 2014 lake-wide standard deviations were lower than the baseline standard deviation. The high number of stations used in

2014 resulted in greater geographic coverage within the waterbodies and therefore better represents the natural variability among stations.

Evidence of mine-related change was observed in Sheardown Lake NW in 2008, attributable to the 2008 bulk sampling program. Post-2008 monitoring results for the same parameters (arsenic, iron and manganese) appear generally consistent with 2007.

Also within Sheardown Lake NW sediment, differences were observed in concentrations between sample stations and years for the following correlated parameters: chromium, copper, nickel, lead and zinc. There is an apparent increase of these five correlated metals over time. A number of factors were considered in establishing the potential cause(s) of the apparent increase:

- The previous baseline results for Sheardown Lake NW may not have fully represented the range of natural variability of metals in sediment.
- The stations sampled in 2014 with some of the highest metals concentrations are new stations; a lack of continuity in sediment quality stations make interpretation of the results between years difficult.
- There is a gap in the data over the years; i.e., no data collected in 2009 and 2010, limited sampling in 2011.
- A change in sediment sample collection procedure between 2007-2011 and 2012-2014 may contribute to differences in the data.
- The apparent increase in concentrations of the five correlated metals (Cr, Cu, Ni, Pb and Zn) over time is not matched by similar increases in arsenic, iron and manganese over time. Therefore, it does not appear likely that the apparent increase of the five correlated metals is due to ore dust.

It is possible, however, that the apparent increase in these metals over time could be mine-related, though a definitive cause-effect relationship has not been identified. Additional investigation in 2015 would help further understand the natural variability of metals in sediment, and the potential influence of changes in sampling methods and stations on the apparent increase in the five correlated metals.

Adoption of 2014 Data as Baseline - Water Quality

The mine site lakes and streams appear to have been affected by construction-related activities. As such, all 2014 data for nitrogen-containing compounds (ammonia, nitrate and nitrite), as well as aluminum and iron in Camp Lake Tributary should not be adopted as baseline for future comparison. The remaining parameter data are similar to the range of baseline data, and could be incorporated into the baseline for future comparisons.

Adoption of 2014 Data as Baseline - Sediment Quality

The baseline data sets for Mary Lake, Camp Lake and Sheardown Lake SE are small, the time series plots do not indicate upward trending of concentrations, and there is no obvious mine-related source or spatial trends that would indicate mine-related change in the 2014 data sets. Therefore it can be concluded that there is no evidence of mine-related change in Mary Lake, Camp Lake, and Sheardown Lake SE sediments. As such, the respective 2014 sediment quality datasets should be adopted into the baseline for comparison against future monitoring in 2015. A number of factors complicated the interpretation of sediment quality data from Sheardown Lake NW. Consequently, development of final AEMP site-specific benchmarks for Sheardown Lake NW requires additional investigation, and the area-wide interim benchmarks were used for comparison in 2014.

TABLE OF CONTENTS

PAGE

TABLES

FIGURES

APPENDICES

1 – INTRODUCTION

1.1 BACKGROUND

The Core Receiving Environment Monitoring Program (CREMP) is a key element of Baffinland Iron Mines Corporation's (Baffinland's) Aquatic Effects Monitoring Plan (AEMP; Baffinland 2014) for the Mary River Project (the Project).

The CREMP is comprised of two main monitoring study designs:

- Water and sediment quality CREMP (KP, 2014)
- Freshwater biota CREMP (NSC, 2014)

This report presents the results of water and sediment quality monitoring conducted in 2014 as part of the water and sediment quality CREMP. Monitoring under the freshwater biota CREMP is reported separately by North/South Consultants Inc.

1.2 2014 PROJECT ACTIVITIES

Construction of mine infrastructure for the 3.5 million tonne per annum (Mt/a) Early Revenue Phase Project was initiated in mid-2013 and continued through 2014. In mid-September 2014, Baffinland initiated mining activities, including the development of preliminary pit benches, and the haulage, stockpiling, crushing and screening of ore, and subsequent transport over the Milne Inlet Tote Road to Milne Port.

Water and sediment quality monitoring in 2014 was undertaken during the late winter, spring, summer and fall, with the latter concluding prior to the start of mining. Therefore, all 2014 water and sediment quality sampling was conducted concurrent with construction activities at the mine site, but without the potential influence of mining activities.

1.3 MONITORING OBJECTIVES

The objective of monitoring of the water and sediment quality CREMP is to detect mine-related changes in contaminant concentrations within mine site lakes and streams, so as to identify the need to implement the AEMP Response Framework. The key pathways of potential effects of the mine on water and sediment quality include:

- Changes related to discharge of ore or stockpile runoff to freshwater systems (immediate receiving environments: Mary River and Camp Lake Tributary 1).
- Changes (primarily nutrients and total suspended solids [TSS]) related to discharge of treated sewage effluent (immediate receiving environments: Mary River and Sheardown Lake NW).
- Changes due to deposition of dust in lakes and streams (Mine Area in zone of dust deposition).
- Changes due to non-point sources, such as site runoff and use of ammonium nitrate fuel oil (ANFO) explosives in the mine area.

The primary issue of concern with respect to water quality is related to the combined effects on metal and TSS concentration from mine effluent discharges and ore dust deposition on water quality in lake and streams.

1.4 SCOPE OF 2014 MONITORING

Consistent with the water and sediment quality CREMP study design (KP, 2014), an objective of the 2014 monitoring program was to collect additional data that, subject to analysis and validation in this report, could potentially be added to the pre-mining baseline. Therefore, the 2014 monitoring program included the following objectives:

- Monitor construction-related effects, if detectable.
- Determine if the 2014 water and sediment quality data are within the pre-mining baseline range of concentrations.
- Confirm final sediment quality benchmarks (either lake-specific or area-wide).

Provided 2014 monitoring data did not indicate meaningful construction-related effects and was consistent with previous baseline data, the data would be aggregated into the pre-mining datasets to strengthen before-after (BA) evaluations of future monitoring results.

2 – METHODS

2.1 2014 SAMPLING DATES AND LOCATIONS

2.1.1 Water Quality Sampling in 2014

A total of 40 surface water sampling stations were strategically selected within mine site lakes and streams based on proximity to proposed Project facilities (Figure 2.1). The majority of these stations were sampled three times in 2014, in consistent timing windows corresponding with historic sampling campaigns shown in Table 2.1 (lakes) and Table 2.2 (streams).

Table 2.1 Sampling Date Comparison - Lake Water Quality

Year	Winter (Lakes)	Spring	Summer	Fall
2005	No sampling	No sampling	No Sampling	No sampling
2006	No sampling	No sampling	July 31 - Aug 2	Aug 31 - Sept 6
2007	May 6 - 8	No sampling	Aug 5 - Aug 14	Aug 13 - 20; Sept 13 - 20
2008	May 11	June 25	July 30 - 31; Aug 5 - 7	Sept 2 -14
2009	No sampling			
2010	No sampling			
2011	No sampling	No sampling	July 24 - 26	Sept 2 - 6
2012	April 27 - 28	No sampling	No sampling	Aug 21 - 26
2013	May 2 - 5	No sampling	July 25 - 28	Aug 24 - Sept 1
2014	April 30 - May 5	No sampling	July 24 - 27	Aug 23 - 26

