APPENDIX E.9.4

Mary River Project Second Environmental Effects Monitoring (2020) Interpretive Report

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Prepared for:
Baffinland Iron Mines Corporation
Oakville, Ontario

Prepared by:
Minnow Environmental Inc.
Guelph, Ontario

January 2021

Mary River Project Second Environmental Effects Monitoring (2020) Interpretive Report

Paul LePage, M.Sc.
Senior Project Reviewer and Advisor

EXECUTIVE SUMMARY

The Mary River Project is an operating high-grade iron mine located in the Qikiqtani Region of northern Baffin Island, Nunavut. Owned and operated by Baffinland Iron Mines Corporation (Baffinland), the mine began commercial operation in 2015. Mining activities at the Mary River Project include open pit ore extraction, ore haulage, stockpiling, crushing, and screening, followed by transport of ore by truck to Milne Port for subsequent seasonal loading onto bulk carrier ships for transfer to international markets. No milling or additional processing of the ore is conducted on-site and therefore no tailings are produced at the Mary River Project. Mine waste management facilities at the Mary River Project thus consist simply of a mine waste rock stockpile and surface runoff collection/containment ponds currently situated near the mine waste rock stockpile and ore stockpile areas.

The Mary River Project is subject to the Metal and Diamond Mining Effluent Regulations (MDMER) under the *Fisheries Act*. The MDMER outline requirements for routine effluent and water quality monitoring and for biological monitoring, collectively referred to as Environmental Effects Monitoring (EEM) studies. The objective of EEM is to determine whether mine effluent is causing an effect on the fish population, the use of fisheries resources, and/or fish habitat (benthic invertebrate communities). A Study Design for the second (2nd) EEM biological study at the Mary River Project was submitted to Environment and Climate Change Canada (ECCC) which, following comments and provision of a detailed response, was approved for implementation in 2020. The field component of the 2nd EEM biological study at the Mary River Project was implemented in August 2020 using the approach outlined in the approved study design, focusing on the evaluation of effects at effluent-exposed areas of two watercourses, Mary River Tributary-F and Mary River. In accordance with MDMER requirements, this Interpretive Report provides a summary of effluent and water quality monitoring data and the results of the Mary River Project 2nd EEM biological study.

Effluent from the Mary River Project primary discharge (MS-08) met MDMER monthly limits from 2018 to 2020 with the exception of two isolated events in 2019 in which total suspended solids (TSS) were elevated. Mine effluent was non-acutely lethal to rainbow trout over the duration of the current 2nd EEM period, and was also non-acutely lethal to *Daphnia magna* in all but one test over this period. Sublethal toxicity tests conducted using final effluent samples showed no effects on survival or growth of fathead minnow or on growth of green algae over the 2nd EEM period. Effects on survival and/or reproduction of *Ceriodaphnia dubia* and growth inhibition of duckweed were shown in effluent sublethal toxicity tests conducted from 2018 to 2020. However, effluent effect concentrations for these tests were much higher than those expected in the effluent

receiving environment, suggesting limited potential for similar sublethal toxicity effects within the immediate Mary River Tributary-F effluent-exposed area.

Water chemistry at effluent-exposed areas of Mary River Tributary-F showed slightly to moderately elevated specific conductance and concentrations of chloride, nitrate, sulphate, and TSS compared to reference conditions during EEM biological sampling, but concentrations of these parameters were well below applicable Water Quality Guidelines (WQG) within the watercourse. Effluent concentrations in Mary River Tributary-F averaged 2.6%, and were estimated at 3.0% and 2.9% at a distance of 100 m and 250 m downstream, respectively, of the effluent channel, at the time of the EEM biological study. Within the effluent-exposed area of Mary River, specific conductance was slightly elevated, but parameter concentrations were comparable, relative to those shown at each of three separate reference areas at the time of EEM biological sampling in August 2020.

The benthic invertebrate community survey indicated significantly lower density and higher Simpson's Evenness at the effluent-exposed area compared to the reference area of Mary River Tributary-F, as well as differences in Bray-Curtis Index between these areas, but no difference in richness. This suggested there may be a slight effluent-related influence on the benthic invertebrate community of Mary River Tributary-F associated with exposure to the MS-08 mine effluent. The fish population survey indicated no substantial differences in community species composition or arctic charr (*Salvelinus alpinus*) abundance at the Mary River effluent-exposed area compared to either of two reference areas (Angajurjualuk Lake Tributary and Mary River downstream). The Mary River juvenile arctic charr population showed no consistent significant difference in length-frequency distribution, body size, growth, relative liver size, or condition compared to two separate reference areas. In addition, no significant differences in muscle tissue selenium concentrations were indicated in arctic charr of the Mary River effluent-exposed area compared to the same two reference areas, and concentrations at all areas were well below chronic effects criterion indicating no reproductive impairments were likely to occur as a result of exposure to selenium. In turn, this indicated no marked influence of the MS-08 effluent on the health of arctic charr at the Mary River effluent-exposed area in 2020.

Overall, the Mary River Project 2nd EEM biological study indicated very low effluent concentrations within the immediate Mary River Tributary-F receiving environment and commensurately, indicated only minor effluent-related influences on the water quality of this watercourse and farther downstream at Mary River during periods of effluent discharge. Assessment of the benthic invertebrate community EEM primary endpoints indicated significantly lower density, higher Simpson's Evenness, and a difference in Bray-Curtis Index at the effluent-exposed area compared to the reference area of Mary River Tributary-F, but the absolute magnitudes of the differences in density and Simpson's Evenness were below critical effect sizes suggesting that these differences were minor. In addition, no effluent-related influences on juvenile arctic charr health (including tissue selenium concentrations) were indicated at Mary River. Therefore, consistent with the water quality data that showed parameter concentrations in the mine effluent receiving waters were low (i.e., less than WQG), effluent-related influences on the benthic invertebrate community of Mary River Tributary-F were shown to be minor, whereas no effluent-related influences on fish were apparent farther downstream at Mary River.

Based on the prescribed EEM frequency under the MDMER, the Study Design for the next Mary River Project EEM biological study must be submitted to ECCC no later than six months prior to implementing field collections in 2023. Using the EEM framework, the next (third) biological monitoring study will require an effects assessment, in part, to determine whether the occurrence of significant differences in benthic invertebrate community density, Simpson's Evenness, and Bray-Curtis Index effect indicators shown in the current EEM are consistent in the next EEM biological study. The corresponding EEM Interpretive Report for the third biological study must be submitted to ECCC by January 10th, 2024.

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ACRONYMS AND ABBREVIATIONS

AEMP – Aquatic Effects Monitoring Program

ANCOVA – Analysis of Covariance

ANOVA – Analysis of Variance

CALA – Canadian Association for Laboratory Accreditation

CES – Critical Effect Size

CETIS – Comprehensive Environmental Toxicity Information System

CPUE – Catch-per-unit-effort

dbRDA – distance-based Redundancy Analysis

DQR – Data Quality Review

DSS – Digital Sampling System

dw – Dry Weight

ECCC – Environment and Climate Change Canada

EEM – Environmental Effects Monitoring

ERP – Early Revenue Phase

FDP – Final Discharge Point

FFG – Functional Feeding Groups

FL – Family Level

GPS – Global Position System

IC – Inhibition Concentration

LPL – Lowest Practical Level

LRL – Laboratory Reporting Limit

MDMER – Metal and Diamond mining Effluent Regulations

MINNOW – Minnow Environmental Inc.

MMER – Metal Mining Effluent Regulations

MOD – Magnitude of Difference

Mt – Million Tonnes

NAD 83 – North America Datum of 1983

Non-YOY – Non-Young-of-the-Year

NSES – North Shore Environmental Services

QA/QC – Quality Assurance / Quality Control

TAP – Technical Advisory Panel

TSS – Total Suspended Solids

WQG – Water Quality Guidelines

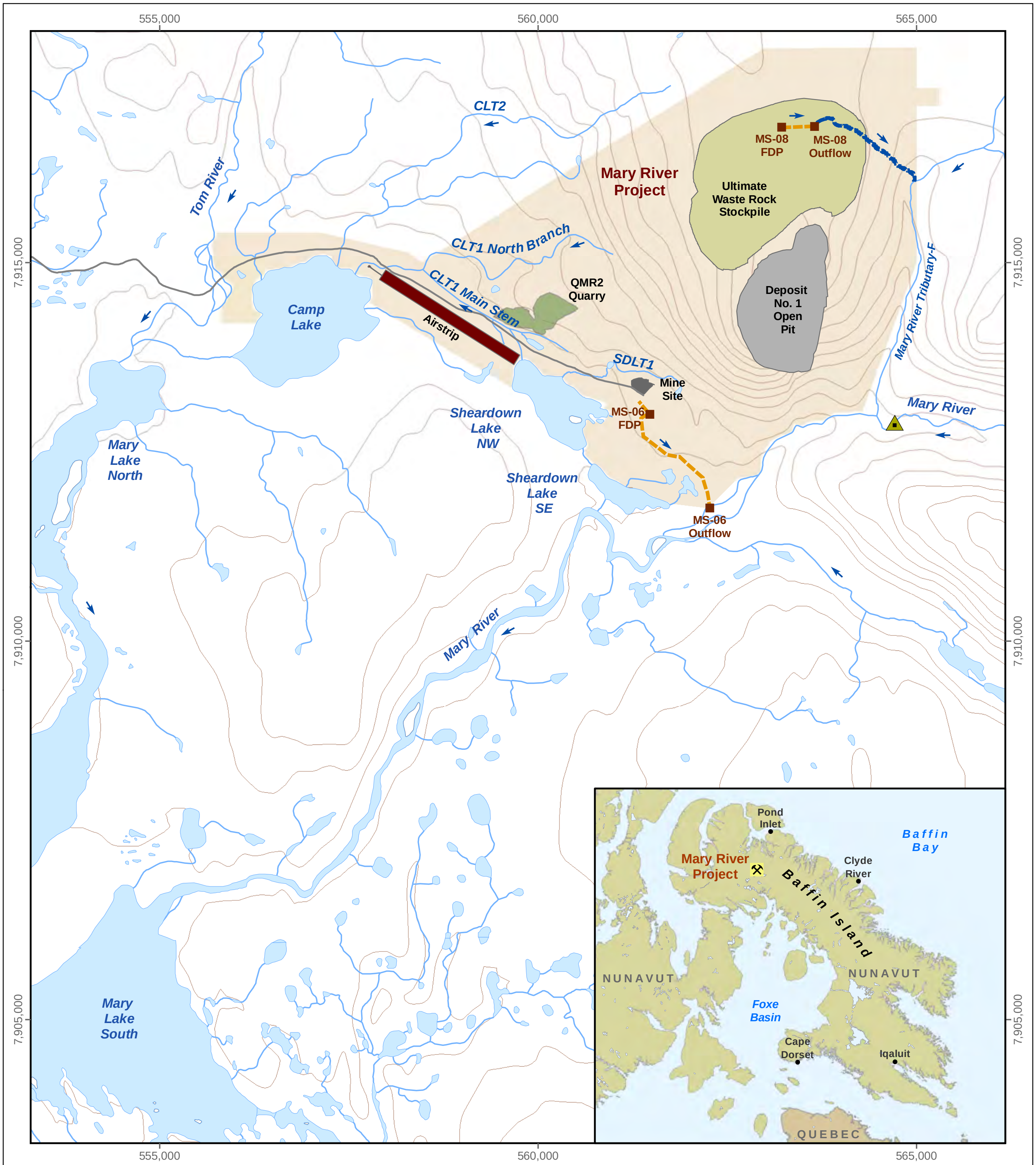
YOY – Young-of-the-Year

1 INTRODUCTION

The Mary River Project (the Project), owned and operated by Baffinland Iron Mines Corporation (Baffinland), is a high-grade iron ore mining operation located in the Qikiqtani Region of northern Baffin Island, Nunavut (Figure 1.1). Commercial open pit mining, including pit bench development, ore haulage, and ore stockpiling, as well as the crushing and screening of high-grade iron ore, commenced at the Project Mine Site in 2015. In the current mining phase, referred to as the Early Revenue Phase (ERP), up to 6 million tonnes (Mt) of crushed/screened ore is mined annually at the Project. Ore from the Project Mine Site is transported in haul trucks along the Milne Inlet Tote Road to Milne Port, located approximately 100 km north of the Mine Site, where it is stockpiled. At Milne Port, the ore is loaded onto bulk carrier ships for transport to international markets during the shipping season. No milling or additional ore processing is conducted at the Mine Site, and thus no tailings are produced at the Project. Mine waste management facilities at the Mary River Project thus consist simply of a mine waste rock stockpile and surface runoff collection/containment ponds currently situated near the mine waste rock stockpile and ore stockpile areas.

Under the Metal and Diamond Mining Effluent Regulations (MDMER, the 'regulations')[1] of the Canadian *Fisheries Act*, Baffinland is required to conduct Environmental Effects Monitoring (EEM) studies as a condition governing the authority to discharge effluent from the site (Environment Canada 2012, Government of Canada 2019). The objective of EEM is to determine whether mine effluent is causing effects on fish, fish habitat (e.g., benthic invertebrate food resources), and/or the human use of fisheries resources (Environment Canada 2012). One study, completed in 2017, has been conducted to meet EEM biological sampling requirements at the Mary River Project (Minnow 2018, 2020). This study indicated very low effluent concentrations (i.e., generally less than 1%) occurred within the immediate Mary River Tributary-F receiving environment and farther downstream at Mary River. Commensurately, only minor effluent-related influences on water quality (i.e., slightly elevated ammonia, nitrate, and sulphate) of this watercourse and farther downstream at Mary River were indicated during periods of effluent discharge. During those periods, pH and concentrations of all parameters potentially associated with the mine effluent consistently met applicable Water Quality Guidelines (WQG) in both watercourses. Assessment of the benthic invertebrate community indicated no significant differences in primary EEM endpoints of density, richness, Simpson's Evenness, and Bray-Curtis Index between effluent-exposed and reference areas of Mary River Tributary-F. In addition, the

[1] On June 1st 2018, changes to the Metal Mining Effluent Regulations (MMER) were enacted that resulted in the creation of the Metal and Diamond Mining Effluent Regulations (MDMER). Environmental Effects Monitoring (EEM) is now administered under the MDMER.



LEGEND

- Final Discharge Point (FDP)
- Mary River Cascade Barrier
- Discharge Line
- Overland Effluent Channel
- Ultimate Deposit No. 1 Pit Limits
- Ultimate Waste Rock Stockpile Limits
- Mine Site Complex Pad
- Airstrip
- Mary River Project
- QMR2 Quarry

Baffinland Iron Mines Corporation, Mary River Project Location

0 1.25 2.5 5 km

N W E S

Map Projection: UTM Zone 17 W NAD 1983
Data Source: Reproduced under licence from Her Majesty the Queen in Rights of Canada, Department of Natural Resources Canada. All rights reserved.

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Project 207202.0046

minnow environmental inc.

Figure 1.1

Document Path: C:\Users\MLaPalme\Trinity Consultants, Inc\Baffinland Iron Mines - 207202.0046 - Phase 2 EEM\4 - GIS\Report\20-46 Figure 1.1 Location.mxd

EEM fish population survey indicated no significant differences in length-frequency distribution and body size (length and weight) of juvenile arctic charr (*Salvelinus alpinus*) older than young-of-the-year (non-YOY) between effluent-exposed and reference areas of Mary River[2]. Although non-YOY arctic charr captured at the effluent-exposed area had significantly lower condition (length-at-weight relationship) than those captured at the reference area in Mary River, the magnitude of this difference was small (i.e., -4.5%) and within the applicable fish condition Critical Effect Size of ±10% used for EEM studies, suggesting that this difference was not ecologically meaningful (Minnow 2018). Overall, concentrations of mine-related parameters in water were below WQG and no significant differences in benthic invertebrate community primary EEM endpoints suggested that factors other than mine-effluent accounted for this difference in non-YOY arctic charr condition.

In accordance with the EEM decision framework, effects reassessment is required in subsequent EEM biological studies to monitor/verify potential effects shown within the mine effluent receiving environment in the previous EEM study (Environment Canada 2012). The Study Design for the second EEM biological study at the Mary River Project (herein referred to as the Mary River Project 2nd EEM Study)[3] was provided to Environment and Climate Change Canada (ECCC) in February 2020 (Minnow 2020). The Study Design built upon the methods, results, and recommendations provided in the previous study (Minnow 2018) as well as comments received from ECCC regarding the initial EEM biological study (Minnow 2020). Upon review of this Study Design, a Technical Advisory Panel (TAP)[4] identified several action items required for approval of the design to which Baffinland provided a detailed response in May 2020 (Appendix A). As per the three-year biological monitoring frequency stipulated in the MDMER, the field component for the 2nd EEM biological study at the Mary River Project was implemented in August 2020. The 2nd EEM biological study was conducted with no deviations from the approved Study Design. In accordance with MDMER requirements, this Interpretive Report provides a summary of effluent and water quality monitoring data and the methods, results, and conclusions of the Mary River Project 2nd EEM biological study.

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[2] No fish were captured within Mary River Tributary-F either downstream or upstream of the MS-08 effluent discharge channel during the August 2017 fish population survey, therefore the fish population survey was conducted in the Mary River.

[3] Baffinland is currently seeking regulatory approval for expansion of the Mary River Project, which has been referred to as the Phase 2 Expansion. In order to avoid possible confusion among regulators and stakeholders with the ongoing approvals process, the EEM convention of referring to a biological study period as a phase was not used in this Interpretive Report. Rather, mention of the first and second EEM biological studies in this document are referred to as 1st and 2nd EEM studies, respectively.

[4] The Technical Advisory Panel (TAP) consists of representatives from Environment and Climate Change Canada (ECCC), Crown-Indigenous Relations and Northern Affairs Canada, and the Nunavut Water Board.

2 METHODS

2.1 Overview

The EEM program consists of effluent and receiving environment water quality studies and biological studies (Government of Canada 2019). The initial EEM biological study showed no significant differences in benthic invertebrate community EEM effect indicators between effluent-exposed and reference areas of Mary River Tributary-F, or in fish population EEM effect indicators between arctic charr populations of effluent-exposed and reference areas of Mary River with the exception of condition, which was lower but within applicable critical effect size (CES) at the effluent-exposed area (Minnow 2018). These findings were generally consistent with the evaluation of receiving environment water chemistry, which showed that concentrations of most parameters were below applicable water quality guidelines at the effluent-exposed areas.[5] Under the EEM decision framework, effects reassessment is required in the subsequent EEM biological study to monitor/verify potential effects shown within the mine effluent receiving environment based on the preceding study (or studies; Environment Canada 2012). The regulatory requirements for the 2nd EEM biological study at the Mary River Project thus included:

1. a benthic invertebrate community survey;
2. a fish population survey;
3. a fish tissue selenium survey; and
4. supporting water quality assessment.

Mercury concentrations in MS-08 effluent over the previous three years leading up to the Study Design submission were consistently below thresholds that trigger implementation of fish tissue mercury surveys, and therefore a fish tissue mercury survey was not required as part of the 2nd EEM biological study (Minnow 2020). Concentrations of selenium in MS-08 effluent were above the EEM individual sampling event trigger for conducting a fish tissue selenium study as defined in the MDMER (i.e., concentrations of selenium in effluent were equal to or above 10 µg/L) on two occasions in 2018 (Section 3.1; Minnow 2020). Therefore, Baffinland was required to conduct a study respecting fish tissue selenium as part of the MDMER obligations for the 2nd EEM biological study. Effluent characterization, effluent sublethal toxicity testing, and receiving environment water quality monitoring was conducted by Baffinland environment department

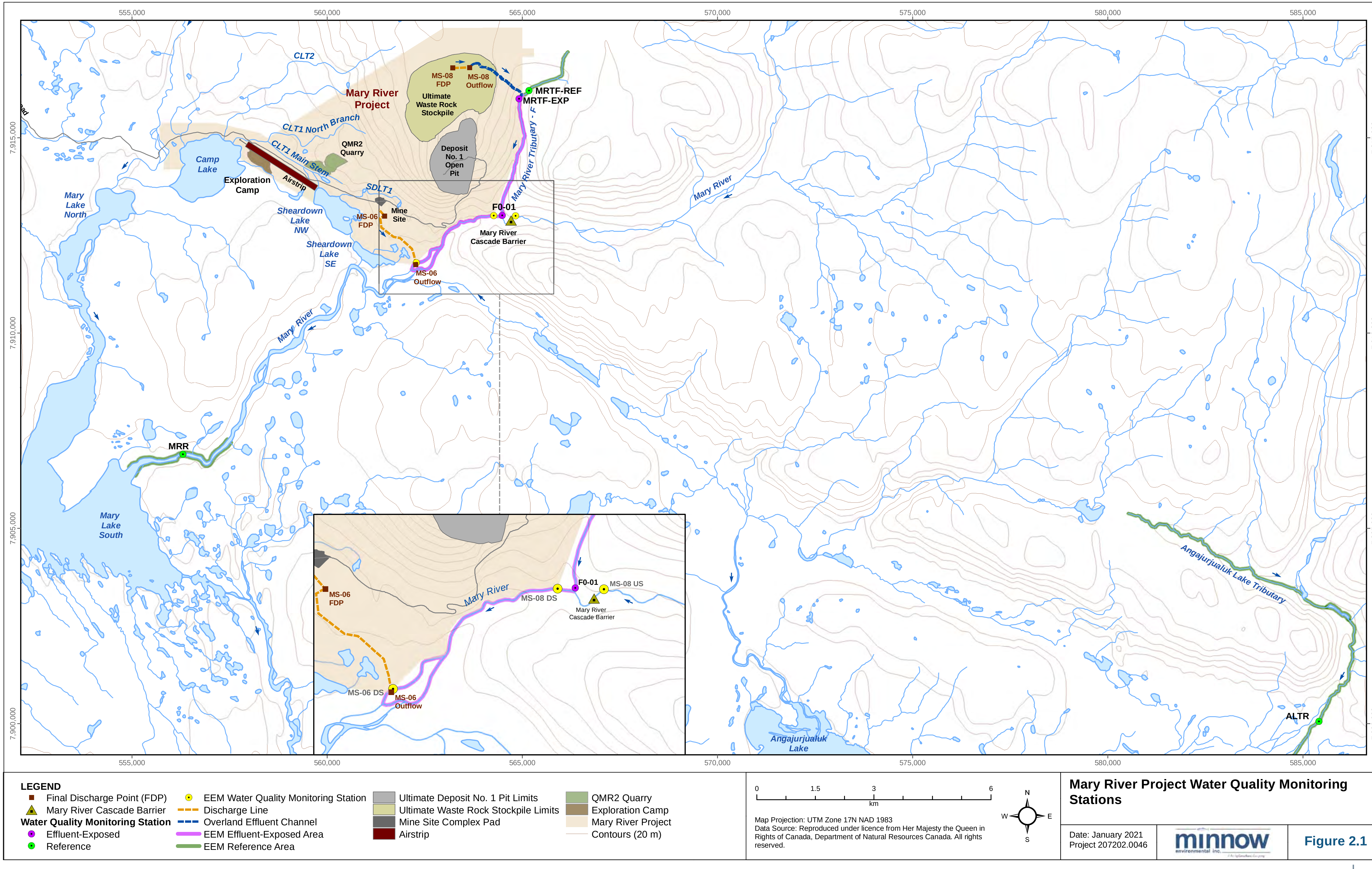
[5] Aluminum and iron concentrations were above water quality guidelines at the effluent-exposed areas, but similar or higher concentrations of these parameters occurred at applicable reference areas, indicating naturally high concentrations in waters of the region.

personnel during periods of effluent discharge in accordance with EEM requirements (Environment Canada 2012) over the 2nd EEM period (i.e., 2018 to 2020). Additional receiving environment water quality data were also collected at the same time as implementation of the biological monitoring field study. The Mary River Project 2nd EEM biological study, including a benthic invertebrate community survey, a fish population survey, and a fish tissue selenium survey, was implemented from August 16th to 19th, 2020 led by Minnow Environmental Inc. (Minnow) biologists. Each EEM study component incorporated a data quality program to provide checks for sample collection and analysis, and to allow for data quality to be assessed in the context of the study objectives. A description of the Mary River Project 2nd EEM study areas and the methods used for sample collection, sample processing, and data analysis for each study component are described in the sub-sections below. The Mary River Project 2nd EEM biological study was conducted without any deviations from the approved Study Design (Minnow 2020; Appendix A) for all benthic invertebrate community survey, fish population survey, fish tissue selenium survey, and supporting water quality assessment components.

2.2 Compliance Point Location Description and Study Areas

Wastewater management at the Mary River Project includes the collection of surface runoff originating from the mine waste rock stockpile into a pond where settling and/or active treatment are used for solids removal. Effluent monitoring is conducted at a sampling port, referred to as the Station MS-08 Final Discharge Point (FDP), where effluent quality is verified to be compliant with applicable territorial and federal limits before being pumped through an approximately 475 m long layflat hose that outflows to the tundra (Figure 2.1). The effluent flows overland (i.e., no defined channel), meeting with an unnamed tributary to the Mary River, herein referred to as Mary River Tributary-F, approximately 2.2 km southeast of the outflow location (Figure 2.1). From this confluence, Mary River Tributary-F flows south approximately 3.3 km before discharging into Mary River (Figure 2.1). The frequency of effluent discharge from the MS-08 pond FDP is dictated by precipitation levels, flight logistics, and climatic conditions, and therefore effluent is discharged intermittently, on an as-needed basis, between approximately late June and September.

A second compliance monitoring station under the MDMER at the Mary River Project, referred to as MS-06, reflects the discharge from a surface water management pond used to monitor and treat stormwater runoff from the ore crusher and stockpile pad. Water retained in the MS-06 surface water management pond is treated for solids removal via pond-based settling. A sample port located below the pumping system used to discharge MS-06 effluent, but upgradient of a connection to the Mine Site treated sewage effluent pipeline, serves as the MS-06 FDP compliance location. Effluent from the MS-06 FDP is pumped to an outflow located approximately 1.3 km southeast of the pond using the same pipeline that transports the Mine Site treated



Mary River Project
Ultimate Waste Rock Stockpile
MS-08 FDP
MS-08 Outflow
MRTF-REF
MRTF-EXP
Deposit No. 1 Open Pit
QMR2 Quarry
Camp Lake
Exploration Camp
Airstrip
Mine Site
MS-06 FDP
F0-01
Mary River Cascade Barrier
MS-06 Outflow
MS-08 US
MS-08 DS
MS-06 DS
MRR
ALTR
Mary Lake North
Mary Lake South
Sheardown Lake NW
Sheardown Lake SE
Angajurjualuk Lake
Angajurjualuk Lake Tributary
Mary River
Mary River Tributary - F
CLT2
CLT1 North Branch
CLT1 Main Stem
SDLT1
LEGEND
Final Discharge Point (FDP)
Mary River Cascade Barrier
Water Quality Monitoring Station
Effluent-Exposed
Reference
EEM Water Quality Monitoring Station
Discharge Line
Overland Effluent Channel
EEM Effluent-Exposed Area
EEM Reference Area
Ultimate Deposit No. 1 Pit Limits
Ultimate Waste Rock Stockpile Limits
Mine Site Complex Pad
Airstrip
QMR2 Quarry
Exploration Camp
Mary River Project
Contours (20 m)
0 1.5 3 6
km
Map Projection: UTM Zone 17N NAD 1983
Data Source: Reproduced under licence from Her Majesty the Queen in Rights of Canada, Department of Natural Resources Canada. All rights reserved.
Mary River Project Water Quality Monitoring Stations
Date: January 2021
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Figure 2.1
Document Path: C:\Users\MLaPalme\Trinity Consultants, Inc\Baffinland Iron Mines - 207202.0046 - Phase 2 EEM\4 - GIS\Report\20-46 Figure 2.1 Mary River Project Water Quality Monitoring Stations.mxd

sewage effluent. From the MS-06 outflow, the effluent is deposited overland where it flows approximately 300 m into Mary River (Figure 2.1). The frequency of effluent discharge from the MS-06 surface water management pond FDP is dictated by precipitation levels, flight logistics, and climatic conditions, and therefore effluent is discharged intermittently, on an as-needed basis, between approximately late June and September.

For the purposes of the 2nd EEM biological study, Mary River Tributary-F downstream of the effluent confluence and Mary River extending approximately 2 km downstream of the Mary River Tributary-F confluence served as the mine effluent-exposed areas for the benthic invertebrate community survey and fish population/fish tissue selenium surveys, respectively (Figure 2.1). Reference areas for the 2nd EEM biological study included Mary River Tributary-F upstream of the effluent channel for the benthic invertebrate community survey, and both an unnamed tributary of Angajurjualuk Lake (ALTR) and Mary River just upstream of Mary Lake were used for the fish population survey (Figure 2.1). Separate reference areas were required for the benthic invertebrate and fish community surveys because in part, as confirmed during the initial EEM biological study, fish are naturally absent from Mary River Tributary-F (Minnow 2018). Similarly, an approximately 20 m high cascade located on Mary River just upstream of the Mary River Tributary-F confluence acts as an impassable barrier to fish migration, contributing to the natural absence of fish from areas located upstream of this confluence and precluding its use as a reference area. Following consultation with ECCC during meetings held on August 16th and 17th, 2017, it was agreed that Mary River upstream of Mary Lake would serve as an appropriate reference area for the fish population survey.

2.3 Effluent and Water Quality Monitoring

Effluent monitoring (effluent volume, chemical characterization, and sub-lethal toxicity) and receiving environment water quality monitoring (chemical characterization) were conducted at the Mary River Project in accordance with MDMER requirements (Environment Canada 2012). As part of its EEM requirements, Baffinland must provide an annual effluent and receiving environment water quality monitoring report to ECCC by March 31st of the following year that includes sampling locations, dates, methods and results together with information on quality assurance and quality control (QA/QC) for this sampling (Government of Canada 2019). Only a summary of routine effluent and water quality monitoring data need be included in the EEM interpretive report, and therefore the following paragraphs provide a brief overview of the effluent and receiving environment water quality monitoring methods. Additional receiving environment water quality samples were collected at the same time as the biological study to support interpretation of the benthic invertebrate community, fish population, and fish tissue selenium survey data, and therefore more detailed methods pertaining to the collection and analyses of these samples are provided below.

2.3.1 Effluent Quality

Effluent quality monitoring included routine monitoring for MDMER deleterious substances, effluent characterization, and effluent sub-lethal toxicity sampling and testing. During periods of discharge, effluent volume and chemistry samples for routine MDMER sampling and chemical characterization were collected at the applicable final discharge point of compliance (i.e., Station MS-08 and/or Station MS-06; Figure 2.1). Volumes of effluent discharged from the final discharge points that were monitored continuously in cubic metres per day (m^3/day) were compared using monthly averages and cumulative totals (in m^3) by year for the current EEM period (i.e., 2018 to 2020). In addition to MDMER deleterious substances (total suspended solids, arsenic, copper, lead, nickel, zinc and radium-226) and pH, effluent characterization included analysis of temperature, conductivity, hardness, alkalinity, ammonia, chloride, nitrate, phosphorus, sulphate, and other metals required for EEM (i.e., aluminum, cadmium, chromium, cobalt, iron, manganese, mercury, molybdenum, selenium, thallium, and uranium). Effluent characterization samples were collected once per calendar quarter during periods of discharge at intervals of not less than 30 days apart from the final effluent discharge point in accordance with the MDMER[6]. Monthly means were calculated for each of the monitored parameters, with those for deleterious substances compared to MDMER limits. Mercury and selenium concentrations in mine effluent were compared to applicable EEM fish tissue survey trigger limits based on individual values, annual means, and laboratory method detection limits (MDL) as specified under the MDMER. The monthly mean data were also compared over the 2nd EEM period to track changes in effluent quality over time.

Effluent samples were collected monthly for acute lethality testing, and up to two times per calendar year for sublethal toxicity testing using effluent collected at Station MS-08. From 2015 to 2019, Baffinland had been conducting sublethal toxicity testing on the MS-08 effluent at the frequency stipulated under the MMER/MDMER to meet EEM effluent monitoring obligations. The suite of tests used to assess sublethal toxicity of each effluent sample included fathead minnow, *Ceriodaphnia dubia*, green alga (*Pseudokirchneriella subcapitata*), and macrophyte (*Lemna minor*) tests. Following the promulgation of the MDMER on June 1st 2018, mines that had been conducting effluent sublethal toxicity sampling over the previous three years were required to conduct effluent sublethal toxicity sampling each calendar quarter using only the

[6] Because effluent is discharged intermittently over the course of a relatively short open-water period (i.e., approximately 3 to 4 months), the requirement that effluent characterization samples be collected not less than 30 days apart can result in a frequency of sampling events lower than than once very quarter.

species that had produced the lowest geometric mean 25% inhibition concentration (IC_{25}) over those previous three years (Government of Canada 2019). Because effluent is discharged only intermittently over two quarters each year at the Project (i.e., June through September corresponding to calendar quarters two and three), Baffinland continued to conduct sublethal toxicity testing twice per year on the full suite of the four test organisms indicated above in 2018 and 2019. In 2020, effluent sublethal toxicity sampling using only *Lemna minor* was initiated on a calendar quarter basis as this species had been shown to be most sensitive based on previous testing. Effluent samples for sublethal toxicity sampling have been collected using methods consistent with Environment Canada (2001, 2012) by Baffinland environment department personnel. The sublethal toxicity tests were performed by a laboratory accredited by the Canadian Association for Laboratory Accreditation Inc. (CALA). The sublethal toxicity data were reported annually to ECCC by Baffinland, and these data, together with data collected historically, are summarized herein.

Final effluent samples were collected into pre-labelled plastic containers provided by the toxicity laboratory, put on ice inside coolers, and shipped to the toxicity laboratory where they arrived within 48 hours of collection. Acute toxicity tests were conducted using rainbow trout (*Oncorhynchus mykiss*) and the invertebrate *Daphnia magna* in accordance with standard Environment Canada (1990, 2000) protocols. Sublethal toxicity tests were conducted using fathead minnow (*Pimephales promelas;* 7-day survival and growth test), a cladoceran invertebrate (*C. dubia;* 7-day survival and reproduction test), duckweed (*L. minor*; 7-day growth inhibition test), and a green alga (*P. subcapitata*; 3-day growth inhibition test) using standard test methods (i.e., Environment Canada 2007a,b,c; 2011). For fathead minnow and *C. dubia* tests, an LC_{50} (i.e., lethal concentration to 50% of test organisms) was provided by the laboratory based on calculations using the mortality data. Chronic toxicity test IC_{25} (inhibitory concentration that reduced larval fathead minnow growth by 25%, reduced the number of *C. dubia* neonates produced by 25%, inhibited *P. subcapitata* and *L. minor* growth and/or frond production by 25%) values were calculated from the growth or reproductive data. Reference toxicant testing was employed to ensure that all test systems met protocol criteria during effluent testing. All IC_{25} data were derived by the toxicity laboratory using non-linear regression models or linear interpolation, as appropriate, aided by Comprehensive Environmental Toxicity Information System (CETIS) software (Tidepool Scientific Software, McKinleyville, CA). As required under the MDMER, the sub-lethal toxicity data were reported to ECCC as part of Baffinland quarterly and annual reporting for the Mary River Project, the results of which are summarized in this report.

2.3.2 Receiving Environment Water Quality

2.3.2.1 Sample Collection and Laboratory Analysis

Receiving environment water quality monitoring included collection of *in situ* measurements and samples for water chemistry analysis. During biological monitoring, *in situ* water temperature, dissolved oxygen, pH, and specific conductance (i.e., temperature standardized measurement of conductivity) were measured near the bottom of the water column at all benthic invertebrate community (benthic) stations. These measurements were made using a calibrated YSI ProDSS (Digital Sampling System) meter equipped with a 4-Port sensor (YSI Inc., Yellow Springs, OH). Additional supporting water quality information, including observations of water colour and clarity, were also recorded at each benthic station during EEM biological sampling in August 2020.

Receiving environment water quality monitoring data were collected routinely by Baffinland personnel at designated MDMER-EEM stations located on Mary River for each of the MS-08 and MS-06 discharges. Water sampling for EEM for the MS-08 FDP is conducted at an effluent-exposed station located downstream of the Mary River Tributary-F confluence on Mary River (Station MS-08-DS), and at a reference station situated upstream of the cascade barrier and Mary River Tributary-F confluence on Mary River (Station MS-08-US) to monitor for influences related to the MS-08 discharge (Figure 2.1). The MS-06 FDP uses the same upstream reference location (Station MS-08-US) and an effluent-exposed area on the Mary River (MS-06-DS) to monitor for influences related to the MS-06 discharge (Figure 2.1).

In accordance with the MDMER, the routine receiving environment water samples were collected during periods of effluent discharge not less than 30 days between sampling events once per calendar quarter[7]. In addition to the sampling stations indicated above, routine water quality monitoring is conducted on Mary River Tributary-F (Station FO-01) and additional reference (GO series stations), effluent-exposed (EO series stations) and other (CO series stations) locations on Mary River (Figure 2.1) to meet environmental regulatory requirements outside of the MDMER. Water chemistry samples were collected by hand from mid-column directly into labelled sample bottles pre-dosed with required chemical preservatives or into collection bottles triple-rinsed with ambient water for analyses not requiring sample preservation using methods consistent with Baffinland standard operating procedures. Following collection, the water quality samples were placed in coolers and maintained at cool temperatures during shipment to the analytical laboratory. Water quality samples were also collected at locations used for benthic

[7] Because effluent is discharged intermittently over the course of a relatively short open-water period (i.e., approximately 3 to 4 months), the requirement that receiving environment water chemistry samples be collected not less than 30 days apart can result in a frequency of sampling events lower than once every quarter.

invertebrate community and fish population/fish tissue selenium sampling (see Sections 2.4 to 2.6), using the same methods described above, during the biological field study in August 2020. All water chemistry samples were shipped to ALS Global (Waterloo, ON) where they were analyzed for the same parameters indicated previously for routine effluent monitoring and effluent characterization using standard laboratory methods. Although holding times for water chemistry samples were generally adhered to, logistical constraints related to the remoteness of the Mary River Project resulted in the laboratory-based analysis of pH that was outside of recommended holding times.

2.3.2.2 Data Analysis

In situ water quality measurements were compared statistically between Mary River Tributary-F effluent-exposed and reference benthic study areas, and between Mary River fish population survey study areas. For the statistical analysis, raw data and log-transformed data were assessed for normality and homogeneity of variance prior to conducting comparisons between study areas. The selection of whether untransformed or log-transformed data were used for the statistical analysis was determined based on which data best met the assumptions of Analysis of Variance (ANOVA). In instances where normality could not be achieved through data transformation, Mann-Whitney U-tests were conducted on rank-transformed data to evaluate differences between study area pairs. Significant differences were assessed at a p-value of ≤ 0.1. The *in situ* water quality statistical tests were conducted using R programming (R Foundation for Statistical Computing, Vienna, Austria). In addition to these comparisons, dissolved oxygen and pH data from each station were compared to applicable Water Quality Guidelines for the protection of aquatic life (WQG)[8]. Effluent concentration in the mine receiver at the time of EEM biological sampling was estimated through extrapolation of field measured specific conductance at the benthic effluent-exposed and reference areas, and for effluent on the same day, as described in Environment Canada (2012).

Water chemistry data were compared between the mine effluent-exposed and reference areas and to applicable WQG. To simplify the discussion of results, the magnitude of elevation in parameter concentrations was calculated as the effluent-exposed area concentration divided by the respective reference area concentration. The magnitude of elevation in parameter concentrations at the effluent-exposed areas were qualitatively assigned as slightly, moderately, or highly elevated compared to concentrations measured at the reference area using the categorization described in Table 2.1.

[8] Canadian Environmental Quality Guidelines (CCME 1999, 2020) were used as the primary source for WQG. For parameters in which no CCME guideline was available, Ontario Provincial Water Quality Objectives (OMOEE 1994) or British Columbia Water Quality Guidelines (BCMOE 2017) were used as WQG.

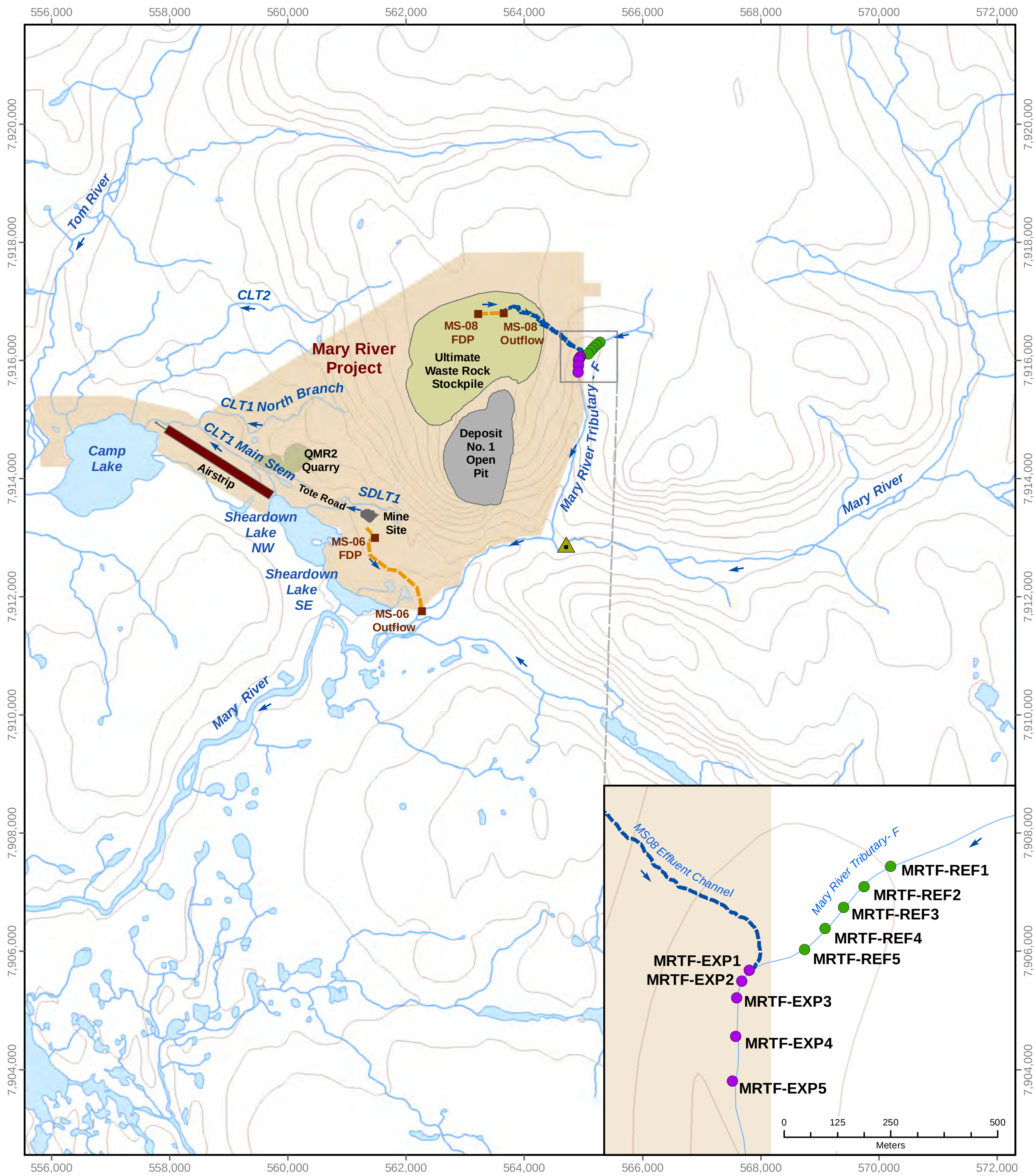
Table 2.1: Magnitude of Elevation Categorizations for Water Chemistry Comparisons

Categorization	Magnitude of Elevation Criterion
Slightly elevated	Concentration 3-fold to 5-fold higher at effluent-exposed area versus the reference area.
Moderately elevated	Concentration 5-fold to 10-fold higher at effluent-exposed area versus the reference area.
Highly elevated	Concentration ≥ 10-fold higher at effluent-exposed area versus the reference area.

2.4 Benthic Invertebrate Community Survey

2.4.1 General Approach and Study Areas

Maximum concentrations of the MS-08 effluent in the Mary River Tributary-F receiving environment can be greater than 1% within 100 m from the point at which effluent enters the watercourse (Minnow 2020). Therefore, the MDMER required implementation of a benthic invertebrate community (benthic) survey (Government of Canada 2019) as part of the 2nd EEM biological study. The benthic survey for the 2nd EEM biological study followed a standard control-impact design incorporating quantitative sampling at an effluent-exposed area (MRTF-EXP) and a comparable reference area (MRTF-REF) located downstream and upstream, respectively, of the confluence with the MS-08 overland discharge pathway on Mary River Tributary-F (Figure 2.2; Table 2.2). No past or present mining activity has occurred within Mary River Tributary-F upstream of the confluence with the MS-08 overland discharge, and thus the upstream portion of the system was able to serve as a suitable reference area. These benthic study areas served as the effluent-exposed and reference study areas in the previous EEM study, and therefore the sampling of these study areas for the 2nd EEM biological study provided temporal continuity. Five stations, separated from one another by a distance of at least 20 m, were sampled at both areas to provide adequate statistical power to detect differences of ± two standard deviations from the normal reference condition (± 2 SD_{REF}) based on Type I and II error probability (α and β, respectively) set equally at 0.10 for the analysis as recommended in EEM standard guidance (Environment Canada 2012). Habitat features including sampling depth and physical properties of the substrate were standardized among stations and between areas, to the extent possible, to minimize natural habitat influences as a factor contributing to benthic invertebrate community differences between study areas. Benthic invertebrate community sampling was conducted on August 19th, 2020.



LEGEND

Benthic Invertebrate Station

- Effluent-exposed
- Reference
- Final Discharge Point (FDP)
- Mary River Cascade Barrier
- Discharge Line
- Overland Effluent Channel
- Ultimate Deposit No. 1 Pit Limits
- Ultimate Waste Rock Stockpile Limits
- Mine Site Complex Pad
- Airstrip
- Mary River Project

Benthic Invertebrate Community Station Locations for the Mary River Project Second EEM, August 2020

0 1.5 3 6 km

N E S W

Map Projection: UTM Zone 17 WN NAD 1983

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Figure 2.2

Document Path: C:\Users\MLaPalme\Trinity Consultants, Inc\Baffinland Iron Mines - 207202.0046 - Phase 2 EEM\4 - GIS\Report\20-46 Figure 2.2 BI Station Locations.mxd

Table 2.2: Summary of Study Areas, Sampling Information, and Laboratory Processing Information, Mary River Project, Second EEM Study

Study Detail	Description
Study Areas	Mary River Tributary-F Downstream (effluent-exposed) Mary River Tributary-F Upstream (reference)
Survey Timing	August 2020
Number of Stations	5 per study area
Sampling Device	0.093 m^2 Surber Sampler
Target Substrate	5 to 10 cm diameter cobble
Target Sampling Depth	0.05 to 0.15 m
Processing Mesh Size	500 um
Composite Sample Area Size	0.279 m^2 per station (3 grabs)
Processing Level of Taxonomy	Lowest practical level (genus, species)

2.4.2 Sample Collection and Laboratory Analysis

Shallow (i.e., ≤0.4 m) riffle-run habitat characterized by cobble-gravel substrate was targeted for benthic sample collection at each of the two Mary River Tributary-F study areas. As in the previous EEM study, benthic samples were collected using a 0.093 m^2 Surber sampler outfitted with 500-µm mesh. One sample, representing a composite of three sub-samples (i.e., 0.279 m^2 total area), was collected at each station to ensure adequate representation of the benthic invertebrate community (Table 2.2). Each sub-sample was collected by carefully placing the base of the Surber sampler onto undisturbed substrate and subsequently scrubbing all coarse material within the sampler area to a depth of approximately 10 cm and allowing the current to carry all dislodged organisms into the sampler net. After all substrate within the sampler had been completely washed and all organisms had been rinsed into the collection net, the sampler was moved to the next sub-sample location and the procedure repeated. Following collection of the third sub-sample using the above procedure, all material and organisms retained in the collection net was carefully transferred into pre-labelled wide-mouth plastic jars. As a precautionary measure, internal sample labels were also used to ensure correct sample identification at the processing laboratory. The benthic samples were then preserved to a level of 10% buffered formalin in ambient water. Supporting information collected at each benthic station included substrate description (type and approximate diameter), water velocity (metres/second; m/s), sampling depth (cm), water quality at the sediment-water interface (see Section 2.3.2), habitat notes, and global positioning system (GPS) coordinates (recorded in latitude and longitude decimal degrees and based on the North America Datum of 1983 [NAD 83] to conform with standard EEM requirements).

