Appendix 44

Whale Tail 2022 Fish Habitat Offset Monitoring Report

MEADOWBANK COMPLEX

2022 FISH HABITAT OFFSETS MONITORING REPORT

In Accordance with

DFO Fisheries Act Authorization 16-HCAA-00370

and

DFO Fisheries Act Authorization 20-HCAA-00275

Prepared by:
Agnico Eagle Mines Limited – Meadowbank Complex

March, 2023

EXECUTIVE SUMMARY

In accordance with Fisheries Act Authorizations 16-HCAA-00370 and 20-HCAA-00275, Agnico Eagle maintains a Fish Habitat Offsets Monitoring Plan (FHOMP; Version 2, July, 2021 – Agnico Eagle, 2021[1]) for the Whale Tail Mine. This Plan was developed to determine whether fish habitat offsetting described in the *Whale Tail Pit - Fish Habitat Offsetting Plan* (C. Portt and Associates, 2018a) and the *Whale Tail Pit Expansion Project Fish Habitat Offsetting Plan* (ERM, 2020) is ultimately constructed and functioning as intended.

Under this Plan, monitoring is conducted under the pre-offsetting ecological monitoring program from 2021 through 2023. This program is intended to demonstrate whether terrestrial flooding that was temporarily required for operational purposes will provide suitable habitat for fish long-term. Permanently raised water levels are accepted offsets under both the 2018 and 2020 offsetting plans for the Whale Tail site, and flood zone assessment prior to permanent sill construction is required under conditions of the associated Fisheries Act Authorization 20-HCAA-00275.

In 2022, FHOMP field assessments included: flood zone water quality data collected through the Core Receiving Environment Monitoring Plan (CREMP) plus supplemental stations, analysis of periphyton growth using artificial substrate samplers, periphyton visual surveys, and small-bodied fish population assessments by shoreline electrofishing. Results of these assessments are presented here in a data report format, with final analysis to be completed following the 2023 monitoring season.

Briefly, 2022 CREMP results continue to indicate an increase in some water quality parameters compared to baseline conditions (especially nutrients) as predicted in the 2018 FEIS Addendum (Agnico Eagle, 2018b), but suitable water quality for aquatic life within the Whale Tail flood zone. Electrofishing studies identified the presence of small-bodied fish populations in newly created shoreline habitat at catch rates and size ranges that appear similar to reference areas. Though some periphyton substrate samplers came loose from their anchors or were stranded due to a significant late-season drop in water levels, it is evident that seasonal periphyton growth is greater in WTS than reference lakes, and potentially elevated in A20 compared to reference sites. These observations are in line with 2018 FEIS Addendum predictions for increased nutrient concentrations and primary productivity in flood zone lakes. Further adjustments to sampler design are proposed for the 2023 season to reduce data loss. Periphyton visual surveys identified a wide range of periphyton cover conditions across both flood zone and reference lakes, from no coverage to >75% coverage, without a clear relationship to flood status. When present, the texture of periphyton communities within flood zone lakes may be somewhat looser (less compact) than reference

[1] Version 2 of the FHOMP was developed to include requirements of both Whale Tail site FAAs (16-HCAA-00370 and 20-HCAA-00275) and was submitted to DFO in July, 2021. No comment from DFO has yet been received but Agnico has undertaken monitoring and reporting according to this version starting in 2021 since no monitoring is scheduled under Version 1 until 2026.

sites, though this observation may have been influenced by the presence of decomposing terrestrial organic matter, and will be specifically confirmed in 2023.

In addition to flooding and other constructed habitat offsetting features, a portion of offsetting for Whale Tail Mine is provided through a suite of complementary measures (research projects). No physical monitoring is conducted in relation to research projects. However, progress monitoring is conducted to document annual activities, and results are summarized here to determine when criteria for success have been met.

Six research studies form the complementary measures for Whale Tail Mine offsetting. Due to delays that were largely as a result of the COVID-19 pandemic, some study periods have been extended, as indicated in Table 1 below. In 2021, Study 4: *Arctic Grayling Occupancy Modelling* was completed and criteria for success were met with publication of a peer-reviewed manuscript, as described in the 2021 Fish Habitat Offsets Monitoring Report.

Table 1. Whale Tail Mine complementary measures (research projects). *Extended due to COVID or other delays (estimated termination dates as of Dec. 2022 shown).

Study	Lead Researcher	Study Period
Study 1: Assessment of changes in aquatic productivity and fish populations due to flooding of Whale Tail South and downstream lakes during operations	H. Swanson	2018 – 2023/2024*
Study 2: Assessment of impacts of the Baker Lake wastewater outflow on aquatic systems including fish and fish habitat	H. Swanson	2019 – 2025/2026*
Study 3: Literature review and field validation of northern lake fish habitat preferences	S. Doka	2018 – 2024*
Study 4: Arctic Grayling occupancy modelling (COMPLETE)	H. Swanson	2018 – 2021
Study 5: End pit lake habitat use	TBD	2027 – 2035 (est.)
Study 6: eDNA methods development	J. Stetefeld	2018 – 2023/2024

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SECTION 1 • INTRODUCTION

1.1 BACKGROUND

In accordance with Fisheries Act Authorizations (FAAs) 16-HCAA-00370 and 20-HCAA-00275, Agnico Eagle maintains a Fish Habitat Offsets Monitoring Plan (FHOMP; Version 2, July, 2021 – Agnico Eagle, 2021[2]) for the Whale Tail Mine. This Plan was developed to determine whether fish habitat offsetting described in the Whale Tail Pit - Fish Habitat Offsetting Plan (C. Portt and Associates, 2018a) and the Whale Tail Pit Expansion Project Fish Habitat Offsetting Plan (ERM, 2020) is ultimately constructed and functioning as intended.

This monitoring program is organized to meet the requirements of the FAAs listed above, specifically:

Fisheries Act Authorization 16-HCAA-00370 (July, 2018):

- Condition 4.3 – Offsetting criteria to assess the implementation and effectiveness of the offsetting measures: All fish habitat offsetting measures shall be completed and functioning according to the following criteria:
  - 4.3.1 – Offsetting measures shall be carried out in accordance with the measures set out in the Proponent's Whale Tail Pit Fish Habitat Offsetting Plan (including the updated Appendix C, dated May 2018), or the most recent version approved by DFO;
  - 4.3.2 – All offsetting features are to be constructed prior to re-flooding of the north basin of Whale Tail Lake in accordance to the schedule outlined in the Whale Tail Pit Fish Habitat Offsetting Plan dated March, 2018 (or most recent approved version);
  - 4.3.3 – The offsetting features (e.g. shoals) have established aquatic biota and are being utilized by fish for one or more of their life history functions.
- Condition 5.1 – the proponent shall conduct monitoring of the implementation of offsetting measures according to the approved timeline and criteria;
  - 5.1.1 – List of timeline(s) and monitoring and reporting criteria:,
    - 5.1.1.4 – the Proponent shall provide an annual Whale Tail Pit Fish Habitat Offset Monitoring Report to DFO (and interested parties)

[2] Version 2 of the FHOMP was developed to include requirements of both Whale Tail site FAAs (16-HCAA-00370 and 20-HCAA-00275) and was submitted to DFO in July, 2021. No comment from DFO has yet been received but Agnico has undertaken monitoring and reporting according to this version staring in 2021 since under Version 1 of the FHOMP (Agnico Eagle, 2018a), no field monitoring was scheduled until 2026.

following the construction of the offsetting habitat by March 31. The proponent is required to provide the report until DFO indicates this requirement has been met.

- 5.1.1.5 – As part of the annual report, the Proponent shall include, but not limited to:

  - A digital photographic record with GPS coordinates of pre-construction, during construction, and post-construction conditions shall be compiled using the same vantage points and direction to show that the approved works have been completed in accordance with the offsetting plan;

  - A summary of field observations for each respective year as well as the as-built survey;

  - A detailed analysis report summarizing the effectiveness of the offsetting measures.

Fisheries Act Authorization 20-HCAA-00275 (July, 2020):

- Condition 4.3 – Offsetting criteria to assess the implementation and effectiveness of the offsetting measures: All fish habitat offsetting measures shall be completed and functioning according to the criteria below;

  - 4.3.1 - Offsetting measures shall be carried out in accordance with the measures set out in the Proponent's offsetting plan dated June 5, 2020 in the Whale Tail Pit Expansion Project - Information Requirements in Support of the Application for Authorization Under Paragraph 35(2)(b) of the Fisheries Act prepared by ERM Consultants Canada Ltd and Appendix H – Offsetting Design;

  - 4.3.2 - Where Proponent did not provide the detailed engineering plans, offsetting measures shall also be carried out in accordance with the measures as agreed upon after consultation with DFO and other interested parties as per section 4.8.1;

  - 4.3.3 - The Proponent shall provide DFO with sufficient information for DFO to determine if flooding of south portion of Whale Tail Lake area as a result of the Whale Tail Dike (PATH No.: 16-HCAA-00370) provides suitable habitat and enhances productivity of target species as identified through consultation with local communities prior to commencement of consultation on final design of offsetting sill. A report shall be presented to DFO as outlined in section 5.3.1 of this Authorization.

- Condition 5.1 - Schedule and criteria: The Proponent shall conduct monitoring of the implementation of offsetting measures according to the timeline and criteria below [or according to the timeline and criteria in the offsetting plan approved by DFO, referred to in section 4.2 and attached to this authorization and which are the following:
    - 5.1.1 List of timeline(s) and monitoring and reporting criteria:
        - 5.1.1.1 The Proponent shall monitor the geotechnical aspect of the proposed offsetting sill to establish its efficacy to maintain water levels as predicted and examine erosion or slumping twice a year over a 10-year period following the construction of the offsetting sill in 2026.
        - 5.1.1.2 The Proponent shall monitor both biological (fish use, health and biological traits) and ecological (water quality, periphyton productivity) properties of the offsetting habitat expanding on required monitoring in the Fisheries Act Authorization for the Approved Project (PATH No.: 16-HCAA-00370). The proponent shall conduct the biological monitoring programs every year from the date of issuance of the Authorization to the construction of the offsetting sill to show compliance with criteria 4.3.3 and in years 1, 3, 5 and 10 following the construction of the offsetting habitat to establish efficacy of the offsetting measures to provide suitable habitat and enhance productivity of target species.
- Condition 5.2 - List of reports to be provided to DFO: The Proponent shall report to DFO on whether the offsetting measures were conducted according to the conditions of this authorization by providing the following:
    - 5.2.1 The Proponent shall provide a Whale Tail Expansion Fish Habitat Offset Monitoring Report to DFO including geotechnical and biological and ecological monitoring as per section 5.1.1. The Proponent is required to provide the Report by March 31 of 2027 and update annually for 10 years or until DFO indicates requirements of this Authorization have been met.
    - 5.2.2 As part of the annual report the Proponent shall include, but is not limited to:
        - 5.2.2.1 a digital photographic record with GPS coordinates of pre-construction, during construction and post construction conditions shall be compiled using the same vantage points and direction to show that the approved works have been completed in accordance with the offsetting plan, and as-built plans and engineering diagrams;
        - 5.2.2.2 a summary of field observations for each respective year; and,

        - 5.2.2.3 a detailed analysis report summarizing the effectiveness of the offsetting measures including the final engineering designs, and maps from flooding models.

    - 5.2.3 The Proponent shall provide a summary report of all Whale Tail Expansion Fish Habitat Offset Monitoring Reports described in section 5.2.1 before March 31, 2036 to DFO (and interested parties) which shall analyse results from the offsetting measures of the Whale Tail Expansion Project following the construction of the offsetting habitat. DFO reserves the right to request additional Summary Report if annual reporting were to continue until requirement has been met.

- Condition 5.3 Other monitoring and reporting conditions for offsetting:

    - 5.3.1 The Proponent shall provide a detailed Impact Analysis of Fish Habitat from Flooding by March 31 2024. The content of this report shall be discussed and approved by DFO (and interested parties) and will be used to establish if the proposed offsetting measures are likely to provide suitable habitat and enhance productivity of target species.

Further, in accordance with monitoring recommendations in DFO guidance documents (e.g. Smokoroski et al., 2015), two types of monitoring are specified:

1. “Compliance” monitoring assesses the physical structure and stability of offsetting features to verify that they were constructed as designed.

2. “Effectiveness” monitoring of biological and ecological endpoints (water quality, periphyton growth, fish use) to assess whether offsetting features are functioning effectively as fish habitat.

1.2 OBJECTIVES

The majority of habitat gains for Whale Tail Site offsetting are planned to be achieved through habitat creation and enhancement efforts. To ensure that offsets are functioning as effective fish habitat, assessment of the structure, stability, and successful utilization of these features by fish are the primary goals of the monitoring program for habitat enhancement/creation offsets.

The overall objectives of this report are:

a. To describe the compliance and effectiveness monitoring methods for assessments conducted in the preceding year according to the FHOMP and describe any deviations from the FHOMP.
b. To present the results of data analyses conducted according to the FHOMP.

c. Using those results, to determine whether defined criteria for success have been met.

In addition to the constructed habitat offsetting features to be monitored through this plan, a portion of offsetting for Whale Tail Mine (FAA 16-HCAA-00370) will be provided through a suite of complementary measures (research projects). Full progress reporting is completed for these programs under separate cover and provided to DFO by May 30 annually, according to conditions of the FAA. Study plans and success criteria for the complementary measures are described in the *Whale Tail Pit - Fish Habitat Offsetting Plan* – Appendix C (May 2018) and referred to minimally here. However, this report does include a summary of research study progress, along with annual activities of the oversight body (Meadowbank Fisheries Research Advisory Group; MFRAG) and indicates when criteria for success have been achieved.

1.3 SUMMARY OF OFFSETTING FEATURES

The following constructed features will create or enhance fish habitat to offset losses occurring from the Whale Tail Mine. Complementary measures (research projects) are also summarized. Further details are provided in the *Whale Tail Pit - Fish Habitat Offsetting Plan* (March, 2018 and its Appendix C, May 2018) and the *Whale Tail Pit Expansion Project Fish Habitat Offsetting Plan* (March, 2020).

1.3.1 Constructed Offsets

1.3.1.1 Rock Shoals and Road Scarification

Placement of rock material to change lake basin substrate from fine or mixed to coarse (i.e., the creation of rock shoals) is a commonly used fish habitat enhancement technique. In the dewatered area of Whale Tail Lake (Figure 1), roads and jetties will be scarified or converted to coarse substrate as necessary to create shoal-like features. In addition, an 8.7 ha network of shoals (termed grid shoals based on their conceptual design pattern) will convert a portion of the North Basin to higher-value habitat. Works will be conducted prior to the start of reflooding (est. 2026) and be accessible to fish post-reflooding (est. 2042).

1.3.1.2 Water Retention Sills and Flooding

During the operations period for the Whale Tail site, flooding of terrestrial zones in Whale Tail Lake (South Basin) and areas to the southwest is required for water management purposes (Figure 1). Flooding was initiated in 2019 and was complete in 2020. The majority of fish habitat offsets for the Whale Tail Mine will be obtained by constructing two permanent water control structures (sills) to maintain elevated water levels in this area long-term.

Prior to the pit reflooding period (est. start 2026) while Whale Tail Lake North Basin is still dry, one sill will be constructed just upstream (east) of Mammoth Dike. Once the Whale Tail Dike and Mammoth Dike are breached and flows resume their natural direction from Whale Tail

Lake to Mammoth Lake, this feature will ensure that water levels in the re-flooded Whale Tail Lake remain at 1 m higher than baseline conditions, creating approximately 46.6 ha of new aquatic habitat. This sill is further described in the *Whale Tail Pit - Fish Habitat Offsetting Plan* (C. Portt and Associates, 2018a).

Similarly, a sill is planned to be constructed between lake A18 and Whale Tail Lake. This structure will maintain water levels in the southwest flood zone (A18 – A22 & A63, termed “Lake A18” in the offsetting plan) at 1.3 m above baseline, creating approximately 31.35 ha of permanent aquatic habitat. This sill is further described in the *Whale Tail Pit Expansion Project Fish Habitat Offsetting Plan* (ERM, 2020).