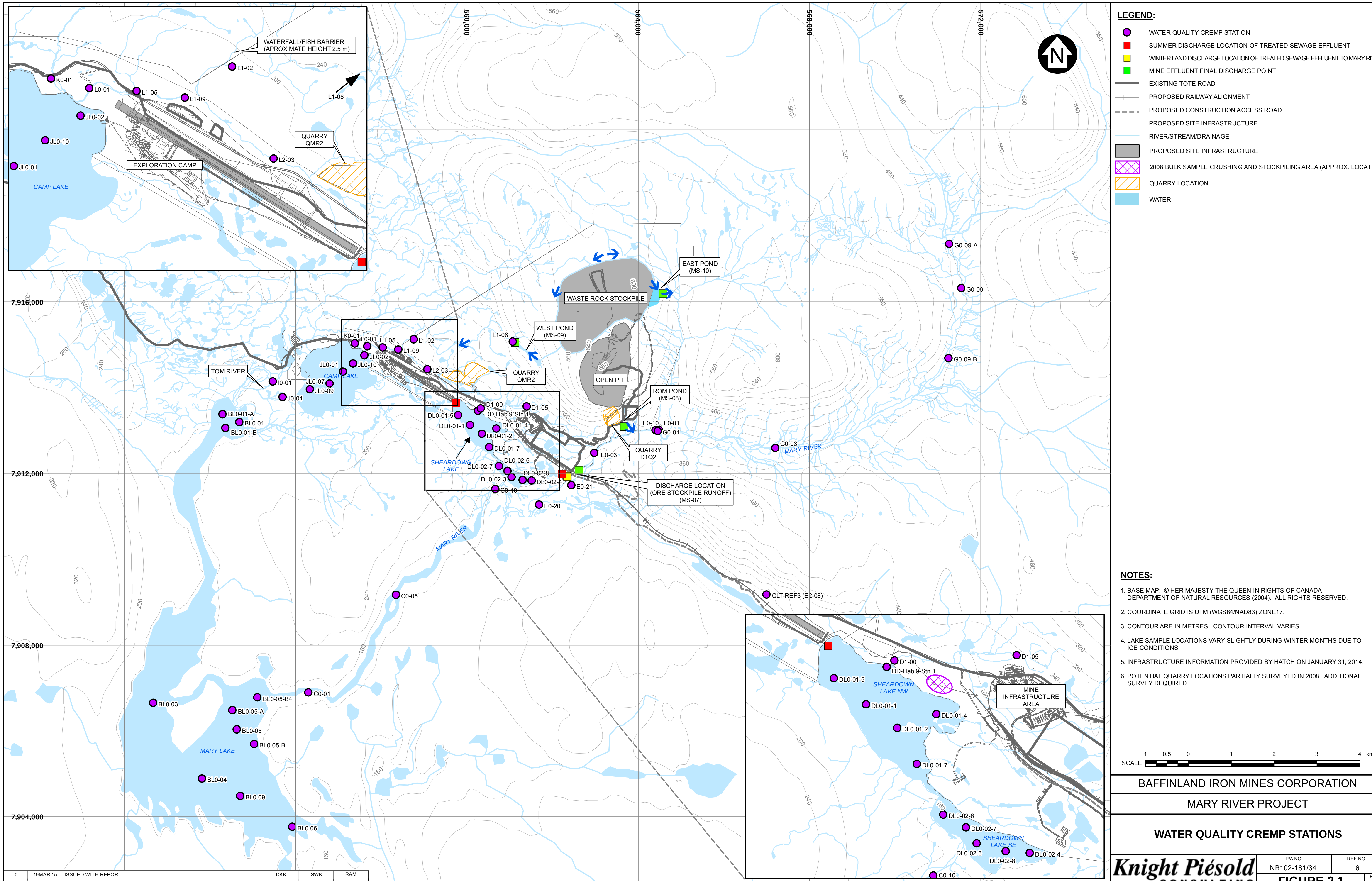

LEGEND:
WATER QUALITY CREMP STATION
SUMMER DISCHARGE LOCATION OF TREATED SEWAGE EFFLUENT
WINTER LAND DISCHARGE LOCATION OF TREATED SEWAGE EFFLUENT TO MARY RIVER
MINE EFFLUENT FINAL DISCHARGE POINT
EXISTING TOTE ROAD
PROPOSED RAILWAY ALIGNMENT
PROPOSED CONSTRUCTION ACCESS ROAD
PROPOSED SITE INFRASTRUCTURE
RIVER/STREAM/DRAINAGE
PROPOSED SITE INFRASTRUCTURE
2008 BULK SAMPLE CRUSHING AND STOCKPILING AREA (APPROX. LOCATION)
QUARRY LOCATION
WATER
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 (WGS84/NAD83) ZONE17.
3. CONTOUR ARE IN METRES. CONTOUR INTERVAL VARIES.
4. LAKE SAMPLE LOCATIONS VARY SLIGHTLY DURING WINTER MONTHS DUE TO ICE CONDITIONS.
5. INFRASTRUCTURE INFORMATION PROVIDED BY HATCH ON JANUARY 31, 2014.
6. POTENTIAL QUARRY LOCATIONS PARTIALLY SURVEYED IN 2008. ADDITIONAL SURVEY REQUIRED.
SCALE 1 0.5 0 1 2 3 4 km
BAFFINLAND IRON MINES CORPORATION
MARY RIVER PROJECT
WATER QUALITY CREMP STATIONS
Knight Piésold CONSULTING
P/A NO. NB102-181/34
REF NO. 6
FIGURE 2.1
REV 0
WATERFALL/FISH BARRIER (APROXIMATE HEIGHT 2.5 m)
EXPLORATION CAMP
CAMP LAKE
QUARRY QMR2
WASTE ROCK STOCKPILE
EAST POND (MS-10)
WEST POND (MS-09)
OPEN PIT
ROM POND (MS-08)
QUARRY D1Q2
DISCHARGE LOCATION (ORE STOCKPILE RUNOFF) (MS-07)
TOM RIVER
SHEARDOWN LAKE
MARY RIVER
MARY LAKE
SHEARDOWN LAKE NW
SHEARDOWN LAKE SE
MINE INFRASTRUCTURE AREA
CLT-REF3 (E2-08)
7,916,000
7,912,000
7,908,000
7,904,000
560,000
564,000
568,000
572,000
0 19MAR'15 ISSUED WITH REPORT DKK SWK RAM
REV DATE DESCRIPTION DESIGNED DRAWN REVIEWED

Table 2.2 Sampling Date Comparison - Stream Water Quality

Year	Winter	Spring	Summer	Fall
2005	No sampling	June 9 - 11	August 9 - 12	September 9 - 11
2006	No sampling	June 18 - 26	July 2 - 30; Aug 6 - 14	Aug 20 - Sept 20
2007	No sampling	June 13 - 24	July 1 - 28; August 5 - 12	Aug 19 - 31; Sept 2 - 30
2008	No sampling	June 9 - 24	July 1 - 21; August 1 - 11	Aug 18 - Sept 16
2009	No sampling	June 29	July 6 - 20	Aug 9 - 18; Sept 2 - 14
2010	No sampling	No sampling	No sampling	Aug 13; Sept 15
2011	No sampling	No sampling	July 21 - 26	Aug 28 - Sept 1
2012	No sampling	June 18 - 23	July 22 - 24	Aug 24 - 31
2013	No sampling	June 21 - 23	July 23 - 25	Aug 20 - Sept 3
2014	No sampling	June 19 - 25	July 24 – 27	Aug 21 - 23

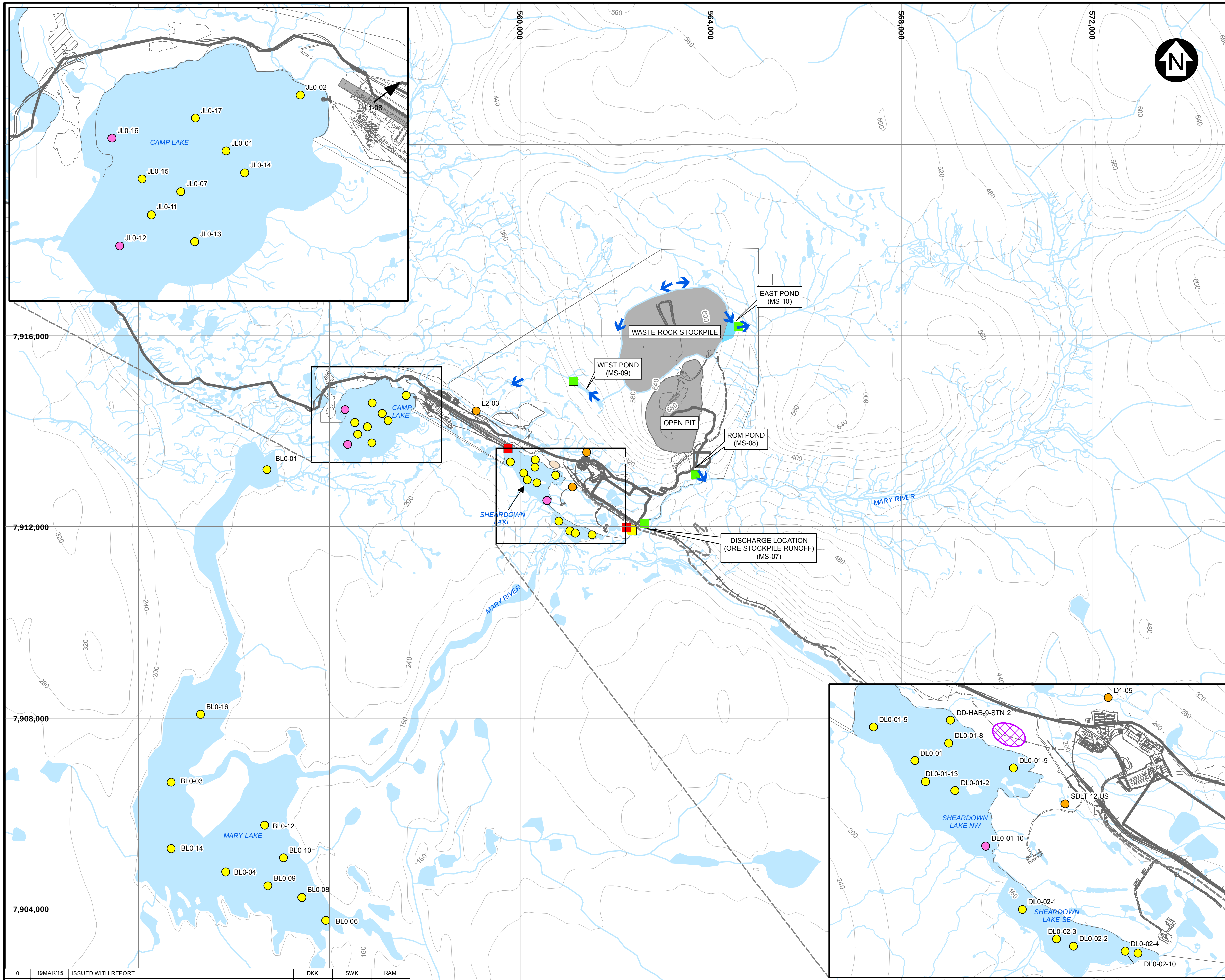
NOTES:
1. NO SAMPLING WAS CONDUCTED DUE TO NO FLOW AT THE STREAM STATION IN WINTER.
2. DURING 2009 AND 2010 VERY LIMITED SAMPLING OCCURRED, ONLY WITHIN MARY RIVER.

2.1.2 Sediment Quality Sampling in 2014

The 2014 sediment quality monitoring program included a total of 34 stations (31 lake stations in 4 lakes, plus 3 stream stations) (Figure 2.2). The sediment quality monitoring stations were sampled once in 2014, with the majority having been sampled during the fall field campaign (Table 2.3).