As in the previous EEM study, the benthic samples were submitted to a qualified laboratory that includes taxonomists certified by the Society of Freshwater Sciences (i.e., Zeas Inc., Nobleton, ON). At the laboratory, sample material that was retained by a 500 µm mesh was examined under a stereomicroscope at a magnification of at least ten times. All benthic organisms were removed from the sample debris and placed into vials containing 70% ethanol by a technician. A senior taxonomist later enumerated and identified the benthic organisms to the lowest practical level (typically genus or species) using up-to-date taxonomic keys. This level of taxonomy exceeds the Environment Canada (2012) minimum requirement of “family level” for EEM studies, and provided additional supporting information for effects assessment. During taxonomic identification, representative specimens of each taxon were checked against the voucher collection created in the previous EEM study, and any newly identified taxa were placed in separately labelled vials, preserved using a 75% ethanol / 3% glycerol solution, and added to the existing voucher collection for future reference. The benthic sample processing described above conformed with standard sorting methods that incorporate recognized quality assurance and quality control (QA/QC) measures (e.g., Environment Canada 2012). Benthic sample processing QA/QC measures were conducted on a minimum of 10% of samples. These measures were used to verify that sub-sampling accuracy and precision was within 20% and that greater than 90% of the total organisms were recovered from the benthic invertebrate community samples (Environment Canada 2012). The application of the QA/QC measures and checks against the existing voucher collection ensured that data were as comparable as possible between EEM studies.

2.4.3 Data Analysis

Benthic invertebrate communities were evaluated using EEM primary metrics of mean invertebrate density (average number of organisms per m^2), taxonomic richness (number of taxa), Simpson’s Evenness Index, and the Bray-Curtis Index of Dissimilarity, all calculated using family level (FL) taxonomy, as required under the MDMER (Table 2.3). Additional comparisons were also conducted using taxonomic richness, Simpson’s Evenness, and Bray-Curtis Index calculated based on lowest practical level (LPL) taxonomy, absolute densities and/or percent composition of dominant/indicator taxa (calculated as the abundance of each respective taxonomic group relative to the total number of organisms in the sample), functional feeding groups, and habit preference groups, to assist with data interpretation. Simpson’s E was calculated using the formula provided by Environment Canada (2012). Bray-Curtis Index was computed using procedures recently recommended by ECCC for EEM studies (i.e., Borcard and Legendre 2013).

Table 2.3: Required and Supporting Endpoints to be Examined, Mary River Project, Second EEM Study

Response	Endpoint	Critical Effect Size
Effects on Benthic Invertebrates [a] (Family Level Taxonomy)	Organism density (number of invertebrates·m^2)	± 2 standard deviations of the reference mean (MOD > ± 2)
	Taxonomic richness (number of taxa)	± 2 standard deviations of the reference mean (MOD > ± 2)
	Simpson's Evenness	± 2 standard deviations of the reference mean (MOD > ± 2)
	Bray-Curtis Index of dissimilarity	-
Supporting Response Variables [b]	Taxonomic richness (lowest practical level taxonomy)	-
	Simpson's Evenness (lowest practical level taxonomy)	-
	Dominant invertebrate groups (% composition)	-
	Functional Feeding Groups (% composition)	-
	Shannon-Wiener Diversity	-
	Habit Preference Groups (% composition)	-

[a] Endpoints to be used for determining "effects" as designated by statistically significant differences between effluent-exposed and reference areas (Government of Canada 2019)

[b] These analyses are for informational purposes and significant differences between effluent-exposed and reference areas are not necessarily used to designate an effect (Environment Canada 2012).

All required and selected endpoints except Bray-Curtis Index were summarized by separately reporting mean, median, minimum, maximum, standard deviation, standard error, and sample size for each study area. For these endpoints, statistical comparisons between the effluent-exposed area and the reference area were conducted using univariate statistical tests. Differences between the effluent-exposed and reference areas for these endpoints were assessed using Analysis of Variance (ANOVA) following tests to determine data homogeneity and normality. For data that were not normally distributed, logarithmic transformation to the base 10 (log_{10}) were applied, and the data were then re-evaluated for normality and assessed using ANOVA if the transformed data were normally distributed. In instances where normality could not be achieved through data transformation, Mann-Whitney U-tests were conducted on rank-transformed data to evaluate differences between study areas. The statistical comparisons described above were conducted using R programming (R Foundation for Statistical Computing, Vienna, Austria). An effect on the benthic invertebrate community was defined as a statistically significant difference between the effluent-exposed area and the reference area at an alpha level of 0.10 (Environment Canada 2012). The magnitude of effect for all benthic invertebrate community effect indicators that differ significantly between study areas was calculated for the effluent-exposed area based on the formula provided in the MDMER. For effect indicators of density, richness, and Simpson's Evenness Index, the derived magnitude of difference (MOD) was compared to CES applicable to the benthic invertebrate community endpoints that are presented in the MDMER (i.e., ±2 SD_{REF}; Table 2.3). The CES was used to define ecologically relevant 'effects', which are analogous to differences beyond those expected to occur naturally between two areas that have not been influenced by anthropogenic inputs (i.e., between pristine reference areas; see Munkittrick et al. 2009; Environment Canada 2012).

The Bray-Curtis Index was used to evaluate community level differences between study areas, and was computed and assessed statistically using procedures recommended by ECCC for EEM studies (i.e., Borcard and Legendre 2013). Specifically, community level differences between study areas were assessed in a pairwise fashion using ln-transformed abundance data, and with homogeneity of group variance calculated according to the PERMDISP2 procedure provided by Anderson (2006). A Mantel Test and distance-based Redundancy Analysis (dbRDA) was then used to determine potential differences in community structure between study areas using R statistical software (as per Borcard and Legendre 2013).

Temporal comparisons of the benthic invertebrate community survey data were conducted to assess consistent type and direction of responses for all primary EEM metrics, including comparison of the magnitude of-effect (direction and size) for the primary EEM metrics between studies to assist with the determination of the path forward for the EEM program.

2.5 Fish Population Survey

2.5.1 General Approach

Maximum concentrations of MS-08 effluent in the Mary River Tributary-F receiving environment can be greater than 1% within 250 m from the point at which effluent enters the watercourse (Minnow 2020). Therefore, the MDMER required implementation of a fish population survey (Government of Canada 2019) as part of the 2nd EEM biological study. The fish population (fish) survey for the 2nd EEM biological study employed a Control-Impact sampling design targeting juvenile (non-YOY) arctic charr (*Salvelinus alpinus*). Historical baseline studies, the previous EEM fish survey, and this 2nd EEM biological study at the Project have indicated that arctic charr is the only fish species present within regional watercourses in adequate abundance to meet the sample sizes recommended for EEM fish population surveys, and that only juvenile arctic charr likely reside in watercourses that directly receive effluent from the Project (Baffinland 2012; Minnow 2018, 2020). Therefore, the fish survey for the 2nd EEM biological study targeted juvenile (non-YOY) arctic charr for the assessment of effects on fish. The fish survey included aspects of both traditional (lethal) and non-lethal sampling designs to reflect the occurrence of fish in non-reproductive condition (i.e., juveniles) and the consequent inability to visually identify the sex of individuals using either external or internal cues. The fish survey for the 2nd EEM biological study was conducted from the 16th to 19th of August 2020, which corresponded closely with the seasonal timing/dates used for the initial EEM fish population survey in 2017.

2.5.2 Study Areas

Fish sampling conducted during the initial EEM biological field study indicated that fish were absent from Mary River Tributary-F (Minnow 2018). An average gradient of 12% occurs through the lower 750 m of Mary River Tributary-F, including an approximately 1.75 m high barrier to fish located about 50 m upstream of Mary River on Mary River Tributary-F. Therefore, the absence of fish at Mary River Tributary-F was believed to reflect a combination of complete freezing of the watercourse over the winter, a high stream gradient, and the presence of natural in-stream barriers that prevent fish upstream migration into Mary River Tributary-F during the ice-free period.

As a result of the natural absence of fish from Mary River Tributary-F, two areas of Mary River were sampled during the initial EEM fish population survey: an MS-08 effluent-exposed area located approximately 2.0 km downstream of the confluence with Mary River Tributary-F, and a downstream reference area located near the Mary River outlet to Mary Lake approximately 10.8 km downstream of the Mary River Tributary-F confluence (Figure 2.1). The fish survey for the 2nd EEM biological study used the same Mary River near-field effluent-exposed area (MRE) and far-field area (MRR) as used during the initial EEM study (Table 2.4; Figure 2.3), in part to provide temporal continuity between studies. For the 2nd EEM biological study, an unnamed tributary of Angajurjualuk Lake (ALTR) was used as a second reference area for the fish population survey (Table 2.4; Figure 2.3), the selection of which followed a field reconnaissance survey in which three candidate reference areas were identified and proposed in the 2nd EEM Study Design (Minnow 2020). This Angajurjualuk Lake Tributary was selected as a second reference area due to comparable habitat features (Appendix B) and presence of juvenile arctic charr at comparable relative abundance to the Mary River effluent-exposed and/or reference

Table 2.4: Endpoints to be Examined for EEM Lethal and Non-Lethal Fish Population Survey

Response			Endpoint	Statistical Test[c,d,e]	Critical Effect Size
Lethal Comparisons	Effects on Fish[a]	Survival	Age	ANOVA	± 25%
			Age-frequency distribution	K-S Test	-
		Growth	Size-at-age (body weight against age)	ANCOVA	± 25%
		Reproduction	Relative gonad size (gonad weight against body weight)	ANCOVA	± 25%
		Energy Storage	Condition (body weight against length)	ANCOVA	± 10%
			Relative liver size (liver weight against body weight)	ANCOVA	± 25%
	Supporting Response Variables[b]	Growth	Size-at-age (length against age)	ANCOVA	± 25%
		Reproduction	Relative fecundity (# of eggs against body weight)	ANCOVA	± 25%
		Energy Storage	Relative egg size (mean egg weight against body weight)	ANCOVA	± 25%
Non-Lethal Comparisons	Effects on Fish[a]	Survival	Length-frequency distribution	K-S Test	-
		Growth	Length	ANOVA	± 25%
			Weight	ANOVA	± 25%
		Reproduction	Relative abundance of YOY (% composition)	None	-
		Energy Storage	Condition (body weight against length)	ANCOVA	± 10%

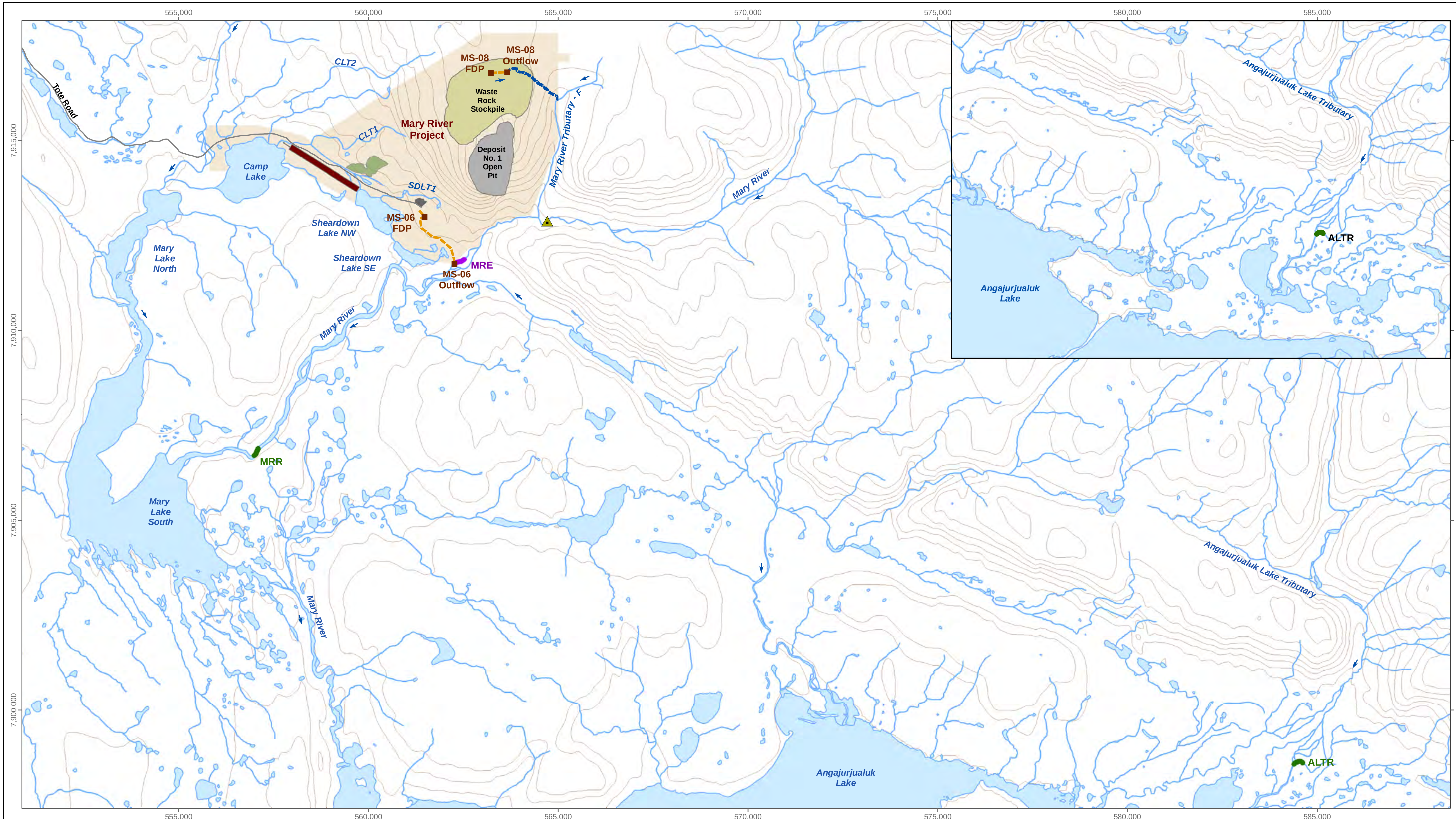
[a] Endpoints to be used for determining "effects" as designated by statistically significant differences between exposure and reference areas (Environment Canada 2012).

[b] These analyses are for informational purposes and significant differences between exposure and reference areas are not necessarily used to designate an effect (Environment Canada 2012).

[c] ANOVA (Analysis of Variance) used except for non-parametric data, where Mann Whitney U-test may be used to verify the results by ANOVA.

[d] ANCOVA (Analysis of Covariance). For the ANCOVA analyses, the first term in parentheses is the endpoint (dependent variable Y) that is analyzed for an effluent effect. The second term in parentheses is the covariate, X (age, weight, or length).

[e] K-S Test (Kolmogorov-Smirnov test).



LEGEND

Fish Survey Sampling Location
- Effluent-Exposed
- Reference
- Discharge Line
- Final Discharge Point (FDP)
- QMR2 Quarry
- Ultimate Deposit No. 1 Pit Limits
- Ultimate Waste Rock Stockpile Limits
- Mine Site Complex Pad
- Airstrip
- Mary River Project
- Contours (20 m)
- Tote Road

0 1.5 3 6 km

N E S W

Map Projection: UTM Zone 17 W NAD 1983
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Fish Survey Sampling Locations for the Mary River Project Second EEM, August 2020

Date: January 2021
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Figure 2.3

Document Path: C:\Users\MLaPalme\Trinity Consultants, Inc\Baffinland Iron Mines - 207202.0046 - Phase 2 EEM\4 - GIS\Report\20-46 Figure 2.3 Fish Survey Sampling Locations for the Mary River Project Second EEM.mxd areas versus the other candidate reference areas. No past or present mining activity has occurred within the Angajurjualuk Lake Tributary watershed. In addition, this watercourse is used as a water chemistry reference area under territorial Aquatic Effects Monitoring Program (AEMP) requirements, and thus a robust water quality record was available for this study area.

In response to an Action Item 4 stemming from the ECCC TAP review of the 2nd EEM Study Design (Appendix A), the feasibility of sampling Mary River in the immediate vicinity of the confluence with Mary River Tributary-F was assessed at the outset of fish population survey sampling of the effluent-exposed area in August 2020. As in the initial EEM study, no fish were collected or observed at this location in August 2020 based on limited backpack electrofishing effort. Fishing effort was limited at this area by difficult habitat conditions, including the occurrence of large boulder substrate adjacent to deep, fast-flowing water and high turbidity of the water limiting in-stream visibility, which together with the remote/difficult access to this area (i.e., this area has steep approach slopes, confounding use of radio communication, helicopter access, and emergency response in the event that an injury and/or swift water incident) present substantial safety concerns to personnel attempting to conduct such sampling. In addition, the habitat at this confluence is not comparable to that found at either the Angajurjualuk Lake Tributary reference area or the Mary River reference area. Therefore, the Mary River effluent-exposed area used for the fish population survey in the 2nd EEM biological study (Figure 2.2) was the same as that used for the initial EEM study.

2.5.3 Sample Sizes and Sampling Procedures

Consistent with EEM sample size requirements for non-lethal fish surveys, a minimum of 100 arctic charr juveniles older than young-of-the-year (referred to as non-YOY herein), which were the dominant age class, were targeted at each effluent-exposed and reference area (Table 2.4). These requisite sample sizes were adequate for the evaluation of differences in arctic charr size and condition based on power analyses conducted using data collected during the first EEM study and a CES of ±25% (size endpoints) or ±10% (condition endpoint), as applicable (Minnow 2018). Of the 100 non-YOY arctic charr collected at each study area, twenty (20) were sub-sampled lethally to allow evaluation of growth (size-at-age) and relative liver size (liver weight-at-body weight) endpoints. The presence of only juvenile arctic charr precluded the ability to separately assess the fish population by sex, and to implement a traditional lethal assessment that included reproductive endpoints (e.g., relative gonad weight). A minimum sample size of 20 was anticipated to be sufficient to detect a ±25% difference in growth and relative liver size endpoints based on Environment Canada (2012) recommendations for traditional lethal fish surveys.

Arctic charr were collected by an electrofishing team consisting of a backpack electrofisher operator and a single netter. 'Open' station sampling was conducted in an upstream direction at each study area. All fish captured at each open station were placed into buckets containing aerated water. At the conclusion of sampling at each station, total shocking effort (i.e., electrofishing seconds) was recorded to allow calculation of time-standardized catch, and station upstream and downstream boundaries were georeferenced using a handheld GPS unit. All captured fish were identified to species and enumerated. Arctic charr were retained for subsequent measures (see description below), and all non-target fish species were released at the area of capture once the requisite number of arctic charr were captured.

Arctic charr were processed on the shoreline at each study area shortly following collection. Measurements and observations collected from each individual fish were consistent with those recommended for the EEM program (Environment Canada 2012). Briefly, these included an initial visual evaluation of the external condition of each fish, measurement of fork and total length to the nearest millimetre using a standard measuring board, and measurement of fresh body weight to the nearest milligram using an analytical balance outfitted with a surrounding draft shield to achieve precision within one percent. Of the 100 non-YOY individuals collected at each study area, a sub-sample of 20 randomly chosen individuals were set aside for additional processing at a dedicated field laboratory as soon as possible following collection. The arctic charr not included in the sub-sampled set were placed in a bucket containing aerated water immediately following recording of the measurements indicated above and later, upon recovery to an upright, alert position, were released to the study area at which they were collected. The sub-sampled individuals were sacrificed for the collection of otolith aging structures, determination of relative liver weight, and for eight randomly sampled individuals, sampling for the fish tissue selenium survey (Section 2.6). At the field laboratory, the sub-sampled arctic charr were sacrificed using a decisive blow to the head. Fish length and weight were then measured, as described above. The body cavity of the individual was then opened and whole livers were removed and weighed to the nearest milligram (0.001 g) using an analytical balance outfitted with a surrounding draft shield. During processing, the sub-sampled arctic charr were inspected for internal abnormalities (e.g., parasites, lesions, tumours, etc.) with appropriate descriptions recorded. The fish carcasses from these individuals were then placed in labelled bags, and upon return from the field, frozen for later removal of age structures and sampling for the tissue selenium survey (see Section 2.6), as applicable.

2.5.4 Laboratory Sample Analyses

Arctic charr age determination samples were shipped to North Shore Environmental Services (NSES; Thunder Bay, ON) for otolith removal and processing at the completion of the field program. Otoliths were used as the primary aging structure, with pectoral fin rays used as back-up and/or confirmatory age structures. Otoliths were prepared using a "crack-and-burn" method, which involves cracking the otoliths in half through the center and then lightly charring the cracked otolith to make the annuli visible. Pectoral fin rays were processed by embedding the cleaned structures in an epoxy resin and, after the epoxy had hardened, sectioning the structures near the base. Otolith and pectoral fin ray sections were then mounted on a glass slide using a mounting medium and aged (i.e., annuli were counted) under a compound microscope using transmitted light. For each structure, the age and edge condition were recorded along with a confidence rating for the age determination.

2.5.5 Data Analysis

Fish community sampling data were tabulated, and electrofishing catch-per-unit-effort (CPUE) was calculated separately for each effluent-exposed and reference study area. The electrofishing CPUE was calculated as the number of fish captured per electrofishing minute. Analysis of the fish community sampling data included comparisons of total fish species richness, total number of fish captured, and total CPUE among study areas. In addition, temporal comparison of fish assemblage and relative abundance (i.e., CPUE) was conducted for the Mary River study areas to evaluate potential changes in fish community features between the first and second EEM studies.

Data analysis methods followed those recommended for EEM fish population surveys (Environment Canada 2012). The initial analysis included plotting of length-frequency distributions so that, together with aging data, young-of-the-year (YOY) individuals could be distinguished from non-YOY individuals. Summary statistics including mean, median, minimum, maximum, standard deviation, standard error, and sample size were calculated separately by study area (effluent-exposed and reference) for endpoints of age, length, weight, and liver weight for non-YOY individuals by study area.[9] The endpoints indicated above were used to assess differences in arctic charr survival, growth, and energy storage between the effluent-exposed and reference areas using methods consistent with EEM recommendations for lethal and non-lethal assessments, as appropriate (Table 2.4; Environment Canada 2012). Briefly, length-frequency distributions were compared using a non-parametric, two-sample, Kolmogorov-Smirnov goodness of fit test. Non-YOY arctic charr age and body measurements of length and fresh weight were $\log_{10}$ transformed and then compared between the effluent-exposed area and each reference area separately using ANOVA. These data were evaluated for normality and

[9] No young-of-the-year arctic charr were captured at any of the effluent-exposed or reference areas, precluding summation of the measurements indicated here for this age class as required under the non-lethal EEM fish population survey outlined in Technical Guidance (Environment Canada 2012), and evaluation of differences in reproduction.

homogeneity of variance before applying parametric statistical procedures. In cases where data did not meet the assumptions of ANOVA despite $\log_{10}$ transformation, non-parametric Mann-Whitney U-tests were performed to test for between-area differences for these endpoints. Growth (i.e., weight-at-age, age, length-at-age), relative liver weight, and condition (body weight-at-fork length) endpoints were compared between study areas using Analysis of Covariance (ANCOVA) following accepted approaches as described in available technical guidance (Table 2.4; Environment Canada 2012).

An effect on the fish population, defined as a statistically significant difference between an effluent-exposed area and a reference area at an alpha level of 0.10 (Environment Canada 2012), was evaluated for each of the EEM effect endpoints (Table 3.4). For endpoints showing significant area differences, the magnitude of difference between the effluent-exposed and reference areas was calculated as described in the MDMER using mean (for ANOVA) and adjusted mean (for ANCOVA with no significant interaction) values, or as described by Environment Canada (2012) using predicted values (for ANCOVA with significant interaction), as applicable. Similar to CES applied to the benthic survey, a magnitude of difference of ± 25% for endpoints of survival, growth, and relative liver size, and a magnitude of difference of ± 10% for condition, were used as fish population survey CES applicable for defining ecologically relevant differences between study areas (Table 2.4; Munkittrick et al. 2009; Government of Canada 2019).

Finally, *a priori* power analyses were completed to determine appropriate sample sizes for future fish population surveys as recommended by Environment Canada (2012). The power analyses were completed based on the mean square error values generated during the ANOVA or ANCOVA procedures calculated with alpha and beta equal to 0.10. Two main assumptions underlie the power analyses that were conducted. The first assumption was that the fish caught in each of the effluent-exposed and reference areas were representative of the population at large (i.e., similar distribution and variance with respect to the parameters examined). The second assumption was that the characteristics of the populations would not change substantially prior to the next EEM study. The power analysis results were reported as the minimum sample size (number of fish/area) required to detect a given magnitude of difference (effect size) between the effluent-exposed and reference area populations for each effect endpoint.

Temporal comparisons of the fish survey data were conducted, including comparison of the magnitude of-effect (direction and size) for the primary EEM metrics between studies to assist with the determination of the path forward for the EEM program.

2.6 Fish Tissue Selenium Survey

2.6.1 General Approach

Concentrations of selenium in MS-08 effluent were above the EEM individual sampling event trigger for conducting a fish tissue selenium study as defined in the MDMER (i.e., concentrations of selenium in effluent were equal to or above 10 µg/L) on two occasions in 2018 (Section 3.1; Minnow 2020). Therefore, Baffinland was required to conduct a study respecting fish tissue selenium as defined in the MDMER for the 2nd EEM biological study. Notably, the concentration of selenium in MS-06 effluent was consistently below the applicable EEM triggers for conducting a study respecting fish tissue selenium in all years that effluent was released from this final discharge point (Section 3.1).

The objective of the fish tissue selenium survey was to determine whether fish tissue selenium concentrations differed between the effluent-exposed and reference areas, and to evaluate fish tissue selenium concentrations relative to appropriate aquatic life criteria. The fish tissue selenium survey was implemented using a standard Control-Impact design and focused on comparisons of fish tissue selenium concentrations among the same Mary River near-field effluent-exposed area, Mary River downstream reference area, and selected Angajurjualuk Lake tributary second reference area used for the fish population survey (Figure 2.3; Table 2.4; Section 2.5). Arctic charr was the only fish species captured in sufficient abundance at these effluent-exposed and reference areas, and thus served as the target (sentinel) fish species for the fish tissue selenium survey. A minimum sample size of eight (8) arctic charr was targeted from each effluent-exposed and reference area (Table 2.4). The fish tissue selenium survey was conducted from the 16th to 19th of August 2020, concurrent with the implementation of the field study for the 2nd EEM fish population survey (Section 2.5).

2.6.2 Sample Collection and Processing

Arctic charr tissue selenium samples were collected from the sub-set of individuals sacrificed for acquisition of aging and relative liver size endpoints at each study area as part of the fish population survey (see Section 2.5.3). From each sub-set of arctic charr, eight (8) individuals were selected for the collection of muscle tissue for selenium analysis. To the extent possible, arctic charr of similar lengths from the sub-set of sacrificed individuals were sampled within and among the near-field effluent-exposed and reference study areas. Each individual used for the fish tissue selenium survey was subject to measurement of length (fork and total) and weight, examination for external and internal abnormalities, and determination of liver weight in the field as described previously (Section 2.5.3). Carcasses of these fish, which were frozen upon return from the field, were used for age structure and muscle tissue sampling at a dedicated laboratory upon completion of the EEM biological field study. Samples for tissue selenium analysis were taken from partially thawed individuals and, using clean implements (cutting boards, fillet knives, and forceps), a boneless and skinless muscle tissue sample was collected from each individual. The tissue samples were placed in labelled sample bags and subsequently frozen. Upon completion of the sampling program, tissue samples were submitted frozen to a qualified laboratory (ALS, Waterloo, ON) for percent moisture determination and total metal (including selenium) concentration analyses using standard analytical methods. The tissue selenium concentrations were presented in both wet weight and dry weight concentrations. The remaining portion of the carcasses were placed back into the original sample collection bags, re-frozen, and together with those samples not assessed for tissue selenium, shipped to NSES for removal and aging of appropriate aging structures (otoliths and pectoral fin rays; Section 2.5.4).

2.6.3 Data Analysis

Fish tissue selenium concentrations were compared statistically between the near-field effluent-exposed and each individual reference area, as well as to applicable chronic effects criteria for selenium. Statistical testing with ANOVA was used to assess for significant differences in concentrations of selenium in arctic charr muscle tissue samples between the effluent-exposed and reference study areas. Each data set was assessed for normality and equality of variance, and transformed as required, prior to applying any parametric statistical procedures. If data significantly violated the assumption of normality following transformation, non-parametric statistics were applied using rank transformed data. Similarly, in instances in which variances of normal data could not be homogenized by transformation, Student's t-tests were applied assuming unequal variance using either raw or transformed data to confirm the ANOVA statistical results. The determination of effects on fish tissue associated with selenium concentrations was assessed as a significantly higher tissue selenium concentration, coupled with muscle tissue selenium concentrations exceeding the USEPA (2016) chronic effects criterion (11.3 mg/kg dry weight [dw]), at the near-field effluent-exposed area compared to individual reference areas

3 EFFLUENT QUALITY AND SUBLETHAL TOXICITY

3.1 Effluent Volume and Quality

Effluent discharge from the primary FDP, MS-08, over the 2nd EEM period occurred from June to September in 2018, from June to October in 2019, and from June to August in 2020 (Figure 3.1), corresponding to the usual open-water period for non-coastal areas of the Mary River Project region. The total monthly volume of effluent discharge ranged from approximately 931 to 45,870 cubic metres (m^3) over this period (Figure 3.1). Notably, effluent was released intermittently on an as-needed basis, generally resulting in continuous discharge in 2018 and 2019 through the open-water period and discharge periods ranging from one to 12 days in 2020 (Appendix Table C.1). Cumulative volumes of effluent discharged to the receiving environment were considerably higher in 2019 than in the other two years of the 2nd EEM period (Figure 3.1). Effluent was also discharged from the MS-06 FDP, however discharge volumes were substantially less than for the MS-08 FDP, and ranged from 263 to 1,582 m^3 on an intermittent frequency over the 2nd EEM period from 2018 to 2020 (Appendix Figure C.1; Appendix Table C.2).

Final effluent at MS-08 met MDMER authorized pH limits and monthly mean and grab-sample concentration limits for all deleterious substances in 2018, 2019, and 2020, except for Total Suspended Solids (TSS) samples collected in June and September 2019 (Table 3.1; Appendix Tables C.3 to C.5). Final effluent at MS-06 met all MDMER authorized pH limits and monthly mean and grab-sample concentration limits for deleterious substances in 2018, 2019, and 2020 (Table 3.2; Appendix Tables C.6 to C.8). Effluent monitoring indicated that individual grab-sample mercury concentrations were well below the 0.10 µg/L trigger for an EEM fish tissue mercury survey over the 2nd EEM period for both the MS-08 and MS-06 final effluent discharges (Appendix Tables C.3 to C.5, and C.6 to C.8). However, concentrations of selenium in MS-08 effluent were above the MDMER individual sampling event trigger for conducting a fish tissue selenium survey (i.e., equal to or above 10 µg/L) on two occasions in 2018 (Minnow 2020). Final effluent at MS-08 and MS-06 was consistently non-acutely lethal to rainbow trout (*Oncorhynchus mykiss*) from 2018 to 2020, and except for a single test in 2018 conducted using MS-08 effluent, was not acutely lethal to *Daphnia magna* over the 2nd EEM period (Tables 3.1 and 3.2).

Effluent quality at Station MS-08 showed high variability in annual average concentrations of parameters from year to year, with no clear changes apparent between the initial EEM and 2nd EEM periods apart from nitrate concentrations, which were consistently higher during the current 2nd EEM period (Appendix Table C.11). On average, concentrations of most parameters were

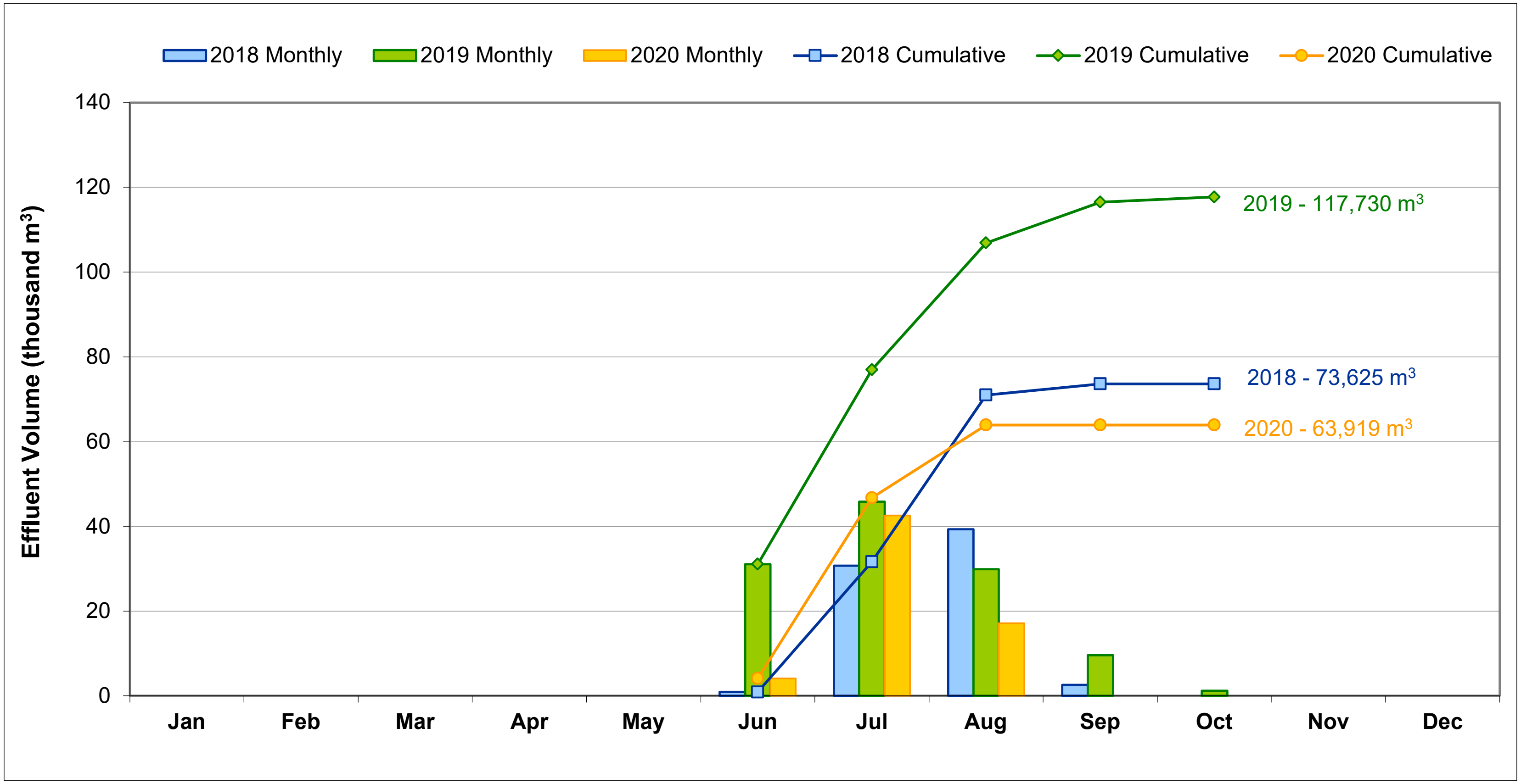


Figure 3.1: Mary River Project Average Monthly and Cumulative Effluent Discharge at Station MS-08 for the Second EEM Study Period (2018 to 2020)

Table 3.1: Summary of Routine MDMER and Effluent Characterization Data at Station MS-08[a], Mary River Project Second EEM Study, 2018 to 2020

	Analyte	Units	MMER Monthly Mean Limit [d]	2018				2019					2020		
				June	July	August	September	June	July	August	September	October	June	July	August
Monthly Average Routine Monitoring [b]	Total Monthly Volume	m^3	-	931	30,720	39,348	2,626	31,088	45,870	29,920	9,618	1,234	4,152	42,587	17,180
	pH (lab)	pH units	6.0 to 9.5	8.89	8.28 to 9.16	8.57 to 9.23	8.76	6.43 to 7.81	7.00 to 8.92	7.46 to 8.89	6.91 to 8.47	8.79	7.16	7.24 to 7.60	7.42 to 8.49
	Total Suspended Solids	mg/L	15	6.4	5.8	10.5	10.8	15.5	9.2	10.0	35.3	6.0	3.9	5.2	7.5
	Arsenic (As)	mg/L	0.5	0.00050	0.00050	0.00050	0.0050	0.00040	0.00050	0.00160	0.00050	0.00050	0.00010	0.00070	0.00072
	Copper (Cu)	mg/L	0.30	0.0050	0.0080	0.0192	0.0500	0.0045	0.0068	0.0163	0.0050	0.0050	0.00151	0.00395	0.00721
	Lead (Pb)	mg/L	0.20	0.00025	0.00025	0.00025	0.0025	0.00040	0.00030	0.00080	0.0012	0.00030	0.00008	0.00042	0.00037
	Nickel (Ni)	mg/L	0.50	0.0153	0.0287	0.0359	0.025	0.0531	0.0209	0.0250	0.0533	0.0071	0.0203	0.0283	0.0297
	Zinc (Zn)	mg/L	0.50	0.0150	0.0150	0.0150	0.150	0.0134	0.0150	0.0488	0.0150	0.0150	0.0015	0.0211	0.0215
	Radium-226	Bq/L	0.37	0.048	0.258	0.0294	0.032	0.0077	0.039	0.052	0.014	0.018	0.007	0.012	0.011
Acute Toxicity	Rainbow trout [e]	Pass/Fail	NL	-	NL	NL	NL	NL	NL	NL	NL	NL	NL	NL	NL
	Daphnia magna [e]	Pass/Fail	-	-	NL	NL	L	NL	NL	NL	NL	NL	NL	NL	NL
Effluent Characterization [c]	Specific Conductance (lab)	µS/cm	-	-	3,360	5,010	-	712	4,180	-	-	5,040	473	-	1,955
	Hardness	mg/L	-	-	2,520	4,120	-	375	3,260	-	-	3,990	225	-	1,205
	Alkalinity	mg/L	-	-	37.0	57.0	-	<10	15.0	-	-	39.0	10.6	-	42.5
	Ammonia (NH_3)	mg/L	-	-	2.90	2.98	-	0.425	6.98	-	-	3.79	0.609	-	0.783
	Nitrate (NO_3)	mg/L	-	-	6.50	18.7	-	1.76	21.2	-	-	16.7	3.85	-	23.9
	Phosphorus (P)	mg/L	-	-	<0.030	<0.0030	-	0.0096	<0.0030	-	-	<0.0030	<0.050	-	0.253
	Sulphate (SO_4)	mg/L	-	-	2,340	4,930	-	375	3,070	-	-	4,070	200	-	1,070
	Chloride (Cl)	mg/L	-	-	6.51	12.0	-	1.38	14.0	-	-	17.2	3.5	-	16.5
	Aluminum (Al)	mg/L	-	-	<0.050	0.088	-	0.531	<0.050	-	-	0.0820	0.0853	-	0.200
	Cadmium (Cd)	mg/L	-	-	<0.000050	<0.000050	-	0.000059	<0.000050	-	-	<0.000050	0.0000375	-	0.0000595
	Chromium (Cr)	mg/L	-	-	<0.00050	0.00058	-	0.00130	<0.0050	-	-	<0.0050	0.00016	-	<0.0050
	Cobalt (Co)	mg/L	-	-	<0.00010	<0.00010	-	0.0405	0.0097	-	-	0.0050	0.0149	-	0.0243
	Iron (Fe)	mg/L	-	-	1.66	4.04	-	2.65	1.56	-	-	0.420	0.178	-	0.370
	Manganese (Mn)	mg/L	-	-	5.59	6.92	-	2.79	8.57	-	-	1.12	0.962	-	2.91
	Mercury (Hg)	mg/L	0.00010	-	<0.000010	<0.000010	-	<0.000010	<0.0000050	-	-	<0.0000050	<0.0000050	-	0.0000050
	Molybdenum (Mo)	mg/L	-	-	<0.00050	<0.00050	-	0.000536	<0.00050	-	-	0.00141	0.00129	-	0.00233
	Selenium (Se)	mg/L	-	-	0.00430	0.00956	-	0.00113	0.00674	-	-	0.00642	0.000926	-	0.00427
	Thallium (Tl)	mg/L	-	-	0.00015	0.00017	-	0.000026	0.00026	-	-	<0.00010	0.000011	-	<0.00010
	Uranium (U)	mg/L	-	-	0.00014	0.00073	-	0.000407	0.00019	-	-	0.0019	0.000525	-	0.00551

[shaded box] Indicates monthly mean value above applicable limit for deleterious substances, mercury concentration above fish usability assessment trigger value, *or* acute toxicity test failure based on individual test result.

[a] In cases where analyte concentrations were less than Method Detection Limits (MDL), the MDL was used for calculation of mean values. Appendix C provides raw data.

[b] Deleterious substances and pH as defined under Schedule 4 of the MMER (Government of Canada 2020).

[c] Required effluent characterization and site-specific parameters as defined under Schedule 5 of the MMER (Government of Canada 2020).

[d] Limits indicated refer to maximum authorized monthly mean concentrations as per MMER except mercury, where the limit provided is the grab concentration trigger for conducting a fish tissue survey for EEM.

[e] Indicates that all acute toxicity tests must 'pass' test criteria (i.e., an effluent at 100% concentration that kills less than 50% of test organisms over a 96-hour [rainbow trout] or 48-hour [*D. magna*] period when tested in accordance with Environment Canada protocols). "NL" refers to a non-lethal 'pass' test result, "L" refers to a lethal 'failure' test result.

Table 3.2: Summary of Routine MMER and Effluent Characterization Data at Station MS-06[a], Mary River Project Second EEM Study, 2018 to 2020

	Analyte	Units	MMER Monthly Mean Limit [d]	2018			2019		2020
				June	July	August	August	September	August
Monthly Average Routine Monitoring [b]	Volume	m^3	-	622	1,582	783	602	1,059	263
	pH (lab)	pH units	6.0 to 9.5	7.52 to 7.65	7.55 to 7.78	6.84 to 7.46	7.01	7.08	7.28
	Total Suspended Solids	mg/L	15	4.2	2.9	2.6	4.7	2.7	4.0
	Arsenic (As)	mg/L	0.5	0.00012	0.0002	0.0001	0.00050	0.00050	0.00060
	Copper (Cu)	mg/L	0.30	0.0009	0.0016	0.003	0.0050	0.0050	0.00300
	Lead (Pb)	mg/L	0.20	0.00015	0.0001	0.000162	0.00030	0.00030	0.00030
	Nickel (Ni)	mg/L	0.50	0.0092	0.0081	0.0151	0.0969	0.0944	0.0355
	Zinc (Zn)	mg/L	0.50	0.0070	0.008	0.0041	0.0150	0.0150	0.0180
	Radium-226	Bq/L	0.37	0.009	0.014	0.010	0.013	0.023	0.010
Acute Toxicity	Rainbow trout [e]	Pass/Fail	NL	NL	NL	NL	NL	NL	NL
	Daphnia magna [e]	Pass/Fail	-	NL	NL	NL	NL	NL	NL
Effluent Characterization [c]	Specific Conductance (lab)	µS/cm	-	-	1,160	-	2,220	-	1,590
	Hardness	mg/L	-	385	644	-	1,430	-	917
	Alkalinity	mg/L	-	31.0	41.0	-	<10	-	13.0
	Ammonia (NH_3)	mg/L	-	0.308	0.042	-	2.72	-	0.272
	Nitrate (NO_3)	mg/L	-	4.06	6.17	-	10.2	-	14.9
	Phosphorus (P)	mg/L	-	<0.030	1.74	-	<0.0030	-	<0.50
	Sulphate (SO_4)	mg/L	-	314	572	-	1,390	-	952
	Chloride (Cl)	mg/L	-	12.8	21.5	-	26.9	-	22.8
	Aluminum (Al)	mg/L	-	0.154	<0.050	-	<0.050	-	0.068
	Cadmium (Cd)	mg/L	-	0.000027	<0.000050	-	0.000339	-	0.000206
	Chromium (Cr)	mg/L	-	-	-	-	<0.0050	-	<0.0050
	Cobalt (Co)	mg/L	-	<0.0050	0.0037	-	0.0895	-	0.010
	Iron (Fe)	mg/L	-	0.509	0.110	-	0.140	-	0.160
	Manganese (Mn)	mg/L	-	1.11	1.60	-	14.1	-	7.87
	Mercury (Hg)	mg/L	0.00010	<0.000010	<0.000010	-	<0.0000050	-	<0.0000050
	Molybdenum (Mo)	mg/L	-	0.000501	0.00082	-	<0.00050	-	0.00113
	Selenium (Se)	mg/L	-	0.000899	0.00126	-	0.00223	-	0.00210
	Thallium (Tl)	mg/L	-	0.000020	<0.00010	-	0.00015	-	0.00010
	Uranium (U)	mg/L	-	0.00191	0.0013	-	0.00012	-	0.00269

[grey box] Indicates monthly mean value above applicable limit for deleterious substances, mercury concentration above fish usability assessment trigger value, *or* acute toxicity test failure based on individual test result.

Note: "-" indicates data not available.

[a] In cases where analyte concentrations were less than Method Detection Limits (MDL), the MDL was used for calculation of mean values. Appendix C provides raw data.

[b] Deleterious substances and pH as defined under Schedule 4 of the MMER (Government of Canada 2020)

[c] Required effluent characterization and site-specific parameters as defined under Schedule 5 of the MMER (Government of Canada 2020)

[d] Limits indicated refer to maximum authorized monthly mean concentrations as per MMER except mercury, where the limit provided is the grab concentration trigger for conducting a fish tissue survey for EEM.

[e] Indicates that all acute toxicity tests must 'pass' test criteria (i.e., an effluent at 100% concentration that kills less than 50% of test organisms over a 96-hour [rainbow trout] or 48-hour [*D. magna*] period when tested in accordance with Environment Canada protocols). "NL" refers to a non-lethal 'pass' test result, "L" refers to a lethal 'failure' test result.

higher from 2017 to 2019 than in 2015, 2016, and 2020 (Appendix Table C.11). Parameter concentrations in the MS-08 effluent in 2020 were generally within the range of those shown from 2015 to 2019, and thus reflect intermediate conditions in terms of effluent quality.

3.2 Effluent Sublethal Toxicity

Sublethal toxicity tests conducted using MS-08 final effluent samples over the 2nd EEM period showed no adverse effects on survival or growth of fathead minnow (*Pimephales promelas*), survival of *Ceriodaphnia dubia*, or on growth of the green alga, *Pseudokirchneriella subcapitata* (Table 3.3). *Ceriodaphnia dubia* reproduction was affected at effluent effect concentrations of 27 to 40% in samples collected in 2018 and 2019 (Table 3.3). Duckweed (*Lemna minor*) growth inhibition was observed in most tests using the MS-08 effluent, with reduced frond weight and frond production occurring at effluent effect concentrations ranging from approximately 66% to 80% and 27% to 36%, respectively, in all tests conducted except the August 2018 and 2020 samples in which no toxicity was reported (Table 3.3).

Maximum concentrations of MS-08 effluent at Mary River Tributary-F and Mary River were previously estimated as 2.6% and 0.04%, respectively, based on extrapolation of effluent discharge volumes and watershed hydrology data collected in 2015 (Section 4.1, Minnow 2016). Because the minimum effluent effect concentration for *C. dubia* and *L. minor* (i.e., 27%) was well above the concentration of effluent expected in Mary River Tributary-F, no toxicity to representative planktonic invertebrates or macrophytes was likely in the MS-08 effluent receiving environment. Notably, no aquatic vascular plants were observed at effluent-exposed and reference areas of both Mary River Tributary-F and Mary River during the EEM field study (Appendix B).