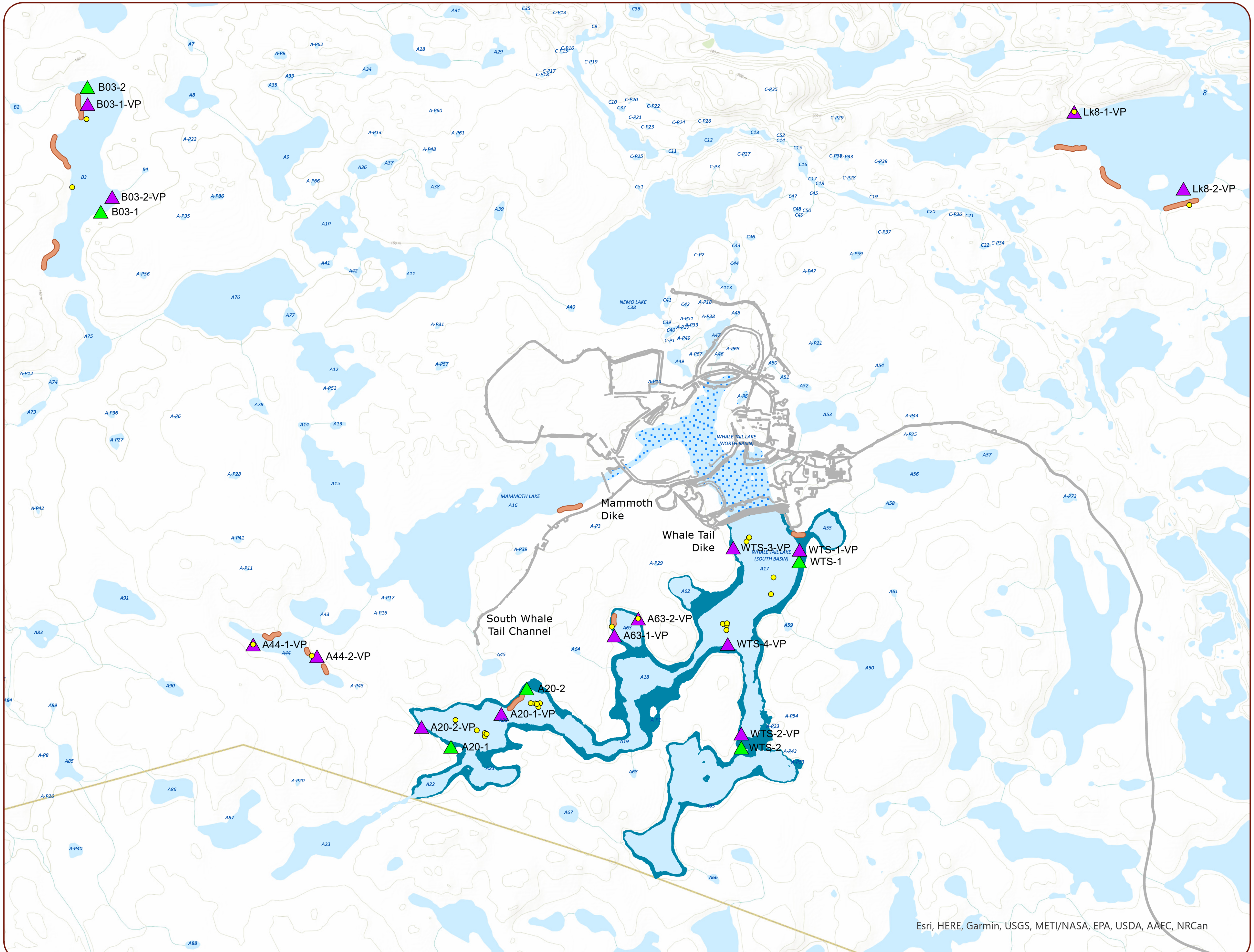
PROJECT: DA11-062-08

CLIENT: Agnico-Eagle Mines Ltd. Meadowbank Division

DATE: 21, March 2023

DRAWN BY: Janel Sauder/ David Scott/ Jade Lacsamana

Figure 1: 2022 FHOMP Monitoring Locations



Legend

- Periphyton (Visual)
- Periphyton (Substrate)
- Water Chemistry Stations
- Shoreline Electrofishing Routes
- Infrastructure
- Dewatered Lake
- Flood Zone

N

0 0.55 1.1 km

UTM Zone 17N NAD83

AGNICO EAGLE

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Disclaimer:
The information displayed on this map has been compiled from various sources. While every effort has been made to accurately depict the information, this map should not be relied on as being a precise indicator of locations, features, or roads, nor as a guide to navigation.

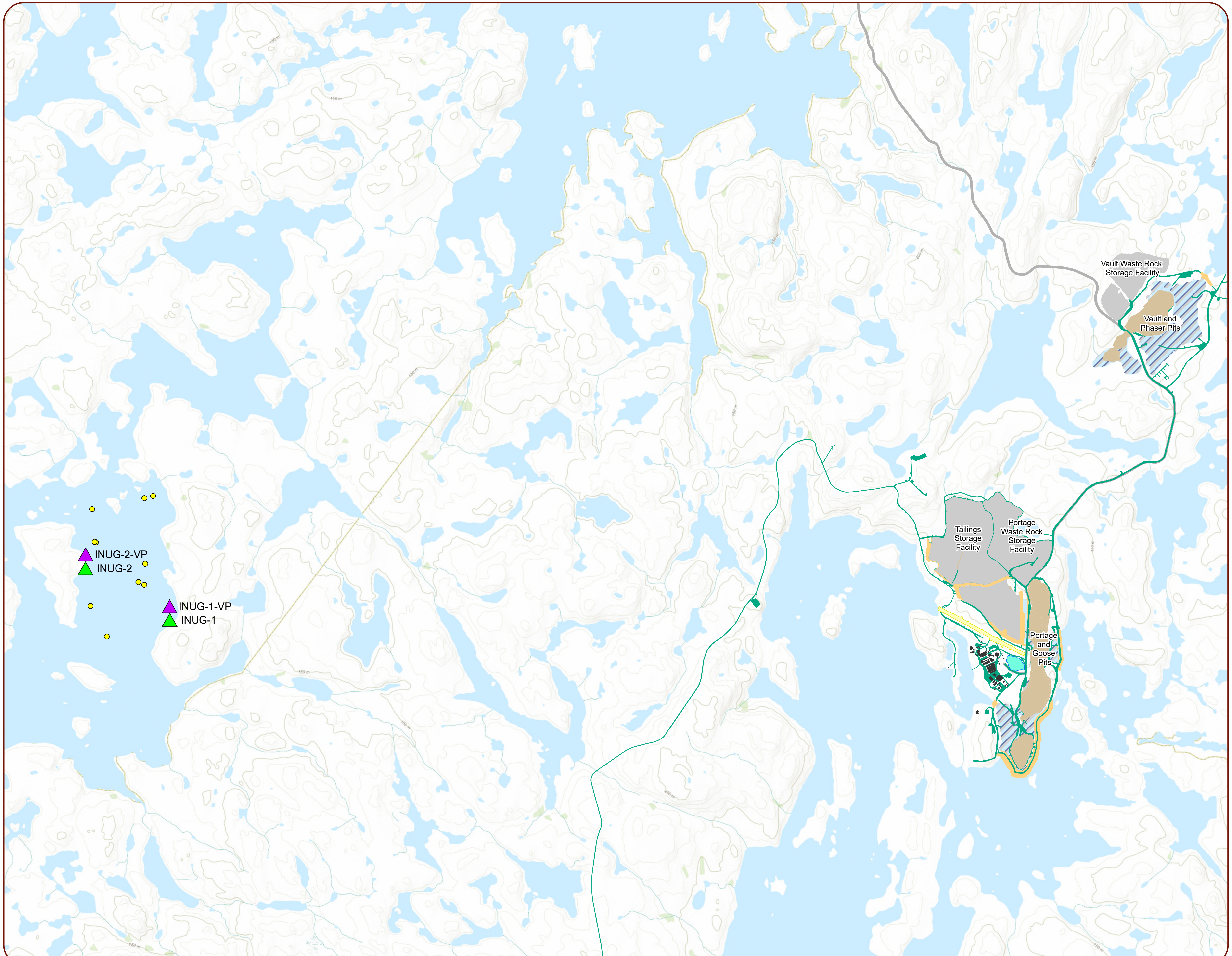
PROJECT: DA11-062-08

CLIENT: Agnico-Eagle Mines Ltd. Meadowbank Division

DATE: 10, February 2023

DRAWN BY: D. Scott

Figure 2: 2022 FHOMP Monitoring Locations



Legend

- Periphyton (Substrate)
- Periphyton (Visual)
- Water Chemistry Stations

Mine Plan

- Dewatered Lake
- Roads
- Pits
- Airstrip
- Dikes
- Facilities
- Waste Rock/Tailings Storage Facility
- Stormwater Management Pond

0 1.5 3 km

N

UTM Zone 17N NAD83

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Disclaimer:
The information displayed on this map has been compiled from various sources. While every effort has been made to accurately depict the information, this map should not be relied on as being a precise indicator of locations, features, or roads, nor as a guide to navigation.

1.3.2 Complementary Measures

A suite of complementary measures (research projects) is included as offsetting for the Whale Tail Mine. These studies continue to inform Agnico Eagle's offset planning in Nunavut as well as fish and fish habitat monitoring techniques. The complete scope of these complementary measures including methods, timelines, deliverables, and budgets is provided in Appendix C (May, 2018) of the *Whale Tail Pit - Fish Habitat Offsetting Plan* (C. Portt and Associates, 2018a). Studies include:

1. Assessment of changes in aquatic productivity and fish populations due to flooding of Whale Tail South and downstream lakes during operations
2. Assessment of impacts of the Baker Lake wastewater outflow on aquatic systems including fish and fish habitat
3. Literature review and field validation of northern lake fish habitat preferences
4. Arctic Grayling occupancy modeling (complete)
5. Assessment of pit lake habitat and use by fish
6. Development of methods for the collection and analysis of aquatic eDNA for fish community assessment

These programs have been developed in collaboration with research partners at academic institutions, and generally consist of 2-5 year study plans initiated in 2018 or 2019. One study (pit lake habitat use assessment) is planned to begin in or around 2027 at the Meadowbank site, following completion of flooding for the Phaser and Vault Pits, unless a suitable alternate research site is identified in the nearer term.

1.4 SCHEDULE FOR MONITORING

The proposed schedule for monitoring of offsets is described in the FHOMP (Agnico Eagle, 2021).

Generally, a pre-offsetting monitoring program is underway from 2021 – 2023, prior to construction of any permanent sills, to determine effectiveness of flooded terrestrial zones as fish habitat. For monitoring years 2021 and 2022, results are provided in a data report format, with a final assessment to be completed following the 2023 season (Table 2).

Final monitoring for constructed offsets is planned to begin after 2026, when construction of the permanent sills is complete. Monitoring for the A18 flood zone and Whale Tail South flooding offsets will occur from 2027 – 2036 and monitoring for the Whale Tail North flooding and shoals offsets will occur from 2040 – 2052.

Progress updates for complementary measures will be provided annually.

Table 2. General schedule of assessments conducted under the pre-offsetting ecological monitoring program for the Whale Tail site.

Component	2021	2022	2023
Water quality - from CREMP	✓	✓	✓
Periphyton	✓*	✓	✓
Small-bodied fish – shoreline habitat	✓	✓	Opportunistic**
Large-bodied fish - foraging and spawning habitat			✓
Report	Data report (by Mar. 31, 2022)	Data report (by Mar. 31, 2023)	Final analysis (by Mar. 31, 2024)

**Pilot study*

***Not required under FHOMP, but will be collected opportunistically.*

SECTION 2 • MONITORING METHODS

2.1 CONSTRUCTED OFFSETS

Constructed habitat offsets for the Whale Tail Mine consist of rock shoals and two water retention sills to maintain specified flood levels. The monitoring plan for these habitat features consists of both physical and ecological components. Monitoring of physical components is intended to confirm and report compliance with requirements of the associated Fisheries Act Authorizations to construct specific habitat offsets. Ecological monitoring will be conducted to assess the effectiveness of these features in counterbalancing HADD of fish habitat. A complete description of scheduled monitoring to assess physical structure and ecological function of the offsetting features is provided in the FHOMP, and methods for assessments completed in 2022 are described below.

2.1.1 Physical Structure Monitoring

Once permanent offsetting features are constructed, physical monitoring will include an assessment of flood zone area (ha flooded, using measured water levels), shoal area, and stability of the features. No physical structure monitoring is specified in the FHOMP prior to that time. However, a review of water levels in the flooded Whale Tail South area is provided here to document flood conditions. This information provides context for the ongoing pre-offsetting ecological monitoring of flood zone habitat and will assist in the eventual final analysis of flood zone habitat suitability. Throughout the operations phase, water levels within the Whale Tail South flood zone are measured every 3 h by piezometers installed in the Whale Tail Dike.

2.1.2 Ecological Monitoring

As indicated in Table 2, ecological monitoring was conducted in 2022 in support of the pre-offsetting ecological monitoring program. This included water quality monitoring under the existing CREMP, periphyton growth assessments, and small-bodied fish population assessments for the newly created shoreline habitat. Details of these assessments including dates, locations, field methods and laboratory analyses are described below. Locations are presented in Figures 1 and 2.

2.1.2.1 Flood Zone Water Quality

Water quality analyses conducted primarily under the CREMP are used to confirm suitable water quality within the Whale Tail area terrestrial flood zones that form part of offsetting plans. Under this program, mid-water column samples in areas > 5 m deep are collected at two sites from each of two formerly separate lakes in the flood zone (Whale Tail South and A20), as well as reference lake Inuggugayualik Lake, up to 5x/year. For the purposes of FHOMP monitoring, supplemental water quality sampling following CREMP methods is conducted once annually in A63 (part of the flood zone) and reference lakes B03, A44, and/or Lake 8 (as feasible).

Complete methods are described in the 2022 CREMP Report (Azimuth, 2023), an Appendix of the Meadowbank Complex 2022 Annual Report.

2.1.2.2 Periphyton Growth

The periphyton community consists of a collection of microorganisms, including algae, that grow attached to or in very close proximity to submerged substrate. Colonization of the community occurs over time, with rates depending on factors such as nutrient and light availability. Periphyton is an important food source for benthic invertebrates and has been broadly used as an indicator metric in biomonitoring protocols for many years.

For the Whale Tail site, colonization of periphyton is monitored to provide a commentary on growth in flood zone habitat compared to reference areas. Historical data analysis as part of the 2015 CREMP design update (Azimuth, 2016) has indicated that due to extreme natural variability, statistical comparisons of periphyton on in-situ substrate (e.g., submerged rock faces) are not well suited for receiving environment monitoring in this area. As a result, periphyton monitoring for the Whale Tail site incorporates two components:

1) Visual surveys in designated locations within newly created flood zones to qualitatively assess progression of periphyton development on underwater rock substrate.

2) Deployment of artificial substrate samplers to confirm whether colonization rates are comparable to reference systems, indicating that a healthy periphyton community can become established.

Since periphyton sampling using artificial substrate had not previously been used at the Meadowbank site, a pilot study was conducted in 2021 with a limited set of lakes to assess feasibility and field test methods. This study was expanded to its full scope in 2022, and visual surveys were also conducted in accordance with the FHOMP.

2.1.2.2.1 Artificial Substrate Sampling

In 2021, a pilot study was conducted to test the feasibility of measuring a periphyton growth metric (chlorophyll-a) on artificial substrate within the study lakes over the ice-free season. Although there was a high rate of sample substrate loss, this pilot study was successful in demonstrating that seasonal periphyton biomass as represented by chlorophyll-a concentration can be effectively measured using artificial substrate samplers in the Whale Tail flood zone. With some adjustments to sampler design intended to improve sample security, periphyton substrates were again deployed in 2022 across the target lake basins, according to the FHOMP. Details of the samplers, dates, locations, and analysis are described below.

Artificial Substrate Samplers – Each periphyton sampler consisted of two Plexiglas slides (30.5 cm x 20.3 cm each) suspended side-by-side approximately 25 cm below a wood float, with supplemental rubber buoy. A metal weight (U-bolt or washer) was attached to each slide to help keep them suspended vertically in the water column (Figure 3).

Figure 3. Artificial substrate sampler for periphyton pilot study in 2022.

Sample Locations & Dates – For the 2022 study, two periphyton samplers, each holding two Plexiglas slides, were deployed at each monitoring station (Figures 1 & 2). Each sampler was deployed in a shoreline location in 1 – 2 m water depth and secured using two anchor weights affixed to the ends of the wood float (Figure 4).

Samplers at WTS and A20 locations were deployed on July 4 and collected on September 11. Samplers at B03 and INUG locations were deployed on July 9 and retrieved on September 11 and 15, respectively. All samplers except those at the far field reference site (INUG) were checked mid-season, and fixed as needed (e.g., re-attached rubber buoys, re-tied loose or untied anchor ropes, moved to deeper water as needed due to rapidly dropping water levels). In one case (B03-1) the anchor rope had come untied and both samplers were found on shore. They were re-deployed (August 18). At sample collection, only one of the four samplers deployed at INUG locations was intact in the water column. Two samplers were found onshore and one was not found. Any impacts of sampler loss on final results are presented in Section 3.1.2.2.1.