Table 2.3 Number of Sediment Samples by Year and Location

Waterbody	2005	2006	2007	2008	2011	2012	2013	2014
Camp Lake	0	0	6	0	0	3	3	9
Camp Lake Tributary	3	0	4	0	3	7	5	1
Mary Lake	0	2	5	0	0	1	1	10
Sheardown Lake NW	0	0	7	12	3	4	6	8
Sheardown Lake SE	0	0	5	0	0	1	1	5
Sheardown Lake Tributary	2	0	5	3	4	3	1	2



REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED
0	19MAR'15	ISSUED WITH REPORT	DKK	SWK	RAM

LEGEND:

- LAKE SEDIMENT SAMPLE LOCATION
- STREAM SEDIMENT SAMPLE LOCATION
- 2014 LAKE SEDIMENT SAMPLE LOCATION (RESULTS DID NOT MEET CUTOFF CRITERIA)
- MINE EFFLUENT FINAL DISCHARGE POINT
- SUMMER DISCHARGE LOCATION OF TREATED SEWAGE EFFLUENT
- WINTER LAND DISCHARGE LOCATION OF TREATED SEWAGE EFFLUENT TO MARY RIVER
- EXISTING TOTE ROAD
- PROPOSED RAILWAY ALIGNMENT
- PROPOSED CONSTRUCTION ACCESS ROAD
- PROPOSED SITE INFRASTRUCTURE
- RIVER/STREAM/DRAINAGE
- PROPOSED SITE INFRASTRUCTURE
- 2008 BULK SAMPLE CRUSHING AND STOCKPILING AREA (APPROX. LOCATION)
- WATER

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 (WGS84/NAD83) ZONE17.
3. CONTOUR ARE IN METRES. CONTOUR INTERVAL VARIES.
4. LAKE SAMPLE LOCATIONS VARY SLIGHTLY DURING WINTER MONTHS DUE TO ICE CONDITIONS.
5. INFRASTRUCTURE INFORMATION PROVIDED BY HATCH ON JANUARY 31, 2014.

SCALE 1 0.5 0 1 2 3 4 km

BAFFINLAND IRON MINES CORPORATION

MARY RIVER PROJECT

SEDIMENT QUALITY CREMP STATIONS

Knight Piésold CONSULTING

P/A NO.	REF NO.
NB102-181/34	6

FIGURE 2.2 REV 0

2.2 QUALITY ASSURANCE/QUALITY CONTROL (QA/QC) PROTOCOLS

A strict QA/QC program has been implemented from the on-set of the environmental baseline program to ensure that representative data of the highest quality are obtained in a manner which is scientifically defensible, repeatable, and well documented. This program aims to ensure the highest level of QA/QC standard methods and protocols were used for the collection and analysis of all environmental media samples. Quality assurance is obtained at the project management level through organization and planning and the enforcement of both external and internal quality control. The following lists summarize the QA/QC procedures and practices that were being followed:

- Internal Quality Control:
  - Staffing the project with experienced/trained individuals.
  - Ensuring that representative, meaningful data are collected through planning and efficient research.
  - Use of standard protocols for sample collection, preservation, and documentation.
  - Regular calibration and maintenance of all field equipment.
  - Collection of duplicate, blank, and filter blank samples for submission for analysis (approximately 10% of overall samples).
- External Quality Control:
  - Employment of fully accredited analytical laboratories for the analysis of all samples.
  - Determination of analytical precision and accuracy through the interpretation of the analysis reports for the blind duplicate, blank, and filter blank samples.

The outcome of the QA/QC program is described in Section 4.

2.3 FIELD DATA COLLECTION PROCEDURES

2.3.1 Equipment

Three multi-parameter probes were used for field sampling. Two multi-parameter probes (YSI 6820 and YSI 600QS) were supplied and maintained by Baffinland. One multi-parameter probe (YSI 600QS) was supplied and maintained by KP. The probes were used for measuring *in situ* pH, temperature, dissolved oxygen and conductivity, and were calibrated prior to sampling. The multi-parameter probes were calibrated daily for dissolved oxygen. Daily accuracy checks of the pH and conductivity probes were conducted, and recalibrates as required. In cases where water quality sampling events were longer than two days, all probes were recalibrated every three days using standard solutions. The probes were recalibrated more frequently if the parameter readings were suspect.

During sampling, the multi-parameter probe was rinsed with sample water at each station and the in situ measurements were recorded once the parameter values stabilized. Additional equipment used for processing samples (i.e., gloves, filters, and syringes) is disposable and new packaged equipment was used at each site.

2.3.2 Field Procedures

Field procedures for this program are described in the Water and Sediment Quality Sampling Protocol presented as Appendix A of the Water and Sediment Quality CREMP (KP, 2014). All staff engaged in this work read the sampling protocol prior to conducting any water or sediment quality work on-site.

Field notes and in situ data were recorded on waterproof paper. At the end of each day, field personnel checked their field notes and sample labels to ensure that no samples were missing and that notes were complete. The laboratories provided protocols for sample labelling, preservation, and shipment. Bottles and preservatives were shipped with labels and a digital chain of custody (COC) form was utilized on site for sample tracking and laboratory submission. Water quality samples were labelled with their actual site name rather than an identification code since the samples are re-labelled by the lab prior to analysis.

The repeatability and reliability of sample results was evaluated by submitting duplicate water samples, field blanks, and travel blanks for the same parameters for which the primary samples are analyzed. This allows for the detection and reduction of errors that may occur due to contamination of samples. The QA/QC samples conformed to standard sampling methods, outlined by the CCME and were labelled as QA/QC samples because the laboratory adds their own labels upon sample receipt (CCME, 2011). Details regarding each type of QA/QC sample are outlined below:

- **Duplicate Samples** - The purpose of a duplicate sample is to estimate sampling and laboratory analytical precision. At least one duplicate sample is collected for every sampling event and the total number of duplicate samples is maintained at a level of at least 10% of the total number of samples. Duplicate samples are obtained using the same collection and handling procedures and are collected at the same time as the primary sample. Duplicate lake samples were obtained from the water in the Kemmerer sampler used to obtain the primary sample.
- **Field Blank Sample** - The purpose of a field blank is to identify potential sources of contamination with preservatives, field filtration, sample handling or transportation, as well as any potential contamination from analytical procedures. Field blanks were prepared from distilled water provided by the laboratory. The distilled water was added to sample bottles using the same field techniques as other samples, including field filtration and field preservation.
- **Travel Blank Sample** - The purpose of a travel blank is to identify potential sources of contamination associated with sample containers, shipping, storage, and analysis. These samples are prepared by the laboratory with distilled water and are never opened. Travel blanks travel with the sample bottles sent from the laboratory to the field site, and back to the laboratory. The use of travel blanks in the north is a challenge. Coolers containing laboratory-provided sample bottles are typically sent weeks in advance to be sure they arrive at site. In some instances, coolers containing empty bottles may be stored in temperature-unregulated areas. Travel blanks can, therefore, be exposed to conditions that are not representative of samples delivered to the laboratory. For these reasons, travel blanks were not used in the 2013 sampling program. To address this issue. During the 2014 program, travel blanks were ordered from the lab but not delivered to site. Distilled water containers were provided instead of laboratory prepared travel blank sample sets with security seals, therefore no travel blanks were used in the 2014 program.

The outcome of the QA/QC program is described in Section 4.

2.4 LABORATORY ANALYSIS

Baffinland retained EXOVA Laboratories (EXOVA) to conduct analysis of the water and sediment samples collected in 2014. EXOVA subcontracted the dissolved and total metals in water analyses to ALS Environmental (ALS) in Vancouver for the winter and spring sampling events, which has been the procedure since 2007. Both EXOVA and ALS are members of the Canadian Association for Laboratory Accreditation (CALA) for water and sediment quality analysis and apply rigorous internal QA/QC procedures.

The summer and fall water samples were analyzed entirely by EXOVA. EXOVA reported concentrations of number of metals in water at higher method detection limits (MDLs) than ALS, and as such some of the non-detect results were higher than the site-specific AEMP benchmark for some parameters.

Water samples were analyzed for the following:

- Physical Tests - Hardness, pH, specific conductivity, total dissolved solids (TDS), total suspended solids (TSS), and turbidity.
- Dissolved Anions - Alkalinity (bicarbonate, carbonate, and hydroxide), bromide, chloride, fluoride, and sulphate.
- Nutrients - Ammonium nitrogen, nitrate, nitrite, dissolved orthophosphate, and total and dissolved phosphate.
- Total and Dissolved Metals - analyzed at low levels to meet the Canadian Environmental Quality Guidelines (CEQG) criteria values.
- Organics - Total organic carbon (TOC).

EXOVA analyzed all sediment quality samples collected in 2014. EXOVA has historically completed lab analyses of all sediment samples on the Project. Sediment samples were analyzed for the following:

- Physical Tests - Moisture content, pH, and particle size distribution
- Organics - Total organic carbon (TOC)
- Total Metals

Laboratory reports were issued to Baffinland and copied to KP.