Temporal comparisons of the effluent sublethal toxicity test data suggested that, based on geometric mean effluent effect concentrations by EEM period, no toxicity to fathead minnow or the alga *P. subcapitata* has occurred over the first and second EEM periods (Table 3.3 and Appendix Table C.12). Although a lower geometric mean effluent effect concentration was shown for *C. dubia* reproduction in the 2nd EEM period compared to previously, higher geometric mean effluent effect concentration was shown for duckweed frond increase in the most recent EEM period (Table 3.3 and Appendix Table C.12).

Table 3.3: Sublethal Toxicity Test Effluent Effect Concentration Results (% effluent)[a] using Mary River Project Final Effluent (Station MS-08), 2018 to 2020

Study Period	Sample Date	Fathead Minnow		*Ceriodaphnia dubia*		*Lemna minor*		*Pseudokirchneriella subcapitata*
		Survival LC_{50}	Growth IC_{25}	Survival LC_{50} [a]	Reproduction IC_{25} [a]	Dry Weight IC_{25}	Frond Increase IC_{25}	Growth IC_{25}
Second EEM	03-Jul-18	>100	>100	>100	35	80	36	> 91
	21-Aug-18	>100	>100	>100	40	>97	>97	> 91
	17-Jun-19	>100	>100	>100	37	66	36	>91
	22-Jul-19	>100	>100	>100	27	70	31	>91
	28-Jun-20	-	-	-	-	-	27	-
	18-Aug-20	-	-	-	-	-	>97	-
	Geometric Mean	**100**	**100**	**100**	**34**	**77**	**47**	**> 91**

Note: "-" indicates test not required. Sublethal toxicity testing was reduced to *Lemna minor* only following the promulgation of the MDMER on June 1st 2018.

[a] LC_{50} is the effluent concentration causing 50% mortality among tested organisms; IC_{25} is the effluent concentration causing a 25% inhibition/reduction in endpoint compared to the control group for the organism tested.

4 WATER QUALITY

4.1 Mary River Tributary-F

In situ water temperature was significantly lower at the effluent-exposed area than at the reference area of Mary River Tributary-F at the time of the August 2020 EEM biological field study (Figure 4.1; Appendix Tables D.1 and D.2). The difference in water temperature between areas likely reflected natural influences of warming ambient air temperature between morning effluent-exposed area and afternoon reference area sampling on the day of sampling. Dissolved oxygen concentrations did not differ significantly between the Mary River Tributary-F effluent-exposed and reference study areas[10], and were well above the WQG[11] lowest acceptable concentration for sensitive early life stages of cold water biota (i.e., 9.5 mg/L) at both study areas (Figure 4.1; Appendix Tables D.1 and D.1). Although pH was significantly lower at the effluent-exposed area than at the reference area of Mary River Tributary-F, the mean incremental difference in pH between areas was very small (i.e., 0.13 units) and pH values were well within the WQG acceptable range for the protection of aquatic life (Figure 4.1; Appendix Tables D.1 and D.2). As a result, the difference in pH between the Mary River Tributary-F effluent-exposed and reference areas was likely not ecologically meaningful.

Specific conductance was significantly higher at the effluent-exposed area than at the reference area of Mary River Tributary-F at the time of the August 2020 EEM field study, indicating an effluent-related influence on water quality of the tributary (Figure 4.1; Appendix Tables D.1 and D.2). Extrapolation of field measured specific conductance at the benthic invertebrate community effluent-exposed and reference areas and the specific conductance of the MS-08 effluent discharge from the same day (i.e., 3,000 µS/cm) was used to provide an estimate of average effluent concentration in the immediate receiving environment. The corresponding average proportion of effluent at the Mary River Tributary-F effluent-exposed area below the effluent channel confluence was estimated as 2.6% at the time of benthic invertebrate community sampling. At distances of 100 m and 250 m downstream of the effluent channel confluence on Mary River Tributary-F, effluent concentrations of 3.0% and 2.9% were estimated, respectively, at the time of benthic invertebrate community sampling using the same methods described above. These effluent concentrations were higher than the effluent concentration range

[10] When comparing dissolved oxygen between study areas, dissolved oxygen saturation was deemed a more informative metric as it accounts for potential differences in water temperature. Dissolved oxygen measured in units of mg/L was also provided to allow comparison to water quality guidelines.

[11] Canadian Environmental Quality Guidelines (CCME 1999, 2017) were used as the primary source for WQG. For parameters in which no CCME guideline was available, Ontario Provincial Water Quality Objectives (OMOEE 1994) or British Columbia Water Quality Guidelines (BCMOE 2017) were used as WQG.

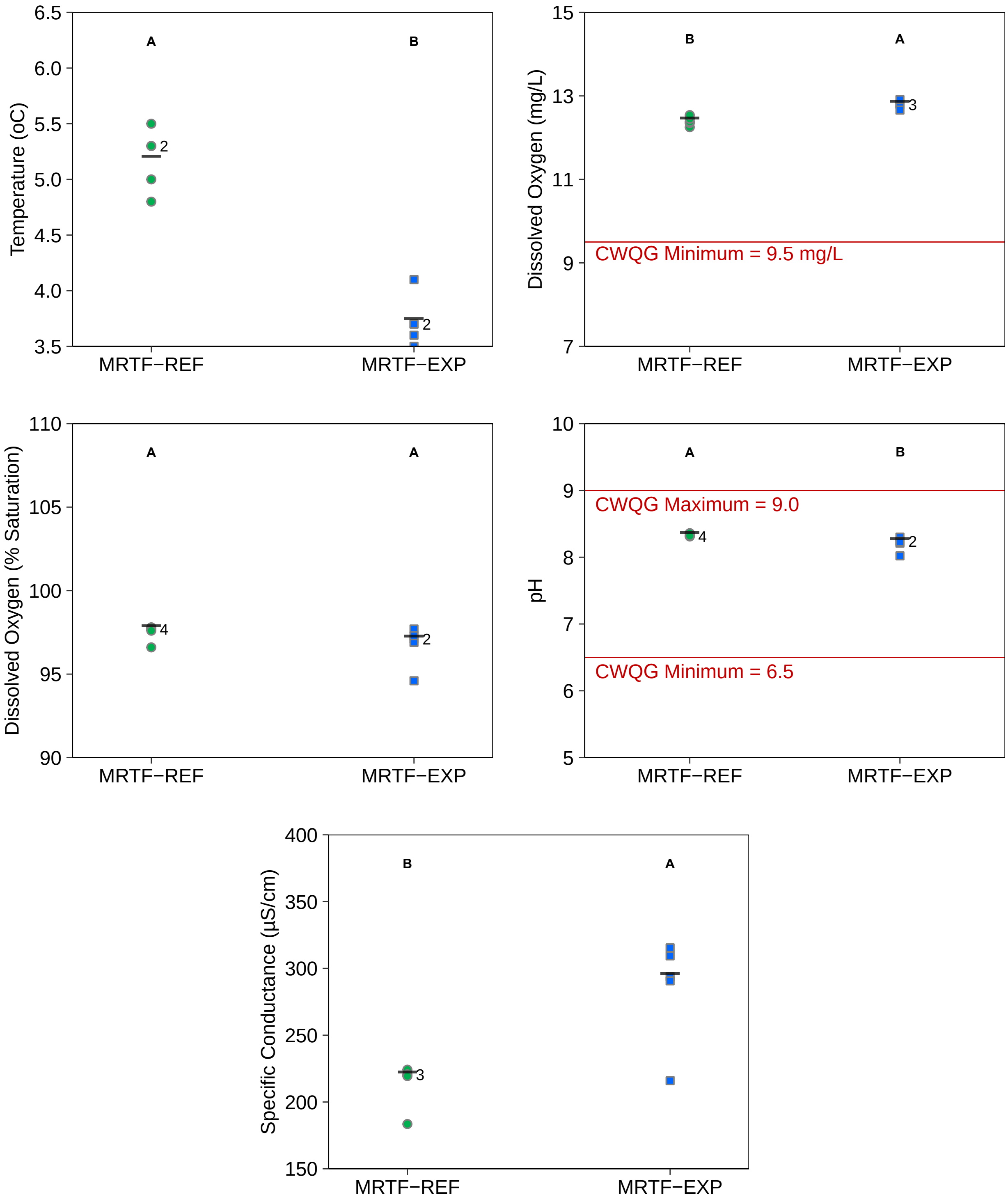


Figure 4.1: Comparisons of *In Situ* Water Quality Measured at Mary River Tributary-F Mine −Exposed (MRTF−EXP) and Reference (MRTF−REF) Benthic Invertebrate Community Sampling Areas, Mary River Project Second EEM Study, August 2020

Notes: Areas that share a letter do not differ significantly (a=0.1). Horizontal bars indicate measures of central tendency (i.e., mean). Numbers indicate the number of overlapping points.

of 0.03 and 1.3% estimated by Minnow (2016) for the immediate mine receiving environment using watershed discharge rates pro-rated from six stream gauging stations monitored at the Project and average MS-08 effluent discharge volume.

Water chemistry of the Mary River Tributary-F at the time of biological sampling in August 2020 showed slightly elevated (i.e., approximately three- to five-fold higher) concentrations of chloride, nitrate, and TSS, and moderately elevated (i.e., five- to ten-fold higher) concentrations of sulphate at the effluent-exposed area compared to the upstream reference area (Appendix Table D.6). However, concentrations of these parameters and all others were all well below applicable water quality criteria at the effluent-exposed and reference area of Mary River Tributary-F at the time of benthic invertebrate community sampling in August 2020 (Appendix Table D.6). Water chemistry monitoring conducted outside of EEM in the lower portion of Mary River Tributary-F (Station FO-01) to meet territorial regulatory requirements in 2019 and 2020 showed that concentrations of total aluminum and total phosphorus can be above applicable water quality guidelines on occasion downstream of the effluent channel that receives the MS-08 discharge (Appendix Tables D.4 and D.5). Overall, only a minor influence on water quality was indicated at Mary River Tributary-F due to the MS-08 effluent discharge at the time of EEM biological sampling, reflected as slightly elevated specific conductance and concentrations of chloride, nitrate, sulphate, and TSS, but consistently meeting applicable water quality guidelines.

4.2 Mary River

In situ water temperature and dissolved oxygen concentrations at the Mary River effluent-exposed area did not differ significantly from those measured at the Mary River reference area at the time of the August 2020 EEM fish population field study (Figure 4.2). In addition, dissolved oxygen concentrations at each of these study areas were well above the WQG lowest acceptable concentration for early life stages of cold-water biota (i.e., 9.5 mg/L; Figure 4.2). The pH at the Mary River fish population survey effluent-exposed area was significantly higher than at the reference area, but the mean incremental difference in pH between areas was very small (i.e., 0.13 units). The effluent-exposed area pH was also well within the WQG range considered protective of aquatic life (Figure 4.2) and therefore the difference in pH between the Mary River fish population survey effluent-exposed and reference study areas was not likely to be ecologically meaningful. Specific conductance was also slightly, but significantly, higher at the Mary River fish population survey effluent-exposed area than at the reference area at the time of the EEM biological field study (Figure 4.1). The occurrence of slightly higher specific conductance at the effluent-exposed area was consistent with previous estimates of effluent concentrations in Mary River, which indicated that effluent was likely to constitute less than 0.1% of flow in Mary River (Minnow 2016).

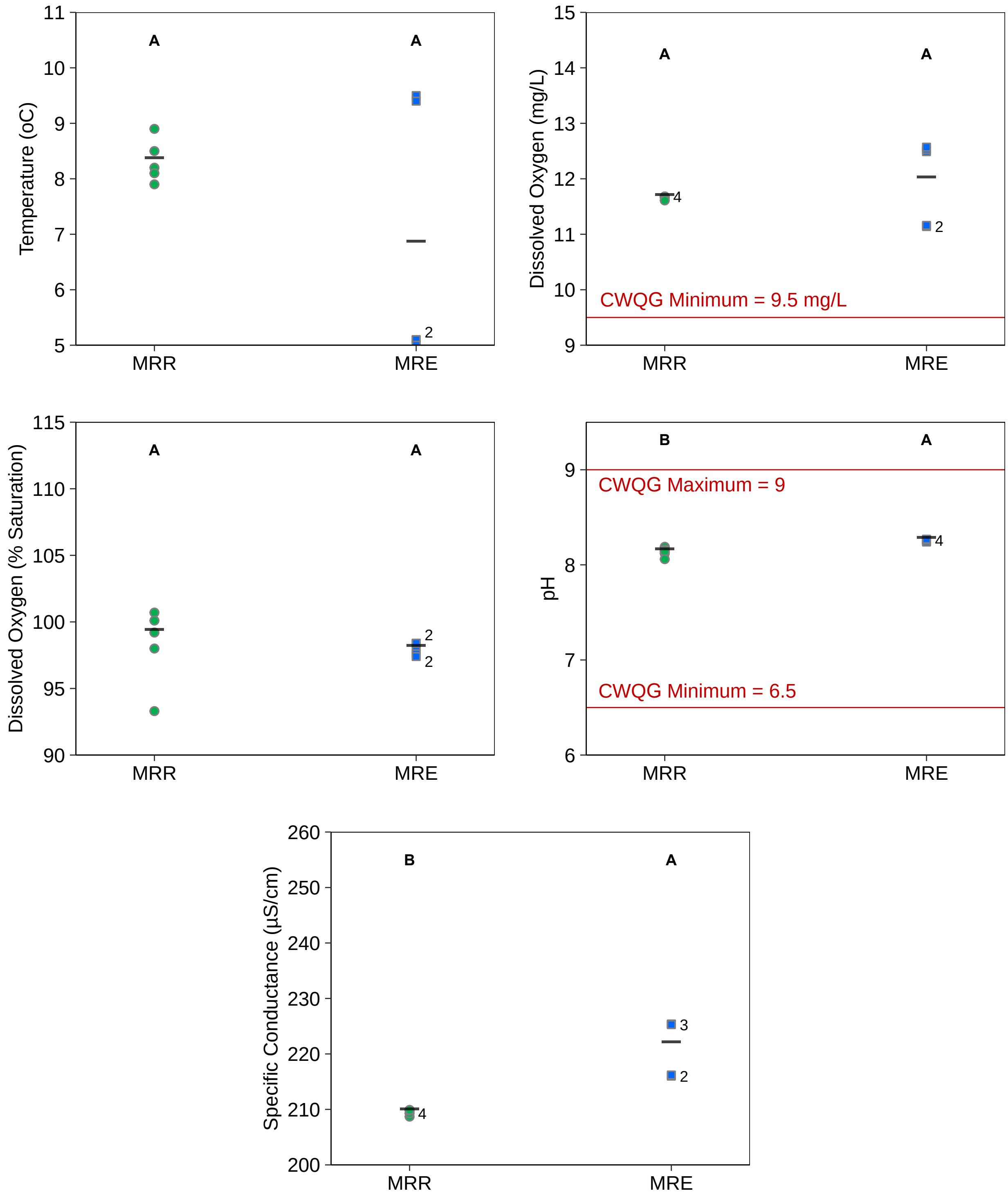


Figure 4.2: Comparisons of *In Situ* Water Quality Measured at Mary River Mine−Exposed (MRE) and Reference (MRR) Fish Survey Areas, Mary River Project Second EEM Study, August 2020

Notes: Areas that share a letter are not significant (a=0.1). Bars indicate measures of central tendency. Numbers indicate the number of overlapping points.

Water quality monitoring at Mary River EEM stations (MS-08-US and MS-08-DS) indicated similar annual average water chemistry upstream and downstream of the Mary River Tributary-F confluence over the 2nd EEM period (i.e., 2018 to 2020; Table 4.1). On average, total concentrations of aluminum (2018, 2019, 2020) and iron (2019, 2020) were above respective WQG at the Mary River effluent-exposed station, but similar annual average concentrations of these metals were observed at the Mary River upstream reference station during any given sampling event (Table 4.1), indicating natural elevation of aluminum and iron concentrations above WQG in Mary River. Comparison of water chemistry during the EEM fish population and fish tissue selenium surveys in August 2020 indicated similar water quality at the effluent-exposed area (MRE) compared to the Angajurjualuk Lake Tributary reference (ALTR), the upstream Mary River Reference area (MS-08-US), and the far-field reference area (MRR; Appendix Table D.6). Although the concentration of aluminum was above WQG at the Mary River effluent-exposed area at the time of the fish population survey, concentrations at this area were lower than at all three reference areas (Appendix Table D.6). Overall, no substantial MS-08 effluent-related influences on water quality were indicated at the Mary River effluent-exposed area at the time of EEM biological sampling, consistent with the occurrence of very low effluent concentrations estimated in the river.

Table 4.1: Annual Average Water Chemistry at Mary River EEM Stations during Periods of Effluent Discharge, 2018 to 2020

Parameters		Units	Water Quality Guideline (WQG)[a]	Mary River Upstream (MS-08-US)			Mary River Downstream (MS-08-DS)		
				2018	2019	2020	2018	2019	2020
Routine Monitoring[b]	pH (lab)	pH	6.5 - 9.0	7.83	7.91	7.86	7.80	7.90	7.82
	Total Suspended Solids	mg/L	-	<2.0	2.5	10.3	3.0	3.7	9.4
	Arsenic (As)	mg/L	0.0050	<0.00010	0.00011	0.00016	<0.00010	0.00011	0.00018
	Copper (Cu)[d]	mg/L	0.0020	0.0010	0.0012	0.0016	<0.0010	0.0013	0.0018
	Lead (Pb)[d]	mg/L	0.0010	0.000164	0.000231	0.000526	0.000224	0.000279	0.000611
	Nickel (Ni)[d]	mg/L	0.025	0.00052	0.00072	0.0013	0.00055	0.00094	0.0014
	Zinc (Zn)[d]	mg/L	0.0075	<0.0030	0.0037	0.0031	<0.0030	<0.0030	0.0035
	Radium-226	Bq/L	-	0.0069	0.0079	-	0.0056	0.0097	-
Receiving Water Characterization[c]	Conductivity (lab)	µmho/cm	-	61	147	187	68	160	194
	Hardness (as $CaCO_3$)	mg/L	-	29	63	62	31	69	64
	Alkalinity (as $CaCO_3$)	mg/L	-	25	63	60	25	64	63
	Ammonia (NH_4^+)[e]	mg/L	1.04	<0.020	<0.010	<0.0050	<0.020	0.011	0.0089
	Nitrate	mg/L	3	<0.020	0.11	0.084	<0.020	0.061	0.10
	Total Phosphorus	mg/L	0.02	0.006	0.011	0.019	0.007	0.014	0.020
	Chloride (Cl)	mg/L	120	1.62	6.53	6.54	1.55	6.71	6.64
	Sulphate (SO_4)	mg/L	128	0.70	4.11	3.98	2.42	8.64	5.13
	Aluminum (Al)[e]	mg/L	0.100	0.256	0.312	0.683	0.275	0.384	0.751
	Cadmium (Cd)	mg/L	0.000040	<0.0000050	0.0000056	<0.0000050	<0.0000050	<0.0000050	0.0000054
	Chromium (Cr)	mg/L	0.0089	0.0005	0.0007	0.0015	0.0006	0.0009	0.0017
	Cobalt (Co)	mg/L	0.0040	<0.00010	0.00015	0.00032	0.00012	0.00021	0.00038
	Iron (Fe)	mg/L	0.30	0.173	0.269	0.678	0.264	0.407	0.813
	Manganese (Mn)	mg/L	0.675	0.00215	0.00393	0.00951	0.00389	0.00735	0.0112
	Mercury (Hg)	mg/L	0.000026	<0.000010	<0.0000050	<0.0000050	<0.000010	<0.000010	<0.0000050
	Molybdenum (Mo)	mg/L	0.073	0.0002	0.0003	0.0003	0.0001	0.0003	0.0003
	Selenium (Se)	mg/L	0.0010	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Thallium (Tl)	mg/L	0.00080	<0.000010	0.00001	0.00002	<0.000010	0.00001	0.00003
	Uranium (U)	mg/L	0.015	0.0006	0.0033	0.0035	0.0006	0.0031	0.0034

[shaded] Indicates value above applicable long-term Water Quality Guideline for the protection of aquatic life.

Note: "-" indicates data not available.

[a] Canadian Water Quality Guideline for the protection of aquatic life (CWQG; CCME 2014) or British Columbia Water Quality Guidelines (BCWQG; BCMOE 2017; BCMOECCS 2019) .

[b] Deleterious substances and pH as defined under Schedule 4 of the MDMER (Government of Canada 2020) applicable to effluent quality

[c] Required effluent characterization and site-specific parameters as defined under Schedule 5 of the MDMER (Government of Canada 2020) applicable to effluent quality.

[d] Hardness-based guidelines calculated using the minimum hardness observed for all samples (11.9 mg/L).

[e] Based on most conservative guideline using highest temperature (13.1) and pH (8.34)

5 BENTHIC INVERTEBRATE COMMUNITY SURVEY

5.1 Second EEM Results

Benthic invertebrate density was significantly lower at the Mary River Tributary-F effluent-exposed area compared to the reference area, but the absolute magnitude of this difference was less than the benthic invertebrate community CES of ±2 SD_{REF} (CES_{BIC}) and thus was not likely to be ecologically meaningful (Figure 5.1; Table 5.1). Richness, calculated using both family level (FL) and lowest practical level (LPL) taxonomy, did not differ significantly between areas (Figure 5.1; Table 5.1). Simpson's Evenness was significantly higher at the effluent-exposed area compared to the reference area, at an absolute MOD above the CES_{BIC}, when calculated using FL taxonomy (Figure 5.1; Table 5.1). Notably, community richness below ten can considerably bias Simpson's Evenness (Routledge 1980). Because the average FL richness was approximately five at both Mary River Tributary-F study areas (Appendix Table E.6), interpretation of Simpson's Evenness calculated at LPL taxonomy was potentially a better indicator of community evenness. Although Simpson's Evenness calculated using LPL taxonomy was also significantly higher at the Mary River Tributary-F effluent-exposed area, the absolute MOD was below the CES_{BIC} suggesting that this difference was not likely to be ecologically meaningful (Figure 5.1; Table 5.1). Bray-Curtis Index comparisons indicated significant compositional dissimilarity between the effluent-exposed and reference areas based on calculation using both FL and LPL taxonomy (Appendix Table E.9; Appendix Figure E.5).

Among dominant benthic invertebrate taxonomic groups[12], differences in community composition between the effluent-exposed and reference areas of Mary River Tributary-F were reflected by a significantly lower proportion (%) of Chironomidae, including metal-sensitive Chironomidae, at the effluent-exposed area (Figure 5.2; Table 5.1). For both Chironomidae and metal-sensitive Chironomidae, the absolute MOD between areas was greater than the CES_{BIC} (Table 5.1). This suggested that between-area differences in metal concentrations may have affected benthic invertebrate community composition at the effluent-exposed area. Although not significantly different, a distinctly higher proportion of Simuliidae was present at the effluent-exposed area than at the reference area (Figure 5.2; Table 5.1). The proportion of Tipulidae in the benthic invertebrate community did not differ significantly different between the effluent-exposed and reference areas of Mary River Tributary-F (Figure 5.2, Table 5.1).

[12] Dominant taxonomic groups included groups representing ≥10% of the community at any one station, and/or an average ≥5% of the community at any one study area.

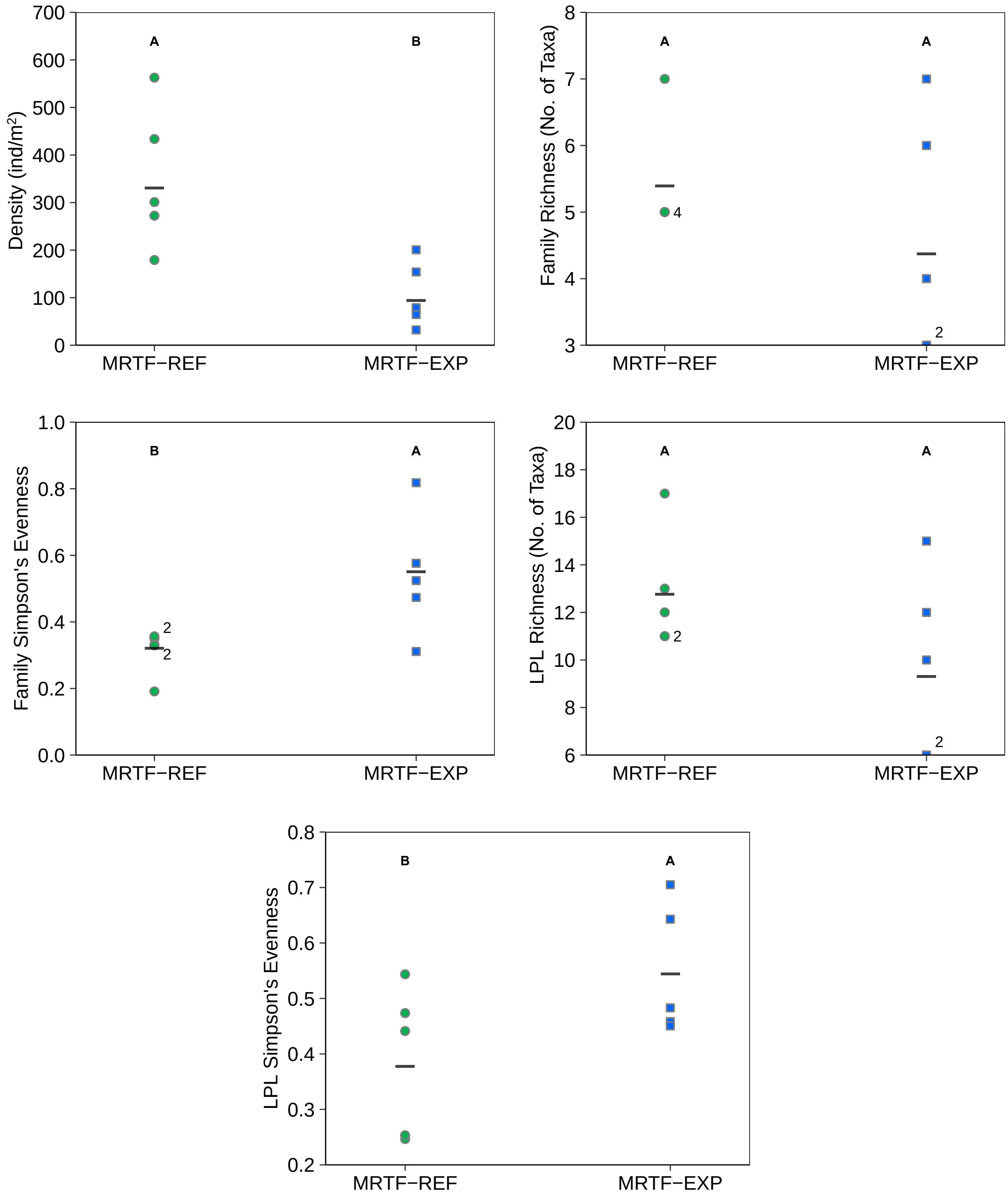


Figure 5.1: Benthic Invertebrate Community Endpoint Comparisons for Mary River Tributary-F Mine−Exposed (MRTF−EXP) and Reference (MRTF− REF) Areas, Mary River Project Second EEM Study, August 2020

Notes: Areas that share a letter are not significant (a=0.1). Bars indicate measures of central tendency. Numbers indicate the number of overlapping points.

Table 5.1: Benthic Invertebrate Community Metric Statistical Comparisons Between Mine-Exposed (MRTF-EXP) and Reference (MRTF-REF) Areas, Mary River Project Second EEM Study, August 2020

Endpoint			Data Transformation	Test	Test P-value	MCT[a]		MOD (%)
						REF	EXP	
EEM Effect Indicators	Density (No./m²)		log10	tequal	0.009	324	87.3	-1.6
	FL Richness (No. of Taxa)		log10	tequal	0.290	5.35	4.32	ns
	FL Simpson's Evenness		none	tequal	0.031	0.312	0.541	3.3
	LPL Richness (No. of Taxa)		log10	tequal	0.151	12.6	9.17	ns
	LPL Simpson's Evenness		log10	tequal	0.087	0.372	0.538	1.0
Group Percentage (%)	Taxa	Chironomidae	log10	tequal	0.029	76.3	52.8	-3.9
		Metal Sensitive Chironomidae	log10	tequal	0.005	50.8	21.0	-4.1
		Simuliidae	log10(x+1)	tunequal	0.118	2.75	19.2	ns
		Tipulidae	log10(x+1)	tequal	0.996	16.3	16.2	ns
	FFG	Collector-Gatherer	log10	tunequal	0.054	77.3	53.5	-3.5
		Filterer	log10(x+1)	tequal	0.070	3.31	20.3	11.4

(grey) P-value < 0.1.
(blue) P-value < 0.1 and MOD < -2.
(green) P-value < 0.1 and MOD > 2.

Note: MOD = Magnitude of Difference = $(MCT_{Exp} - MCT_{Ref})/SD_{Ref}$. FFG = Functional Feeding Group.

[a] MCT = Measure of Central Tendency; MCT reported as median for rank-transformed data and as back-transformed mean for all other cases.

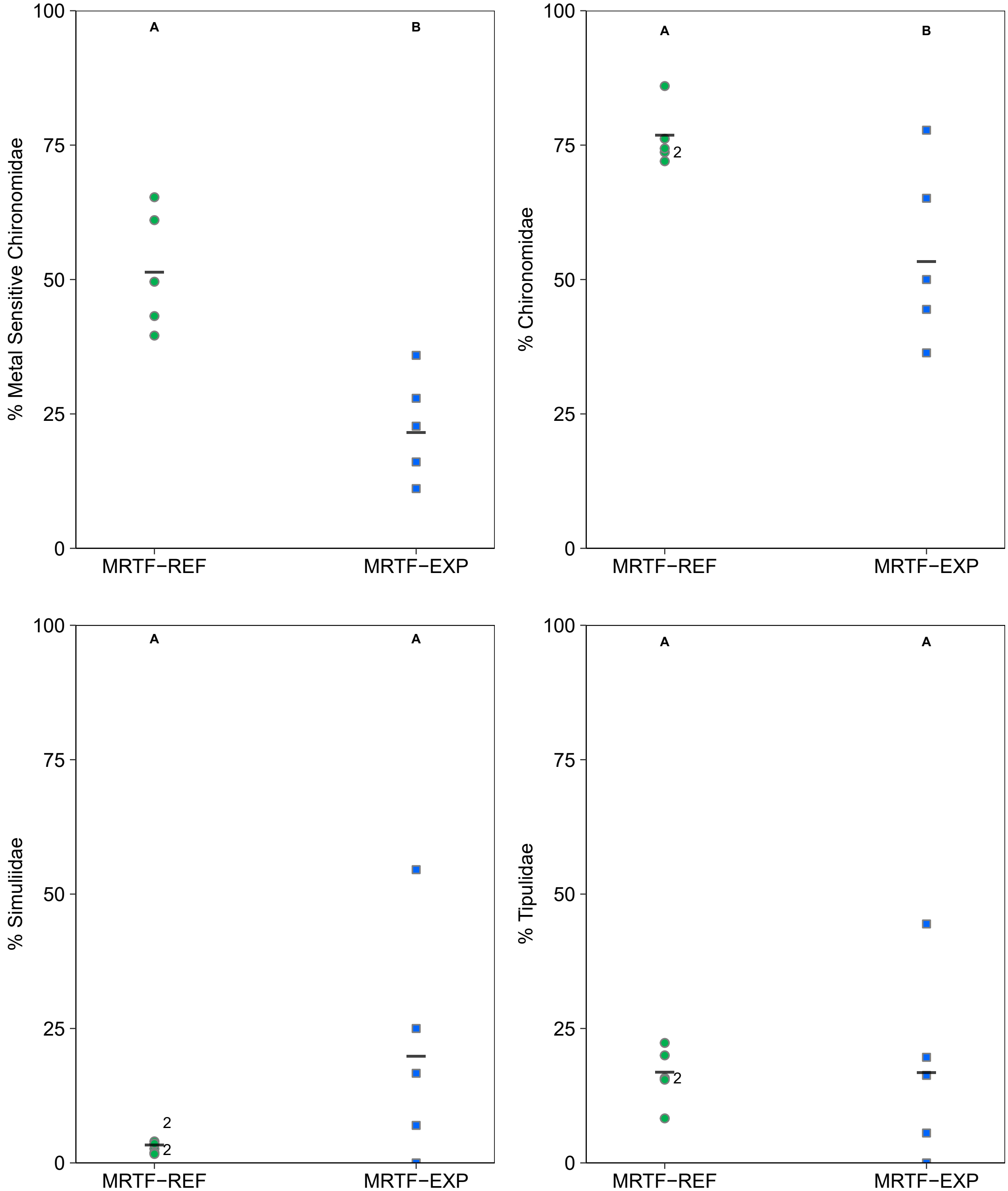


Figure 5.2: Benthic Invertebrate Community Major Taxonomic Group Comparisons for Mary River Tributary-F Mine−Exposed (MRTF−EXP) and Reference (MRTF−REF) Areas, Mary River Project Second EEM Study, August 2020

Notes: Areas that share a letter are not significant (a=0.1). Bars indicate measures of central tendency. Numbers indicate the number of overlapping points.

Analysis of functional feeding groups (FFG) indicated a significantly lower and greater proportion of collector-gatherers and filterers, respectively, at the effluent-exposed area than at the reference area (Figure 5.3; Table 5.1). The filterer FFG was primarily composed of Simuliidae, and therefore the difference in filterer FFG proportion between study areas reflected the higher proportion of Simuliidae indicated at the effluent-exposed area of Mary River Tributary-F (Figures 5.2 and 5.3; Table 5.1). High densities of Simuliidae (blackflies) can often occur at the outlets of tributaries and in larger-sized streams (Carlsson 1967; Grillet and Barrera 1997; Pramual and Wongpakum 2010), possibly due to greater inputs of suspended organic matter that serves as the predominant food source for blackflies, at these habitats (Carlsson et al. 1977). Therefore, a greater proportion of Simuliidae downstream of the MS-08 effluent channel confluence on Mary River Tributary-F compared to the upstream reference area may have reflected increased food resources originating from the effluent-channel. Notably, blackfly larval densities do not appear to be strongly influenced by plankton abundance (Carlsson 1967), suggesting that non-living organic matter received from runoff potentially accounted for the higher proportion of blackflies in the benthic invertebrate community at the effluent-exposed area, rather than an increase in plankton productivity.

In summary, although benthic invertebrate density and Simpson's Evenness (calculated at LPL taxonomy) were significantly higher and lower, respectively, at the effluent-exposed area compared to the reference area, the absolute magnitude of these differences were below CES_{BIC}. A significant difference in Bray-Curtis Index between areas, potentially reflecting lower density and/or a lower proportion of Chironomidae at the effluent-exposed area, was indicative of community composition differences compared to the reference area. A lower proportion of metal-sensitive Chironomidae at the effluent-exposed area suggested that the differences in benthic invertebrate community between areas was potentially related to mine effluent. However, differences in the proportion of the filterer FFG suggested that the organic inputs from the effluent-channel may have also contributed to difference in community composition between study areas located downstream and upstream of the effluent channel confluence on Mary River Tributary-F. No significant differences in sample station depth, water velocity, or substrate embeddedness were indicated between the Mary River Tributary-F effluent-exposed and reference study areas (Appendix Table E.3), suggesting that the community differences between these areas were unrelated to these variables.

Overall, statistical differences in primary EEM metrics of density, Simpson's Evenness, and Bray-Curtis Index between the effluent-exposed and reference areas of Mary River Tributary-F potentially indicated a slight effluent-related influence on the benthic invertebrate community downstream of the MS-08 effluent discharge.

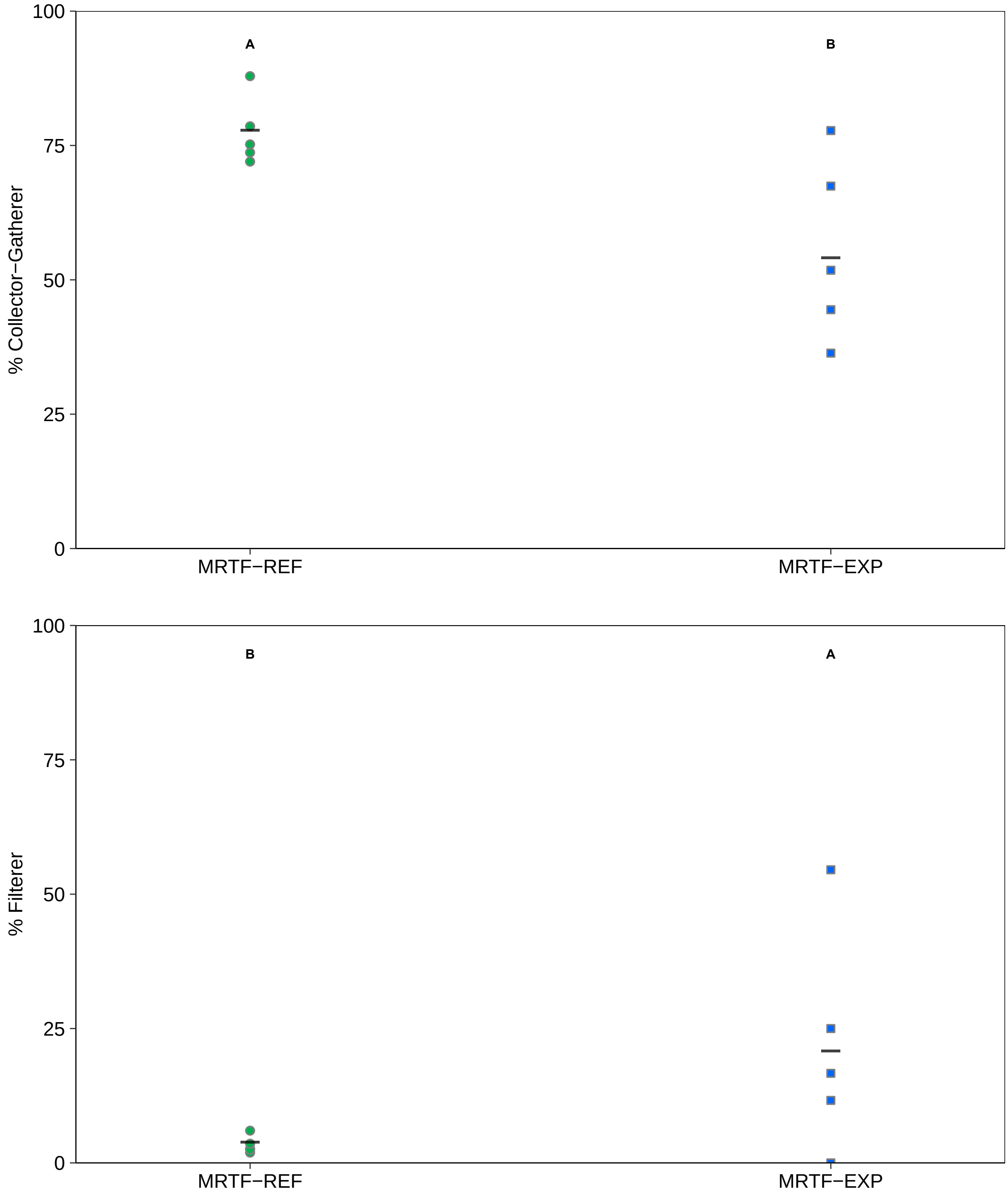


Figure 5.3: Benthic Invertebrate Community Functional Feeding Groups (FFG) Comparison for Mary River Tributary-F Mine−Exposed (MRTF−EXP) and Reference (MRTF−REF) Areas, Mary River Project Second EEM Study, August 2020

Notes: Areas that share a letter are not significant (a=0.1). Bars indicate measures of central tendency. Numbers indicate the number of overlapping points.

5.2 Comparison to Previous EEM Study

Differences in density, Simpson's Evenness, and Bray-Curtis Index were indicated between the Mary River Tributary-F effluent-exposed and reference areas in the 2nd EEM biological study that were not evident in the previous EEM biological study (Table 5.2; Appendix Tables E.9 and E.10). Between EEM studies, noticeably lower density and higher Simpson's Evenness (LPL taxonomy) were indicated at the effluent-exposed area in second study compared to the first study, whereas no marked changes in these metrics were indicated at the reference area between these EEM studies (Figure 5.4). Because between-area differences in EEM metrics of density, Simpson's Evenness, and Bray-Curtis Index were evident only in the 2nd EEM study, the subsequent third EEM biological study will be used to confirm consistency in these differences over time.

Table 5.2: Temporal Comparison of Primary EEM Benthic Invertebrate Community Metrics between Mary River Tributary-F Effluent-Exposed and Reference Study Areas

Endpoint		Statistically Significant Differences Observed? [a]	
		First EEM 2017	Second EEM 2020
Density (organisms/m^2)		No	**Yes (-1.6)**
Family Level (FL) Taxonomy	Richness (no. of taxa)	No	No
	Simpson's Evenness	No	**Yes (3.3)**
	Bray-Curtis Index [b]	No	**Yes**
Lowest Practical Level (LPL) Taxonomy	Richness (no. of taxa)	No	No
	Simpson's Evenness	**Yes (-1.1)**	**Yes (1.0)**
	Bray-Curtis Index [b]	No	**Yes**

[a] Magnitude of difference (in brackets) expressed as number of standard deviations (SD) from the reference mean.

[b] Bray-Curtis Index calculated using methods provided in Borcard and Legendre (2013).

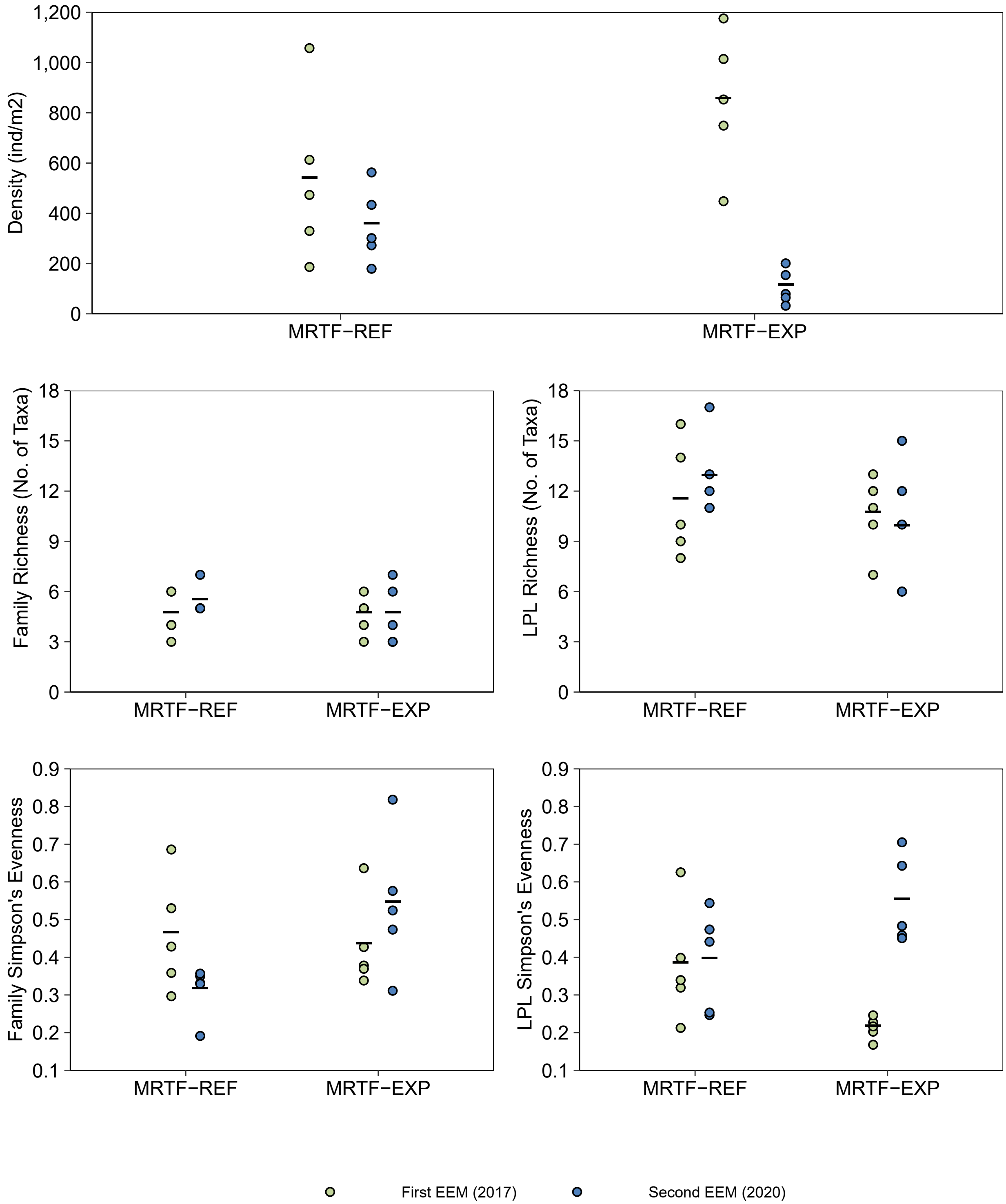


Figure 5.4: Temporal Comparison of Benthic Invertebrate Community EEM Primary Metrics for Mary River Tributary-F Mine−Exposed (MRTF−EXP) and Reference (MRTF−REF) Areas, Mary River Project First and Second EEM Studies, August 2017 and 2020

Notes: Bars indicate sample means.

6 FISH POPULATION AND FISH TISSUE SURVEYS

6.1 Fish Community

6.1.1 Species Composition and Relative Abundance

The fish community at the effluent-exposed area of Mary River[13] was represented entirely by arctic charr (*Salvelinus alpinus*), which differed slightly from that of the Angajurjualuk Lake Tributary and Mary River reference areas, where low numbers of ninespine stickleback (*Pungitius pungitius*) were captured in addition to arctic charr (Table 6.1; Appendix Table F.1). Arctic charr catch-per-unit-effort (CPUE) was comparable among the effluent-exposed and two reference areas (Table 6.1), suggesting that the abundance of arctic charr at the Mary River effluent-exposed area was similar to that at each of the Angajurjualuk Lake Tributary and Mary River reference areas. The apparent absence of ninespine stickleback at the Mary River effluent-exposed area may reflect faster water velocities and a general absence of shallow pool habitat containing vegetative (moss) and/or silt substrate cover structure, the preferred habitat of ninespine stickleback, compared to the reference areas. Overall, no effluent-related influences on arctic charr abundance or fish community composition were apparent at the Mary River receiving environment.