Figure 4. Artificial substrate periphyton sampler in-situ.

Sample Collection and Analysis – Periphyton samplers were retrieved from the water and placed in labelled sample bags after tether ropes were removed. Care was used not to disturb periphyton on the slides during this process. Slides were stored in a dark cooler with ice packs prior to processing (periphyton removal) onsite. Upon return to the onsite laboratory, Plexiglas slides were removed from sample bags and scraped clean into the sample bags using a plastic scraper and a small amount of deionized water. Sample bags were sealed and stored frozen prior to and during shipping to the accredited laboratory for analysis. Analysis for chlorophyll-a as a relative measure of biomass was performed by ALS Laboratories using procedures modified from EPA Method 445.0. Briefly, chlorophyll-a content by mass is determined using a 90% acetone extraction followed with analysis by fluorometry.

2.1.2.2.2 Visual Surveys

At the end of the summer season (September 2 – 15), visual observations of periphyton growth were recorded at two to four stations in the study lakes (Figure 1 and 2). A rectangular plot of 1 x 2 m was observed and photographed, and specified periphyton characteristics were recorded. Methods followed those used by Portt & Associates for baseline surveys conducted for the Whale Tail Mine FEIS (Agnico Eagle, 2016), and described in Golder (2015). Specifically, for each sampling location:

- A shoreline area of approximately 1 x 2 m was identified, extending from the water's edge. Locations were marked to facilitate re-analysis in the next year.
- To retain a visual record, photographs were taken of each plot at the micro scale (substrate/periphyton as seen looking down on the plot) and macro scale (~20 m of shoreline).
- The following information was recorded:
  - Substrate proportions at the microhabitat level
  - Description of colour, approx. thickness, and texture of periphyton at the microhabitat level
  - Percent cover of periphyton at the micro habitat scale (none 0%, sparse <5%, low 5-25%, moderate 25-75%, high >75%) and evenness at the macrohabitat scale (even/patchy)

For the purposes of this data report, a qualitative summary of results with discussion of observed differences between lakes is provided. Inter-annual comparison with incorporation of baseline survey results (available for a subset of locations) will be included in the final pre-ecological monitoring report (March, 2024).

2.1.2.3 Fish Use

In 2022, field assessments for the pre-offsetting ecological monitoring program focused on use of shoreline habitat by small-bodied species, as described below. In 2023, deeper water habitat use by large bodied species will also be assessed.

2.1.2.3.1 Flood Zone Habitat – Habitat Types 2 & 3 (Shoreline)

To determine effectiveness of offsetting habitat, relative abundance and population dynamics indicators for resident small-bodied fish in flooded shoreline areas (inundated areas, or terrestrial habitat that are part of the lake and have undergone physical changes due to flooding) are evaluated and compared to reference sites.

According to the Whale Tail site Habitat Evaluation Procedure (HEP; Portt & Associates, 2018; ERM, 2020), the newly created shoreline in Whale Tail Lake will provide primarily foraging habitat for Ninespine Stickleback (*Pungitius pungitius*) and Slimy Sculpin (*Cottus cognatus*), as Habitat Types 2 and 3. This assumption was tested beginning in the first year post-flooding

(2020[3]) and again in 2021 and 2022 by shoreline electrofishing at selected flooded lake areas (WTS, A63, A65, and A20), downstream areas (Mammoth Lake – supplemental to the FHOMP), and reference areas (Lake 8, A44, B03) (Figure 1, Table 3).

Electrofishing is an active fishing technique that uses pulsed direct current to initiate an involuntary swimming action in fish. When exposed to the electrical field, fish become oriented toward the electrofisher and involuntarily swim towards the anode and are collected with a dip net. In all study years to date, backpack electrofishing was conduced by a team of two (including at least one person experienced and trained in backpack electrofishing). One person with a backpack electrofisher, and another with a dip net, collected fish by wading along representative shorelines in Habitat Types 2 and 3 of flooded lakes and reference lakes. Electrofishing locations for 2022 are shown in Figure 1. When time and access allowed, electrofishing was conducted until a minimum of 30 Slimy Sculpin were collected per lake (number selected by the research team for Study 1 (Section 2.2) in 2019 using an *a priori* power analysis to determine minimum sample size). In 2022, the objective was met or nearly met in all lakes fished except A44. For all study sites, duration of shocking (seconds) was recorded for calculation of catch-per-unit effort (CPUE).

In 2022, all fish collected were identified to the lowest taxonomic level possible (typically to species), and length and weight were recorded. In previous years, a subset of fish were lethally sampled to allow additional analyses for supplemental research objectives (e.g., tissue chemistry), and examination of otoliths for aging is planned for a further subset of fish. However, under the FHOMP, lethal sampling was not required in 2022 for any endpoint except aging. Since otolith aging of small-bodied fish is highly uncertain, and since no other lethal sampling was required this season, the decision was made in consultation with the Study 1 research program lead Dr. Heidi Swanson to live-release all fish in 2022 to reduce rates of mortality. Age data will be available for 2020 and 2021, and Agnico will discuss with DFO the merits of collecting age data again in 2023 for any small-bodied fish surveys that are conducted.

[3]Small-bodied fish electrofishing was conducted in 2020 under complementary measures Study 1, and while not specifically part of the FHOMP requirements, results are included here as supplemental data. Small-bodied fish electrofishing was also conducted prior to flooding (2018) and during flooding (2019) as part of Study 1, and pending study completion, the final pre-ecological monitoring report will incorporate those data in a BACI-style comparison if feasible.

Table 3. Summary of shoreline electrofishing effort (total shocking time across species) under the FHOMP pre-offsetting ecological monitoring program for the Whale Tail site. NF = previously fished for research purposes, but not fished in 2022 under FHOMP (not planned to remain flooded).

Habitat Type	Waterbody	2020		2021		2022	
		Dates	Duration (min)	Dates	Duration (min)	Dates	Duration (min)
Flooded	Whale Tail South	Aug 26	42	Aug 14, 15, 16	143	Aug 21	36
	A63	Aug 26	16	Aug 16	54	Aug 23	51
	A65	Aug 27	34	Aug 12	74	NF	NF
	A20	Aug 27	44	Aug 10	100	Aug 21	53
Downstream	Mammoth Lake	Aug 21, 25	150	Aug 17	41	Aug 18	66
Reference	Lake 8	Aug 23, 24	96	Aug 15	84	Aug 20	105
	A44	Aug 29	45	Aug 13	72	Aug 19	57
	B03	Aug 29	14	Aug 14, 18	57	Aug 22	59

2.2 COMPLEMENTARY MEASURES

As required by Fisheries Act Authorization 16-HCAA-00370, complete annual progress reports on complementary measures are provided to DFO by May 30 of the following year, including methods and preliminary results.

An interim update is provided in this report for each project, along with a description of activities of the MFRAG in the preceding year. These interim updates will focus on general activities and identifying progress towards study completion, and do not include specific methods and results.

SECTION 3 • RESULTS & DISCUSSION

3.1 CONSTRUCTED OFFSETS

3.1.1 Physical Structure Monitoring (Water Levels)

Throughout the operations phase, water levels in the Whale Tail flood zone have been recorded every three hours using piezometers installed in the Whale Tail Dike. Measured water levels through 2022 are shown in Figure 5. During the first year of scheduled flooding

(2019), peak water levels exceeded predictions in July (up to 155.8 meters above sea level; masl), but did not reach the maximum predicted final flood elevation of 156.0 masl). This was likely a result of record precipitation in that year. Since 2020, water levels have remained lower than FEIS model predictions, after an amendment to the final design[4] of the South Whale Tail Channel outlet was made. The design change included a decrease in the channel inlet elevation by 0.5 m, to 155.3 masl, in order to reduce peak water levels against the Whale Tail Dike. Operational water levels moving forward are therefore predicted remain lower than the original 156.0 masl prediction. To date (2020 - 2022) flood-zone water levels have ranged between approximately 154.55 and 155.75 masl over the course of a year.

Despite a reduction in operational water levels compared to FEIS predictions throughout the flood zone, measured elevations are the same as or exceed those that will eventually be maintained permanently for offsetting purposes, following sill construction.

For Whale Tail Lake, offsetting plans assume an increase to 154.02 masl from a baseline of 153.02 masl (baseline determined from July 21, 2011 CanVEC imagery). Current operational water levels in late July have remained in the range of 155.2 – 155.4 masl, or about 1.2 – 1.4 m higher than they will be post-offsetting. As a result, shoreline habitat in Whale Tail Lake – South Basin that is evaluated now under the pre-offsetting ecological monitoring program may be considered representative of, but not identical to, post-closure shoreline habitat in this area, once water levels are drawn down by 1.2 – 1.4 m.

For Lake A18, offsetting plans assume an increase to 155.3 masl from a baseline of 154.0 masl in A18 (at the A18 sill)[5]. Since the Whale Tail South Channel which is the current outlet for the flood zone was constructed at 155.3 masl, current operational water levels align with this plan and no significant change in water levels or shoreline habitat would be expected following sill construction.

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[4] The completed construction summary report for the South Whale Tail Channel is available through the NWB public registry here: ftp://ftp.nwb-oen.ca/registry/2%20MINING%20MILLING/2A/2AM%20-%20Mining/2AM-WTP1830%20Agnico/3%20TECH/D%20CONSTRUCTION/D16/South%20Channel/

[5] For lakes further upgradient from A18 that will be permanently joined to it by flooding (A19 – A22 plus A63), baseline water elevations are higher than A18, so flooding to the planned 155.3 masl increases water depths in those lakes by less than 1.3 m. For example, baseline depths in A22 were measured at 155.0 masl in the offsetting plan, so flooding to 155.3 masl adds 0.3 m above baseline.

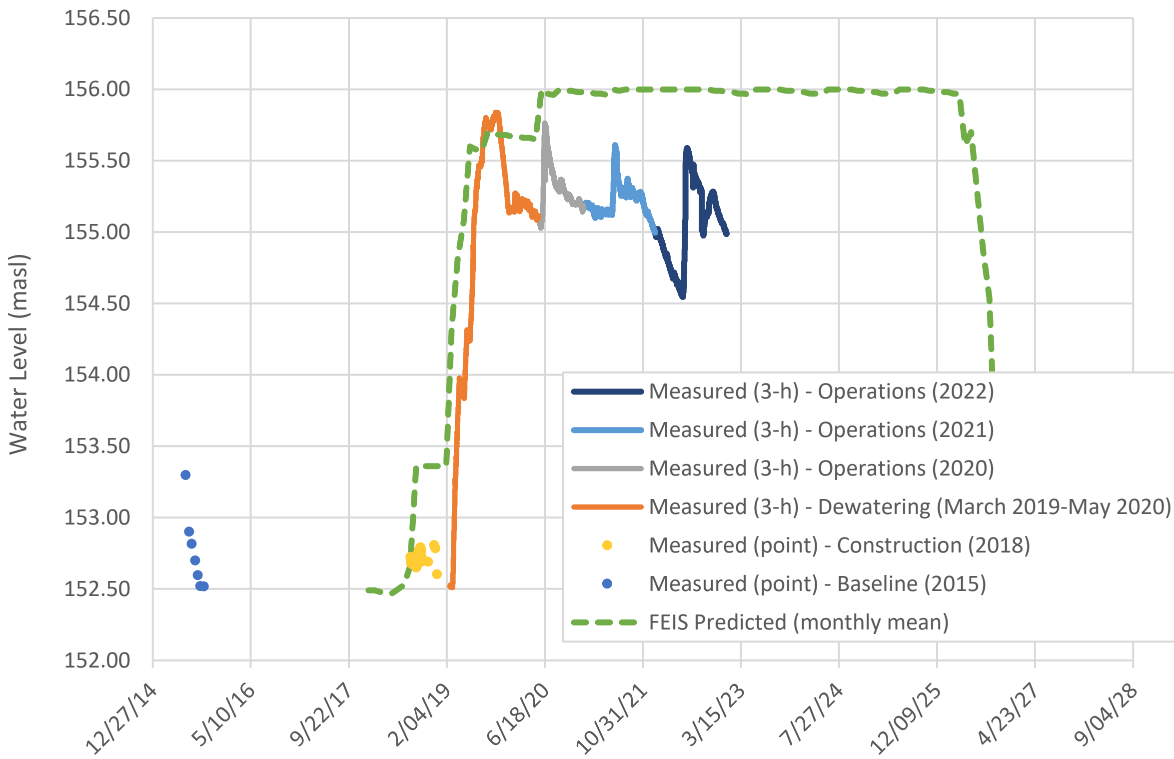

Figure 5. Measured and predicted water levels in the Whale Tail South flood zone (point measurement by GPS survey, 3-h interval by piezometer, or modeled monthly mean, as indicated). Predicted water levels from FEIS Addendum for the Whale Tail Pit Expansion Project, Appendix 6-O, Table D-14 (Agnico Eagle, 2018b).

3.1.2 Ecological Monitoring

3.1.2.1 Flood Zone Water Quality

Complete results of annual CREMP water quality monitoring within the Whale Tail flood zone (samples collected in WTS and A20) are presented in the 2022 CREMP Report (an appendix of the 2022 Meadowbank Complex Annual Report). Results will be compiled and presented in the FHOMP context (along with supplemental location water quality sampling results) to support analyses as part of the final pre-offsetting ecological monitoring report in 2024 (*Impact Analysis of Fish Habitat from Flooding*).

Briefly, in 2022, some exceedances of CREMP water quality triggers and statistically significant increases relative to baseline/reference conditions were observed in WTS and A20 for:

- Ionic compounds (TDS and constituent ions such as calcium, magnesium, potassium, and sodium),

- Nutrients (total Kjeldahl nitrogen, total phosphorus, total organic carbon and dissolved organic carbon),
- Titanium (WTS) – *likely not mine-related*.

Similar to results seen over the years at the Meadowbank study lakes, these trends represent increases above baseline/reference conditions only; except for total phosphorus, none of these analytes have CCME effects-based guidelines for the protection of aquatic life and the observed changes are classified as “minor” according to the CREMP Adaptive Management Plan. While mine-related changes have occurred, changes are not expected to result in adverse effects to aquatic life. The one exception was mean annual total phosphorus at WTS and A20 which is classified as a moderate change because there were significant increases above the early warning trigger in 2022. The CREMP early warning trigger for total phosphorus is set at 0.004 mg/L, which is equivalent to the lower bound for oligotrophic lake classification (CCME, 2004), and is less than monthly FEIS predictions for the flood zone. FEIS-predicted (Agnico Eagle, 2018b) and measured concentrations of total phosphorus (and other nutrients) to date are shown in Figure 6. While some measured concentrations of phosphorus have exceeded monthly FEIS predictions in WTS, all were within an order of magnitude (the level of uncertainty assigned to these predictions in the FEIS), and measured concentrations have remained within predicted trophic levels to date. According to the FEIS, phosphorus and nitrate levels are predicted to increase in WTS until 2026, after which time concentrations are predicted to decline.

Under the CREMP, phytoplankton community sampling is also conducted at the same time as the water chemistry program. Though changes in phytoplankton biomass or species richness compared to baseline/reference in 2022 were not statistically significant due to high variability, effect sizes for biomass at FHOMP lakes WTS and A20 (along with other near-field lakes) exceeded the 20% trigger. These results follow an apparent but not always statistically significant increases in biomass from 2019 – 2021 (Figure 7). This increase in lower trophic level production was predicted in the FEIS Addendum, but not quantified (Agnico Eagle, 2018b).

