AGNICO EAGLE

WHALE TAIL PIT

# CREMP Addendum - Appendix A:
# Mercury Monitoring Plan for Whale Tail South Area

Prepared by:
Agnico Eagle Mines Limited – Meadowbank Division

Version 2
March, 2019

# EXECUTIVE SUMMARY

**General Information**

In accordance with Condition 63 of NIRB Project Certificate No. 008 and NWB Water License 2AM-WTP1826 Part I, Condition 5, this Mercury Monitoring Plan (MMP) defines the sampling methods and data analysis that will be used to assess impacts of the Project on concentrations of mercury and methylmercury in the Whale Tail South basin area.

**Record of Changes**

A record will document all significant changes that have been incorporated in the MMP subsequent to the latest review. The record will include the names of the persons who made and approved the change, as well as the date of the approval.

**Distribution List**

Agnico Eagle Mines Limited will maintain a distribution list for the MMP, providing information about all parties that receive the plan including mine personnel, departments, and outside agencies.

## IMPLEMENTATION SCHEDULE

The implementation schedule for this plan is effective immediately subject to any modifications proposed as a result of the review and approval process.

## DISTRIBUTION LIST

Agnico - Environmental Superintendent

Agnico – Environmental Coordinator

Agnico – General Mine Manager

Agnico – Site Services Superintendent

Agnico – Field Services Supervisor

Agnico – Engineering Superintendent

# DOCUMENT CONTROL

**Document Control**

| Version | Date (YMD) | Section | Page | Revision |
|---|---|---|---|---|
| 1 | 2018/07/09 | All | All | Initial document |
| 2 | 2019/03/31 | 2.1<br>2.3.2<br>3.0<br>3.1 | | Mid-field station A76 added<br>Small-bodied fish tissue analysis added<br>Information on analytical methods added<br>Depth profile confirmatory sampling in 2019 added |
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Version 2

Prepared By: Meadowbank Environment Department

Approved By: 

*Robin Allard*
*General Supervisor Environment*

# TABLE OF CONTENTS

# SECTION 1 • INTRODUCTION

The diversion of Whale Tail Lake during construction and operation of Whale Tail Pit will cause flooding of Whale Tail Lake south basin sub-watershed lakes, potentially resulting in increased concentrations of mercury in water and biota, largely due to the decomposition of newly flooded vegetation.

In accordance with Condition 63 of NIRB Project Certificate No. 008 and NWB Water License 2AM-WTP1826 Part I, Condition 5, this Mercury Monitoring Plan (MMP) was developed to define the sampling methods and data evaluation that will be used to assess impacts of the Project on concentrations of mercury in the Whale Tail South flooded area.

The objectives of this plan are to describe supplemental sampling methods that will be implemented as part of the Core Receiving Environment Monitoring Program (CREMP) to track concentrations of mercury in the aquatic environment, and identify how these results will be interpreted.

# SECTION 2 • STUDY DESIGN

This mercury monitoring program will be carried out as a supplemental component of the CREMP, and thus follows the same study design, with a before-after-control-impact (BACI) approach to assess changes in concentrations of mercury in the Whale Tail South area as a result of Project-related flooding.

It includes analysis of mercury concentrations in surface water, sediment, and fish tissue. Analysis of mercury in benthic invertebrate and zooplankton tissue was conducted as a component of baseline studies, and will be assessed post-flooding following similar methods in the event that impact assessment predictions for water quality, sediment quality and fish tissue are exceeded or increase more rapidly than anticipated (see Section 5).

## 2.1 SAMPLING AREAS

Sampling areas are fully described in the CREMP: 2015 Plan Update – Whale Tail Pit Addendum (Azimuth, 2018).

Reference (REF) sampling areas include Inuggugayualik Lake (INUG) and Pipedream Lake (PDL), which have been used as project reference sites since 2006 and 2009, respectively (Figure 2.1).

Near-field (NF) areas of the CREMP that will be sampled include Whale Tail Lake South (A17) and Mammoth Lake (A16) (refer to Figure 2.2). Nemo Lake will not be included as a near-field area for the purposes of mercury monitoring, since it is not impacted by the planned flooding.

