Photograph 16: Itivia Site, Downstream end of Culverts Through Access Road (22 September 2017)

\\golder.gds\gal\burnaby\final\2016\3 proj\1660296 agnico_provide engineering s_nunavu\1660296-024-r-rev0-3000\appendix d\d1 itivia site appendix.docx

APPENDIX D 2

Itivia By-pass Road Inspection Photographs

Photograph 17: Itivia Bypass Road, Culverts at 0.1 Kilometers from Intersection with AWAR, View of Culverts on Northwest Side of the Road, Looking Northeast (22 September 2017)

Photograph 18: Itivia Bypass Road, Culverts at 0.1 Kilometers from Intersection with AWAR, View of Culverts on Southeast Side of the Road, Looking Southeast (22 September 2017)

Photograph 19: Itivia Bypass Road, Culverts at 0.3 Kilometers from Intersection with AWAR, View of Culverts on Northwest Side of the Road, Looking Southwest (22 September 2017)

Photograph 20: Itivia Bypass Road, Culverts at 0.3 Kilometers from Intersection with AWAR, View of Culverts on Southeast Side of the Road, Looking South (22 September 2017)

Photograph 21: Itivia Bypass Road, Ponded Water on the West Side of the Road, No Culverts (22 September 2017)

Photograph 22: Itivia Bypass Road, Ponded Water on the East Side of the Road, No Culverts (22 September 2017)

Photograph 23: Itivia Bypass Road, Looking South at Road Surface Approaching Culverts at 1.3 Kilometers from Intersection with AWAR (22 September 2017)

Photograph 24: Itivia Bypass Road, Culverts at 1.3 Kilometers from Intersection with AWAR. View of Culverts on West Side of the Road, Looking Northwest (22 September 2017)

Photograph 25: Itivia Bypass Road, Culverts at 1.3 Kilometers from Intersection with AWAR. View of Culverts on East Side of the Road, Looking South (22 September 2017)

Photograph 26: Itivia Bypass Road, View of Road Over Culverts at 1.3 Kilometers from Intersection with AWAR, Looking North (22 September 2017)

Photograph 27: Itivia Bypass Road, Culverts at 1.4 Kilometers from Intersection with AWAR. View of Culverts on West Side of Road, Looking Southwest (22 September 2017)

Photograph 28: Itivia Bypass Road, Culverts at 1.4 Kilometers from Intersection with AWAR. View of Culverts on East Side of Road, Looking Southeast (22 September 2017)

Photograph 29: Itivia Bypass Road, View of Road Over Culverts at 1.4 Kilometers from Intersection with AWAR, Looking South (22 September 2017)

Photograph 30: Itivia Bypass Road, Culverts at 1.45 Kilometers from Intersection with AWAR. View of Culverts on West Side of the Road Looking South (22 September 2017)

Photograph 31: Itivia Bypass Road, Culverts at 1.45 Kilometers from Intersection with AWAR. View of Culverts on West Side of the Road Looking North (22 September 2017)

Photograph 32: Itivia Bypass Road, Culverts at 1.45 Kilometers from Intersection with AWAR. View of Culverts on East Side of the Road Looking North (22 September 2017)

Photograph 33: Itivia Bypass Road, Culverts at 1.5 Kilometers from Intersection with AWAR. View of Culvert on West Side of Road, Looking North (22 September 2017)

Photograph 34: Itivia Bypass Road, Culverts at 1.5 Kilometers from Intersection with AWAR. View of culvert on East Side of Road, Looking South (22 September 2017)

As a global, employee-owned organisation with over 50 years of experience, Golder Associates is driven by our purpose to engineer earth's development while preserving earth's integrity. We deliver solutions that help our clients achieve their sustainable development goals by providing a wide range of independent consulting, design and construction services in our specialist areas of earth, environment and energy.

For more information, visit golder.com

Africa	+ 27 11 254 4800
Asia	+ 86 21 6258 5522
Australasia	+ 61 3 8862 3500
Europe	+ 44 1628 851851
North America	+ 1 800 275 3281
South America	+ 56 2 2616 2000

solutions@golder.com
www.golder.com

Golder Associates Ltd.
Suite 200 - 2920 Virtual Way
Vancouver, BC, V5M 0C4
Canada
T: +1 (604) 296 4200

Golder Associates

Appendix J

Aquatic Effects Monitoring Program – 2017 Annual Report

GOLDER

REPORT

Aquatic Effects Monitoring Program - 2017 Annual Report

Agnico Eagle Mines Limited - Meliadine Gold Project

Submitted to:

Agnico Eagle Mines Limited

Meliadine Project
Rankin Inlet, Nunavut X0C 0G0

Submitted by:

Golder Associates Ltd.

16820 107 Avenue Edmonton, Alberta, T5P 4C3 Canada

+1 780 483 3499

1787610_671_RPT_Rev0

26 March 2018

Distribution List

Electronic Copy - Agnico Eagle Mines Limited

Electronic Copy - Golder Associates Ltd.

Executive Summary

Overview

The Meliadine Gold Mine (Mine) is located in the Kivalliq District of Nunavut near the western shore of Hudson Bay, in Northern Canada, approximately 25 km north of Rankin Inlet. Pre-development works started in 2015 and construction started in fall of 2016.

The Aquatic Effects Monitoring Program (AEMP) is a requirement of the Type A Water Licence (2AM-MEL-1631, Part I, Item 3). The AEMP is structured as a comprehensive monitoring program that incorporates various aquatic components and provides integration between components. The study areas include Meliadine Lake and three peninsula lakes. The core components of the AEMP are water quality, sediment quality, benthic invertebrate community, and fish (fish health and fish tissue chemistry), with a targeted, plankton study. The AEMP was intended to function as an integrated monitoring program, which considers pathways to potential effects of the Mine on the aquatic environment including changes in surface water quality, sediment quality, lower trophic communities, fish habitat, and fish health due to release of mine water, physical alteration of watersheds, and air emissions during construction, operations, and closure are considered in the AEMP.

The overall objective of the AEMP is to assess potential mine related effects on the aquatic ecosystem, meet regulatory requirements outlined in the Type A Water Licence (2AM-MEL-1631), and meet commitments made during the environmental permitting process. There are two distinct programs in the AEMP for the Meliadine Mine: the Meliadine Lake study and the Peninsula Lakes study. The Meliadine Lake study was designed around the key aspects of environmental effects monitoring requirements under the Metal Mining Effluent Regulations. The core components of the Meliadine Lake study are water quality, sediment quality, benthic invertebrate communities, and fish health and fish tissue chemistry. A targeted plankton study was also included to investigate the potential of plankton as a useful monitoring tool to support interpretations of potential mine effects on the aquatic environment. The Peninsula Lakes study was designed to detect potential indirect effects from deposition of aerial emissions or alteration of watersheds. Water quality is the core component of the Peninsula Lakes study, with the intent to add biological studies if the water quality results suggest mine-related changes have occurred.

Data and results presented in this report were collected as per the approved AEMP study design for the Meliadine Mine. This report documents data collected in 2017 (documentation of 2015 and 2016 data were included in the 2016 annual report) with detailed evaluation of all data collected from 2015 to 2017. This is the first interpretative AEMP baseline report for the Meliadine Mine. For water quality, sediment quality, and fish (health and tissue), provisional normal ranges were calculated for ecologically relevant parameters and biological endpoints (e.g., fish weight, fish length). A normal range is the range of data that includes 95% of reference or background data. The normal ranges presented in this report are considered provisional due to limited sample size for some components. The normal ranges, in addition to guidelines and trends in data will be used to evaluate future monitoring data and the potential effect of the Mine on the aquatic community once the Mine enters operations.

Mine Development Updates

The mine plan proposes open pit and underground mining methods for the development of the Tiriganiaq gold deposit, with two open pits (Tiriganiaq Pit 1 and Tiriganiaq Pit 2) and one underground mine.

Pre-construction activities were completed at the Mine in 2015 and 2016, and construction activities were initiated in October 2016. The sewage treatment plant associated with Water Licence 2BB MEL 1424 was operational in 2015, 2016, and 2017. The sewage treatment plant and effluent discharge associated with the Type A Water Licence (2AM MEL 1631) became operational as of 2017. Water management related activities that occurred in 2017 included completion of dikes around CP1 (the final water management pond on site) and CP5, construction of berms to direct water to CP1, construction and installation of the effluent pipeline and diffuser to Meliadine Lake, and evaporation of water from the P-area. Discharge of water from CP1 through the diffuser was planned for September to October 2017, but did not occur.

Water Quality

Water quality sampling was conducted in 2015, 2016, and 2017 from Meliadine Lake and from three peninsula lakes. For 2017, water quality sampling was conducted in Meliadine Lake during open water conditions (July, August, and September) and during ice covered conditions (January and February) from up to 25 stations across five sampling areas. The three peninsula lakes were sampled during open water conditions (July and August) from three stations per lake. Similar data collection occurred in 2015 and 2016.

Overall, water quality in Meliadine Lake in 2017 was similar to water quality in 2015 and 2016 (baseline conditions prior to construction). Water quality in Meliadine Lake is characterized as consistent in temperature through the water column, well oxygenated, neutral to alkaline, clear water, low specific conductivity, soft water, oligotrophic (very low in nutrients), and very low in metals.

Water quality data were analyzed to determine if there are differences between the Near-field exposure area, the Mid-field exposure area, and the pooled reference areas of Meliadine Lake. Many water quality parameters were different in the Near-field as compared to the Mid-field and the reference areas for open-water conditions, and in the Near-field as compared to the Mid-field area for ice-covered conditions. Concentrations of major ions (e.g., chloride), nutrients (e.g., phosphorus), and metals (e.g., arsenic and nickel) were higher in the Near-field as compared to other areas. It is noted that the differences were small and statistically significant, but not ecologically relevant as concentrations were orders of magnitude lower than water quality guidelines.

Overall, water quality in the peninsula lakes in 2017 was similar to water quality in 2015 and 2016 (baseline conditions prior to construction). Water quality in the peninsula lakes is characterized as consistent water temperature through the water column, well oxygenated (with some exceptions in late spring), neutral to alkaline, oligotrophic to mesotrophic (low to moderate nutrients), generally higher concentrations of water quality constituents as compared to Meliadine Lake, but, generally at concentrations less than the water quality guidelines.

The peninsula lakes were sampled for chlorophyll *a* during open-water conditions (July and August; 2015 to 2017); these lakes were not sampled for phytoplankton and zooplankton biomass and diversity. In general, chlorophyll *a* varied among lakes, months, and years, but typically concentrations were higher in August as compared to July.

Provisional normal ranges for ecologically relevant water quality parameters (i.e., parameters that have the potential for chronic or acute toxicity effects when elevated above a certain concentration) were calculated for Meliadine Lake (separately for ice-covered and open-water conditions) and for peninsula lakes (open-water conditions).

Sediment Quality

Sediment quality sampling was conducted in Meliadine Lake in August of 2015 and 2016; there was no new sediment sample collection in 2017. In 2015, sediments were collected from the Near-field and Mid-field areas in Meliadine Lake; in 2016, sediments were collected from the Near-field and Mid-field, and three reference areas in Meliadine Lake. Sediments were analyzed for particle size, organic carbon, and metals. Concentrations of arsenic, chromium, and copper exceeds the Canadian sediment quality guidelines for more than half of the samples. Specifically, arsenic concentrations exceeded the ISQG and PEL in 77% and 40%, respectively, of the samples, and exceeded the ISQG for chromium and copper in 51% and 71%, respectively, of the samples.

Data analysis revealed that the reference areas had significantly more sand and the Near-field area had significantly more silt. As proportion of fine sediment in a sample can influence the total concentration of metals, the sediment chemistry data were normalized to the percent of fines before evaluation of statistical comparisons of areas of Meliadine Lake, and calculation of normal ranges for Meliadine Lake.

Arsenic, iron and mercury concentrations were higher in the Near-field area compared to the reference area, whereas total organic carbon, calcium, strontium and sulphur were higher in the reference area compared to Near-field area.

Normal ranges for Meliadine Lake were calculated for sediment quality parameters after normalization to percent fines. The complete dataset was used to calculate the normal ranges, because discharge of treated mine effluent to Meliadine Lake has not occurred.

Benthic Invertebrate Community

Benthic invertebrates (i.e., small animals with no backbones) live within sediments, or on the sediment surface, for all or part of their life cycles, and are an integral part of Arctic ecosystem food webs. Benthic invertebrate community (BIC) sampling was conducted in Meliadine Lake in August of 2015 (Near-field and Mid-field areas) and 2016 (Near-field, Mid-field, and three Reference Areas); BIC samples were not collected in 2017. This report provides an interpretation of benthic invertebrate community data collected during baseline conditions before the effluent discharge associated with the Type A Water Licence to the Near-field area of Meliadine Lake.

Low total density and richness characterized the exposure and reference area invertebrate communities. Invertebrate communities were dominated by midges and fingernail clams and were diverse. Spatial and temporal differences in community structure among areas were attributed to a combination of (1) habitat (i.e., substrate type) variation among sampling areas, (2) potential differences in water quality, and (3) among-year biological variability.

Based on 2016 data, the benthic invertebrate community in the Near-field area was significantly different from reference area communities in terms of total density and Bray-Curtis distance calculated using the environmental effects monitoring (EEM) method. Further evidence of differences among sampling areas was evident in multivariate analysis results, which showed that the Near-field area community was dissimilar from the reference area and Mid-field area communities. In addition, there were differences among the reference areas. Invertebrate density and diversity were higher in Reference Area 1 compared to Reference Areas 2 and 3. Reference area 1 appears to be closest to the Near-field area in terms of benthic invertebrate community structure.

Based on the variability in the dataset (i.e., year-to-year variability in the Near-field and Mid-field areas, and variability among reference areas) and possible confounding influences, normal ranges for BIC endpoints were not calculated. Additional sampling may be required to refine reference area locations and evaluate existing differences in water quality among sampling areas.

Fish Health and Fish Tissue

A fish health and tissue chemistry program was conducted in Meliadine Lake in 2015 (Near-field exposure area) and 2017 (two reference areas); a fish program was not conducted in the peninsula lakes. This report describes data collection in 2017 and provides a comparison of the 2015 and 2017 datasets. Threespine Stickleback were collected from the Near-field area and reference areas of Meliadine Lake, and Lake Trout was collected from the Near-field area.

Threespine Stickleback from the Near-field area were larger than those collected from the two reference areas. Provisional normal ranges were calculated using baseline data from each of the sampling areas. Fish health parameters for male Threespine Stickleback sampled from the Near-field area exceeded provisional normal ranges for length, body weight, carcass weight, and condition factor in fish from the Near-field area.

Threespine Stickleback from the Near-field and reference areas were analyzed for tissue chemistry. Concentrations of arsenic and tin in fish from the Near-field area were higher than the provisional normal range, but concentrations of chromium, iron, molybdenum, nickel, rubidium, and selenium in fish from the Near-field area were lower than the provisional normal range.

The Near-field sampling program was conducted in 2015 and the reference area sampling program was conducted in 2017. As the Near-field and reference areas were sampled in separate years, it could not be determined from the baseline data whether differences in fish health and fish tissue endpoints between the Near-field and reference areas resulted from geographic or interannual variation. During future AEMP sampling, the Near-field and reference areas will be sampled in the same year and at the same time, thus controlling the temporal factor.

The majority of Threespine Stickleback captured were infected by a tapeworm that competes with the host for available resources and decreases the energy allocated to storage and spawning. This represents a confounding factor that needs to be considered in the design and interpretation of future fish health and fish tissue monitoring programs.

Based on these data, Threespine Stickleback were confirmed to be a suitable sentinel species for the Meliadine Gold Project AEMP.

Plankton

Plankton monitoring was conducted as a targeted study to characterize baseline conditions for the plankton community in Meliadine Lake and to evaluate the usefulness of plankton as a potential long-term monitoring tool.

Plankton sampling (including phytoplankton, zooplankton, chlorophyll *a*, and depth integrated nutrients) was conducted in Meliadine Lake during open water conditions (July, August, and September) in 2015, 2016, and 2017. Results from the targeted study show that there is spatial and seasonal variability observed in the majority of plankton endpoints (e.g., density, species diversity). However, the use of phytoplankton communities and chlorophyll *a* are expected to be the most useful monitoring tools to be carried forward to provide an integrated measure of biological effects.

In Meliadine Lake, variability among years in the phytoplankton community was generally high in July and September, but low in August. In August, abundance and biomass were higher in the Near-field area compared to the Mid-field and reference areas. The current dataset shows a reasonable correlation between phytoplankton biomass and chlorophyll *a* with a moderate amount of variability between the two measurements suggesting that chlorophyll *a* may be a potentially useful indicator of phytoplankton biomass in Meliadine Lake. Concurrent sampling of chlorophyll *a* and phytoplankton biomass will further refine the relationship.

Among-year variability in the zooplankton community sampled in each area was high. Consistent spatial trends in zooplankton abundance or biomass could not be discerned due to the high temporal and seasonal variability. Inherent variability in the zooplankton community may limit the usefulness of zooplankton community endpoints for long-term monitoring.

The targeted study provided useful information to characterize plankton communities in Meliadine Lake and to inform selection of monitoring tools that could be incorporated into the AEMP.

Conclusions

The report provides interpretation and summary of the core components of the Meliadine Lake study and the Peninsula Lakes study for data collected from 2015 to 2017, and interpretation and summary of the targeted plankton study. Results from this study will be used to update the benchmarks and response framework in the AEMP design plan.

As per the AEMP design plan, water quality monitoring in Meliadine Lake and the peninsula lakes is an annual program, while monitoring for sediment quality, BIC, and fish health and fish tissue moves to the EEM schedule after baseline data have been collected and once the mine triggers under Metal Mining Effluent Regulations (MMER). Meliadine Mine triggered under the MMER in 2016 after dewatering of Lake H17. The Cycle 1 study design was submitted in August 2017 and will be completed in 2018.

Acknowledgements

Golder would like to acknowledge the support of Agnico Eagle (Jamie Quesnel, Jeffrey Pratt, and Jessica Huza) during the execution of the program and preparation of this report. During field programs, Agnico Eagle provided on the ground logistic support, provision of workspace, and provision of field personal. In particular, Golder would like to recognize field and logistical support from Agnico Eagle (Alexandre Gauthier, Louis Ulayok, Tara Kringayark, Justin MacMillan, Philip Roy, Randy Schwandt, and Nicholas Blackburn) and Golder (Jarett Nevill, Jamie Weir, Amy Wiebe).