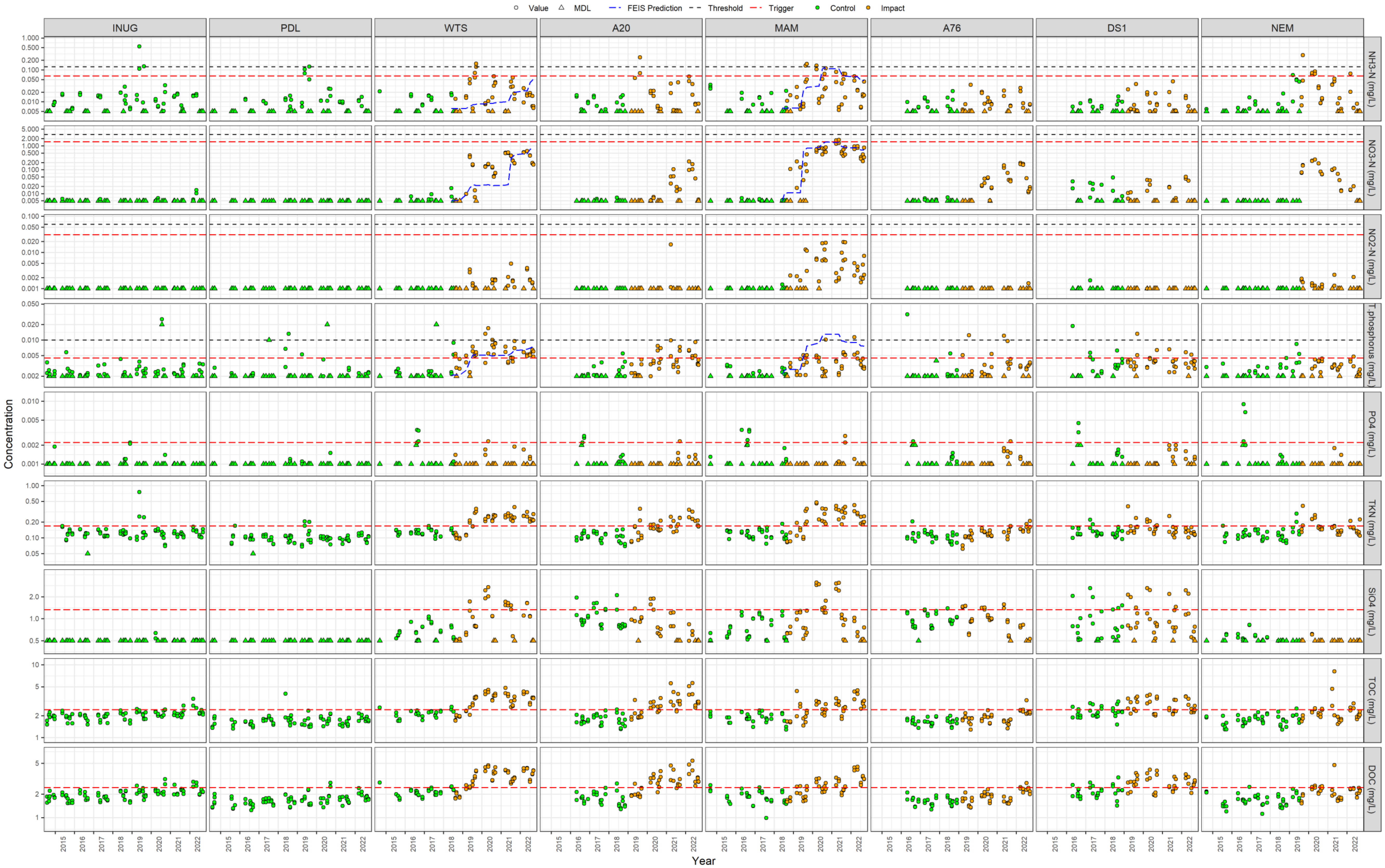

Figure 6. Nutrient parameters measured in Whale Tail Mine area lakes since 2014. Blue dashed line indicates FEIS Addendum model prediction. Figure from Azimuth (2023).

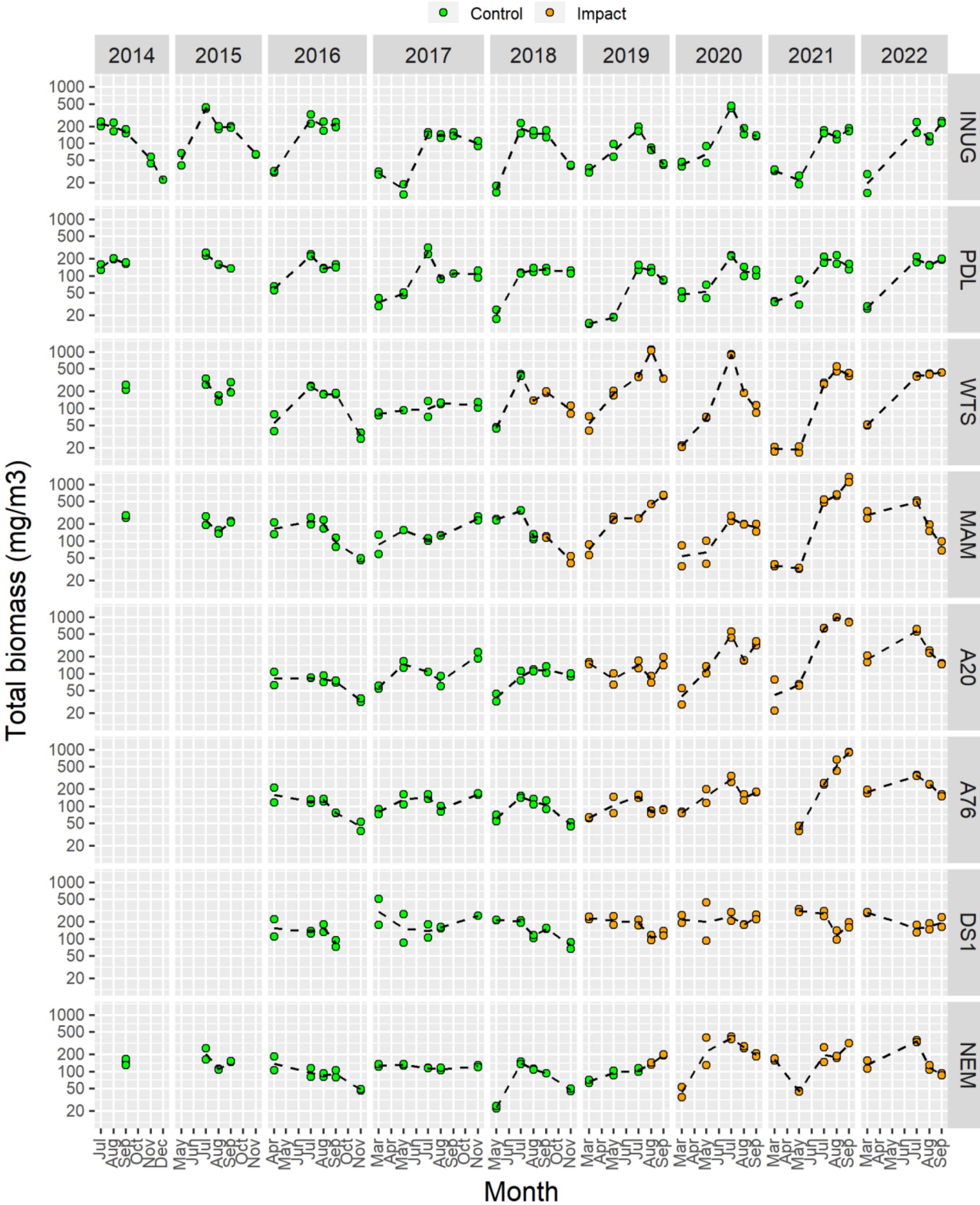

Figure 7. Total phytoplankton biomass (mg/m^3) from the Whale Tail Mine study lakes since 2015. Figure from Azimuth (2023).

3.1.2.2 Periphyton Growth

3.1.2.2.1 Artificial Substrate Sampling

Sample Recovery - In total, 16 periphyton samplers were deployed (each holding two Plexiglas sample slides). As described in Section 2.1.2.2.1 and Table 4, below, some loss of samplers occurred, particularly in reference lakes, and primarily due to anchor ropes detaching or breaking, or a rapid decline in water levels that occurred from late August to early September in the flood zone lakes. No loss of Plexiglas slides from the float occurred in 2022, which is a significant improvement over 2021 pilot study methods. Plans for further improvement in 2023 are discussed below.

Periphyton Biomass – Results of the chlorophyll-a analysis are presented in Table 4. While results for many reference site samplers must be interpreted with caution (see comments in Table 4), it is clear that seasonal periphyton growth is greater in WTS than reference lakes. This observation is in line with 2018 FEIS Addendum predictions for increased nutrient concentrations and primary productivity in WTS (Agnico Eagle, 2018b), as well as 2022 CREMP results, which showed increased concentrations of both nutrients and phytoplankton biomass in flood zone lakes compared to baseline/reference (Azimuth, 2023; as described in Section 3.1.2.1). Periphyton growth may also be elevated in A20 compared to reference sites.The difference is less apparent than for WTS, but this trend is similar to observations for water-column chlorophyll-a measured through the CREMP in 2022. . During the 2021 pilot study, only three samples were collected in WTS, but mean chlorophyll-a (0.064+/-0.029 μg/cm^2) was less than any WTS measurement in 2022, and similar to A20 results for 2022. Only one sample result was available from INUG in the pilot study year and chlorophyll-a was not detectable, which is comparable to 2022 results for reference sites B03 and INUG.

Table 4. Periphyton chlorophyll-a results for artificial substrate samplers. ND = not detectable. Sample results that are interpreted with caution due to various sampling concerns (see Comments) are indicated in brackets.

Lake	Station ID	Sample ID	Chlorophyll-a (μg/cm^2)	Comments
Whale Tail South	WTS-1	WTS-1-a	0.148	Visible light brown periphyton. No sampling concerns.
		WTS-1-b	0.169	
		WTS-1-c	0.136	
		WTS-1-d	0.127	
	WTS-2	WTS-2-a	0.107	Visible darker brown periphyton. No sampling concerns.
		WTS-2-b	0.204	
		WTS-2-c	0.170	
		WTS-2-d	0.201	
A20	A20-1	A20-1-a	(ND)	Slides in contact with substrate due to rapid drop in water level
		A20-1-b	(ND)	
		A20-1-c	(0.003)	
		A20-1-d	(0.034)	

Lake	Station ID	Sample ID	Chlorophyll-a (µg/cm²)	Comments
	A20-2	A20-2-a	0.023	Minimal visible periphyton. No sampling concerns.
		A20-2-b	0.009	
		A20-2-c	0.016	
		A20-2-d	ND	
B03	B03-1	B03-1-a	(0.003)	A few bright green patches. Samplers found onshore at mid-season check (Aug 18), and re-deployed.
		B03-1-b	(0.005)	
		B03-1-c	(0.004)	
		B03-1-d	(0.002)	
	B03-2	B03-2-a	ND	Minimal periphyton (a few green patches). No sampling concerns.
		B03-2-b	ND	
		B03-2-c	ND	
		B03-2-d	ND	
Inuggugayualik	INUG-1	INUG-1-a	ND	No sampling concerns.
		INUG-1-b	ND	
		INUG -1-c	(ND)	Found onshore.
		INUG -1-d	(ND)	
	INUG-2	INUG -2-a	(0.001)	Slides in contact with substrate.
		INUG -2-b	(ND)	
		INUG -2-c	-	Missing
		INUG -2-d	-	

Conclusions and Next Steps – Despite the high rate of sampling concerns, primarily due to loss of anchors and rapidly declining water levels, it is evident that seasonal periphyton biomass as represented by chlorophyll-a concentration is greater within the WTS flood zone than reference sites. With an additional year of sampling (2023), it is expected that these data combined with visual periphyton assessments will be able to address offsetting criteria for success with regards periphyton.

Further adjustments to sampler design will be implemented in 2023 to reduce sample loss. In particular, the installation depth and anchoring method will be reviewed to determine whether techniques can be improved to keep samplers stable in the water column throughout the season.

The 2022 study design will be replicated in 2023, with four sample slides deployed at two stations within each target flood zone basin (Whale Tail South Basin and A20, to align with CREMP water quality stations) and reference lakes B03 and INUG.

3.1.2.2.2 Visual Surveys

Complete visual survey results for each station are provided in Appendix A, along with site photos at both the micro and macrohabitat scale. Key characteristics are summarized in Table 5.

Periphyton cover at the microhabitat scale (1 x 2 m) varied across both flood zone and reference lakes from none (0%) to high (>75%), with both patchy and even coverage at the macrohabitat scale (20 m of shoreline). Nearly all periphyton was brown in colour, with a thickness of 1 – 3 mm. Within the flooded lakes (Whale Tail, A20, and A63), periphyton texture was more commonly characterized as spongy mat, compared to either flat/compact, or loosely attached periphyton in reference lakes (Lake 8, A44, B03, Inuggugayualik). This difference may be an artifact of the qualitative reporting method, or may in fact indicate the presence of decomposing terrestrial organic matter such as lichens. Texture differences between flood zone and reference lakes will be more specifically examined in 2023.

Table 5. Periphyton visual survey – summary of key results.

Lake	Station ID	Cover Category	Colour	Thickness	Texture	Evenness
Whale Tail	WTS-1-VP	Sparse	Brown	3 mm	Spongy mat	One patch
	WTS-2-VP	Moderate	Brown	1 mm	Spongy mat	Patchy
	WTS-3-VP	None	-	-	-	-
	WTS-4-VP	Moderate	Brown	1 mm	Spongy mat	Patchy
A20	A20-1-VP	High	Brown	1 – 2 mm	Spongy mat	Even
	A20-2-VP	High	Brown	1 – 3 mm	Spongy mat	Even
A63	A63-1-VP	Moderate	Brown	1 – 3 mm	Spongy mat	Even
	A63-2-VP	High	Brown	2 – 3 mm	Spongy mat	Even
Lake 8	Lake8-1-VP	Moderate	Brown	1 mm	Flat, compact	Patchy
	Lake8-2-VP	Moderate	Brown	1 – 3 mm	Loosely attached	Patchy
A44	A44-1-VP	Moderate	Brown/beige	1 mm	Compact	Patchy
	A44-2-VP	High	Light brown	2 – 3 mm	Filamentous	Patchy
B03	B03-1-VP	Moderate	Light brown	1 mm	Loosely attached	Even
	B03-2-VP	Moderate	Light brown with some green	1 – 3 mm	Loosely attached	Patchy
Inuggugayualik	INUG-1-VP	None	-	-	-	-
	INUG-2-VP	High	Brown	1 – 5 mm	Firmly loose	Even

3.1.2.3 Fish Use

Total catch of fish captured through backpack electrofishing of shoreline habitat annually since 2020 is provided in Table 6, and catch-per-unit effort is shown in Figure 8. It is noted that total catch was greater in 2020 since additional fish were captured for research purposes.

In 2022, both Ninespine Stickleback and Slimy Sculpin appear to have been present in flooded shoreline habitat at rates no lower than reference lakes, on average. These data will be further analyzed and discussed in the context of multi-year results as part of the final report following the 2023 field season.

Table 6. Total catch of Ninespine Stickleback, Slimy Sculpin and other fish by-catch from shoreline electrofishing (by-catch not recorded in 2020). *Values for 2020 were corrected in this 2022 report, as they previously included only fish retained for further laboratory analyses. NF = not fished.

Habitat Type	Waterbody	2020*		2021			2022		
		NSSB	SLSC	NSSB	SLSC	Other	NSSB	SLSC	Other
Flooded	WTS	129	33	15	32	LKTR, RNWH, BURB, ARCH	29	25	Unknown
	A63	70	NF	16	29	-	66	34	-
	A65	35	35	3	12	LKTR, RNWH, ARCH,	NF	NF	-
	A20	107	37	19	6	ARCH	12	35	-
Downstream	MAM	9	100	32	31	-	13	35	BURB, LKTR
Reference	Lake 8	NF	102	NF	10	ARCH, Sal.	0	34	LKTR
	A44	8	34	4	8	LKTR	33	12	BURB, Unknown
	B03	1	34	9	30	ARCH, LKTR, BURB	1	38	-
Total		**359**	**375**	**98**	**158**	-	**154**	**213**	-

NSSB = Ninespine Stickleback; SLSC = Slimy Sculpin; LKTR = Lake Trout; ARCH = Arctic Char; RNWH = Round Whitefish; BURB = Burbot; Sal. = Salmonid species

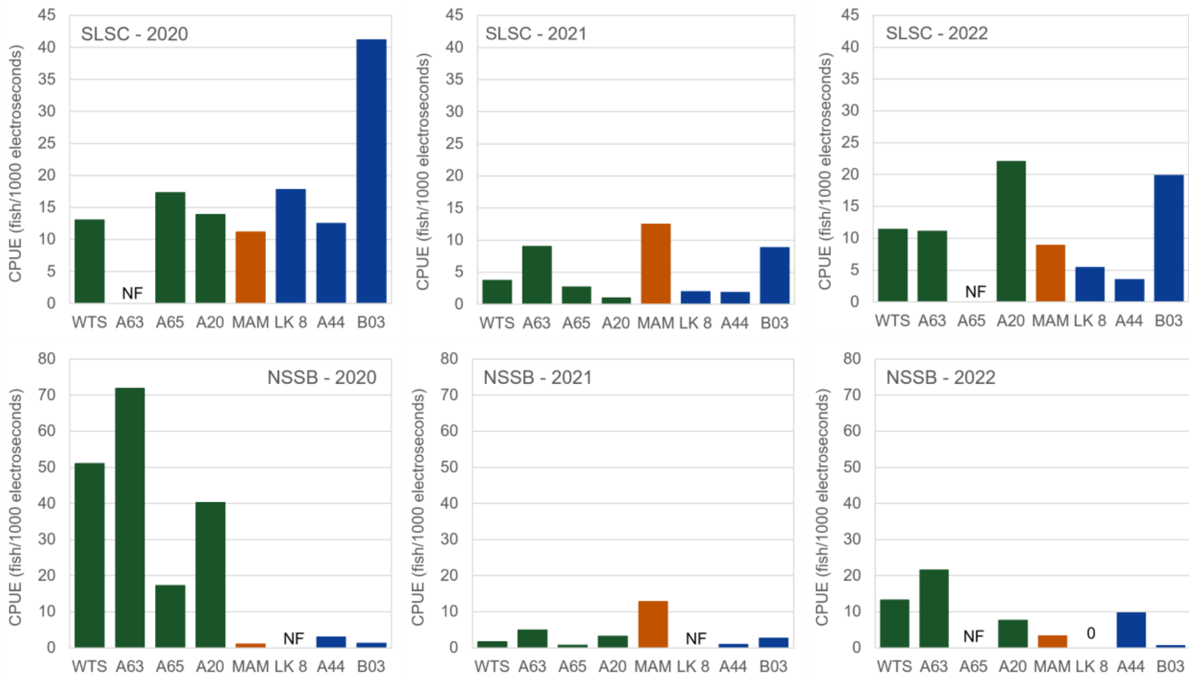

Figure 8. Catch per unit effort of Slimy Sculpin and Ninespine Stickleback collected from 2020 - 2022 in the study lakes (green = flooded, orange = downstream, blue = reference). NF = not fished.