6.1.2 Comparison to Previous EEM Study

Arctic charr CPUE was similar between the Mary River effluent-exposed and reference areas in the 2nd EEM biological study, whereas in contrast, arctic charr CPUE was substantially greater at the effluent-exposed area than at the reference area in the initial EEM biological study (Figure 6.1). In addition, arctic charr CPUE at the Mary River effluent-exposed area and the reference area, and ninespine stickleback CPUE at the Mary River reference area, were substantially higher in the 2nd EEM study than in the initial EEM study (Figure 6.1). The higher CPUE shown for one or both species at each study area in the 2nd EEM study may have been a result of lower water levels at the time of the field study, and field crew targeting of locations previously shown to yield higher numbers of fish, in turn leading to a higher capture efficiency in the 2nd EEM study compared to the initial EEM study. Therefore, no substantial change in fish

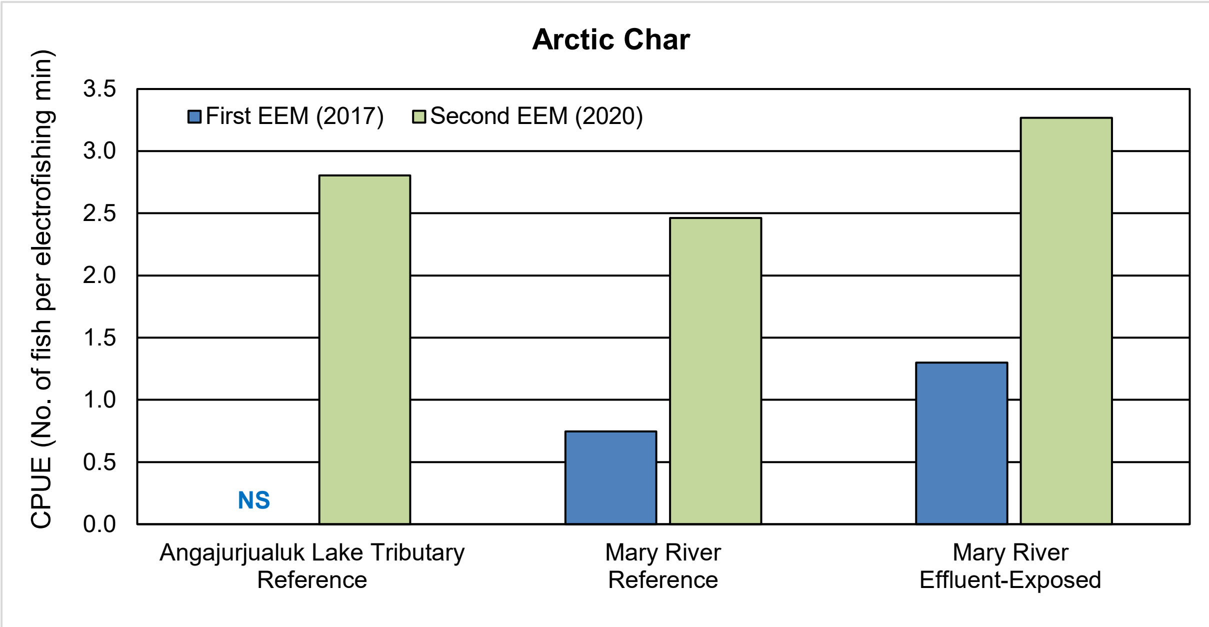
[13] During the fish population survey in the 2nd EEM biological study, no fish sampling was conducted immediately downstream of the MRTF confluence on Mary River (effluent-exposed area) due to safety concerns for field crews associated with the occurrence of large boulder substrate adjacent to deep, fast-flowing water, high turbidity of the water which limited visibility, and the remote/difficult access to this area (i.e., this area has steep approach slopes, confounding use of radio communication, helicopter access, and emergency response in the event of an injury and/or swift water incident). In addition, the habitat at the MRTF confluence with Mary River is not comparable to that found at either the Angajurjualuk Lake Tributary or the Mary River reference area, which could result in slight natural differences in arctic charr fish population traits between this location and the reference areas.

Table 6.1: Summary of Fish Catches at Mary River Project Second EEM Study Fish Population Study Areas, August 2020

Study Area	Total Effort		Summary Statistic Endpoint	Fish Species			Catch Summary	
	Distance Sampled (m)	Electrofishing Seconds		Arctic Char		Ninespine Stickleback	Totals	Total No. Species
				YOY [b]	Non-YOY [b]			
Angajurjualuk Lake Tributary Reference (ALTR)	234	2,226	Total No. Caught	0	104	2	**106**	**2**
			CPUE[a]	0	2.80	0.05	**2.86**	
Mary River Reference (MRR)	200	2,972	Total No. Caught	0	122	35	**157**	**2**
			CPUE[a]	0	2.46	0.71	**3.17**	
Mary River Effluent-Exposed (MRE)	228	2,241	Total No. Caught	0	122	0	**122**	**1**
			CPUE[a]	0	3.27	0	**3.27**	

[a] Electrofishing catch-per-unit-effort (CPUE) represents number of fish captured per minute of electrofishing.

[b] Young-of-the-year (YOY).



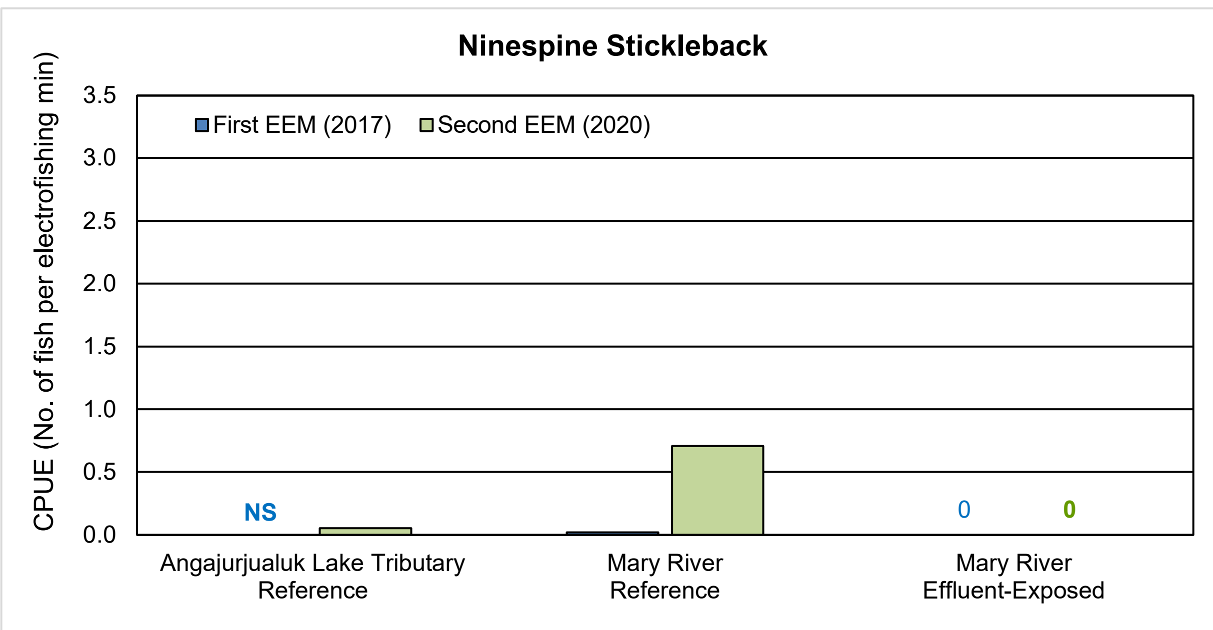


Figure 6.1: Catch-per-unit-effort (CPUE) of Arctic Charr and Ninespine Stickleback Captured by Backpack Electrofishing at Mary River Project First and Second EEM Studies Fish Population Study Areas, August 2017 and 2020

Note: "NS" indicates area was not sampled in given EEM study. "0" indicates no fish captured.

community composition or relative abundance were indicated between the first two EEM biological studies.

6.2 Fish Population Survey

6.2.1 Arctic Charr Assessment

Length and weight measurements were collected from 108, 100, and 100 arctic charr at Mary River effluent-exposed, Angajurjualuk Lake Tributary reference, and Mary River reference study areas, respectively, for the assessment of EEM fish population endpoints (Table 6.2; Appendix Tables F.2 to F.4). No arctic charr YOY were captured at any of the effluent-exposed or the reference areas based on evaluation of length-frequency distributions coupled with supporting age determinations (Figure 6.2), precluding non-lethal assessment of reproduction and YOY growth and condition endpoints. In Arctic streams and rivers, winter freezing can seasonally eliminate habitat available to fish for eight to nine months each year (Craig 1989), requiring that fish overwinter in lakes and then ascend lotic habitats during/following freshet. For arctic charr YOY, stream/river occupancy is mediated by physical barriers created by distance from the lake where egg hatch/larval emergence occurred, lake-ice dynamics near the stream/river mouth, water velocity, water depth, and turbidity (Sinnatamby et al. 2012). Arctic charr YOY are not able to access areas in which water velocities greater than 0.1 m/s must be ascended, primarily limiting YOY occupancy to low-velocity pools and back eddies adjacent to stream banks a relatively short distance upstream of lakes (Sinnatamby et al. 2012). The Mary River effluent-exposed, Angajurjualuk Lake Tributary reference, and Mary River reference study areas each share similar distance upstream of the nearest lake that could serve as an overwintering refuge for arctic charr (i.e., range from approximately 2.4 km to 2.9 km among the three areas; Figure 2.2). Reaches characterized by riffle and/or rapid stream morphology and exhibiting water velocities much greater than 0.1 m/s occur at five or more locations between each EEM fish population study area and the closest lake into which the river drains. Therefore, the absence of arctic charr YOY at each of the EEM study areas likely reflected natural physical barriers to occupancy related to distance from refuge lake and high water velocities within each creek/river.

The length-frequency distribution of arctic charr captured at the effluent-exposed area differed significantly from the distribution shown at the Angajurjualuk Lake Tributary reference area, but did not differ significantly from the distribution shown at the Mary River reference area (Table 6.2; Figure 6.2; Appendix Tables F.6 and F.9). The difference in length-frequency distribution between the Mary River effluent-exposed area and the Angajurjualuk Lake Tributary reference area reflected a greater proportion of arctic charr with fork lengths greater than 10 cm (i.e., larger fish) at the effluent-exposed area (Figure 6.2).

Table 6.2: Summary of Non-YOY Arctic Charr Endpoint Statistical Comparison Results Between Effluent-Exposed and Reference Areas, Mary River Project First and Second EEM Studies, August 2017 and 2020

Endpoint [a]	Applicable Critical Effect Size	Sample Size	Statistically Significant Differences Observed?[b]				
			First EEM (2017)		Second EEM (2020)		
			Test	MRE vs MRR	Test	MRE vs ALTR	MRE vs MRR
Survival (Age Frequency Distribution)*	none	100[c]	K-S	No	K-S	**Yes (-22%)**	No
Survival (Age)*	± 25%	20	n/a	n/a	K-W	**Yes (+50%)**	No
Body Size (Fork Length)	none	100[c]	t-test	No	K-W	**Yes (+12%)**	No
		20	n/a	n/a	ANOVA	No	No
Body Size (Body Weight)	none	100	t-test	No	K-W	**Yes (+36%)**	No
		20	n/a	n/a	ANOVA	No	No
Energy Usage (Length-at-age)	none	20	n/a	n/a	ANCOVA	No	No
Energy Usage (Weight-at-age)*	± 25%	20	n/a	n/a	ANCOVA	No	No
Energy Storage (liver weight at body weight)*	± 25%	20	n/a	n/a	ANOVA	No	No
Energy Storage (condition)*	± 10%	100[c]	ANCOVA	**Yes (-4.5%)**	ANCOVA	No	No
		20	n/a	n/a	ANCOVA	No	No

[shaded box] Indicates an absolute magnitude of difference (MOD) greater than applicable Critical Effect Size for fish population survey EEM effect indicators.

Notes: YOY = young-of-the year; MRR = Mary River reference area; MRE = Mary River effluent-exposed area; ALTR = Angajurjualuk Lake Tributary reference area; n/a indicates endpoint not applicable (i.e., endpoint associated with lethal sampling).

[a] Endpoints denoted with an asterisk represent primary EEM endpoints used for the determination of "effects" for a lethal fish population study.

[b] Information provided indicates whether a significant difference occurred between areas (**yes**/no) and the magnitude of difference for any differences (in parentheses).

[c] Sample size varied between areas. In First Study, n=100 at the effluent-exposed and reference area. In Second Study, n=108 for length measures and 100 for weight and condition measures at the effluent-exposed area, and n=100 at the reference areas.

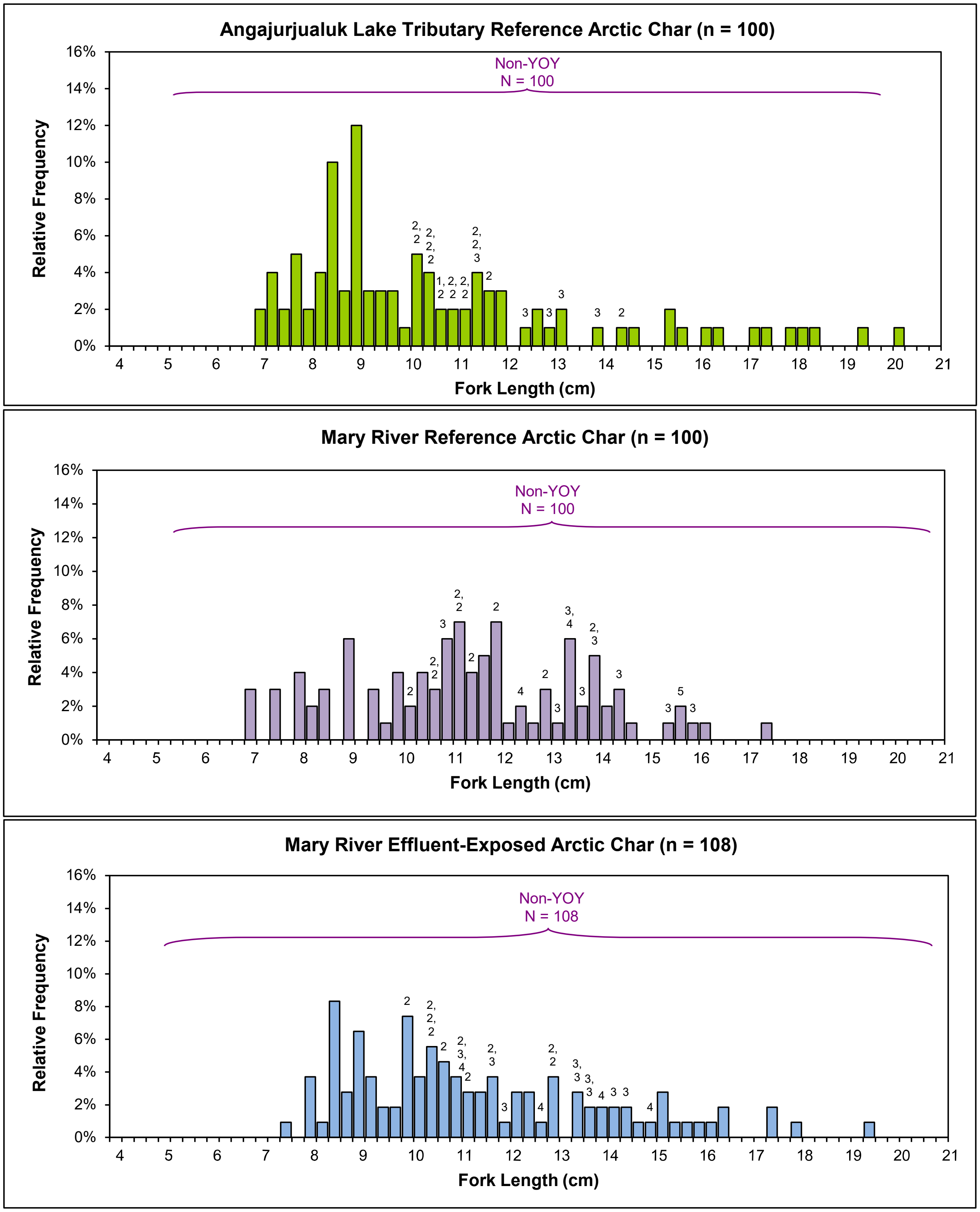


Figure 6.2: Length-frequency Distributions for Arctic Char Collected at Mary River Project Second EEM Study Effluent-Exposed and Reference Study Areas, August 2020

Note: Numbers above bars represent individual fish ages, where available.

No separation of age (i.e., cohorts) was possible at any of the study areas using the length-frequency distribution and confirmatory aging results, with some overlap among fish aged from two, three, and/or four apparent at all three study areas (Figure 6.2). Visual evaluation of the plotted data suggested a similar arctic charr length-at-age relationship between the effluent-exposed and reference areas (Figure 6.2). Nevertheless, for those fish sampled to acquire lethal endpoints (i.e., n = 20 from each area), arctic charr captured from the Mary River effluent-exposed area were significantly older than those captured at the Angajurjualuk Lake Tributary reference area at an absolute MOD above the CES of 25% (Table 6.2; Appendix Table F.9). Among lethally sampled arctic char, ages ranged from two to four years at the Mary River effluent-exposure and reference areas, and from one to three years at the Angajurjualuk Lake Tributary reference area (Figure 6.2; Appendix Table F.2 to F.4). No significant difference in age was shown between Mary River effluent-exposed and reference areas among those fish that were lethally sampled (Table 6.2; Appendix Table F.9).

Arctic charr sampled at the Mary River effluent-exposed area were significantly longer and heavier than those sampled at the Angajurjualuk Lake Tributary reference area (Table 6.2; Appendix Table F.6). However, no significant differences in arctic charr length or weight were indicated between the Mary River effluent-exposed and reference study areas (Table 6.2; Appendix Tables F.6 and F.9). In addition, all endpoints of growth (i.e., fork length-at-age and body weight-at-age), relative liver size (i.e., liver weight-at-body weight), and condition (i.e., body weight-at-fork length) did not differ significantly between the Mary River effluent-exposed area and either of the Angajurjualuk Lake Tributary or Mary River reference areas (Table 6.2; Figure 6.3; Appendix Tables F.6 and F.9). No externally visible abnormalities or parasitic infections were observed on any arctic charr captured at the Mary River effluent-exposed area. Overall, the absence of any significant differences in EEM effect indicators related to growth, relative liver size, and condition in arctic charr captured at the Mary River effluent-exposed area compared to those captured at either the Angajurjualuk Lake Tributary or Mary River reference areas indicated no marked influence of the MS-08 effluent on the health of arctic charr at Mary River in 2020.

6.2.2 Comparison to Previous EEM Study

Non-lethal measurements of length and weight were collected from approximately 100 non-YOY arctic charr at the same Mary River effluent-exposed and reference areas in the two EEM biological studies conducted to date, allowing temporal comparison of non-YOY arctic charr length-frequency distribution, body size, and condition between EEM studies. Sampling of Angajurjualuk Lake Tributary, and lethal sampling of non-YOY arctic charr to assess for differences in age, growth, and relative liver size, was conducted only in the 2nd EEM

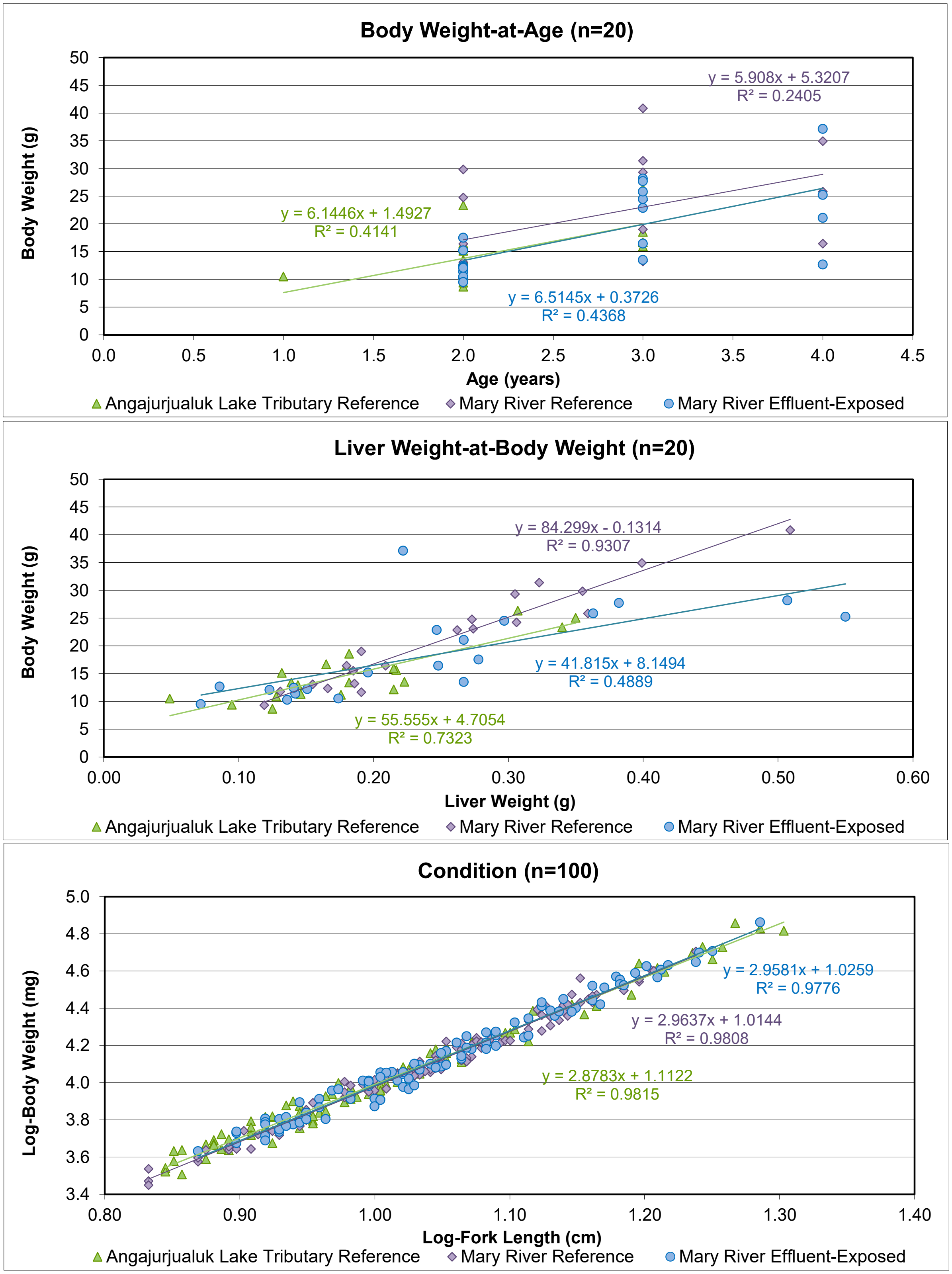


Figure 6.3: Comparison of EEM Endpoints for Non-YOY Arctic Charr Collected at Mary River Effluent-Exposed and Reference Areas, August 2020

biological study. Therefore, temporal comparison of the non-YOY arctic charr health endpoints between the first two EEM studies was limited to endpoints of length-frequency distribution, body size, and condition between Mary River near-field effluent-exposed (MRE) and reference (MRR) areas.

Length-frequency distributions and body size of non-YOY arctic charr captured at the Mary River effluent-exposed area were not significantly different than the distribution and body size indicated at the Mary River reference area in either the first or second EEM studies (Table 6.2). Although non-YOY arctic charr condition was significantly lower at the Mary River effluent-exposed area than at the reference area in the initial EEM study (at a magnitude within the CES of ±10%), no significant difference in condition was indicated between these areas in the 2nd EEM biological study (Table 6.2). Therefore, there were no consistent significant differences in non-YOY arctic charr health endpoints between the Mary River effluent-exposed and reference areas from 2017 to 2020, suggesting minimal influence of the MS-08 effluent on the health of arctic charr residing in Mary River.

6.3 Fish Tissue Selenium Survey

Muscle tissue selenium concentrations in arctic charr at the Mary River effluent-exposed area did not differ significantly from concentrations indicated in arctic charr from either the Angajurjualuk Lake Tributary or Mary River reference areas (Figure 6.4; Appendix Table F.12). Muscle tissue selenium concentrations in arctic charr captured at the effluent-exposed area were well below the USEPA (2016) chronic effects criterion of 11.3 mg/kg dw for protection of aquatic life (Figure 6.4), suggesting reproductive impairments (e.g., deformities, mortality) to Mary River arctic charr were highly unlikely. Notably, selenium concentrations in MS-08 effluent were consistently very low during the 2nd EEM period (2018 to 2020; Appendix Table C.3 to C.5), and thus effects to fish tissues in the Mary River receiver were not expected as a result of exposure to the mine effluent. Overall, no effluent-related influences on selenium concentrations in arctic charr muscle tissue were indicated at Mary River, which was consistent with low selenium concentrations associated with the MS-08 effluent and low effluent concentrations in Mary River.

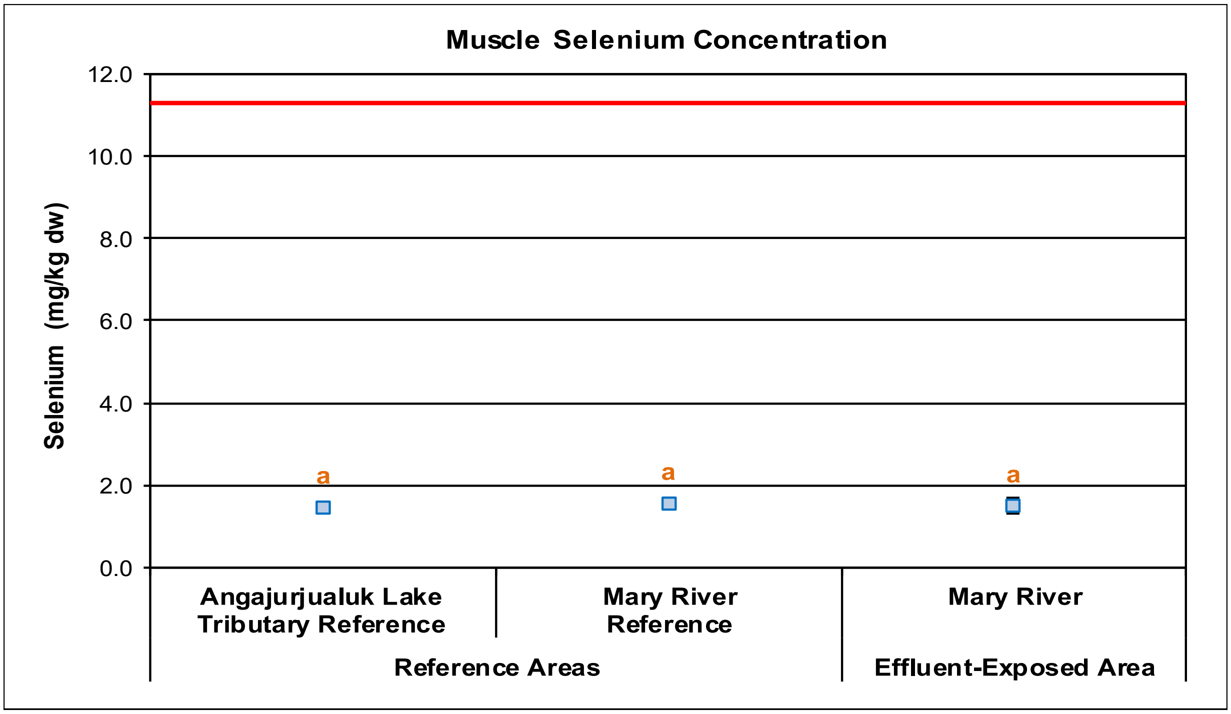


Figure 6.4: Selenium Concentrations (mean ± SD; n = 8) in Dorsal Muscle Tissue of Arctic Charr Captured at Effluent-Exposed and Reference Study Areas, Mary River Project Second EEM Study, August 2020

Note: Data points with the same letters do not differ significantly.

7 CONCLUSIONS

The objective of the Mary River Project 2nd EEM biological study was to provide an evaluation of the influence of mine effluent on biota of the mine receiver. To meet this objective, effluent quality and receiving environment water quality were used to support the interpretation of benthic invertebrate community and fish population survey data collected at effluent-exposed areas and respective reference areas of Mary River Tributary-F and Mary River. The main conclusions from the 2nd EEM biological study are:

- Effluent from the Mary River Project primary discharge (MS-08) met MDMER monthly limits from 2018 to 2020 except for two elevated TSS events in 2019. Mine effluent was non-acutely lethal to rainbow trout over the duration of the current 2nd EEM period, and was also non-acutely lethal to *Daphnia magna* in all but one test over this period. Sublethal toxicity tests conducted using final effluent samples showed no effects on survival or growth of fathead minnow or on growth of green algae over the 2nd EEM period. Effects on survival and/or reproduction of *Ceriodaphnia dubia* and growth inhibition to duckweed were shown in effluent sublethal toxicity tests conducted from 2018 to 2020. However, effluent effect concentrations for these tests were much higher than those expected in the effluent receiving environment, suggesting limited potential for similar sublethal toxicity effects within the immediate Mary River Tributary-F effluent-exposed area.
- Water chemistry at effluent-exposed areas of Mary River Tributary-F showed slightly to moderately elevated specific conductance and concentrations of chloride, nitrate, sulphate, and TSS compared to reference conditions during EEM biological sampling, but concentrations of these parameters were well below applicable WQG within the watercourse. Effluent concentrations in Mary River Tributary-F averaged 2.6%, and were estimated at 3.0% and 2.9% at a distance of 100 m and 250 m downstream, respectively, of the effluent channel during the 2nd EEM biological study. Within the effluent-exposed area of Mary River, specific conductance was slightly elevated, but parameter concentrations were comparable, relative to those shown at each of three separate reference areas at the time of biological sampling in August 2020.
- The benthic invertebrate community survey indicated significantly lower density and higher Simpson's Evenness at the effluent-exposed area compared to the reference area of Mary River Tributary-F, as well as differences in Bray-Curtis Index between these areas, but no difference in richness. This suggested there may be a slight effluent-related influence on

the benthic invertebrate community of Mary River Tributary-F associated with exposure to the MS-08 mine effluent.

- The fish population survey indicated no substantial differences in community species composition or arctic charr abundance at the Mary River effluent-exposed area compared to either of two reference areas (Angajurjualuk Lake Tributary and Mary River downstream). The Mary River non-YOY arctic charr population showed no consistent significant difference in length-frequency distribution, body size, growth, relative liver size, or condition compared to the two reference areas. In addition, no significant differences in muscle tissue selenium concentrations were indicated in arctic charr of the Mary River effluent-exposed area compared to the same two reference areas, and concentrations at all areas were well below chronic effects criterion indicating no reproductive impairments were likely to occur. In turn, this indicated no marked influence of the MS-08 effluent on the health of arctic charr at the Mary River effluent-exposed area in 2020.

Overall, the Mary River Project 2nd EEM biological study indicated very low effluent concentrations within the immediate Mary River Tributary-F receiving environment and commensurately, only minor effluent-related influences on water quality of this watercourse and farther downstream at Mary River were indicated during periods of effluent discharge. Although benthic invertebrate density, Simpson's Evenness, and Bray-Curtis Index differed significantly between effluent-exposed and reference areas of Mary River Tributary-F, the absolute magnitudes of the differences in density and Simpson's Evenness were below CES_{BIC} suggesting that these differences were minor. In addition, no effluent-related influences on non-YOY arctic charr health (including tissue selenium concentrations) were indicated at Mary River. Therefore, consistent with the water quality data that showed parameter concentrations in the Project effluent receiving waters were low (i.e., less than WQG), effluent-related influences on the benthic invertebrate community of Mary River Tributary-F were shown to be minor whereas no effluent-related influences on fish were apparent farther downstream at Mary River.

Based on the prescribed EEM frequency under the MDMER, the Study Design for the next Mary River Project EEM biological study must be submitted to ECCC no later than six months prior to implementing field collections in 2023. Using the EEM framework, the next (third) biological monitoring study will require an effects assessment, in part, to determine whether the occurrence of significant differences in benthic invertebrate community density, Simpson's Evenness, and Bray-Curtis Index effect indicators shown in the current EEM are consistent in the next EEM study. The corresponding EEM Interpretive Report for the third biological study must be submitted to ECCC by January 10th, 2024.

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APPENDIX A

STUDY DESIGN APPROVAL CORRESPONDENCE

Prairie and Northern Region
Environmental Protection Operations Directorate
Environment and Climate Change Canada
9250 – 49th Street NW
Edmonton, AB T6B 1K5

File #: MM3108

April 22, 2020

Via email to: Timothy.Sewell@baffinland.com

Timothy Sewell
Head of Health, Safety, Environment and Security
Baffinland Iron Mines Corporation
2275 Upper Middle Road East, Suite 300
Oakville, ON L6H 0C3

Dear Timothy Sewell:

Subject: Mary River Project 2nd EEM Study Design – action items identified

Environment and Climate Change Canada (ECCC) has reviewed your "Mary River Project Second Phase Environmental Effects Monitoring Study Design," submitted February 7, 2020. Our review took into account requirements of the *Metal and Diamond Mining Effluent Regulations* (MDMER) of the *Fisheries Act*, information in the EEM Technical Guidance Document as well as generally accepted standards of good scientific practice. This review is not a substitute for reading the MDMER and does not in any way supersede or modify the *Fisheries Act* or the MDMER. In the event of an inconsistency between this review and the Act and/or the MDMER, the Act and the Regulations prevail.

The compiled review comments are attached. Comments in bold indicate where further information is required to meet regulatory requirements. Your response should be submitted, as an addendum, to the Environmental Effects Monitoring Electronic Reporting (EEMER) system (https://ec.ss.ec.gc.ca/).

If you have any questions or concerns about the EEM program or if you wish to discuss the study design, please contact Regional Coordinator Erik Allen at 780-717-4884 or at erik.allen@canada.ca. For questions regarding EEMER, please contact ec.esee-eem.ec@canada.ca.

Sincerely,

A McLandress

Andrea McLandress
Regional Director

Enclosure: Review comments and recommendations on "Mary River Project Second Phase Environmental Effects Monitoring Study Design", February 2020 submission

cc:	Cristina Ruiu	Environment and Climate Change Canada, Regina
	Erik Allen	Environment and Climate Change Canada, Edmonton
	Monika Trottier	Environment and Climate Change Canada, Iqaluit
	Bridget Campbell	Crown-Indigenous Relations and Northern Affairs Canada, Iqaluit
	Assol Kubeisinova	Nunavut Water Board
	William Bowden	Baffinland Iron Mines Corporation
	Connor Devereaux	Baffinland Iron Mines Corporation

Review comments and recommendations on “Mary River Project Second Phase Environmental Effects Monitoring Study Design”, February 2020 submission

The following comments and recommendations are based on the review of the report by members of a Technical Advisory Panel (TAP) consisting of representatives from Environment and Climate Change Canada (ECCC), Crown-Indigenous Relations and Northern Affairs Canada and Nunavut Water Board.

Action items

1. p. 8. ECCC. The study design indicates that runoff from historical drilling sites may have confounded the conductivity-based estimates of effluent concentration in Tributary F. To address this, you estimated effluent concentrations based on stream flows extrapolated from nearby watersheds in 2018. For the MS-08 final discharge point (FDP), you estimated maximum effluent concentrations of 19.6% in Tributary F and 0.71% in the Mary River. For the MS-06 FDP, you estimated a maximum effluent concentration of 0.039% in Mary River.

   The MDMER require study designs to include a summary of information referred to in Schedule 5, paragraph 10(a), including an estimate of effluent concentration at 100 m and 250 m from every point at which effluent enters the exposure area from a FDP, and – in respect of each calendar year – any supporting information for the estimate (Schedule 5, paragraph 13(2)(a)).

   a. You indicate that estimates of effluent concentration for Tributary F (MS-08) apply at 100 m and 250 m from the point at which effluent enters the tributary, since there are no substantial sources of dilution near the confluence with the effluent stream. For MS-06, you estimated a maximum effluent concentration of 0.039% “downstream of the effluent confluence”. **Does this estimate apply at both 100 m and 250 m downstream from the point at which effluent from MS-06 enters the exposure area?**

   b. You estimated effluent concentrations based on stream flows and effluent discharge volumes in 2018 – to what extent would these estimates change based on conditions in 2017 or 2019?

   c. Conductivity-based estimates of effluent concentration in Tributary F (near the effluent inflow) should not be confounded by inputs from historical drilling sites, since the increase in conductivity occurred downstream from the confluence with the effluent stream. As a result, you may be able to verify your estimates with conductivity measurements from water quality monitoring in previous years. You could also consider conductivity-based estimates of effluent concentration based on field measurements conducted during the current study.

2. p. 29. ECCC. The fish population study will target juvenile char with a combined non-lethal and lethal survey. The study design proposes to assess fish reproduction with the non-lethal indicator, by comparing the proportion of young-of-the-year (YOY) between populations. Given that only a few YOY were captured in the Phase 1 study, please describe any additional sampling methods that could be used to increase the likelihood of capturing YOYs.

3. p. 30. ECCC. The fish sampling areas proposed for Mary River are located near the MS-06 FDP and the treated sewage discharge. Could exposure of fish to these effluent streams confound the assessment of effects from the MS-08 effluent?

4. p. 30. ECCC. Similar to the Phase 1 study, the exposure area for the fish survey is located in the Mary River, two km downstream of the Tributary F confluence. A gorge restricts access further upstream near the confluence. Would it be feasible to sample in the area upstream of the gorge, in the immediate vicinity of the confluence with Tributary F?
5. p. 31. ECCC. Figure 3.2 shows fish sampling areas proposed for the Phase 2 study. You have not proposed fish sampling in Tributary F, based on an assessment in 2017 that showed fish are unable to access the stream due to a barrier at the confluence with the Mary River. Are you aware of any changes to the fish barrier or conditions at the confluence that would enable fish to access to Tributary F?
6. p. 32. ECCC. The study design includes a new reference area for the fish population and fish tissue studies, to be selected from one of three tributaries to Lake Angarjurjuak. You propose to evaluate the tributaries for habitat features and fish presence this summer before selecting the site that is most comparable to the exposure area. **Please provide any available information on the candidate reference streams in accordance with Schedule 5, subparagraph 10(a)(ii).** It is noted that you intend to provide a detailed description of the selected reference area in the interpretive report.
7. ECCC sent you review comments on the Phase 1 interpretive report by email on October 18, 2019. Responses to the review comments should be submitted as an addendum to the interpretive report in EEMER.

Other items

8. p. 11. ECCC. The report refers to elevated ammonia, nitrate and sulphate concentrations in Tributary F; please specify where in the tributary you collected these samples.
9. p. 22. ECCC. The first study found no significant difference in YOY abundance between sampling areas, however it should be noted that only two YOY were captured in the exposure area and none were captured in the reference area.
10. p. 32. ECCC. You proposed a sample size of 20 fish per area for the lethal fish survey, and 100 juvenile fish for the non-lethal survey. Please note that EEM suggests up to seven days of fishing effort to achieve target sample sizes.
11. p. 36. ECCC. In Table 3.5, you indicate ‘qualitative’ analysis of non-lethal fish reproduction; however, earlier in the text on p. 35, you describe the statistical comparison of length frequency distributions and relative proportions of YOY to evaluate differences in reproductive success. It was unclear if you were referring to these methods as ‘qualitative’ – please note that the EEM technical guidance document recommends assessment of the non-lethal reproduction indicator by comparison of size frequency distributions, with and without YOYs, using the Kolmogorov-Smirnov test, or by direct comparison of YOY proportions with the Chi-squared test (see Section 3.4.2.2, EC 2012).
12. p. 39. ECCC. Please ensure the interpretive report includes descriptive statistics (mean, median, standard error standard deviation, minimum and maximum) for fish tissue selenium concentrations (dry weight) and percentage moisture content, in accordance with Schedule 5, subparagraph 12(1)(e)(iv).

Reference

Environment Canada (EC) 2012. *Metal Mining Technical Guidance for Environmental Effects Monitoring.*

Baffinland

May 11, 2020

Andrea McLandress
Regional Director
Prairie and Northern Region
Environment and Climate Change Canada
9250 – 49th Street NW
Edmonton, AB T6B 1K5
Sent via email

RE: Baffinland's Response to the Environment and Climate Change Canada's Comments Mary River Project 2nd EEM Study Design

Baffinland Iron Mines Corporation (Baffinland) provides Environment and Climate Change Canada (ECCC) with the following response to the action items identified in a letter[1] issued to Baffinland regarding the Mary River Project 2nd EEM Study Design. The attached Table 1 provides Baffinland's responses to the action items.

Should you have any additional concerns or questions regarding the attached responses, please to not hesitate to contact the undersigned at your convenience.

Regards,

Connor Devereaux

Environmental Superintendent

Cc: Megan Lord-Hoyle, Lou Kamermans, Tim Sewell, Shawn Stevens, Christopher Murray, Amanda McKenzie (Baffinland) Erik Allen, Monika Trottier, Christina Ruiu (ECCC) Bridget Campbell (CIRNAC) Assol Kubeisinova (NWB)

Attachments

Attachment 1 – Table 1 - Baffinland Responses to ECCC's Mary River Project Second Phase EEM Study Design – Action Items Identified

Attachment 2 – Supporting Documents in Response to ECCC's Mary River Project Second Phase EEM Study Design Comments

[1] ECCC (2020) Re: Baffinland Iron Mines Corporation's Mary River Project 2nd EEM Study Design – Action Items Identified. Letter dated April 22, 2020.

ATTACHMENT 1

Baffinland Responses to ECCC's Mary River Project Second Phase EEM Study Design – Action Items Identified

Table 1: Baffinland Responses to ECCC's Mary River Project Second Phase EEM Study Design – Action Items Identified

ID	ECCC Description of Action Item	BIM Response
Action Item 1a	p. 8. ECCC. The study design indicates that runoff from historical drilling sites may have confounded the conductivity-based estimates of effluent concentration in Tributary F. To address this, you estimated effluent concentrations based on stream flows extrapolated from nearby watersheds in 2018. For the MS-08 final discharge point (FDP), you estimated maximum effluent concentrations of 19.6% in Tributary F and 0.71% in the Mary River. For the MS-06 FDP, you estimated a maximum effluent concentration of 0.039% in Mary River. The MDMER require study designs to include a summary of information referred to in Schedule 5, paragraph 10(a), including an estimate of effluent concentration at 100 m and 250 m from every point at which effluent enters the exposure area from a FDP, and – in respect of each calendar year – any supporting information for the estimate (Schedule 5, paragraph 13(2)(a)). You indicate that estimates of effluent concentration for Tributary F (MS-08) apply at 100 m and 250 m from the point at which effluent enters the tributary, since there are no substantial sources of dilution near the confluence with the effluent stream. For MS-06, you estimated a maximum effluent concentration of 0.039% "downstream of the effluent confluence". Does this estimate apply at both 100 m and 250 m downstream from the point at which effluent from MS-06 enters the exposure area?	Correct. Similar to the MS-08 discharge, no substantial sources of dilution occur downstream of the location that Mary River receives the MS-06 discharge until the confluence of a small unnamed creek located approximately 500 m downstream of the effluent source, on the opposite side of the river (see Figure 2.1). Therefore, similar concentrations of MS-06 effluent can be expected to occur in Mary River at points within the initial mixing zone and 100 m and 250 m downstream of the confluence with the MS-06 effluent discharge pathway.
Action Item 1b	You estimated effluent concentrations based on stream flows and effluent discharge volumes in 2018 – to what extent would these estimates change based on conditions in 2017 or 2019?	In 2017, the MS-08 effluent was estimated to constitute, on annual average, 2.9% and 0.15% of flow in Mary River Tributary-F and Mary River, respectively, during periods of effluent deposition (Addendum Table 1). Maximum daily effluent concentrations at Mary River Tributary-F and Mary River in 2017 were 8.4% and 0.70%, respectively. In 2018, the MS-08 effluent was estimated to constitute, on annual average, 6.4% and 0.21% of flow in Mary River Tributary-F and Mary River, respectively, during periods of effluent deposition (Addendum Table 2). Maximum daily effluent concentrations at Mary River Tributary-F and Mary River in 2018 were 19.6% and 0.71%, respectively. In 2019, the MS-08 effluent was estimated to constitute, on annual average, 7.8% and 0.22% of flow in Mary River Tributary-F and Mary River, respectively, during periods of effluent deposition (Addendum Table 3). Maximum daily effluent concentrations at Mary River Tributary-F and Mary River in 2019 were 27.0% and 0.82%, respectively. Therefore, the 2018 effluent concentration data presented in the study design were intermediate to those that occurred in 2017 and 2019. On average, effluent concentrations in Mary River Tributary-F have increased each year since 2017.

ID	ECCC Description of Action Item	BIM Response
Action Item 1c	Conductivity-based estimates of effluent concentration in Tributary F (near the effluent inflow) should not be confounded by inputs from historical drilling sites, since the increase in conductivity occurred downstream from the confluence with the effluent stream. As a result, you may be able to verify your estimates with conductivity measurements from water quality monitoring in previous years. You could also consider conductivity-based estimates of effluent concentration based on field measurements conducted during the current study.	Agreed. Specific conductance measurements collected at the EEM benthic invertebrate community stations during a period of effluent discharge in August 2017 were used to estimate an effluent concentration of 0.17% in the immediate MS-08 effluent receiving environment. This estimate was in the range of effluent concentrations predicted for the MS-08 immediate receiving environment using the methods described in the Phase 2 EEM Study Design and application of the 2017 data (i.e., 0.02% to 8.4%; Addendum Table 1). Therefore, either method of effluent concentration estimation (i.e., conductivity or pro-rating using hydrometric station data) may be used to provide a prediction of effluent concentration in the MS-08 effluent receiving environment. During the field work for the Phase 2 EEM biological study, conductivity measurements will be collected in the MS-08 receiving environment at all benthic invertebrate community stations, as well as at points 100 m and 250 m downstream of the effluent pathway confluence with Mary River Tributary-F. These data, as well as conductivity measurements of the MS-08 effluent itself, will be used to provide effluent concentration estimates for the MS-08 effluent in Mary River Tributary-F at the station/points indicated above. These estimates will be included in the Phase 2 EEM Interpretive Report.

ID	ECCC Description of Action Item	BIM Response
Action Item 2	p. 29. ECCC. The fish population study will target juvenile char with a combined non-lethal and lethal survey. The study design proposes to assess fish reproduction with the non-lethal indicator, by comparing the proportion of young-of-the-year (YOY) between populations. Given that only a few YOY were captured in the Phase 1 study, please describe any additional sampling methods that could be used to increase the likelihood of capturing YOYs.	The approach presented for the collection of arctic charr during the Phase 1 EEM was consistent with EEM technical guidance for non-lethal surveys (Section 3.4.2 in Environment Canada 2012). Specifically, a minimum of 100 fish older than YOY were targeted from each study area, and YOY acquired during the collection of these fish were retained and sampled (measured) during the 2017 field study. The proportion of fish that were YOY was then estimated from the first 100 fish collected. Because the methods used for fish collection were able to effectively sample YOY, this life history stage was adequately represented in the sampled population during the 2017 study. Annual shoreline backpack electrofishing conducted in August at shoreline areas of mine-exposed and reference lakes sampled to meet territorial Aquatic Effects Monitoring Plan (AEMP) requirements has consistently resulted in the capture of YOY charr in each year from 2015 to 2019. Therefore, backpack electrofishing is an effective sampling method for collection of YOY charr, and it was unlikely that YOY were not represented in the sampled population due to collection method. With the exception of large individuals that are able to visually detect and quickly evade the electrofishing sampling team, electrofishing methods are unlikely to result in any substantial size limited bias for the sample in habitats like those of Mary River compared to other methods (e.g., mesh size in various types of traps/nets). Habitat of Mary River predominantly consists of swiftly running (riffle and moderate gradient run habitat with water velocities often greater than 0.5 m/s), moderately deep (i.e., approximately 1 m), waters with substrate consisting of boulder and cobble. Habitats suitable for setting various types of small mesh passive gear suitable for potentially capturing YOY (e.g., minnow traps, hoop nets, gill nets, fyke nets) are very limited on an areal basis (e.g., areas at least 30 cm deep with slow enough flow that allows gear to be deployed effectively), and deployment of such gear may present personnel with safety concerns (i.e., Mary River is often 'workable' only along the shoreline; most areas of the river below the mine are too deep/fast moving to wade across safely, and areas with large boulders present very uneven surfaces with rapid change in depth). For these reasons, the use of traps/nets are likely to be ineffective and/or present greater (unacceptable) safety risk for personnel. Finally, as discussed in the study design, no overwintering habitat is available for arctic charr in Mary River due to complete freezing in the winter. Therefore, YOY, juvenile and, to a lesser extent, adult arctic charr, inhabit Mary River only through the open-water period (i.e., June to September) following overwintering in lake environments. Because spawning only occurs in lakes of the region, the presence of YOY in Mary River only results in the migration of YOY from lakes. For juvenile arctic charr, preferred stream occupancy is mediated by physical barriers created by water velocity, distance from the lake, lake-ice dynamics, water depth, and turbidity. Water velocities result in stream habitat segregation by fish size, with YOY mainly found in low-velocity pools and back eddies adjacent to stream banks, but not in water velocities >0.1 m/s (see Sinnatamby et al. 2012. Summer habitat use and feeding of juvenile Arctic charr, Salvelinus alpinus, in the Canadian High Arctic, Ecology of Freshwater Fish 21: 309-322). Thus, migration, ascension, and occupancy of YOY into Mary River is likely to be limited by the physical habitat factors indicated above. The near absence of YOY in the sampled population in 2017 likely reflected limitations for YOY based on habitat conditions, and not the method of sampling. Based on the use of an approach consistent with EEM technical guidance recommendations, the fact that electrofishing has been shown to effectively sample arctic charr YOY in lakes and is not size-selective, and the presence of habitat that is largely non-conducive to inhabitation by YOY or deployment of small-mesh trapping/netting gear suitable for capturing YOY that also presents field personnel with safety risks, it is maintained that the use of electrofishing is the most suitable sampling gear for the collection of arctic charr YOY at Mary River.