2.5 BENCHMARKS

2.5.1 Water Quality Benchmarks

The assessment of surface water quality data over the life of the Project will be on-going, and the recommended benchmarks of comparison throughout this process may change, as more data become available. Water quality benchmarks were established for the AEMP and were compared to the 2014 data as discussed in Section 2.6.1. The water quality benchmarks calculated from the historic baseline data review (2005-2013) are shown in Table 2.4 (lakes) and Table 2.5 (streams). The method used to develop each of the benchmarks is denoted in the table by an (A) adoption of the generic Canadian Council of Ministers of the Environment (CCME) Canadian Water Quality Guideline for the Protection of Freshwater Aquatic Life (CWQG); (B) adoption of the 97.5th percentile of baseline (the CCME background concentration procedure); or (C) 3x the Method Detection Limit (MDL). The selection of water quality benchmarks is described in Appendix C of the AEMP (Intrinsik, 2014 in Baffinland, 2014).

Table 2.4 AEMP Benchmarks - Lake Water Quality

Parameter	Units	Camp Lake	Mary Lake	Sheardown Lake	Benchmark Method(s)
Aluminium	mg/L	0.1	0.13	0.179 - Shallow 0.173 - Deep	A - Camp Lake B - Mary/Sheardown Lakes
Arsenic	mg/L	0.005	0.005	0.005	A
Cadmium	mg/L	0.0001	0.00006	0. 00009	A
Chromium	mg/L	0.0003	0.0005	0.000642	C - Camp Lake B - Mary/Sheardown Lakes
Chromium $^{+3}$	mg/L	0.0089	0.0089	0.0089	A
Chromium $^{+6}$	mg/L	0.015	0.003	0.003	C
Cobalt	mg/L	0.004	0.004	0.004	A
Copper	mg/L	0.004	0.0024	0.0024	B
Iron	mg/L	0.3	0.3	0.3	A
Lead	mg/L	0.001	0.001	0.001	A
Nickel	mg/L	0.025	0.025	0.025	A
Silver	mg/L	0.0001	0.0001	0.0001	A
Thallium	mg/L	0.0008	0.0008	0.0008	A
Vanadium	mg/L	0.006	0.006	0.006	A
Zinc	mg/L	0.030	0.030	0.030	A
Chloride (Cl)	mg/L	120	120	120	A
Ammonia (NH_3+NH_4)	mg N/L	0.855	0.855	0.855	A
Nitrite (NO_2)	mg N/L	0.060	0.060	0.060	A
Nitrate (NO_3)	mg N/L	13	13	13	A
Sulphate	mg/L	218	218	218	A

NOTES:

1. METAL PARAMETERS SHOWN AS TOTAL CONCENTRATIONS UNLESS OTHERWISE NOTED.

Table 2.5 AEMP Benchmarks - Stream Water Quality

Parameter	Units	Camp Lake Tributary	Mary River	Benchmark Method
Aluminium	mg/L	0.179	0.966	B
Arsenic	mg/L	0.005	0.005	A
Cadmium	mg/L	0.00008	0.00006	A
Chromium	mg/L	0.000856	0.0023	B
Chromium $^{+3}$	mg/L	0.0089	0.0089	A
Chromium $^{+6}$	mg/L	0.003	0.003	C
Cobalt	mg/L	0.004	0.004	A
Copper	mg/L	0.0022	0.0024	B
Iron	mg/L	0.326	0.874	B
Lead	mg/L	0.001	0.001	A
Nickel	mg/L	0.025	0.025	A
Silver	mg/L	0.0001	0.0001	A
Thallium	mg/L	0.0008	0.0008	A
Vanadium	mg/L	0.006	0.006	A
Zinc	mg/L	0.030	0.030	A
Chloride (Cl)	mg/L	120	120	A
Ammonia (NH_3+NH_4)	mg N/L	0.855	0.855	A
Nitrite (NO_2)	mg N/L	0.060	0.060	A
Nitrate (NO_3)	mg N/L	13	13	A
Sulphate	mg/L	218	218	A

NOTES:
1. METAL PARAMETERS SHOWN AS TOTAL CONCENTRATIONS UNLESS OTHERWISE NOTED.

2.5.2 Sediment Quality Benchmarks

The Water and Sediment CREMP Study Design (KP, 2014) presented area-wide interim sediment quality benchmarks to be applied to the Project. A stated objective of the study design was to collect additional sediment quality data from the mine site area lakes in 2014, and to develop final sediment quality benchmarks once the additional pre-mining sediment quality data were considered.

Intrinsik (2015) completed a review of the 2014 sediment quality data and recommended final sediment quality benchmarks applying the same approach that was applied in the development of the water quality benchmarks and the interim sediment quality benchmarks. The final sediment quality benchmarks are presented in Table 2.6. As with the water quality benchmarks, the method used to develop each of the benchmarks is denoted in the table by an (A) adoption of the generic Canadian Council of Ministers of the Environment (CCME) Canadian Water Quality Guideline for the Protection of Freshwater Aquatic Life (CWQG); (B) adoption of the 97.5th percentile of baseline (the CCME background concentration procedure); or (C) 3x the MDL.

Table 2.6 AEMP Benchmarks - Sediment Quality

Parameter	Units	Camp Lake	Mary Lake	Sheardown Lake NW [1]	Sheardown Lake SE
Arsenic	mg/kg	5.9 (A)	5.9 (A)	6.2 (B)	5.9 (A)
Cadmium	mg/kg	1.5 (C)	1.5 (C)	1.5 (C)	1.5 (C)
Chromium	mg/kg	98 (B)	98 (B)	97 (B)	79 (B)
Copper	mg/kg	50 (B)	50 (B)	58 (B)	56 (B)
Iron	mg/kg	52,400 (B)	52,400 (B)	52,200 (B)	34,400 (B)
Lead	mg/kg	35 (A)	35 (A)	35 (A)	35 (A)
Manganese	mg/kg	4,370 (B)	4,370 (B)	4,530 (B)	657 (B)
Nickel	mg/kg	72 (B)	72 (B)	77 (B)	66 (B)
Phosphorus	mg/kg	1,580 (B)	1,580 (B)	1,958 (B)	1,278 (B)
Zinc	mg/kg	135 (B)	135 (B)	123 (A)	123 (A)

NOTES:
1. THE INTERIM AREA-WIDE SEDIMENT QUALITY BENCHMARK VALUES FOR SHEARDOWN LAKE NW ARE USED IN THIS REPORT, AS DISCUSSED BELOW.
2. THE ORIGIN OF THE AEMP BENCHMARKS ARE IDENTIFIED AS (A) METHOD A = WATER QUALITY GUIDELINE FROM CCME/B.C. MOE; (B) METHOD B = 97.5 PERCENTILE OF BASELINE; OR (C) METHOD C = 3* MDL.

Intrinsik's review identified different sediment chemistry in both Sheardown Lake NW and Sheardown Lake SE, compared to similar sediment chemistry in Camp Lake and Mary Lake. Additionally, sediment quality in Sheardown Lake NW showed signs of elevated arsenic, iron and manganese in 2008, likely attributable to the bulk sampling program. A number of factors have complicated the interpretation of the Sheardown Lake NW sediment quality data. For example, changes in sampling protocols, variation in sample locations based on the CREMP gradient study design and the proximity of Sheardown Lake to the mining activities may all contribute to the observed differences among the datasets. As such, development of final site-specific sediment quality benchmarks for Sheardown Lake NW requires additional investigation, and the interim area-wide benchmarks have been used for comparison.

2.6 DATA ANALYSIS

2.6.1 Water Quality Data Analysis

As indicated in Section 1.4, the 2014 monitoring program was undertaken during mine construction activities but prior to mining, to detect any construction-related changes in water quality within core receiving environment. The intent is to incorporate the 2014 water quality monitoring results into the pre-mining baseline, if appropriate.

The CREMP study design (KP, 2014) specifies the steps for monitoring and data analysis, briefly summarized below.

Step 1: Initial Data Analysis

Step 1 consists of data management, quality assurance/quality control (QA/QC) review, compilation of summary statistics, comparison of results to AEMP reference values (benchmarks and midpoints), and determination of whether or not 2014 data is comparable with pre-existing baseline data. This was completed using exploratory data analysis (EDA) techniques applied in the water and sediment baseline review and CREMP study design report (KP, 2014).

Step 2: Determine if Change is Mine-Related

Step 2 involves determining if the changes in water quality parameters of concern are due to the Project or due to natural variability or other causes. This may be a qualitative assessment using the EDA approach, or possibly using statistical data analysis (SDA). SDA was not used to evaluate the 2014 monitoring data.

In some instances, results were identified that were considered potentially indicative of change, but for which a mine-related linkage is absent, or the weight of evidence (i.e., other elevated parameters) does not suggest a mine-related change. No actions were identified for these circumstances, as no mine-related linkage was present.

Results that indicate a potential mine-related change are further evaluated under Step 3.

Step 3: Determine Action Level

Step 3 involves determination of the action level associated with the observed monitoring results through comparisons to the benchmark. If Step 2 identifies with some certainty that a measured change is mine-related, then Step 3 is carried out. Alternatively, if the weight of evidence suggests that a change (above or below the benchmark) is not mine-related, Step 3 is not carried out.

It is expected that benchmarks will be exceeded some of the time for those parameters that are naturally elevated and for which benchmarks have been established based on the 97.5^{th} percentile of the baseline dataset. As such, it is expected that 2.5% of data will be detected above the 97.5^{th} percentile value. Such exceedances may occur more frequently if the baseline dataset upon which the 97.5^{th} percentile is calculated is limited in size.

Interpretation of Mine-Related Changes Triggering Low and Moderate Action

The data assessment and management response framework developed by Baffinland is highly conservative. The approach focuses on identifying and responding to mine-related change before benchmarks are exceeded, or are exceeded on a consistent basis. A low action response is taken when a change has been detected which is attributed to mine activities. Implementation of a low action response does not equate to an environmental effect. The low action response allows Baffinland to identify and respond to a potential issue before a moderate action response is triggered. Table 2.7 provides a summary of the EDA-based data evaluation criteria with subsequent determinations of potential mine-related change and associated actions as per the response framework.