Length-frequency distributions for Slimy Sculpin and Ninespine Stickleback are provided in Figures 9 and 10. Though relatively few Ninespine Stickleback were captured in reference lakes until 2022, length-frequencies with sufficient data appear normally distributed each year for both flood and reference lakes. These data will be further analyzed in 2023 for the final data report, but suggest that population structure, growth, and recruitment of fish within flood zone populations are not substantially different from reference lake populations.

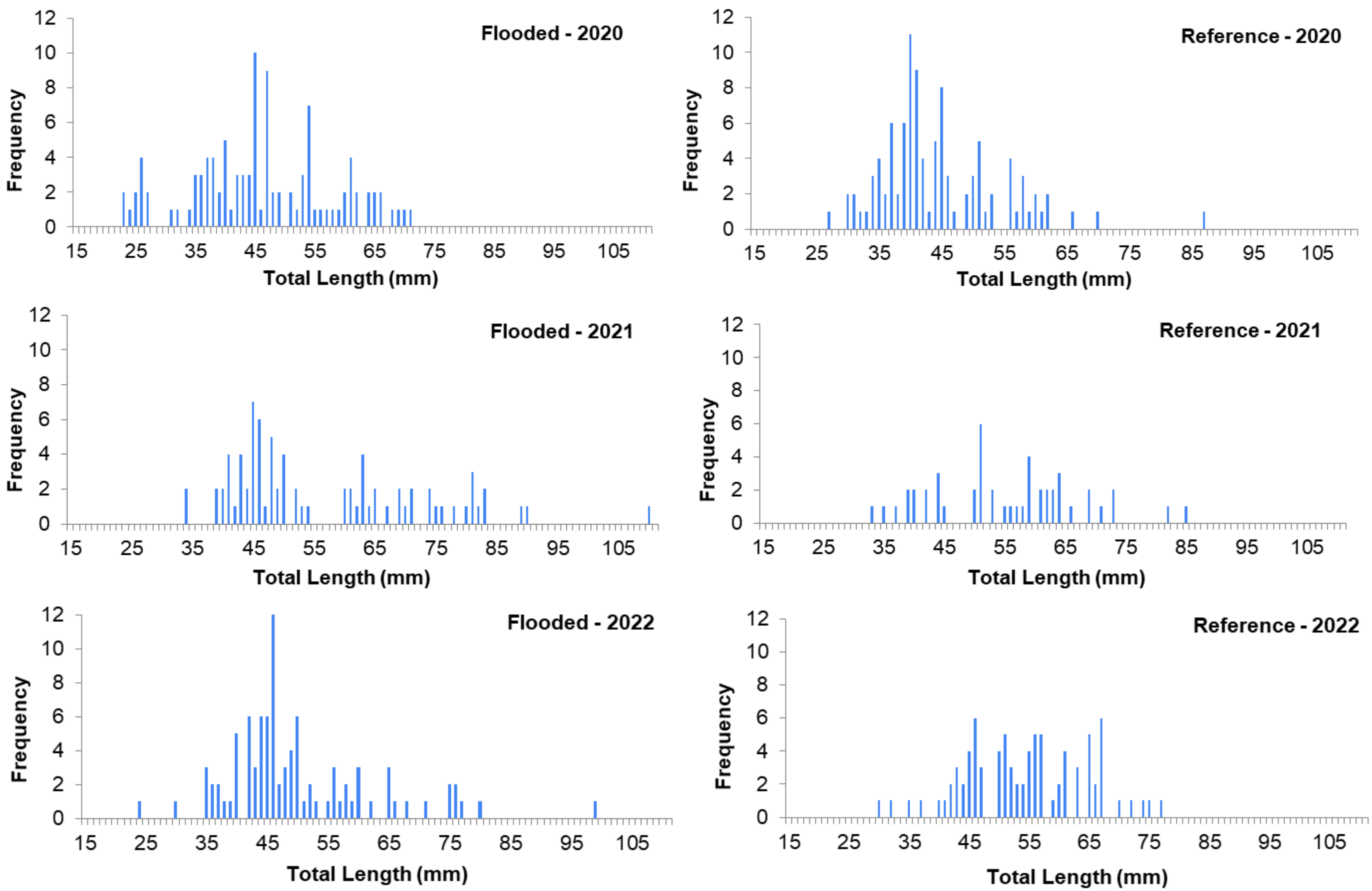

Figure 9. Length-frequency distributions for Slimy Sculpin collected in flooded lakes (WTS, A20, A63, A65) and reference lakes (A44, B3, Lake 8).

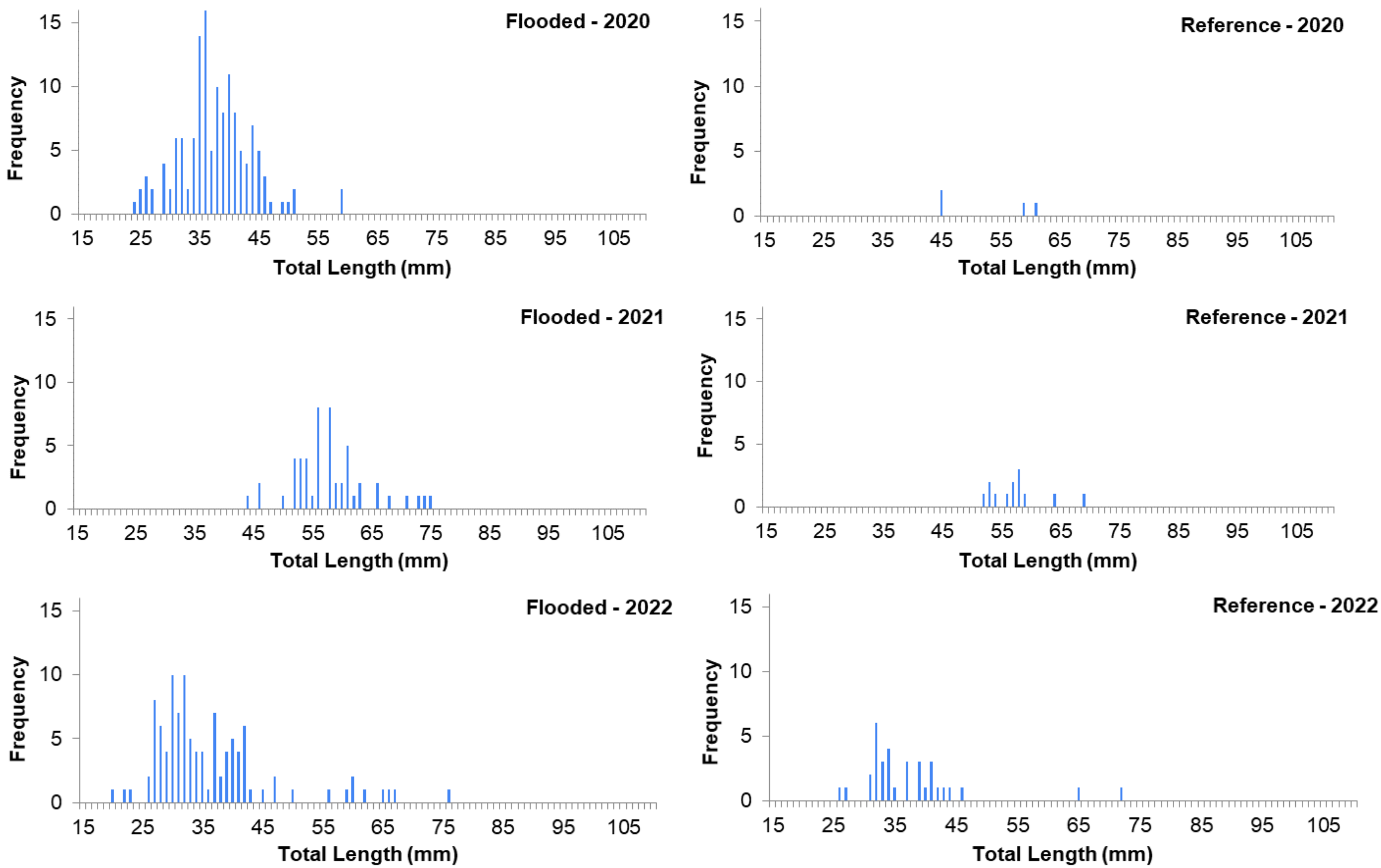

Figure 10. Length-frequency distributions for Ninespine Stickleback collected in flooded lakes (WTS, A20, A63, A65) and reference lakes (A44, B3, Lake 8).

3.2 COMPLEMENTARY MEASURES

An update is provided here on activities of the MFRAG along with a summary of progress for each research study in 2022. Full research methods are documented in annual progress reports provided to DFO by May 30 annually.

3.2.1 Activities of the MFRAG

As part of the Fish Habitat Offsetting Plan for Whale Tail Mine (C. Portt and Associates, 2018a), the MFRAG was conceptualized to provide a forum for input from key stakeholders. The MFRAG meets annually to review project progress reports, propose and approve or reject new projects or project components, and assess whether criteria for success have been met.

In 2019, Agnico Eagle confirmed interest in MFRAG participation by DFO, the Kivalliq Inuit Association (KivIA), and the Baker Lake Hunters and Trappers Organization (BLHTO). As planned in the Fish Habitat Offsetting Plan for Whale Tail Mine, Appendix C (C. Portt and Associates, 2018a), Agnico Eagle also identified a third party external advisor (Dr. Kelly Munkittrick, University of Calgary) who will participate in all MFRAG activities. A draft Memorandum of Understanding and Terms of Reference (TOR) were developed by Agnico Eagle and reviewed by all parties. The initial meeting of the MFRAG was held on December 12, 2019 in Montreal, Quebec. Representatives from all member groups were in attendance. The group received presentations by lead researchers involved in each study, and had the opportunity for questions, comments, and open discussion. Each MFRAG member group was requested to provide written comments, if any, by February 28, 2020. Written comments were distributed to research study leads for consideration.

In 2020, the MFRAG TOR were finalized, and signed by all parties as of March, 2021. The second annual meeting of the MFRAG was held by video conference due to COVID restrictions on December 2, 2020, with all member groups participating (Agnico Eagle, DFO, KivIA, BLHTO). As in 2019, the group received presentations by lead researchers involved in each study, and had the opportunity for questions, comments, and open discussion. Each MFRAG member group was requested to provide written comments, if any, by January 13, 2021. Written comments were again distributed to all member groups and the research study leads for consideration. No major concerns with research study progress were raised during the meeting or in follow-up comments.

In 2021, the third annual meeting of the MFRAG was held by video conference due to COVID restrictions on December 14, 2021, with all member groups participating. As in previous years, the group received presentations by lead researchers involved in each study, and had the opportunity for questions, comments, and open discussion. Each MFRAG member group agreed to provide written comments, if any, by January 25, 2022. Written comments were again distributed to all member groups and the research study leads for consideration. No major concerns with research study progress were raised during the meeting or in follow-up comments.

In 2022, the fourth MFRAG meeting was held by video conference on November 18, 2022, with all member groups participating. The meeting format was the same as previous years. In advance of the meeting, all member groups received the previous year's Annual Progress Report, along with a non-technical summary in English and Inuktitut, and had the opportunity for questions, comments, and open discussion with the research teams. For Study 2 - Assessment of Impacts of the Baker Lake Wastewater Outflow on Fish Productivity and Fish Habitat (H. Swanson), a change in objectives was proposed to accommodate a delayed construction schedule for upgrades to the Baker Lake municipal wastewater treatment system. All MFRAG member groups were requested to provide written comments, if any, by December 16. Comments from DFO/KIA were received on December 23. Comments were also received from the external advisor, and were distributed to all parties and researchers for consideration.

3.2.2 Study 1 - Assessment of Changes in Aquatic Productivity and Fish Populations Due to Flooding (H. Swanson)

3.2.2.1 Research Objectives

This research study aims to understand changes in fish population productivity and habitat use during and after flooding occurs, as determined through relative abundance and/or biomass and condition factor within the resident fish population. Since flooding activities were initially planned to occur over a relatively short term (2-3 years), the study focuses on small-bodied fish, which are expected to react first to changes in nutrient profiles.

Changes in productivity will be related to water quality variables and changes in lake morphometry (especially area). Use of newly flooded habitats will be assessed and related to habitat characteristics.

3.2.2.2 Research Methods & Summary of Activities

In 2018, 2019, 2020, and 2021 the study focused on the collection of baseline data (2018) and flooding year 1, 2, and 3 data (2019, 2020, 2021) for small-bodied fish species (Slimy Sculpin, Ninespine Stickleback) within the Whale Tail South area. Shoreline electrofishing was completed for small-bodied fish in up to 10 waterbodies in the area of Whale Tail Lake: Whale Tail Lake, Mammoth Lake, A63, A20, A65, A44, A76, B03, DS1 and Lake 8 (Figure 11). Monitoring endpoints that were selected for analysis included abundance, length, weight, condition, age, catch per unit effort, and weight-at-age.

In addition, the University of Waterloo team collected annual supplemental water quality data, which will be used to support the interpretation of fish population data. Water and sediment quality data collected under compliance monitoring programs will similarly be used in this assessment.

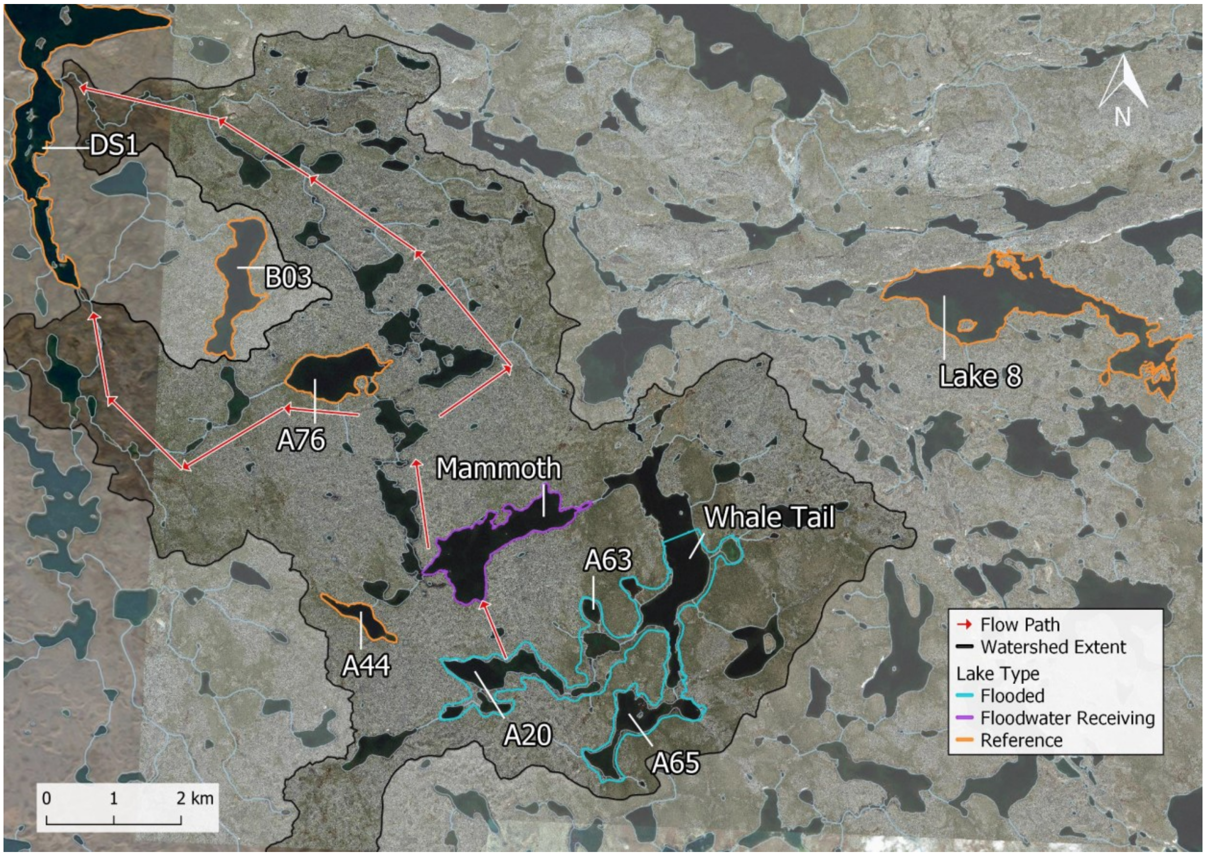

Figure 11. Whale Tail Productivity study area.