The following people contributed to this report as primary authors or senior reviewers:

- Jessica Huza (Agnico Eagle. Mine Description and Summary)
- Zenovia Craciunescu, M.Eng. (Golder. Water Quality)
- Eduardo Richard, M.Sc. (Golder. Sediment Quality)
- Jill LaPorte, B.Sc. (Golder. Benthic Invertebrate Community)
- Bryce Pippy, M.Sc. (Golder. Benthic Invertebrate Community)
- Elaine Irving, Ph.D., R.P.Bio., P.Biol. (Golder. Benthic Invertebrate Community)
- Collin Arens, Ph.D. (Golder. Fish Health and Fish Tissue)
- Rainie Sharpe, M.Sc., Ph.D. (Golder. Senior technical review of Fish Health and Fish Tissue)
- John Sherrin, M.Sc. (Golder. Plankton)
- Suzanne Earle, M.Sc., R.P.Bio (Golder. Plankton)
- Zsolt Kovats, M.Sc. (Golder. Senior technical review of Benthic Invertebrate Community and Plankton)
- Jarett Nevill, B.Sc. (Golder. Overall technical coordination)
- Colleen Prather, Ph.D., P.Biol. (Golder. Overall document review, senior technical review of Water and Sediment Quality)
- Lasha Young, M.Sc.F., PMP (Golder. Senior Review)

Table of Contents

EXECUTIVE SUMMARY i

1.0 INTRODUCTION 1

1.1 Background 1

1.2 Objectives 4

1.3 Report Structure 4

2.0 PROJECT OVERVIEW 5

2.1 Environmental Setting 5

2.2 Mine Description and Summary of Activities from 2015 - 2017 5

2.3 Interactions with the Aquatic Environment 7

3.0 WATER QUALITY 8

3.1 Methods 8

3.1.1 Field Measurements 8

3.1.2 Guideline Analysis 12

3.1.3 Statistical Analyses 15

3.1.4 Normal Range Calculations 16

3.2 Quality Assurance and Quality Control 17

3.2.1 Results 17

3.3 Results and Discussion 18

3.3.1 Meliadine Lake 18

3.3.1.1 Field Measured Physico-chemical Parameters 18

3.3.1.2 Water Chemistry 20

3.3.2 Peninsula Lakes 28

3.3.2.1 Field Measured Physico-chemical Parameters 28

3.3.2.2 Water Chemistry 29

3.3.2.3 Chlorophyll a 33

3.4 Normal Ranges 34

3.4.1 Meliadine Lake 34

3.4.2 Peninsula Lakes 36

4.0 SEDIMENT QUALITY 39

4.1 Methods 39

4.1.1 Sediment Sample Collection 39

4.1.2 Guidelines and Analysis 42

4.1.3 Statistical Analyses 42

4.1.4 Normal Range Calculations 43

4.2 Quality Assurance and Quality Control 44

4.3 Results and Discussion 44

4.3.1 Comparison to Guidelines and Descriptive Statistics 44

4.3.2 Between Area Comparison 54

4.3.3 Normal Range 58

5.0 BENTHIC INVERTEBRATE COMMUNITY 60

5.1 Methods 61

5.1.1 Study Design Overview 61

5.1.2 Field Methods 62

5.1.3 Laboratory Methods 63

5.1.3.1 Benthic Invertebrate Sample Sorting, Enumeration, and Identification 63

5.1.4 Data Analysis 63

5.1.4.1 Selection of Benthic Invertebrate Summary Variables 64

5.1.4.2 Evaluation of the Effects of Habitat Variation 67

5.1.4.3 Characterization of Within Station Variability in Benthic Community Variables 67

5.1.4.4 Statistical Analysis 67

5.1.4.4.1 Approach 67

5.1.4.4.2 Testing Assumptions of Analysis of Variance 68

5.1.4.4.3 Analysis of Variance (ANOVA) and Multiple Comparisons 68

5.1.4.4.4 Kruskal-Wallis Test and Multiple Comparisons 69

5.1.4.4.5 Multivariate Analysis 69

5.2 Quality Assurance and Quality Control 69

5.3 Results and Discussion 70

5.3.1 Supporting Habitat Variables 70

5.3.2 Benthic Invertebrate Community 72
5.3.2.1 Total Density and Total Richness 76
5.3.2.2 Simpson's Diversity and Evenness Indices 78
5.3.2.3 Bray-Curtis Index 80
5.3.2.4 Community Composition 82
5.3.2.5 Multivariate Analysis 85
5.3.3 Effects of Habitat Variation on the Benthic Invertebrate Community 86
5.3.4 Characterization of Within-Station Variability 92
5.3.5 Overview 94

6.0 FISH HEALTH AND FISH TISSUE 97

6.1 Methods 97
6.1.1 Field Methods 98
6.1.2 Population Survey 102
6.1.3 Lethal Surveys 102
6.1.3.1 Histology 102
6.1.3.2 Fecundity 102
6.1.3.3 Tissue Chemistry 104
6.1.4 Data Analysis 106
6.1.5 Descriptive Statistics 107
6.1.6 Inferential Statistics 108
6.1.7 Power Analysis 110
6.1.8 Normal Range Calculations 110
6.2 Quality Assurance and Quality Control 111
6.3 Results and Discussion 112
6.3.1 Catch Data Summaries 112
6.3.2 Population Survey 114
6.3.2.1 Length-Frequency 115
6.3.2.2 Size 119
6.3.2.3 Condition 119
6.3.3 Lethal Survey 120

6.3.3.1 Length-Frequency 124
6.3.3.2 Age 124
6.3.3.3 Size-at-Age 125
6.3.3.4 Size 125
6.3.3.5 Size-at-Maturity 126
6.3.3.6 Gonad Weight 126
6.3.3.7 Fecundity 127
6.3.3.8 Condition 128
6.3.3.9 Liver Weight 129
6.3.3.10 Pathology 130
6.3.3.11 Parasites 131
6.3.4 Fish Tissue Chemistry 132
6.3.4.1 Comparison to Guidelines 135
6.4 Normal Ranges 135
7.0 PLANKTON TARGETED STUDY 140
7.1 Methods 140
7.1.1 Field Methods 142
7.1.1.1 Supporting Environmental Variables, Nutrients, and Chlorophyll a 142
7.1.1.2 Phytoplankton Collection 143
7.1.1.3 Zooplankton Collection 143
7.1.2 Laboratory Methods 143
7.1.3 Data Analysis 144
7.1.3.1 Depth-Integrated Samples 144
7.1.3.2 Trophic Status 144
7.1.3.3 Phytoplankton and Zooplankton 146
7.1.3.4 Spatial and Temporal Trends 147
7.1.3.5 Statistical Analysis 147
7.2 Quality Assurance and Quality Control 148
7.3 Results and Discussion 150
7.3.1 Depth-Integrated Nutrients and Chlorophyll *a* 150
7.3.1.1 Statistical Comparisons of Nutrients and Chlorophyll a 155

7.3.1.2 Evaluation of Variability of Nutrients in Near-field Area Relative to Phytoplankton Biomass and Chlorophyll a 158

7.3.2 Trophic Status Classification 159

7.3.3 Phytoplankton 159

7.3.3.1 Abundance 160

7.3.3.2 Biomass 162

7.3.3.3 Community Composition by Abundance 164

7.3.3.4 Community Composition by Biomass 166

7.3.3.5 Species Richness 168

7.3.3.6 Statistical Comparisons of Phytoplankton Community Variables 170

7.3.3.7 Multivariate Analysis 173

7.3.3.8 Relationship Between Phytoplankton Biomass and Chlorophyll a 175

7.3.4 Zooplankton 176

7.3.4.1 Abundance 176

7.3.4.2 Biomass 178

7.3.4.3 Community Composition as Abundance 180

7.3.4.4 Community Composition as Biomass 182

7.3.4.5 Species Richness 185

7.3.4.6 Statistical Comparisons of Zooplankton Community Variables 187

7.3.4.7 Multivariate Analyses 190

7.3.5 Utility of Plankton as a Monitoring Tool 192

7.3.6 Key Findings from Plankton Monitoring Program 192

8.0 CONCLUSIONS 194

8.1 Summary 194

8.1.1 Water Quality 194

8.1.2 Sediment Quality 195

8.1.3 Benthic Invertebrate Community 195

8.1.4 Fish Health and Fish Tissue 196

8.1.5 Plankton 200

8.2 2018 Monitoring Plan 201

9.0 CLOSURE 202

REFERENCES **203**

GLOSSARY **208**

ABBREVIATIONS AND ACRONYMS **212**

UNITS OF MEASURE **219**

TABLES

Table 3.1-1: Water Quality Sampling Stations and Sampling Effort Summary in 2017 9

Table 3.3-1: Median Concentrations (2015 to 2017) of Selected Field-Measured Parameters, Meliadine Lake 19

Table 3.3-2: Statistical Test Summary for Selected Field-Measured Parameters, Meliadine Lake 19

Table 3.3-3: Median Concentrations (2015 to 2017) of Selected Conventional Parameters, Meliadine Lake 21

Table 3.3-4: Statistical Test Summary for Selected Conventional Parameters, Meliadine Lake 21

Table 3.3-5: Median Concentrations (2015 to 2017) of Major Ions, Meliadine Lake 22

Table 3.3-6: Statistical Test Summary for Selected Major Ions, Meliadine Lake 23

Table 3.3-7: Median Concentrations (2015 to 2017) of Nutrient Parameters, Meliadine Lake 24

Table 3.3-8: Statistical Test Summary for Selected Nutrient Parameters, Meliadine Lake 25

Table 3.3-9: Median Concentrations (2015 to 2017) of Total Metals Parameters, Meliadine Lake 26

Table 3.3-10: Statistical Test Summary for Selected Total Metals, Meliadine Lake 27

Table 3.3-11: Median Concentrations (2015 to 2017) of Selected Field-Measured Parameters, Peninsula Lakes 28

Table 3.3-12: Median Concentrations (2015 to 2017) of Selected Conventional Parameters, Peninsula Lakes 29

Table 3.3-13: Median Concentrations (2015 to 2017) of Selected Major Ions, Peninsula Lakes 30

Table 3.3-14: Median Concentrations (2015 to 2017) of Selected Nutrients Parameters, Peninsula Lakes 31

Table 3.3-15: Median Concentrations (2015 to 2017) of Selected Total Metals, Peninsula Lakes 32

Table 3.4-1: Normal Ranges (2015 to 2017) for Selected Parameters, Meliadine Lake 34

Table 3.4-2: Normal Ranges (2015 to 2017) for Peninsula Lakes 37

Table 4.1-1: Sediment Quality Sampling Stations and Sampling Effort Summary, 2015 and 2016 41

Table 4.1-2: Sediment Quality Guidelines 42

Table 4.3-1: Meliadine Lake Near-field (MEL-01) – Sediment Quality Summary, 2015 to 2016 47

Table 4.3-2: Meliadine Lake Mid-field (MEL-02) – Sediment Quality Summary, 2015 to 2016 49

Table 4.3-3: Meliadine Lake Reference Areas (MEL-03, MEL-04. MEL-05) – Sediment Quality, 2016 51

Table 4.3-4: Linear regression of Sediment Quality parameters to fine grained sediments in Meliadine Lake 54

Table 4.3-5: Pairwise Comparisons for Statistical Analyses of Sediment Quality parameters comparing areas within Meliadine Lake 57

Table 4.3-6: Normal ranges for Sediment Quality Parameters in Meliadine Lake 59

Table 5.1-1: AEMP Baseline Benthic Invertebrate Sampling Program Summary, 2015 and 2016 61

Table 5.3-1: Summary of Mean Habitat Variables for Meliadine Lake, August 2015 and 2016 71

Table 5.3-2: Results of Analysis of Variance for Benthic Invertebrate Community Variables Comparing Near-field and Mid-field Areas to Reference Areas in Meliadine Lake, August 2016 72

Table 5.3-3: Results of Analysis of Variance for Benthic Invertebrate Community Variables Comparing Reference Areas in Meliadine Lake, August 2016 74

Table 5.3-4: Results of Analysis of Variance and Pairwise Comparison with Tukey's HSD of Benthic Invertebrate Community Variables in Meliadine Lake, August 2016 75

Table 5.3-5: Benthic Invertebrate Community ANOSIM Results, 2016 85

Table 5.3-6: Critical Values for Spearman Correlations on Benthic Invertebrate Community Variables 88

Table 5.3-7: Spearman Rank Correlations between Benthic Invertebrate Community Variables and Selected Habitat Variables for Meliadine Lake, August 2015 and 2016 89

Table 5.3-8: Within-Station Variation in Benthic Community Variables in Meliadine Lake, 2016 92

Table 6.1-1: Sampling Dates for Threespine Stickleback Baseline Collections from Meliadine Lake, 2015 and 2017 98

Table 6.1-2: Gonad Maturity Stages Used During the Meliadine Lake Fish Health Assessment, August 2017 103

Table 6.1-3: Analytical Detection Limits for Tissue Samples Processed Using Low Volume Analysis 104

Table 6.1-4: Statistical Procedures Used in the Population Survey 106

Table 6.1-5: Statistical Procedures Used in the Lethal Survey 107

Table 6.3-1: Species Richness and Abundance of Fish Captured at Meliadine Lake, 2015 and 2017 112

Table 6.3-2: Catch-Per-Unit Effort for Fish Captured from Meliadine Lake, 2015 and 2017 113

Table 6.3-3: Sample Sizes for the Meliadine Lake Population Survey, 2015 and 2017 114

Table 6.3-4: Descriptive Statistics for Threespine Stickleback Collected from Meliadine Lake, 2015 and 2017 116

Table 6.3-5: Statistical Comparison of Fish Population Survey Parameters among Meliadine Lake Sampling Areas, 2015 and 2017 116

Table 6.3-6: Sample Sizes for the Meliadine Lake Lethal Survey, 2015 and 2017 120

Table 6.3-7: Descriptive Statistics for Threespine Stickleback Lethally Sampled from Meliadine Lake, 2015 and 2017 121

Table 6.3-8: Statistical Comparison of Lethal Survey Parameters Measured in Threespine Stickleback Sampled from Meliadine Lake, 2015 and 2017 122

Table 6.3-9: Statistical Comparison of Lethal Survey Parameters Measured in Threespine Stickleback Sampled from Meliadine Lake Excluding Fish Parasitized by Tapeworms, 2015 and 2017 123

Table 6.3-10: Number of Lethally Sampled Threespine Stickleback Observed with External and Internal Abnormalities, 2015 and 2017 131

Table 6.3-11: Relative Mesenteric Fat Content of Threespine Stickleback, 2015 and 2017 131

Table 6.3-12: Number of Threespine Stickleback Observed with External and Internal Parasites, 2015 and 2017... 132

Table 6.3-13: Descriptive Statistics for Threespine Stickleback Fish Tissue Chemistry for Carcass Samples Collected from Meliadine Lake, 2015 and 2017.. 133

Table 6.3-14: Statistical Comparison of Fish Tissue Chemistry Parameters Measured in Threespine Stickleback Carcass Samples from Meliadine Lake, 2015 and 2017 134

Table 6.4-1: Normal Ranges for Threespine Stickleback and Lake Trout Fish Health Parameters 135

Table 6.4-2: Normal Ranges for Threespine Stickleback Metal Concentrations in Carcass Tissue.................... 136

Table 6.4-3: Normal Ranges for Lake Trout Metal Concentrations in Muscle Tissue... 137

Table 6.4-4: Normal Ranges for Lake Trout Metal Concentrations in Liver Tissue 138

Table 6.4-5: Normal Ranges for Lake Trout Metal Concentrations in Kidney Tissue 139

Table 7.1-1: Plankton Sampling Stations and Sampling Summary in Meliadine Lake 141

Table 7.1-2: General Trophic Classification of Lakes 145

Table 7.1-3: Trophic Classification of Canadian Lakes Based on Total Phosphorus Trigger Ranges........... 145

Table 7.1-4: Comparison of Trophic State Index Classification and General Trophic Classification of Lakes 146

Table 7.3-1: Results of Statistical Analysis for Nutrients and Chlorophyll a Comparing Years 155

Table 7.3-2: Pairwise Comparisons for Statistical Analyses of Nutrients and Chlorophyll *a* Comparing Years .. 156

Table 7.3-3: Results of Statistical Analysis and Pairwise Comparisons for Nutrients and Chlorophyll *a* Comparing Areas, August 2016-2017... 157

Table 7.3-4: Results of Statistical Analysis for Phytoplankton Community Variables Comparing Years............ 170

Table 7.3-5: Pairwise Comparisons for Statistical Analyses of Phytoplankton Community Variables Comparing Years 171

Table 7.3-6: Results of Statistical Analysis for Phytoplankton Community Variables Comparing Areas, August 2016-2017 172

Table 7.3-7: Results of Statistical Analyses for Zooplankton Community Variables Comparing Years............... 187

Table 7.3-8: Pairwise Comparisons for Statistical Analyses of Zooplankton Community Variables Comparing Year 188

Table 7.3-9: Results of Statistical Analyses for Zooplankton Community Variables Comparing Areas............... 189

Table 8.1-1: Summary of Statistically Significant Differences in Threespine Stickleback Fish Health Endpoints Collected During the Population Survey, 2015 and 2017 197

Table 8.1-2: Summary of Statistically Significant Differences in Threespine Stickleback Fish Health Endpoints Sampled During the Lethal Survey, 2015 and 2017 198

Table 8.1-3: Summary of Statistically Significant Differences in Threespine Stickleback Fish Tissue Chemistry Endpoints for Fish Sampled During the Lethal Survey, 2015 and 2017.............................. 199

FIGURES

Figure 1.1-1: Location of the Meliadine Mine 2

Figure 1.1-2: Study Area for the Meliadine Aquatic Effects Monitoring Program 3

Figure 3.3-1: Mean Chlorophyll a Concentrations in the Peninsula Lakes, 2015 – 2017 33

Figure 4.3-1: Silt content in Sediment Samples from Meliadine Lake 45

Figure 4.3-2: Arsenic in Sediment Samples from Meliadine Lake 53

Figure 4.3-3: Chromium in Sediment Samples from Meliadine Lake 53

Figure 4.3-4: Copper in Sediment Samples from Meliadine Lake 54

Figure 5.3-1: Sediment Particle Size Comparison for Meliadine Lake, August 2015 and 2016 72

Figure 5.3-2: Mean (± SE) Total Benthic Invertebrate Density and Richness in Meliadine Lake, August 2015 and 2016 77

Figure 5.3-3: Mean (± SE) Simpson’s Diversity and Evenness Indices for the Benthic Invertebrate Community Collected for Meliadine Lake, August 2015 and 2016 79

Figure 5.3-4: Mean (± SE) Bray-Curtis Index Values for the Benthic Invertebrate Community in Meliadine Lake, August 2015 and 2016 81

Figure 5.3-5: Relative Densities of Major Benthic Invertebrate Groups in Meliadine Lake (Exposure Areas), August 2015 and 2016 83

Figure 5.3-6: Relative Densities of Major Benthic Invertebrate Groups in Meliadine Lake, August 2016 84

Figure 5.3-7: Ordination Plot of the Benthic Invertebrate Community for Meliadine Lake, August 2016 85

Figure 5.3-8: Scatter-Plots of Benthic Habitat Variables, Sediment Arsenic, and Total Nitrogen in water, versus Benthic Invertebrate Community Variables, August 2015 and 2016 91

Figure 5.3-9: Within-station Variability for Abundance and Richness in Meliadine Lake, August 2016 94

Figure 6.1-1: Meliadine Lake Fish Health Sampling Locations – Near-field Area 99

Figure 6.1-2: Meliadine Lake Fish Health Sampling Locations – Reference Area 1 100

Figure 6.1-3: Meliadine Lake Fish Health Sampling Locations – Reference Area 2 101

Figure 6.3-1: Total Length of Threespine Stickleback Captured From Meliadine Lake, 2015 and 2017 114

Figure 6.3-2: Cumulative Length-Frequency Distribution of Threespine Stickleback Collected from Meliadine Lake, 2015 and 2017 117

Figure 6.3-3: Length-Frequency Distributions for Threespine Stickleback Collected from Meliadine Lake, 2015 and 2017 118

Figure 6.3-4: Length and Weight Threespine Stickleback Measured from Meliadine Lake during the Population Survey, 2015 and 2017 119

Figure 6.3-5: Condition Factor of Threespine Stickleback Collected During the Population Survey from Meliadine Lake, 2015 and 2017 120

Figure 6.3-6: Cumulative Length-Frequency Distribution of Female and Male Threespine Stickleback Lethally Sampled from Meliadine Lake, 2015 and 2017 124

Figure 6.3-7: Length and Weight of Female and Male Threespine Stickleback Lethally Sampled From Meliadine Lake, 2015 and 2017 125

Figure 6.3-8: Size-at-Maturity of Threespine Stickleback With and Without Parasites 126

Figure 6.3-9: Gonadosomatic Index (log_{10}) of Female and Male Threespine Stickleback Lethally Sampled from Meliadine Lake, 2015 and 2017 127

Figure 6.3-10: Fecundity and Egg Weight (log_{10}) for Threespine Stickleback Sampled from Meliadine Lake, 2015 and 2017 128

Figure 6.3-11: Condition Factor for Female and Male Threespine Stickleback Lethally Sampled from Meliadine Lake, 2015 and 2017 129

Figure 6.3-12: Liver Somatic Index of Female and Male Threespine Stickleback Lethally Sampled from Meliadine Lake, 2015 and 2017 130

Figure 7.3-1: Mean Total Nitrogen Concentrations in Meliadine Lake, 2015 - 2017 152

Figure 7.3-2: Mean Total Phosphorus Concentrations in Meliadine Lake, 2015 – 2017 153

Figure 7.3-3: Mean Chlorophyll *a* Concentrations in Meliadine Lake, 2015 – 2017 154

Figure 7.3-4: Nutrients versus Phytoplankton Biomass and Chlorophyll *a* Concentration at MEL-01, 2015 – 2017 158

Figure 7.3-5: Total Phytoplankton Abundance in Meliadine Lake, 2015-2017 161

Figure 7.3-6: Total Phytoplankton Biomass in Meliadine Lake, 2015-2017 163

Figure 7.3-7: Relative Abundance of Major Phytoplankton Groups in July, Meliadine Lake, 2015-2017 165

Figure 7.3-8: Relative Abundance of Major Phytoplankton Groups in August, Meliadine Lake, 2015-2017 165

Figure 7.3-9: Relative Abundance of Major Phytoplankton Groups in September, Meliadine Lake, 2015-2017 166

Figure 7.3-10: Relative Biomass of Major Phytoplankton Groups in July, Meliadine Lake, 2015-2017 167

Figure 7.3-11: Relative Biomass of Major Phytoplankton Groups in August, Meliadine Lake, 2015-2017 167

Figure 7.3-12: Relative Biomass of Major Phytoplankton Groups in September, Meliadine Lake, 2015-2017 168

Figure 7.3-13: Total Phytoplankton Species Richness in Meliadine Lake, 2015-2017 169

Figure 7.3-14: Ordination Plot of August Phytoplankton Biomass in Meliadine Lake in 2016 174

Figure 7.3-15: Ordination Plot of August Phytoplankton Biomass in Meliadine Lake in 2017 174

Figure 7.3-16: Chlorophyll a vs. Phytoplankton Biomass in Meliadine Lake, 2016-2017 175

Figure 7.3-17: Total Zooplankton Abundance in Meliadine Lake, 2015-2017 177

Figure 7.3-18: Total Zooplankton Biomass in Meliadine Lake, 2015-2017 179

Figure 7.3-19: Relative Abundance of Major Zooplankton Groups in July, Meliadine Lake, 2015-2017 181

Figure 7.3-20: Relative Abundance of Major Zooplankton Groups in August, Meliadine Lake, 2015-2017 181