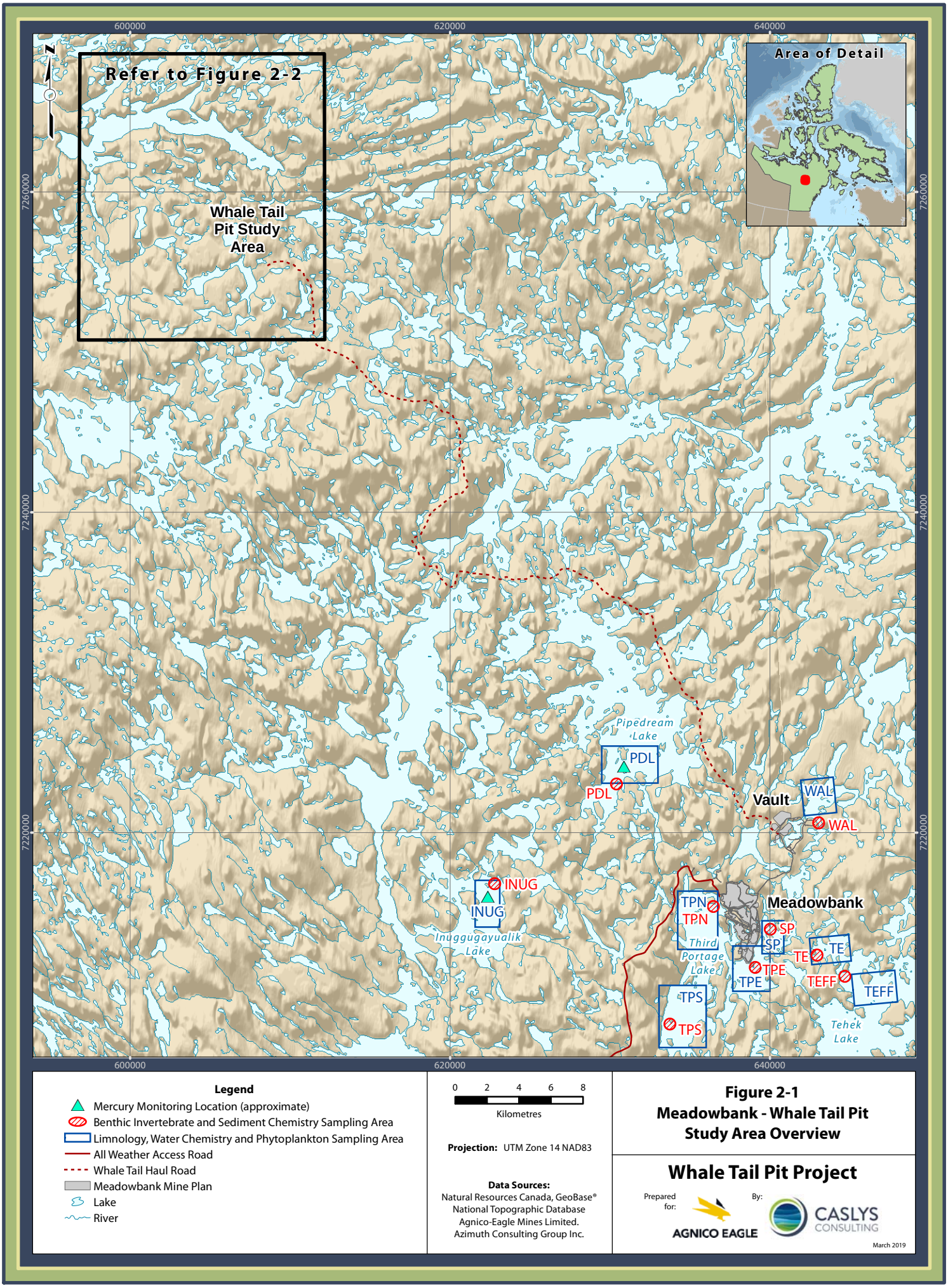
Mid-field (MF) areas of the CREMP will also be sampled. These consist of lakes A20 and A76. Lake A65 will also be included in mercury monitoring since it forms a relatively large proportion of the flooded area (Figure 2.1).