Table 2.7 Data Assessment Procedure

Data Evaluation	Mine-related	Action
Data at one station appear higher than baseline, based on EDA	No	No action
If one sample at one station is trending up, and higher than baseline	No	No action
If one sample at one station is higher than baseline, and considered to be trending up	Possible (Yes)	Low action
If one sample from one station is > AEMP benchmark	Yes	Low Action
If annual mean from one station is > AEMP benchmark	Yes	Moderate Action

Mine-related changes exceeding a benchmark require moderate action responses. The benchmarks were developed using three methods briefly described below and further discussed in Sections 2.5.1 and 2.5.2.

For benchmarks based on generic guidelines (Method A), most of which are based on chronic exposure to aquatic life. If moderate action is triggered based on a single sample exceeding the benchmark, it does not mean adverse effects are occurring, as short-term exceedances of benchmarks are based on generic guidelines would have a low potential of causing harm. Therefore, short-term (acute) exposure to contaminant(s) of concern at a chronic (long-term) exposure level does not necessarily indicate an effect has occurred.

Exceedances of benchmarks developed based on 97.5th percentile of background concentrations (Method B), for parameters naturally elevated in the baseline, may be evaluated differently than generic guideline-based benchmarks (Method A). Exceedances of the Method B benchmarks will occur from time-to-time, given that higher than benchmark results have been measured in the baseline. Therefore, a weight-of-evidence approach is required that considers the frequency at which a site-specific benchmark is exceeded. Despite the likelihood of exceedances, a site-specific benchmark based on a percentile of baseline will also be above the corresponding generic guideline based on chronic exposure. Therefore, an exceedance of a site-specific benchmark may have a higher potential for eliciting adverse effects, depending on the receiving environment and adaptation of resident species to increased concentrations.

Several parameters are present in the baseline at low concentrations, where most samples are below the MDL (<5% detects). Method C was used for those parameters and the benchmark was set at three times the MDL. The Method C benchmarks are well below the generic guidelines, and therefore similar to parameters Method A benchmarks, an exceedance of the benchmarks do not imply an effect.

2.6.2 Sediment Quality Data Analysis

The data analysis process for sediment quality is similar to the process for water quality described above, involving the same steps outlined in the AEMP Data Assessment and Response Framework (Figure 5.1 in the AEMP; Baffinland, 2014). An objective of the 2014 sediment quality monitoring program was to collect additional baseline sediment quality data from mine site lakes to support the development of final sediment quality benchmarks, as described in Section 2.5.2.

The data analysis process for sediment quality applied the cut-offs for TOC and % sand as described in the study design (KP, 2014). This included excluding samples that contained:

- 90% sand or greater
- More than 80% sand and less than 0.6% TOC

The cut-offs have been applied to both the historic baseline and the 2014 results.

Finally, the sediment quality database for the project is relatively limited, and as such, the full range of baseline conditions has not been fully characterized. As mentioned above, one of the objectives of the 2014 monitoring program was to fill these gaps. As a consequence, it is possible and even likely that 2014 concentrations of some metals will vary considerably in relation to the previous baseline dataset.

3 – RESULTS

3.1 WATER QUALITY

The following section includes discussion of the 2014 water quality results for Mary River, Mary Lake, Camp Lake Tributary, Camp Lake, the Sheardown Lake basins, and other mine area streams. The 2014 results have been compared to historic baseline results and the AEMP benchmarks provided in Appendix A. Elevated concentrations of parameters of interest are presented with additional discussion of potential sources and perceived trends compared to historic datasets. The conclusions for each waterbody include whether change from baseline has occurred, and if so, whether the perceived change can be attributed to mine-related sources.

3.1.1 Mary River Water Quality Results

There are 14 water quality stations on the Mary River; three upstream of Mary River falls, three at the confluence of the east pond tributary and seven distributed along the Mary River between the mine site and the outlet into Mary Lake (Figure 2.1). Water quality results from the 2014 sampling events on Mary River have been compared to historic baseline results and the AEMP benchmarks in Table A1.1 (Appendix A1), and key parameters are presented graphically in scatter plots and box and whisker plots of the baseline data in Appendix A2.

Table 3.1 presents a comparison of the 2014 river-wide means for each parameter to the baseline mean and the AEMP benchmark for Mary River as well as the midpoint value between the mean and the benchmark. This comparison is intended to provide a waterbody-wide overview of the 2014 results in relation to the previous baseline data. A number of notes are included below the table where MDL results affect the calculation of statistics.

Table 3.1 Water Quality Summary Statistics - Mary River

Parameter	Baseline Data (2007 through 2013)				AEMP Values		2014 Data			
	Mean	Median	Standard Deviation	n	Benchmark	Midpoint	Mean	Median	Standard Deviation	n
Total Metals										
Aluminum	0.190	0.118	0.281	470	0.966	0.541	0.139	0.107	0.135	54
Arsenic	0.00012	0.00010	0.00025	470	0.005	0.00255	0.00010[4]	0.00010[4]	0.000002	54
Cadmium	0.00003	0.00001	0.00046	469	0.00002	0.000035	0.00001[4]	0.00001[4]	0.000001	54
Chromium	0.0006	0.0001	0.0034	469	0.0023	0.0012	0.0005[5]	0.0005[5]	0.0003	54
Cobalt	0.0002	0.0002	0.0001	464	0.004	0.0021	0.0001[4]	0.0001[4]	0.0001	54
Copper	0.0069	0.0011	0.0747	357	0.0024	0.0018	0.0011	0.0011	0.0005	54
Iron	0.189	0.120	0.234	470	0.874	0.494	0.165	0.101	0.152	54
Lead	0.0002	0.0001	0.0002	280	0.001	0.00056	0.00019	0.00013	0.00019	54
Nickel	0.0008	0.0006	0.0004	261	0.025	0.0128	0.0007	0.0007	0.0002	54
Silver	0.00070	0.00001	0.01439	464	0.0001	0.000055	0.00001	0.00001	0.00001	54
Thallium	0.0001	0.0001	0.0005	351	0.0008	0.00045	0.0001[5]	0.0001[5]	0.0000	54
Vanadium	0.001	0.001	0.0005	463	0.006	0.0035	0.001[6]	0.001[6]	0.0	54
Zinc	0.003	0.003	0.002	297	0.030	0.0165	0.003[4]	0.003[4]	0.0002	54
Nutrients										
Ammonia (NH_3+NH_4)	0.073	0.020	0.146	416	0.855	0.443	0.081	0.060	0.053	54
Nitrite (NO_2)	0.011	0.005	0.020	416	0.06	0.033	0.008[4]	0.005[4]	0.010	54

Parameter	Baseline Data (2007 through 2013)				AEMP Values		2014 Data			
	Mean	Median	Standard Deviation	n	Benchmark	Midpoint	Mean	Median	Standard Deviation	n
Nitrate (NO_3)	0.10	0.10	0.03	476	13	6.55	0.14	0.10	0.15	54
Phosphorus	0.016	0.009	0.054	453	--	--	0.008	0.005	0.007	54
Dissolved Anions										
Chloride (Cl)	6.1	3.00000	9.56125	439	120	61.5000	3.4	2	6.18128	54
Sulphate	3.0	3.00000	1.84709	425	218	110.500	1.7[4]	1[4]	0.99351	54

NOTES:

1. NO 2014 CONCENTRATIONS WERE GREATER THAN MAXIMUM BASELINE CONCENTRATIONS FOR THE PARAMETERS OF INTEREST.
2. SHADED VALUES INDICATE CONCENTRATIONS ABOVE BASELINE STATISTICS.
3. NO 2014 CONCENTRATIONS WERE ABOVE THE MIDPOINT AND/OR BENCHMARK CONCENTRATION.
4. INDICATES MOST VALUES WERE EQUAL TO OR SLIGHTLY ABOVE THE MDL – WHICH RESULTS IN A CALCULATED MEDIAN EQUAL TO THE MDL.
5. NON-DETECT RESULTS AT A HIGHER THAN USUAL MDL DURING SUMMER AND FALL SAMPLING EVENTS IS INFLUENCING SUMMARY STATISTICS UPWARD.
6. INDICATES VALUES WERE CONSISTENTLY BELOW THE METHOD DETECTION LIMIT.

Aggregating the water quality data from all Mary River stations, the 2014 mean and median concentrations are below the corresponding midpoint values as well as the baseline mean and median values for all parameters except ammonia. The mean and median ammonia concentration in 2014 is slightly higher than the corresponding baseline mean and median, and below both the AEMP benchmark for ammonia and the midpoint value. A possible source of ammonia is the treated sewage effluent from the camp, which is discharged to land next to the river (an ice block accumulates during winter and thaws and releases through the summer). Ammonia concentrations within the length of the river are discussed further below.

Table 3.2 presents a summary of the 2014 data for each parameter compared to the AEMP benchmark, midpoint and determination of change for Mary River. Individual sample results that were above the AEMP benchmark or midpoint have been identified.