Figure 7.3-21: Relative Abundance of Major Zooplankton Groups in September, Meliadine Lake, 2015-2017 182

Figure 7.3-22: Relative Biomass of Major Zooplankton Groups in July, Meliadine Lake, 2015-2017 183

Figure 7.3-23: Relative Biomass of Major Zooplankton Groups in August, Meliadine Lake, 2015.................184
Figure 7.3-24: Relative Biomass of Major Zooplankton Groups in September, Meliadine Lake, 2015-2017 184
Figure 7.3-25: Zooplankton Species Richness in Meliadine Lake, 2015-2017 186
Figure 7.3-26: Ordination Plot of August Zooplankton Biomass in Meliadine Lake in 2016 191
Figure 7.3-27: Ordination Plot of August Zooplankton Biomass in Meliadine Lake in 2016 191

APPENDICES

Appendix 2A: Meliadine Mine Layout

Appendix 3A: 2017 Quality assurance and Quality Control

Appendix 3B: 2017 Field Water Profile Measurements

Appendix 3C: 2017 Water Quality Data Summaries

Appendix 3D: Water Quality Statistical Summaries (2015 to 2017 period)

Appendix 3E: Time Series Plots (2015 to 2017 period)

Appendix 3F: Statistical Tests Results

Appendix 5A: Benthic Invertebrate Data

Appendix 5B: Benthic Invertebrate Figures

Appendix 6A: Fishing Effort

Appendix 6B: Fish Health Data

Appendix 6C: Fish Health Boxplots

Appendix 6D: Fish Tissue Data

Appendix 6E: Fish Tissue Boxplots

Appendix 7A: 2017 Plankton Quality Assurance/Quality Control

Appendix 7B: Depth Integrated Nutrients and Chlorophyll a Tables

Appendix 7C: Trophic Status

Appendix 7D: Phytoplankton Community Results

Appendix 7E: Zooplankton Community Results

1.0 INTRODUCTION

1.1 Background

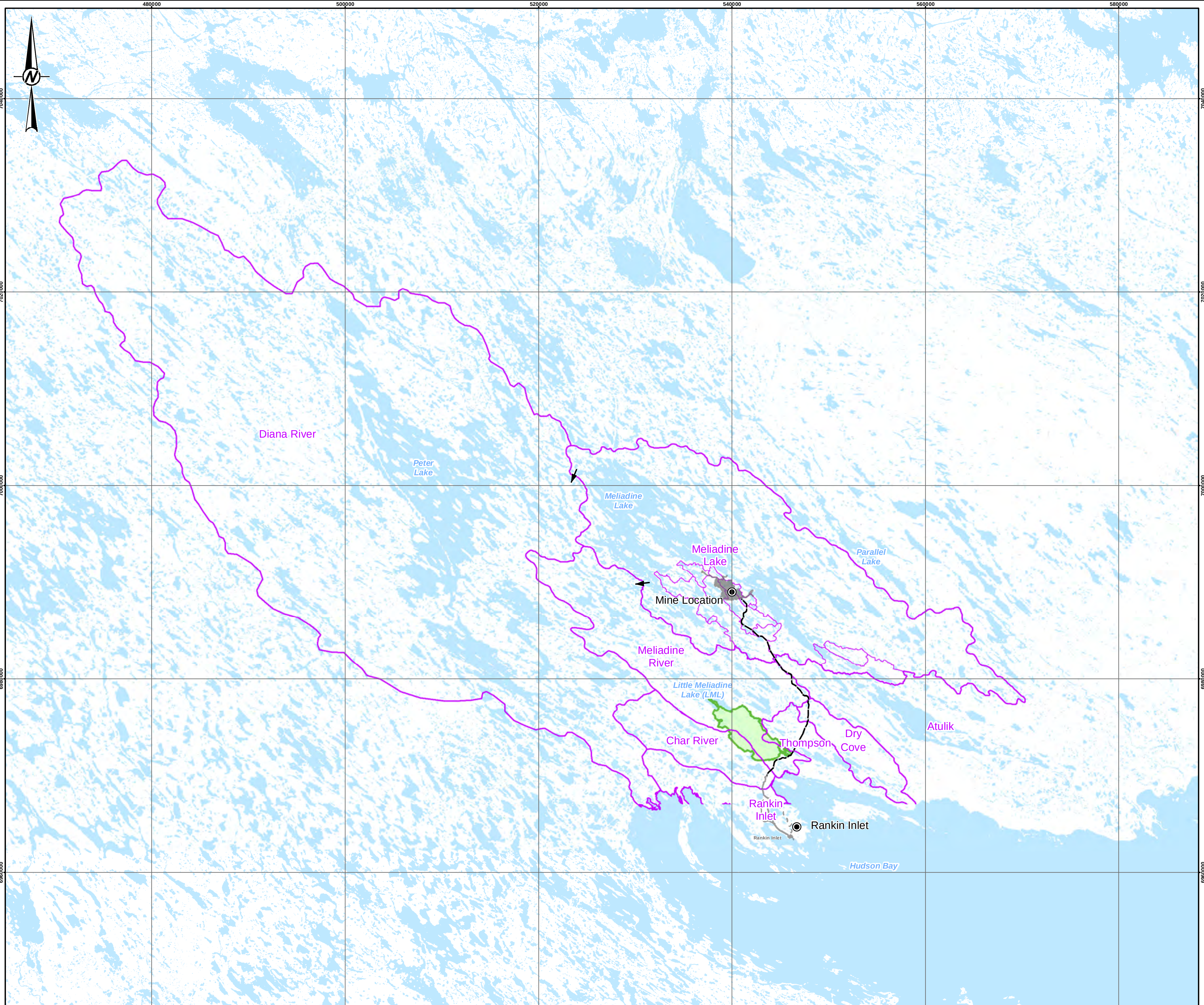
The Meliadine Gold Mine (Mine) is located in the Kivalliq District of Nunavut near the western shore of Hudson Bay, in Northern Canada (Figure 1.1 1). The nearest community is Rankin Inlet (coordinates: 62°48'35''N; 092°05'58''W), approximately 25 km south of the Tiriganiaq deposit (coordinates: 63°01'03''N, 92°12'03''W). The Mine is located within the Meliadine Lake watershed of the Wilson Water Management Area (Nunavut Water Regulations Schedule 4).

The Aquatic Effects Monitoring Program (AEMP) design plan is a requirement of the Type A Water Licence (2AM MEL 1631, Part I, Item 3). The design plan (v1 submitted June 2016; Golder 2016b) was intended to function as an integrated monitoring program, which considers pathways to potential effects of the Mine on the aquatic environment: changes in surface water quality, sediment quality, lower trophic communities, fish habitat, and fish health due to release of mine water, physical alteration of watersheds, and air emissions during construction, operations, and closure are considered in the AEMP.

The AEMP is structured as a comprehensive monitoring plan that incorporates various aquatic components and provides integration, where possible, in terms of stations sampled, sample matrix, and sample analysis. The AEMP for the Mine has been designed around the key aspects of the Metal Mining Effluent Regulations (MMER) Environmental Effects Monitoring (EEM) requirements, with supplemental components included to fulfill the additional conditions and requirements of the Water Licence, and to monitor for potential mine related effects to the aquatic environment. The core components of the AEMP are as follows:

- water quality
- sediment quality
- benthic invertebrate community
- fish (i.e., fish health and fish tissue chemistry)

Two distinct programs are proposed within the AEMP, the Meliadine Lake study and the peninsula lakes study (Figure 1.1-2). In addition, there is a targeted plankton study (e.g., plankton studies) of short duration with focussed objectives.



LEGEND

- DIRECTION OF FLOW AT WATERSHED OUTLET
- ALL-WEATHER ACCESS ROAD (AWAR)
- ROAD - NEW
- ROAD - EXISTING
- MINE FOOTPRINT
- WATERSHED BOUNDARY
- TERRITORIAL PARK
- WATERCOURSE
- WATERBODY

0 8 16

1:400,000 KILOMETRES

REFERENCE(S)

1. BASE DATA OBTAINED FROM AGNICO EAGLE MINES LIMITED.
2. DATUM: NAD83 PROJECTION UTM ZONE 15

CLIENT

AGNICO EAGLE MINES LIMITED

AGNICO EAGLE

PROJECT

MELIADINE GOLD PROJECT
NUNAVUT

TITLE

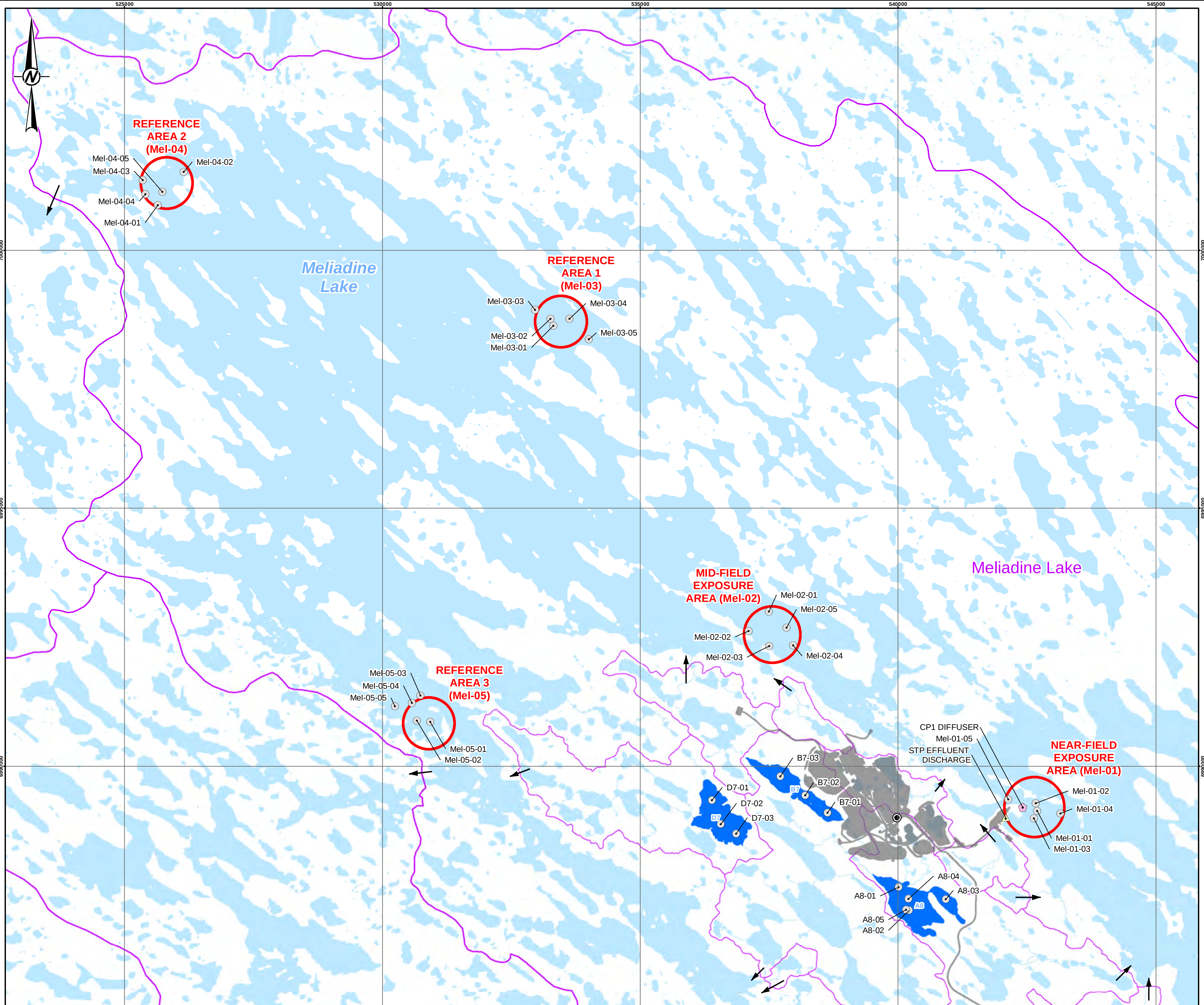
LOCATION OF THE MELIADINE MINE

CONSULTANT

GOLDER

YYYY-MM-DD	2018-03-26
DESIGNED	JN
PREPARED	MH
REVIEWED	RS
APPROVED	RS

PROJECT NO.	CONTROL	REV.	FIGURE
1787610	1000	0	1.1-1



LEGEND

- WATER QUALITY STATION
- DE-WATERING EFFLUENT DISCHARGE LOCATION
- INACTIVE CP1 DIFFUSER
- DIRECTION OF FLOW AT WATERSHED OUTLET
- MINE FOOTPRINT
- WATERSHED BOUNDARY
- WATERCOURSE
- WATERBODY

0 1.5 3

1:75,000 KILOMETRES

REFERENCE(S)

1. BASE DATA OBTAINED FROM AGNICO EAGLE MINES LIMITED.
2. DATUM: NAD83 PROJECTION UTM ZONE 15

CLIENT	AGNICO EAGLE MINES LIMITED
PROJECT	MELIADINE GOLD PROJECT NUNAVUT
TITLE	**STUDY AREA FOR THE MELIADINE AQUATIC EFFECTS MONITORING PROGRAM**

CONSULTANT: GOLDER

YYYY-MM-DD	2018-03-26
DESIGNED	JN
PREPARED	MH
REVIEWED	RS
APPROVED	RS

PROJECT NO.	CONTROL	REV.	FIGURE
1787610	1000	0	1.1-2

1.2 Objectives

The overall objective of the AEMP is to assess potential mine related effects on the aquatic ecosystem, meet regulatory requirements outlined in the Type A Water Licence (2AM MEL 1631), and meet commitments made during the environmental permitting process (see Table 1-1 in the AEMP design plan [Golder 2016b]). Additionally, the AEMP is designed to provide an early warning system where the results of aquatic monitoring are used to reduce or prevent adverse environmental effects through a response framework and regular evaluation of the monitoring program. The Meliadine Mine is currently under construction and is not milling ore, as such, operational discharge has not been initiated.

The specific objectives of this report are to document 2017 data collection, and detailed analyses of data collected from 2015 to 2017 of the core studies on water quality, sediment quality, benthic invertebrate community, and fish health and fish tissue, and the targeted study on plankton. Sections are dedicated to each of these study components with methods, quality assurance and quality control (QA/QC), results and discussion, with supporting appendices.

A commitment was made during the water licence hearings to develop AEMP benchmarks (i.e., to support the Action Levels) as part of the Response Framework for use during operational monitoring (Golder 2016b). Development of the benchmarks was deferred until sufficient baseline data were collected. Baseline data collected from 2015 to 2017, and included in this report, will be used to develop the benchmarks and update the draft Response Framework as presented in the AEMP design plan (Golder 2016b).

1.3 Report Structure

This report addresses Part B, Item 2 and Schedule B, Item 13 of the Water Licence for submission of an annual AEMP report with accompanying results and interpretation. This report includes data collected in 2017, with a summary of data collected in 2015 to 2017. The document is organized as follows:

- Executive Summary
- Project Overview (Section 2)
- Water Quality (Section 3)
- Sediment Quality (Section 4)
- Benthic Invertebrate Community (Section 5)
- Fish Health and Tissue (Section 6)
- Plankton Targeted Study (Section 7)
- Conclusions (Section 8)
- Closure (Section 9)

2.0 PROJECT OVERVIEW

2.1 Environmental Setting

The Mine is located in the Kivalliq Region of Nunavut, near the coast of Hudson Bay. Here, continuous permafrost underlies the ground's surface and the terrain is gently rolling with a mean elevation of 65 m above sea level. Drumlins (glacial till) and eskers (gravel and sand) are also among the dominant land forms within the region. The climate is characterized by long, cold winters and short, cool summers. Total annual precipitation is less than (<) 30 cm and strong winds are prevalent due to the openness of the landscape.

Because low lying areas are poorly drained, the landscape is a series of interconnected shallow ponds and lakes. Local watersheds include Meliadine Lake and the Chickenhead and Control sub watersheds that drain to Meliadine Lake, Meliadine River, and a number of smaller watersheds. Aquatic habitats support a variety of fish species, including Threespine stickleback (*Gasterosteus aculeatus*), Arctic char (*Salvelinus alpinus*), Ninespine stickleback (*Pungitius pungitius*), Cisco (*Coregonus clupeaformis*), Arctic grayling (*Thymallus arcticus*), Lake trout (*Salvelinus namaycush*), and Round whitefish (*Prosopium cylindraceum*).

The region supports some of Canada's largest caribou (*Rangifer tarandus groenlandicus*) herds during the calving season and summer, including the Qamanirjuaq Caribou Herd, which is an important food source for the Inuit. Carnivores such as gray wolf (*Canis lupis*) and polar bear (*Ursus maritimus*) are also found in the region, as are nesting and breeding migratory birds. Protected areas of the Kivalliq region include Arvia'juaq and Qikiqtaarjuk National Historic Site of Canada, East Bay Migratory Bird Sanctuary, Fall Caribou Crossing National Historic Site of Canada, Harry Gibbons Migratory Bird Sanctuary, Iqalugaarjuup Nunanga Territorial Park, Inuujarvik Territorial Park, McConnell River Migratory Bird Sanctuary, and part of the Thelon Wildlife Sanctuary.

Over 80% of the human population in the Kivalliq Region is Inuit. The area is sparsely populated, and the local economy is dependent on subsistence hunting, trapping, and fishing. Other activities in the area include mineral exploration, mining, construction, tourism, and government services.

2.2 Mine Description and Summary of Activities from 2015 - 2017

The mine plan proposes open pit and underground mining methods for the development of the Tiriganiaq gold deposit, with two open pits (Tiriganiaq Pit 1 and Tiriganiaq Pit 2) and one underground mine. The proposed mine will produce approximately 12.1 million tonnes (Mt) of ore, 31.8 Mt of waste rock, 7.4 Mt of overburden waste, and 12.1 Mt of tailings. There are four phases to the development of Tiriganiaq: just over 4 years construction (Q4 Year -5 to Year -1), 8 years mine operation (Year 1 to Year 8), 3 years closure (Year 9 to Year 11), and post-closure (Year 11 forwards) (Agnico Eagle 2015). The AEMP has been designed to encompass all phases of mine development.

Pre-construction activities were completed at the Mine in 2015 and 2016. Pre development activities underway in 2015 included development of an industrial pad, including an access road, pad, and pilings, as well as work on the exploration ramp. Construction activities were initiated at the Mine in October 2016. Construction activities and civil work were also completed at the temporary landfill, industrial pad, exploration ramp, and saline pond in 2016. Construction of the temporary landfill was completed in October; no water monitoring was completed at the site due to frozen conditions. Construction of the saline pond occurred from July to October, and work at the exploration ramp, including construction of the ventilation raise, was completed throughout the year. Water management activities carried out in 2016 in support of mine development were summarized in the 2016 AEMP report (Golder 2017a). The sewage treatment plant and landfarm associated with 2BB MEL 1424 were operational in 2015, 2016, and 2017. The sewage treatment plant effluent was discharged to a rock-bed channel that emptied into Meliadine Lake (shown on Figure 1.1-2) near the exploration camp; water from the landfarm was discharged to land. The sewage treatment plant, landfarm, freshwater intake, and effluent discharge associated with the Type A Water Licence (2AM MEL 1631) were not in use until 2017.

The following water management activities were carried out in support of mine development in 2017 (Tetra Tech 2017a; Tetra Tech 2017b):

- Completion of dikes D-CP1 and D-CP5 (Appendix 2A, Figure 1.2): These dikes were constructed between October 2016 and July 2017. Both dikes are composed of rockfill and transition shells with a geomembrane liner anchored into a key trench within the permafrost foundation (soil or bedrock). A downstream collection sump and two channels were constructed approximately 5 m downstream of the D-CP1 toe to collect surface runoff from the dike and any possible dike seepage for pumping back to CP1. CP1 is the final water management facility on site, and water from various parts of the site will be pumped to CP1 for treatment and discharge to Meliadine Lake. A small collection sump located in a natural depression downstream of CP5 is used to collect surface runoff from the dike and any possible seepage through the dike for pump back to CP5. CP5 will be used seasonally for temporary water storage with active pumping to CP1.
- Construction of the water treatment plant at CP1 (Appendix 2A, Figure 1.2): This also included the construction of the 4 km effluent pipeline and diffuser in Meliadine Lake and was completed in September 2017.
- Construction of Berm 3 and Channel 5 (Appendix 2A, Figure 1.2): Channel 5 and Berm 3 are located west of CP5 and are designed to divert water into CP5 so that this water does not flow into Tiriganiaq Pit 1. Channel 5 is the main water diversion structure; Berm 3 is required to temporarily retain water under an extreme rainfall event when the water level cannot be contained within Channel 5. Channel 5 was constructed in November 2016 and Berm 3 was built in August and September 2017.
- Active evaporation from the P-area (Appendix 2A, Figure 1.2): Active evaporation from the P-area occurred from June to September 2017.

Discharge from CP1 was planned during September to October 2017 but did not occur because concentrations of total dissolved solids (TDS) in CP1 were above the Type A Water Licence discharge criteria of 1,400 mg/L. Concentrations of TDS above the discharge criteria limit started in early August reaching a maximum of 1,800 mg/L; concentrations decreased to 1,500 mg/L by late September. A TDS management plan, that includes a mobile reverse osmosis treatment unit to treat the high TDS water is planned to support management of water before and during freshet 2018.