Consistent with CREMP sampling, the far field (FF) sampling area is lake DS1 (Figure 2.1).

Following CREMP design, water quality sampling will occur at 2 - 5 replicate locations in near-field lakes, 2 locations in mid-field lakes, and up to 3 replicate locations in DS1 and reference lakes. Following flooding, separate samples will be collected from the flood zone and original lake basin locations.

Sediment sampling for mercury (total and methyl) will be conducted at CREMP sediment locations, as well as an additional 3 sites within the newly-flooded former terrestrial zone in A17 (Whale Tail Lake), A65 and A20 (to the extent practicable, specific locations will coincide with soil sampling locations conducted as a component of FEIS mercury modeling as described in Azimuth, 2017).

Consistent with EEM sampling and model predictions, fish sampling for tissue analysis will be conducted in deeper-water basins, targeting Lake Trout, in order to compare measurements to predicted tissue concentrations from the FEIS (Azimuth, 2017). Analysis of tissue concentrations in small-bodied fish (slimy sculpin and/or ninespine stickleback) will also be performed in each of the lakes identified above.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Refer to Figure 2-2
Whale Tail
Pit Study
Area
Area of Detail
Pipedream
Lake
PDL
PDL
Vault
WAL
WAL
INUG
INUG
Inuggugayualik
Lake
TPN
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Meadowbank
SP
SP
TE
TE
Third
Portage
Lake
TPE
TPE
TEFF
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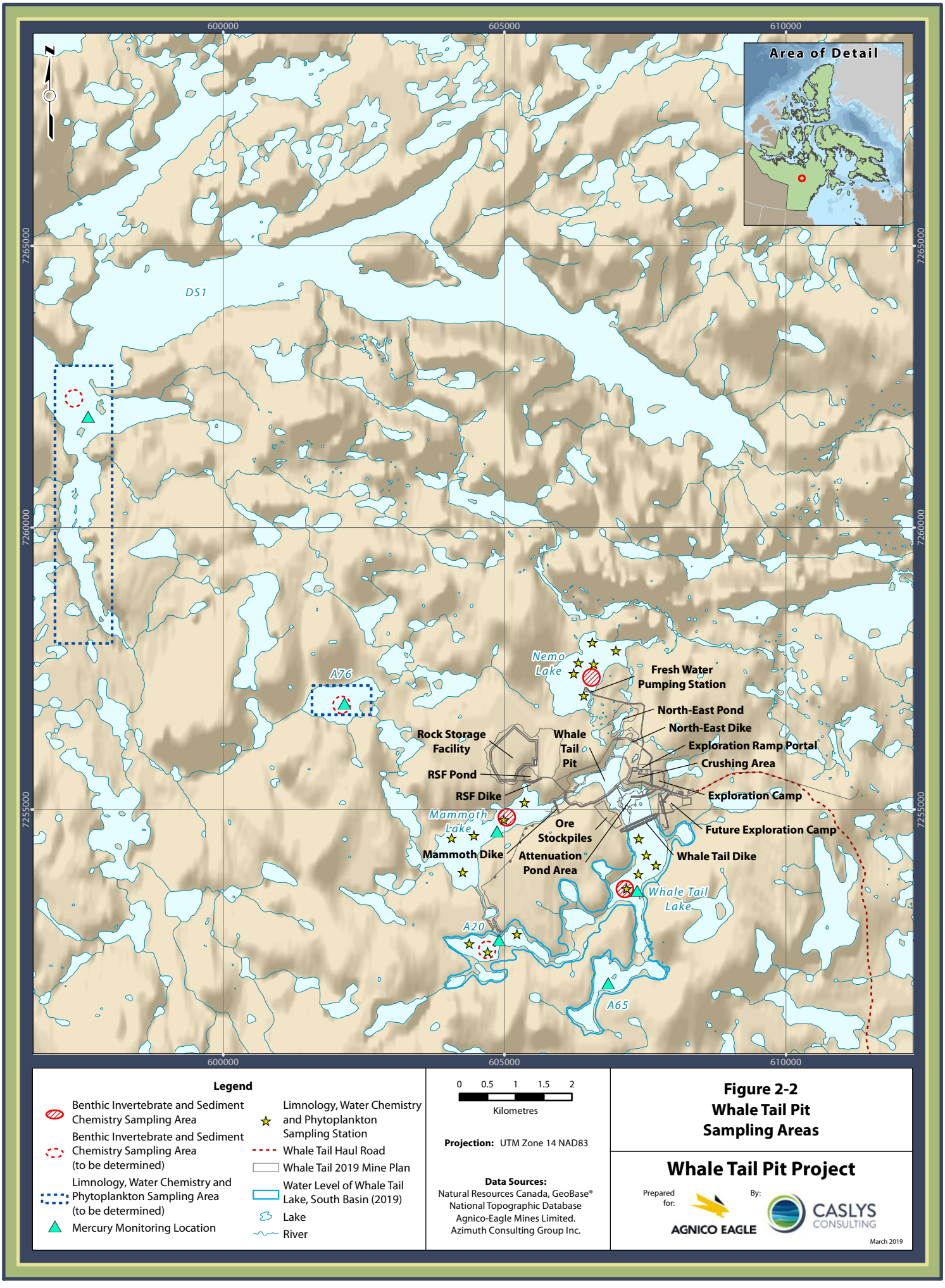
TPS
TPS
Tehek
Lake
Legend
Mercury Monitoring Location (approximate)
Benthic Invertebrate and Sediment Chemistry Sampling Area
Limnology, Water Chemistry and Phytoplankton Sampling Area
All Weather Access Road
Whale Tail Haul Road
Meadowbank Mine Plan
Lake
River
0 2 4 6 8
Kilometres
Projection: UTM Zone 14 NAD83
Data Sources:
Natural Resources Canada, GeoBase®
National Topographic Database
Agnico-Eagle Mines Limited.
Azimuth Consulting Group Inc.
Figure 2-1
Meadowbank - Whale Tail Pit
Study Area Overview
Whale Tail Pit Project
Prepared for:
AGNICO EAGLE
By:
CASLYS CONSULTING
March 2019