ID	ECCC Description of Action Item	BIM Response
Action Item 3	p. 30. ECCC. The fish sampling areas proposed for Mary River are located near the MS-06 FDP and the treated sewage discharge. Could exposure of fish to these effluent streams confound the assessment of effects from the MS-08 effluent?	Fish sampling conducted during the Phase 1 EEM study was conducted upstream of the treated sewage discharge / MS-06 outfall location. However, there is the possibility that fish may be exposed to treated sewage effluent at the Mary River study areas during upstream migration to the effluent-exposed area, or through daily movement. The addition of nutrients to oligotrophic systems such as Mary River may be expected to result in increased fish condition. However, during the initial EEM, arctic charr exhibited slightly lower condition at the effluent-exposed area (-4.5%) compared to the reference area. Therefore, the results of the previous EEM fish population survey were not consistent with effects to fish typically associated with exposure to treated sewage. This suggested that fish captured during the Phase 1 EEM fish population survey either had not resided in the treated sewage effluent plume, or that increased productivity typically associated with treated effluent sewage discharges had not affected arctic charr during the Phase 1 EEM study.
Action Item 4	p. 30. ECCC. Similar to the Phase 1 study, the exposure area for the fish survey is located in the Mary River, two km downstream of the Tributary F confluence. A gorge restricts access further upstream near the confluence. Would it be feasible to sample in the area upstream of the gorge, in the immediate vicinity of the confluence with Tributary F?	During the Phase 1 EEM study, some exploratory electrofishing (i.e., no effort was recorded) was conducted in Mary River at the confluence of Mary River Tributary-F, but no fish were captured. The habitat at this area is characterized by large boulder (≥1 m diameter) substrate and relatively deep water, presenting some safety concerns for field personnel. However, despite this, fish sampling will initially be conducted at the confluence of Mary River Tributary-F to determine whether sufficient sample size can be obtained at this area. In the event of no/low catches, sampling will be conducted downstream of the gorge in the vicinity of the area that was sampled during the Phase 1 EEM study. Please see Photo 1 in the attachments.
Action Item 5	p. 31. ECCC. Figure 3.2 shows fish sampling areas proposed for the Phase 2 study. You have not proposed fish sampling in Tributary F, based on an assessment in 2017 that showed fish are unable to access the stream due to a barrier at the confluence with the Mary River. Are you aware of any changes to the fish barrier or conditions at the confluence that would enable fish to access to Tributary F?	No changes to the fish barrier on Mary River Tributary-F approximately 50 m upstream of Mary River are expected that would enable fish to access the tributary. The physical presence of high gradient at this location, combined with the timing of freshet and upstream migration of arctic charr, are unlikely to have resulted in any change to the fishless condition of Mary River Tributary-F. No fish were collected in Mary River Tributary-F during the Phase 1 EEM, as well as during historical exploratory sampling, the latter of which was not documented. This suggested that the absence of fish in Mary River Tributary-F is on-going and has not changed over time.
Action Item 6	p. 32. ECCC. The study design includes a new reference area for the fish population and fish tissue studies, to be selected from one of three tributaries to Lake Angarjurjuak. You propose to evaluate the tributaries for habitat features and fish presence this summer before selecting the site that is most comparable to the exposure area. Please provide any available information on the candidate reference streams in accordance with Schedule 5, subparagraph 10(a)(ii). It is noted that you intend to provide a detailed description of the selected reference area in the interpretive report.	There is currently no habitat information available for the new reference area on one of the three tributaries to Lake Angarjurjuak proposed as candidates in the Phase 2 EEM study design. These areas were identified simply by reviewing available satellite imagery and selecting areas that had the same watershed size, were situated with flow originating from a high plateau, and appeared to have the same channel width as Mary River (in addition to not being influenced by anthropogenic activities). No roads or trail systems allow access to the proposed reference areas, and access is by helicopter only. Because there has been no development in the area near the proposed reference areas, no habitat information for these tributaries has been collected, based on our knowledge. At the time of the Phase 2 EEM fish population survey, a helicopter reconnaissance will be conducted to identify areas that contain habitat that closely reflects that at the Mary River effluent-exposed area and, once arctic charr presence has been confirmed at the preferred study area, habitat information will be collected to support the fish population survey. This information will be provided in the interpretive report.
Action Item 7	ECCC sent you review comments on the Phase 1 interpretive report by email on October 18, 2019. Responses to the review comments should be submitted as an addendum to the interpretive report in EEMER.	Baffinland will provide responses to the review comments received October 18, 2019 as an addendum to the interpretive report in EEMER.
Item 8	p. 11. ECCC. The report refers to elevated ammonia, nitrate and sulphate concentrations in Tributary F; please specify where in the tributary you collected these samples.	Baffinland routinely samples water quality at Mary River Tributary-F at Station FO-01 for the Project's Aquatic Effects Monitoring Plan (AEMP). The station is located very near to the Mary River Tributary-F outlet to Mary River. Please see Figure 1 for the location of this station on a map.

ID	ECCC Description of Action Item	BIM Response
Item 9	p. 22. ECCC. The first study found no significant difference in YOY abundance between sampling areas, however it should be noted that only two YOY were captured in the exposure area and none were captured in the reference area.	Please refer to response to Action Item 2.
Item 10	p. 32. ECCC. You proposed a sample size of 20 fish per area for the lethal fish survey, and 100 juvenile fish for the non-lethal survey. Please note that EEM suggests up to seven days of fishing effort to achieve target sample sizes.	Acknowledged regarding the seven days of effort to achieve target sample sizes. Please note that the total number of fish targeted for the Phase 2 EEM fish population survey is 100 non-YOY (juvenile) Arctic charr from each study area, and that of these, 20 will be sacrificed as part of the lethal design to acquire information on relative liver size.
Item 11	p. 36. ECCC. In Table 3.5, you indicate ‘qualitative’ analysis of non-lethal fish reproduction; however, earlier in the text on p. 35, you describe the statistical comparison of length frequency distributions and relative proportions of YOY to evaluate differences in reproductive success. It was unclear if you were referring to these methods as ‘qualitative’ – please note that the EEM technical guidance document recommends assessment of the non-lethal reproduction indicator by comparison of size frequency distributions, with and without YOYs, using the Kolmogorov-Smirnov test, or by direct comparison of YOY proportions with the Chi-squared test (see Section 3.4.2.2, EC 2012).	Acknowledged. The term ‘qualitative’ was used to reflect the presumptive assumption that few YOY would be captured during the EEM study precluding statistical evaluation of the data. The analysis of non-lethal fish reproduction will be conducted as indicated in the comment by ECCC. Specifically, comparisons between effluent-exposed and reference study areas will be conducted using size frequency distributions, with and without YOYs, employing the Kolmogorov-Smirnov test, and by direct comparison of YOY proportions with a Chi-squared test
Item 12	p. 39. ECCC. Please ensure the interpretive report includes descriptive statistics (mean, median, standard error standard deviation, minimum and maximum) for fish tissue selenium concentrations (dry weight) and percentage moisture content, in accordance with Schedule 5, subparagraph 12(1)(e)(iv).	Acknowledged. Descriptive statistics (mean, median, standard error standard deviation, minimum and maximum) for fish tissue selenium concentrations (dry weight) and percentage moisture content will be provided in the interpretive report in accordance with Schedule 5, subparagraph 12(1)(e)(iv).

Baffinland

ATTACHMENT 2

Supporting Documents in Response to ECCC's Mary River Project Second Phase EEM Study Design Comments

Photo 1: During the Phase 1 EEM study, some exploratory electrofishing (i.e., no effort was recorded) was conducted in Mary River at the confluence of Mary River Tributary-F, but no fish were captured. The habitat at this area is characterized by large boulder (≥1 m diameter) substrate and relatively deep water.

Table 1: Percent Effluent Relative to Flow in Mary River Tributary-F and Mary River[a], 2017

Date	Flow (m^3/s)		Station MS-08 Discharge			Station MS-06 Discharge	
	Mary River Tributary-F	Mary River	MS-08 Effluent Flow (m^3/s)	MRTF Effluent Concentration (%)	Mary River Effluent Concentration (%)	MS-06 Effluent Flow (m^3/s)	Mary River Effluent Concentration (%)
26-Jun		35.69					
27-Jun	0.90	37.10					
28-Jun	0.91	40.14					
29-Jun	0.89	46.66					
30-Jun	0.87	35.78					
1-Jul	0.87	28.62					
2-Jul	0.85	29.58	0.020	2.28%	0.07%		
3-Jul	0.83	31.93	0.011	1.29%	0.04%		
4-Jul	0.81	36.80					
5-Jul	0.83	29.74					
6-Jul	0.79	20.35					
7-Jul	0.72	24.30					
8-Jul	0.76	30.32	0.000	0.02%	0.00%		
9-Jul	0.80	35.98					
10-Jul	0.82	25.31					
11-Jul	0.71	15.74					
12-Jul	0.61	8.56					
13-Jul	0.43	12.49					
14-Jul	0.63	9.53					
15-Jul	0.46	11.85					
16-Jul	0.50	16.69					
17-Jul	0.60	14.47	0.009	1.45%	0.06%		
18-Jul	0.50	8.19	0.000	0.05%	0.00%		
19-Jul	0.40	8.98	0.015	3.71%	0.18%		
20-Jul	0.49	14.65	0.003	0.58%	0.02%		
21-Jul	0.60	13.64	0.010	1.56%	0.07%		
22-Jul	0.48	12.83					
23-Jul	0.51	22.77					
24-Jul	0.66	26.04					
25-Jul	0.65	39.25					
26-Jul	0.77	16.12					
27-Jul	0.54	12.40					
28-Jul	0.43	28.76					
29-Jul	0.73	51.78	0.004	0.53%	0.01%		
30-Jul	0.66	37.33	0.010	1.52%	0.03%		
31-Jul	0.85	16.26	0.004	0.47%	0.03%	no discharge in 2017	
1-Aug	0.50	8.47	0.005	1.07%	0.07%		
2-Aug	0.37	6.15					
3-Aug	0.21	5.52	0.004	2.03%	0.08%		
4-Aug	0.20	5.20					
5-Aug	0.19	4.92					
6-Aug	0.19	5.53					
7-Aug	0.20	8.68					
8-Aug	0.37	5.07					
9-Aug	0.19	4.56					
10-Aug	0.18	4.05					
11-Aug	0.17	3.49					
12-Aug	0.17	2.96					
13-Aug	0.16	5.66					
14-Aug	0.20	10.35					
15-Aug	0.40	3.62					
16-Aug	0.17	2.45					
17-Aug	0.15	1.72					
18-Aug	0.14	1.59					
19-Aug	0.14	1.54					
20-Aug	0.14	1.45					
21-Aug	0.14	1.38					
22-Aug	0.13	1.55					
24-Aug	0.14	1.37	0.004	3.03%	0.32%		
25-Aug	0.13	2.03	0.004	3.13%	0.22%		
26-Aug	0.14	8.15	0.010	6.54%	0.13%		
27-Aug	0.37	8.17	0.006	1.59%	0.08%		
28-Aug	0.38	8.90	0.003	0.72%	0.03%		
29-Aug	0.37	6.93	0.007	1.83%	0.10%		
30-Aug	0.25	3.57	0.014	5.29%	0.41%		
31-Aug	0.17	3.47	0.012	6.50%	0.35%		
1-Sep	0.17	3.01	0.009	4.99%	0.30%		
2-Sep	0.16	2.40	0.005	3.08%	0.22%		
3-Sep	0.15	2.02	0.014	8.38%	0.70%		
4-Sep	0.14	1.75	0.009	5.98%	0.54%		
5-Sep	0.14	12.00	0.011	7.45%	0.10%		
6-Sep	0.43	66.25	0.010	2.29%	0.02%		
7-Sep	0.94	47.67					
Average	**0.44**	**15.52**	**0.01**	**2.87%**	**0.15%**	**-**	**-**
Maximum	**0.94**	**66.25**	**0.02**	**8.38%**	**0.70%**	**0.0**	**0.000%**

[a] Effluent concentration at the confluence with the effluent pathway for each respective discharge. Only dates for which both streamflow and effluent discharge data were available are displayed and used for calculations of effluent concentration.

Table 2: Percent Effluent Relative to Flow in Mary River Tributary-F and Mary River[a], 2018

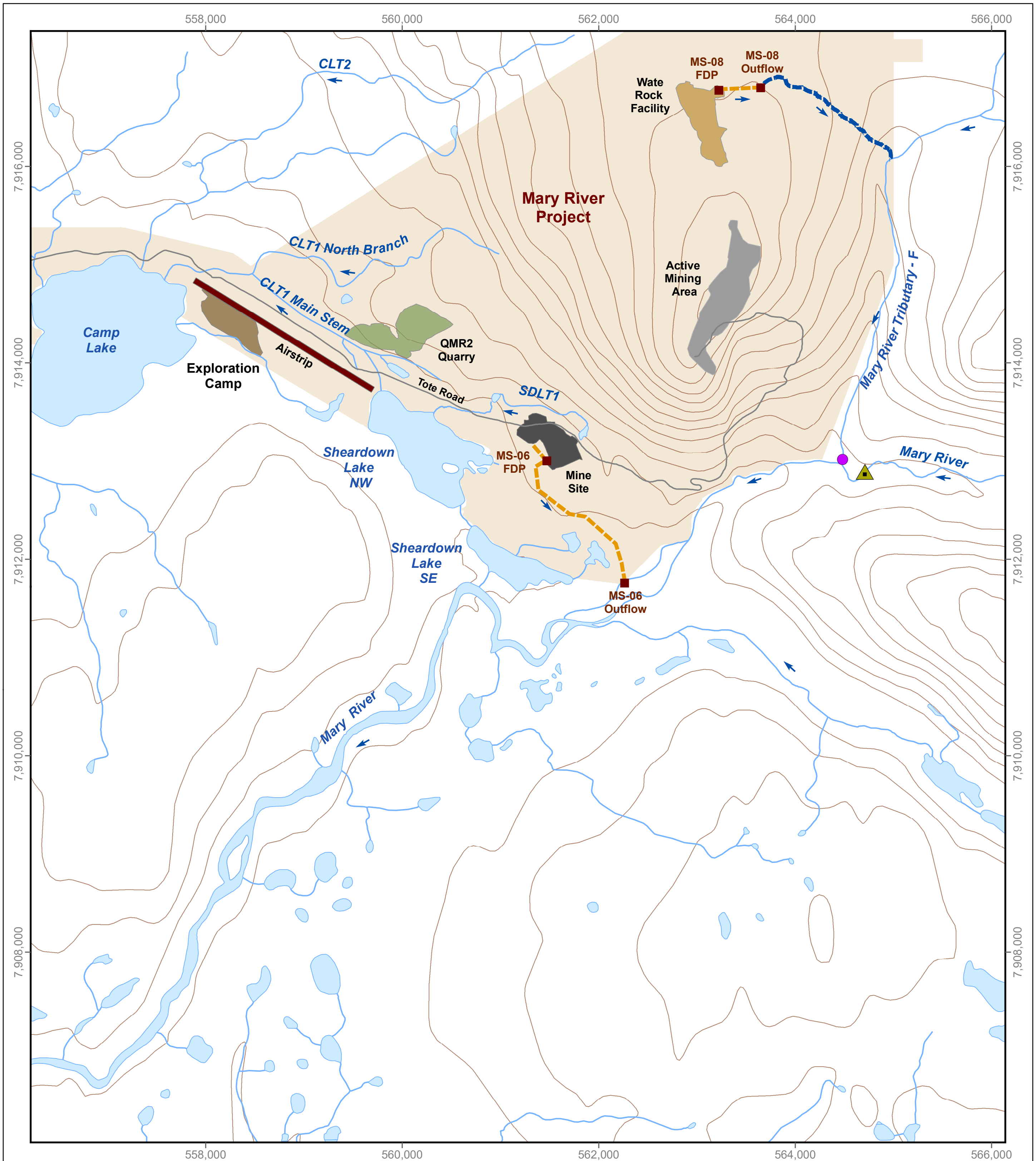
Date	Flow (m^3/s)		Station MS-08 Discharge			Station MS-06 Discharge	
	Mary River Tributary-F	Mary River	MS-08 Effluent Flow (m^3/s)	MRTF Effluent Concentration (%)	Mary River Effluent Concentration (%)	MS-06 Effluent Flow (m^3/s)	Mary River Effluent Concentration (%)
20-Jun	0.13	4.30				0.0005	0.011%
21-Jun	0.10	3.54					
22-Jun	0.35	11.88				0.0003	0.002%
23-Jun	0.27	9.13					
24-Jun	0.24	8.33				0.0010	0.012%
25-Jun	0.24	8.10					
26-Jun	0.23	8.01					
27-Jun	0.25	8.60					
28-Jun	0.25	8.53					
29-Jun	0.35	12.01				0.0006	0.005%
30-Jun	0.40	13.68	0.011	2.6%	0.08%	0.0010	0.007%
1-Jul	0.38	13.07	0.011	2.7%	0.08%		
2-Jul	0.62	21.12	0.016	2.5%	0.08%	0.0005	0.002%
3-Jul	0.41	13.92	0.003	0.7%	0.02%	0.0010	0.007%
4-Jul	0.38	12.84	0.006	1.6%	0.05%	0.0005	0.004%
5-Jul	0.34	11.48	0.044	11.7%	0.38%	0.0009	0.008%
8-Jul	0.40	13.77	0.012	2.9%	0.09%		
11-Jul	0.31	10.76	0.012	3.7%	0.11%	0.0000	0.000%
12-Jul	0.29	9.94	0.016	5.3%	0.16%	0.0007	0.007%
13-Jul	0.61	20.72	0.028	4.4%	0.13%		
14-Jul	0.25	8.43	0.010	4.1%	0.12%	0.0007	0.008%
15-Jul	0.16	5.58	0.017	9.4%	0.30%	0.0005	0.009%
16-Jul	0.14	4.80	0.019	11.8%	0.39%	0.0009	0.018%
17-Jul	0.13	4.38	0.019	12.9%	0.43%	0.0008	0.019%
18-Jul	0.11	3.82				0.0007	0.018%
19-Jul	0.10	3.58	0.003	2.7%	0.08%	0.0009	0.024%
20-Jul	0.12	4.04	0.007	5.7%	0.18%	0.0009	0.022%
21-Jul	0.12	4.10	0.017	12.2%	0.41%	0.0013	0.032%
22-Jul	0.10	3.40	0.011	9.9%	0.32%	0.0009	0.026%
23-Jul	0.08	2.74	0.005	5.9%	0.18%	0.0002	0.006%
24-Jul	0.09	3.10	0.006	6.6%	0.21%	0.0010	0.031%
25-Jul	0.15	5.25	0.009	5.7%	0.18%	0.0011	0.020%
26-Jul	0.11	3.92	0.012	9.2%	0.30%	0.0011	0.028%
27-Jul	0.08	2.84				0.0011	0.039%
28-Jul	0.61	20.96				0.0008	0.004%
29-Jul	0.50	17.10					
30-Jul	0.51	17.44	0.000	0.0%	0.00%		
31-Jul	0.49	16.72	0.038	7.2%	0.23%	0.0008	0.005%
1-Aug	0.48	16.50	0.012	2.4%	0.07%	0.0006	0.004%
2-Aug	0.31	10.63	0.024	7.2%	0.23%	0.0006	0.006%
3-Aug	0.22	7.56	0.054	19.6%	0.71%	0.0011	0.015%
4-Aug	0.92	31.48	0.027	2.9%	0.09%	0.0006	0.002%
5-Aug	1.06	36.12	0.057	5.1%	0.16%	0.0006	0.002%
6-Aug	0.88	30.02	0.045	4.9%	0.15%		
7-Aug	0.52	17.91	0.027	4.9%	0.15%	0.0021	0.012%
8-Aug	0.34	11.48	0.013	3.7%	0.11%	0.0017	0.014%
9-Aug	0.37	12.52	0.000	0.1%	0.00%	0.0015	0.012%
10-Aug	0.23	7.85	0.006	2.4%	0.07%		
11-Aug	0.17	5.98	0.022	11.4%	0.37%	0.0002	0.004%
12-Aug	0.14	4.77	0.026	15.7%	0.54%		
13-Aug	0.12	4.05	0.021	15.1%	0.52%		
14-Aug	0.11	3.64	0.019	15.0%	0.51%		
17-Aug	0.11	3.68	0.010	8.9%	0.28%	0.0001	0.002%
18-Aug	0.09	3.23	0.003	3.3%	0.10%		
21-Aug	0.19	6.50	0.007	3.3%	0.10%		
22-Aug	0.21	7.18					
24-Aug	0.13	4.29					
25-Aug	0.10	3.55	0.000	0.0%	0.00%		
26-Aug	0.09	3.17	0.019	17.2%	0.60%		
27-Aug	0.09	2.96	0.010	9.9%	0.32%		
28-Aug	0.08	2.70				0.0000	0.001%
29-Aug	0.07	2.43	0.011	13.0%	0.43%		
30-Aug	0.06	2.21	0.007	10.0%	0.32%		
31-Aug	0.06	2.10	0.001	0.8%	0.02%		
1-Sep	0.06	1.95					
2-Sep	0.05	1.80					
3-Sep	0.06	1.98					
4-Sep	0.07	2.43	0.003	4.4%	0.14%		
5-Sep	0.16	5.62	0.011	6.3%	0.20%		
6-Sep	0.15	5.26	0.013	7.9%	0.25%		
7-Sep	0.13	4.46	0.003	2.2%	0.07%		
Average	**0.26**	**8.76**	**0.01**	**6.4%**	**0.21%**	**0.0007**	**0.012%**
Maximum	**1.06**	**36.12**	**0.06**	**19.6%**	**0.71%**	**0.0021**	**0.039%**

[a] Effluent concentration at the confluence with the effluent pathway for each respective discharge. Only dates for which both streamflow and effluent discharge data were available are displayed and used for calculations of effluent concentration.

Table 3: Percent Effluent Relative to Flow in Mary River Tributary-F and Mary River[a], 2019

Date	Flow (m^3/s)		Station MS-08 Discharge			Station MS-06 Discharge	
	Mary River Tributary-F	Mary River	MS-08 Effluent Flow (m^3/s)	MRTF Effluent Concentration (%)	Mary River Effluent Concentration (%)	MS-06 Effluent Flow (m^3/s)	Mary River Effluent Concentration (%)
16-Jun	0.91	39.89	0.017	1.9%	0.04%		
17-Jun	1.02	45.14	0.021	2.0%	0.05%		
18-Jun	1.39	46.40	0.026	1.8%	0.06%		
19-Jun	1.18	36.23	0.030	2.5%	0.09%		
20-Jun	0.56	15.95	0.025	4.3%	0.16%		
21-Jun	0.42	10.94	0.026	5.8%	0.24%		
22-Jun	0.37	9.88	0.009	2.4%	0.10%		
23-Jun	0.93	5.33	0.006	0.7%	0.12%		
24-Jun	0.74	28.12	0.009	1.2%	0.03%		
25-Jun	0.65	16.53	0.012	1.8%	0.08%		
26-Jun	0.46	17.10	0.012	2.5%	0.07%		
27-Jun	0.97	23.47	0.014	1.4%	0.06%		
28-Jun	0.90	29.42	0.017	1.9%	0.06%		
29-Jun	0.69	15.99	0.005	0.8%	0.04%		
30-Jun	0.65	13.99	0.007	1.1%	0.05%		
1-Jul	0.51	10.62	0.006	1.2%	0.06%		
2-Jul	0.46	9.24	0.009	1.9%	0.10%		
3-Jul	0.41	6.13	0.008	2.0%	0.14%		
4-Jul	0.28	4.78	0.009	3.1%	0.19%		
5-Jul	0.19	3.93	0.008	4.0%	0.20%		
8-Jul	0.13	3.59	0.003	2.2%	0.08%		
11-Jul	0.47	14.75	0.005	1.0%	0.03%		
12-Jul	0.43	12.35	0.019	4.1%	0.16%		
13-Jul	0.83	20.00	0.035	4.1%	0.18%		
14-Jul	0.56	33.15	0.045	7.4%	0.14%		
15-Jul	0.37	11.53	0.027	6.8%	0.24%		
16-Jul	0.28	10.55	0.025	8.3%	0.25%		
17-Jul	0.23	10.50	0.039	14.5%	0.38%		
18-Jul	0.28	9.52	0.030	9.7%	0.32%		
19-Jul	0.28	17.80	0.028	9.2%	0.16%		
20-Jul	0.15	10.31	0.028	15.7%	0.28%		
21-Jul	0.12	6.20	0.027	18.2%	0.45%		
22-Jul	0.08	4.78	0.023	21.4%	0.48%		
23-Jul	0.15	5.45	0.031	17.4%	0.59%		
24-Jul	0.32	9.25	0.016	4.9%	0.18%		
25-Jul	0.32	9.28	0.019	5.8%	0.21%		
26-Jul	0.22	10.22	0.018	7.6%	0.18%		
27-Jul	0.12	5.20	0.013	10.2%	0.26%		
28-Jul	0.12	5.10	0.011	8.2%	0.21%		
29-Jul	0.10	4.67	0.014	12.9%	0.31%		
30-Jul	0.42	17.20	0.009	2.1%	0.05%		
31-Jul	0.20	8.82	0.025	11.3%	0.30%		
1-Aug	0.12	5.58	0.016	11.5%	0.29%		
2-Aug	0.11	4.52	0.022	17.2%	0.51%		
3-Aug	0.09	4.03	0.032	27.0%	0.82%		
4-Aug	0.08	3.76	0.011	12.1%	0.31%		
5-Aug	0.15	5.05	0.005	3.5%	0.11%		
6-Aug	0.12	4.86	0.012	9.7%	0.26%		
7-Aug	0.09	4.01	0.014	12.8%	0.35%		
8-Aug	0.08	3.63	0.014	15.1%	0.40%		
9-Aug	0.08	3.53	0.020	20.4%	0.59%		
10-Aug	0.08	3.55	0.024	23.5%	0.71%		
11-Aug	0.08	3.49	0.010	11.6%	0.29%		
12-Aug	0.07	3.39	0.015	18.7%	0.46%		
13-Aug	0.07	3.47	0.017	19.3%	0.51%		
14-Aug	0.07	3.53	0.018	20.1%	0.53%		
17-Aug	0.06	3.58	0.001	2.1%	0.04%		
18-Aug	0.06	3.56	0.007	10.0%	0.20%		
21-Aug	0.06	3.39	0.005	7.2%	0.14%		
22-Aug	0.06	3.38	0.010	13.4%	0.30%		
24-Aug	0.29	10.43	0.007	2.4%	0.07%		
25-Aug	0.15	6.79	0.008	5.0%	0.12%		
26-Aug	0.22	6.23	0.015	6.3%	0.24%		
27-Aug	0.14	5.21	0.014	9.0%	0.28%		
28-Aug	0.21	7.33	0.005	2.4%	0.07%		
29-Aug	0.12	5.18	0.005	3.8%	0.10%	0.0002	0.003%
30-Aug	0.42	13.30	0.017	3.8%	0.13%	0.0015	0.012%
31-Aug	0.26	9.86	0.014	4.9%	0.14%	0.0024	0.025%
1-Sep	0.15	6.47	0.006	3.7%	0.09%	0.0023	0.037%
2-Sep	0.11	4.90	0.005	4.1%	0.10%	0.0024	0.050%
3-Sep	0.10	4.36	0.009	8.6%	0.21%	0.0020	0.048%
4-Sep	0.09	4.04	0.004	4.5%	0.11%	0.0019	0.047%
5-Sep	0.08	3.83	0.006	6.5%	0.15%	0.0022	0.059%
6-Sep	0.08	3.57	0.006	6.9%	0.16%	0.0015	0.043%
7-Sep	0.07	3.32	0.004	5.9%	0.14%		
Average	**0.29**	**9.74**	**0.02**	**7.8%**	**0.22%**	**0.18%**	**0.036%**
Maximum	**1.39**	**46.40**	**0.04**	**27.0%**	**0.82%**	**0.0**	**0.059%**

[a] Effluent concentration at the confluence with the effluent pathway for each respective discharge. Only dates for which both streamflow and effluent discharge data were available are displayed and used for calculations of effluent concentration.



LEGEND

- Water Quality Station
- Mary River Cascade Barrier
- Discharge Location
- Discharge Line
- Overland Effluent Channel

Location of Water Quality Monitoring Requested for Item 8 by ECCC

0 0.75 1.5 3 km

N W E S

Map Projection: UTM Zone 17N NAD 1983

Data Source: Reproduced under licence from Her Majesty the Queen in Rights of Canada, Department of Natural Resources Canada.

Date: May 2020

Project No 197202.0032

minnow environmental inc.

A Trinity Consultants Company

Figure 1

Document Path: S:\Projects\197202\197202.0032 - Baffinland 2019 CREMP and EEM SD\4 - GIS\Addendum May 2020\19-32 Figure 1 Location of Water Quality Monitoring Requested in ECCC Item 8.mxd

Prairie and Northern Region
Environmental Protection Operations Directorate
Environment and Climate Change Canada
9250 – 49th Street NW
Edmonton, AB T6B 1K5

File #: MM3108

June 19, 2020

Via email to: Timothy.Sewell@baffinland.com

Timothy Ray Sewell
Senior Director of Health, Safety, Environment, Security and Training
Baffinland Iron Mines Corporation
2275 Upper Middle Road East, Suite 300
Oakville, ON L6H 0C3

Dear Timothy Ray Sewell:

Subject: Mary River Project 2nd EEM Study Design

Environment and Climate Change Canada (ECCC) has reviewed your "Mary River Project Second Phase Environmental Effects Monitoring Study Design," submitted February 7, 2020 and the addendum submitted May 13, 2020. Our review took into account requirements of the *Metal and Diamond Mining Effluent Regulations* (MDMER) of the *Fisheries Act*, information in the EEM Technical Guidance Document as well as generally accepted standards of good scientific practice. This review is not a substitute for reading the MDMER and does not in any way supersede or modify the *Fisheries Act* or the MDMER. In the event of an inconsistency between this review and the Act and/or the MDMER, the Act and the Regulations prevail.

ECCC has completed the review and has no further comments at this time.

ECCC would appreciate receiving a final schedule for the biological monitoring, sent to Erik Allen at erik.allen@canada.ca at least two weeks prior to the commencement of field activities. As required under the MDMER, biological monitoring studies must be conducted in accordance with the study design. If it becomes impossible to follow the study design because of unusual circumstances, the mine must inform the Minister of the Environment (c/o Regional Director at ec.drrpn-rdpnr.ec@canada.ca) of those circumstances, without delay, and how the study will be conducted.

ECCC anticipates receiving the 2nd interpretive report no later than January 10, 2021. Regulated facilities are required to submit EEM reports and biological monitoring data to the Environmental Effects Monitoring Electronic Reporting system (EEMER) at https://ec.ss.ec.gc.ca/.

If you have any questions or concerns about the EEM program or if you wish to discuss the study design, please contact Regional Coordinator Erik Allen at 780-717-4884 or at erik.allen@canada.ca. For questions regarding EEMER, please contact ec.esee-eem.ec@canada.ca.

Sincerely,

Margaret Fairbairn
A/Regional Director

cc:	Cristina Ruiu	Environment and Climate Change Canada, Regina
	Erik Allen	Environment and Climate Change Canada, Edmonton
	Monika Trottier	Environment and Climate Change Canada, Iqaluit
	Bridget Campbell	Crown-Indigenous Relations and Northern Affairs Canada
	Godwin Okonkwo	Crown-Indigenous Relations and Northern Affairs Canada
	Assol Kubeisinova	Nunavut Water Board
	Karén Kharatyan	Nunavut Water Board
	Shawn Stevens	Baffinland Iron Mines Corporation
	Connor Devereaux	Baffinland Iron Mines Corporation
	Aaron MacDonell	Baffinland Iron Mines Corporation

APPENDIX B

HABITAT CHARACTERIZATION INFORMATION

APPENDIX B HABITAT CHARACTERIZATION

B.1 Introduction

Habitat characterization provides information integral to the interpretation of effluent-related influences on benthic invertebrate communities and fish populations residing within aquatic environments that receive mine discharge. At Mary River Project, effluent is released overland into an intermittent channel that meets Mary River Tributary-F approximately 2 km east-northeast of the effluent discharge point. From this confluence, Mary River Tributary-F flows south approximately 3.3 km before discharging into Mary River. Mary River Tributary-F downstream of the effluent confluence and Mary River extending approximately 2.5 km downstream of the Mary River Tributary-F confluence served as the mine effluent-exposed areas for the benthic invertebrate community survey and fish population/fish tissue surveys, respectively (Figure 2.1). In both the 2017 Phase 1 and 2020 Phase 2 EEM biological studies, Mary River Tributary-F upstream of the effluent channel served as the reference area for the benthic invertebrate community (benthic) surveys, and Mary River just upstream of Mary Lake served as a reference area for the fish population and/or fish tissue (fish) surveys (Figure 2.1). In the 2020 Phase 2 EEM biological study, an unnamed tributary discharging into Angajurjualuk Lake served as a second reference area for the fish population and fish tissue surveys (Figure 2.1). Aquatic habitat characterization information collected at the Mary River Project EEM study areas are summarized and contrasted herein to evaluate the degree to which natural habitat influences potentially contributed to differences in biological endpoints between like effluent-exposed and reference areas.

B.2 Benthic Survey Study Areas: Mary River Tributary-F

Mary River Tributary-F occurs as a seasonally-flowing, second-order stream draining a watershed of approximately 6.8 square kilometres (km^2) at the confluence with the MS-08 mine effluent channel and 11.6 km^2 near the mouth at Mary River. Mary River Tributary-F exhibits a moderate gradient through the headwaters and mid-reaches, averaging approximately 4.5% and 6.3% at EEM benthic invertebrate community study areas located upstream and downstream of the MS-08 channel confluence, respectively (Table B.1; Photo Plate B.1). High gradients of approximately 10 to 12% are exhibited within approximately 0.8 km of the outlet to Mary River on Mary River Tributary-F (Photo Plate B.1). The channel of Mary River Tributary-F is typically well defined, exhibiting a slight meander, but areas of interstitial flow and/or channel braiding are not uncommon particularly in the upper and mid-reaches of the watercourse. Stream morphology of Mary River Tributary-F consists predominantly of riffle-run sequences separated by scour pools and rapids within the upper and mid-reaches (Table

B.1), whereas riffle-cascade habitat is more prevalent at high gradient areas of the lower portion of the system. The combination of complete freezing overwinter, a relatively higher stream gradient, and the presence of natural in-stream barriers including an approximately 1.75 m high step-drop over large boulder habitat about 50 m upstream of the outlet to Mary River (Photo Plate B.1) are likely key factors contributing to the naturally fishless condition of Mary River Tributary-F shown in the previous EEM study (Minnow 2018, 2020).

The wetted and bankfull width of Mary River Tributary-F were greater immediately downstream of the MS-08 channel confluence than upstream at the time of the August EEM field studies in 2017 and 2020, although these differences were not shown to differ significantly in the Phase 2 EEM study (Tables B.2 and B.3). Notably, the determination of overall wet channel features was partly confounded by the occurrence of interstitial flow through boulder and/or large cobble substrate at these study areas. On average, water depths and water velocity were greater downstream than upstream of the MS-08 effluent channel confluence during the August 2020 sampling events, but only the difference in water depth was significant between areas (Table B.3).

The substrate of Mary River Tributary-F is composed primarily of cobble and boulder (average of 53% and 35%, respectively, of in-stream substrate; Table B.2). Pebbles (i.e., 2 to 5 cm diameter material) and gravel constituted the remainder of in-stream substrate material observed in field studies conducted in August. Medium to coarse sand was observed only in trace amounts, and was primarily confined to areas of quiescent flow along channel banks and/or immediately downstream of large boulders. On average, substrate diameter (intermediate axis) was slightly larger downstream than upstream of the MS-08 effluent channel confluence on Mary River Tributary-F, although the difference in substrate diameter between these areas was not significant (Tables B.1 and B.3). In-stream vegetation was limited to a thin layer of periphyton (biofilms) attached to rocks not of sandstone or conglomerate origin based on visible and/or tactile assessment. No marked differences in periphyton growth were apparent between the Mary River Tributary-F effluent-exposed and reference study areas at the time of the August 2017 or 2020 EEM field studies (Table B.1).

B.3 Fish Survey Study Areas: Mary River

Mary River is a moderate gradient system (i.e., average gradient of 0.9%) characterized mainly by riffle-run morphology with some rapid/cascade habitat that includes an approximately 20 m high natural cascade located approximately 400 m upstream of the confluence with Mary River Tributary-F (Figure 2.1). At the confluence with Mary River Tributary-F, the Mary River flows through a deep gorge (Photo Plate B.1). The wetted channel width of Mary River decreases from an average of approximately 47 m to 19 m from upstream to downstream of this cascade, respectively, under typical late summer flow conditions. Commensurate with these changes in wetted width, average stream depth and water velocity were lower upstream of the cascade than downstream (0.30 and 0.48 m deep, and 0.43 and 0.85 m/s water velocity, respectively), based on sampling conducted in August 2015 (Minnow 2016). At the confluence with Mary River Tributary-F, Mary River has a watershed area of approximately 233 km^2.

The area of Mary River located a short distance downstream of the gorge served as the effluent-exposed area for the EEM fish population/fish tissue surveys (Figure 2.3). At this location, Mary River occurs as a series of well-defined braided channels. Stream morphology of the braid sampled for the fish population/tissue surveys consisted almost entirely of riffle habitat, with rapids also occurring in limited amounts (Table B.1). The wetted width and depth of this Mary River braid averaged approximately 20 m and 32 cm, respectively, under August flow conditions (Table B.1). The substrate at the Mary River fish population survey effluent-exposed area is composed primarily of cobble (88% of in-stream habitat, on average; Table B.1; Photo Plate B.2). Similar to Mary River Tributary-F, medium to coarse sand was observed in trace amounts at this area of Mary River, and was limited primarily to locations with quiescent flow such as along channel banks and/or immediately downstream of large boulders. Substrate diameter (intermediate axis) averaged approximately 12 cm at the Mary River fish population survey effluent-exposed area (Table B.1).

Lower Mary River, near the outlet to Mary Lake, served as one of two reference area for the EEM fish population/tissue surveys (Figure 2.3). At this area, Mary River occurs as a single, well-defined channel characterized mainly by riffle habitat and a minor amount of rapid habitat (Table B.1; Photo Plate B.2). The wetted width and depth of 73 m and 47 cm, respectively, at the Mary River reference area were much greater than the effluent-exposed area, reflecting braided channel dimensions at the latter, under August flow conditions (Table B.1). Unlike the effluent-exposed area, the substrate at the Mary River reference area is composed primarily of boulders (75% of in-stream habitat) embedded in coarse sand rather than cobble (Table B.1). On average, the substrate diameter (intermediate axis) was 56 cm at the Mary River fish population survey reference area, which was much larger than at the corresponding effluent-exposed area (Table B.1). Overall, some differences in habitat features were apparent between the Mary River effluent-exposed and reference areas used for the fish population/ tissue surveys, including the occurrence of shallower mean depth and smaller substrate diameter (i.e., predominance of cobble versus boulder substrate) at the effluent-exposed area than at the reference area.

B.4 Fish Survey Study Area: Angajurjualuk Lake Tributary Reference

Angajurjualuk Lake Tributary, which served as a reference area for the fish population/tissue surveys (Figure 2.1), is a moderate gradient system characterized by roughly equal proportion of rapid, riffle, and run stream morphology (Table B.1). An area of Angajurjualuk Lake Tributary located approximately 4.0 km upstream of Angajurjualuk Lake was sampled as a reference area for the EEM fish population/fish tissue surveys (Figure 2.3).[1] At this location, Angajurjualuk Lake Tributary occurs as two well-defined braided channels. Stream morphology of the braid sampled for the fish population/tissue surveys consisted of moderate to fast flow, including the presence of rapids (Table B.1). The wetted width and depth of this braid of Angajurjualuk Lake Tributary averaged approximately 23 m and 52 cm, respectively, under August flow conditions (Table B.1; Photo Plate B.3). The substrate at Angajurjualuk Lake Tributary is composed primarily of boulder and cobble (total of 79% of in-stream habitat) and only limited amounts of sand present mainly along shorelines, interstitially, and/or composing substrate in pools (Table B.1; Photo Plate B.3). At the area sampled for the EEM fish population/tissue surveys, Angajurjualuk Lake Tributary has a watershed area of approximately 161 km^2.

Habitat at Angajurjualuk Lake Tributary was generally similar to that shown at the Mary River effluent-exposed area in terms of channel braiding, mean wetted width, channel depth, combined proportion of boulder and cobble substrate, and distance upstream from the nearest fish-bearing lake. The primary differences in habitat between these study areas included a lower proportion of slower-flowing run habitat and larger watershed size at the Mary River effluent-exposed area compared to Angajurjualuk Lake Tributary (Table B.1). However, these differences were not expected to result in marked differences in fish population endpoints or fish tissue metal concentrations between study areas, and thus, combined with the fact that Angajurjualuk Lake Tributary is uninfluenced by past or present mine operations, the latter was considered a suitable reference area for the EEM fish population/tissue surveys.

[1] A small unnamed lake is located between the Angajurjualuk Lake Tributary EEM study area and Angajurjualuk Lake.

1) Mary River Tributary-F Benthic Reference Area.

2) Mary River Tributary-F Benthic Effluent-Exposed Area.

3) Mary River Tributary-F step-drop cascade barrier.

4) Mary River downstream of Mary River Tributary-F confluence.

Photo Plate B.1: Photographs of Mary River Tributary-F and Mary River at Gorge Area, August 2017

1) Mary River Fish Population Effluent-Exposed Area.

2) Mary River Fish Population Effluent-Exposed Area Substrate.

3) Mary River Fish Population Reference Area.

4) Mary River Fish Population Reference Area Substrate.

Photo Plate B.2: Photographs of Mary River Fish Population Survey Effluent-Exposed and Reference Areas, August 2017

1) ALTR Fish Population Reference Area (upper).

2) ALTR Fish Population Reference Area (middle).

3) ALTR Fish Population Reference Area (lower).

4) ALTR Fish Population Reference Area (lower).

Photo Plate B.3: Photographs of Angajurjualuk Lake Tributary Fish Population Survey Reference Area, August 2020

Table B.1: Mean Habitat Features for Mary River Tributary-F, Angajurjualuk Lake Tributary, and Mary River EEM Study Areas Based on Measures and Observations Recorded During the First and Second EEM Field Studies Conducted in August of Each of 2017 and 2020, Respectively

Habitat Characteristic		Mary River Tributary-F		Angajurjualuk Lake Tributary	Mary River	
		Upstream Reference (MRTF-REF)	Downstream Effluent-Exposed (MRTF-EXP)	Fish Reference (ALTR)	Reference (MRR)	Effluent-Exposed (MRE)
Mean Width (m)	Wetted	12.0	10.7	22.7	72.9	20.3
	Bankfull	24.2	26.0	13	not measured	not measured
Mean Depth (cm)	Average	11.7	21.3	43.8	47.7	32.4
Mean Velocity (m/s)	Average	0.28	0.30	not measured	0.30	not measured
Stream Morphology	% Rapid	5	10	31	10	10
	% Riffle	56	76	35	90	90
	% Run	35	11	28	0	0
	% Pool	5	3	6	0	0
	% Gradient	4.8	6.3	not measured	not measured	not measured
Substrate (% areal coverage)		0% bedrock 38% boulder 51% cobble 9% pebble 2% gravel 0% sand	0% bedrock 33% boulder 55% cobble 10% pebble 2% gravel 0% sand	0% bedrock 45% boulder 34% cobble 10% pebble 6% gravel 5% sand	0% bedrock 75% boulder 15% cobble 5% pebble 0% gravel 5% sand	0% bedrock 5% boulder 88% cobble 8% pebble 0% gravel 0% sand
Mean Substrate Size (cm)		9.8	13.3	not measured	55.9	11.9
Aquatic Vegetation (% areal coverage)	Periphyton Description	<0.5 mm thick of attached algae/periphyton on rocks	<0.5 mm thick of attached algae/periphyton on rocks	<0.5 mm thick of attached algae/periphyton on rocks	<0.5 mm thick of attached algae/periphyton on rocks	<0.5 mm thick of attached algae/periphyton on rocks
	Macrophyte Coverage	none observed	none observed	none observed	none observed	none observed

Table B.2: Summary of Habitat Features at Mary River Tributary-F Benthic Invertebrate Community Study Areas for the Mary River Project Second EEM Study, August 2020

Habitat Characteristic		Mary River Tributary-F Reference					Mary River Tributary-F Effluent-Exposed				
		MRTF-REF1	MRTF-REF2	MRTF-REF3	MRTF-REF4	MRTF-REF5	MRTF-EXP1	MRTF-EXP2	MRTF-EXP3	MRTF-EXP4	MRTF-EXP5
Mean Width (m)	Wetted	9.0	9.0	8.5	16.5	17.0	4.0	12.5	19.0	15.0	2.8
	Bankfull	17	19	25	30	30	20	30	35	23	23
Mean Depth (cm)	Average	13.2	8.5	15.7	9.5	11.8	17.5	18.8	14.8	38.2	17.0
Mean Velocity (m/s)	Average	0.33	0.20	0.29	0.35	0.23	0.36	0.38	0.26	0.15	0.34
Stream Morphology	% Pool	0	0	0	0	0	0	0	5	15	30
	% Rapid	100	0	10	30	40	80	85	70	75	70
	% Riffle	0	100	80	70	40	20	10	20	5	0
	% Run	0	0	10	0	20	0	5	5	5	0
	% Gradient	4.5	not measured	5	not measured	6	7	not measured	5	not measured	7
Substrate (% areal coverage)		0% bedrock 55% boulder 40% cobble 5% pebble 0% gravel 0% sand	0% bedrock 35% boulder 50% cobble 10% pebble 5% gravel 0% sand	0% bedrock 35% boulder 50% cobble 10% pebble 5% gravel 0% sand	0% bedrock 35% boulder 50% cobble 10% pebble 5% gravel 0% sand	0% bedrock 25% boulder 65% cobble 10% pebble 0% gravel 0% sand	0% bedrock 30% boulder 60% cobble 10% pebble 0% gravel 0% sand	0% bedrock 35% boulder 50% cobble 10% pebble 5% gravel 0% sand	0% bedrock 20% boulder 65% cobble 10% pebble 5% gravel 0% sand	0% bedrock 35% boulder 50% cobble 10% pebble 5% gravel 0% sand	0% bedrock 45% boulder 45% cobble 10% pebble 0% gravel 0% sand
Aquatic Vegetation (% areal coverage)	Periphyton Description	<0.5 mm thick of attached algae/periphyton on rocks	<0.5 mm thick of attached algae/periphyton on rocks	<0.5 mm thick of attached algae/periphyton on rocks	<0.5 mm thick of attached algae/periphyton on rocks	<0.5 mm thick of attached algae/periphyton on rocks	<0.5 mm thick of attached algae/periphyton on rocks	<0.5 mm thick of attached algae/periphyton on rocks	<0.5 mm thick of attached algae/periphyton on rocks	<0.5 mm thick of attached algae/periphyton on rocks	<0.5 mm thick of attached algae/periphyton on rocks
	Macrophyte Coverage	none observed	none observed	none observed	none observed	none observed	none observed	none observed	none observed	none observed	none observed

Table B.3: Habitat Data Summary and Statistical Comparison Results between Mary River Tributary-F Effluent-Exposed and Reference Study Areas

Channel Feature	Two-Area Comparison			Study Area	Mean	Standard Deviation	Standard Error	Median	Minimum	Maximum
	Significant Difference between Areas?	p-value	Statistical Test							
Wetted Width (m)	NO	0.725	ANOVA	Reference	12.0	4.3	1.9	9.0	8.5	17.0
				Effluent-Exposed	10.7	7.0	3.2	12.5	2.8	19.0
Bankfull Width (m)	NO	0.657	ANOVA	Reference	24.2	6.1	2.7	25.0	17.0	30.0
				Effluent-Exposed	26.0	6.3	2.8	22.5	20.0	35.0
Water Depth (cm)	YES	0.065	ANOVA	Reference	11.7	2.9	1.3	11.8	8.5	15.7
				Effluent-Exposed	21.3	9.6	4.3	17.5	14.8	38.2
Water Velocity (m/s)	NO	0.707	ANOVA	Reference	0.28	0.06	0.03	0.29	0.20	0.35
				Effluent-Exposed	0.30	0.09	0.04	0.34	0.15	0.38
Stream Gradient (% slope)	NO	0.1145	Mann Whitney U-test	Reference	4.8	0.6	0.3	4.5	4.5	5.5
				Effluent-Exposed	6.3	1.2	0.7	7.0	5.0	7.0
Substrate Size (cm)	NO	0.2359	ANOVA	Reference	9.8	3.1	1.8	9.7	6.7	12.9
				Effluent-Exposed	13.3	3.2	1.8	12.5	10.7	16.8

Highlighted values indicate significant difference between study areas based on ANOVA p-value less than 0.1.