2.3 Interactions with the Aquatic Environment

The Project will interact with the aquatic environment throughout all phases of mine development through the following pathways:

- the release of treated effluent
- the release of air emissions (acidifying emissions, dust, and associated metals)
- the alteration of natural watersheds
- potential accidental seepage and spills
- Influence from underground workings

Additionally, for peninsula lakes in particular, Project components that may affect the aquatic environment include the alteration of watersheds through dewatering operations, diverting natural drainage paths, constructing new drainage channels, and changing the water balance.

3.0 WATER QUALITY

In support of the AEMP and Water Licence requirements for the Mine, water quality monitoring was completed in 2015, 2016 and 2017 at Meliadine Lake areas and peninsula lakes (Figure 1.1-2). The specific objective of monitoring activities was to characterize water quality conditions in Meliadine Lake so that water quality trends and adaptive management strategies can be identified, as required, during the life of mine.

This report section provides a summary of the water quality monitoring programs completed in 2017 at Meliadine Lake and the peninsula lakes, analysis of data collected between 2015 and 2017, and an interpretation of the results. Data analysis presented in this report are based on the AEMP study design (Golder 2016b), and response to comments from Environment and Climate Change Canada (ECCC) and Indigenous and Northern Affairs Canada (INAC) during review of the 2016 AEMP annual report (Golder 2017a).

3.1 Methods

3.1.1 Field Measurements

Design of the water quality program in 2017 was based on the Meliadine AEMP design plan (Golder 2016b) and consisted of two sampling events during ice-covered conditions and three sampling programs during open-water conditions (Table 3.1-1). This is consistent with the sampling frequency of water quality data collected in 2016; in 2015 samples were collected only during open-water conditions (Golder 2017a). The 2016 and 2017 programs targeted the exposure and reference areas of Meliadine Lake, while the 2015 program targeted the exposure areas of Meliadine Lake. The study design includes five stations in each of the proposed Near-field and Mid-field exposure areas, and Reference Areas 1, 2, and 3 of Meliadine Lake, at a target water depth of 8 to 10 m, and three stations in each of the peninsula lakes at a target water depth of 1.5 to 2.5 m (Figure 1.1-2). The location and timing of sample collection in 2017 is summarized in Table 3.1-1. Sampling events conducted in 2015 and 2016 are summarized in Golder 2017a.

Table 3.1-1: Water Quality Sampling Stations and Sampling Effort Summary in 2017

Waterbody	Area	Station ID	UTM Coordinates (NAD 83, Zone 15V)		Average Total Depth[a] (m)	Average Secchi Depth[b] (m)	2017				
							Ice-Covered		Open-Water		
			Easting	Northing			19 to 20 January	18 to 19 February	16 to 23 July	8 to 15 August	1 to 5 September
							Winter-1	Winter-2[c]	Late Spring[c]	Summer[c]	Fall[c]
Meliadine Lake	Near-field Exposure	Mel-01-01	542693	6989136	9.4	6.3	Yes	Yes	Yes	Yes	Yes
		Mel-01-02	542666	6989280	8.1	6.5	Yes	Yes	Yes	Yes	Yes
		Mel-01-03	542634	6988989	9.0	6.0	Yes	Yes	Yes	Yes	Yes
		Mel-01-04	543145	6989088	8.6	5.8	Yes	Yes	Yes	Yes	Yes
		Mel-01-05	542136	6989358	8.0	5.7	Yes	Yes (QC-dup)	Yes (QC-dup)	Yes	Yes
	Mid-field Exposure	Mel-02-01	537491	6992999	7.8	7.0	Yes	Yes	Yes	Yes (QC-dup)	Yes
		Mel-02-02	537102	6992624	9.1	7.5	Yes	Yes	Yes	Yes	Yes
		Mel-02-03	537499	6992327	9.2	7.0	Yes	Yes	Yes	Yes	Yes
		Mel-02-04	537963	6992341	8.2	7.4	Yes	Yes (QC-dup)	Yes	Yes	Yes
		Mel-02-05	537834	6992688	8.8	6.7	Yes	Yes	Yes	Yes	Yes (QC-dup)
	Reference Area 1	Mel-03-01	533317	6998541	6.9	6.7	-	-	Yes	Yes (QC-dup)	Yes
		Mel-03-02	533256	6998671	8.4	7.7	-	-	Yes	Yes	Yes
		Mel-03-03	532962	6998844	10.0	8.5	-	-	Yes	Yes	Yes
		Mel-03-04	533628	6998672	8.1	7.3	-	-	Yes	Yes	Yes
		Mel-03-05	534001	6998272	7.5	7.5	-	-	Yes	Yes	Yes
	Reference Area 2	Mel-04-01	525647	7000878	7.5	7.5	-	-	-	Yes	-
		Mel-04-02	526149	7001519	9.5	9.5	-	-	-	Yes	-
		Mel-04-03	525351	7001359	9.5	9.5	-	-	-	Yes	-
		Mel-04-04	525401	7001085	8.1	8.1	-	-	-	Yes	-
		Mel-04-05	525735	7001129	8.4	8.4	-	-	-	Yes (QC-dup)	-
	Reference Area 3	Mel-05-01	530926	6990858	10.0	9.0	-	-	-	Yes (QC-dup)	-

Waterbody	Area	Station ID	UTM Coordinates (NAD 83, Zone 15V)		Average Total Depth[a] (m)	Average Secchi Depth[b] (m)	2017				
							Ice-Covered		Open-Water		
			Easting	Northing			19 to 20 January	18 to 19 February	16 to 23 July	8 to 15 August	1 to 5 September
							Winter-1	Winter-2[c]	Late Spring[c]	Summer[c]	Fall[c]
		Mel-05-02	530669	6990884	8.7	8.7	-	-	-	Yes	-
		Mel-05-03	530735	6991374	8.0	8.0	-	-	-	Yes	-
		Mel-05-04	530570	6991223	10.0	10.0	-	-	-	Yes	-
		Mel-05-05	530240	6991162	7.8	7.8	-	-	-	Yes	-
Peninsula Lakes	Lake A8	A8-01	540009	6987658	2.5	2.5	-	-	Yes (QC-dup)	Yes	-
		A8-02	540211	6987203	2.1	2.1	-	-	Yes	Yes	-
		A8-03	540922	6987423	1.9	1.9	-	-	Yes	Yes	-
	Lake B7	B7-01	538628	6989096	1.5	1.5	-	-	Yes	Yes	-
		B7-02	538198	6989437	2.0	2.0	-	-	Yes	Yes	-
		B7-03	537713	6989800	2.0	2.0	-	-	Yes (QC-dup)	Yes	-
	Lake D7	D7-01	536391	6989339	1.7	1.7	-	-	Yes	Yes	-
		D7-02	536563	6988874	1.9	1.9	-	-	Yes	Yes	-
		D7-03	536859	6988692	1.9	1.9	-	-	Yes	Yes	-

(a) The total depths recorded during each sampling program were averaged for individual stations.

(b) The average Secchi depth (a measure of the clarity of surface waters) was calculated based on Secchi depths recorded during each of the open-water (i.e., late spring, summer, and fall) sampling programs.

(c) Blank samples (i.e., travel, field, equipment) were collected.

“yes” = field measurements recorded and water sample collected for laboratory analysis; QC-dup = duplicate quality control samples were collected; - = the site was not included in the sampling plan for a particular field program.

ID = identifier; UTM = Universal Transverse Mercator; NAD = North American Datum; QC = quality control; dup = duplicate.

Field Measurements

At each sampling station, water depth and physico-chemical measurements were collected. Total depth of the water column was measured either by using a sounding line or a boat-mounted sonar unit. In situ physico-chemical measurements of water temperature, dissolved oxygen (DO), pH, and specific conductivity collected at each lake station using a submersible multi-sensor probe system (Manta II multiprobe). In situ physico-chemical measurements were taken just below the surface (or below the ice during ice-covered conditions) and every 1 m (Meliadine Lake areas) or 0.5 m (peninsula lake areas) thereafter throughout the water column ending at approximately 1 m above the lake bed. During open-water conditions, Secchi depth was measured using a Secchi disk at each station. A Secchi disk is a black and white disk that is lowered into the water and the depth is recorded at which it is no longer visible; this information was used to provide a coarse estimate of the euphotic zone depth for the purposes of the depth-integrated nutrient sample collection to support the plankton special study (Section 7.0). During ice-covered conditions, ice thickness was measured.

Water Sample Collection

Discrete water samples were collected at each sampling station from mid-depth within the water column using a Kemmerer sampler. At each station, the Kemmerer was triple-rinsed with surface water representative of the station, and then lowered to the required depth (i.e., mid-depth in the water column), triggered by the messenger to collect a sample, returned to the surface, and used to fill the lab-supplied sample bottles. This procedure was repeated until all sample bottles for the station were filled.

Sample bottles were provided by ALS Environmental (ALS; Edmonton location), an analytical laboratory accredited by the Canadian Association for Laboratory Accreditation Inc (CALA). Water samples were processed (i.e., filtered and/or preserved as required, and refrigerated) at site according to the instructions provided by ALS. Water samples requiring filtration were filtered through a 0.45 micrometre (µm) Millipore filter in a Nalgene filter tower using a vacuum pump before being preserved with laboratory-provided preservative based on the required analysis. Water samples were kept refrigerated before shipping; ice-packs were added to the coolers to keep the samples as cool as possible during transport. Samples were shipped to ALS as soon as possible after sample collection and processing.

Water quality samples were analyzed for a suite of parameters, including:

- conventional parameters (i.e., pH, specific conductivity, total alkalinity, hardness, total dissolved solids [TDS], total suspended solids [TSS], and turbidity)
- major ions (i.e., bicarbonate, carbonate, hydroxide, chloride, fluoride, sulphate, calcium, magnesium, potassium, sodium, and silica)
- nutrients (i.e., nitrate, nitrite, total ammonia, total Kjeldahl nitrogen [TKN], total nitrogen [TN], total phosphorus [TP], total dissolved phosphorus [TDP], orthophosphate, total organic carbon [TOC], and dissolved organic carbon [DOC])
- total and dissolved metals, metalloids, and non-metals[1] (i.e., aluminum, antimony, arsenic, barium, beryllium, bismuth, boron, cadmium, chromium, cobalt, copper, iron, lead, lithium, manganese, mercury, molybdenum, nickel, selenium, silver, strontium, thallium, tin, titanium, uranium, vanadium, and zinc)
- cyanide (i.e., weak acid dissociable, total, free)

[1] Henceforth, metals, metalloids (e.g., arsenic), and non-metals (e.g., selenium) will be referred to as "metals.

The samples were analyzed using laboratory test methods with analytical detection limits (DLs) less than the *Canadian Council of Ministers of the Environment (CCME) Canadian Water Quality Guidelines (CWQGs*) *for the protection of aquatic life* (CCME 1999) and *Health Canada Drinking Water Quality Guidelines (DWQGs;* Health Canada 2014*).*

Samples for chlorophyll a analysis were collected from the peninsula lakes according to the methods described in the plankton section (Section 7.1.1.1).

3.1.2 Guideline Analysis

Water quality aquatic life guidelines are numerical limits or narrative statements based on the most current, scientifically defensible toxicological data available for the parameter of interest, and are designed to be protective of all forms of aquatic life including the most sensitive life stage of the most sensitive species. An exceedance of a guideline does not necessarily imply the likelihood of an adverse environmental effect. Exceedances of guidelines under baseline conditions indicate naturally elevated concentrations relative to other sites, and suggest that resident aquatic biota have adapted to these concentrations. Similarly, water quality results can be compared to drinking water guidelines to evaluate if water is of sufficient quality for consumption by humans or if there is potential risk to human and wildlife health.

Water quality results for Meliadine Lake stations and peninsula lakes were compared to acute and chronic Canadian water quality guidelines (CWQGs) for the protection of aquatic life (CCME 1999) and aesthetic and drinking water quality guidelines (DWQGs, Health Canada 2014). Water quality results from Meliadine Lake stations were also compared to the site-specific water quality objectives developed for the Mine (Golder 2013). These guidelines and objectives are summarized in Table 3.1-2; these guidelines, in addition to baseline data, form a starting point for the future monitoring benchmarks.

Table 3.1-2:Water Quality Guidelines

Parameter	Unit	Aquatic Life [a]		Drinking Water [b]	Aesthetic [b]	SSWQO [c]
		Acute	Chronic			
Field Parameters						
Dissolved Oxygen	mg/L	-	6.5[d]	-	-	-
pH	NA	-	6.5 to 9.0	7.0 to 10.5	-	-
Temperature	ºC	-	-	-	15	-
Conventional Parameters						
Total dissolved solids	mg/L	-	-	-	500	-
pH	NA		6.5 to 9.0	-	7.0 to 10.5	-
Major Ions						
Chloride	mg/L	640	120	-	250	-
Fluoride	mg/L	-	0.12	1.5	-	2.8
Sodium	mg/L	-	-	-	200	-
Sulphate	mg/L	-	-	-	500	-
Cyanide Species						
Cyanide	mg/L	-	0.005	0.2	-	-
Nutrients						
Nitrate	mg-N/L	124	2.9	10	-	-
Nitrite	mg-N/L	-	0.06	1	-	-
Total ammonia	mg-N/L	-	2.68[e]	-	-	-
Total Metals						
Aluminum	µg/L	-	5 to 100[g]	-	200	-
Antimony	µg/L	-	-	6	-	-
Arsenic	µg/L	-	5	10	-	25
Barium	µg/L	-	-	1,000	-	-
Boron	µg/L	29,000	1,500	5,000	-	-

Parameter	Unit	Aquatic Life [a]		Drinking Water [b]	Aesthetic [b]	SSWQO [c]
		Acute	Chronic			
Cadmium	µg/L	0.45[f]	0.04[f]	5	-	-
Chromium	µg/L	-	1	50	-	-
Copper	µg/L	-	2[f]	-	1,000	-
Iron	µg/L	-	300	-	300	1,060
Lead	µg/L	-	1[f]	10	-	-
Manganese	µg/L	-	-	-	50	-
Mercury	µg/L	-	0.026	1	-	-
Molybdenum	µg/L	-	73	-	-	-
Nickel	µg/L	-	25[f]	-	-	-
Selenium	µg/L	-	1	50	-	-
Silver	µg/L	-	0.25	-	-	-
Thallium	µg/L	-	0.8	-	-	-
Uranium	µg/L	33	15	20	-	-
Zinc	µg/L	-	30	-	5,000	-

(a) CCME 1999.

(b) Health Canada 2014.

(c) SSWQO developed for the Meliadine Gold Mine (Golder 2013). SSWQOs supersede generic guidelines for review of monitoring and determination of effects.

(d) Lowest acceptable for cold water biota CCME 1999.

(e) The guideline shown corresponds to a temperature of 10°C and pH of 7.5. For individual samples, the guidelines were calculated based on the specific temperature and pH measured from the sample (CCME 2010).

(f) The guideline is hardness dependent (value shown corresponds to a median hardness of 22.7 mg/L as $CaCO_3$). For individual samples, the guideline was calculated based on the specific hardness measurement taken from the sample.

(g) The guideline is pH dependent. The 5 µg/L guideline correspond to a pH<6.5 and 100 µg/L corresponds to a pH≥6.5. Guidelines were applied to individual sample based on specific pH measurement taken from the sample.

Note: Only parameters that have guidelines are presented.

SSWQO = site-specific water quality objective; NA = not applicable; mg/L = milligrams per litre; - = no guideline; mg-N/L = milligrams nitrogen per litre; µg/L = micrograms per litre.

Water quality data collected in 2017 represents third year of data collected at Meliadine Lake and peninsula lakes following the AEMP design plan. Water quality data collected between 2015 and 2017 at Meliadine Lake were separated by season: ice-covered (January and February) and open-water (July to September). Water quality data for peninsula lakes represents only the open-water conditions (July and August).

Field data (physico-chemical) profiles were compared graphically within each lake area (by showing results for each station) and by season (ice-covered and open-water). Water temperature, dissolved oxygen concentration and percent saturation, pH, and specific conductivity, were plotted against measured depth.

Water chemistry results were plotted in time series scatter-plot for each parameter at each station and guidelines to aid in visual assessment of data trends relative to sampling event and guidelines.

3.1.3 Statistical Analyses

Descriptive statistics (i.e., minimum, median, mean, maximum, standard deviation, number of values below DL, and percentage of values above the water quality guidelines and objectives) were calculated to compare and evaluate the spatial and temporal data collected within Meliadine Lake; descriptive statistics were also used to compare water quality among the three peninsula lakes. A summary of statistics analysis calculated for each sampling area representing the conditions for 2015 to 2017 period are presented in this report.

Prior to completing statistical analyses, values below DL were substituted with one-half of the DL. Subsequently, statistical outliers were removed from the dataset. Statistical outliers were identified using standardized residual, which provide a measure of the difference between observed and expected values (i.e., residuals), normalized to the variance of the dataset, and were calculated as follows:

Standardized Residual: $x_z = \frac{x_i}{\sigma}$

Where: x_z is the standardized residual

x_i is the residual of a data point

σ is the sample standard deviation

Data points with standardized residuals greater than |3.5| (i.e., more than 3.5 standard deviations from the sample mean), were omitted from the analysis.

To compare the water quality parameters between the exposure areas (i.e., Near-field, and Mid-field areas), and the reference areas at Meliadine Lake, a series of Analysis of Variance (ANOVA) tests were completed (Systat 2009). The comparisons of Near-field or Mid-field areas and reference areas were completed for open-water conditions. In addition, comparisons between Near-field and Mid-field areas were completed for open-water and ice-covered conditions. Prior to data analyses, the water quality data were checked for statistical assumptions (e.g., normality, and homoscedasticity; Zar 1996). If data did not meet the statistical assumptions, the equivalent non-parametric tests (e.g., Mann-Whitney U; Zar 1996) were completed. Significant differences were determined using $\alpha = 0.05$. One half the DL was substituted for non-detect values in the dataset prior to data analyses.

3.1.4 Normal Range Calculations

Normal range concentrations were calculated for Meliadine Lake for open-water conditions based on 2016 and 2017 data collected at the reference areas (MEL-03, MEL-04, and MEL-05) and for ice-covered conditions based on data collected at the Mid-field area (MEL-02). Normal ranges for peninsula lakes were calculated separately for each lake.

The calculation methods used to estimate normal ranges followed the methods outlined in Barrett et. al. 2015.

When the baseline data were normally distributed, the normal range was estimated for the average of five observations as the 95% prediction interval (PI) of the dataset selected to represent natural variability (Barrett et al. 2015). Normality was assessed using the Shapiro Wilk test, using $p < 0.05$ to detect a significant departure from normality. When the baseline data were not normally distributed, but normality could be achieved after $\log_{10}$ transformation, the normal range was calculated on the log-transformed data and the upper and lower bound of the normal ranges were back-transformed. If both the untransformed data and log-transformed datasets were non-normal, the normal range boundaries were defined as the 2.5th and 97.5th percentile of the baseline data. In cases where the percentile method was used, 1,000 random samples of size five were generated from the normal range dataset and the 2.5th and 97.5th percentile were calculated from this distribution of 1,000 mean values to estimate the normal range of mean values. Finally, in cases where the untransformed data were normally distributed but the lower bound of the normal range calculated using the PI method was less than zero, the normal range was calculated using either the log-PI method or the percentile method, depending on whether normality could be achieved after $\log_{10}$ transformation. This approach resulted in the lower bound of the normal range always being greater than zero.

The normal ranges provided in this report are considered provisional during initial monitoring under the AEMP due to the limited sample sizes used in the calculations. The normal range is intended to estimate the range of natural spatial and temporal variability, and the more reference data incorporated into the calculation, the more accurate the estimate becomes. These normal ranges may be re-defined in future reports to allow for the inclusion of additional monitoring data after Mine construction has begun. Normal ranges were not calculated for water quality constituents that were represented by other constituents (e.g., turbidity was not included because it is represented by TSS), for constituents that have no ecological relevance (e.g., bicarbonate), or for constituents that were detectable in less than 50% of the samples.

Each calculated normal range was evaluated for representativeness. For example, some parameters had variable DLs, or parameters with low detection frequency could have calculated upper bound normal ranges that were less than the DL, whereas actual concentrations could be anywhere between zero and the DL. Therefore, the calculated normal ranges for parameters with non-detect concentrations in the dataset were revised according to the following criteria:

- If all values were less than the DL, then the lower bound of the normal range was set to zero and the upper bound was set to the DL value.
- If the lower bound of the normal range was less than the DL, then it was set to zero.
- If the upper bound of the normal range was less than the DL, then it was set to the DL value.
- If the dataset included a mix of DLs and all the values were non-detect, then the normal range was set to zero (lower bound) and the most common used DL (upper bound).

- If the dataset included a mix of DLs, and the upper bound of the normal range was between the lowest and highest DL, then the upper bound of the normal range was set to the highest DL.
- If the dataset included a mix of DLs, and the DLs varied by more than an order of magnitude, then the data with the higher DL was removed analysis and the normal range was re-calculated.