**Legend**

- Benthic Invertebrate and Sediment Chemistry Sampling Area
- Benthic Invertebrate and Sediment Chemistry Sampling Area (to be determined)
- Limnology, Water Chemistry and Phytoplankton Sampling Area (to be determined)
- Mercury Monitoring Location
- Limnology, Water Chemistry and Phytoplankton Sampling Station
- Whale Tail Haul Road
- Whale Tail 2019 Mine Plan
- Water Level of Whale Tail Lake, South Basin (2019)
- Lake
- River

0 0.5 1 1.5 2

Kilometres

**Projection:** UTM Zone 14 NAD83

**Data Sources:**
Natural Resources Canada, GeoBase®
National Topographic Database
Agnico-Eagle Mines Limited.
Azimuth Consulting Group Inc.

**Figure 2-2**
**Whale Tail Pit**
**Sampling Areas**

## Whale Tail Pit Project

Prepared for: AGNICO EAGLE

By: CASLYS CONSULTING

March 2019

## 2.2 SAMPLING COMPONENTS

As described in the CREMP: 2015 Plan Update - Whale Tail Pit Addendum (Azimuth, 2018), standard CREMP monitoring includes limnology, water chemistry, sediment chemistry, phytoplankton, and benthic invertebrates. Regular CREMP analysis of water and sediment samples includes only total mercury at regular detection limits.