APPENDIX C

EFFLUENT QUALITY DATA

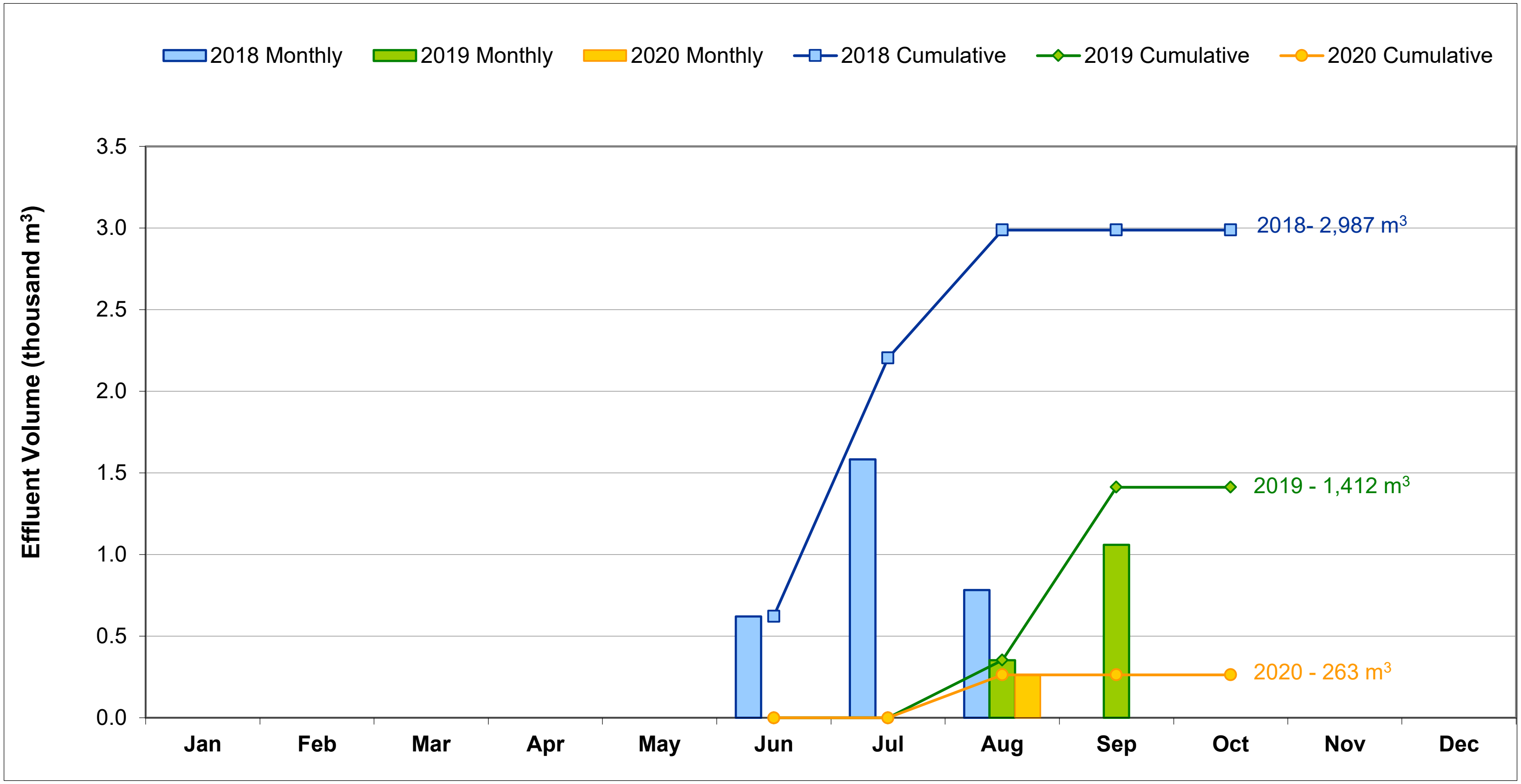


Figure C.1: **Mary River Project Average Monthly and Cumulative Effluent Discharge at Station MS-06 for the Second EEM Study, Period (2018 to 2020)**

Table C.1: Station MS-08 Effluent Daily Discharge Volumes, 2018 to 2020

Year	Date	Volume Discharged (m^3)
	30-Jun-18	931
	01-Jul-18	931
	02-Jul-18	1,375
	03-Jul-18	265
	04-Jul-18	530
	05-Jul-18	3,826
	06-Jul-18	806
	07-Jul-18	80
	08-Jul-18	1,044
	10-Jul-18	2,074
	11-Jul-18	1,043
	12-Jul-18	1,404
	13-Jul-18	2,387
	14-Jul-18	906
	15-Jul-18	1,470
	16-Jul-18	1,618
	17-Jul-18	1,632
	19-Jul-18	253
	20-Jul-18	622
	21-Jul-18	1,442
	22-Jul-18	946
	23-Jul-18	433
	24-Jul-18	556
	25-Jul-18	801
	26-Jul-18	1,008
	30-Jul-18	0
	31-Jul-18	3,269
	01-Aug-18	1,018
2018	02-Aug-18	2,071
	03-Aug-18	4,649
	04-Aug-18	2,349
	05-Aug-18	4,916
	06-Aug-18	3,872
	07-Aug-18	2,315
	08-Aug-18	1,127
	09-Aug-18	34
	10-Aug-18	482
	11-Aug-18	1,937
	12-Aug-18	2,239
	13-Aug-18	1,817
	14-Aug-18	1,626
	15-Aug-18	844
	16-Aug-18	769
	17-Aug-18	907
	18-Aug-18	279
	19-Aug-18	1,187
	20-Aug-18	284
	21-Aug-18	562
	26-Aug-18	1,663
	27-Aug-18	825
	29-Aug-18	913
	30-Aug-18	618
	31-Aug-18	44
	04-Sep-18	285
	05-Sep-18	952
	06-Sep-18	1,136
	07-Sep-18	252

Table C.1: Station MS-08 Effluent Daily Discharge Volumes, 2018 to 2020

Year	Date	Volume Discharged (m^3)
2019	07-Jun-19	328
	08-Jun-19	2,998
	10-Jun-19	1,889
	11-Jun-19	2,155
	12-Jun-19	1,124
	13-Jun-19	468
	15-Jun-19	1,640
	16-Jun-19	1,499
	17-Jun-19	1,795
	18-Jun-19	2,222
	19-Jun-19	2,628
	20-Jun-19	2,140
	21-Jun-19	2,228
	22-Jun-19	787
	23-Jun-19	538
	24-Jun-19	776
	25-Jun-19	1,049
	26-Jun-19	1,026
	27-Jun-19	1,228
	28-Jun-19	1,495
	29-Jun-19	474
	30-Jun-19	603
	01-Jul-19	528
	02-Jul-19	779
	03-Jul-19	724
	04-Jul-19	771
	05-Jul-19	671
	08-Jul-19	255
	11-Jul-19	407
	12-Jul-19	1,614
	13-Jul-19	3,045
	14-Jul-19	3,851
	15-Jul-19	2,336
	16-Jul-19	2,179
	17-Jul-19	3,394
	18-Jul-19	2,579
	19-Jul-19	2,421
	20-Jul-19	2,417
	21-Jul-19	2,338
	22-Jul-19	1,950
	23-Jul-19	2,699
	24-Jul-19	1,412
	25-Jul-19	1,663
	26-Jul-19	1,567
	27-Jul-19	1,156
	28-Jul-19	917
	29-Jul-19	1,213
	30-Jul-19	785
	31-Jul-19	2,200
	01-Aug-19	1,373
	02-Aug-19	1,931
	03-Aug-19	2,803
	04-Aug-19	981
	05-Aug-19	454
	06-Aug-19	1,079
	07-Aug-19	1,171
	08-Aug-19	1,235
	09-Aug-19	1,759
	10-Aug-19	2,114
	11-Aug-19	864
	12-Aug-19	1,325
	13-Aug-19	1,485

Table C.1: Station MS-08 Effluent Daily Discharge Volumes, 2018 to 2020

Year	Date	Volume Discharged (m^3)
2019	14-Aug-19	1,583
	17-Aug-19	110
	18-Aug-19	597
	21-Aug-19	391
	22-Aug-19	844
	23-Aug-19	531
	24-Aug-19	624
	25-Aug-19	703
	26-Aug-19	1,253
	27-Aug-19	1,217
	28-Aug-19	452
	29-Aug-19	421
	30-Aug-19	1,452
	31-Aug-19	1,169
	01-Sep-19	503
	02-Sep-19	404
	03-Sep-19	778
	04-Sep-19	365
	05-Sep-19	491
	06-Sep-19	480
	07-Sep-19	383
	28-Sep-19	939
	29-Sep-19	1,824
	30-Sep-19	3,452
	01-Oct-19	714
	02-Oct-19	520
2020	29-Jun-20	1,464
	30-Jun-20	2,688
	01-Jul-20	2,760
	02-Jul-20	3,360
	03-Jul-20	4,560
	04-Jul-20	3,928
	05-Jul-20	3,648
	06-Jul-20	2,528
	07-Jul-20	2,544
	08-Jul-20	2,750
	09-Jul-20	1,503
	10-Jul-20	191
	15-Jul-20	898
	16-Jul-20	1,180
	17-Jul-20	2,235
	18-Jul-20	3,280
	19-Jul-20	3,087
	20-Jul-20	3,456
	21-Jul-20	680
	03-Aug-20	537
	04-Aug-20	252
	09-Aug-20	38
	11-Aug-20	33
	17-Aug-20	361
	18-Aug-20	467
	19-Aug-20	537
	21-Aug-20	1,181
	22-Aug-20	1,207
	23-Aug-20	3,720
	24-Aug-20	3,552
	25-Aug-20	1,490
	28-Aug-20	227
	29-Aug-20	940
	30-Aug-20	1,179
	31-Aug-20	1,460

Table C.2: Station MS-06 Effluent Daily Discharge Volumes, 2018 to 2020

Year	Date	Volume Discharged (m^3)
2018	11-Jun-18	1
	12-Jun-18	3
	13-Jun-18	61
	14-Jun-18	58
	15-Jun-18	61
	17-Jun-18	69
	18-Jun-18	8
	19-Jun-18	79
	20-Jun-18	39
	22-Jun-18	23
	24-Jun-18	88
	29-Jun-18	49
	30-Jun-18	83
	02-Jul-18	39
	03-Jul-18	83
	04-Jul-18	46
	05-Jul-18	78
	06-Jul-18	56
	07-Jul-18	56
	11-Jul-18	2
	12-Jul-18	58
	14-Jul-18	58
	15-Jul-18	45
	16-Jul-18	74
	17-Jul-18	71
	18-Jul-18	59
	19-Jul-18	74
	20-Jul-18	77
	21-Jul-18	112
	22-Jul-18	76
	23-Jul-18	14
	24-Jul-18	84
	25-Jul-18	91
	26-Jul-18	96
	27-Jul-18	97
	28-Jul-18	66
	31-Jul-18	71
	01-Aug-18	53
	02-Aug-18	52
	03-Aug-18	99
	04-Aug-18	49
	05-Aug-18	49
	07-Aug-18	180
	08-Aug-18	143
	09-Aug-18	129
	11-Aug-18	20
	17-Aug-18	7
	28-Aug-18	3
2019	29-Aug-19	13
	30-Aug-19	132
	31-Aug-19	208
	01-Sep-19	201
	02-Sep-19	204
	03-Sep-19	177
	04-Sep-19	160
	05-Sep-19	189
	06-Sep-19	128
2020	04-Aug-20	21
	07-Aug-20	44
	08-Aug-20	29
	09-Aug-20	39
	10-Aug-20	56
	11-Aug-20	33
	12-Aug-20	31
	13-Aug-20	10

Table C.3: Water Chemistry at Effluent Station MS-08 FDP, Collected for Weekly Deleterious Substance and pH Testing and Effluent Characterization, 2018

Parameters		Units	Date of Sampling Event												Summary Statistics		
			30-Jun-18	3-Jul-18	11-Jul-18	16-Jul-18	21-Jul-18	24-Jul-18	1-Aug-18	10-Aug-18	15-Aug-18	21-Aug-18	27-Aug-18	4-Sep-18	N	Average	SD
Conventionals	Conductivity (lab)	umho/cm	3,170	3,360	3,160	3,410	3,420	3,450	2,360	5,010	5,290	3,890	5,460	8,970	12	4,246	1,765
	pH (lab)	pH	8.89	8.88	9.16	8.33	8.53	8.28	8.83	9.23	8.57	8.83	8.78	8.76	12	8.76	0.29
	Hardness (as $CaCO_3$)	mg/L	-	2,520	-	-	-	-	-	4,120	-	2,760	-	9,570	4	4,743	3,295
	Total Suspended Solids (TSS)	mg/L	6.4	3.6	3.6	<2.0	12.4	14.8	4.4	19.3	12	7.2	9.6	10.8	12	8.8	5.2
	Total Dissolved Solids (TDS)	mg/L	3,220	3,950	3,220	3,740	3,860	3,780	2,580	6,370	7,000	3,920	6,710	12,700	12	5,088	2,810
	Turbidity	NTU	12.5	-	6.8	14.3	19.4	10.1	4.9	-	13.0	-	1.8	-	8	10.4	5.7
	Alkalinity (as $CaCO_3$)	mg/L	-	37	-	-	-	-	-	57	-	48	-	79	4	55	18
Nutrients and Anions	Total Ammonia	mg/L	-	2.900	-	-	2.02 *	1.940	1.320	2.980	3.490	1.520	2.89	4.290	8	2.666	1.012
	Nitrate	mg/L	-	6.5	-	-	-	-	-	18.700	-	9.76	-	29.9	4	16.215	10.480
	Total Kjeldahl Nitrogen (TKN)	mg/L	-	3.41	-	-	-	-	-	3.5	-	2.19	-	4.32	4	3.355	0.878
	Dissolved Organic Carbon	mg/L	-	1.6	-	-		-	-	2.0	-	2.9	-	5.1	4	2.9	1.6
	Total Organic Carbon	mg/L	-	1.9	-	-		-	-	2.4	-	3.2	-	3.5	4	2.7	0.7
	Total Phosphorus	mg/L	-	<0.030	-	-	-	-	-	<0.0030	-	<0.030	-	<0.0030	4	0.0165	0.0156
	Chloride (Cl)	mg/L	-	6.5	-	-	-	-	-	12.0	-	7.9	-	23.0	4	12.4	7.5
	Sulphate (SO_4)	mg/L	-	2,340	-	-	-	-	-	4,930	-	2,700	-	10,600	4	5,143	3,814
Total Metals	Aluminum (Al)	mg/L	0.058	<0.050	<0.050	<0.050	0.08	<0.050	<0.050	0.088	0.072	0.057	0.116	<0.50	12	0.102	0.127
	Antimony (Sb)	mg/L	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.010	12	0.00175	0.00260
	Arsenic (As)	mg/L	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.010	12	0.00175	0.00260
	Barium (Ba)	mg/L	0.0186	0.0183	0.0141	0.0177	0.0195	0.0178	0.0221	0.0201	0.0220	0.0182	0.0209	0.0210	12	0.0192	0.0022
	Beryllium (Be)	mg/L	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.010	12	0.00175	0.00260
	Bismuth (Bi)	mg/L	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.0050	12	0.0009	0.0013
	Boron (B)	mg/L	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<1.0	12	0.175	0.260
	Cadmium (Cd)	mg/L	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	0.000142	<0.000050	<0.000050	<0.000050	0.000055	<0.00050	12	0.00010	0.00013
	Calcium (Ca)	mg/L	223	287	196	197	180	195	109	321	365	206	304	623	12	267	133
	Chromium (Cr)	mg/L	<0.0050	<0.0050	<0.0050	0.00690	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.050	12	0.0089	0.0130
	Cobalt (Co)	mg/L	0.0119	0.03410	0.0083	0.0345	0.0439	0.0155	0.0317	0.0271	0.0348	0.0189	0.0344	0.0200	12	0.0263	0.0111
	Copper (Cu)	mg/L	<0.010	0.0110	<0.010	0.0110	<0.010	<0.010	<0.010	0.0340	0.0270	0.0120	0.0180	<0.10	12	0.0219	0.0258
	Iron (Fe)	mg/L	2.19	1.66	0.73	3.31	4.31	1.23	1.16	4.04	2.71	1.71	3.57	1.90	12	2.38	1.19
	Lead (Pb)	mg/L	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.0050	12	0.0009	0.0013
	Lithium (Li)	mg/L	0.054	0.0670	0.0540	0.0570	0.0520	0.0540	0.03	0.0610	0.0630	0.0400	0.067	<0.10	12	0.058	0.017
	Magnesium (Mg)	mg/L	393	440	451	524	547	551	346	800	986	617	931	1930	12	710	436
	Manganese (Mn)	mg/L	3.2	5.6	3.7	7.9	8.9	4.5	7.3	6.9	10.5	5.6	9.4	19.5	12	7.8	4.3
	Mercury (Hg)	mg/L	-	<0.000010	-	-	-	-	-	<0.000010	-	<0.000010	-	<0.000010	4	0.00001	0
	Molybdenum (Mo)	mg/L	<0.00050	<0.00050	<0.00050	0.00285	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	0.00063	<0.00050	<0.0050	12	0.0011	0.0014
	Nickel (Ni)	mg/L	0.015	0.039	0.011	0.044	0.056	0.020	0.044	0.028	0.040	0.024	0.044	<0.050	12	0.035	0.014
	Potassium (K)	mg/L	3.86	4.01	3.57	4.02	4.39	4.46	4.13	4.76	5.60	4.99	5.43	6.80	12	4.67	0.92
	Selenium (Se)	mg/L	0.00336	0.0043	0.00403	0.0038	0.00523	0.00494	0.00413	0.00956	0.01	0.0062	0.0108	0.0161	12	0.0069	0.0039
	Silicon (Si)	mg/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<10	12	1.75	2.60
	Silver (Ag)	mg/L	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.0050	12	0.0009	0.0013
	Sodium (Na)	mg/L	6.5	5.4	51.5	16.8	16.9	17.0	6.9	4.8	5.8	4.8	5.4	7.8	12	12.5	13.3
	Strontium (Sr)	mg/L	0.476	0.592	0.305	0.369	0.279	0.295	0.146	0.655	0.751	0.379	0.576	1.150	12	0.498	0.271
	Thallium (Tl)	mg/L	0.00011	0.00015	0.00011	0.00013	<0.00020	0.00011	<0.00010	0.00017	0.00017	<0.00010	0.00015	<0.0010	12	0.0002	0.0003
	Tin (Sn)	mg/L	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.010	12	0.0018	0.0026
	Titanium (Ti)	mg/L	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.030	12	0.0053	0.0078
	Uranium (U)	mg/L	0.0002	0.0001	0.0006	0.0005	0.0006	0.0004	0.0003	0.0007	0.0006	0.0006	0.0006	0.0025	12	0.0006	0.0006
	Vanadium (V)	mg/L	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.050	12	0.0088	0.0130
	Zinc (Zn)	mg/L	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.30	12	0.0525	0.0779

Table C.4: Water Chemistry at Effluent Station MS-08 FDP, Collected for Weekly Deleterious Substance and pH Testing and Effluent Characterization, 2019

Parameters		Units	Date of Sampling Event																	Summary Statistics		
			7-Jun-19	11-Jun-19	17-Jun-19	24-Jun-19	30-Jun-19	8-Jul-19	15-Jul-19	21-Jul-19	29-Jul-19	5-Aug-19	12-Aug-19	21-Aug-19	26-Aug-19	2-Sep-19	28-Sep-19	30-Sep-19	1-Oct-19	N	Average	SD
Conventionals	Conductivity (lab)	umho/cm	5,380	888	712	930	1,060	4,440	3,340	4,180	3,690	6,620	6,030	6,960	4,420	3,180	1,390	870	5,040	17	3,478	2,163
	pH (lab)	pH	6.43	6.63	6.70	7.20	7.81	7.50	7.00	8.78	8.92	8.07	7.46	8.73	8.89	8.47	6.91	6.92	8.79	17	7.72	0.90
	Hardness (as $CaCO_3$)	mg/L	502	-	375	-	-	3,150	-	3,260	-	5,570	-	-	-	2,350	-	479	3,990	8	2,460	1,899
	Total Suspended Solids (TSS)	mg/L	20	28.0	10.8	15.6	3.2	12	11.1	6	7.6	6.8	17.2	6.3	9.6	10	40.5	55.5	6	17	15.7	13.9
	Total Dissolved Solids (TDS)	mg/L	742	684	561	772	985	4,670	3,480	4,720	4,030	7,990	7,410	8,610	4,390	3,190	1,080	643	5,620	17	3,505	2,762
	Turbidity	NTU	18.7	34.5	20.3	19.8	2.3	14.1	24.3	8.6	12.1	8.2	30.1	9.7	24.4	9.3	42.1	72.1	4.5	17	20.9	17.1
	Alkalinity (as $CaCO_3$)	mg/L	<10	-	<10	-	-	18	-	15	-	10	-	-	-	63	-	25	39	8	24	19
Nutrients and Anions	Total Ammonia	mg/L	0.405	0.379	0.425	0.537	0.860	7.400	3.700	6.980	5.700	8.650	7.040	5.710	2.770	1.430	0.500	0.39	3.790	17	3.333	2.998
	Nitrate	mg/L	186	-	1.76	-	-	14.2	-	21.2	-	27.9	-	-	-	10.4	-	2.71	16.7	8	35.1	61.600
	Total Kjeldahl Nitrogen (TKN)	mg/L	0.63	-	0.67	-	-	3.75	-	8.4	-	8.73	-	-	-	1.31	-	<1.5	4.38	8	3.67	3.317
	Dissolved Organic Carbon	mg/L	1.8	-	1.0	-	-	3.1	-	3.4	-	3.2	-	-	-	2.9	-	1.3	3.8	8	2.6	1.0
	Total Organic Carbon	mg/L	1.6	-	1.6	-	-	3.7	-	4.0	-	3.5	-	-	-	3.5	-	2.2	4.2	8	3.0	1.1
	Total Phosphorus	mg/L	0.0095	-	0.0096	-	-	<0.0030	-	<0.0030	-	<0.0030	-	-	-	0.0036	-	0.0520	<0.0030	8	0.0108	0.0169
	Chloride (Cl)	mg/L	2.0	-	1.4	-	-	9.5	-	14.0	-	20.1	-	-	-	11.0	-	2.2	17.2	8	9.7	7.3
	Sulphate (SO_4)	mg/L	498	-	375	-	-	3,130	-	3,070	-	5,470	-	-	-	2,490	-	424	4,070	8	2,441	1,883
Total Metals	Aluminum (Al)	mg/L	0.605	1.070	0.531	0.712	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.50	<0.050	0.092	1.02	1.880	0.082	17	0.405	0.522
	Antimony (Sb)	mg/L	<0.0010	<0.0010	<0.00010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	17	0.0015	0.00221
	Arsenic (As)	mg/L	<0.0010	<0.0010	0.00011	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	17	0.0015	0.00221
	Barium (Ba)	mg/L	0.0096	0.0164	0.0136	0.0139	0.0110	0.0337	0.0232	0.0356	0.0230	0.0307	0.0268	0.0260	0.0197	0.0150	0.0148	0.0175	0.0120	17	0.0201	0.0081
	Beryllium (Be)	mg/L	<0.0010	<0.0010	<0.00010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	17	0.0015	0.00221
	Bismuth (Bi)	mg/L	<0.00050	<0.00050	<0.000050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.0050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	17	0.0007	0.0011
	Boron (B)	mg/L	<0.10	<0.10	0.015	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<1.0	<0.10	<0.10	<0.10	<0.10	<0.10	17	0.148	0.221
	Cadmium (Cd)	mg/L	0.000085	0.000078	0.0000588	0.000063	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.00050	<0.000050	<0.000050	0.000133	0.000066	<0.000050	17	0.00009	0.00011
	Calcium (Ca)	mg/L	18	20	22	35	52	305	214	362	307	662	488	626	269	199	45	31	507	17	245	222
	Chromium (Cr)	mg/L	<0.0050	<0.0050	0.00130	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	17	0.0074	0.0110
	Cobalt (Co)	mg/L	0.0742	0.06290	0.0405	0.0375	0.037	0.0271	0.0384	0.0097	0.0105	0.0157	0.0501	0.02	0.0129	0.0366	0.0691	0.0359	0.0050	17	0.0343	0.0210
	Copper (Cu)	mg/L	<0.010	<0.010	0.0024	<0.010	<0.010	<0.010	<0.010	0.0120	<0.010	<0.010	<0.010	<0.10	<0.010	<0.010	<0.010	<0.010	<0.010	17	0.0150	0.0220
	Iron (Fe)	mg/L	6.58	4.93	2.65	1.76	0.60	4.50	7.69	1.56	1.19	1.98	6.97	1.40	1.74	0.96	4.43	6.55	0.42	17	3.29	2.48
	Lead (Pb)	mg/L	<0.00050	0.000680	0.000453	0.00051	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.0050	<0.00050	<0.00050	0.0012	0.00227	<0.00050	17	0.0009	0.0011
	Lithium (Li)	mg/L	0.011	0.0130	0.0084	<0.010	0.0160	0.0500	0.036	0.0710	0.0590	0.0940	0.0710	<0.10	0.0320	0.0260	<0.010	<0.010	0.0300	17	0.038	0.031
	Magnesium (Mg)	mg/L	107	101	81	109	146	646	455	551	521	1030	871	1160	570	462	169	98	664	17	455	346
	Manganese (Mn)	mg/L	3.9	3.7	2.8	2.8	3.4	14.7	7.4	8.6	6.3	16.3	16.5	11.3	4.9	9.4	5.9	3.3	1.1	17	7.2	4.9
	Mercury (Hg)	mg/L	<0.000010	-	<0.000010		-	<0.000010	-	<0.0000050	-	<0.0000050	-	-	-	<0.0000050	-	<0.0000050	<0.0000050	8	0.00001	0
	Molybdenum (Mo)	mg/L	<0.00050	<0.00050	0.00054	0.00075	0.00076	<0.00050	<0.00050	<0.00050	<0.00050	0.00059	<0.00050	<0.0050	<0.00050	0.00082	0.00072	0.00121	0.00141	17	0.0009	0.0011
	Nickel (Ni)	mg/L	0.078	0.067	0.042	0.040	0.039	0.025	0.039	0.010	0.009	0.014	0.045	<0.050	0.016	0.044	0.077	0.038	0.007	17	0.038	0.022
	Potassium (K)	mg/L	1.72	2.05	2.16	2.73	2.83	6.18	5.51	7.48	6.77	7.98	7.76	9.10	5.57	7.38	2.76	3.85	6.91	17	5.22	2.46
	Selenium (Se)	mg/L	0.00112	0.00105	0.00113	0.00152	0.00194	0.00622	0.00465	0.00674	0.00548	0.00852	0.00867	0.0093	0.00564	0.00525	0.00243	0.00123	0.00642	17	0.0045	0.0029
	Silicon (Si)	mg/L	1.30	2.80	1.69	1.90	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<10	<1.0	1.10	2.30	3.60	<1.0	17	1.98	2.20
	Silver (Ag)	mg/L	<0.00050	<0.00050	<0.000050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.0050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	17	0.0007	0.0011
	Sodium (Na)	mg/L	0.8	0.9	1.0	1.3	1.6	4.5	3.3	5.5	4.9	7.0	6.4	9.6	5.2	5.6	1.5	1.6	6.4	17	4.0	2.7
	Strontium (Sr)	mg/L	0.025	0.027	0.042	0.083	0.151	0.663	0.426	0.974	0.655	1.250	1.020	1.200	0.494	0.337	0.033	0.027	1.580	17	0.529	0.511
	Thallium (Tl)	mg/L	<0.00010	<0.00010	0.000026	<0.00010	<0.00010	0.00014	0.00011	0.00026	0.00018	0.00012	0.00024	<0.0010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	17	0.0002	0.0002
	Tin (Sn)	mg/L	<0.0010	<0.0010	<0.00010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.00180	<0.010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	17	0.0015	0.0022
	Titanium (Ti)	mg/L	0.024	0.0449	0.0243	0.0305	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.030	<0.0030	0.006	0.0547	0.0893	0.0037	17	0.0195	0.0245
	Uranium (U)	mg/L	0.0005	0.0004	0.0004	0.0007	0.0002	0.0003	0.0003	0.0002	0.0003	0.0004	0.0003	<0.0010	0.0009	0.0040	0.0015	0.0026	0.0019	17	0.0009	0.0010
	Vanadium (V)	mg/L	<0.0050	<0.0050	0.0009	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	17	0.0074	0.0110
	Zinc (Zn)	mg/L	<0.030	<0.030	0.007	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.30	<0.030	<0.030	<0.030	<0.030	<0.030	17	0.0445	0.0661

Table C.5: Effluent Characterization Data Mary River Project Station MS-08, 2020

	Variable	Units	MDMER Grab Limit [a]	June	August	
				28-Jun-20	4-Aug-20	19-Aug-20
Routine Monitoring [b]	Volume	m^3/day	-	0	252	537
	pH	pH units	6.0 - 9.5	7.16	7.42	7.75
	TSS	mg/L	30	3.9	3.8	11.2
	Arsenic (As)	mg/L	1.00	<0.00010	<0.0010	<0.0010
	Copper (Cu)	mg/L	0.60	0.00151	<0.0050	<0.0050
	Lead (Pb)	mg/L	0.40	0.000151	<0.00050	<0.00050
	Nickel (Ni)	mg/L	1.00	0.0203	0.0398	0.0282
	Zinc (Zn)	mg/L	1.00	<0.0030	<0.030	<0.030
	Radium-226	Bq/L	1.11	<0.0070	0.012	0.011
Effluent Characterization [c]	Conductivity	µS/cm	-	473	2,110	1,800
	Hardness	mg/L (as $CaCO_3$)	-	225	1,360	1,050
	Alkalinity	mg/L (as $CaCO_3$)	-	10.6	38	47
	Ammonia (NH_4^+)	mg/L	-	0.609	1.46	0.106
	Nitrate (NO_3)	mg/L	-	3.85	26.9	20.9
	Aluminum (Al)	mg/L	-	0.085	<0.050	0.350
	Cadmium (Cd)	mg/L	-	0.0000375	0.000069	<0.000050
	Iron (Fe)	mg/L	-	0.178	0.120	0.620
	Mercury (Hg)	mg/L	0.000010	<0.0000050	<0.0000050	<0.0000050
	Molybdenum (Mo)	mg/L	-	0.00129	0.00231	0.00235
	Selenium (Se)	mg/L	-	0.000926	0.00476	0.00378

[grey box] Indicates grab sample concentration above applicable limit for deleterious substances *or* grab sample mercury concentration that exceeded fish usability assessment trigger value.

[a] Limits indicated refer to maximum authorized grab sample concentrations as per Schedule 4 of the MDMER (Government of Canada 2020) except the limit for mercury, which has been included as a fish usability assessment trigger limit based on a grab sample concentration of 0.0001 mg/L.

[b] Deleterious substances and pH as defined under Schedule 4 of the MDMER (Government of Canada 2020).

[c] Required effluent characterization and site-specific parameters as defined under Schedule 5 of the MDMER (Government of Canada 2020).

Table C.6: Water Chemistry at Effluent Station MS-06 FDP, Collected for Weekly Deleterious Substance and pH Testing and Effluent Characterization, 2018

Parameters		Units	Date of Sampling Event											Summary Statistics		
			13-Jun-18	19-Jun-18	24-Jun-18	2-Jul-18	11-Jul-18	18-Jul-18	26-Jul-18	1-Aug-18	7-Aug-18	18-Aug-18	28-Aug-18	N	Average	SD
Conventionals	Conductivity (lab)	umho/cm	-	836	943	1,050	1,040	1,140	1,160	1,140	921	1,120	1,060	10	1,041	109
	pH (lab)	pH	7.65	7.61	7.52	7.68	7.78	7.76	7.55	0.46	7.30	6.84	7.37	11	6.87	2.14
	Hardness (as $CaCO_3$)	mg/L	385	430	463	-	-	-	644	-	-	-	574	5	499	107
	Total Suspended Solids (TSS)	mg/L	5.5	2.7	7.6	2.8	4.0	2.8	2	<2.0	2.8	2.4	4	11	3.5	1.7
	Total Dissolved Solids (TDS)	mg/L	518 *	648 *	700	763 *	814	919	895	645	740	878	900	8	811	104
	Turbidity	NTU	15.8	-	-	17.9	13.2	5.5	-	4.9	11.0	9.8	-	7	11.2	4.9
	Alkalinity (as $CaCO_3$)	mg/L	31	31	33	-	-	-	41	-	-	-	24	5	32	6
Nutrients and Anions	Total Ammonia	mg/L	0.308	0.444	0.440	-	-	0.159	0.042	0.024	<0.020	0.03	0.040	9	0.167	0.182
	Nitrate	mg/L	4.06	4.66	4.88	-	-	-	6.17	-	-	-	4.35	5	4.82	0.814
	Total Kjeldahl Nitrogen (TKN)	mg/L	0.61	0.81	0.88	-	-	-	<0.15	-	-	-	<0.15	5	0.52	0.352
	Dissolved Organic Carbon	mg/L	1.7	1.5	2.2	-	-	-	1.2	-	-	-	0.9	5	1.5	0.5
	Total Organic Carbon	mg/L	1.5	1.7	1.8	-	-	-	1.3	-	-	-	1.0	5	1.5	0.3
	Total Phosphorus	mg/L	<0.030	<0.0030	<0.015	-	-	-	1.740	-	-	-	<0.030	4	0.447	0.8621
	Chloride (Cl)	mg/L	12.8	15.3	16.7	-	-	-	21.5	-	-	-	15.3	5	16.3	3.2
	Sulphate (SO_4)	mg/L	314	387	426	-	-	-	572	-	-	-	539	5	448	107
Total Metals	Aluminum (Al)	mg/L	0.154	0.063	0.0389	0.0497	0.051	0.016	<0.050	0.025	0.044	0.017	0.084	11	0.054	0.039
	Antimony (Sb)	mg/L	-	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.0010	<0.00010	<0.00010	<0.00010	<0.00010	10	0.00019	0.00028
	Arsenic (As)	mg/L	0.00013	0.00012	0.00011	0.00013	0.00014	<0.00010	<0.0010	0.00011	0.00011	0.00011	<0.00010	11	0.00020	0.00027
	Barium (Ba)	mg/L	-	0.0106	0.0121	0.0135	0.0132	0.0145	0.0162	0.0141	0.0133	0.0175	0.0170	10	0.0142	0.0022
	Beryllium (Be)	mg/L	-	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.0010	<0.00010	<0.00010	<0.00010	<0.00010	10	0.00019	0.00028
	Bismuth (Bi)	mg/L	-	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.00050	<0.000050	<0.000050	<0.000050	<0.000050	10	0.0001	0.0001
	Boron (B)	mg/L	-	0.025	0.032	0.029	0.032	0.034	<0.10	0.03	0.024	0.032	0.023	10	0.0361	0.023
	Cadmium (Cd)	mg/L	0.000027	0.000042	0.0000442	0.000041	0.000035	0.0000439	<0.000050	0.0000289	0.0000222	0.0000685	0.0000553	11	0.00004	0.00001
	Calcium (Ca)	mg/L	27	35	45	47	51	60	61	54	45	60	50	11	49	11
	Chromium (Cr)	mg/L	-	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.0050	<0.00050	<0.00050	<0.00050	<0.00050	10	0.0010	0.0014
	Cobalt (Co)	mg/L	-	0.00601	0.00603	0.00528	0.00453	0.00524	0.0037	0.00664	0.00448	0.0168	0.0090	10	0.0068	0.0038
	Copper (Cu)	mg/L	0.0012	<0.0010	0.0015	<0.0010	<0.0010	<0.0010	<0.010	<0.0010	<0.0010	<0.0010	0.0113	11	0.0028	0.0039
	Iron (Fe)	mg/L	0.51	0.21	0.13	0.18	0.16	0.06	0.11	0.17	0.18	2.09	0.33	11	0.37	0.58
	Lead (Pb)	mg/L	0.00028	0.000138	0.00012	0.000089	0.000055	0.000079	<0.00050	<0.000050	<0.000050	<0.000050	0.000572	11	0.0002	0.0002
	Lithium (Li)	mg/L	-	0.0150	0.0181	0.0185	0.0196	0.0201	0.0220	0.0199	0.0148	0.019	0.0142	10	0.018	0.003
	Magnesium (Mg)	mg/L	70	82	98	97	108	116 *	120	103 *	93	109 *	101	8	96	15
	Manganese (Mn)	mg/L	1.1	1.4	1.6	1.6	1.7	2.0	1.6	1.4	1.1	1.9	1.6	11	1.5	0.3
	Mercury (Hg)	mg/L	<0.000010	<0.000010	<0.000010	-	-	-	<0.000010	-	-	-	<0.000010	5	0.00001	0
	Molybdenum (Mo)	mg/L	0.00050	0.00067	0.00079	0.00095	0.00088	0.00099	0.00082	0.00013	0.00020	0.00008	0.00012	11	0.0006	0.0004
	Nickel (Ni)	mg/L	0.010	0.009	0.009	0.009	0.008	0.008	0.007	0.012	0.008	0.024	0.017	11	0.011	0.005
	Potassium (K)	mg/L	8.51	9.77	10.70	11.00	11.10	11.30	12.00	9.99	8.77	10.30	8.84	11	10.21	1.15
	Selenium (Se)	mg/L	0.0009	0.0010	0.0011	0.0013	0.0012	0.0013	0.0013	0.0011	0.0011	0.0010	0.0009	11	0.0011	0.0001
	Silicon (Si)	mg/L	-	0.45	0.49	0.43	0.37	0.26	<1.0	0.17	0.15	0.13	0.19	10	0.36	0.26
	Silver (Ag)	mg/L	-	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.00050	<0.000050	<0.000050	<0.000050	<0.000050	10	0.0001	0.0001
	Sodium (Na)	mg/L	5.4	0.5	7.1	7.0	7.4	7.2	7.7	6.2	5.6	6.1	5.0	11	5.9	2.0
	Strontium (Sr)	mg/L	-	0.057	0.063	0.072	0.074	0.089	0.087	0.076	0.066	0.077	0.071	10	0.073	0.010
	Thallium (Tl)	mg/L	0.00002	0.000023	0.000029	0.000031	0.00003	0.000032	<0.00010	0.000034	0.000027	0.000038	0.000035	11	0.0000	0.0000
	Tin (Sn)	mg/L	-	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.0010	<0.00010	<0.00010	<0.00010	<0.00010	10	0.0002	0.0003
	Titanium (Ti)	mg/L	-	<0.00080 *	<0.00040	<0.0007 *	0.00045	<0.00030	<0.0030	<0.00070 *	<0.00070 *	<0.00030	<0.0035	6	0.0013	0.0015
	Uranium (U)	mg/L	0.0019	0.0019	0.0020	0.0016	0.0016	0.0015	0.0013	0.0005	0.0003	0.0002	0.0001	11	0.0012	0.0007
	Vanadium (V)	mg/L	-	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.0050	<0.00050	<0.00050	<0.00050	<0.00050	10	0.0010	0.0014
	Zinc (Zn)	mg/L	0.0035	0.0089	0.0103	0.0061	0.0039	0.0072	<0.030	0.0034	<0.0030	0.004	0.0073	11	0.0080	0.0077

Table C.7: Effluent Chemistry at Station MS-06 FDP, Collected for Weekly Deleterious Substance and pH Testing and Effluent Characterization, 2019

Parameters		Units	Date of Sampling Event		Annual Average
			29-Aug-19	02-Sep-19	
Conventionals	Conductivity (lab)	umho/cm	2,220	2,210	2,215
	pH (lab)	pH	7.01	7.08	7.05
	Hardness (as $CaCO_3$)	mg/L	1,430	1,410	1,420
	Total Suspended Solids (TSS)	mg/L	4.7	2.7	3.7
	Total Dissolved Solids (TDS)	mg/L	1,960	2,010	1,985
	Turbidity	NTU	6.4	7.9	7.2
	Alkalinity (as $CaCO_3$)	mg/L	<10	<10	10
Nutrients and Anions	Total Ammonia	mg/L	2.720	2.610	2.665
	Nitrate	mg/L	10.2	10.5	10.35
	Total Kjeldahl Nitrogen (TKN)	mg/L	3.06	2.18	2.62
	Dissolved Organic Carbon	mg/L	0.6	0.6	0.6
	Total Organic Carbon	mg/L	1.7	0.9	1.3
	Total Phosphorus	mg/L	<0.0030	<0.0030	0.0030
	Chloride (Cl)	mg/L	26.9	28.1	27.5
	Sulphate (SO_4)	mg/L	1,390	1,500	1,445
Total Metals	Aluminum (Al)	mg/L	<0.050	<0.050	0.050
	Antimony (Sb)	mg/L	<0.0010	<0.0010	0.001
	Arsenic (As)	mg/L	<0.0010	<0.0010	0.001
	Barium (Ba)	mg/L	0.0213	0.0196	0.0205
	Beryllium (Be)	mg/L	<0.0010	<0.0010	0.001
	Bismuth (Bi)	mg/L	<0.00050	<0.00050	0.0005
	Boron (B)	mg/L	<0.10	<0.10	0.1
	Cadmium (Cd)	mg/L	0.000339	0.000337	0.00034
	Calcium (Ca)	mg/L	106	107	107
	Chromium (Cr)	mg/L	<0.0050	<0.0050	0.0050
	Cobalt (Co)	mg/L	0.0895	0.0842	0.0869
	Copper (Cu)	mg/L	<0.010	<0.010	0.0100
	Iron (Fe)	mg/L	0.14	0.15	0.15
	Lead (Pb)	mg/L	<0.00050	<0.00050	0.0005
	Lithium (Li)	mg/L	0.057	0.0610	0.059
	Magnesium (Mg)	mg/L	280	280	280
	Manganese (Mn)	mg/L	14.1	13.8	14.0
	Mercury (Hg)	mg/L	<0.0000050	<0.0000050	0.00001
	Molybdenum (Mo)	mg/L	<0.00050	<0.00050	0.0005
	Nickel (Ni)	mg/L	0.097	0.094	0.096
	Potassium (K)	mg/L	11.70	11.70	11.70
	Selenium (Se)	mg/L	0.00223	0.00219	0.0022
	Silicon (Si)	mg/L	2.20	2.20	2.20
	Silver (Ag)	mg/L	<0.00050	<0.00050	0.0005
	Sodium (Na)	mg/L	6.9	6.8	6.9
	Strontium (Sr)	mg/L	0.198	0.203	0.201
	Thallium (Tl)	mg/L	0.00015	0.00013	0.0001
	Tin (Sn)	mg/L	<0.0010	<0.0010	0.0010
	Titanium (Ti)	mg/L	<0.0030	<0.0030	0.0030
	Uranium (U)	mg/L	0.0001	<0.00010	0.0001
	Vanadium (V)	mg/L	<0.0050	<0.0050	0.0050
	Zinc (Zn)	mg/L	<0.030	<0.030	0.0300

Table C.8: Effluent Characterization Data, Mary River Project Station MS-06, 2020

	Variable	Units	MDMER Grab Limit [a]	August 04-Aug-20
Routine Monitoring [b]	Volume	m^3/day	-	21
	pH	pH units	6.0 - 9.5	7.26
	TSS	mg/L	30	6.0
	Arsenic (As)	mg/L	1.00	<0.0010
	Copper (Cu)	mg/L	0.60	<0.0050
	Lead (Pb)	mg/L	0.40	<0.00050
	Nickel (Ni)	mg/L	1.00	0.0361
	Zinc (Zn)	mg/L	1.00	<0.030
	Radium-226	Bq/L	1.11	<0.0095
Effluent Characterization [c]	Conductivity	µS/cm	-	1,590
	Hardness	mg/L (as $CaCO_3$)	-	917
	Alkalinity	mg/L (as $CaCO_3$)	-	13
	Ammonia (NH_4^+)	mg/L	-	0.272
	Nitrate (NO_3)	mg/L	-	14.9
	Aluminum (Al)	mg/L	-	0.068
	Cadmium (Cd)	mg/L	-	0.000206
	Iron (Fe)	mg/L	-	0.16
	Mercury (Hg)	mg/L	0.000010	<0.0000050
	Molybdenum (Mo)	mg/L	-	0.00113
	Selenium (Se)	mg/L	-	0.0021

[grey box] Indicates grab sample concentration above applicable limit for deleterious substances *or* grab sample mercury concentration that exceeded fish usability assessment trigger value.

[a] Limits indicated refer to maximum authorized grab sample concentrations as per Schedule 4 of the MDMER (Government of Canada 2020) except the limit for mercury, which has been included as a fish usability assessment trigger limit based on a grab sample concentration of 0.0001 mg/L.

[b] Deleterious substances and pH as defined under Schedule 4 of the MDMER (Government of Canada 2020).

[c] Required effluent characterization and site-specific parameters as defined under Schedule 5 of the MDMER (Government of Canada 2020).