3.2 Quality Assurance and Quality Control

The quality assurance/quality control (QA/QC) practices applied during this study and detailed results of the quality control (QC) analyses for discrete water quality samples collected at Meliadine Lake and peninsula lakes are provided in Appendix 3A. Quality assurance (QA) components of the program included the use of trained personnel and an accredited analytical laboratory; QC components included assessments of duplicates and field, equipment, and travel blank samples. Dissolved and total parameter concentrations were also compared.

3.2.1 Results

A total of 22 QC samples consisting of field duplicates, field blanks, travel blanks and equipment blanks were collected during the 2017 programs.

Key QC findings for the water quality monitoring programs include the following:

- Field physico-chemical data for most parameters were reliable and within expected ranges, with the exception of dissolved oxygen measurements during ice-covered conditions (January and February). During winter programs dissolved oxygen readings were higher than the acceptable ranges and were excluded for data analysis. The cold environment where these measurements were taken can affect the functionality of the probes. To minimize the potential for data gaps and improve the QC/QA practices for dissolved oxygen measurements, Winkler tests were performed on 12% of the samples in the subsequent field programs.
- The water quality QC sample evaluation indicated that for the equipment, field, and travel blanks, 3.1%, 1.3%, and 1.2% of parameters, respectively, were detected at concentrations more than five times the DL. Results of blank samples indicated a potential phosphorus contamination during the February sampling program and total and dissolved phosphorus results measured in February were excluded from data analysis.
- Approximately 7.5% of paired concentrations in duplicate discrete water quality samples differed by more than 20%.
- Concentrations of dissolved parameters were generally lower than corresponding total concentrations for the discrete and QC samples. For the discrete dataset, including duplicates, only 2.7% of dissolved concentrations were higher than total concentrations. In blank samples, dissolved concentrations were higher than total concentrations for 1.7% of metals pairs.

The overall quality of the water quality dataset is considered high and the results of the 2017 monitoring program is expected to be adequate to support the AEMP program for the Mine.

3.3 Results and Discussion

In situ physico-chemical measurements and discrete laboratory-measured water quality data collected at Meliadine Lake and the Peninsula lakes in 2017 are summarized in Section 3.3.1 and 3.3.2, respectively. Detailed 2017 data are presented in Appendices 3B and 3C; detailed data collected in 2015 and 2016 are summarized in Golder 2017a.

3.3.1 Meliadine Lake

Meliadine Lake areas were sampled during ice-covered conditions (January, February) and open-water conditions (July, August, September). A total of 20 discrete samples were collected during ice-covered conditions and 55 discrete samples during open-water conditions in 2017.

3.3.1.1 Field Measured Physico-chemical Parameters

Water column profiles of in situ measurements for water temperature, dissolved oxygen, pH, and specific conductivity at Meliadine Lake areas in 2017 are presented in Appendix 3B; in situ profiles for 2015 and 2016 programs are presented in Golder 2017a.

There was no evidence of thermal stratification at Meliadine Lake in 2017 (Appendix 3B, Figures 3B1-1 to 3B1-5) and temperatures ranged from 0 to 2°C during ice-covered conditions and from 9 to 14°C during open-water conditions. Similar temperatures were measured in 2015 and 2016.

Some oxic stratification was observed during the ice-covered conditions in 2017; however, most of the DO measurements during ice-covered conditions were higher than the acceptable range and deemed unreliable and excluded from analysis (Appendix 3B, Tables 3B1 to 3B5). Some stratification of DO measurements were also observed in the past during ice-covered conditions. In 2016, DO concentrations measured at the bottom were lower than those measured at the surface and some concentrations (21% of measurements) in the Near-field area were lower than the minimum chronic guideline requirement for the protection of aquatic life (CCME 1999).

There was no evidence of oxic stratification during open-water conditions (Appendix 3B, Figures 3B.2-1 to 3B.2-3). Water was well-oxygenated, ranging from 10.3 to 11.6 mg/L (100 to 110% saturation) and was within the CWQG for the protection of aquatic life (CCME 1999). Similar DO concentrations were observed in 2015 and 2016 (Appendix 3E, Figure 3E.1-1*a*).

Water in Meliadine Lake was circumneutral to basic, ranging from 6.6 to 8.3 during ice-covered conditions and from 7.0 to 8.1 during open-water conditions (Appendix 3B, Figures 3B.3-1 to 3B.3-5). Similar pH values were observed in 2015 and 2016 (Appendix 3E, Figure 3E.1-1*b*). Most pH values were within the CWQGs and DWQG ranges (i.e., pH=6.5 to 9 and pH = 7.0 to 10.5, respectively), with some exceptions at the exposure areas. The minimum CWQG for the protection of aquatic life was exceeded in 8% of samples collected during ice-covered conditions (2016), and the DWQG was exceeded in 40% of total samples collected during ice-covered conditions (2016 and 2017) and 2% of total samples collected during open-water conditions (2015 to 2017) (Appendix 3D, Tables 3D.1 to 3D.5).

Water column profile measurements of specific conductivity were generally similar among stations and sampling programs. During ice-covered conditions in 2017 specific conductivity ranged from 30 to 117 µS/cm and during open-water conditions ranged from 68 to 82 µS/cm (Appendix 3B, Figures 3B.4-1 to 3B.4-5). Similar conductivity values were observed in 2015 and 2016 (Appendix 3E, Figure 3E.1-2*a*). Specific conductivity values were slightly higher at the Near-field area (MEL-01) and generally more variable during ice-covered conditions.

Median pH was similar between ice-covered and open-water conditions, but conductivity was generally higher during under-ice conditions (as compared to open-water conditions), and dissolved oxygen (and temperature) were lower during under-ice conditions (as compared to open-water conditions) (Table 3.3-1). Statistical tests indicate that both, Near-field and Mid-field areas, had statistically different pH and conductivity values, lower and higher respectively, than the reference areas; conductivity was also statistically different between Near-field and Mid-field areas under open-water conditions (Table 3.3-2). Dissolved oxygen was similar between all areas.

Table 3.3-1: Median Concentrations (2015 to 2017) of Selected Field-Measured Parameters, Meliadine Lake

Parameter	Unit	Ice-Covered		Open-Water				
		MEL-01	MEL-02	MEL-01	MEL-02	MEL-03	MEL-04	MEL-05
pH	NA	7.3	7.1	7.5	7.6	7.6	7.6	7.7
Specific conductivity	µS/cm	75	87	72	69	67	67	70
Temperature	°C	1.1	1.1	12.6	12.5	12.6	13.6	13.3
Dissolved oxygen	mg/L	8.9	11.5	10.5	11.8	10.8	10.2	10.6
Dissolved oxygen	%	64	84	101	102	104	99	102

NA = not applicable; µS/cm = microsiemens per centimetre; mg/L = milligrams per litre; % = percentage saturation.

Table 3.3-2: Statistical Test Summary for Selected Field-Measured Parameters, Meliadine Lake

Parameter	Ice-Covered		Open-Water					
	MEL-01 versus MEL-02		MEL-01 versus MEL-02		MEL-01 versus Reference		MEL-02 versus Reference	
	P-value	Test	*P*-value	Test	*P*-value	Test	*P*-value	Test
Dissolved oxygen	0.035	ANOVA	0.330	ANOVA	0.737	ANOVA	0.172	M-W U test
pH	0.334	ANOVA	0.744	ANOVA	**0.009**	ANOVA	**0.035**	ANOVA
Specific conductivity	0.271	ANOVA	**0.001**	ANOVA	**<0.001**	ANOVA	**0.045**	ANOVA

Note: **Bolded** cells represent statistically different values (i.e., p <0.05).

ANOVA = analysis of variance; M-W U tests = Mann-Whitney U statistical test.

3.3.1.2 Water Chemistry

Water chemistry results for discrete samples collected from Meliadine Lake areas in 2017 are provided in Appendix 3C, Tables 3C.1 to 3C.5. Summaries of the 2015 and 2016 dataset were provided in Golder 2017a and a summary of statistical analysis for each Meliadine Lake area on the 2015 to 2017 dataset is provided in Appendix 3D, Tables 3D.1 to 3D.5. Time series plots for selected parameters of interest are presented in Appendix 3E to illustrate general trends in parameter concentrations in Meliadine Lake.

Conventional Parameters

Consistent with field measurements, laboratory-measured conductivity in 2017 was slightly higher at the Near-field area as compared to the rest of the areas during each sampling program (Appendix 3C). Also, slightly higher conductivities were observed during ice-covered conditions as compared to open-water conditions (Table 3.3-3). Similar trends were observed in 2015 and 2016 (Appendix 3E, Figure 3E.1-2*a*). Statistical tests indicated that both Near-field and Mid-field areas had statistically different conductivity values than the reference areas; conductivity was also statistically different between Near-field and Mid-field areas (Table 3.3-4).

Water hardness was generally higher at the Near-field area than all areas during open-water conditions and higher than the Mid-field area during ice-covered conditions. In 2017, hardness ranged from 25 to 32 mg/L (ice-covered conditions) and from 19 to 25 mg/L (open-water conditions) and classified as *very soft* water (McNeely et al 1979). Similar hardness values were measured in 2015 to 2016 (Appendix 3E, Figure 3E.1-2b). Statistical tests indicate that hardness at the Near-field area was statistically different than the Mid-field and reference areas (Table 3.3-4).

Alkalinity in 2017 was consistent among stations and seasons and ranged from 13 to 21 mg/L, which classifies Meliadine Lake as *moderately sensitive* to acid deposition (Saffran and Trew 1996). Similar hardness values were measured in 2015 to 2016 (Appendix 3E, Figure 3E.1-2*c*)

Concentrations of total dissolved solids (TDS) in 2017 ranged from less than the DL to 67 mg/L (Appendix 3C, Tables 3C.1 to 3C.5). Concentrations of TDS were consistent among years and stations (Appendix 3E, Figure 3E.1-2*d*) and all TDS concentrations were well below the Health Canada Aesthetic guideline (Health Canada 2014).

Concentrations of total suspended solids (TSS) ranged from less than DL to 7.6 mg/L (Appendix 3C). Concentrations were consistent among years and stations, but TSS was more frequently detected in samples collected during open-water conditions in 2017 (Appendix 3E.1-2*e*).

Statistical tests indicate that both, Near-field and Mid-field areas, had statistically higher TDS concentrations than the reference areas. The Near-field area also had statistically higher TDS concentrations than the Mid-field area during ice-covered conditions, but TDS concentrations between the Near-field and Mid-field were not statistically different during open-water conditions (Table 3.3-4).

Table 3.3-3: Median Concentrations (2015 to 2017) of Selected Conventional Parameters, Meliadine Lake

Parameter	Unit	Ice-Covered		Open-Water				
		MEL-01	MEL-02	MEL-01	MEL-02	MEL-03	MEL-04	MEL-05
Specific conductivity	µS/cm	91	83	74	70	67	67	71
Total hardness	mg/L	27	26	23	21	21	21	22
Total alkalinity	mg/L	17	17	15	16	16	16	17
Total dissolved solids	mg/L	54	45	47	45	43	41	44
Total suspended solids	mg/L	<1.0	<1.0	1.2	1.1	<1.0	<1.0	<1.0
Turbidity	NTU	0.18	0.15	0.41	0.31	0.27	0.25	0.25

µS/cm = microsiemens per centimetre; mg/L = milligrams per litre; NTU = Nephelometric turbidity unit; < = less than.

Table 3.3-4: Statistical Test Summary for Selected Conventional Parameters, Meliadine Lake

Parameter	Ice-Covered		Open-Water					
	MEL-01 versus MEL-02		MEL-01 versus MEL-02		MEL-01 versus Reference		MEL-02 versus Reference	
	P-value	Test	*P*-value	Test	*P*-value	Test	*P*-value	Test
Specific conductivity	**<0.001**	ANOVA	**<0.001**	ANOVA	**<0.001**	ANOVA	**<0.001**	ANOVA
Total hardness	**0.010**	ANOVA	**0.001**	ANOVA	**<0.001**	ANOVA	0.774	M-W U test
Total alkalinity	0.937	ANOVA	0.869	ANOVA	0.229	ANOVA	0.231	M-W U test
Total dissolved solids	**0.022**	ANOVA	0.449	ANOVA	**<0.001**	ANOVA	**0.067**	M-W U test

Note: **Bolded** cells represent statistically different values (i.e., $p < 0.05$).

ANOVA = analysis of variance; M-W U tests = Mann-Whitney U statistical test; < = less than.

Major Ions

Concentrations of major ions measured in 2017 were within similar ranges as those measured in previous two years (Appendix 3C). Bicarbonate, chloride, and fluoride were the dominant anions during both ice-covered and open-water conditions (Table 3.3-5); carbonate and hydroxide were non-detectable in all samples.

Major ions concentrations measured between 2015 and 2017 were generally consistent throughout the sampling period and among stations, with the exception of some ions concentrations being higher at the Near-field area and some being higher during ice-covered conditions (Appendix 3D, Tables 3D.1 to 3D.5; Appendix 3E, Figures 3E.1-3).

In 2017, chloride concentrations ranged from 8 to 13 mg/L and were slightly higher in the Near-field area as compared to all areas during open-water and as compared to the Mid-field during ice-covered conditions (Table 3.3-5). Fluoride concentrations ranged <0.02 to 0.04 mg/L and were consistent among areas and seasons (Appendix 3C). Both, chloride and fluoride, were in concentrations lower than the applicable CWQGs for the protection of aquatic life, DWQGs, and SSWQOs (Table 3.1-2). Similar trends and concentrations were observed in 2015 and 2016 (Appendix 3E, Figures 3E.1-3*c* and 3E.1-3*d*).

Sulphate concentrations ranged from 3.1 to 5.5 mg/L and silica concentrations ranged from 0.21 to 0.62 mg/L and both were generally higher at the Near-field area (Appendix 3C, Tables 3C.1 to 3C.5). Similar sulphate and silica concentrations were observed in 2015 and 2016 (Appendix 3E, Figures 3E.1-3*h* and 3E.1-3*i*).

Major cations were overall slightly higher at the Near-field area as compared to the Mid-field and reference areas; major cations were also higher during ice-covered conditions as compared to the open-water conditions (Table 3.3-5). Calcium concentrations ranged from 6.2 to 10.2 mg/L, magnesium concentrations ranged from 1.0 to 1.6 mg/L; potassium concentrations ranged from 0.8 to 1.1 mg/L; and sodium concentrations ranged from 3.9 to 6.3 mg/L. Similar trends and ranges were observed in 2015 and 2016 (Appendix 3E, Figures 3E.1-3*b, e, f, g*).

Statistical tests indicate than most ions concentrations were statistically higher in the Near-field as compared to the Mid-field during under-ice conditions, and in the Near-field and Mid-field as compared to the reference areas during open-water conditions (Table 3.3-6). It is noted that the concentrations are not ecologically relevant (i.e., at concentrations that could cause ecological or toxicological effects) as they are orders of magnitude below the generic and conservative guidelines.

Table 3.3-5: Median Concentrations (2015 to 2017) of Major Ions, Meliadine Lake

Parameter	Unit	Ice-Covered		Open-Water				
		MEL-01	MEL-02	MEL-01	MEL-02	MEL-03	MEL-04	MEL-05
Bicarbonate	mg/L	21	21	19	19	19	19	21
Calcium	mg/L	8.9	8.2	7.1	6.7	6.5	6.4	6.9
Chloride	mg/L	12	10	9.4	8.6	8.0	8.1	8.2
Fluoride	mg/L	0.027	0.026	0.024	0.030	0.026	0.028	0.026
Magnesium	mg/L	1.5	1.4	1.2	1.1	1.1	1.1	1.1
Potassium	mg/L	1.1	1.0	0.9	0.9	0.9	0.8	0.9
Sodium	mg/L	5.9	5.3	4.9	4.4	4.2	4.1	4.3
Sulphate	mg/L	5.2	4.4	4.1	3.7	3.4	3.5	3.5
Silica (reactive)	mg/L	0.57	0.41	0.47	0.29	0.22	0.22	0.24

mg/L = milligrams per litre.

Table 3.3-6: Statistical Test Summary for Selected Major Ions, Meliadine Lake

Parameter	Ice-Covered		Open-Water					
	MEL-01 versus MEL-02		MEL-01 versus MEL-02		MEL-01 versus Reference		MEL-02 versus Reference	
	P-value	Test	*P*-value	Test	*P*-value	Test	*P*-value	Test
Chloride	**<0.001**	M-W U test	**<0.001**	M-W U test	**<0.001**	M-W U test	**<0.001**	M-W U test
Fluoride	0.447	M-W U test	0.223	M-W U test	0.025	M-W U test	0.118	M-W U test
Calcium	**0.027**	ANOVA	**0.005**	ANOVA	<0.001	ANOVA	0.657	ANOVA
Magnesium	**<0.001**	ANOVA	**<0.001**	ANOVA	**<0.001**	ANOVA	**0.002**	ANOVA
Potassium	0.057	ANOVA	0.230	ANOVA	**0.006**	ANOVA	0.082	ANOVA
Sodium	**<0.001**	ANOVA	**<0.001**	ANOVA	**<0.001**	ANOVA	**<0.001**	ANOVA
Sulphate	**<0.001**	ANOVA	**<0.001**	ANOVA	**<0.001**	ANOVA	**<0.001**	ANOVA
Silica (reactive)	**<0.001**	ANOVA	**<0.001**	ANOVA	**<0.001**	ANOVA	**<0.001**	ANOVA

Note: **Bolded** cells represent statistically different values (i.e., p <0.05).

M-W U tests = Mann-Whitney U statistical test; ANOVA = analysis of variance; < = less than.

Nutrients

Nutrients concentrations in 2017 were low and generally consistent among stations and sampling events (Appendix 3C, Tables 3C.1 to 3C.5). Nitrate concentrations ranged from <0.005 to 0.17 mg-N/L and were slightly higher in September at Mid-field area, and some stations within the Near-field area and Reference Area 1 (MEL-03). Nitrite concentrations ranged from <0.001 to 0.004 mg-N/L and were all lower than the CWQG for the protection of aquatic life. Concentrations were low in all areas (Table 3.3-7); however, nitrate concentrations were statistically different between the two exposure areas during ice-covered conditions but not open-water conditions and concentrations were not statistically different during open-water conditions (Table 3.3-8).

Total ammonia concentrations were also low in 2017, ranging from <0.005 to 0.030 mg-N/L, with slightly higher values during ice-covered conditions (Table 3.3-7). Similar concentrations and trends were observed in 2015 and 2016 and concentrations were statistically different between the two exposure areas during ice-covered conditions; concentrations were similar between all areas during open-water conditions (Table 3.3-8). All detected ammonia concentrations were below the CWQGs for the protection of aquatic life.

Concentrations of TKN ranged from 0.10 to 0.39 mg-N/L (Appendix 3C) and were slightly higher at the exposure areas (Table 3.3-7). Similar TKN concentrations and trends were observed in 2015 and 2016 (Appendix 3E, Figures 3E.1-4*c* and 3E.1-4*d*) and, during open-water conditions, concentrations were statistically higher in the Near-field and Mid-field as compared to the reference areas (Table 3.3-8).

Total phosphorus (TP) and dissolved phosphorus (TDP) were detected in most samples in 2017 and concentrations ranged from <0.001 to 0.013 mg-P/L and 0.006 mg-P/L, respectively (Appendix 3C). Similar concentrations were observed in 2015 and 2016 (Appendix 3E, Figures 3E.1-4*e* and 3E.1-4*f*). Statistical tests indicate that TP concentrations at the Near-field area were statistically different than Mid-field and reference areas during open-water conditions (Table 3.3-8).

Based on the range of TP concentrations reported for Meliadine Lake in 2017 (median of 0.004 mg-P/L), and TP trigger ranges for Canadian lakes (CCME 2004), Meliadine Lake can be classified as *oligotrophic* (i.e., concentrations are generally within the 0.0004 to 0.01 mg-P/L range). Trophic status, as based on nutrient and chlorophyll *a* concentrations, and Secchi depth, is classified as *oligotrophic* (Section 7.3.2).

Organic carbon occurred primarily in dissolved form as opposed to particulate organic carbon. Total organic carbon (TOC) concentrations ranged from 2.0 to 4.3 mg/L; dissolved organic carbon (DOC) concentrations ranged from 2.0 to 4.1 mg/L.

Table 3.3-7: Median Concentrations (2015 to 2017) of Nutrient Parameters, Meliadine Lake

Parameter	Unit	Ice-Covered		Open-Water				
		MEL-01	MEL-02	MEL-01	MEL-02	MEL-03	MEL-04	MEL-05
Nitrate	mg-N/L	0.010	0.006	<0.005	<0.005	<0.005	<0.005	<0.005
Nitrite	mg-N/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Ammonia	mg-N/L	0.024	0.016	<0.005	<0.005	<0.005	<0.005	<0.005
TKN	mg-N/L	0.20	0.18	0.17	0.17	0.14	0.14	0.11
Total phosphorus	mg-P/L	0.003	0.003	0.006	0.004	0.004	0.004	0.004
Dissolved phosphorus	mg-P/L	0.001	0.002	0.002	0.002	0.002	0.002	0.003
Orthophosphate	mg-P/L	0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Total organic carbon	mg/L	3.2	2.9	2.9	2.6	2.3	2.3	2.4
Dissolved organic carbon	mg/L	3.2	2.9	2.9	2.6	2.2	2.2	2.2

TKN= total Kjeldahl nitrogen; mg-N/L = milligrams nitrogen per litre; mg-P/L = milligrams phosphorus per litre; mg/L = milligrams per litre; < = less than.