3.2.2.3 Study Completion

This study was scheduled for completion (final journal article submission) in 2022. However, due to COVID-related delays, a two-year extension is currently anticipated, with final journal article submission in 2024. The final field season was completed on time as originally scheduled, in 2021.

3.2.3 Study 2 – Assessment of Impacts of the Baker Lake Wastewater Outflow on Fish Productivity and Fish Habitat (H. Swanson)

3.2.3.1 Research Objectives

A 5-year research program lead by Dr. Rob Jamieson (Dalhousie University) is underway to assess the current status of the wastewater treatment system in the hamlet of Baker Lake and develop designs for upgrades. This study was awarded an NSERC Collaborative Research and Development grant (NSERC-CRD) in 2019 to supplement funding from Agnico. As part of this holistic assessment, key questions related to understanding fish health, fish habitat, nutrient status and fish productivity are included as offsetting for the Whale Tail Mine. The fish and fish habitat portion of the study is being conducted by Dr. Heidi Swanson (Laurier University, formerly the University of Waterloo).

The following goals specific to fish and fish habitat were originally developed:

1. Quantify the current fish habitat, fish health and fish productivity in the Arctic wastewater system.
2. Quantify changes in fish habitat, fish health and fish productivity associated with Arctic wastewater treatment system upgrades.

However, due to a longer timeline than originally anticipated for construction of a new municipal wastewater facility, the following revised goals were proposed to the MFRAG in 2022, along with specific revised objectives:

1. Quantify the current fish habitat, fish health and fish productivity in the Arctic wastewater system (extended pre-construction assessment).
2. Develop and delivery training activities to support community-lead environmental monitoring programs for the post-construction period, tailored to the interests of community organizations.

Having received agreement from the MFRAG, the revised project objectives were presented to NSERC for consideration and approved. Changes to planned study activities are presented briefly, below, and the complete revised study plan will be provided in the 2022 Annual Progress Report to DFO (May 30, 2023).

3.2.3.2 Research Methods & Summary of Activities

General study methods follow Environmental Effects Monitoring (EEM) protocols to assess changes in large-bodied fish population health and habitat that occur as a result of wastewater treatment outflow. Supplemental methods similar to those employed in Study 1 will be used to further assess changes in productivity in small-bodied fish, which may occur under shorter time frames. Specific target lakes include those within the current wastewater flow path, as well as a reference system (Figure 12). This study is focusing on:

- Finger Lake,
- Lagoon Lake,
- Airplane Lake,
- Baker Lake,
- the connecting streams, and
- reference lakes.

Figure 12. Baker Lake wastewater study lakes and reference lakes.

In 2018, 2019 and 2021, the University of Waterloo completed field reconnaissance and collected water quality, sediment samples, fish tissue samples, and conducted presence/absence surveys.

2018:

- Reconnaissance year
- Collected water samples and sampled fish in Finger Lake and Airplane Lake
- Evaluated potential reference sites

2019:

- Selection of reference lakes
- Shoreline electrofishing, minnow trapping, gill netting in 5 waterbodies (Lagoon, Finger, Airplane Lake, R1 and R2)
- Fish presence/ absence
- Collected Ninespine Stickleback and Arctic Grayling for health indicators, otoliths, and tissue
- Working in collaboration with University of Manitoba and Dalhousie University, collected water quality samples and submitted for analysis.

2020: Due to restrictions under the COVID-19 pandemic, the 2020 field season could not proceed. The study period has thus been extended by one year.

2021:

- Shoreline electrofishing, minnow trapping, gill netting in 5 waterbodies and the outlet of Airplane Lake (Lagoon, Finger, Airplane Lake, Airplane Lake creek, R1 and R2).
- Fish presence/ absence.
- Collected Ninespine Stickleback and Arctic Grayling for health indicators, aging structures (i.e., otoliths), and tissue.
- Collected sediment chemistry data.
- Collected periphyton and zooplankton data.
- Working in collaboration with University of Manitoba and Dalhousie University, collected water quality samples and submitted for analysis.
- Completed otolith microchemistry analysis at University of Manitoba.
- Data analysis, interpretation, thesis and manuscript writing.

2022: Ongoing data analysis. No field data collection.

2023: Field data collection as required, to be detailed in the updated study plan that will be provided in the 2022 Annual Progress Report to DFO (May 30, 2023).

3.2.3.3 Study Completion

With the proposed change in study objectives, final manuscript submission for the fish health and habitat portion of the study is anticipated for 2025 or 2026.

3.2.4 Study 3 – Literature Review and Field Validation of Northern Lake Fish Habitat Preferences (S. Doka)

3.2.4.1 Research Objectives

Habitat preferences of northern fish species are not well understood, which causes significant uncertainty in habitat-based offset calculations. This study aims to:

1 - Identify literature data gaps in habitat associations of Meadowbank-area lake fishes such as Lake Trout, Arctic Char, and Round Whitefish,

2 - Field-test a variety of methods for filling data gaps.

3.2.4.2 Research Methods and Summary of Activities

This study was planned to be conducted over three years, from 2018 – 2020. Methods include a literature review, data gap analysis, and field programs to assess various sampling techniques for identifying fish habitat associations. Field surveys occurred in 2018 and 2019.

Literature Review and Gap Analysis - Following closely the Centre of Environmental Evidence guidelines for systematic literature review, a graduate student with Lakehead University under the co-supervision of Dr. Mike Rennie and Dr. Susan Doka reviewed primary and grey literature sources as well as unpublished data (e.g., Golder & Associates 2016, DFO FishOut database) on 11 northern species, including Lake Trout (*Salvelinus namaycush*) Burbot (*Lota lota*), Lake Whitefish (*Coregonus clupeaformis*), Lake Cisco (*Coregonus artedi*), Round Whitefish (*Prosopium cylindraceum*), Arctic Char (*Salvelinus alpinus*), Arctic Grayling (*Thymallus arcticus*), Slimy Sculpin (*Cottus cognatus*), Ninespine Stickleback (*Pungitius pungitius*), Dolly Varden (*Salvelinus malma*) and Bull Trout (*Salvelinus confluentus*) with current fish distributions in lakes of Nunavut and the Northwest Territories (Mandrak, et al. in review) and expert input from individuals that have been in the field in recent years (C. Portt & Associates, 2018b). The data extracted from the review has been analyzed using appropriate statistical methods to synthesize the information by life stage (3 stages: spawning, nursery, juvenile/adult habitats) for the 11 northern fish species.

Field Programs - Fisheries and Oceans in partnership with Lakehead University conducted ten days of sampling (August 20-30, 2018) in the vicinity of the Amaruq mine camp. The objective of this work was to perform reconnaissance sampling to test efficiencies and logistical challenges of using conventional methods used by scientific consultants and government researchers in the south to assess habitat and fish communities. A variety of equipment was used to meet this objective including, a multi-probe water quality sonde (EXO), passive and active fish sampling gears in both lakes and connecting channels (e.g., minnow traps, GoPro video footage, backpack electrofishing, drift nets) and hydroacoustic surveys (BioSonics MX) for physical habitat mapping (e.g., depth and substrate). The latter was conducted to complement hydroacoustic fish distribution data collected by Milne Technologies (mid-July 2018). Troubleshooting these methods in the field during 2018 informed how to standardize methods for fish habitat sampling in the North (Arctic Region) and how to proceed with habitat and fish assessment pilot tests during the 2019 field season.

Based on year one field tests and literature review results, field work in year two (2019) focussed on pilot testing methods to fill data gaps around habitat associations for small-bodied fishes, while assessing novel or alternative sampling approaches. The 2019 field program consisted of an analysis of Visible Implant Elastomer tagging methods for use in mark-recapture studies to evaluate stream habitat preferences, as well as deep water electrofishing, near-shore electrofishing, and netting techniques. Those programs were conducted over two study periods, in late June and August/September. Analysis of the 2019 field trial results continues.

3.2.4.3 Study Completion

The MSc thesis fulfilling objective 1 of this study (literature data gap review) was completed in September, 2020 (Hancock, 2020). Final reporting for this study including result and recommendations of field trials was initially planned for 2020 but was delayed due to DFO staffing constraints under the COVID-19 pandemic. The final report submission has now been extended four years, to 2024.

3.2.5 Study 4 – Arctic Grayling Occupancy Modelling (H. Swanson)

Objectives of this work were the development of occupancy models for Arctic grayling in the Meadowbank region, and a comparison of habitat predictors in this area with those observed in the NWT. Understanding the potential for occupancy of fluvial systems by fish species based on readily measurable habitat characteristics could facilitate and improve the accuracy of environmental impact assessment and offset planning.

This study was conducted from 2018 – 2021, and final reports consist of an MSc thesis submitted to the University of Waterloo in April, 2020 (Ellenor, 2020), and a peer- reviewed manuscript published in November, 2021 (Ellenor et al., 2021). These documents contain the complete research objectives, methods, and results. Briefly, from Ellenor et al. (2021):

> *Visual surveys of young-of-year Arctic grayling were conducted in 48 streams near Baker Lake, Nunavut, Canada. Occupancy modeling was used to relate stream habitat and landscape variables to fish presence/absence. The best predictors of occupancy were total area of contributing upstream lakes and landcover (upland/lowland); stream basins with larger contributing upstream lake area and more lowland cover were more likely to be occupied. Results suggest that occupancy reflects reliability of stream connectivity throughout the open water season and across years. The occupancy model developed here can adequately predict stream suitability for young-of-year Arctic grayling using lake area and land classification data that are remotely accessed. This may lessen the considerable financial and logistical constraints of conducting field research on Arctic grayling in the vast Barrenlands and facilitate more directed field programs to inform conservation and mitigation plans.*

Publication of the peer-reviewed manuscript fulfills this study's criteria for success, and it is now considered complete.

3.2.6 Study 5 – End-pit Lake Habitat Suitability Assessment

Fish use of re-flooded pit areas with good connectivity to natural systems is not well understood, yet these areas may represent a significant opportunity for fish habitat offsetting. Since multiple pits of various sizes at the Meadowbank site are planned to be reflooded in the relatively near term (2027 – 2029), there is an opportunity to thoroughly characterize fish use of pit lake habitat and population growth in re-flooded lakes through a research program. This study will aim to characterize fish use of new pit lake habitat in relation to habitat and water quality variables, and particularly in relation to reference systems. The research team and program details will be developed by the MFRAG prior to study initiation (est. 2026).

While study methods and research members will not be determined until closer to study initiation, a literature review was provided to DFO in February 2019 in fulfillment of Condition 4.2.1.3 of FAA 16-HCAA-00370.

3.2.7 Study 6 – eDNA Methods Development (J. Stetefeld and M. McDougall)

3.2.7.1 Research Objectives

eDNA methods present a potentially useful tool for rapid and non-invasive assessments of fish communities but have not been significantly developed or validated for Arctic systems. The main goal of this project is to develop and optimize monitoring tools based on eDNA metabarcoding technology to assess fish species assemblages (presence/absence and relative abundance) in the Kivalliq region.

Objectives are:

1. Development and optimization of the eDNA metabarcoding technique adapted for the arctic environment as a substitute for current fish species determination approaches.

2. Producing guidelines for handling and analyzing of samples and deliver the method and provide training to the local community.

3. Produce long-term reliable and precise baseline data on the distribution of aquatic associated fish species in the Amaruq mine site lakes using developed eDNA technology.

4. Producing data on the physiochemical properties of the lake water including dissolved mineral content to understand if any changes in stated parameters affect the eDNA/fish assemblage results.

5. Examine the impact of flooding Whale Tail Lake South Basin with the coincident changes in physiochemical properties of the aquatic area (e.g., increase in turbidity, dissolved solids) on the fish population using developed eDNA technique.

6. Collecting baseline eDNA and water quality data on lakes nearby Amaruq mine site outside the mining activity (potential candidates include B03 or DS1) and use them as a control for population changes.

3.2.7.2 Research Methods & Summary of Activities

This study involves a 5-year plan to develop and utilize an eDNA metabarcoding approach to measure fish assemblages in the Whale Tail area. Environmental DNA metabarcoding technology will be developed and optimized to detect fish species including Arctic Char, Arctic Grayling, Lake Trout, Round Whitefish, Burbot, Slimy Sculpin, Ninespine Stickleback, Hybridized Lake Trout/Arctic Char and analyze their relative abundances. For water quality data, temperature, pressure, dissolve oxygen, pH, salinity, conductivity, and dissolved metals including Cu/Zn/Cd/Fe/Hg/Mn will be measured.

The first two rounds of sampling were completed before significant in-water construction (July 2017). The second round of sampling was done in August, 2018, during construction of the Whale Tail Dike. The third round of sampling was done in August 2019, during flooding of the Whale Tail South area. Additional sampling was completed after flooding (2021). No further field programs are scheduled. The results will be used to assess the influence of mining activity on changes in fish species populations, as measured through eDNA methods.

In furthering the training objectives of this project, eDNA sampling workshops were held at the University of Manitoba in February 2019 and 2020, with 4 and 7 members of the Kivalliq Inuit community in attendance, respectively. The 3-day workshops featured of number of lecturers in the eDNA community, as well as a hands-on DNA extraction laboratory, and a foundation for further involvement of the Inuit community in eDNA sampling was laid. In the 2019 season, two of the trainees from the program assisted in sample collection. This field training will set the stage for sampling independent of the University of Manitoba.

3.2.7.3 Study Completion

This study is on track for substantial completion in 2023, as originally planned. Initially, one manuscript was planned to be submitted for publication in 2020, with another in 2023. Submission of the initial methods manuscript has been extended from 2020 to 2023, largely due to COVID-related restrictions on laboratory access and difficulties encountered in refining analytical methods. Submission of the second manuscript may be extended in 2024.

SECTION 4 • ASSESSMENT OF SUCCESS

4.1 CONSTRUCTED OFFSETS

Year 2 monitoring was conducted in 2022 under the FHOMP's pre-offsetting ecological monitoring program (Agnico Eagle, 2021). According to this Plan, results are provided here in a data report format, with a final assessment to be conducted following the 2023 monitoring year. Results will be evaluated in the context of the Plan's criteria for success at that time. However in general, results in 2022 appear to indicate suitable water quality for aquatic life within the Whale Tail flood zone, growth of periphyton with coverage that is similarly variable in flood lakes and reference lakes, and presence of small bodied fish populations in newly created shoreline habitat at rates no lower than reference areas.

4.2 COMPLEMENTARY MEASURES

Criteria for success for each research project are focussed on publication of study results in the peer-reviewed literature, or similar primary sources. In 2021, Study 4 – *Arctic Grayling Occupancy Modelling* was completed and met these criteria with manuscript submission (Ellenor et al. 2022).

As a result of COVID-related delays or restrictions, original timelines for study completion have been extended for four of the six studies (Table 7). In the interim, several studies have been presented at academic conferences, and two MSc theses publications have been completed.

Table 7. Target study publication dates and publication or presentation references. *Current as of December 2022.