Table C.9: Mary River Project Effluent (Station MS-08) Acute Lethality Results for Tests Conducted on Rainbow Trout and *Daphnia magna*, 2018 to 2020

Year	Date Sample Collected	Rainbow Trout (percent mortality in 100% effluent)	*Daphnia magna* (percent mortality in 100% effluent)
2018	03-Jul-18	0	3.3
	10-Aug-18	0	0
	04-Sep-18	20	100
2019	17-Jun-19	0	0
	08-Jul-19	0	0
	05-Aug-19	10	0
	02-Sep-19	0	0
	01-Oct-19	0	0
2020	28-Jun-20	0	0
	21-Jul-20	0	0
	18-Aug-20	0	10

Table C.10: Mary River Project Effluent (Station MS-06) Acute Lethality Results for Tests Conducted on Rainbow Trout and *Daphnia magna*, 2018 to 2020

Year	Date Sample Collected	Rainbow Trout (percent mortality in 100% effluent)	*Daphnia magna* (percent mortality in 100% effluent)
2018	24-Jun-18	0	0
	26-Jul-18	0	0
	28-Aug-18	0	0
2019	29-Aug-19	0	0
	02-Sep-19	0	0
2020	04-Aug-20	0	0

Table C.11: Mean Annual MDMER and Effluent Characterization Data for Station MS-08, 2015 to 2020

	Parameter	Units	MDMER Monthly Mean Limit	Phase 1			Phase 2		
				2015	2016	2017	2018	2019	2020
Routine Monitoring	Total Volume	m^3	-	-	-	-	73,625	117,730	63,919
	pH	pH units	6.0 - 9.5	7.56	7.21	6.31	8.83	8.79	7.16
	TSS	mg/L	15	9.12	6.34	11.3	8.36	15.2	5.53
	Arsenic (As)	mg/L	0.5	0.0003	0.0001	0.0007	0.0016	0.0007	0.0005
	Copper (Cu)	mg/L	0.3	0.001	0.003	0.010	0.021	0.008	0.004
	Lead (Pb)	mg/L	0.2	0.0004	0.0003	0.0013	0.0008	0.0006	0.0003
	Nickel (Ni)	mg/L	0.5	0.017	0.038	0.230	0.026	0.032	0.026
	Zinc (Zn)	mg/L	0.5	-	0.009	-	0.049	0.021	0.015
	Radium-226	Bq/L	0.37	0.012	0.012	0.017	0.092	0.026	0.010
	Acute Toxicity - Rainbow Trout	Pass/Fail (N)[a]	NL	Pass (2)	Pass (3)	Pass (3) / Fail (1)	Pass (3)	Pass (5)	Pass (3)
	Acute Toxicity - *Daphnia magna*	Pass/Fail (N)[a]	NL	Pass (2)	Pass (3)	Pass (2) / Fail (3)	Pass (2) / Fail (1)	Pass (5)	Pass (3)
Effluent Characterization	Specific Conductance	µS/cm	-	1,134	667	1,993	4,185	3,311	1,214
	Hardness	mg/L (as $CaCO_3$)		594	363	1,154	3,320	2,542	715
	Alkalinity	mg/L (as $CaCO_3$)	-	37.8	14.8	46.0	47.0	21.3	26.6
	Ammonia (NH_3)	mg/L	-	0.43	0.36	1.05	2.94	3.73	0.70
	Nitrate (NO_3)	mg/L	-	4.4	2.7	5.2	13	13	14
	Phosphorus (P)	mg/L	-	-	-	-	<0.030	0.005	0.152
	Sulphate (SO_4)	mg/L	-	-	-	-	3,635	2,505	635
	Chloride (Cl)	mg/L	-	-	-	-	9.26	10.9	10.0
	Aluminum (Al)	mg/L	-	0.214	0.349	0.043	0.069	0.221	0.143
	Cadmium (Cd)	mg/L	-	0.00012	0.00010	0.00022	0.000050	0.000053	0.000049
	Chromium (Cr)	mg/L	-	-	-	-	0.00054	0.0032	0.0026
	Cobalt (Co)	mg/L	-	-	-	-	<0.00010	0.0251	0.0196
	Iron (Fe)	mg/L	-	0.401	0.537	3.79	2.85	1.54	0.274
	Manganese (Mn)	mg/L	-	-	-	-	6.26	5.68	1.94
	Mercury (Hg)	mg/L	0.0001	0.000010	0.000010	0.000010	0.000010	0.000007	0.000005
	Molybdenum (Mo)	mg/L	-	0.00028	0.00028	0.00028	0.00050	0.00082	0.00181
	Selenium (Se)	mg/L	-	0.0020	0.0010	0.0030	0.0069	0.0048	0.002598
	Thallium (Tl)	mg/L	-	-	-	-	0.00016	0.00014	0.000056
	Uranium (U)	mg/L	-	-	-	-	0.00044	0.00030	0.0030

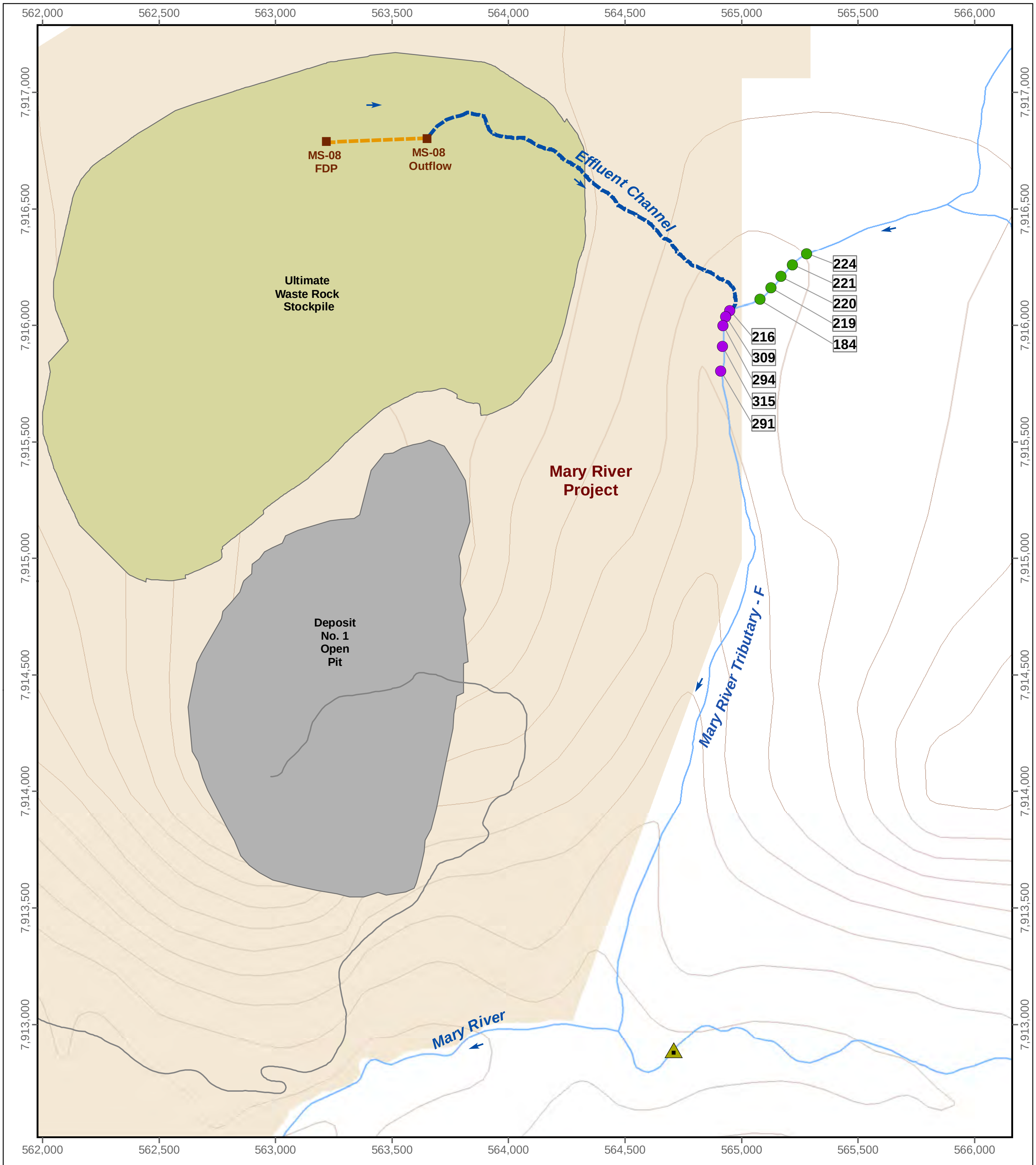
[grey box] Indicates grab sample concentration above applicable limit for deleterious substances *or* grab sample mercury concentration that exceeded fish usability assessment trigger value.

Notes: "NL" refers to a non-lethal 'pass' test result, "L" refers to a lethal 'failure' test result. The number in parentheses (N) represents the number of tests with the same test result completed during specified year.

[a] Indicates that all acute toxicity tests must 'pass' test criteria (i.e., an effluent at 100% concentration that kills less than 50% of test organisms over a 96-hour [rainbow trout] or 48-hour [D. *magna*] period when tested in accordance with Environment Canada protocols).

APPENDIX D

RECEIVING ENVIRONMENT WATER QUALITY DATA



LEGEND

Sampling Location

- Effluent-exposed
- Reference
- Mary River Cascade Barrier
- Final Discharge Point (FDP)
- Discharge Line
- Overland Effluent Channel
- 229 Specific Conductance (uS/cm)

Specific Conductance Data for Mary River Tributary-F During the EEM Field Study

0 0.25 0.5 1 km

Map Projection: UTM Zone 17N NAD 1983

Data Source: Reproduced under licence from Her Majesty the Queen in Rights of Canada, Department of Natural Resources Canada.

N E S W

Date: January 2021

Project 207202.0046

minnow environmental inc.

Figure D.1

Document Path: C:\Users\MLaPalme\Trinity Consultants, Inc\Baffinland Iron Mines - 207202.0046 - Phase 2 EEM\4 - GIS\Report\20-46 Figure D.1 Specific Conductance Data.mxd

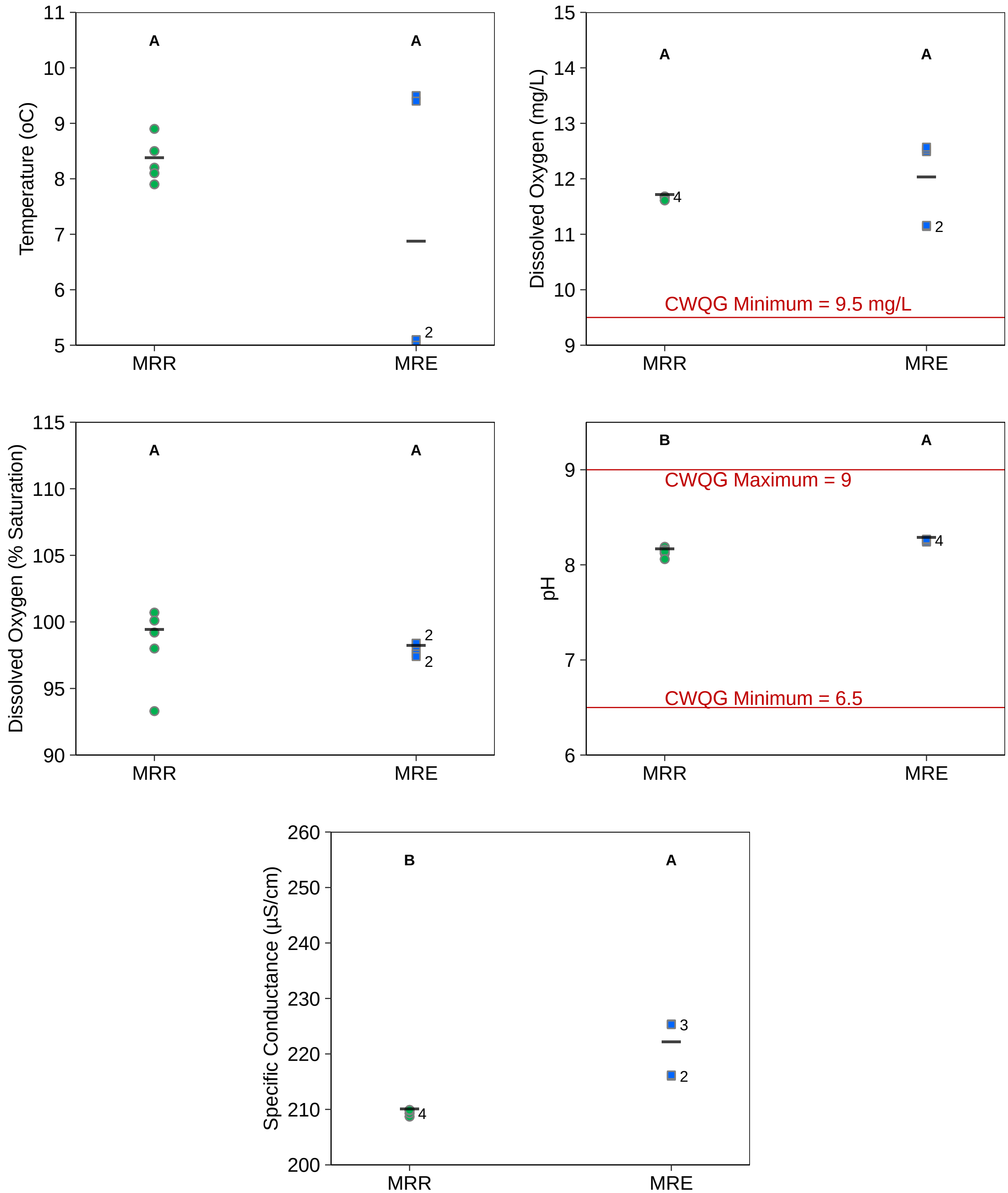


Figure D.2: Comparisons of In Situ Water Quality Measured at Mary River Effluent −Exposed (MRE) and Reference (MRR) Fish Survey Study Areas, Mary River Project Phase 2 EEM, August 2020

Notes: Areas that share a letter are not significant (p-value < 0.1). Bars indicate measures of central tendency. Numbers indicate the number of overlapping points.

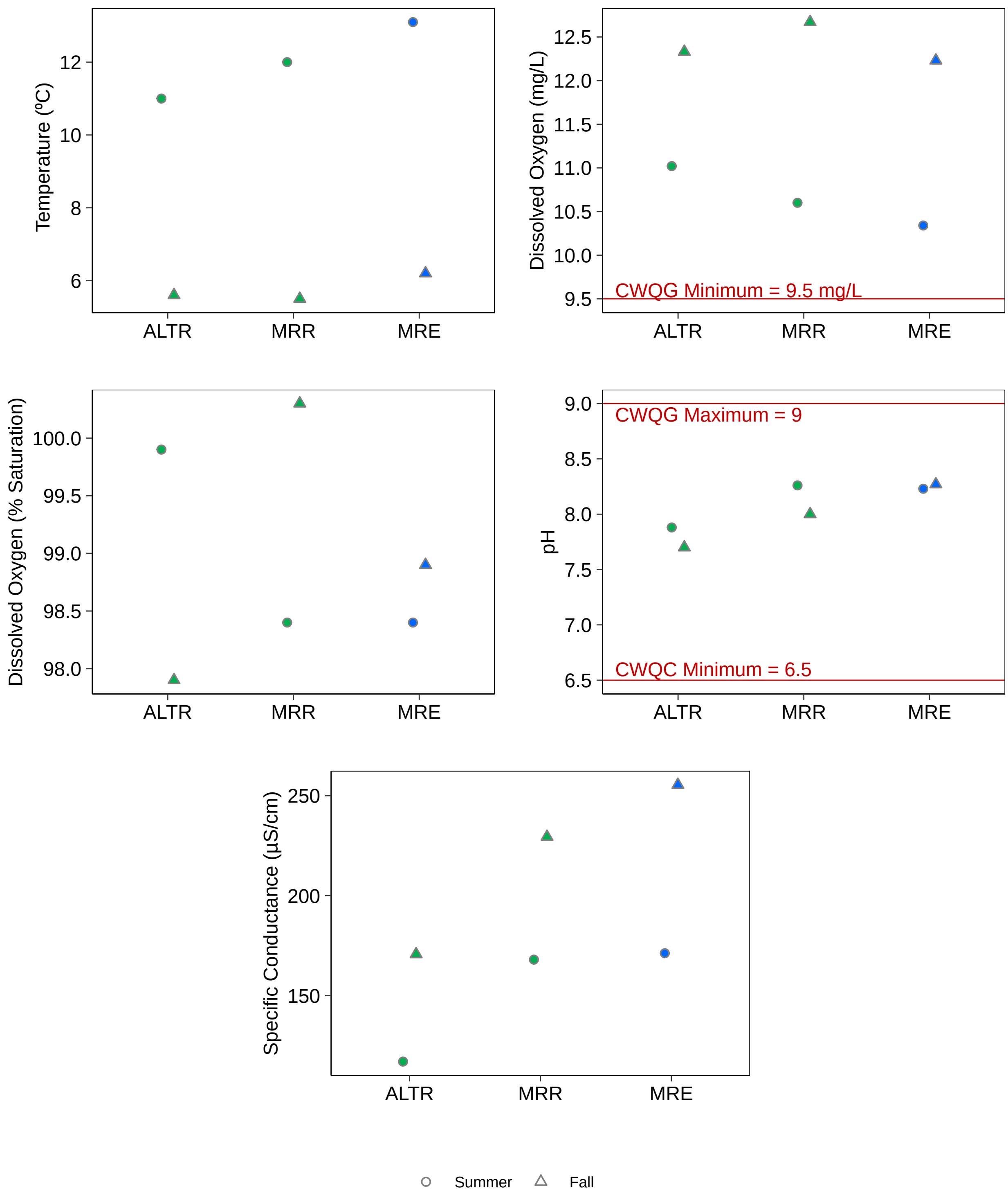


Figure D.3: Comparisons of In Situ Water Quality Measured among Mary River Effluent −Exposed (MRE/E0-10), Mary River Reference (MRR/C0−01), and Angajurjualuk Lake Tributary Reference (ALTR/MRY−REF3) Fish Survey Areas, Mary River Project Phase 2 EEM, July and August 2020

Notes: Reference areas are shown in green and effluent-exposed areas are shown in blue.

Table D.1: ***In Situ*** **Water Quality Measurements Collected at Benthic Invertebrate Community Stations and Fish Population Study Areas for the Mary River Project EEM, August 2020**

Study Area		Station	Date	Temperature (°C)	Dissolved Oxygen (mg/L)	Dissolved Oxygen (% Saturation)	pH (pH units)	Specific Conductance (µS/cm)
Mary River Tributary-F	Reference	MRTF-REF1	19-Aug-20	5.5	12.25	96.6	8.36	224
		MRTF-REF2	19-Aug-20	5.3	12.35	97.7	8.31	221
		MRTF-REF3	19-Aug-20	5.3	12.38	97.8	8.32	220
		MRTF-REF4	19-Aug-20	5.0	12.45	97.7	8.32	219
		MRTF-REF5	19-Aug-20	4.8	12.54	97.6	8.32	184
	Effluent-exposed	MRTF-EXP1	19-Aug-20	4.1	12.79	97.7	8.30	216
		MRTF-EXP2	19-Aug-20	3.7	12.81	97.1	8.24	309
		MRTF-EXP3	19-Aug-20	3.7	12.80	96.9	8.21	294
		MRTF-EXP4	19-Aug-20	3.5	12.91	97.3	8.23	315
		MRTF-EXP5	19-Aug-20	3.6	12.66	94.6	8.02	291
Mary River	Mary River Reference (MRR / CO-05)	MRR-1	11-Aug-20	8.9	11.68	100.7	8.12	209
		MRR-2	11-Aug-20	8.5	11.68	100.1	8.19	209
		MRR-3	11-Aug-20	8.2	11.68	99.2	8.16	210
		MRR-4	11-Aug-20	7.9	11.66	98.0	8.14	210
		MRR-5	11-Aug-20	8.1	11.61	93.3	8.06	210
	Mary River Effluent-Exposed (MRE / EO-01)	MRE-1	13-Aug-20	5.1	12.49	98.0	8.25	225
		MRE-2	13-Aug-20	5.1	12.53	98.4	8.26	225
		MRE-3	13-Aug-20	5.0	12.57	98.4	8.24	225
		MRE-4	11-Aug-20	9.5	11.14	97.6	8.26	216
		MRE-5	11-Aug-20	9.4	11.16	97.4	8.27	216

Table D.2: ***In Situ*** **Water Quality Data Summary and Statistical Comparison Results Between Mary River Tributary-F Effluent-Exposed (MRTF-EXP) and Reference (MRTF-REF) Benthic Study Areas, and Between Mary River Effluent-Exposed (MRE) and Reference (MRR) Fish Study Areas, Mary River Project Phase 2 EEM, August 2020**

System	Water Quality Parameter	Two-Area Comparison			Station	n	Mean	SD	SE	Minimum	Median	Maximum
		Data Transformation	Test	Test P-value								
Mary River Tributary-F	Temperature (°C)	none	tequal	<0.001	MRTF-REF	5	5.18	0.277	0.124	4.8	5.3	5.5
					MRTF-EXP	5	3.72	0.228	0.102	3.5	3.7	4.1
	Dissolved Oxygen (mg/L)	log10	tequal	<0.001	MRTF-REF	5	12.40	0.11	0.05	12.20	12.40	12.50
					MRTF-EXP	5	12.80	0.09	0.04	12.70	12.80	12.90
	Dissolved Oxygen (% Saturation)	rank	M-W	0.205	MRTF-REF	5	97.5	0.5	0.2	96.6	97.7	97.8
					MRTF-EXP	5	96.7	1.2	0.5	94.6	97.1	97.7
	pH	rank	M-W	0.011	MRTF-REF	5	8.33	0.02	0.01	8.31	8.32	8.36
					MRTF-EXP	5	8.20	0.11	0.05	8.02	8.23	8.30
	Specific Conductance (µS/cm)	rank	M-W	0.095	MRTF-REF	5	214	17	8	184	220	224
					MRTF-EXP	5	285	40	18	216	294	315
Mary River	Temperature (°C)	none	tequal	0.205	MRR	5	8.32	0.39	0.17	7.90	8.20	8.90
					MRE	5	6.82	2.40	1.07	5.00	5.10	9.50
	Dissolved Oxygen (mg/L)	none	tequal	0.378	MRR	5	11.66	0.03	0.01	11.61	11.68	11.68
					MRE	5	11.98	0.76	0.34	11.14	12.49	12.57
	Dissolved Oxygen (% Saturation)	rank	M-W	0.344	MRR	5	98.3	3.0	1.3	93.3	99.2	100.7
					MRE	5	98.0	0.5	0.2	97.4	98.0	98.4
	pH	none	tequal	<0.001	MRR	5	8.13	0.05	0.02	8.06	8.14	8.19
					MRE	5	8.26	0.01	0.01	8.24	8.26	8.27
	Specific Conductance (µS/cm)	log10	tequal	<0.001	MRR	5	209.5	0.5	0.2	208.7	209.8	209.9
					MRE	5	221.6	5.1	2.3	216.0	225.3	225.4

(grey) Indicates significant difference between study areas based on a p-value less than 0.1.

(blue) P-value < 0.1 and MOD < -2.

(green) P-value < 0.1 and MOD > 2.

Table D.4: Water Chemistry at Mary River Tributary-F and Mary River Stations during Periods of Effluent Discharge in 2019

	Parameters	Units	Water Quality Guideline[a]	Mary River Tributary-F			Mary River Upstream			
				FO-01	FO-01	FO-01	MS-08-US	MS-08-US	MS-08-US	MS-08-US
				26-Jun-19	1-Aug-19	20-Aug-19	17-Jun-19	22-Jul-19	26-Aug-19	30-Sep-19
Routine Monitoring[b]	pH (lab)	pH	6.5 - 9.0	7.82	8.13	8.34	7.33	8.00	8.15	7.97
	Total Suspended Solids	mg/L	-	4.8	<2.0	<2.0	2.4	2.6	3.3	2.4
	Arsenic (As)	mg/L	0.0050	<0.00010	<0.00010	<0.00010	<0.00010	0.00012	0.00011	<0.00010
	Copper (Cu)[d]	mg/L	0.0020	0.00055	0.00110	0.00120	<0.0010	0.00160	0.00140	0.00110
	Lead (Pb)[d]	mg/L	0.0010	0.000165	0.000118	0.000133	0.000282	0.000439	0.000273	0.000099
	Nickel (Ni)[d]	mg/L	0.025	0.00053	0.00067	0.00090	0.00054	0.00106	0.00073	0.00055
	Zinc (Zn)[d]	mg/L	0.0075	<0.0030	<0.0030	<0.0030	0.0066	<0.0030	<0.0030	<0.0030
	Radium-226	Bq/L	-	-	-	-	<0.0076	<0.011	0.0061	<0.0069
Receiver Water Characterization[c]	Conductivity (lab)	µmho/cm	-	114	465	571	23.3	114	240	167
	Hardness (as $CaCO_3$)	mg/L	-	57	249	294	12	56	95	72
	Alkalinity (as $CaCO_3$)	mg/L	-	46	100	120	11	57	88	73
	Total Ammonia[e]	mg/L	1.04	0.010	0.016	<0.010	<0.010	<0.010	<0.010	<0.010
	Nitrate	mg/L	3	0.057	0.883	0.988	<0.020	<0.020	0.176	0.074
	Total Phosphorus	mg/L	0.02	0.009	0.004	0.005	0.020	0.011	0.010	0.008
	Chloride (Cl)	mg/L	120	4.27	14.2	17.2	<0.50	2.92	13.60	7.20
	Sulphate (SO_4)	mg/L	218	14.0	126	164	<0.30	1.42	9.07	4.48
	Aluminum (Al)[e]	mg/L	0.100	0.106	0.089	0.077	0.295	0.697	0.360	0.123
	Cadmium (Cd)	mg/L	0.000040	<0.000010	<0.0000050	<0.0000050	0.0000081	<0.0000050	<0.0000050	<0.0000050
	Chromium (Cr)	mg/L	0.0089	<0.00050	<0.00050	<0.00050	0.00061	0.00127	0.00065	<0.00050
	Cobalt (Co)	mg/L	0.0040	0.00011	0.00017	0.00018	0.00015	0.00025	0.00014	<0.00010
	Iron (Fe)	mg/L	0.30	0.135	0.107	0.088	0.295	0.567	0.298	0.121
	Manganese (Mn)	mg/L	0.675	0.0041	0.0030	0.0016	0.0058	0.0064	0.0041	0.0022
	Mercury (Hg)	mg/L	0.000026	<0.000010	<0.0000050	<0.0000050	<0.000010	<0.0000050	<0.0000050	<0.0000050
	Molybdenum (Mo)	mg/L	0.073	0.000051	0.000265	0.000346	0.000054	0.000324	0.000497	0.000289
	Selenium (Se)	mg/L	0.0010	<0.0010	0.000249	0.000241	<0.000050	<0.000050	<0.000050	<0.000050
	Thallium (Tl)	mg/L	0.00080	<0.00010	<0.000010	<0.000010	<0.000010	0.000017	<0.000010	<0.000010
	Uranium (U)	mg/L	0.015	0.0003	0.0030	0.0044	0.0002	0.0019	0.0062	0.0036
Total Metals	Total Dissolved Solids	mg/L	-	42	304	399	-	-	-	107
	Dissolved Organic Carbon	mg/L	-	0.96	1.43	1.38	1.35	2.3	1.69	2.24
	Total Organic Carbon	mg/L	-	1.64	1.31	1.70	1.97	4.88	2.1	2.47
	Total Kjeldahl Nitrogen	mg/L	-	<0.15	0.23	0.19	0.17	0.17	0.23	<0.15
	Fluoride (F)[d]	mg/L	0.120	-	-	-	<0.020	0.027	0.031	0.027
	Antimony (Sb)	mg/L	0.020	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Barium (Ba)	mg/L		0.0048	0.0197	0.0247	0.00382	0.0117	0.016	0.0102
	Beryllium (Be)	mg/L	-	<0.00050	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Bismuth (Bi)	mg/L	-	<0.00050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Boron (B)	mg/L	1.5	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
	Calcium (Ca)	mg/L	-	10.5	39.7	47.9	2.45	11.7	19.9	14.7
	Cesium (Cs)	mg/L	-	-	-	-	0.000038	0.000091	0.000041	0.000019
	Lithium (Li)	mg/L	-	0.0014	0.0042	0.0026	<0.0010	0.0013	0.0011	<0.0010
	Magnesium (Mg)	mg/L	-	7.71	34.9	41.6	1.46	6.43	11	8.6
	Potassium (K)	mg/L	-	0.59	1.61	1.81	0.412	1.20	1.58	1.02
	Rubidium (Rb)	mg/L	-	-	-	-	0.00135	0.00341	0.00257	0.00151
	Silicon (Si)	mg/L	-	0.55	0.95	0.74	0.88	2.16	1.67	1.24
	Silver (Ag)	mg/L	0.00025	<0.000010	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Sodium (Na)	mg/L	-	0.369	1.82	2.91	0.353	1.76	5.27	3.13
	Strontium (Sr)	mg/L	-	0.0171	0.0752	0.0603	0.0025	0.013	0.0237	0.0148
	Sulfur (S)	mg/L	-	-	-	-	<0.50	<0.50	2.53	1.66
	Tellurium (Te)	mg/L	-	-	-	-	<0.00020	<0.00020	<0.00020	<0.00020
	Thorium (Th)	mg/L	-	-	-	-	0.00025	0.00069	0.00042	0.00013
	Tin (Sn)	mg/L	0.0000080	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Titanium (Ti)	mg/L	-	<0.010	0.00547	0.00457	0.0176	0.0341	0.0182	0.00718
	Tungsten (W)	mg/L	-	-	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Vanadium (V)	mg/L	0.006	<0.0010	<0.00050	<0.00050	0.00066	0.00139	0.00076	<0.00050
	Zirconium (Zr)	mg/L	-	-	<0.00030	0.00035	0.00034	0.00114	0.00088	0.00034

[grey box] Indicates value above applicable long-term Water Quality Guideline for the protection of aquatic life.

Note: "-" indicates data not available.

[a] Canadian Water Quality Guideline for the protection of aquatic life (CWQG; CCME 2014) or British Columbia Water Quality Guidelines (BCWQG; BCMOE 2017; BCMOECCS 2019) .

[b] Deleterious substances and pH as defined under Schedule 4 of the MDMER (Government of Canada 2020) applicable to effluent quality

[c] Required receiving water characterization as defined under Schedule 5 of the MDMER (Government of Canada 2020).

[d] Hardness-based guidelines calculated using the minimum hardness observed for all samples (12.1 mg/L).

[e] Based on most conservative guideline using highest temperature (13.1) and pH (8.34)

Table D.4: Water Chemistry at Mary River Tributary-F and Mary River Stations during Periods of Effluent Discharge in 2019

	Parameters	Units	Water Quality Guidelines[a]	Mary River Upstream	Mary River Downstream				
				MS-08-US	MS-08-DS	MS-08-DS	MS-08-DS	MS-08-DS	MS-08-DS
				01-Oct-19	17-Jun-19	22-Jul-19	26-Aug-19	30-Sep-19	01-Oct-19
Routine Monitoring[b]	pH (lab)	pH	6.5 - 9.0	8.08	7.37	7.92	8.2	7.94	8.08
	Total Suspended Solids	mg/L	-	2.0	6.0	3.6	3.1	3.2	2.8
	Arsenic (As)	mg/L	0.0050	<0.00010	0.0001	0.00013	0.00011	<0.00010	<0.00010
	Copper (Cu)[d]	mg/L	0.0020	0.00100	0.00110	0.00170	0.00130	0.00120	<0.0010
	Lead (Pb)[d]	mg/L	0.0010	0.000062	0.000426	0.000497	0.000265	0.000128	0.000077
	Nickel (Ni)[d]	mg/L	0.025	<0.00050	0.00146	0.00116	0.00078	0.00072	0.00058
	Zinc (Zn)[d]	mg/L	0.0075	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030
	Radium-226	Bq/L	-	0.0081	0.01	<0.012	0.0093	<0.0080	0.0094
Receiver Water Characterization[c]	Conductivity (lab)	µmho/cm	-	192	28.3	134	271	170	199
	Hardness (as $CaCO_3$)	mg/L	-	81	16	66	109	73	83
	Alkalinity (as $CaCO_3$)	mg/L	-	85	13	58	91	72	85
	Total Ammonia[e]	mg/L	1.04	<0.010	<0.010	<0.010	<0.010	0.013	<0.010
	Nitrate	mg/L	3	0.074	<0.020	0.048	0.082	0.074	0.082
	Total Phosphorus	mg/L	0.02	0.0042	0.0295	0.0128	0.0178	0.0073	0.005
	Chloride (Cl)	mg/L	120	8.41	0.50	3.67	14.2	6.98	8.2
	Sulphate (SO_4)	mg/L	128	5.26	0.90	9.04	18.8	6.8	7.65
	Aluminum (Al)[e]	mg/L	0.100	0.084	0.665	0.662	0.333	0.144	0.118
	Cadmium (Cd)	mg/L	0.000040	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
	Chromium (Cr)	mg/L	0.0089	<0.00050	0.00159	0.00138	0.00064	<0.00050	<0.00050
	Cobalt (Co)	mg/L	0.0040	<0.00010	0.00046	0.00027	0.00014	<0.00010	<0.00010
	Iron (Fe)	mg/L	0.30	0.066	0.912	0.591	0.274	0.140	0.117
	Manganese (Mn)	mg/L	0.675	0.0012	0.0189	0.0069	0.0038	0.0047	0.0025
	Mercury (Hg)	mg/L	0.000026	<0.0000050	<0.000010	<0.0000050	<0.0000050	<0.0000050	<0.0000050
	Molybdenum (Mo)	mg/L	0.073	0.000364	0.000056	0.000301	0.000473	0.000286	0.000321
	Selenium (Se)	mg/L	0.0010	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Thallium (Tl)	mg/L	0.00080	<0.000010	0.000012	0.000017	<0.000010	<0.000010	<0.000010
	Uranium (U)	mg/L	0.015	0.0045	0.0002	0.0019	0.0061	0.0033	0.0042
Total Metals	Total Dissolved Solids	mg/L	-	85	-	-	-	96	90
	Dissolved Organic Carbon	mg/L	-	1.68	1.29	2.26	1.54	2.31	1.6
	Total Organic Carbon	mg/L	-	2.22	1.91	2.21	2.17	2.42	2.19
	Total Kjeldahl Nitrogen	mg/L	-	<0.15	0.16	0.16	0.24	<0.15	<0.15
	Fluoride (F)[d]	mg/L	0.120	0.03	<0.020	0.028	0.029	0.025	0.027
	Antimony (Sb)	mg/L	0.020	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Barium (Ba)	mg/L		0.0111	0.00553	0.012	0.0162	0.00999	0.0112
	Beryllium (Be)	mg/L	-	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Bismuth (Bi)	mg/L	-	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Boron (B)	mg/L	1.5	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
	Calcium (Ca)	mg/L	-	16.6	2.85	13.5	21.7	14.7	16.5
	Cesium (Cs)	mg/L	-	0.000011	0.00007	0.000094	0.00004	0.000019	0.000014
	Lithium (Li)	mg/L	-	<0.0010	<0.0010	0.0018	0.0012	<0.0010	<0.0010
	Magnesium (Mg)	mg/L	-	9.6	2.2	7.76	13.2	8.88	10.2
	Potassium (K)	mg/L	-	1.1	0.51	1.21	1.58	1.01	1.09
	Rubidium (Rb)	mg/L	-	0.00161	0.00221	0.00351	0.00251	0.00156	0.00154
	Silicon (Si)	mg/L	-	1.31	1.38	2.07	1.59	1.26	1.26
	Silver (Ag)	mg/L	0.00025	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Sodium (Na)	mg/L	-	3.68	0.28	1.78	5.06	2.95	3.41
	Strontium (Sr)	mg/L	-	0.017	0.0025	0.0191	0.0265	0.0147	0.0167
	Sulfur (S)	mg/L	-	1.92	<0.50	3.21	6.46	2.38	2.64
	Tellurium (Te)	mg/L	-	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
	Thorium (Th)	mg/L	-	<0.00010	0.00032	0.00072	0.00037	0.00012	<0.00010
	Tin (Sn)	mg/L	0.0000080	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Titanium (Ti)	mg/L	-	0.00375	0.0372	0.0357	0.0163	0.00799	0.00541
	Tungsten (W)	mg/L	-	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Vanadium (V)	mg/L	0.006	<0.00050	0.00119	0.00143	0.00073	<0.00050	<0.00050
	Zirconium (Zr)	mg/L	-	0.00026	0.00032	0.00104	0.00086	0.00031	0.00026

[shaded] Indicates value above applicable long-term Water Quality Guideline for the protection of aquatic life.

Note: "-" indicates data not available.

[a] Canadian Water Quality Guideline for the protection of aquatic life (CWQG; CCME 2014) or British Columbia Water Quality Guidelines (BCWQG; BCMOE 2017; BCMOECCS 2019) .

[b] Deleterious substances and pH as defined under Schedule 4 of the MDMER (Government of Canada 2020) applicable to effluent quality

[c] Required receiving water characterization as defined under Schedule 5 of the MDMER (Government of Canada 2020).

[d] Hardness-based guidelines calculated using the minimum hardness observed for all samples (12.1 mg/L).

[e] Based on most conservative guideline using highest temperature (13.1) and pH (8.34)

Table D.5: **Water Chemistry at Mary River Tributary-F and Mary River Stations during Periods of Effluent Discharge in 2020**

Parameters		Units	Water Quality Guideline[a]	Mary River Tributary-F			Mary River Upstream		
				F0-01	F0-01	F0-01	MS-08-US	MS-08-US	MS-08-US
				03-Jul-20	01-Aug-20	28-Aug-20	28-Jun-20	04-Aug-20	19-Aug-20
Routine Monitoring[b]	pH (lab)	pH	6.5 - 9.0	7.89	8.30	8.32	7.25	8.13	8.20
	Total Suspended Solids	mg/L	-	9.8	<2.0	<2.0	16.7	9.0	5.2
	Arsenic (As)	mg/L	0.0050	<0.00010	<0.00010	<0.00010	0.00013	0.00026	<0.00010
	Copper (Cu)[d]	mg/L	0.0020	0.00051	<0.0010	0.00086	0.00094	0.0026	0.00132
	Lead (Pb)[d]	mg/L	0.0010	0.000212	<0.000050	<0.000050	0.000411	0.000951	0.000215
	Nickel (Ni)[d]	mg/L	0.025	<0.00050	0.00057	<0.00050	0.00070	0.00209	0.00101
	Zinc (Zn)[d]	mg/L	0.0075	<0.0030	<0.0030	<0.0030	<0.0030	0.0033	<0.0030
Receiver Water Characterization[c]	Conductivity (lab)	μmho/cm	-	108	345	403	-	182	192
	Hardness (as $CaCO_3$)	mg/L	-	50	166	211	12	83	90
	Alkalinity (as $CaCO_3$)	mg/L	-	39	122	132	10	79	91
	Ammonia (NH_4^+)[e]	mg/L	1.04	<0.010	<0.010	<0.010	<0.0050	<0.010	<0.010
	Nitrate (NO_3)	mg/L	3	0.187	0.714	1.09	0.0076	0.100	0.143
	Total Phosphorus	mg/L	0.02	0.0377	<0.0030	<0.0030	0.0261	0.0227	0.0068
	Chloride (Cl)	mg/L	120	1.34	13.7	11.7	0.57	8.46	10.6
	Sulphate (SO_4)	mg/L	218	11.8	36.0	60.7	<0.30	5.42	6.22
	Aluminum (Al)	mg/L	0.100	0.170	0.034	0.041	0.439	1.26	0.349
	Cadmium (Cd)[d]	mg/L	0.000040	<0.000010	<0.0000050	<0.000010	<0.0000050	<0.0000050	<0.0000050
	Chromium (Cr)	mg/L	0.0089	<0.00050	<0.00050	<0.00050	0.00094	0.00287	0.00076
	Cobalt (Co)	mg/L	0.0040	0.00016	<0.00010	0.00017	0.00024	0.0006	0.00012
	Iron (Fe)	mg/L	0.30	0.202	0.028	0.050	0.487	1.28	0.267
	Manganese (Mn)	mg/L	0.675	0.00905	0.00103	0.00182	0.0101	0.0154	0.00302
	Mercury (Hg)	mg/L	0.000026	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
	Molybdenum (Mo)	mg/L	0.073	0.000099	0.000491	0.000408	<0.000050	0.000481	0.000453
	Selenium (Se)	mg/L	0.0010	<0.0010	0.000070	<0.0010	<0.000050	<0.000050	<0.000050
	Thallium (Tl)	mg/L	0.00080	<0.00010	<0.000010	<0.000010	0.000012	0.000032	<0.000010
	Uranium (U)	mg/L	0.015	0.0003	0.0037	0.0048	0.0002	0.0049	0.0053
Total Metals	Total Dissolved Solids	mg/L	-	90	190	224	13	96	111
	Dissolved Organic Carbon	mg/L	-	2.12	1.69	1.96	2.09	2.330	1.79
	Total Organic Carbon	mg/L	-	2.94	2.74	2.27	1.65	3.60	1.72
	Total Kjeldahl Nitrogen	mg/L	-	<0.15	0.32	0.16	0.077	0.26	<0.15
	Fluoride (F)[d]	mg/L	0.120	-	-	-	<0.020	0.035	0.035
	Antimony (Sb)	mg/L	0.020	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Barium (Ba)	mg/L		0.00544	0.0165	0.0179	0.00486	0.0194	0.013
	Beryllium (Be)	mg/L	-	<0.00050	<0.00010	<0.00050	<0.00010	<0.00010	<0.00010
	Bismuth (Bi)	mg/L	-	<0.00050	<0.000050	<0.00050	<0.000050	<0.000050	<0.000050
	Boron (B)	mg/L	1.5	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
	Calcium (Ca)	mg/L	-	9.35	29.4	36.7	2.38	17.2	18.5
	Cesium (Cs)	mg/L	-	-	-	-	0.000061	0.000203	0.000041
	Lithium (Li)	mg/L	-	<0.0010	0.0026	0.0018	<0.0010	0.0029	0.0011
	Magnesium (Mg)	mg/L	-	6.67	21.4	27.8	1.45	9.72	10.6
	Potassium (K)	mg/L	-	0.65	1.81	1.69	0.439	1.78	1.42
	Rubidium (Rb)	mg/L	-	-	-	-	0.00189	0.00628	0.00255
	Silicon (Si)	mg/L	-	0.64	1.00	1.09	1.07	2.93	1.57
	Silver (Ag)	mg/L	0.00025	<0.000010	<0.000050	<0.000010	<0.000010	<0.000050	<0.000050
	Sodium (Na)	mg/L	-	0.439	3.23	3.39	0.383	4.27	4.81
	Strontium (Sr)	mg/L	-	0.00994	0.0414	0.0373	0.00267	0.0208	0.0214
	Sulfur (S)	mg/L	-	-	-	-	<0.50	1.91	2.35
	Tellurium (Te)	mg/L	-	-	-	-	<0.00020	<0.00020	<0.00020
	Thorium (Th)	mg/L	-	-	-	-	0.00041	0.00187	0.00033
	Tin (Sn)	mg/L	-	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Titanium (Ti)	mg/L	-	0.011	0.00167	<0.010	0.0286	0.0776	0.0162
	Tungsten (W)	mg/L	-	-	0.00019	-	<0.00010	<0.00010	<0.00010
	Vanadium (V)	mg/L	0.006	<0.0010	<0.00050	<0.0010	0.00102	0.00269	0.00068
	Zirconium (Zr)	mg/L	-	-	<0.00030	-	0.00047	0.00143	0.00061

Indicates value above applicable long-term Water Quality Guideline for the protection of aquatic life.

Note: "-" indicates data not available.

[a] Canadian Water Quality Guideline for the protection of aquatic life (CWQG; CCME 2014) or British Columbia Water Quality Guidelines (BCWQG; BCMOE 2017; BCMOECCS 2019) .

[b] Deleterious substances and pH as defined under Schedule 4 of the MDMER (Government of Canada 2020) applicable to effluent quality

[c] Required receiving water characterization as defined under Schedule 5 of the MDMER (Government of Canada 2020).

[d] Hardness-based guidelines calculated using the minimum hardness observed for all samples (11.9 mg/L).

[e] Based on most conservative guideline using highest temperature (10.2) and pH (8.33)

Table D.5: Water Chemistry at Mary River Tributary-F and Mary River Stations during Periods of Effluent Discharge in 2020

	Parameters	Units	Water Quality Guideline[a]	Mary River Downstream					
				MS-08-DS	MS-08-DS	MS-08-DS	MRR CO-01	MRR CO-01	MRR CO-01
				28-Jun-20	04-Aug-20	19-Aug-20	03-Jul-20	19-Aug-20	28-Aug-20
Routine Monitoring[b]	pH (lab)	pH	6.5 - 9.0	7.30	8.01	8.14	7.61	8.22	8.16
	Total Suspended Solids	mg/L	-	12.7	11.6	4	9.4	5.6	2
	Arsenic (As)	mg/L	0.0050	<0.00010	0.00033	<0.00010	<0.00010	0.00011	<0.00010
	Copper (Cu)[d]	mg/L	0.0020	0.00085	0.00325	0.00117	0.00065	0.00143	0.00107
	Lead (Pb)[d]	mg/L	0.0010	0.000354	0.0013	0.000179	0.000159	0.000356	0.000077
	Nickel (Ni)[d]	mg/L	0.025	0.00075	0.00288	0.00062	0.00057	0.00111	0.00072
	Zinc (Zn)[d]	mg/L	0.0075	<0.0030	0.0045	<0.0030	<0.0030	<0.0030	<0.0030
Receiver Water Characterization[c]	Conductivity (lab)	µmho/cm	-	-	186	201	54.7	192	232
	Hardness (as $CaCO_3$)	mg/L	-	13	87	92	24	89	110
	Alkalinity (as $CaCO_3$)	mg/L	-	11.4	86	93	24	89	93
	Ammonia (NH_4^+)[e]	mg/L	1.04	0.0068	<0.010	<0.010	<0.010	<0.010	<0.010
	Nitrate (NO_3)	mg/L	3	0.021	0.124	0.167	0.042	0.146	0.23
	Total Phosphorus	mg/L	0.02	0.0235	0.0292	0.0084	0.024	0.0126	0.0101
	Chloride (Cl)	mg/L	120	0.58	8.73	10.6	1.3	9.47	11.5
	Sulphate (SO_4)	mg/L	218	0.57	6.43	8.4	1.97	7.81	10.7
	Aluminum (Al)	mg/L	0.100	0.407	1.6400	0.207	0.244	0.483	0.107
	Cadmium (Cd)[d]	mg/L	0.000040	0.0000051	0.0000060	<0.0000050	<0.000010	<0.0000050	<0.000010
	Chromium (Cr)	mg/L	0.0089	0.00089	0.00379	0.00055	<0.00050	0.00093	<0.00050
	Cobalt (Co)	mg/L	0.0040	0.00022	0.00081	<0.00010	<0.00010	0.00022	<0.00010
	Iron (Fe)	mg/L	0.30	0.466	1.77	0.203	0.184	0.528	0.097
	Manganese (Mn)	mg/L	0.675	0.00966	0.0213	0.00277	0.00415	0.00681	0.00246
	Mercury (Hg)	mg/L	0.000026	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
	Molybdenum (Mo)	mg/L	0.073	<0.000050	0.000478	0.00046	0.000091	0.000462	0.000584
	Selenium (Se)	mg/L	0.0010	<0.000050	<0.000050	<0.000050	<0.0010	<0.000050	<0.0010
	Thallium (Tl)	mg/L	0.00080	0.00001	0.000045	<0.000010	<0.00010	0.000013	<0.00010
	Uranium (U)	mg/L	0.015	0.0002	0.0048	0.0053	0.0002	0.0037	0.0051
Total Metals	Total Dissolved Solids	mg/L	-	11	122	94	77	129	134
	Dissolved Organic Carbon	mg/L	-	2.3	3.36	2.04	2.12	2.28	2.11
	Total Organic Carbon	mg/L	-	1.85	3.70	1.77	3.18	1.93	2.45
	Total Kjeldahl Nitrogen	mg/L	-	0.085	0.17	<0.15	<0.15	<0.15	<0.15
	Fluoride (F)[d]	mg/L	0.120	<0.020	0.035	0.035	-	0.035	-
	Antimony (Sb)	mg/L	0.020	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Barium (Ba)	mg/L		0.00461	0.0221	0.0129	0.00532	0.0137	0.0149
	Beryllium (Be)	mg/L	-	<0.00010	<0.00010	<0.00010	<0.00050	<0.00010	<0.00050
	Bismuth (Bi)	mg/L	-	<0.000050	<0.000050	<0.000050	<0.00050	<0.000050	<0.00050
	Boron (B)	mg/L	1.5	<0.010	0.011	<0.010	<0.010	<0.010	<0.010
	Calcium (Ca)	mg/L	-	2.57	17.3	18.7	4.9	18	21.4
	Cesium (Cs)	mg/L	-	0.000054	0.000276	0.000031	-	0.000057	-
	Lithium (Li)	mg/L	-	<0.0010	0.0035	0.0011	<0.0010	0.0015	<0.0010
	Magnesium (Mg)	mg/L	-	1.62	10.6	10.9	3.26	10.7	13.0
	Potassium (K)	mg/L	-	0.433	1.96	1.32	0.62	1.37	1.46
	Rubidium (Rb)	mg/L	-	0.00179	0.00811	0.00223	-	0.00299	-
	Silicon (Si)	mg/L	-	0.99	3.66	1.31	0.87	1.81	0.91
	Silver (Ag)	mg/L	0.00025	<0.000010	<0.000050	<0.000050	<0.000010	<0.000050	<0.000010
	Sodium (Na)	mg/L	-	0.373	4.33	4.59	0.789	4.12	5.1
	Strontium (Sr)	mg/L	-	0.00268	0.0221	0.0216	0.00475	0.0196	0.0234
	Sulfur (S)	mg/L	-	<0.50	2.22	3.02	-	2.78	-
	Tellurium (Te)	mg/L	-	<0.00020	<0.00020	<0.00020	-	<0.00020	-
	Thorium (Th)	mg/L	-	0.00035	0.0026	0.00024	-	0.00047	-
	Tin (Sn)	mg/L	-	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Titanium (Ti)	mg/L	-	0.0274	0.105	0.011	<0.010	0.0256	<0.010
	Tungsten (W)	mg/L	-	<0.00010	<0.00010	<0.00010	-	<0.00010	-
	Vanadium (V)	mg/L	0.006	0.00092	0.00352	0.00055	<0.0010	0.00097	<0.0010
	Zirconium (Zr)	mg/L	-	<0.00060	0.00165	0.00046	-	0.00085	-

[shaded box] Indicates value above applicable long-term Water Quality Guideline for the protection of aquatic life.