Table 3.3-8: Statistical Test Summary for Selected Nutrient Parameters, Meliadine Lake

Parameter	Ice-Covered		Open-Water					
	MEL-01 versus MEL-02		MEL-01 versus MEL-02		MEL-01 versus Reference		MEL-02 versus Reference	
	P-value	Test	*P*-value	Test	*P*-value	Test	*P*-value	Test
Nitrate	**0.006**	ANOVA	0.402	ANOVA	0.087	ANOVA	0.559	M-W U test
Ammonia	**<0.001**	ANOVA	0.456	ANOVA	0.357	ANOVA	0.834	M-W U test
TKN	0.052	ANOVA	0.394	ANOVA	**<0.001**	ANOVA	**0.006**	ANOVA
Total phosphorus	0.051	ANOVA	**0.005**	ANOVA	**<0.001**	ANOVA	0.163	M-W U test

Note: **Bolded** cells represent statistically different values (i.e., p <0.05).

ANOVA = analysis of variance; M-W U test = Mann-Whitney U statistical test; < = less than.

Metals

Total and dissolved metals analyzed in 2017 were detected in most samples but concentrations were low and within similar ranges as those measured in the past two years, with some exceptions. During the September program, concentrations of some total metals (i.e., aluminum, molybdenum, nickel, tin, and zinc) and dissolved metals (cadmium and molybdenum) were slightly higher than in past programs, primarily at some stations in the Near-field area. Metals were analyzed using DLs lower than applicable guidelines and site-specific objectives and all detected metals concentrations in 2017 were lower than the guidelines or objectives (Appendix 3C, Tables 3C.1 to 3C.5).

Between 2015 and 2017, total beryllium was not detected in any sample, and total bismuth, cadmium, chromium, silver, thallium, tin, titanium, and vanadium were not detected in any sample collected during ice-covered conditions, but were detected during open-water conditions (Appendix 3D, Tables 3D.1 to 3D.5; Appendix 3E, Figures 3E.1-5).

Total metals concentrations were generally consistent among sampling programs and seasons. Among sampling stations, detected concentration of some total metals (e.g., arsenic, cobalt, manganese, nickel, strontium) and dissolved metals (e.g., arsenic, iron, lead, nickel, zinc) were generally slightly higher at the Near-field area as compared to the Mid-field or reference areas (Table 3.3-9; Appendix 3E, Figures 3E.1-5). Statistical tests indicate that total arsenic, barium, cobalt, copper, iron, lithium, manganese, mercury, nickel, strontium, and uranium were statistically different between the exposure and reference areas (Table 3.3-10; Appendix 3F, Table 3F.1). Concentrations of arsenic, cobalt, iron, manganese, and nickel were statistically higher in the Near-field as compared to Mid-field during ice-covered and open-water conditions and reference areas during open-water conditions. Concentrations of barium were higher in the reference areas as compared to the Near-field and Mid-field areas, and concentrations of mercury, strontium and uranium were higher in the Near-field and Mid-field as compared to the reference areas during open-water conditions. It is noted that the concentrations are not ecologically relevant as they are orders of magnitude below the guidelines.

Table 3.3-9: Median Concentrations (2015 to 2017) of Total Metals Parameters, Meliadine Lake

Parameter	Unit	Ice-Covered		Open-Water				
		MEL-01	MEL-02	MEL-01	MEL-02	MEL-03	MEL-04	MEL-05
Aluminum	µg/L	1.1	1.0	2.9	2.4	2.7	2.2	1.9
Antimony	µg/L	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Arsenic	µg/L	0.38	0.28	0.39	0.26	0.20	0.18	0.25
Barium	µg/L	8.8	8.8	7.3	7.5	7.5	7.6	7.7
Beryllium	µg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Bismuth	µg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Boron	µg/L	5.4	5.1	<5.0	<5.0	<5.0	<5.0	5.0
Cadmium	µg/L	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Chromium	µg/L	<0.06	<0.06	<0.06	<0.06	<0.1	<0.1	<0.1
Cobalt	µg/L	0.013	<0.010	0.021	0.015	0.010	0.011	0.011
Copper	µg/L	0.89	0.82	0.74	0.74	0.71	0.69	0.70
Iron	µg/L	8.6	4.1	21	13	11	7.2	7.6
Lead	µg/L	<0.01	0.012	<0.01	<0.01	<0.01	<0.01	<0.01
Lithium	µg/L	0.85	0.84	0.69	0.62	<0.5	0.67	0.60
Manganese	µg/L	2.3	1.4	5.5	4.2	2.3	2.6	2.8
Mercury	µg/L	0.0005	<0.0005	0.0006	0.0006	0.0006	0.0006	<0.0005
Molybdenum	µg/L	0.080	0.074	0.066	0.063	0.062	0.065	0.073
Nickel	µg/L	0.67	0.53	0.59	0.51	0.37	0.37	0.37
Selenium	µg/L	0.040	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
Silver	µg/L	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Strontium	µg/L	42	39	33	31	31	31	32
Thallium	µg/L	<0.005	<0.005	<0.005	<0.005	0.0021	<0.005	<0.005
Tin	µg/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Titanium	µg/L	<0.1	<0.1	0.13	<0.1	0.34	<0.5	<0.5

Parameter	Unit	Ice-Covered		Open-Water				
		MEL-01	MEL-02	MEL-01	MEL-02	MEL-03	MEL-04	MEL-05
Uranium	µg/L	0.015	0.013	0.015	0.014	0.014	0.014	0.014
Vanadium	µg/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Zinc	µg/L	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	1.3

µg/L = microgram per litre; < = less than.

Table 3.3-10: Statistical Test Summary for Selected Total Metals, Meliadine Lake

Parameter	Ice-Covered		Open-Water					
	MEL-01 versus MEL-02		MEL-01 versus MEL-02		MEL-01 versus Reference		MEL-02 versus Reference	
	P-value	Test	*P*-value	Test	*P*-value	Test	*P*-value	Test
Aluminum	0.101	ANOVA	0.200	ANOVA	0.168	M-W U test	0.168	M-W U test
Arsenic	**<0.001**	ANOVA	<0.001	ANOVA	**<0.001**	M-W U test	**<0.001**	M-W U test
Barium	0.464	ANOVA	0.044	ANOVA	**0.018**	M-W U test	**0.018**	M-W U test
Boron	0.306	ANOVA	0.751	ANOVA	0.432	M-W U test	0.432	M-W U test
Cadmium	-	-	-	-	0.284	M-W U test	0.284	M-W U test
Cobalt	**<0.001**	ANOVA	**<0.001**	ANOVA	**<0.001**	M-W U test	**<0.001**	M-W U test
Copper	**<0.001**	ANOVA	0.288	ANOVA	**0.001**	M-W U test	**0.001**	M-W U test
Iron	**<0.001**	ANOVA	**<0.001**	ANOVA	**<0.001**	M-W U test	**<0.001**	M-W U test
Lead	-	-	-	-	0.282	M-W U test	0.282	M-W U test
Manganese	**<0.001**	ANOVA	**<0.001**	ANOVA	**<0.001**	M-W U test	**<0.001**	M-W U test
Mercury	-	-	0.263	ANOVA	**0.023**	M-W U test	**0.023**	M-W U test
Molybdenum	**0.015**	ANOVA	0.453	ANOVA	0.690	M-W U test	0.690	M-W U test
Nickel	**<0.001**	ANOVA	**<0.001**	ANOVA	**<0.001**	M-W U test	**<0.001**	M-W U test
Strontium	0.093	ANOVA	0.115	ANOVA	**<0.001**	M-W U test	**<0.001**	M-W U test
Uranium	-	-	0.119	ANOVA	**0.008**	M-W U test	**0.008**	M-W U test
Zinc	-	-	-	-	0.844	M-W U test	0.844	M-W U test

Note: **Bolded** cells represent statistically different values (i.e., $p < 0.05$).

ANOVA = analysis of variance; M-W U test = Mann-Whitney U statistical test; < = less than; - = statistical test not completed as more than 50% of the results were non-detect.

Cyanide

Free and weak acid dissociable cyanide species measured between 2015 and 2017 were below the analytical DL for all stations and sampling events (Appendix 3D, Tables 3D.1 through 3D.5). Detection limits for cyanide species were at, or lower than, applicable guidelines (i.e., 0.005 mg/L CCME 1999).

3.3.2 Peninsula Lakes

Three peninsula lakes were sampled in July and August 2017 during open-water conditions. Water quality samples were also collected at the peninsula lakes in 2015 (August) and 2016 (July and August) and a summary of the 2015 and 2016 data were provided in Golder 2017a. Detailed water quality data collected at peninsula lakes in 2017 is summarized in Appendix 3C and a general characterization is presented in this section.

3.3.2.1 Field Measured Physico-chemical Parameters

In situ measurements of physico-chemical parameters at the peninsula lakes during the 2017 sampling programs did not indicate stratification within the water column at the time of sampling and results were generally similar to those measured in the previous two years (Appendix 3B, Figures 3B.6 to 3B.8; Golder 2017a).

Water temperatures at the peninsula lakes in 2017 ranged from 9.4°C to 14.7°C and were overall consistent among lakes. Dissolved oxygen concentrations ranged from 10.0 to 11.6 mg/L (100 to 108% saturation) and were also similar among lakes. Dissolved oxygen concentrations in 2017 were all above the minimum CWQG requirements for the protection of aquatic life (i.e., 6.5 mg/L). Similar temperatures and oxygen concentrations were measured in 2015 and 2016 (Appendix 3E, Figure 3E.2-1).

Peninsula lakes had slightly basic conditions (Cowardin et al. 1979), with pH values ranging from 7.9 to 8.4; similar pH conditions were observed in 2015 and 2016. All pH measurements in 2017 were within CWQG for the protection of aquatic life and Health Canada guidelines ranges (i.e., pH = 6.5 to 9 and 7.0 to 10.5, respectively).

Specific conductivity profiles were consistent throughout the water column at each lake. Conductivities ranged from 151 to 306 µS/cm and were slightly higher at Lake A8 as compared to lakes B7 and D7 (Table 3.3-11). Similar conductivity trend was observed in the past (Appendix 3D, Tables 3D.6 to 3D.8).

Field-measured parameters at the peninsula lakes were similar to those measured in Meliadine Lake, with exception of specific conductivities, which were lower in Meliadine Lake (median = 69 µS/cm; Section 3.2.1.1).

Table 3.3-11: Median Concentrations (2015 to 2017) of Selected Field-Measured Parameters, Peninsula Lakes

Parameter	Unit	Lake A8	Lake B7	Lake D7
pH	NA	8.2	7.9	8.3
Specific conductivity	µS/cm	289	159	147
Temperature	°C	14.1	12.1	12.9
Dissolved oxygen	mg/L	9.8	9.8	10.7
Dissolved oxygen	%	96	96	103

NA = not applicable; µS/cm = microsiemens per centimetre; mg/L = milligrams per litre; % = percentage saturation.

3.3.2.2 Water Chemistry

Water chemistry results for discrete samples collected at the peninsula lakes in 2017 are presented in Appendix 3C (Tables 3C.6 to 3C.8). A descriptive statistic summary for 2015 to 2017 dataset is presented in Appendix 3D (Tables 3D.6 to 3D.8) and detailed results of the 2015 and 2016 sampling programs are presented in Golder 2017a. Summary plots for selected parameters of interest to illustrate general trends in parameter concentrations in the peninsula lakes are presented in Appendix 3E.

Conventional Parameters

Water hardness in peninsula lakes in 2017 ranged from 52 to 115 mg $CaCO_3$/L and was consistently higher at Lake A8 (Table 3.3-12). Lakes A8 and B7 had *moderately soft* water (McNeeley et al. 1979), while Lake D7 had *soft* water.

Based on alkalinity, peninsula lakes are classified as having *minimal* or *low sensitivity* to acid deposition (Saffran and Trew 1996). Alkalinities ranged from 37 to 55 mg $CaCO_3$/L, and were slightly higher at Lake D7 (Appendix 3C).

Peninsula lakes had low to moderate ionic strength; TDS concentrations ranged from 89 to 229 mg/L and were higher at Lake A8. Concentrations of TSS and turbidity indicate that water in the peninsula lakes was clear (i.e., TSS concentrations were less than 3.4 mg/L and turbidity less than 1.0 NTU; Appendix 3C, Tables 3C.6 to 3C.8).

Similar trends and concentrations of conventional parameters were observed in 2015 and 2016. Hardness, specific conductivity, and TDS concentrations were higher at Lake A8, and alkalinity was slightly higher at D7 (Table 3.3-12; Appendix 3E, Figures 3E.2-2).

Higher conductivity, hardness, alkalinity, and TDS concentrations were observed in the peninsula lakes than those measured in Meliadine Lake (Section 3.2.1.1).

Table 3.3-12: Median Concentrations (2015 to 2017) of Selected Conventional Parameters, Peninsula Lakes

Parameter	Unit	Lake A8	Lake B7	Lake D7
Specific conductivity	µS/cm	285	163	146
Total hardness	mg/L	108	63	52
Total alkalinity	mg/L	45	37	52
Total dissolved solids	mg/L	197	108	90
Total suspended solids	mg/L	<1.0	1.1	<1.0
Turbidity	NTU	0.50	0.43	0.82

µS/cm = microsiemens per centimetre; mg/L = milligrams per litre; NTU = Nephelometric turbidity unit; < = less than.

Major Ions

Concentrations of major ions in 2017 differed among peninsula lakes, but were similar among stations and sampling events within each lake. Lake D7 had higher bicarbonate and fluoride concentrations, and Lake A8 had higher chloride, sulphate, and major cations than the other two lakes (Table 3.3-13). Carbonate and hydroxide were non-detectable in all samples (Appendix 3C, Tables 3C.6 to 3C.8). Similar concentrations and trends were observed in 2015 and 2016 (Appendix 3E, Figures 3E.2-3).

None of the measured concentrations of major ions (i.e., chloride, fluoride, and sulphate) exceeded associated guidelines and/or objectives (Appendix 3C, Tables 3C.6 to 3C.8). With exception of the non-detectable ions (i.e., carbonate and hydroxide), all other major ions had higher concentrations in the peninsula lakes than in Meliadine Lake (Section 3.2.1.1).

Table 3.3-13: Median Concentrations (2015 to 2017) of Selected Major Ions, Peninsula Lakes

Parameter	Unit	Lake A8	Lake B7	Lake D7
Bicarbonate	mg/L	54	45	63
Calcium	mg/L	36	21	16
Chloride	mg/L	57	24	12
Fluoride	mg/L	0.03	0.03	0.04
Magnesium	mg/L	4.5	2.4	2.9
Potassium	mg/L	2.0	1.3	1.3
Sodium	mg/L	7.8	3.9	8.0
Sulphate	mg/L	6.6	4.6	4.3
Silica (reactive)	mg/L	0.58	0.83	0.21

mg/L = milligrams per litre.

Nutrients

Concentrations of nutrients measured in 2017 at the peninsula lakes were generally consistent among lakes, with exception of some phosphorus-based nutrients (Appendix 3C, Tables 3C.6 to 3C.8).

Nitrate and nitrite were non-detected in the peninsula lakes in 2017. Total ammonia concentrations were also low, ranging from <0.005 to 0.042 mg-N/L, and were all below the applicable CWQG for the protection of aquatic life.

Total and dissolved phosphorus concentrations were detected in all samples and ranged from 0.005 to 0.017 mg-P/L and from 0.0015 to 0.0064 mg-P/L, respectively. Orthophosphate concentrations were typically below the DL and ranged from <0.001 to 0.004 mg-P/L (Appendix 3C, Tables 3C.6 to 3C.8). Phosphorus-based nutrients were generally higher at Lake D7 (Table 3.3-14). Based on the range of TP concentrations and trigger ranges for Canadian Lakes (CCME 2004) the peninsula lakes can be classified as *oligotrophic* (Lakes A8 and B7) to *mesotrophic* (Lake D7).

Similar nutrients concentrations and trends were observed in 2015 and 2016 (Appendix 3E, Figures 3E.2-4). Nutrient concentrations measured at the peninsula lakes were similar to those measured at Meliadine Lake (Section 3.2.1.1).

Table 3.3-14: Median Concentrations (2015 to 2017) of Selected Nutrients Parameters, Peninsula Lakes

Parameter	Unit	Lake A8	Lake B7	Lake D7
Nitrate	mg-N/L	<0.005	<0.005	<0.005
Nitrite	mg-N/L	<0.001	<0.001	<0.001
Ammonia	mg-N/L	0.005	0.006	0.006
TKN	mg-N/L	0.31	0.33	0.35
Total phosphorus	mg-P/L	0.006	0.007	0.013
Dissolved phosphorus	mg-P/L	0.002	0.002	0.004
Orthophosphate	mg-P/L	<0.001	<0.001	0.001
Total organic carbon	mg/L	4.0	5.3	4.8
Dissolved organic carbon	mg/L	4.0	5.2	4.5

TKN= total Kjeldahl nitrogen; mg-N/L = milligrams nitrogen per litre; mg-P/L = milligrams phosphorus per litre; mg/L = milligrams per litre; < = less than.

Metals

Total and dissolved metals analyzed in 2017 at the peninsula lakes were detected in most samples, but concentrations were generally low (Appendix 3C; Tables 3C.6 to 3C.8). Total beryllium, bismuth, chromium, silver, and titanium were non-detected in the peninsula lakes, and total antimony, boron, selenium, tin, and vanadium were only detected in one or two lakes. Dissolved beryllium and silver were non-detected in any sample; the remaining dissolved metals were detected at least once in one or all lakes.

Total metals concentrations were generally consistent among years, but some metals (i.e., total arsenic, barium, molybdenum, nickel, and selenium) were slightly higher in 2016 and 2017 as compared to 2015. Also, most metals concentrations were similar among lakes, with some exceptions. Lake D7 had slightly higher total boron, lithium, molybdenum, selenium, uranium, and vanadium, and Lake A8 had higher total arsenic, barium, and strontium than other lakes (Table 3.3-15; Appendix 3E, Figures 3E.2-5).

Metals were analyzed using DLs lower than applicable guidelines and all detected metals concentrations in 2017 were lower than these guidelines or objectives (Appendix 3C, Tables 3C.6 to 3C.8).

Metals concentrations in the peninsula lakes were similar to those measured in Meliadine Lake, with exception of total and dissolved arsenic, barium, lithium, and strontium, which had higher concentrations at the peninsula lakes (Appendix 3E, Figures 3E.1-5 and 3E.2-5).

Table 3.3-15: Median Concentrations (2015 to 2017) of Selected Total Metals, Peninsula Lakes

Parameter	Unit	Lake A8	Lake B7	Lake D7
Aluminum	µg/L	1.7	1.8	5.1
Arsenic	µg/L	2.1	1.4	1.0
Barium	µg/L	29	19	16
Boron	µg/L	<5	<5	13
Cadmium	µg/L	<0.005	<0.005	<0.005
Chromium	µg/L	<0.06	<0.06	<0.06
Cobalt	µg/L	0.033	0.039	0.044
Copper	µg/L	0.66	0.71	0.75
Iron	µg/L	46	74	52
Lead	µg/L	<0.01	0.011	<0.01
Manganese	µg/L	8.8	6.4	10
Mercury	µg/L	0.0008	0.0007	0.0007
Molybdenum	µg/L	0.21	0.17	0.43
Nickel	µg/L	0.81	0.92	0.65
Strontium	µg/L	257	147	78
Uranium	µg/L	0.043	0.026	0.081
Zinc	µg/L	<0.8	<0.8	<0.8

µg/L – micrograms per litre; < = less than.

Cyanide

Free and weak acid dissociable cyanide species measured between 2015 and 2017 in the peninsula lakes were below the analytical DL for all stations and sampling events (Appendix 3D, Tables 3D.6 to 3D.8). Detection limits for cyanide species were at, or lower than, applicable guidelines (i.e., 0.005 mg/L CCME 1999).

3.3.2.3 Chlorophyll a

Chlorophyll *a* concentrations in the peninsula lakes varied among years and among lakes with generally lower concentrations of chlorophyll *a* in 2017 than in previous years (Figure 7.3-28). In July, mean concentrations of chlorophyll *a* were lower in all lakes than in 2016 with a mean of 1.2 ± 0.03 µg/L in Lake A8, 0.6 ± 0.3 µg/L in Lake B7, and 1.8 ± 0.08 µg/L in Lake D7. By comparison, mean chlorophyll *a* concentrations in 2016 were 2.5 ± 0.1 µg/L in Lake A8, 1.8 ± 0.08 µg/L in Lake B7, and 3.5 ± 0.09 µg/L in Lake D7. In August, chlorophyll *a* was slightly higher in each lake than in July but lower in 2017 than in previous years with high variability observed in Lake A8. Mean chlorophyll in August 2017 was 1.2 ± 2.4 µg/L in Lake A8, 1.3 ± 0.06 µg/L in Lake B7, and 2.3 ± 0.05 µg/L in Lake D7.