Study	Study Initiation	Target Final Publication Submission Date		Publications and Presentations
		Original	Current*	
Study 1: Productivity (H. Swanson)	2018	2022	2023/2024	Ellenor, J., Portt, C., and Swanson, H.K. 2019. Variation in Slimy Sculpin (*Cottus cognatus*) monitoring endpoints at six Barrenland lakes in central Nunavut. Poster presentation. Canadian Conference for Fisheries Research on January 3-6, 2019.
Study 2: Wastewater (H. Swanson)	2019	2021 & 2024	2025/2026	Bronte McPhedran presented preliminary findings and research methods at Young Environmental Scientists SETAC conference in Texas, on March 9-11, 2020.
Study 3: Habitat Preferences (S. Doka)	2018	2020	2024	**MSc Thesis**: Hancock H., 2020. Physical habitat associations of fish species in the Kivalliq region of Nunavut, Canada. Lakehead University, Orillia, Ontario. Available at: http://ceelab.ca/wpcontent/ uploads/2020/10/Hannah final- thesis-10132020.pdf Two presentations have been given at scientific fora by the graduate student, Hannah Hancock of Lakehead University: at Canadian Conference for Fisheries Research in London ON in January, 2019 and at the American Fisheries Society -Ontario Chapter meeting in Orillia ON in February, 2019.
Study 4: Arctic Grayling Occupancy (H. Swanson) - **COMPLETE**	2018	2021	2021	**Manuscript**: Ellenor, J.R., P.A. Cott and H.K. Swanson (2021). Occupancy of young-of-year Artic grayling (*Thymallus arcticus*) in Barrenland streams. Hydrobiologia (published online 15 November 2021).

Study	Study Initiation	Target Final Publication Submission Date		Publications and Presentations
		Original	Current*	
				Available at: https://link.springer.com/article/10.1007%2Fs10750-021-04742-3 **MSc Thesis**: Ellenor, J. 2020, June. Habitat use of young-of-year Arctic Grayling (*Thymallus arcticus*) in Barrenland streams of central Nunavut, Canada. University of Waterloo, Waterloo, Ontario. Available from http://hdl.handle.net/10012/15969. **Conference presentation**: Ellenor J., Swanson, H. K., 2019. Factors influencing how Arctic Grayling (*Thymallus arcticus*) use Barrenland streams near Baker Lake, Nunavut. Platform presentation. ArcticNet Annual Scientific Meeting on December 2-5, 2019.
Study 5: End Pit Lake Habitat Use (Researcher TBD)	2027	2030-2034	2030-2035	-
Study 6: eDNA Study (J. Stetefeld/M. McDougall)	2018	2020 (interim), 2023 (final)	2023 (interim), 2023/2024 (final)	-

SECTION 5 • ACTIONS

5.1 CONSTRUCTED OFFSETS

Monitoring in 2023 will follow the FHOMP (Agnico Eagle, 2021) for the pre-offsetting ecological monitoring period. As described in that document, this will include water quality as collected under the CREMP (and supplemental lakes A63, A44, B03, and Lake 8, as feasible), periphyton visual assessments and artificial substrate surveys, as well as fish surveys. Shoreline electrofishing surveys for small-bodied fish populations are not specifically required in 2023, since three years of post-flood monitoring data are now available, but these surveys will be conducted opportunistically. The FHOMP-scheduled single-year assessments for large-bodied fish will be conducted as follows:

- Evaluation of Habitat Types 6 & 9 (2 – 4 m and > 4 m with mixed substrate) that are created through flooding, and their use by large-bodied fish for foraging
    - Methods: Short-set gillnetting in Whale Tail Lake, A18/A20, and reference sites.
    - Differences in relative abundance (CPUE) and length-frequency distributions for Lake Trout and Arctic Char between flood zone and reference habitat are the key metrics to be evaluated for this assessment.
- Spawning habitat re-evaluation
    - Methods: Building on underwater camera methods described in C. Portt & Associates (2018b), the previously identified Lake Trout spawning shoals will be re-visited in Whale Tail Lake South Basin, along with any newly created high-potential spawning areas and a similar number of shoals to be identified in Lake A18.
    - Effectiveness targets for use of spawning habitat in the flood zone lakes will be any demonstrated evidence of spawning in the target locations.

5.2 COMPLEMENTARY MEASURES

In 2023, field programs, laboratory assessments, and/or data analysis will continue for studies 2, 3, and 6.

Study 6 is planned to be completed with manuscript submission.

A fifth meeting of the MFRAG is planned for November or December 2023.

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APPENDIX A

2022 Periphyton Visual Survey Results

Whale Tail Lake South

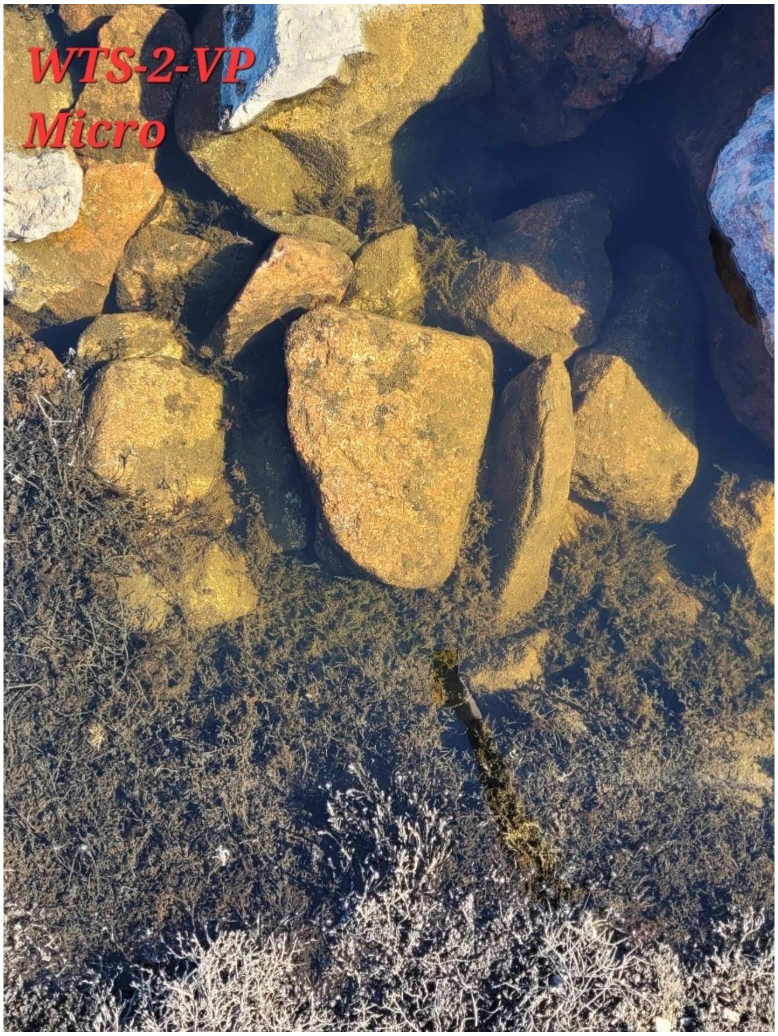
Date/Time:	*2022-09-03 (15:53)*	Initials:	*EL LA KM*
Lake Name:	Whale Tail	Station ID:	*WTS-1-VP*
GPS Coordinates:	*14W 607920 7254235*		
Microhabitat			
Periphyton % Cover Category*:	*Sparse*	Substrate^	%
Colour (e.g. brown, olive, bright green):	*Brown*	Organic matter (e.g. decaying plants in flooded terrestrial zone)	*80*
Thickness (mm):	*3*	Sand/silt/clay (<2 mm)	*15*
Texture‡:	*Spongy Mat*	Small gravel (2 – 16 mm)	*0*
Photo #s:	*Micro: _155622*	Large gravel (16 – 64 mm)	*0*
		Small cobble (64 – 128 mm)	*5*
		Large cobble (128 – 256 mm)	*0*
		Boulder (>256 mm)	*0*
		Bedrock	*0*
Macrohabitat			
Periphyton Evenness (even/patchy):	*Patchy: Only 1 spot with periphyton*	Photo #s: Macro: _160302 Facing North: _160015 Facing South: _155857	
Other Notes (e.g. water clarity, variation, ice scour):		*Clear water, flooded land*	
* Options: none (0%), sparse (<5%), low (5-25%), moderate (25-75%), high (>75%)			
^Provide estimate of % of each substrate type/size in the plot, indicate if clear change in cover by depth.			
‡ Texture examples: Firmly/loosely attached, flat, compact, crust-like, filamentous, non-filamentous, spongy mat			

App A - Figure 1. Periphyton station WTS-VP-1 in 2022.

App A - Figure 2. Periphyton station WTS-VP-1 in 2022

Date/Time:	*2022-09-03 (15:35)*	Initials:	*LA EL KM*
Lake Name:	Whale Tail	Station ID:	*WTS-2-VP*
GPS Coordinates:	*14W 607308 7252480*		
Microhabitat			
Periphyton % Cover Category*:	*Moderate (60%)*	Substrate^	%
Colour (e.g. brown, olive, bright green):	*Brown*	Organic matter (e.g. decaying plants in flooded terrestrial zone)	*15*
Thickness (mm):	*1*	Sand/silt/clay (<2 mm)	*0*
Texture‡:	*Spongy mat*	Small gravel (2 – 16 mm)	*0*
Photo #s:	*Micro: _153756*	Large gravel (16 – 64 mm)	*0*
		Small cobble (64 – 128 mm)	*0*
		Large cobble (128 – 256 mm)	*65*
		Boulder (>256 mm)	*20*
		Bedrock	*0*
Macrohabitat			
Periphyton Evenness (even/patchy):	*Patchy: Some rocks are more even then others*	Photo #s: Macro: _154440 Facing South: _154125 Facing North: _154019	
Other Notes (e.g. water clarity, variation, ice scour):		*Clear water, flooded land*	
* Options: none (0%), sparse (<5%), low (5-25%), moderate (25-75%), high (>75%)			
^Provide estimate of % of each substrate type/size in the plot, indicate if clear change in cover by depth.			
‡ Texture examples: Firmly/loosely attached, flat, compact, crust-like, filamentous, non-filamentous, spongy mat			

App A - Figure 3. Periphyton station WTS-VP-2 in 2022



App A - Figure 4. Periphyton station WTS-VP-2 in 2022

Date/Time:	*2022-09-03 (14:38)*	Initials:	*LA EL KM*
Lake Name:	Whale Tail	Station ID:	*WTS-3-VP*
GPS Coordinates:	*14W 607235 7254428*		
Microhabitat			
Periphyton % Cover Category*:	*None*	Substrate^	%
Colour (e.g. brown, olive, bright green):	*N/A*	Organic matter (e.g. decaying plants in flooded terrestrial zone)	*45*
Thickness (mm):	*N/A*	Sand/silt/clay (<2 mm)	*50*
Texture‡:	*N/A*	Small gravel (2 – 16 mm)	*0*
Photo #s:	*Micro: _144135*	Large gravel (16 – 64 mm)	*0*
		Small cobble (64 – 128 mm)	*0*
		Large cobble (128 – 256 mm)	*5*
		Boulder (>256 mm)	*0*
		Bedrock	*0*
Macrohabitat			
Periphyton Evenness (even/patchy):	*N/A*	Photo #s: Macro: _145117 Facing North: _144257 Facing South: _144412	
Other Notes (e.g. water clarity, variation, ice scour):		*Clear water, nothing other than sand and organic matter. Looks like a flooded land.*	
* Options: none (0%), sparse (<5%), low (5-25%), moderate (25-75%), high (>75%)			
^Provide estimate of % of each substrate type/size in the plot, indicate if clear change in cover by depth.			
‡ Texture examples: Firmly/loosely attached, flat, compact, crust-like, filamentous, non-filamentous, spongy mat			

App A - Figure 5. Periphyton station WTS-VP-3 in 2022

App A - Figure 6. Periphyton station WTS-VP-3 in 2022

Date/Time:	*2022-09-02 (15:15)*	Initials:	*EL KM LA*
Lake Name:	Whale Tail	Station ID:	*WTS-4-VP*
GPS Coordinates:	*14W 607170 7253398*		
Microhabitat			
Periphyton % Cover Category*:	*Moderate*	Substrate^	%
Colour (e.g. brown, olive, bright green):	*Brown*	Organic matter (e.g. decaying plants in flooded terrestrial zone)	*10*
Thickness (mm):	*1*	Sand/silt/clay (<2 mm)	*0*
Texture‡:	*Spongy Mat*	Small gravel (2 – 16 mm)	*0*
Photo #s:	*Micro: _151709*	Large gravel (16 – 64 mm)	*0*
		Small cobble (64 – 128 mm)	*0*
		Large cobble (128 – 256 mm)	*60*
		Boulder (>256 mm)	*30*
		Bedrock	*0*
Macrohabitat			
Periphyton Evenness (even/patchy):	*Patchy, only on the rocks, not the organics*	Photo #s: Macro: _152828 Facing North: _152029 Facing South: _152206	
Other Notes (e.g. water clarity, variation, ice scour):		*Clear water, flooded land.*	
* Options: none (0%), sparse (<5%), low (5-25%), moderate (25-75%), high (>75%)			
^Provide estimate of % of each substrate type/size in the plot, indicate if clear change in cover by depth.			
‡ Texture examples: Firmly/loosely attached, flat, compact, crust-like, filamentous, non-filamentous, spongy mat			

App A - Figure 7. Periphyton station WTS-VP-4 in 2022

App A - Figure 8. Periphyton station WTS-VP-4 in 2022

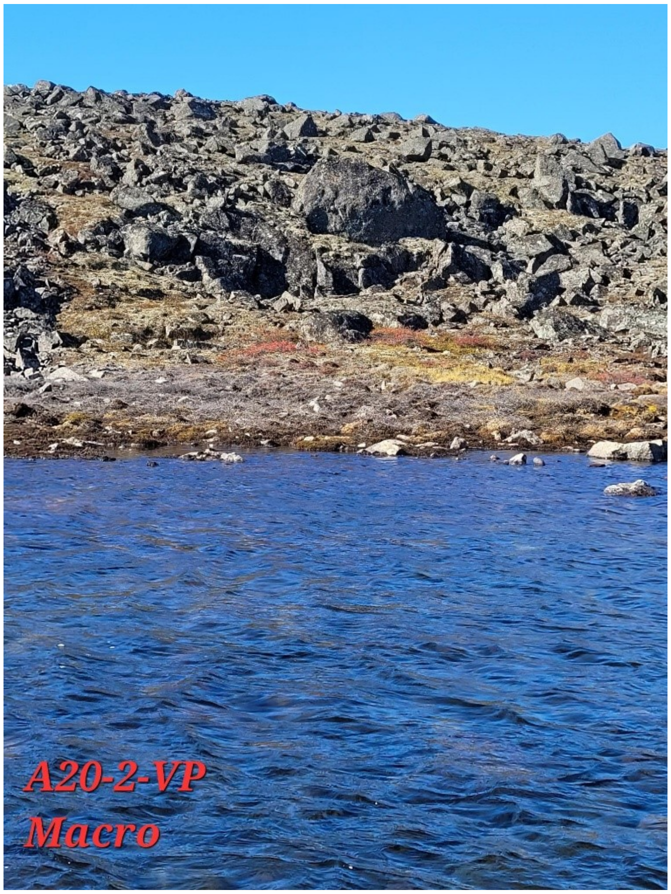
Lake A20

Date/Time:	*2022-09-02 (11:56)*	Initials:	*LA, EL, KM*
Lake Name:	A20	Station ID:	*A20-1-VP*
GPS Coordinates:	*14W 604886 7252758*		
Microhabitat			
Periphyton % Cover Category*:	*High*	Substrate^	%
Colour (e.g. brown, olive, bright green):	*Brown*	Organic matter (e.g. decaying plants in flooded terrestrial zone)	*5*
Thickness (mm):	*1 – 2 mm*	Sand/silt/clay (<2 mm)	*0*
Texture‡:	*Spongy mat*	Small gravel (2 – 16 mm)	*0*
Photo #s:	*20220902_120221 – Micro*	Large gravel (16 – 64 mm)	*0*
		Small cobble (64 – 128 mm)	*20*
		Large cobble (128 – 256 mm)	*50*
		Boulder (>256 mm)	*25*
		Bedrock	*0*
Macrohabitat			
Periphyton Evenness (even/patchy):	*Even*	Photo #s:	20220902_114939 –North view *20220902_120457 – South view 20220902_120634 – North View (closer to shore)*
Other Notes (e.g. water clarity, variation, ice scour):		*Clear water, less dense then the south shore but still even.*	
* Options: none (0%), sparse (<5%), low (5-25%), moderate (25-75%), high (>75%)			
^Provide estimate of % of each substrate type/size in the plot, indicate if clear change in cover by depth.			
‡ Texture examples: Firmly/loosely attached, flat, compact, crust-like, filamentous, non-filamentous, spongy mat			

App A - Figure 9. Periphyton station A20-VP-1 in 2022

App A - Figure 10. Periphyton station WTS-VP-1 in 2022.