These standard CREMP monitoring data will be supplemented by additional data collected at the lakes listed in Section 2.1 and illustrated in Figure 1 for the assessment of impacts of flooding which will include:

- Water sample analysis for total and dissolved mercury and methylmercury at ultra-low detection limits.
- Sediment grab sample analysis for total mercury and methylmercury at regular CREMP and supplemental, flood-zone locations (ie. A20 and A65).
- Fish tissue analysis for total mercury (large-bodied fish, targeting Lake Trout collected in conjunction with Environmental Effects Biological Monitoring (EEM program, under MMER requirements).

Other relevant water quality parameters (e.g., pH, temperature, dissolved organic carbon, total suspended solids, chlorophyll – see CREMP, Azimuth, 2016) are monitored concurrently with mercury sample collection, and will be used as necessary to support interpretation of mercury monitoring results.

## 2.3 SAMPLING EFFORT AND FREQUENCY

### 2.3.1 Water and Sediment Quality

As described in the CREMP: 2015 Plan Update (Azimuth, 2018), CREMP sampling effort (i.e., number of replicates per event) and frequency (i.e., number of events per year) follows recommendations from the CREMP Design Document 2012 (Azimuth, 2012). NWB interveners were consulted over several years during the re-design of the CREMP that was resubmitted following the Meadowbank Type A renewal in 2015 and subsequently approved by regulators. CREMP sampling at the Whale Tail Pit Study Area will follow the same level of effort and frequency by area type (see CREMP: 2015 Plan Update – Whale Tail Pit Addendum, Table 2-2).

Generally, sampling for mercury in surface water will occur monthly during April/May (except FF locations), June, July, August, and November/December (except FF locations). Sampling for mercury in sediment will occur in August. Following the CREMP study design, sampling

frequency at FF locations may not occur every year if no changes are observed at NF areas in the previous year.

### 2.3.2 Fish Tissue

Analysis of mercury in large-bodied fish tissue will be synchronized with the EEM Biological Monitoring program. An increased sampling frequency will occur in the event that data evaluation criteria are exceeded (Section 5).

Analysis of tissue concentrations in small-bodied fish (slimy sculpin and/or ninespine stickleback) will be conducted initially in 2018, 2019, and 2020. Continued analysis of small-bodied fish tissue will be determined at that time based on results to date.

# SECTION 3 • SAMPLING METHODS

Sampling for mercury follows the CREMP Standard Operating Procedures (SOPs) for each of the monitoring components. The SOPs include general information on field collections, pre-trip planning, field collection materials, field quality assurance/quality control protocols, step-by-step instructions on sample collection, bottle requirements and list of parameters, sample preservation, and sample handling and transportation. The SOPs are appended to the CREMP 2015 plan update (Azimuth, 2015):

- General water chemistry sampling methods are outlined in Appendix A
- Sediment grab chemistry methods are outlined in Appendix B
- Sediment coring is outlined in Appendix C

In addition to these general requirements for sampling, specific methods for each media type are provided below.

## 3.1 SURFACE WATER & DEPTH PROFILES

Surface water samples collected to monitor concentrations of mercury in the Whale Tail area will generally follow the standard operating procedure (SOP) described for the Meadowbank and Whale Tail Pit CREMP programs (Azimuth, 2015), with some exceptions as described here. Detailed guidance from the analytical laboratory and research partner at the University of Waterloo on field sampling protocols for ultra-trace mercury will be followed. Samples will primarily be collected as surface level grabs rather than 3 m depth using a pump and tubing, which is the protocol for regular CREMP samples. For dissolved mercury and dissolved methylmercury analyses, surface water will be filtered in the field using a single-use syringe and 0.45 um syringe filtered provided by the analytical laboratory, or using ultra-clean bottles and muffled filters. The sample collection team will follow a “clean hands/dirty hands” method, with one team member designated the “clean hands” to handle inner bag, sample container,

and filtering, and the second team member designated “dirty hands” will to handle the outer bag, but never contact the sample container or inner bag.