Table 3.2 Mary River - 2014 Water Quality Data Summary

Steps	Step 1			Step 2	Step 3
Parameter	Initial Data Analysis			Determine if Change is Mine-Related	Determine Action Level
	Above AEMP Benchmark	Above Midpoint	Determine if there is a change		
Total Metals					
Aluminum (B)	None	G0-09A (summer)	No change evident. Data consistent with baseline.	N/A	N/A
Arsenic (A)	None	None	No change evident. Data consistent with baseline.	N/A	N/A
Cadmium (A)	None	None	No change evident. Data consistent with baseline.	N/A	N/A
Chromium (B)	None	G0-09A (spring/summer)	No change evident. Data consistent with baseline. Highest concentrations occur upstream the mine.	N/A	N/A
Cobalt (A)	None	None	No change evident. Most 2014 data are at MDL.	N/A	N/A

Steps	Step 1			Step 2	Step 3
Parameter	Initial Data Analysis			Determine if Change is Mine-Related	Determine Action Level
	Above AEMP Benchmark	Above Midpoint	Determine if there is a change		
Copper (B)	None	E0-03 (spring)	No change evident. Data consistent with baseline.	N/A	N/A
Iron (B)	None	G0-09-A (spring/summer) G0-09-B (summer)	No change evident. All 2014 data are within the range of the previous data, except G0-09 located upstream mine.	N/A	N/A
Lead (A)	E0-03	G0-09-A (summer)	Potential change observed.	See discussion below	N/A
Nickel (A)	None	None	No change evident. Data consistent with baseline.	N/A	N/A
Silver (A)	None	None	No change evident. Data consistent with baseline.	N/A	N/A
Thallium (A)	None	None	No change evident. Data consistent with baseline.	N/A	N/A
Vanadium (A)	None	None	No change evident. Data consistent with baseline.	N/A	N/A
Zinc (A)	None	None	No change evident. Data consistent with baseline.	N/A	N/A
Nutrients					
Ammonia (NH_3+NH_4) (A)	None	None	No change evident. Data consistent with baseline.	N/A	N/A
Nitrite (NO_2) (A)	None	None	No change evident. Data consistent with baseline.	N/A	N/A
Nitrate (NO_3) (A)	None	None	No change evident. Data consistent with baseline.	N/A	N/A
Dissolved Anions					
Chloride (Cl) (A)	None	None	No change evident. Data consistent with baseline.	N/A	N/A
Sulphate (A)	None	None	No change evident. Data consistent with baseline.	N/A	N/A

NOTES:

1. THE ORIGIN OF THE AEMP BENCHMARKS ARE IDENTIFIED AS (A) METHOD A = WATER QUALITY GUIDELINE FROM CCME/B.C. MOE; (B) METHOD B = 97.5 PERCENTILE OF BASELINE; OR (C) METHOD C = 3* MDL.

Concentrations of the parameters of interest were generally within the range of historic baseline data. The exceptions are discussed below.

Elevated Metals at Upstream of the Mine Site (G0-09, G0-09-A and G0-09-B)

Aluminum, chromium, iron and lead were observed to be elevated, and above the corresponding midpoint values at G0-09-A. Other adjacent samples (G0-09 and G0-09-B) showed similar elevated levels but below midpoint values. Concentrations were generally highest in the spring sampling event. All of the G-series sample stations are upstream of Deposit No. 1 and the mine site, and as such are not attributable to the mine site. A review of the Mary River plots in Appendix A2 shows that such periodic high concentrations of these metals do occur from time to time.

Total Lead at E0-03

Total lead at station E0-03 (0.00117 mg/L) was the only metal concentration measured above its benchmark value (0.001 mg/L) in the Mary River, and only during the spring sampling event. TSS was measured at 11 mg/L in this sample. High TSS was noted in other spring samples collected in the Mary River. The dissolved concentration of lead measured at 0.0007 mg/L (below the total lead benchmark), compared to mostly non-detect for dissolved lead elsewhere in the river. The high suspended sediment load likely influenced the total and dissolved lead concentrations in this sample. Total lead at the downstream stations E0-21 and E0-20 were also elevated during the spring sampling event (0.00056 mg/L and 0.00038 mg/L, respectively). As indicated above, several elevated metals including lead were noted at the upstream stations during the spring sampling event and to a lesser degree in the summer and fall sampling events. The scatter plots in Appendix A2 show occasional high total values historically, throughout the Mary River. Therefore, the benchmark exceedance is not an outlier but is expected to be resulting from natural causes.

General Parameters, Nutrients and Anions

Mean and median ammonia concentrations of aggregated 2014 Mary River samples were noted to increase slightly over baseline. Review of the box plots in Appendix A2, however, shows that the upstream stations (G0-09 series) were among the highest in concentration. Elevated ammonia concentrations at the G0-09 stations are not attributable to the mine. Ammonia concentrations decrease downstream to station E0-20, which is immediately downstream of the treated sewage effluent discharge location (see Figure 2.1). Treated sewage effluent was discharged to the Mary River for the first time in 2014, starting in winter with land discharge forming an ice block of treated sewage effluent on the west of the river. During summer, loadings would result from both direct discharge of treated sewage, and from the melting ice block. Ammonia concentrations appear to increase between E0-21 (located upstream of the sewage discharge location) and E0-20 (located downstream the sewage discharge location). However, the concentrations at E0-20 and downstream are comparable to historic values as well as those measured at the upstream G0-09 stations.

Conclusion - Is there Evidence of Mine-Related Change in the Mary River?

The 2014 monitoring program noted elevated concentrations of several metals (aluminum, chromium, iron and lead) in the upstream sampling cluster (G0-09, G0-09A and G0-09B), and one of the same metals (total lead) exceeded the AEMP benchmark for total lead at a station next to the mine site (E0-03). While differences were observed, it is unlikely to be mine-related on the basis of the following:

- Elevated concentrations of several metals were documented upstream of the mine.
- Similar elevated concentrations have been documented in the baseline.
- No production or handling of ore was undertaken over the sampling period in 2014, and no ore dust or mine effluent was discharged to the Mary River.

It is speculated that erosional events upstream of the mine site, which have been documented to occur from time to time, resulted in a shorter term metals loading in the upper reaches of the Mary River.

3.1.2 Mary Lake Water Quality Results

There are 10 water quality stations within Mary Lake, each with a shallow and deep sample collected (n=20). The stations are geographically distributed with three close to the outlet of the Mary River, another four are spread across the main (southern) basin and three of which are in the northern basin of the north arm near the outlets of the Tom River and Camp Lake (Figure 2.1). Water quality results from the 2014 sampling events on Mary Lake have been compared to historic baseline results and the AEMP benchmarks in Table A1.2 (Appendix A1), and key parameters are presented graphically in scatter plots and box and whisker plots of the baseline data in Appendix A3.

Table 3.3 presents a comparison of the 2014 lake-wide means for each parameter to the baseline mean and the AEMP benchmark for Mary Lake, as well as the midpoint value between the mean and the benchmark.

Table 3.3 Water Quality Summary Statistics - Mary Lake

Parameter	Baseline Data (2007 through 2013)				AEMP Values		2014 Data			
	Baseline Mean	Median	Standard Deviation	n	Benchmark	Midpoint	Annual Mean	Median	Standard Deviation	n
Total Metals										
Aluminum	0.04733	0.03870	0.04027	71	0.13	0.08390	0.04191	0.03350	0.03759	60
Arsenic	0.00011	0.00010	0.00004	71	0. 005	0.00255	0.00010[6]	0.00010[6]	0.0	60
Cadmium	0.00002	0.00001	0.00003	71	0.00006	0.00004	0.00001	0.00001	0.0	60
Chromium	0.00047	0.00050	0.00024	71	0.0005	0.00050	0.00037[5]	0.00050[5]	0.00019	60
Cobalt	0.00011	0.00010	0.00003	71	0.004	0.00125	0.00010[6]	0.00010[6]	0.0	60
Copper	0.00095	0.00079	0.00058	65	0.0024	0.00155	0.00071[5]	0.00069[5]	0.00018	60
Iron	0.06187	0.05200	0.04260	71	0.3	0.17000	0.04803	0.04000	0.04087	60
Lead	0.00007	0.00006	0.00002	63	0.001	0.00053	0.00011	0.00007	0.00012	60
Nickel	0.00055	0.00050	0.00010	63	0.025	0.01275	0.00051[4]	0.00050[4]	0.00003	60
Silver	0.00001	0.00001	0.0[6]	71	0.0001	0.00006	0.00001[4]	0.00001[4]	0.000004	60
Thallium	0.00006	0.00010	0.00005	63	0.0008	0.00045	0.00007[5,6]	0.00010[5,6]	0.00005	60
Vanadium	0.00105	0.00100	0.00032	71	0.006	0.00350	0.00100[6]	0.00100[6]	0.0	60
Zinc	0.00198	0.00150	0.00097	63	0.030	0.01650	0.00376[4]	0.00300[4]	0.00499	60
Nutrients										
Ammonia (NH_3+NH_4)	0.08732	0.05000	0.08685	71	0.855	0.455	0.07483	0.06	0.03442	60
Nitrite (NO_2)	0.00961	0.00500	0.02231	71	0.060	0.0325	0.005[6]	0.005[6]	0	60
Nitrate (NO_3)	0.10113	0.10000	0.00667	71	13	6.55	0.103[4]	0.1[4]	0.01629	60
Phosphorus	0.00606	0.005	0.00415	71	-	-	0.004[4]	0.003[4]	0.00296	60

Parameter	Baseline Data (2007 through 2013)				AEMP Values		2014 Data			
	Baseline Mean	Median	Standard Deviation	n	Benchmark	Midpoint	Annual Mean	Median	Standard Deviation	n
Dissolved Anions										
Chloride (Cl)	3..2	2	2.54370	71	120	61	2.3	2	1.73986	60
Sulphate	2.7	3	1.48893	71	218	110	1.6[4]	1[4]	0.88681	60

NOTES:

1. 2014 VALUES GREATER THAN MAXIMUM BASELINE CONCENTRATIONS WERE IDENTIFIED FOR LEAD, ZINC AND NITRATE AT VARIOUS STATIONS.
2. SHADED VALUES INDICATE CONCENTRATIONS ABOVE BASELINE STATISTICS.
3. NO 2014 CONCENTRATIONS WERE NOTED ABOVE THE MIDPOINT AND/OR BENCHMARK CONCENTRATIONS.
4. INDICATES MOST VALUES WERE EQUAL TO OR SLIGHTLY ABOVE THE MDL – WHICH RESULTS IN A CALCULATED MEDIAN EQUAL TO THE MDL.
5. NON-DETECT RESULTS AT A HIGHER THAN USUAL MDL DURING SUMMER AND FALL SAMPLING EVENTS IS INFLUENCING SUMMARY STATISTICS UPWARD.
6. INDICATES VALUES WERE CONSISTENTLY BELOW THE METHOD DETECTION LIMIT.