Date/Time:	*2022-09-02 (11:06)*	Initials:	*LA, EL, KM*
Lake Name:	A20	Station ID:	*A20-2-VP*
GPS Coordinates:	*14W 0604039 7252582*		
Microhabitat			
Periphyton % Cover Category*:	*High*	Substrate^	%
Colour (e.g. brown, olive, bright green):	*Brown*	Organic matter (e.g. decaying plants in flooded terrestrial zone)	*60*
Thickness (mm):	*1 – 3 mm*	Sand/silt/clay (<2 mm)	*0*
Texture‡:	*Spongy uniform mat*	Small gravel (2 – 16 mm)	*0*
Photo #s:	*Micro: _110837*	Large gravel (16 – 64 mm)	*0*
		Small cobble (64 – 128 mm)	*0*
		Large cobble (128 – 256 mm)	*50*
		Boulder (>256 mm)	*10*
		Bedrock	*0*
Macrohabitat			
Periphyton Evenness (even/patchy):	*Even*	Photo #s: Macro: _112018 Facing North: _111122 Facing South: _111356	
Other Notes (e.g. water clarity, variation, ice scour):		*Clear water, and even growth everywhere.*	
* Options: none (0%), sparse (<5%), low (5-25%), moderate (25-75%), high (>75%)			
^Provide estimate of % of each substrate type/size in the plot, indicate if clear change in cover by depth.			
‡ Texture examples: Firmly/loosely attached, flat, compact, crust-like, filamentous, non-filamentous, spongy mat			



App A - Figure 11. Periphyton station A20-VP-2 in 2022

App A - Figure 12. Periphyton station A20-VP-2 in 2022

Lake A44

Date/Time:	*2022-09-05 (13:00)*	Initials:	*EL/LA/KM*
Lake Name:	A44	Station ID:	*A44-1-VP*
GPS Coordinates:	*14W 602316 7253392*		
Microhabitat			
Periphyton % Cover Category*:	*Moderate*	Substrate^	%
Colour (e.g. brown, olive, bright green):	*Brown/ beige*	Organic matter (e.g. decaying plants in flooded terrestrial zone)	*5*
Thickness (mm):	*1*	Sand/silt/clay (<2 mm)	*50*
Texture‡:	*compact*	Small gravel (2 – 16 mm)	*10*
Photo #s:	*Micro: _130534*	Large gravel (16 – 64 mm)	*10*
		Small cobble (64 – 128 mm)	*10*
		Large cobble (128 – 256 mm)	*10*
		Boulder (>256 mm)	*5*
		Bedrock	*0*
Macrohabitat			
Periphyton Evenness (even/patchy):	*Patchy, only present on the rocks*	Photo #s:	
Other Notes (e.g. water clarity, variation, ice scour): Windy conditions (35-50kmh-SE) water is turbid along this northern shoreline. The filter was visibly more saturated with solids than usual.		*Macro: _131021* *Facing North: _130655* *Facing South: _130859* *Example of periphyton cover: _130752*	
* Options: none (0%), sparse (<5%), low (5-25%), moderate (25-75%), high (>75%)			
^Provide estimate of % of each substrate type/size in the plot, indicate if clear change in cover by depth.			
‡ Texture examples: Firmly/loosely attached, flat, compact, crust-like, filamentous, non-filamentous, spongy mat			

App A - Figure 13. Periphyton station A44-VP-1 in 2022.

App A - Figure 14. Periphyton station A44-VP-1 in 2022.

Date/Time:	*2022-09-05 (13:40)*	Initials:	*EL/LA/KM*
Lake Name:	A44	Station ID:	*A44-2-VP*
GPS Coordinates:	*14W 602915 7253276*		
Microhabitat			
Periphyton % Cover Category*:	*high*	Substrate^	%
Colour (e.g. brown, olive, bright green):	*Light brown*	Organic matter (e.g. decaying plants in flooded terrestrial zone)	*0*
Thickness (mm):	*2-3*	Sand/silt/clay (<2 mm)	*5*
Texture‡:	*filamentous*	Small gravel (2 – 16 mm)	*10*
Photo #s:	*Micro: _140352*	Large gravel (16 – 64 mm)	*0*
		Small cobble (64 – 128 mm)	*15*
		Large cobble (128 – 256 mm)	*60*
		Boulder (>256 mm)	*10*
		Bedrock	*0*
Macrohabitat			
Periphyton Evenness (even/patchy):	*Patchy near shore*	Photo #s:	
Other Notes (e.g. water clarity, variation, ice scour): Off shore wind on this side of the lake. Very windy 35-50kmh from the south east		*Not able to take macro or south facing. No boat available and water was too rough to wade out,steep drop off nearby as well as very slippery rocks.* *Facing north:_134310*	
* Options: none (0%), sparse (<5%), low (5-25%), moderate (25-75%), high (>75%)			
^Provide estimate of % of each substrate type/size in the plot, indicate if clear change in cover by depth.			
‡ Texture examples: Firmly/loosely attached, flat, compact, crust-like, filamentous, non-filamentous, spongy mat			

App A - Figure 15. Periphyton station A44-VP-2 in 2022.

Lake A63

Date/Time:	*2022-09-05 (14:00)*	Initials: EL/LA/KM	
Lake Name:	A63	Station ID:	*A63-1-VP*
GPS Coordinates:	*14 W 605985 7253574*		
Microhabitat			
Periphyton % Cover Category*:	*Moderate (60-%70)*	Substrate^	%
Colour (e.g. brown, olive, bright green):	*brown*	Organic matter (e.g. decaying plants in flooded terrestrial zone)	*15*
Thickness (mm):	*Rock: 1-2* *Organics: 2-3*	Sand/silt/clay (<2 mm)	*0*
Texture‡:	*Spongy mat*	Small gravel (2 – 16 mm)	*0*
Photo #s:	*Micro: _140352*	Large gravel (16 – 64 mm)	*5*
		Small cobble (64 – 128 mm)	*10*
		Large cobble (128 – 256 mm)	*60*
		Boulder (>256 mm)	*10*
		Bedrock	*0*
Macrohabitat			
Periphyton Evenness (even/patchy):	*even*	Photo #s:	
Other Notes (e.g. water clarity, variation, ice scour): This station was on the north shore of the lake, waves were coming into shore. We chose an area in amongst some rocks which were able to help break up the waves and diminish the turbidity		*Macro : _140752* *Facing North: _140641* *Facing South: _140507*	
* Options: none (0%), sparse (<5%), low (5-25%), moderate (25-75%), high (>75%)			
^Provide estimate of % of each substrate type/size in the plot, indicate if clear change in cover by depth.			
‡ Texture examples: Firmly/loosely attached, flat, compact, crust-like, filamentous, non-filamentous, spongy mat			

App A - Figure 16. Periphyton station A63-VP-1 in 2022.

App A - Figure 17. Periphyton station A63-VP-1 in 2022.

Date/Time:	*2022-09-05 (14:17)*	Initials: EL/LA/KM	
Lake Name:	A63	Station ID: A63-2-VP	
GPS Coordinates:	*14W 606255 7253657*		
Microhabitat			
Periphyton % Cover Category*:	*high*	Substrate^	%
Colour (e.g. brown, olive, bright green):	*brown*	Organic matter (e.g. decaying plants in flooded terrestrial zone)	*90*
Thickness (mm):	*2-3*	Sand/silt/clay (<2 mm)	*0*
Texture‡:	*Spongy mat*	Small gravel (2 – 16 mm)	*0*
Photo #s:	*Micro: _141825*	Large gravel (16 – 64 mm)	*0*
		Small cobble (64 – 128 mm)	*0*
		Large cobble (128 – 256 mm)	*10*
		Boulder (>256 mm)	*0*
		Bedrock	*0*
Macrohabitat			
Periphyton Evenness (even/patchy):	*Even*	Photo #s:	
Other Notes (e.g. water clarity, variation, ice scour): South shore of the lake, wind is blowing offshore. (35-50kmh SE) Clear-ish water, high winds. Shoreline is flooded plain		*Macro: Unable to get a macro photo. No boat available, I was unable to see the bottom well enough to wade out due to the high winds.* *Facing North: _142036* *Facing South: _142221*	
* Options: none (0%), sparse (<5%), low (5-25%), moderate (25-75%), high (>75%)			
^Provide estimate of % of each substrate type/size in the plot, indicate if clear change in cover by depth.			
‡ Texture examples: Firmly/loosely attached, flat, compact, crust-like, filamentous, non-filamentous, spongy mat			

App A - Figure 18. Periphyton station A63-VP-2 in 2022.

App A - Figure 19. Periphyton station A63-VP-2 in 2022.

Lake B03

Date/Time:	*2022-09-15 10:20*	Initials: RW EM JO	
Lake Name:	B03	Station ID: B03-VP-1	
GPS Coordinates:	*14W 600510 7258927*		
Microhabitat			
Periphyton % Cover Category*:	*moderate*	Substrate^	%
Colour (e.g. brown, olive, bright green):	*Light brown*	Organic matter (e.g. decaying plants in flooded terrestrial zone)	
Thickness (mm):	*1*	Sand/silt/clay (<2 mm)	
Texture‡:	*Loosely attached*	Small gravel (2 – 16 mm)	
Photo #s:		Large gravel (16 – 64 mm)	
		Small cobble (64 – 128 mm)	*10*
		Large cobble (128 – 256 mm)	*10*
		Boulder (>256 mm)	*80*
		Bedrock	
Macrohabitat			
Periphyton Evenness (even/patchy):	*even*	Photo #s:	
Other Notes (e.g. water clarity, variation, ice scour):		*Water was turbid due to high winds*	
* Options: none (0%), sparse (<5%), low (5-25%), moderate (25-75%), high (>75%)			
^Provide estimate of % of each substrate type/size in the plot, indicate if clear change in cover by depth.			
‡ Texture examples: Firmly/loosely attached, flat, compact, crust-like, filamentous, non-filamentous, spongy mat			

App A - Figure 20. Periphyton station B03-VP-1 in 2022.

App A - Figure 21. Periphyton station B03-VP-1 in 2022.

Date/Time:	*2022-09-15 10:45*	Initials: RW EM JO	
Lake Name:	B03	Station ID: B03-VP-2	
GPS Coordinates:	*14W 600840 7257845*		
Microhabitat			
Periphyton % Cover Category*:	*moderate*	Substrate^	%
Colour (e.g. brown, olive, bright green):	*Light brown with hints of green*	Organic matter (e.g. decaying plants in flooded terrestrial zone)	
Thickness (mm):	*1-3*	Sand/silt/clay (<2 mm)	*30*
Texture‡:	*Loosely attached*	Small gravel (2 – 16 mm)	*20*
Photo #s:		Large gravel (16 – 64 mm)	*30*
		Small cobble (64 – 128 mm)	
		Large cobble (128 – 256 mm)	*10*
		Boulder (>256 mm)	*10*
		Bedrock	
Macrohabitat			
Periphyton Evenness (even/patchy):	*patchy*	Photo #s:	
Other Notes (e.g. water clarity, variation, ice scour):		*Water was turbid due to high winds*	
* Options: none (0%), sparse (<5%), low (5-25%), moderate (25-75%), high (>75%)			
^Provide estimate of % of each substrate type/size in the plot, indicate if clear change in cover by depth.			
‡ Texture examples: Firmly/loosely attached, flat, compact, crust-like, filamentous, non-filamentous, spongy mat			

App A - Figure 22. Periphyton station B03-VP-2 in 2022.

App A - Figure 23. Periphyton station B03-VP-2 in 2022.

Inuggugayualik Lake

Date/Time:	*2022/09/11*	Initials:FQS	
Lake Name:	INUG	Station ID:INUG-1	
GPS Coordinates:	*14 W 0623269 7214542*		
Microhabitat			
Periphyton % Cover Category*:	*None*	Substrate^	%
Colour (e.g. brown, olive, bright green):	*N/A*	Organic matter (e.g. decaying plants in flooded terrestrial zone)	
Thickness (mm):	*N/A*	Sand/silt/clay (<2 mm)	
Texture‡:	*N/A*	Small gravel (2 – 16 mm)	*10*
Photo #s:		Large gravel (16 – 64 mm)	*10*
		Small cobble (64 – 128 mm)	*80*
		Large cobble (128 – 256 mm)	
		Boulder (>256 mm)	
		Bedrock	
Macrohabitat			
Periphyton Evenness (even/patchy):	*N/A*	Photo #s: 0548,0549	
Other Notes (e.g. water clarity, variation, ice scour):		*Clear*	
* Options: none (0%), sparse (<5%), low (5-25%), moderate (25-75%), high (>75%)			
^Provide estimate of % of each substrate type/size in the plot, indicate if clear change in cover by depth.			
‡ Texture examples: Firmly/loosely attached, flat, compact, crust-like, filamentous, non-filamentous, spongy mat			

App A - Figure 24. Periphyton station INUG-1 in 2022.

Date/Time:	*2022/09/11*	Initials:FQS	
Lake Name:	INUG	Station ID:INUG-2	
GPS Coordinates:	*14 W 0621752 7215583*		
Microhabitat			
Periphyton % Cover Category*:	*High*	Substrate^	%
Colour (e.g. brown, olive, bright green):	*Bown*	Organic matter (e.g. decaying plants in flooded terrestrial zone)	
Thickness (mm):	*1-5 MM*	Sand/silt/clay (<2 mm)	
Texture‡:	*Firmly loose*	Small gravel (2 – 16 mm)	
Photo #s:	*552*	Large gravel (16 – 64 mm)	
		Small cobble (64 – 128 mm)	*10*
		Large cobble (128 – 256 mm)	*80*
		Boulder (>256 mm)	*10*
		Bedrock	
Macrohabitat			
Periphyton Evenness (even/patchy):	*Even*	Photo #s: 550,551	
Other Notes (e.g. water clarity, variation, ice scour):		*Clear*	
* Options: none (0%), sparse (<5%), low (5-25%), moderate (25-75%), high (>75%)			
^Provide estimate of % of each substrate type/size in the plot, indicate if clear change in cover by depth.			
‡ Texture examples: Firmly/loosely attached, flat, compact, crust-like, filamentous, non-filamentous, spongy mat			

App A - Figure 25. Periphyton station INUG-VP-2 in 2022.

Lake 8

Date/Time:	*2022-09-15 11:25*	Initials: RW EM JO	
Lake Name:	LK8	Station ID: LK8-VP-1	
GPS Coordinates:	*14W 610714 7258845*		
Microhabitat			
Periphyton % Cover Category*:	*moderate*	Substrate^	%
Colour (e.g. brown, olive, bright green):	*brown*	Organic matter (e.g. decaying plants in flooded terrestrial zone)	
Thickness (mm):	*1*	Sand/silt/clay (<2 mm)	
Texture‡:	*Flat & Compact*	Small gravel (2 – 16 mm)	
Photo #s:		Large gravel (16 – 64 mm)	
		Small cobble (64 – 128 mm)	
		Large cobble (128 – 256 mm)	*15*
		Boulder (>256 mm)	*85*
		Bedrock	
Macrohabitat			
Periphyton Evenness (even/patchy):	*patchy*	Photo #s:	
Other Notes (e.g. water clarity, variation, ice scour):		*Water was clearer due to location being in a protected bay. The water depth drops quite drastically here.*	
* Options: none (0%), sparse (<5%), low (5-25%), moderate (25-75%), high (>75%)			
^Provide estimate of % of each substrate type/size in the plot, indicate if clear change in cover by depth.			
‡ Texture examples: Firmly/loosely attached, flat, compact, crust-like, filamentous, non-filamentous, spongy mat			

App A - Figure 26. Periphyton station LK8-VP-1 in 2022.

Date/Time:	*2022-09-15 12:00*	Initials: RW EM JO	
Lake Name:	LK8	Station ID: LK8-VP-2	
GPS Coordinates:	*14W 611890 7257890*		
Microhabitat			
Periphyton % Cover Category*:	*moderate*	Substrate^	%
Colour (e.g. brown, olive, bright green):	*brown*	Organic matter (e.g. decaying plants in flooded terrestrial zone)	
Thickness (mm):	*1-3*	Sand/silt/clay (<2 mm)	
Texture‡:	*Loosely attached*	Small gravel (2 – 16 mm)	
Photo #s:		Large gravel (16 – 64 mm)	
		Small cobble (64 – 128 mm)	*5*
		Large cobble (128 – 256 mm)	*15*
		Boulder (>256 mm)	*80*
		Bedrock	
Macrohabitat			
Periphyton Evenness (even/patchy):	*patchy*	Photo #s:	
Other Notes (e.g. water clarity, variation, ice scour):		*Water was turbid due to high winds*	
* Options: none (0%), sparse (<5%), low (5-25%), moderate (25-75%), high (>75%)			
^Provide estimate of % of each substrate type/size in the plot, indicate if clear change in cover by depth.			
‡ Texture examples: Firmly/loosely attached, flat, compact, crust-like, filamentous, non-filamentous, spongy mat			

App A - Figure 27. Periphyton station LK8-VP-2 in 2022.