While changes in mercury concentrations with depth may be a consideration in stratified systems, CREMP baseline data for this area indicates that lakes within the flood zone tend to be well mixed (Azimuth, 2016). Although the deepest lake (Lake A20) shows some thermal stratification, concentrations of constituents that are predictive of metals movement (e.g. dissolved oxygen) are consistent throughout their profile. Nevertheless, confirmatory sampling will be conducted in Lake A20 in 2019 to determine whether there are any differences between surface and near-sediment concentrations of mercury. Results of this assessment will be used to determine the necessity of ongoing collection of water samples at depth. This assessment will be conducted by Agnico’s research partner at the University of Waterloo, following their own procedures for ultra-trace mercury sampling in the lower water column.

Analysis of water samples will be conducted at Biotron laboratory at the University of Western Ontario. This is a CALA-accredited laboratory, with detection limits for mercury that are lower than those available from commercial analytical labs. Samples will be transported in coolers with ice packs and shipped to Biotron at the earliest convenience to minimize the possibility of exceeding the recommended hold-times between collection and analysis. Samples will be analyzed using ultra-low detection methods for total mercury (Cold Vapour Atomic Fluorescence – Digestion, Method Ref. modified from EPA 1631, Lab Method ID - TM.0811) and methyl mercury (Cold Vapour Atomic Fluorescence Spectrophotometry, Method Ref. modified from EPA 1630, Lab Method ID - TM.0812).

## 3.2 SEDIMENT

Sediment samples collected to monitor concentrations of mercury in the Whale Tail area will follow the standard operating procedure (SOP) for sediment sampling described in the CREMP: 2015 Plan Update (Azimuth, 2015).

Grab samples targeting the top 3 – 5 cm will be collected annually, with sediment core samples collected at a minimum every three years. Consultation with Agnico’s academic research partner at the University of Waterloo has indicated that grab samples collected in the manner described in Azimuth (2015), Appendix B, are appropriate for analysis of mercury in sediment.

Sediment samples will be analyzed by a commercial analytical laboratory. Samples will be transported in coolers with ice packs and shipped at the earliest convenience to minimize the possibility of exceeding the recommended hold-times between collection and analysis.

### 3.3 FISH TISSUE

Sampling of fish tissue for mercury analysis will be conducted in conjunction with EEM Biological Monitoring. Briefly, samples of skinless, boneless dorsal muscle will be collected from 20+ Lake Trout from each study lake and analyzed for total mercury. The muscle samples will be removed from each fish using a standard filleting knife and individually sealed in Whirl-Pak bags. The sealed Whirl-pak bags will be sealed inside larger Ziplock bags and frozen in a -20°C freezer prior to shipment to the analytical laboratory.

Tissue samples for small-bodied fish (slimy sculpin and/or ninespine stickleback) will be collected and analyzed in a similar fashion. This sampling and analysis is conducted as a component of a University of Waterloo-lead research study on productivity changes within the flooded area (Portt, 2018, Appendix C).

Muscle tissue concentrations of mercury will be analyzed at Biotron at the University of Western Ontario using a Milestone® DMA-80 Direct Mercury Analyzer in accordance with U.S. EPA method 7473 (U.S. EPA, 2007).

## SECTION 4 • QA/QC

Quality assurance/quality control methods will follow those described in the CREMP: 2015 Plan Update (Azimuth, 2015).

## SECTION 5 • DATA EVALUATION

Data evaluation for mercury monitoring associated with flooding will focus on comparison of analytical results with predictions made in the FEIS for Whale Tail Pit, and supporting documents (i.e. Azimuth, 2017). Literature review predicted that methylmercury concentrations could increase 10 to 20 times in water and two to nine times in fish, relative to baseline. Maximum baseline total mercury in water in Whale Tail Lake was less than the detection limit (i.e., <0.005 µg/L) (FEIS Volume 6, Appendix 6-G, Tables 2-1 and 2-2). Assuming a literature-based increase for permanently flooded reservoirs (which is a highly conservative assumption) total mercury could increase to a maximum of 0.05 to 0.1 µg/L which is above the aquatic life guideline (0.026 µg/L; CCME 1999) but below the drinking water quality guideline (1 µg/L; Health Canada 2014).