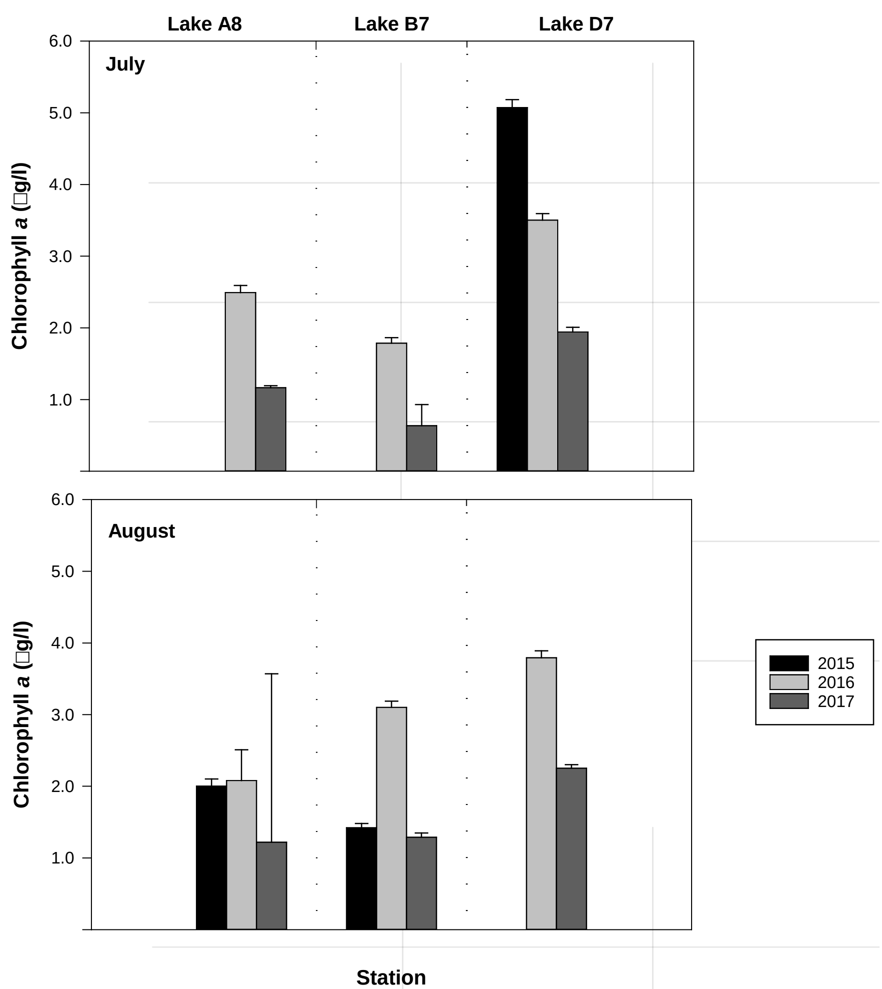


Figure 3.3-1: Mean Chlorophyll a Concentrations in the Peninsula Lakes, 2015 – 2017

Notes: Mean values are presented for each area. Error bars represent standard error (SE).

µg/l = micrograms per litre.

3.4 Normal Ranges

Provisional normal ranges were calculated for ecologically relevant water quality parameters (i.e., parameters with known toxicological benchmarks as defined by generic chronic or acute aquatic life guidelines). Normal ranges are provided for Meliadine Lake and the Peninsula Lakes.

3.4.1 Meliadine Lake

The provisional ice-covered normal range for Meliadine Lake was calculated using ice-covered data collected at the Mid-field area and the provisional open-water normal range for Meliadine Lake was calculated using open-water data from the reference areas (Table 3.4-1). This was done as it was noted that concentrations for some constituents were higher at the Near-field as compared to the Mid-field area during ice-covered conditions and higher at the Near-field and Mid-field as compared to the reference areas during open-water conditions. This may be a reflection of natural within lake variability and will attempt to be resolved by examining baseline data reported in the environmental impact statement report (Agnico Eagle 2014).

Median TDS concentrations at all stations were within the normal ranges, with the exception of the Near-field area during open-water (i.e., 47 mg/L, Table 3.3-3) which had slightly higher median TDS concentration than the normal range upper bound (i.e., 46 mg/L; Table 3.4-1). Median concentrations of major ions at the Near-field area during ice-covered conditions were all slightly higher than the upper bound of normal ranges calculated for ice-covered conditions. During open-water conditions, the Near-field area had slightly higher median calcium, sodium, magnesium, chloride, and sulphate concentrations than the normal ranges and the Mid-field area had slightly higher median chloride, fluoride, and sulphate concentrations than the normal ranges (Table 3.4-1). Median nitrate concentrations were within the provisional normal ranges. Under ice-covered conditions, the Near-field area had higher median ammonia concentration conditions than the normal range. Median TP concentrations were within the normal ranges. Under ice-covered condition, median concentrations of total arsenic, copper, iron, manganese, molybdenum, nickel, and uranium at the Near-field area were slightly higher than the upper bound of the normal range. Under open-water conditions, median concentrations of arsenic, iron, manganese, and nickel at the exposure areas were slightly higher than the normal range.

Table 3.4-1: Normal Ranges (2015 to 2017) for Selected Parameters, Meliadine Lake

Parameter	Unit	Detection Limit	Ice-Covered (Mid-field Area)			Open-Water (Reference Areas)		
			Method	Lower Bound	Upper Bound	Method	Lower Bound	Upper Bound
Major Ions								
Chloride	mg/L	0.5	PI	9.3	11.0	PI	7.8	8.3
Fluoride	mg/L	0.02	%tile	0.024	0.029	%tile	0[(a)]	0.028
Potassium	mg/L	0.02	PI	0.96	1.07	%tile	0.81	0.91
Sulphate	mg/L	0.3	PI	4.08	4.74	PI	3.26	3.59
Nutrients								
Nitrate	mg-N/L	0.005	%tile	0[(a)]	0.010	%tile	0[(a)]	0.006

Parameter	Unit	Detection Limit	Ice-Covered (Mid-field Area)			Open-Water (Reference Areas)		
			Method	Lower Bound	Upper Bound	Method	Lower Bound	Upper Bound
Total ammonia	mg-N/L	0.005	PI	0.011	0.021	%tile	0[(a)]	0.006
Total phosphorus	mg-P/L	0.001	PI	0.002	0.004	%tile	0.004	0.006
Total Metals								
Aluminum	µg/L	0.3	PI	0.82	1.22	%tile	2.07	4.84
Arsenic	µg/L	0.02	PI	0.256	0.297	PI	0.177	0.231
Barium	µg/L	0.05	PI	8.42	9.31	PI	7.33	7.74
Boron	µg/L	5	PI	0[(a)]	6.3	%tile	0[(a)]	6.2
Cadmium	µg/L	0.005	-	0[(c)]	0.005[(c)]	-	0[(a)]	0.005[(b)]
Cobalt	µg/L	0.005/0.01	%tile	0[(a)]	0.01[(b)]	%tile	0[(a)]	0.016
Copper	µg/L	0.1	PI	0.784	0.868	%tile	0.676	0.822
Iron	µg/L	1	log-PI	2.92	5.92	%tile	7.2	15.3
Lead	µg/L	0.01	%tile	0[(a)]	0.025	%tile	0[(a)]	0.059
Manganese	µg/L	0.05	log-PI	1.11	1.76	%tile	2.06	3.04
Mercury	µg/L	0.0005	%tile	0[(a)]	0.0005[(b)]	%tile	0[(a)]	0.00072
Molybdenum	µg/L	0.05	PI	0.064	0.079	%tile	0[(a)]	0.077
Nickel	µg/L	0.06	PI	0.502	0.564	%tile	0.334	0.400
Strontium	µg/L	0.2	PI	35.5	42.2	PI	29.8	32.1
Uranium	µg/L	0.01	%tile	0.012	0.014	PI	0.013	0.016
Zinc	µg/L	0.5/0.8	%tile	0[(a)]	0.85	%tile	0[(a)]	2.61

(a) the lower bound of the normal range was less than the detection limit; therefore, the lower bound of the normal range was set to zero.

(b) the upper bound of the normal range was less than the detection limit; therefore, the upper bound of the normal range was set to the detection limit.

(c) all values in the dataset were non-detect; therefore, the normal range was set from zero to the detection limit.

%tile = 2.5th and 97.5th percentiles; PI = 95% prediction intervals; log-PI = 95% prediction interval on log-transformed data.

mg/L = milligrams per litre; mg-N/L = milligrams nitrogen per litre; mg-P/L = milligrams phosphorus per litre; µg/L = micrograms per litre.

3.4.2 Peninsula Lakes

The provisional open-water normal range for the Peninsula Lakes was calculated using open-water data collected from lakes A8, B7, and D7 (Table 3.4-2).

Table 3.4-2: Normal Ranges (2015 to 2017) for Peninsula Lakes

Parameter	Unit	Detection Limit	Lake A8			Lake B7			Lake D7		
			Method	Lower Bound	Upper Bound	Method	Lower Bound	Upper Bound	Method	Lower Bound	Upper Bound
Major Ions											
Chloride	mg/L	0.5	%tile	45	59	%tile	22	25	%tile	10	12
Fluoride	mg/L	0.02	PI	0.028	0.037	%tile	0.021	0.034	%tile	0.036	0.046
Potassium	mg/L	0.02	%tile	1.79	2.13	PI	1.27	1.38	PI	1.10	1.44
Sulphate	mg/L	0.05	%tile	6.14	7.77	%tile	4.25	5.32	%tile	3.58	4.85
Nutrients											
Nitrate	mg-N/L	0.005	%tile	0[a]	0.0083	%tile	0[a]	0.005[b]	-	0[c]	0.005[c]
Total ammonia	mg-N/L	0.005	%tile	0[a]	0.009	%tile	0[a]	0.020	PI	0[a]	0.009
Total phosphorus	mg-P/L	0.001	PI	0.005	0.008	%tile	0.006	0.008	%tile	0.012	0.021
Total Metals											
Aluminum	µg/L	0.7	log-PI	1.15	2.57	%tile	1.61	5.73	PI	4.06	6.37
Arsenic	µg/L	0.02	PI	1.79	2.35	log-PI	1.29	1.73	PI	0.94	1.13
Barium	µg/L	0.02	%tile	25	30	PI	18	20	PI	15	17
Boron	µg/L	5	%tile	0[a]	5.2	%tile	0[a]	6.8	PI	10.1	16
Cadmium	µg/L	0.005	-	0[a]	0.005[b]	%tile	0[a]	0.005[b]	-	0[a]	0.005[b]

Parameter	Unit	Detection Limit	Lake A8			Lake B7			Lake D7		
			Method	Lower Bound	Upper Bound	Method	Lower Bound	Upper Bound	Method	Lower Bound	Upper Bound
Chromium	µg/L	0.06	%tile	0[(a)]	0.06[(b)]	-	0[(c)]	0.06[(c)]	%tile	0[(a)]	0.06[(b)]
Cobalt	µg/L	0.005	PI	0.021	0.045	PI	0.034	0.046	%tile	0.039	0.046
Copper	µg/L	0.1	PI	0.56	0.83	log-PI	0.60	0.89	PI	0.60	0.98
Iron	µg/L	1	PI	25	64	PI	57	98	%tile	47	97
Lead	µg/L	0.01	%tile	0[(a)]	0.018	%tile	0[(a)]	0.042	%tile	0[(a)]	0.015
Manganese	µg/L	0.05	PI	4.5	12.4	%tile	4.9	8.2	PI	9	12.1
Mercury	µg/L	0.0005	PI	0[(a)]	0.0011	log-PI	0[(a)]	0.0013	PI	0[(a)]	0.0009
Molybdenum	µg/L	0.05	%tile	0.18	0.22	PI	0.14	0.19	%tile	0.31	0.45
Nickel	µg/L	0.05	%tile	0.788	0.878	%tile	0.872	1.190	PI	0.571	0.725
Strontium	µg/L	0.05	%tile	213	264	PI	138	153	%tile	65	81
Uranium	µg/L	0.003	%tile	0.033	0.049	PI	0.023	0.029	PI	0.066	0.097
Zinc	µg/L	0.5	%tile	0[(a)]	1.53	%tile	0[(a)]	4.27	%tile	0[(a)]	1.69

(a) the lower bound of the normal range was less than the detection limit; therefore, the lower bound of the normal range was set to zero.

(b) the upper bound of the normal range was less than the detection limit; therefore, the upper bound of the normal range was set to the detection limit.

(c) all values in the dataset were non-detect; therefore, the normal range was set from zero to the detection limit.

%tile = 2.5^{th} and 97.5^{th} percentiles; PI = 95% prediction intervals; log-PI = 95% prediction interval on log-transformed data.

DL= detection limit; mg/L = milligram per litre; mg-N/L = milligrams nitrogen per litre; mg-P/L = milligrams phosphorus per litre; µg/L = micrograms per litre.

4.0 SEDIMENT QUALITY

Sediment quality monitoring was completed at Meliadine Lake in 2015 and 2016 to support the AEMP and Water Licence requirements for the Mine; sampling was completed in August of each year. The objective of the sediment monitoring activities was to characterize baseline conditions so that sediment quality trends and adaptive management strategies can be identified, as required, during the life of mine. A summary of the 2015 and 2016 data was provided in the 2016 annual report (Golder 2017a). The 2017 report included some initial data analysis (e.g., comparison to guidelines, calculation of descriptive statistics). This report uses those same data but includes more detailed evaluation of the data with statistical comparison between sampling areas, evaluation of differences in particle size, and discussion of potential confounding factors that could influence future monitoring.

This section of the report provides a detailed analysis of sediment quality based on the 2015 and 2016 dataset. The specific objectives are as follows:

- present detailed descriptive statistics (mean, median, standard deviation and standard error) for each sampling area
- evaluate differences between the exposure and reference areas of Meliadine Lake
- evaluate the effect of particle size on sediment chemistry (including differences in arsenic concentrations)
- discuss confounding factors that may influence future monitoring programs once full effluent discharge starts

4.1 Methods

4.1.1 Sediment Sample Collection

The sediment quality baseline program consisted of one sampling event during open-water conditions in each of 2015 and 2016, and was based on the Meliadine AEMP design plan (Golder 2016b). Sediment samples were collected from the exposure area only of Meliadine Lake in August 2015 and from all five sampling areas in August 2016 (Table 4.1-1). The sediment quality samples were collected as grab samples from the surficial sediments at the water quality stations. Sediment samples were collected either on the same day or within a couple days before or after collection of water quality samples. When water and sediment samples were collected on the same day, sediment samples were collected after all in situ measurements and water quality samples had been collected.

Composite sediment samples were collected using a stainless steel 15 cm Ekman grab. Each composite sample was comprised of up to five separate sample grabs collected within close proximity around the sampling station. Lake sediment was removed from the Ekman grab with a plastic trowel; sediments were removed from the centre of the grab to avoid the metal sides of the Ekman, and from the upper 5 cm of the grab. The process was repeated up to five times, until sufficient sediment was collected (approximately 450 g dry weight or 1.5 kg wet weight) for analysis of the required parameters. Sediment samples were composited by placing each of the five sub-samples into a clean, shallow, plastic pan and mixing with a plastic spoon. Sediment samples were placed in laboratory-provided plastic bags and kept refrigerated until they could be transported to ALS.

Sediment samples were analyzed by ALS for the following:

- physical parameters (i.e., particle size distribution [sand: 0.05 to 2 millimetres {mm}; silt: 0.002 to 0.05 mm; and clay: <0.002 mm])
- nutrients (i.e., total organic carbon)
- metals (i.e., aluminum, antimony, arsenic, barium, beryllium, bismuth, cadmium, chromium, cobalt, copper, iron, lead, lithium, manganese, mercury, molybdenum, nickel, selenium, silver, strontium, sulfur, thallium, tin, titanium, uranium, vanadium, and zinc)

Laboratory test methods with analytical detection limits less than the CCME sediment quality guidelines for the protection of aquatic life (CCME 2001) were used to analyze the samples.

Table 4.1-1:Sediment Quality Sampling Stations and Sampling Effort Summary, 2015 and 2016

Waterbody	Area	Station ID	UTM Coordinates (NAD 83, Zone 15V)		Total Depth (m)	Sampling Dates	
			Easting	Northing		14 to 19 August 2015	11 to 16 August 2016
Meliadine Lake	Near field Exposure	Mel-01-01	542693	6989136	9.3	SQ	SQ
		Mel-01-02	542666	6989280	8.0	SQ	SQ
		Mel-01-03	542634	6988989	8.9	SQ	SQ
		Mel-01-04	543145	6989088	8.8	SQ	SQ
		Mel-01-05	542136	6989358	7.9	SQ, QC(a)	SQ, QC(b)
	Mid-field Exposure	Mel-02-01	537491	6992999	7.2	SQ	SQ
		Mel-02-02	537102	6992624	9.6	SQ	SQ
		Mel-02-03	537499	6992327	8.8	SQ	SQ
		Mel-02-04	537963	6992341	8.3	SQ	SQ
		Mel-02-05	537834	6992688	8.2	SQ	SQ
	Reference Area 1	Mel-03-01	533317	6998541	7.0	-	SQ, QC(b)
		Mel-03-02	533256	6998671	8.3	-	SQ
		Mel-03-03	532962	6998844	10.0	-	SQ
		Mel-03-04	533628	6998672	8.0	-	SQ
		Mel-03-05	534001	6998272	7.7	-	SQ
	Reference Area 2	Mel-04-01	525647	7000878	8.2	-	SQ
		Mel-04-02	526149	7001519	10.5	-	SQ
		Mel-04-03	525351	7001359	9.7	-	SQ
		Mel-04-04	525401	7001085	9.1	-	SQ
		Mel-04-05	525735	7001129	7.4	-	SQ
	Reference Area 3	Mel-05-01	530926	6990858	9.3	-	SQ
		Mel-05-02	530669	6990884	9.4	-	SQ
		Mel-05-03	530735	6991374	8.5	-	SQ
		Mel-05-04	530570	6991223	10.2	-	SQ
		Mel-05-05	530240	6991162	8.6	-	SQ

(a) Multiple QC samples (i.e., replicates) were collected.

(b) Duplicates were collected.

ID = identifier; UTM = Universal Transverse Mercator; NAD = North American Datum; SQ = sediment quality samples;

QC = quality control samples; - = the site was not included in the sampling plan for a particular field program, or was not sampled due to weather, environment, or schedule limitations.

4.1.2 Guidelines and Analysis

Sediment chemistry results were compared to the Interim Sediment Quality Guidelines (ISQG) and Probable Effects Level (PEL) guidelines for the protection of aquatic life (CCME 2001; Table 4.1-2). At concentrations below the ISQG, adverse biological effects are not expected to occur. At concentrations above the ISQG, adverse biological effects may occur. At concentrations above the PEL, adverse biological effects are likely, but not certain, to occur.

Table 4.1-2:Sediment Quality Guidelines

Parameter	Unit	Canadian Council of Ministers of the Environment Sediment Quality Guidelines [(a)]	
		Interim Sediment Quality Guidelines (ISQG)	Probable Effect Level (PEL)
Total Metals			
Arsenic	µg/g dw	5.9	17
Cadmium	µg/g dw	0.6	3.5
Chromium	µg/g dw	37.3	90
Copper	µg/g dw	35.7	197
Lead	µg/g dw	35	91.3
Mercury	µg/g dw	0.17	0.486
Zinc	µg/g dw	123	315

(a) CCME 2001.

µg/g dw = micrograms per gram dry weight.

Sediment quality can vary spatially within a lake or between lakes due to lake morphology, composition of the bedrock, interaction of surface and groundwater, streams, and other factors. Descriptive statistics were calculated to evaluate differences within Meliadine Lake.

4.1.3 Statistical Analyses

Prior to completing statistical analyses (univariate hypothesis tests [i.e group comparison] and normal range calculations, one half the detection limit was substituted for non-detect values in the dataset. Sediment quality data were then normalized to the fraction of fine sediments ([silt + clay]/100) due to the relation of most parameters with percent-fines. If a linear regression with a single parameter to percent-fines was significant at $p<0.05$, normalization was achieved by dividing each individual metal concentration to the respective fine sediments proportion of the same sample.

Statistical outliers were identified using standardized residuals, which provide a measure of the difference between observed and expected values (i.e., residuals), normalized to the variance of the dataset, and were calculated as follows:

Standardized Residual$x_z = \frac{x_i}{\sigma}$

where x_z is the standardized residual, x^i is the residual of a data point, μ is the sample mean, and σ is the sample standard deviation. Data points with standardized residuals greater than |3.5| (i.e., more than 3.5 standard deviations from the sample mean), were omitted from the analysis.

To assess differences among sampling areas (Near-field vs Mid-field vs. Reference), univariate hypothesis testing was performed. Prior to data analysis, data were screened to remove outliers. Data were checked for normality and/or other assumptions prior to data analyses. An analysis of variance (ANOVA) (for data that met normality and homogeneity of variances) was performed at a significance level of α = 0.05 (Zar 1996; Systat 2009). If data did not meet the statistical assumptions (i.e., normality, homoscedasticity [Zar 1996]), then the equivalent
non-parametric test (i.e., Kruskall-Wallis [KW]) was completed. If more than 50% of data (or of any group) consisted of values below detection limits (DL), data analyses were not performed.