Aggregating the water quality data from all Mary Lake stations, the 2014 mean and median concentrations are below the corresponding midpoint values as well as the baseline mean and median values for all parameters except lead and zinc. Table 3.4 presents a data analysis summary of the 2014 data for each parameter compared to the AEMP benchmark, midpoint and determination of change for Mary Lake. Individual sample results that were above the AEMP benchmark or midpoint have been identified.

Table 3.4 Mary Lake - 2014 Water Quality Data Summary

Steps	Step 1			Step 2	Step 3
Parameter	Initial Data Analysis			Determine if Change is Mine-Related	Determine Action Level
	Above AEMP Benchmark	Above Midpoint	Determine if there is a Change		
Total Metals					
Aluminum (B)	BL0-05-A-S, BL0-05-B-S (summer)	BL0-05-S/D BL0-05-A-D BL0-05-B-S (summer)	Elevated concentrations at stations close to the mouth of Mary River.	Not mine-related; see discussion	N/A
Arsenic (A)	None	None	No change evident. Data consistent with baseline (one sample measured above MDL).	N/A	N/A
Cadmium (A)	None	None	No change evident. All samples measured at MDL.	N/A	N/A
Chromium (B)	None	None	Unknown. A large proportion of samples were reported at a high MDL.	N/A	N/A
Cobalt (A)	None	None	No change evident. All samples measured at MDL.	N/A	N/A

Steps	Step 1			Step 2	Step 3
Parameter	Initial Data Analysis			Determine if Change is Mine-Related	Determine Action Level
	Above AEMP Benchmark	Above Midpoint	Determine if there is a Change		
Copper (B)	None	None	No change evident. Data consistent with baseline.	N/A	N/A
Iron (B)	None	BL0-05-B-D (summer)	Potentially elevated concentrations at stations close to the mouth of Mary River.	Not mine-related; see discussion	N/A
Lead (A)	None	BL0-01-A-S (summer)	Elevated values were noted at a majority of the sites.	Not mine-related; see discussion	N/A
Nickel (A)	None	None	No change evident. Data consistent with baseline.	N/A	N/A
Silver (A)	None	None	Unknown. A large proportion of samples were reported at a high MDL.	N/A	N/A
Thallium (A)	None	None	Unknown. A large proportion of samples were reported at a high MDL.	N/A	N/A
Vanadium (A)	None	None	No change evident. All samples measured at MDL.	N/A	N/A
Zinc (A)	BL0-01-B-S (summer)	BL0-01-B-S (summer)	One benchmark exceedance at north end of the lake. A large proportion of samples were reported at a high MDL.	Not mine-related; see discussion	N/A
Nutrients					
Ammonia (NH_3+NH_4) (A)	None	None	2014 results appeared to be consistently between the baseline median and 75th percentile.	N/A	N/A
Nitrite (NO_2) (A)	None	None	No change evident. While a large proportion of samples were reported at a high MDL, all results remained within baseline.	N/A	N/A
Nitrate (NO_3) (A)	None	None	No change evident. Data consistent with baseline.	N/A	N/A
Dissolved Anions					
Chloride (Cl) (A)	None	None	Unknown. A large proportion of samples were reported at multiple high MDLs.	N/A	N/A
Sulphate (A)	None	None	Unknown. A large proportion of samples were reported at multiple high MDLs.	N/A	N/A

NOTES:

1. THE ORIGIN OF THE AEMP BENCHMARKS ARE IDENTIFIED AS (A) METHOD A = WATER QUALITY GUIDELINE FROM CCME/B.C. MOE; (B) METHOD B = 97.5 PERCENTILE OF BASELINE; OR (C) METHOD C = 3* MDL.

Concentrations of the parameters of interest were generally within the range of historic baseline data. The exceptions are discussed below.

Total Aluminum in Mary Lake near the Outlet of Mary River (BL0-05, BL0-05-A and BL0-05-B)

Elevated concentrations of total aluminum were detected during the summer sampling program at three stations located near the mouth of the Mary River. The shallow and deep samples at all three stations exceeded the midpoint value (half way between the median and the benchmark), and of these, total aluminum concentrations in BL0-05-A-S (the shallow sample at BL0-05-A) and BL0-05-B-D (the deep sample at BL0-05-B) exceeded the AEMP benchmark for total aluminum of 0.137 mg/L on two sampling events (0.145 mg/L and 0.138 mg/L, respectively). The corresponding dissolved aluminum concentrations were unremarkable, and the winter and fall results for total and dissolved aluminum at these three stations were below the benchmark and midpoint values.

Nearby stations in Mary Lake include BL0-04, BL0-06 and BL0-09. Review of the 2014 data against the baseline box plots in Appendix A3 suggests potentially elevated measurements of total aluminum in the deep samples at each of these stations.

Total aluminum concentrations are naturally elevated throughout the mine site area, which is the basis of adopting waterbody specific benchmarks for total aluminum based on background concentrations. The selected AEMP benchmark for the Mary River is 0.966 mg/L, considerably higher than the background concentration-based AEMP benchmark for Mary Lake (0.137 mg/L) as well as the generic CWQG criterion of 0.1 mg/L.

Mary River is the largest tributary flowing into Mary Lake and provides the lake with connectivity to potential influence of upstream activities. A review of total aluminum concentrations in the Mary River (see Section 3.1.1) shows one exceedance of the Mary River midpoint value, at the most upstream sample station (G0-09A). Otherwise, the 2014 data for total aluminum in the Mary River are unremarkable, in terms of confirming an upstream source of the aluminium benchmark exceedances in Mary Lake.

Total Zinc at BL0-01-B-S at the North End of Mary Lake

Zinc was not detectable in Mary Lake during most sampling events, however, one sample collected during the winter period at the north end of the lake (near the outlet of both Tom River and Camp Lake) measured a total zinc concentration of 0.0414 mg/L, exceeding the benchmark of 0.03 mg/L. The corresponding dissolved zinc concentration was non-detect (<0.003 mg/L). Review of the physical parameters for this sample show total suspended solids below the MDL (<2 mg/L), but the dissolved solids were nearly double the open-water samples. Utilizing the maximum baseline concentration of total zinc (0.003 mg/L) as the upper threshold to identify outliers, it is likely than the BL0-01-B-S zinc concentration is also an outlier as shown in Table 4 of Appendix A3. Nearby station BL0-01-S contained measurable concentrations of zinc during spring and fall sampling events, and BL0-03-D (at the south end of the north arm of the lake) contained measurable zinc.

Water quality within the contributing Tom River (station I0-01; unaffected by the Project) and the Camp Lake outlet (station J0-01) low contained concentrations of dissolved zinc (0.001 mg/L) and non-detect total zinc concentrations during the spring sampling campaign, whereas summer and fall results were all non-detect. Summer and fall 2013 water quality data were reviewed and show concentrations of dissolved zinc at both stations, in all seasons consistently above the detection limit ranging from 0.0003 mg/L to 0.0033 mg/L. Total zinc concentrations at these station in 2013 were all below detection with the exception of station J0-01 in August (0.0016 mg/L). The source of the elevated zinc sample is not apparent and does not provide a clear linkage to any mine-related sources.

Method Detection Limits of Chromium and Silver

The total chromium and silver laboratory detection limits during the summer and fall events were higher than the historic and spring baseline detection limits. This difference plots the 2014 values at the upper and lower extremes of the boxplots in Appendix A3. Future monitoring will require lower total chromium and silver detection limits for comparison to baseline.

General Parameters, Nutrients and Anions

The general parameters, nutrients and dissolved anion concentrations measured in 2014 were generally within the range of historic baseline data.

Conclusion - Is there Evidence of Mine-Related Change in Mary Lake?

The 2014 monitoring program has signaled a change in the concentration of total aluminum in Mary Lake. The observed elevated aluminum levels in the Mary Lake closest to the outlet of the Mary River may be due to natural causes based on the higher aluminum concentrations in the Mary River, which were highest upstream of the mine site. Potential sources of elevated metals (including aluminum) such as ore dust or mine effluent were not present. Therefore, while change has occurred, it is unlikely to be mine-related. It is speculated that erosional events upstream of the mine site, which have been documented to occur from time to time, resulted in a shorter term loading of aluminum in sediments that occurred between sampling events in the Mary River. Aluminum will be carried forward on the 2015 Watch List to understand the findings further.

One isolated exceedance of total zinc was noted in the north arm of Mary Lake. Upstream sampling, however, cannot explain the results as natural (an outlier) or mine-related.