Baseline total mercury in Lake Trout (not adjusted for size) in Whale Tail Lake ranged from 0.077 to 2.19 µg/g ww, with an average of 0.49 µg/g ww (just below the guideline of 0.5 µg/g; CFIA 2014) (Volume 6, Appendix 6-K, Appendix C). Assuming a literature-based increase for permanently flooded reservoirs (which is a highly conservative assumption), the FEIS assumed that maximum total mercury in Lake Trout could range from 4.4 to 19.7 µg/g ww, with an average ranging from 1.0 to 4.41 µg/g ww. Further detailed modeling by Azimuth

(2017) predicted an increase of 2 – 3x baseline concentrations, or an expected range of 0.9 – 1.75 µg/g ww (95% CI) for a 550 mm Lake Trout.

For water quality, the yearly mean measured concentration of total mercury in each study lake will be compared to the FEIS maximum predicted value of 0.1 µg/L. Concentrations of total mercury in fish tissue will be compared to the model results from Azimuth (2017), with an anticipated 95% CI for 550 mm (1800 g ww) fish of 0.9 – 1.75 µg/g ww.

This approach differs slightly from the CREMP in which results are initially compared to site-specific triggers and/or threshold values, as well as Meadowbank's FEIS water quality model predictions. Triggers are based on absolute or statistical differences from baseline/reference conditions (e.g. half-way between baseline and effects-based thresholds). Thresholds are based on legal requirements, regulatory guidelines, or other discrete published benchmarks. The Meadowbank CREMP threshold for mercury is equivalent to the CCME Guideline for the Protection of Aquatic Life (0.026 µg/L), which was predicted to be exceeded (based on conservative literature review) in the short term during flooding of the Whale Tail South area. Development of alternative effects-based thresholds for mercury and/or methylmercury may be pursued in the event that measured concentrations exceed FEIS predictions.

While no specific data evaluation criteria are identified here for sediment because sediment concentrations of mercury were not predicted as a component of the FEIS, measured concentrations will be compared to baseline values and CCME Sediment Quality Guidelines for the Protection of Aquatic Life to track changes in mercury flux between sediment and overlying water, as this is the predominant anticipated source of mercury inputs during flooding.

Finally, the current monitoring plan does not specifically propose to assess risk to human health from consumption of fish residing in the Project-area lakes on an ongoing basis. Azimuth (2017) modeled expected concentrations in fish tissue, and addressed impacts of increased mercury concentrations in fish on Health Canada's recommended consumption rates. Further risk-based analyses will be implemented in the event that monitoring results exceed these model predictions. This approach is supported by the low rates of fishing by local residents in the Project area (see FEIS Volume 7, Section 7.3), and a no-fishing policy for workers while onsite.

## SECTION 6 • REFERENCES

Azimuth (Azimuth Consulting Group Partnership). 2017. Whale Tail Pit project: Predicted changes in Fish Mercury Concentrations in the Flooded Area of Whale Tail Lake (South Basin). Prepared for Agnico Eagle Mines Ltd., Meadowbank Division. February 2017.

Azimuth (Azimuth Consulting Group Partnership). 2018. Core Receiving Environment Program: 2015 Update- Whale Tail Pit Addendum. Prepared by Azimuth Consulting Group Inc., Vancouver, BC for Agnico-Eagle Mines Ltd., Vancouver, BC. May, 2016.

Azimuth (Azimuth Consulting Group Partnership). 2016. Whale Tail Pit Core Receiving Environment Monitoring Program (CREMP) 2014-2015 Baseline Studies. Prepared by Azimuth Consulting Group Inc., Vancouver, BC for Agnico-Eagle Mines Ltd., Vancouver, BC. January, 2016.

Azimuth (Azimuth Consulting Group Partnership). 2015. Core Receiving Environment Program: 2015 Update. Prepared by Azimuth Consulting Group Inc., Vancouver, BC for Agnico-Eagle Mines Ltd., Vancouver, BC. November, 2015.

Portt (C. Portt & Associates), 2018. Whale Tail Pit Fish Habitat Offsetting Plan. Version 1. March, 2018.