When significant results were identified, a *post-hoc* test was performed to determine which groups differed. A Tukey's Honest Significant Difference test (Tukey's HSD) was performed after ANOVA, while a Pairwise Wilcox Rank Sum test with P-values adjusted was performed after KW.

4.1.4 Normal Range Calculations

Normal ranges for concentrations of sediment quality parameters in Meliadine Lake were estimated using baseline data collected from the Near-field, Mid-field, and reference areas in 2015 and 2016. The calculation methods used to estimate normal ranges followed the methods outlined in Barrett et al (2015).

When the baseline data were normally distributed, the normal range was estimated for the mean of the observations as the 95% prediction interval (PI) of the data selected to represent the natural variability of the system (Barrett et al. 2015). Normality was assessed by using the Shapiro-Wilk test and the data were considered normally distributed if the probability statistic *P* was greater than 0.05. When the baseline data were not normally distributed, but normality could be achieved after $\log_{10}$ transformation, the normal range was defined using $\log_{10}$ transformed data and the upper and lower bounds of the normal range were back-transformed to the original scale.

When both the untransformed and transformed data sets were non-normal, the normal range boundaries were estimated as the 2.5th and 97.5th percentiles of the baseline data. In cases where the percentile method was used, 1000 random samples were generated from the normal range dataset and the 2.5th and 97.5th percentiles were calculated from the distribution of 1000 mean values to estimate the normal range of mean values. Finally, in cases where the untransformed data were normally distributed but the lower bound of the normal range calculated using the PI method was less than zero the normal range was calculated using either the log-PI method or the percentiles method, depending on whether normality could be achieved after $\log_{10}$ transformation. This approach resulted in the lower bound of the normal range always being greater than zero, which was important when evaluating the potential effects related to toxicological impairment.

The normal ranges provided in this report are considered provisional during initial monitoring under the AEMP due to the limited sample sizes used in the calculations. The normal range is intended to estimate the range of natural spatial and temporal variability, and the more reference data incorporated into the calculation, the more accurate the estimate becomes. These normal ranges may be re-defined in future reports to allow for the inclusion of additional monitoring data after Mine construction has begun.

Each calculated normal range was evaluated for representativeness. For example, parameters with low detection frequency could have calculated upper bound normal ranges that were less than the detection limit. Therefore, the calculated normal ranges for parameters with non-detect concentrations in the dataset were revised according to the following criteria:

- If all values were less than the detection limit, then the lower bound of the normal range was set to zero and the upper bound was set to the lowest detection limit.
- If the lower bound of the normal range was less than detection limit, then it was set to zero.
- If the upper bound of the normal range was less than the detection limit, then it was set to the detection limit.
- If the baseline dataset included a mix of detection limits, and the lower bound of the normal range was less than the lowest detection limit, then the lower bound of the normal range was set to zero.
- If the baseline dataset included a mix of detection limits, and the upper bound of the normal range was less than the lowest detection limit, then the lower bound of the normal range was set to the lowest detection limit.
- If the baseline dataset included a mix of detection limits, and the detection limits varied by more than an order of magnitude, then the data with the higher detection limit was removed from the dataset, and the normal range was re-calculated.

If the baseline dataset included a mix of detection limits, and all values with the lowest detection limit were non-detect, then the normal range was set to zero (lower bound) and the lowest detection limit (upper bound).

4.2 Quality Assurance and Quality Control

As new sediment data were not collected in 2017, QA/QC results are not provided in this report. As reported in Golder (2017), the overall quality of the sediment quality dataset is considered moderate, and the results for the 2015 and 2016 monitoring programs are expected to be adequate to support the AEMP program for the Mine.

4.3 Results and Discussion

4.3.1 Comparison to Guidelines and Descriptive Statistics

Descriptive statistics (minimum, median, mean, maximum, standard deviation, standard error, and count) were calculated for the Near-field, Mid-field, and reference areas (combined) and results were compared to the PEL and ISQG (Tables 4.3.1 to 4.3.3).

Median and mean values for total metals and total organic carbon followed the general pattern of higher concentrations in the Near-field (MEL 01) and Mid-field (MEL 02) as compared to the reference areas (MEL-03, MEL-04, and MEL-05). Particle size composition varies among Meliadine Lake areas (Figure 4.3-1). Sediments in the Near-field are mainly composed of loamy sediments (i.e. median silt concentration of 68%), whereas sediments in the Mid-field (median of 51%) and reference areas (median of 62%) are mainly composed of sand.

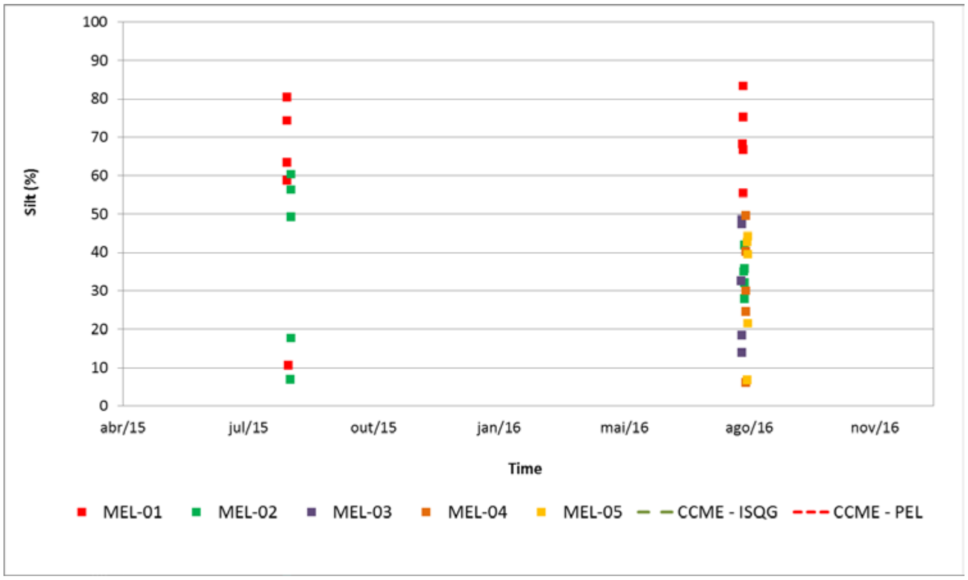


Figure 4.3-1: Silt content in Sediment Samples from Meliadine Lake

Median concentrations of total metals in the Near-field area were up to ten times higher than median concentrations in the reference areas. Median concentrations of total metals in the Mid-field were up to 2.4 times higher than median concentrations in the reference areas.

Arsenic, chromium, and copper concentrations exceeded the guidelines in most samples from all areas in Meliadine Lake (Tables 4.3.1 to 4.3.3). Arsenic was the only parameter with concentrations that exceeded the PEL in Meliadine Lake.

Within the Near-field area, arsenic concentration in 90% of the samples were above both the ISQG and the PEL , with a maximum of 151 µg/g dw in the silt dominated sample from MEL 01-04 from 2016 (Figure 4.3-2). Within the Mid-field area, arsenic concentration in 90% of the samples were above the ISQG whereas only 50% of samples were above than PEL. The highest arsenic concentration in the Mid-field area was 52 µg/g dw (MEL 02-01, August 2016). In contrast, arsenic concentration in 60% of the samples from the reference areas exceeded the ISGQ with no concentrations above the PEL. Arsenic in the reference areas ranged from 1.4 to 12 µg/g dw, with the maximum at MEL 05-02 in 2016.

Chromium concentrations in the Near-field ranged from 13 to 56 µg/g dw with a maximum reported for MEL 01-04 in 2015 (Figure 4.3-3); Chromium concentration in 90% of samples were above ISQG but none were above the PEL. In addition, as based on the low standard deviation, variability in chromium concentration in the Near-field was low (Figure 4.3-3). Chromium concentrations in the Mid-field varied from 10 to 58 µg/g dw (maximum recorded at MEL 02-02 in 2015) and concentrations exceeded the ISQG in 70% of samples. Within the reference areas, chromium concentrations ranged from 9 to 40 µg/g dw, and concentrations in two samples exceeded the ISQG (13% of total).

Copper concentrations in the Near-field ranged from 8.5 to 98 µg/g dw (standard deviation of 24 µg/g dw; Table 4.3-1), with the maximum value reported in 2015. In this area, 80% of samples exceeded the ISQG (Figure 4.3-4). Copper concentrations in the Mid-field were more variable and ranged from 7 to 111 µg/g dw (standard deviation of 36 µg/g dw; Table 4.3-2) with the maximum value reported in 2016 (Figure 4.3-4). Copper concentrations in 70% of samples from the Mid-field exceeded ISQG. Finally, copper concentrations in the reference areas ranged from 9 to 83 µg/g dw and concentrations in 67% of the samples exceeded the ISQG.

Table 4.3-1:Meliadine Lake Near-field (MEL-01) – Sediment Quality Summary, 2015 to 2016

Parameter	Unit (Dry Weight)	Guidelines		Annual Summary								
				2015 - 2016								
		ISQG	PEL	Median	Mean*	Minimum	Maximum	Standard Deviation	Standard Error	Count	% Above Guideline	
											I	P
Carbon Content												
Total organic carbon	%	-	-	4.7	4.4	0.44	6.8	1.8	0.57	10	-	-
Total Metals												
Aluminum	µg/g	-	-	11,550	10,914	3,430	14,600	2,924	925	10	-	-
Antimony	µg/g	-	-	0.19	0.17	<0.1	0.25	0.050	0.016	10	-	-
Arsenic	µg/g	5.9	17	**64**(I, P)	**74**(I, P)	5.5	**151**(I, P)	48	15	10	90	90
Barium	µg/g	-	-	114	106	19	149	35	11	10	-	-
Beryllium	µg/g	-	-	0.28	0.26	<0.1	0.34	0.078	0.025	10	-	-
Boron	µg/g	-	-	6.5	6.0	<5.0	8.5	1.2	0.38	10	-	-
Cadmium	µg/g	0.6	3.5	0.45	0.4	0.033	0.52	0.14	0.045	10	-	-
Calcium	µg/g	-	-	4,065	3,875	1,390	4,720	914	289	10	-	-
Chromium	µg/g	37	90	**45**(I)	**43**(I)	13	**56**(I)	11	**3.5**	10	90	-
Cobalt	µg/g	-	-	19	16	2.3	23	6.5	2.1	10	-	-
Copper	µg/g	36	197	**68**(I)	**64**(I)	8.5	**98**(I)	**24**	**7.7**	10	80	-
Iron	µg/g	-	-	43,800	42,768	7,380	83,400	21,245	6,718	10	-	-
Lead	µg/g	35	91	13	11	2.0	15	3.9	1.2	10	-	-
Lithium	µg/g	-	-	14	14	4.4	17	3.3	1.0	10	-	-
Magnesium	µg/g	-	-	6,340	6,120	2,010	7,610	1,485	470	10	-	-
Manganese	µg/g	-	-	531	517	129	871	216	68	10	-	-
Mercury	µg/g	0.17	0.49	0.053	0.051	0.0055	0.093	0.024	0.0077	10	-	-
Molybdenum	µg/g	-	-	6.0	6.0	0.71	14	3.5	1.1	10	-	-
Nickel	µg/g	-	-	64	61	11	84	21	6.7	10	-	-

Parameter	Unit (Dry Weight)	Guidelines		Annual Summary								
		ISQG	PEL	2015 - 2016								
				Median	Mean*	Minimum	Maximum	Standard Deviation	Standard Error	Count	% Above Guideline	
											I	P
Potassium	µg/g	-	-	2,100	2,020	499	2,650	579	183	10	-	-
Selenium	µg/g	-	-	1.0	1.0	<0.2	1.4	0.32	0.10	10	-	-
Silver	µg/g	-	-	0.16	0.16	<0.1	0.24	0.040	0.013	10	-	-
Sodium	µg/g	-	-	295	277	<100	360	67	21	10	-	-
Strontium	µg/g	-	-	23	21	8.0	26	5.2	1.6	10	-	-
Thallium	µg/g	-	-	0.28	0.27	<0.05	0.39	0.086	0.027	10	-	-
Tin	µg/g	-	-	<2.0	-	<2.0	<2.0	-	-	10	-	-
Titanium	µg/g	-	-	637	615	229	815	151	48	10	-	-
Uranium	µg/g	-	-	3.3	3.1	0.53	4.4	1.0	0.31	10	-	-
Vanadium	µg/g	-	-	53	49	12	64	13	4	10	-	-
Zinc	µg/g	123	315	80	76	18	101	24	8	10	-	-
Sulfur	µg/g	-	-	2,125	3,512	160	17,600	4,801	1,518	10	-	-
Bismuth	µg/g	-	-	0.3	0.27	<0.2	0.38	0.059	0.019	10	-	-
Particle Size And Moisture												
Grain size, 0.002-0.05 mm	%	-	-	68	64	11	83	20	6	10	-	-
Grain size, less than 0.002 mm	%	-	-	9.2	8.9	0.55	15	4.1	1.3	10	-	-
Grain size, 2-5 mm	%	-	-	23	27	3.4	89	23	7	10	-	-

Bolded values are higher than sediment quality guidelines.

(I) = value higher than the Interim Sediment Quality Guideline.

(P) = value higher than the Probable Effects Level.

Sediment quality data shown in this table were rounded to reflect laboratory precision after comparisons to guidelines. Therefore, values slightly above guidelines may be displayed as being equal to the guidelines and identified as exceedances. Measured concentrations equal to the guideline values were not identified as exceedances.

- = no guideline or data.

* Means were calculated by replacing non-detect values with the detection limit. Means of parameters with > 50% non-detect values were not calculated.

Table 4.3-2:Meliadine Lake Mid-field (MEL-02) – Sediment Quality Summary, 2015 to 2016

Parameter	Unit (Dry Weight)	Guidelines		Annual Summary								
				2015 - 2016								
		ISQG	PEL	Median	Mean*	Minimum	Maximum	Standard Deviation	Standard Error	Count	% Above Guideline	
											I	P
Carbon Content												
Total organic carbon	%	-	-	5.2	4.7	0.14	11	3.4	1.1	10	-	-
Total Metals												
Aluminum	µg/g	-	-	10,350	10,092	3,300	13,700	2,760	873	10	-	-
Antimony	µg/g	-	-	0.15	0.14	<0.1	0.31	0.067	0.021	10	-	-
Arsenic	µg/g	5.9	17	**16**(I)	**19**(I, P)	5.1	**52**(I, P)	12	3.8	10	90	50
Barium	µg/g	-	-	105	91	17	134	38	12	10	-	-
Beryllium	µg/g	-	-	0.25	0.23	<0.1	0.33	0.086	0.027	10	-	-
Boron	µg/g	-	-	5.7	5.6	<5.0	10	1.6	0.52	10	-	-
Cadmium	µg/g	0.6	3.5	0.33	0.29	0.034	0.53	0.18	0.057	10	-	-
Calcium	µg/g	-	-	4,475	4,151	1,690	5,710	1,364	431	10	-	-
Chromium	µg/g	37	90	**42**(I)	**40**(I)	10	**58**(I)	13	4.1	10	70	-
Cobalt	µg/g	-	-	11	13	2.5	38	9.0	2.8	10	-	-
Copper	µg/g	36	197	**73**(I)	**64**(I)	7.0	**111**(I)	36	11	10	70	-
Iron	µg/g	-	-	21,800	22,866	8,460	42,400	8,430	2,666	10	-	-
Lead	µg/g	35	91	8.8	8.8	2.6	15	3.9	1.2	10	-	-
Lithium	µg/g	-	-	14	13	4.9	16	3.0	0.93	10	-	-
Magnesium	µg/g	-	-	6,225	5,777	2,010	7,020	1,406	445	10	-	-
Manganese	µg/g	-	-	301	311	114	518	100	32	10	-	-
Mercury	µg/g	0.17	0.49	0.027	0.028	0.007	0.051	0.015	0.0048	10	-	-
Molybdenum	µg/g	-	-	4.7	5.1	0.83	12	2.7	0.85	10	-	-
Nickel	µg/g	-	-	48	44	8.7	69	18	5.8	10	-	-

Parameter	Unit (Dry Weight)	Guidelines		Annual Summary								
				2015 - 2016								
		ISQG	PEL	Median	Mean*	Minimum	Maximum	Standard Deviation	Standard Error	Count	% Above Guideline	
											I	P
Potassium	µg/g	-	-	1,910	1,824	548	2,670	562	178	10	-	-
Selenium	µg/g	-	-	0.92	0.78	<0.2	1.3	0.042	0.013	10	-	-
Silver	µg/g	-	-	0.15	0.13	<0.1	0.23	0.061	0.019	10	-	-
Sodium	µg/g	-	-	270	239	<100	400	99	31	10	-	-
Strontium	µg/g	-	-	24	22	9.9	31	7.2	2.3	10	-	-
Thallium	µg/g	-	-	0.22	0.21	<0.05	0.4	0.12	0.037	10	-	-
Tin	µg/g	-	-	<2.0	-	<2.0	<2.0	-	-	10	-	-
Titanium	µg/g	-	-	554	571	252	746	135	43	10	-	-
Uranium	µg/g	-	-	3.0	3.0	0.5	4.9	1.3	0.42	10	-	-
Vanadium	µg/g	-	-	51	48	12	67	15	4.6	10	-	-
Zinc	µg/g	123	315	87	75	19	106	28	8.8	10	-	-
Sulfur	µg/g	-	-	1,980	1,954	<100	5,090	1,471	465	10	-	-
Bismuth	µg/g	-	-	0.22	0.21	<0.2	0.33	0.044	0.014	10	-	-
Particle Size And Moisture												
Grain size, 0.002-0.05 mm	%	-	-	36	36	7.2	60	16	5.0	10	-	-
Grain size, less than 0.002 mm	%	-	-	9.6	8.9	0.44	15	5.2	1.7	10	-	-
Grain size, 2-5 mm	%	-	-	51	55	25	92	19	6.1	10	-	-

Bolded values are higher than sediment quality guidelines.

(I) = value higher than the Interim Sediment Quality Guideline.

(P) = value higher than the Probable Effects Level.

Sediment quality data shown in this table were rounded to reflect laboratory precision after comparisons to guidelines. Therefore, values slightly above guidelines may be displayed as being equal to the guidelines and identified as exceedances. Measured concentrations equal to the guideline values were not identified as exceedances.

- = no guideline or data.

* Means were calculated by replacing non-detect values with the detection limit. Means of parameters with > 50% non-detect values were not calculated.

Table 4.3-3:Meliadine Lake Reference Areas (MEL-03, MEL-04. MEL-05) – Sediment Quality, 2016

Parameter	Unit (Dry Weight)	Guidelines		Annual Summary								
				2016								
		ISQG	PEL	Median	Mean*	Minimum	Maximum	Standard Deviation	Standard Error	Count	% Above Guideline	
											I	P
Carbon Content												
Total organic carbon	%	-	-	4	3.7	0.53	7.9	2.4	0.53	15	-	-
Total Metals												
Aluminum	µg/g	-	-	7,070	6,618	2,730	9,630	1,886	422	15	-	-
Antimony	µg/g	-	-	<0.1	-	<0.1	0.15	-	-	15	-	-
Arsenic	µg/g	5.9	17	6.7(I)	6.6(I)	1.4	12(I)	3.3	0.74	15	60	-
Barium	µg/g	-	-	67	64	18	102	24	5.5	15	-	-
Beryllium	µg/g	-	-	0.17	0.15	<0.1	0.2	0.035	0.0078	15	-	-
Boron	µg/g	-	-	5.5	-	<5.0	7.9	-	-	15	-	-
Cadmium	µg/g	0.6	3.5	0.19	0.17	<0.02	0.29	0.079	0.018	15	-	-
Calcium	µg/g	-	-	3,760	3,447	1,410	4,980	1,011	226	15	-	-
Chromium	µg/g	37	90	27	25	9	40(I)	8.4	1.9	15	13	-
Cobalt	µg/g	-	-	6.3	5.9	2	9.2	2.0	0.45	15	-	-
Copper	µg/g	36	197	54(I)	44(I)	9	83(I)	23	5.1	15	67	-
Iron	µg/g	-	-	12,300	11,671	4,610	16,900	3,375	755	15	-	-
Lead	µg/g	35	91	4.8	4.8	1.6	9.3	2.0	0.45	15	-	-
Lithium	µg/g	-	-	9.8	9.4	5.3	12	2.1	0.47	15	-	-
Magnesium	µg/g	-	-	4,110	4,011	1,600	6,230	1,238	277	15	-	-
Manganese	µg/g	-	-	157	152	60	232	45	10	15	-	-
Mercury	µg/g	0.17	0.49	0.017	0.016	<0.005	0.036	0.0083	0.0019	15	-	-
Molybdenum	µg/g	-	-	2	2.2	0.47	4.5	1.2	0.27	15	-	-
Nickel	µg/g	-	-	29	27	6.9	43	9.9	2.2	15	-	-