3.1.3 Camp Lake Tributary Water Quality Results

There are six water quality stations on the Camp Lake Tributary; two stations are located on the L1 tributary that will receive mine effluent discharged from the west waste rock storm water pond, one station is located on the L2 tributary at the base of the hill and flowing parallel to the laydown areas and the airstrip, and three stations are on the lower reach crossing the tote road ultimately reporting to Camp Lake (Figure 2.1). Water quality results from the 2014 sampling events within the Camp Lake Tributary have been compared to historic baseline results and the AEMP benchmarks in Table A1.3 (Appendix A1), and key parameters are presented graphically in scatter plots and box and whisker plots of the baseline data in Appendix A4.

Table 3.5 presents a comparison of the 2014 lake-wide means for each parameter to the baseline mean and the AEMP benchmark for Camp Lake Tributary as well as the midpoint value between the mean and the benchmark.

Table 3.5 Water Quality Summary Statistics - Camp Lake Tributary

Parameter	Baseline Data				AEMP Values		2014 Data			
	Mean	Median	Standard Deviation	n	Benchmark	Midpoint	Mean	Median	Standard Deviation	n
Total Metals										
Aluminum	0.024658	0.01	0.044388	88	0.179	0.14750	0.03838	0.01300	0.055596	18
Arsenic	0.000165	0.0001	0.00058	88	0.005	0.00255	0.00010	0.00010[4]	0.000002	18
Cadmium	0.000125	0.00001	0.001065	88	0.00008	0.00005	0.00001[6]	0.00001[6]	0.0	18
Chromium	0.000204	0.0001	0.000348	88	0.000856	0.00048	0.00042[5,6]	**0.00050[5,6]**	0.000137	18
Cobalt	0.000173	0.0001	0.00012	88	0.004	0.00210	0.00011[4]	0.00010[4]	0.000032	18
Copper	0.001521	0.0016	0.000514	85	0.0022	0.00165	0.00154	**0.00170**	0.000386	18
Iron	0.068353	0.05	0.076211	88	0.326	0.21950	0.10439[5]	0.0600[5]	0.109107	18
Lead	0.000094	0.00005	0.000090	88	0.001	0.00056	0.00008[4]	0.00005[4]	0.000060	18
Nickel	0.00085	0.000765	0.000399	52	0.025	0.01282	0.00081	0.00080	0.00027	18
Silver	0.000003	0.000001	0.000004	57	0.0001	0.00006	0.00001[6]	0.00001[6]	0.0	18
Thallium	0.000206	0.0001	0.001072	71	0.0008	0.00045	0.00007[5,6]	0.00010[5,6]	0.000044	18
Vanadium	0.001092	0.001	0.000972	86	0.006	0.00350	0.00100[6]	0.00100[6]	0.0	18
Zinc	0.002403	0.003	0.001401	61	0.030	0.01650	0.00307[4]	0.00300[4]	0.000194	18
Nutrients										
Ammonia (NH_3+NH_4)	0.08686	0.02	0.158591	86	0.855	0.44250	0.08833	0.085	0.06784	18
Nitrite (NO_2)	0.015209	0.005	0.024664	86	0.060	0.03250	0.01267[4]	0.005[4]	0.01707	18
Nitrate (NO_3)	0.096067	0.1	0.019165	89	13	6.55000	0.21556[4]	0.1[4]	0.24469	18
Phosphorus	0.016826	0.004	0.055886	86	-	-	0.00322[4]	0.003[4]	0.00065	18
Dissolved Anions										
Chloride (Cl)	6.1	2	13.62745	89	120	61.50000	7.4	4.5	9.63	18
Sulphate	2.8	3	1.634135	88	218	110.50000	1.8[4]	1[4]	1.54	18

NOTES:

1. 2014 VALUES GREATER THAN MAXIMUM BASELINE CONCENTRATIONS WERE IDENTIFIED FOR NITRATE AT VARIOUS STATIONS.
2. SHADED VALUES INDICATE CONCENTRATIONS ABOVE BASELINE STATISTICS.
3. BOLD, SHADED VALUES INDICATE 2014 CONCENTRATIONS NOTED ABOVE THE BENCHMARK CONCENTRATIONS.
4. INDICATES MOST VALUES WERE EQUAL TO OR SLIGHTLY ABOVE THE MDL – WHICH RESULTS IN A CALCULATED MEDIAN EQUAL TO THE MDL.
5. NON-DETECT RESULTS AT A HIGHER THAN USUAL MDL DURING SUMMER AND FALL SAMPLING EVENTS IS INFLUENCING SUMMARY STATISTICS UPWARD.
6. INDICATES VALUES WERE CONSISTENTLY BELOW THE METHOD DETECTION LIMIT.

Aggregating the water quality data from all Camp Lake Tributary stations, the 2014 mean and median concentrations are below the corresponding midpoint values as well as the baseline mean and median values. Most 2014 results are very close to baseline statistics except for nitrate, ammonia and sulphate. For these parameters, the corresponding median and standard deviations have increased. Table 3.6 presents a data analysis summary of the 2014 data for each parameter compared to the AEMP benchmark, midpoint and determination of change for Camp Lake Tributary. Individual sample results that were above the AEMP benchmark or midpoint have been identified.

Table 3.6 Camp Lake Tributary - 2014 Water Quality Data Summary

Parameter	Step 1			Step 2	Step 3
	Initial Data Analysis			Determine if Change is Mine-Related	Determine Action Level
	Above AEMP Benchmark	Above Midpoint	Determine if there is a Change		
Total Metals					
Aluminum (B)	L2-03 (fall)	L1-05 L1-09 (spring)	All 2014 data are within the range of the previous data, except L2-03 and L1-09.	Yes	Moderate Action
Arsenic (A)	None	None	No change evident. All samples measured at MDL.	N/A	N/A
Cadmium (A)	None	None	No change evident. All samples measured at MDL.	N/A	N/A
Chromium (B)	None	None	Unknown. A large portion of samples were reported at a high MDL, slightly above the midpoint.	N/A	N/A
Cobalt (A)	None	None	No change evident. All measured at MDL except L2-03.	N/A	N/A
Copper (B)	None	L1-02 (summer)	No change evident. Data consistent with baseline.	N/A	N/A
Iron (B)	L2-03 (fall)	L2-03 (spring/ summer)	No change evident. All 2014 data are within the range of the previous data, except L2-03.	Yes	Moderate Action
Lead (A)	None	None	No change evident. Data consistent with baseline.	N/A	N/A
Nickel (A)	None	None	No change evident. Data consistent with baseline.	N/A	N/A
Silver (A)	None	None	Unknown. All data reported at high MDL.	N/A	N/A
Thallium (A)	None	None	No change evident. Data consistent with baseline.	N/A	N/A
Vanadium (A)	None	None	No change evident. Data consistent with baseline.	N/A	N/A
Zinc (A)	None	None	No change evident. Data consistent with baseline.	N/A	N/A

Parameter	Step 1			Step 2	Step 3
	Initial Data Analysis			Determine if Change is Mine-Related	Determine Action Level
	Above AEMP Benchmark	Above Midpoint	Determine if there is a Change		
Nutrients					
Ammonia (NH_3+NH_4) (A)	None	None	Slightly elevated at L2-03, otherwise data are consistent with baseline.	Yes	Low Action
Nitrite (NO_2) (A)	L2-03 (summer)	None	Slightly elevated at L2-03 and L1-09, otherwise data are consistent with baseline.	Yes	Moderate Action
Nitrate (NO_3) (A)	None	None	No change evident. Data consistent with baseline.	N/A	N/A
Dissolved Anions					
Chloride (Cl) (A)	None	None	No change evident. Data consistent with baseline.	N/A	N/A
Sulphate (A)	None	None	No change evident. Data consistent with baseline.	N/A	N/A

NOTES:

1. THE ORIGIN OF THE AEMP BENCHMARKS ARE IDENTIFIED AS (A) METHOD A = WATER QUALITY GUIDELINE FROM CCME/B.C. MOE; (B) METHOD B = 97.5 PERCENTILE OF BASELINE; OR (C) METHOD C = 3* MDL

Concentrations of the parameters of interest were generally within the range of historic baseline data. The exceptions are discussed below:

Total Aluminum at L1-09 and L2-03, Total Iron at L2-03

Aluminum concentrations at station L1-09 (0.098 mg/L) in spring were slightly above the midpoint concentration of 0.095 mg/L. The adjacent downstream station L1-05 showed a similar elevated concentration (0.105 mg/L) above the midpoint. Aluminum concentrations in the summer and fall were also similar between these stations (0.009 mg/L to 0.010 mg/L), all below the AEMP benchmark. Aluminum concentrations at station L2-03 (0.219 mg/L) in spring were above the benchmark concentration (0.179 mg/L). Station L1-09 and L1-05 are downstream of the L2-03 stream confluence with the main branch of the Camp Lake Tributary.

Total iron concentrations at station L2-03 in the spring (0.245 mg/L) and summer (0.320 mg/L) were above the midpoint value (0.188 mg/L), and fall iron (0.400 mg/L) above the benchmark (0.326 mg/L). Given that a quarry was in operation upstream of these sampling stations, and nitrogen compounds were also elevated at the same stations as well as SNP stations monitoring the quarry (see below), it is expected that total aluminum and total iron exceedances are also mine-related.

Nitrogen Compounds

The general parameters, nutrients and dissolved anion concentrations measured in 2014 were generally within the range of historic baseline data except for nitrite, nitrate and total ammonia.