Note: "-" indicates data not available.

[a] Canadian Water Quality Guideline for the protection of aquatic life (CWQG; CCME 2014) or British Columbia Water Quality Guidelines (BCWQG; BCMOE 2017; BCMOECCS 2019) .

[b] Deleterious substances and pH as defined under Schedule 4 of the MDMER (Government of Canada 2020) applicable to effluent quality

[c] Required receiving water characterization as defined under Schedule 5 of the MDMER (Government of Canada 2020).

[d] Hardness-based guidelines calculated using the minimum hardness observed for all samples (11.9 mg/L).

[e] Based on most conservative guideline using highest temperature (10.2) and pH (8.33)

Table D.6: Water Chemistry at Benthic Invertebrate Community and Fish Population/Tissue Selenium Study Areas at the Time of the Phase 2 EEM Biological Sampling, August 2020

Parameters		Units	Water Quality Guideline[a]	Benthic Invertebrate Community Survey Areas		Fish Population and Fish Tissue Selenium Survey Areas			
				Mary River Tributary-F		Angajurjualuk Lake Tributary	Mary River		
				Reference	Effluent-Exposed	Reference	Upstream Reference	Downstream Reference	Effluent-Exposed
				MRTF-REF	MRTF-EXP	ALTR	MS-08-US	MRR	MRE
				19-Aug-20	19-Aug-20	19-Aug-20	19-Aug-20	19-Aug-20	19-Aug-20
Routine Monitoring[b]	pH (lab)	pH	6.5 - 9.0	8.33	8.31	7.79	8.20	8.22	8.14
	Total Suspended Solids	mg/L	-	2.4	6.7	6.8	5.2	5.6	4
	Arsenic (As)	mg/L	0.0050	<0.00010	<0.00010	0.00014	<0.00010	0.00011	<0.00010
	Copper (Cu)[d]	mg/L	0.0020	0.00053	0.00054	0.00189	0.00132	0.00143	0.00117
	Lead (Pb)[d]	mg/L	0.0010	<0.000050	<0.000050	0.00054	0.000215	0.000356	0.000179
	Nickel (Ni)[d]	mg/L	0.025	<0.00050	<0.00050	0.00088	0.00101	0.00111	0.00062
	Zinc (Zn)[d]	mg/L	0.0075	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030
Receiver Water Characterization[c]	Conductivity (lab)	µmho/cm	-	217	285	127	192	192	201
	Hardness (as $CaCO_3$)	mg/L	-	121	150	50	90	89	92
	Alkalinity (as $CaCO_3$)	mg/L	-	124	119	37	91	89	93
	Ammonia (NH_4^+)[e]	mg/L	1.04	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
	Nitrate (NO_3)	mg/L	3	0.104	0.448	0.096	0.143	0.146	0.167
	Total Phosphorus	mg/L	0.02	<0.0030	<0.0030	0.0165	0.0068	0.0126	0.0084
	Chloride (Cl)	mg/L	120	1.23	3.47	11.2	10.6	9.47	10.6
	Sulphate (SO_4)	mg/L	218	6.34	36.4	14.5	6.22	7.81	8.4
	Aluminum (Al)	mg/L	0.100	<0.0050	<0.0050	0.580	0.349	0.483	0.207
	Cadmium (Cd)[d]	mg/L	0.000040	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
	Chromium (Cr)	mg/L	0.0089	<0.00050	<0.00050	0.00133	0.00076	0.00093	0.00055
	Cobalt (Co)	mg/L	0.0040	<0.00010	<0.00010	0.00024	0.00012	0.00022	<0.00010
	Iron (Fe)	mg/L	0.30	<0.010	<0.010	0.582	0.267	0.528	0.203
	Manganese (Mn)	mg/L	0.675	<0.00050	<0.00050	0.00741	0.00302	0.00681	0.00277
	Mercury (Hg)	mg/L	0.000026	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
	Molybdenum (Mo)	mg/L	0.073	0.000195	0.000206	0.000499	0.000453	0.000462	0.00046
	Selenium (Se)	mg/L	0.0010	<0.000050	0.000067	<0.000050	<0.000050	<0.000050	<0.000050
	Thallium (Tl)	mg/L	0.00080	<0.000010	<0.000010	0.000015	<0.000010	0.000013	<0.000010
	Uranium (U)	mg/L	0.015	0.0051	0.0038	0.0022	0.0053	0.0037	0.0053
Total Metals	Total Dissolved Solids	mg/L	-	116	162	87	111	129	94
	Dissolved Organic Carbon	mg/L	-	1.28	1.28	1.58	1.79	2.28	2.04
	Total Organic Carbon	mg/L	-	1.43	1.49	1.77	1.72	1.93	1.77
	Total Kjeldahl Nitrogen	mg/L	-	0.27	0.27	<0.15	<0.15	<0.15	<0.15
	Fluoride (F)[d]	mg/L	0.120	<0.020	<0.020	0.044	0.035	0.035	0.035
	Antimony (Sb)	mg/L	0.020	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Barium (Ba)	mg/L		0.00782	0.00883	0.0139	0.013	0.0137	0.0129
	Beryllium (Be)	mg/L	-	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Bismuth (Bi)	mg/L	-	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Boron (B)	mg/L	1.5	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
	Calcium (Ca)	mg/L	-	25.1	26.5	10.8	18.5	18	18.7
	Cesium (Cs)	mg/L	-	<0.000010	<0.000010	0.000077	0.000041	0.000057	0.000031
	Lithium (Li)	mg/L	-	<0.0010	0.0011	0.0013	0.0011	0.0015	0.0011
	Magnesium (Mg)	mg/L	-	14.1	20.4	5.69	10.6	10.7	10.9
	Potassium (K)	mg/L	-	0.891	0.967	1.22	1.42	1.37	1.32
	Rubidium (Rb)	mg/L	-	0.00109	0.00117	0.00365	0.00255	0.00299	0.00223
	Silicon (Si)	mg/L	-	1.03	1.01	2.14	1.57	1.81	1.31
	Silver (Ag)	mg/L	0.00025	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Sodium (Na)	mg/L	-	1.22	1.48	4.82	4.81	4.12	4.59
	Strontium (Sr)	mg/L	-	0.0143	0.0191	0.0243	0.0214	0.0196	0.0216
	Tellurium (Te)	mg/L	-	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
	Thorium (Th)	mg/L	-	<0.00010	<0.00010	0.00114	0.00033	0.00047	0.00024
	Tin (Sn)	mg/L	-	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Titanium (Ti)	mg/L	-	<0.00030	<0.00030	0.0353	0.0162	0.0256	0.011
	Tungsten (W)	mg/L	-	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Vanadium (V)	mg/L	0.006	<0.00050	<0.00050	0.00116	0.00068	0.00097	0.00055
	Zirconium (Zr)	mg/L	-	<0.00020	<0.00020	0.00114	0.00061	0.00085	0.00046

Indicates value above applicable long-term Water Quality Guideline for the protection of aquatic life.

Note: "-" indicates data not available.

[a] Canadian Water Quality Guideline for the protection of aquatic life (CWQG; CCME 2014) or British Columbia Water Quality Guidelines (BCWQG; BCMOE 2017; BCMOECCS 2019) .

[b] Deleterious substances and pH as defined under Schedule 4 of the MDMER (Government of Canada 2020) applicable to effluent quality

[c] Required receiving water characterization as defined under Schedule 5 of the MDMER (Government of Canada 2020).

[d] Hardness-based guidelines calculated using the minimum hardness observed for all samples (11.9 mg/L).

[e] Based on most conservative guideline using highest temperature (10.2) and pH (8.33)

APPENDIX E

BENTHIC INVERTEBRATE COMMUNITY DATA

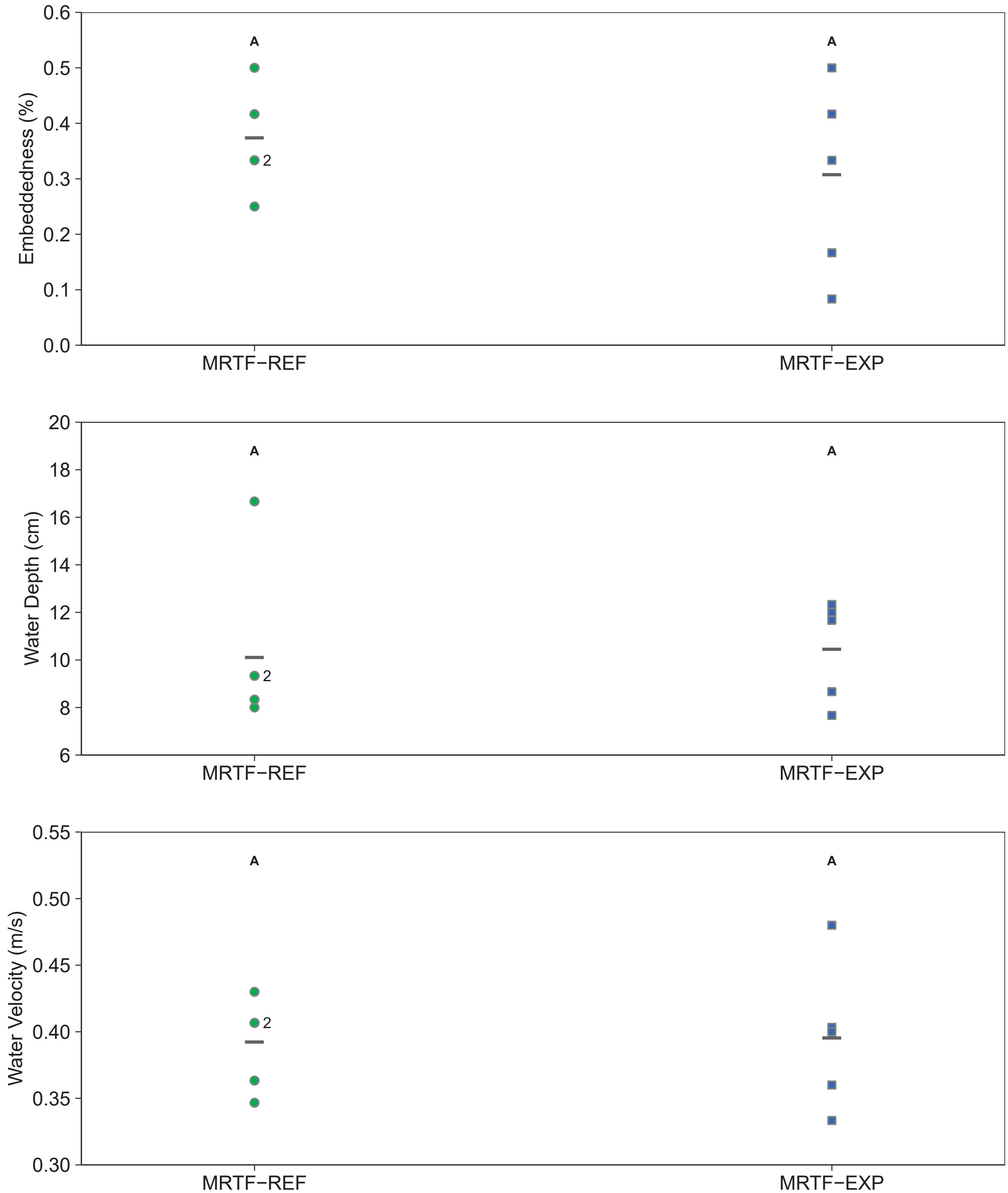


Figure E.1: Comparisons of Benthic Invertebrate Community Replicate Station Habitat Measures Between Mary River Tributary-F Effluent−Exposed (MRTF−EXP) and Reference (MRTF−REF) Study Areas, Mary River Project Phase 2 EEM, August 2020

Notes: Areas that share a letter are not significant (p-value < 0.1). Bars indicate measures of central tendency. Numbers indicate the number of overlapping points.

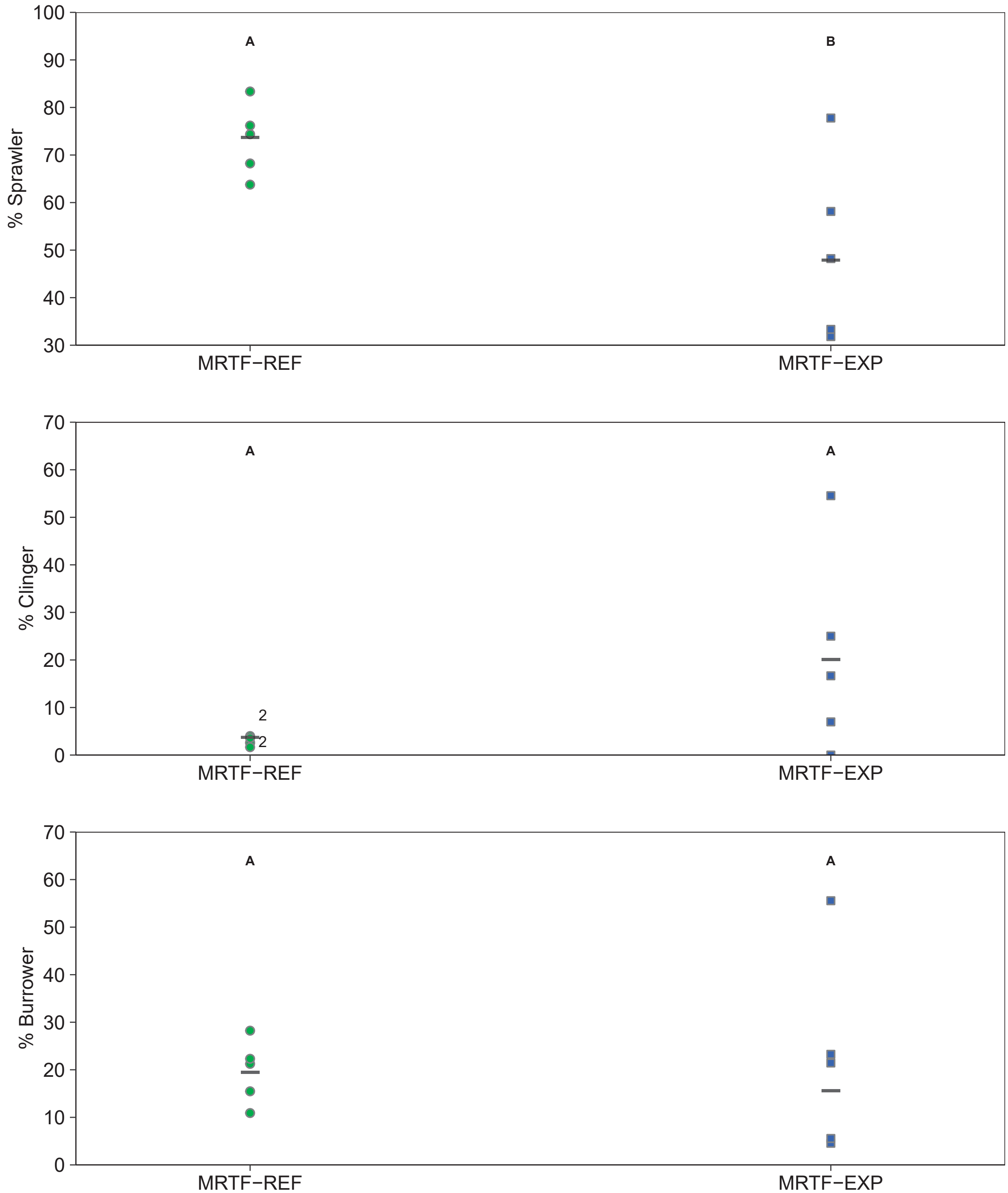


Figure E.2: Benthic Invertebrate Community Habit Preference Group (HPG) Comparisons Between Mary River Tributary-F Effluent−Exposed (MRTF−EXP) and Reference (MRTF−REF) Study Areas, Mary River Project Phase 2 EEM, August 2020

Notes: Areas that share a letter are not significant (p-value < 0.1). Bars indicate measures of central tendency. Numbers indicate the number of overlapping points.

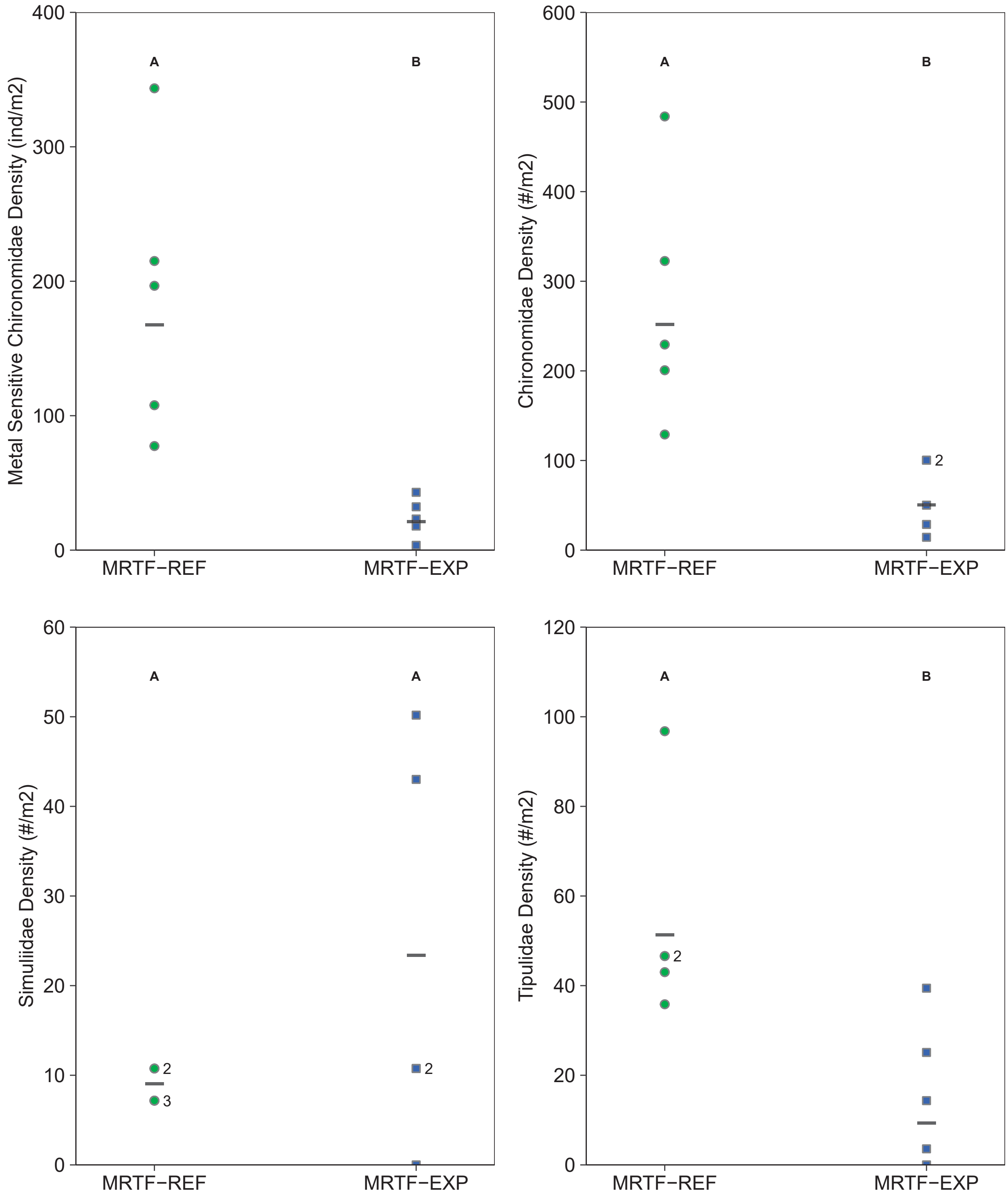


Figure E.3: Benthic Invertebrate Dominant Group Density Comparisons Between Mary River Tributary-F Effluent−Exposed (MRTF−EXP) and Reference (MRTF−REF) Study Areas, Mary River Project Phase 2 EEM, August 2020

Notes: Areas that share a letter are not significant (p-value < 0.1). Bars indicate measures of central tendency. Numbers indicate the number of overlapping points.

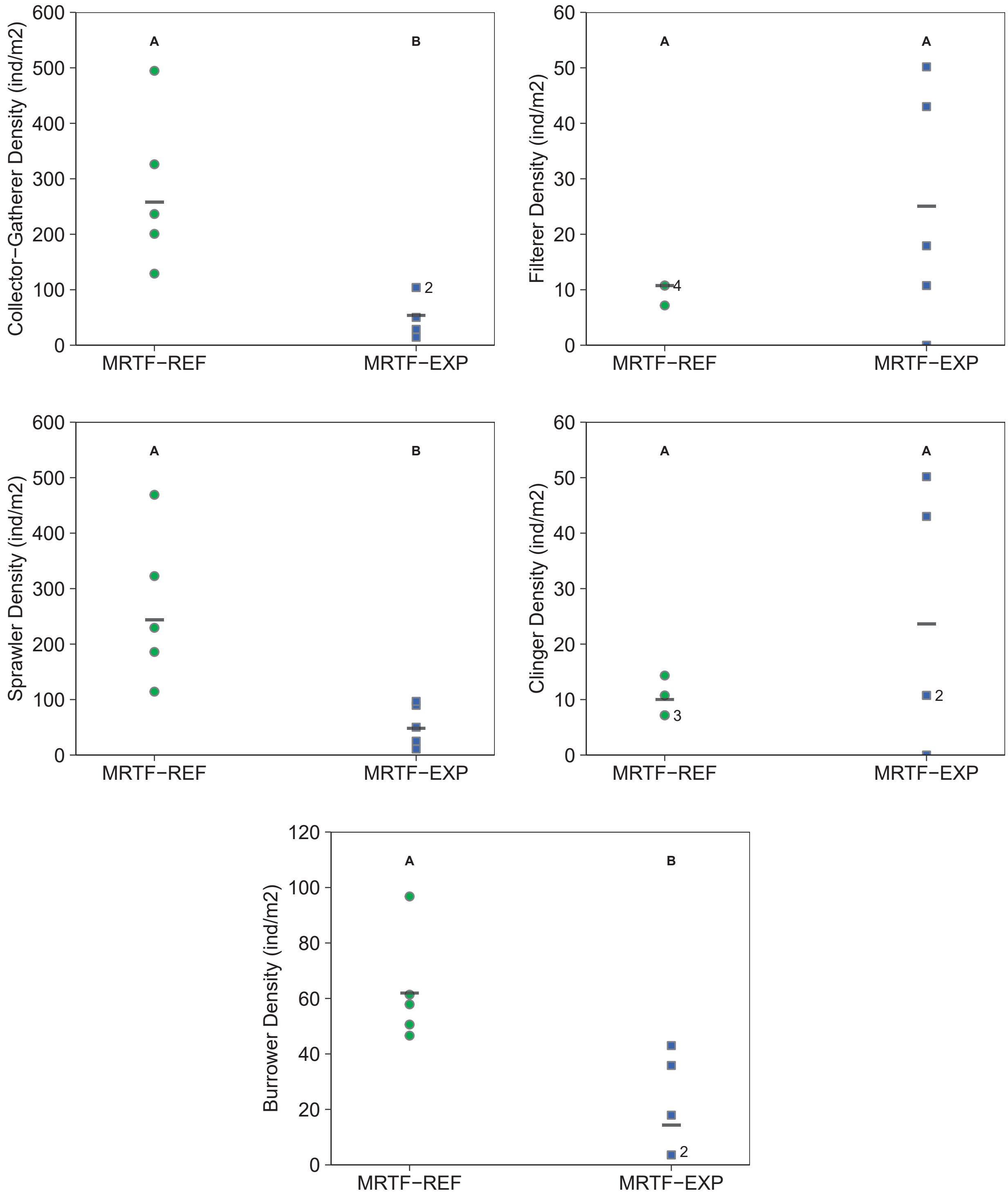
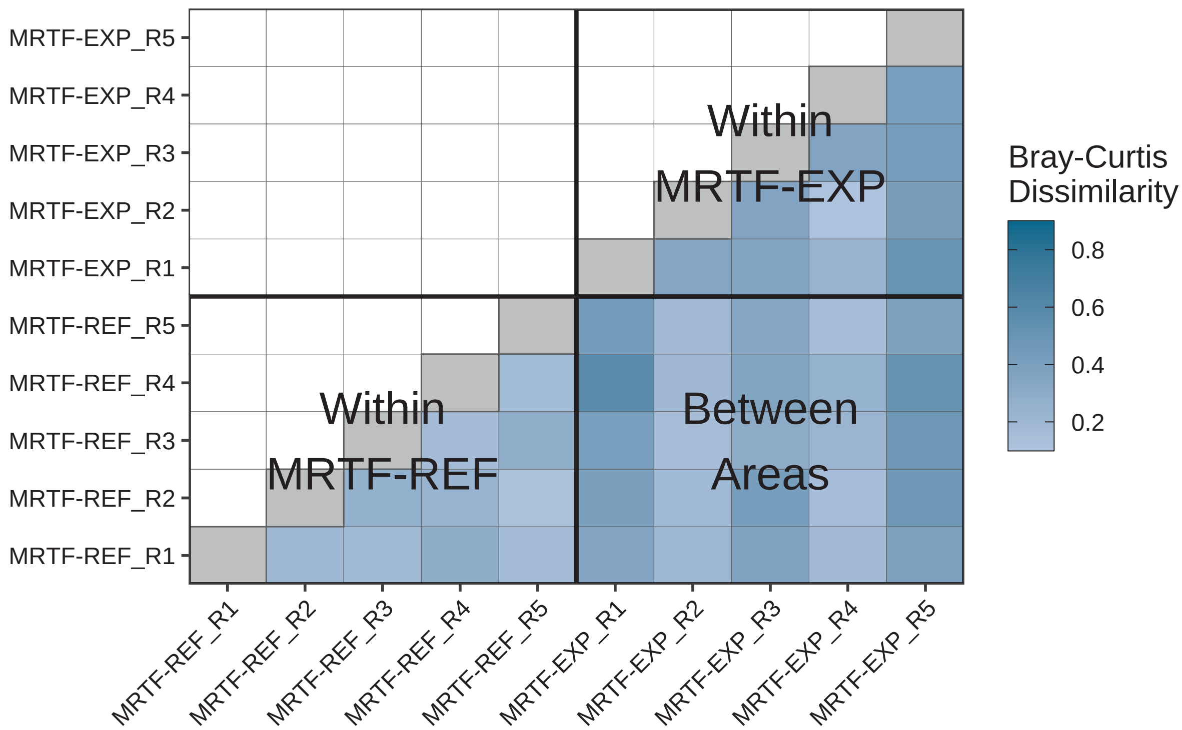


Figure E.4: Benthic Invertebrate FFG and HPG Density Comparisons Between Mary River Tributary-F Effluent−Exposed (MRTF−EXP) and Reference (MRTF−REF) Study Areas, Mary River Project Phase 2 EEM, August 2020

Notes: Areas that share a letter are not significant (p-value < 0.1). Bars indicate measures of central tendency. Numbers indicate the number of overlapping points.



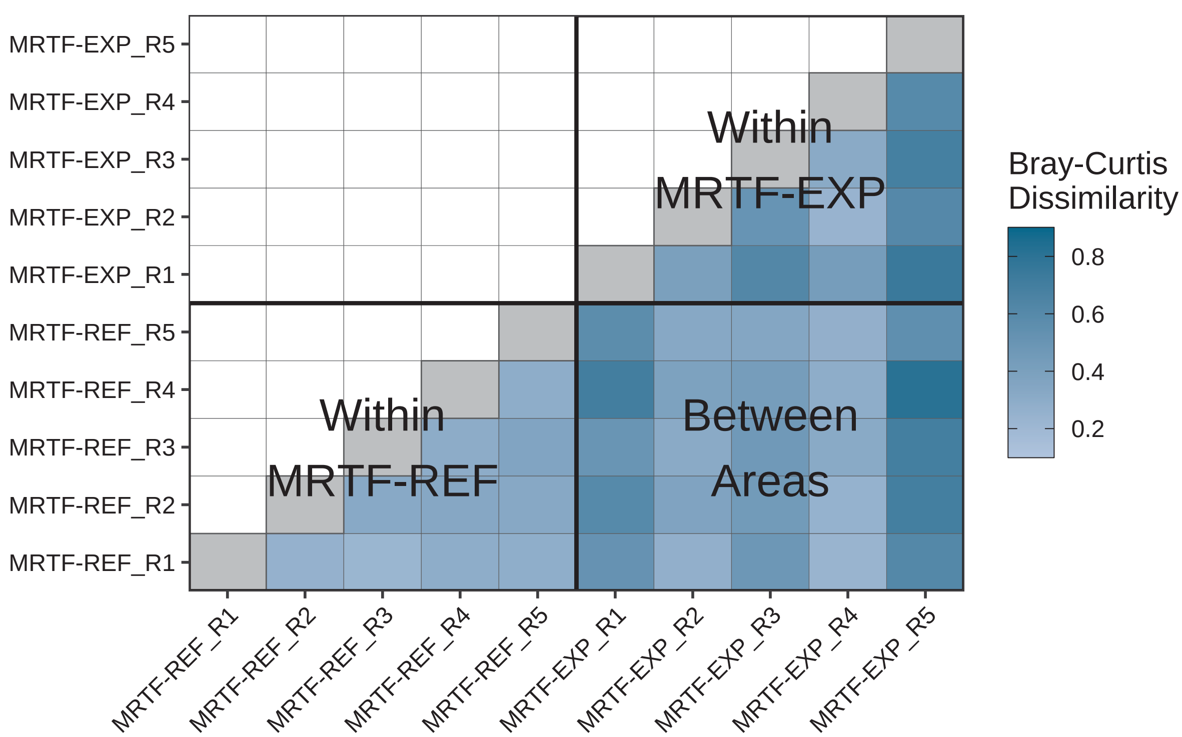


Figure E.5: Heatmap of Benthic Invertebrate Bray-Curtis Dissimilarity Between Mary River Tributary-F Effluent−Exposed (MRTF−EXP) and Reference (MRTF−REF) Study Areas at Family Level (upper) and Lowest Practical Level (lower) Taxonomic Resolution, Mary River Project Phase 2 EEM, August 2020

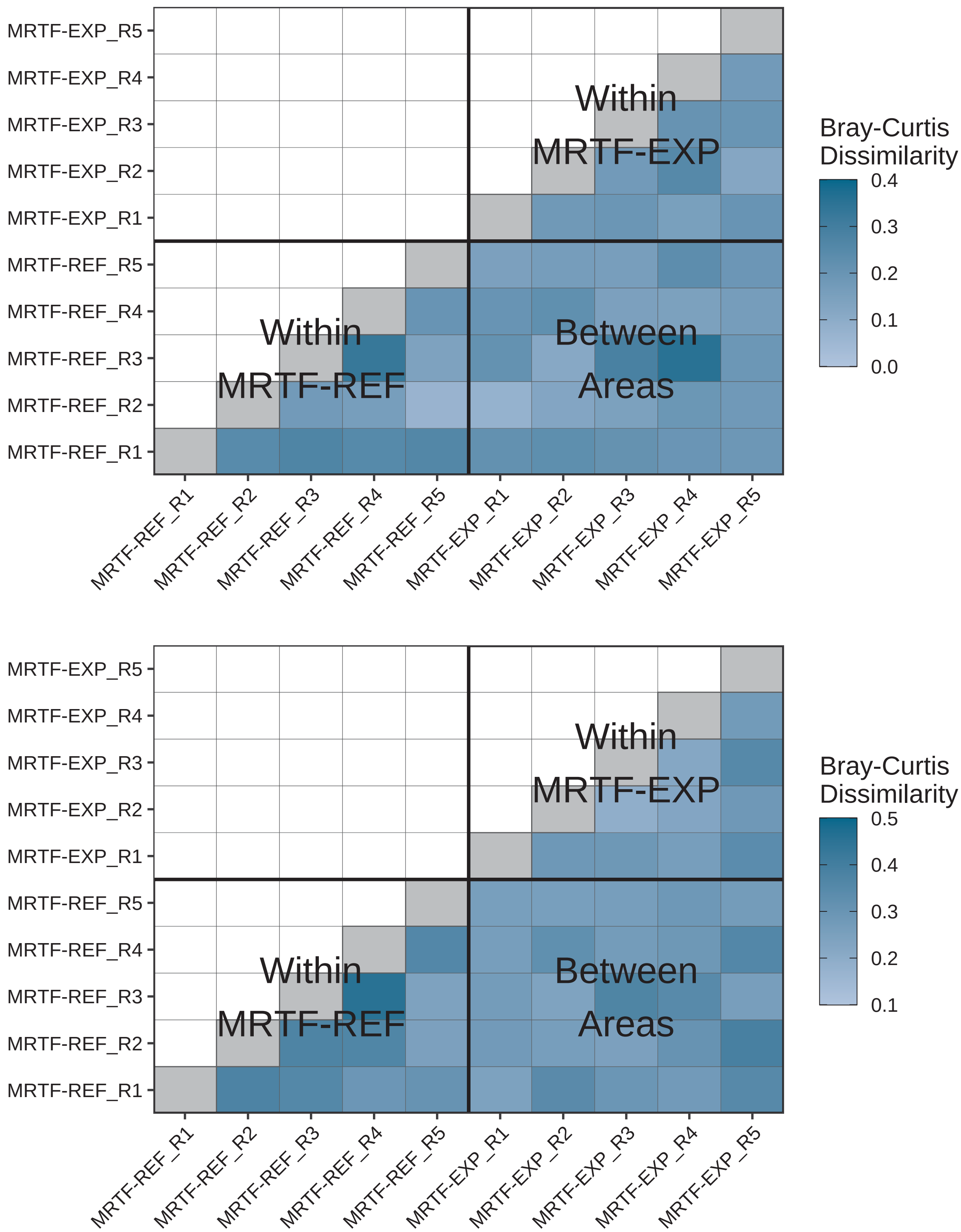


Figure E.6: Heatmap of Benthic Invertebrate Bray-Curtis Dissimilarity Between Mary River Tributary-F Effluent−Exposed (MRTF−EXP) and Reference (MRTF−REF) Study Areas at Family Level (upper) and Lowest Practical Level (lower) Taxonomic Resolution, Mary River Project Phase 1 EEM, August 2017

Table E.1: Coordinates of Benthic Invertebrate Community Sampling Stations Used for the Mary River Project Phase 2 EEM, August 2020

Study Area	Station	Date Sampled	GPS Coordinates[a]	
			Latitude	Longitude
Mary River Tributary-F Reference	MRTF-REF1	19-Aug-20	71.34018	-79.17194
	MRTF-REF2	19-Aug-20	71.33962	-79.17342
	MRTF-REF3	19-Aug-20	71.33920	-79.17506
	MRTF-REF4	19-Aug-20	71.33882	-79.17619
	MRTF-REF5	19-Aug-20	71.33849	-79.17762
Mary River Tributary-F Effluent-Exposed	MRTF-EXP1	19-Aug-20	71.33793	-79.18114
	MRTF-EXP2	19-Aug-20	71.33771	-79.18165
	MRTF-EXP3	19-Aug-20	71.33736	-79.18201
	MRTF-EXP4	19-Aug-20	71.33656	-79.18226
	MRTF-EXP5	19-Aug-20	71.33562	-79.18246

Note: GPS = global positioning system.

[a] Coordinates presented as decimal degrees using 1983 North American Datum (NAD 83).

Table E.2: Replicate Habitat Measurements Collected at Benthic Invertebrate Community Stations, Mary River Project, Phase 2 EEM, August 2020

Study Area	Station	Water Depth (cm)			Water Velocity (m/s)			Embeddedness (%)		
		Replicate Grab 1	Replicate Grab 2	Replicate Grab 3	Replicate Grab 1	Replicate Grab 2	Replicate Grab 3	Replicate Grab 1	Replicate Grab 2	Replicate Grab 3
Mary River Tributary-F Reference	MRTF-REF1	15	18	17	0.34	0.39	0.49	0%	75%	75%
	MRTF-REF2	8	6	10	0.32	0.42	0.35	25%	50%	25%
	MRTF-REF3	9	10	9	0.33	0.40	0.31	25%	75%	25%
	MRTF-REF4	8	7	10	0.44	0.44	0.41	0%	50%	25%
	MRTF-REF5	8	8	12	0.32	0.39	0.51	25%	25%	50%
Mary River Tributary-F Effluent-Exposed	MRTF-EXP1	20	10	6	0.41	0.33	0.47	0%	25%	25%
	MRTF-EXP2	8	18	11	0.43	0.43	0.58	50%	25%	25%
	MRTF-EXP3	8	8	10	0.31	0.42	0.35	0%	25%	0%
	MRTF-EXP4	8	6	9	0.33	0.39	0.48	25%	75%	50%
	MRTF-EXP5	16	12	7	0.30	0.38	0.32	25%	25%	75%

Table E.3: Habitat Characteristics Summary and Statistical Comparison Results Between Effluent-Exposed (MRTF-EXP) and Reference (MRTF-REF) Benthic Study Areas, Mary River Project, Phase 2 EEM, August 2020

Replicate Feature	Two-Area Comparison				Station	n	Mean	SD	SE	Median	Minimum	Maximum
	Data Transformation	Test	Test P-value	MOD (%)								
Embeddedness (%)	none	tequal	0.471	ns	MRTF-REF	5	0.367	0.0950	0.0425	0.333	0.250	0.500
					MRTF-EXP	5	0.300	0.173	0.0773	0.333	0.0833	0.500
Water Depth (cm)	log10	tequal	0.841	ns	MRTF-REF	5	10.3	3.59	1.61	9.33	8.00	16.7
					MRTF-EXP	5	10.5	2.14	0.958	11.7	7.67	12.3
Water Velocity (m/s)	log10	tequal	0.923	ns	MRTF-REF	5	0.391	0.0344	0.0154	0.407	0.347	0.430
					MRTF-EXP	5	0.395	0.0556	0.0248	0.400	0.333	0.480

P-value < 0.1.

Table E.4: Benthic Invertebrate Community Density (individuals/m^2) at Family Level (FL) Taxonomy, Mary River Project Phase 2 EEM, August 2020

Phylum	Class	Order	Family	Reference Station Replicate					Effluent-Exposed Station Replicate				
				1	2	3	4	5	1	2	3	4	5
Annelida	Oligochaeta	Haplotaxida	Enchytraeidae	-	-	4	4	-	-	7	-	-	-
Arthropoda	Arachnida	Trombidiformes	Sperchonidae	11	4	-	-	7	4	4	-	4	4
	Insecta	Collembola	not assigned	11	4	4	-	-	4	4	-	4	-
		Diptera	Chironomidae	201	484	129	323	229	29	100	50	100	14
			Empididae	-	4	-	-	-	-	-	-	-	-
			Simuliidae	7	11	7	7	11	43	11	11	50	-
			Tipulidae	43	47	36	97	47	-	25	4	39	14
		Ephemeroptera	Baetidae	-	11	-	4	7	-	4	-	4	-

Note: "-" indicates no individuals occurred in the sample.

Table E.5: Benthic Invertebrate Community Density (individuals/m^2) at Lowest Practical Level (LPL) Taxonomy, Mary River Project Phase 2 EEM, August 2020

Class	Order	Family	Genus	MRTF−REF (reference)					MRTF−EXP (Effluent-Exposed)				
				1	2	3	4	5	1	2	3	4	5
Oligochaeta	-	Enchytraeidae	-	0	0	4	4	0	0	7	0	0	0
Arachnida	Trombidiformes	Sperchonidae	*Sperchon*	11	4	0	0	7	4	4	0	4	4
Insecta	Ephemeroptera	Baetidae	*Acentrella feropagus*	0	11	0	4	7	0	4	0	4	0
	Collembola	-	-	11	4	4	0	0	4	4	0	4	0
	Diptera	Chironomidae	*Chaetocladius*	4	11	0	4	0	0	0	0	0	0
			Corynoneura	0	4	4	0	0	0	0	0	0	0
			Diamesa	85	89	52	129	171	18	39	4	18	0
			Diplocladius	0	4	0	0	0	0	0	4	4	0
			Eukiefferiella	22	48	11	68	22	7	39	12	32	0
			Krenosmittia	4	7	4	54	15	0	0	15	7	4
			Limnophyes	4	0	0	4	0	0	4	0	4	0
			Metriocnemus	15	15	15	0	0	4	11	0	4	4
			Paraphaenocladius	0	0	0	0	4	0	0	0	0	4
			Pseudokiefferiella	19	247	22	32	11	0	4	4	7	0
			Tokunagaia	37	11	22	29	4	0	0	4	18	0
			Tvetenia	11	26	0	0	4	0	4	4	4	4
			Orthocladius complex	0	22	0	4	0	0	0	4	4	0
		Empididae	*Clinocera*	0	4	0	0	0	0	0	0	0	0
		Simuliidae	*Gymnopais*	7	11	7	7	11	43	11	11	50	0
		Tipulidae	*Tipula*	43	47	36	97	47	0	25	4	39	14

Table E.6: Benthic Invertebrate Community Endpoints, Mary River Project, Phase 2 EEM, August 2020

		Station	MRTF-REF					MRTF-EXP				
		Replicate	R1	R2	R3	R4	R5	R1	R2	R3	R4	R5
Primary Endpoints		Density (No./m²)	272	563	179	434	301	79	154	64	201	32
		Family Richness (No. Taxa)	5	7	5	5	5	4	7	3	6	3
		Family Simpson's Evenness	0.35	0.19	0.36	0.33	0.33	0.58	0.31	0.52	0.47	0.82
		LPL Richness (No. Taxa)	13	17	11	12	11	6	12	10	15	6
		LPL Simpson's Evenness	0.47	0.25	0.54	0.44	0.25	0.46	0.48	0.71	0.45	0.64
Group Percentage (%)	Dominant Taxa	Chironomidae	74	86	72	74	76	36	65	78	50	44
		Metal Sensitive Chironomidae	40	61	43	50	65	23	28	36	16	11
		Simuliidate	2.6	1.9	4	1.7	3.6	54	7	17	25	0
		Tipulidae	16	8.3	20	22	16	0	16	5.6	20	44
	FFG	Collector-Gatherer	74	88	72	75	79	36	67	78	52	44
		Filterer	2.6	1.9	6	2.5	3.6	54	12	17	25	0
	HPG	Sprawler	68	83	64	74	76	32	58	78	48	33
		Clinger	2.6	2.5	4	1.7	3.6	54	7	17	25	0
		Burrower	21	11	28	22	16	4.5	23	5.6	21	56
Group Density (#/m²)	Dominant Taxa	Chironomidae	201	484	129	323	229	29	100	50	100	14
		Metal Sensitive Chironomidae	108	344	77	215	197	18	43	23	32	3.6
		Simuliidae	7.2	11	7.2	7.2	11	43	11	11	50	0
		Tipulidae	43	47	36	97	47	0	25	3.6	39	14
	FFG	Collector-Gatherer	201	495	129	326	237	29	104	50	104	14
		Filterer	7.2	11	11	11	11	43	18	11	50	0
	HPG	Sprawler	186	469	114	323	229	25	90	50	97	11
		Clinger	7.2	14	7.2	7.2	11	43	11	11	50	0
		Burrower	58	61	51	97	47	3.6	36	3.6	43	18

Notes: FFG = Functional Feeding Groups. HPG = Habit Preference Groups.

Table E.7: Benthic Invertebrate Community Endpoint Summary Statistics, Mary River Project Phase 2 EEM, August 2020

Endpoint			Station	n	Mean	SD	SE	Median	Minimum	Maximum
Primary Endpoints	Density (No./m²)		MRTF-REF	5	350	150	67.0	301	179	563
			MRTF-EXP	5	106	69.2	31.0	78.8	32.3	201
	Family Richness (No. Taxa)		MRTF-REF	5	5.40	0.894	0.400	5.00	5.00	7.00
			MRTF-EXP	5	4.60	1.82	0.812	4.00	3.00	7.00
	Family Simpson's Evenness		MRTF-REF	5	0.312	0.0684	0.0306	0.331	0.191	0.357
			MRTF-EXP	5	0.541	0.184	0.0824	0.524	0.311	0.818
	LPL Richness (No. Taxa)		MRTF-REF	5	12.8	2.49	1.11	12.0	11.0	17.0
			MRTF-EXP	5	9.80	3.90	1.74	10.0	6.00	15.0
	LPL Simpson's Evenness		MRTF-REF	5	0.392	0.135	0.0602	0.441	0.247	0.544
			MRTF-EXP	5	0.548	0.118	0.0526	0.483	0.451	0.705
Group Percentage (%)	Dominant Taxa	Chironomidae	MRTF-REF	5	76.5	5.54	2.48	74.4	72.0	86.0
			MRTF-EXP	5	54.7	16.6	7.43	50.0	36.4	77.8
		Metal Sensitive Chironomidae	MRTF-REF	5	51.7	11.1	4.98	49.6	39.6	65.3
			MRTF-EXP	5	22.7	9.74	4.36	22.7	11.1	35.9
		Simuliidae	MRTF-REF	5	2.75	1.02	0.456	2.63	1.65	4.00
			MRTF-EXP	5	20.6	21.2	9.48	16.7	0	54.5
		Tipulidae	MRTF-REF	5	16.4	5.36	2.40	15.8	8.28	22.3
			MRTF-EXP	5	17.2	17.2	7.68	16.3	0	44.4
	FFG	Collector-Gatherer	MRTF-REF	5	77.5	6.31	2.82	75.2	72.0	87.9
			MRTF-EXP	5	55.6	16.9	7.55	51.8	36.4	77.8
		Filterer	MRTF-REF	5	3.32	1.61	0.722	2.63	1.91	6.00
			MRTF-EXP	5	21.6	20.5	9.19	16.7	0	54.5
	HPG	Sprawler	MRTF-REF	5	73.2	7.54	3.37	74.4	63.8	83.4
			MRTF-EXP	5	49.9	19.0	8.51	48.2	31.8	77.8
		Clinger	MRTF-REF	5	2.88	0.923	0.413	2.63	1.65	4.00
			MRTF-EXP	5	20.6	21.2	9.48	16.7	0	54.5
		Burrower	MRTF-REF	5	19.6	6.65	2.98	21.2	10.9	28.2
			MRTF-EXP	5	22.1	20.6	9.23	21.4	4.55	55.6
Group Density (No./m^2)	Dominant Taxa	Chironomidae	MRTF-REF	5	273	137	61.1	229	129	484
			MRTF-EXP	5	58.8	40.0	17.9	50.2	14.3	100
		Metal Sensitive Chironomidae	MRTF-REF	5	188	104	46.7	197	77.4	344
			MRTF-EXP	5	24.0	14.9	6.65	23.2	3.58	43.0
		Simuliidae	MRTF-REF	5	8.60	1.96	0.878	7.17	7.17	10.8
			MRTF-EXP	5	22.9	22.2	9.92	10.8	0	50.2
		Tipulidae	MRTF-REF	5	53.8	24.4	10.9	46.6	35.8	96.8
			MRTF-EXP	5	16.5	16.1	7.22	14.3	0	39.4
	FFG	Collector-Gatherer	MRTF-REF	5	277	141	62.9	237	129	495
			MRTF-EXP	5	60.2	41.9	18.7	50.2	14.3	104
		Filterer	MRTF-REF	5	10.0	1.60	0.717	10.8	7.17	10.8
			MRTF-EXP	5	24.4	21.4	9.58	17.9	0	50.2
	HPG	Sprawler	MRTF-REF	5	264	137	61.3	229	114	469
			MRTF-EXP	5	54.5	38.1	17.1	50.2	10.8	96.8
		Clinger	MRTF-REF	5	9.32	3.21	1.43	7.17	7.17	14.3
			MRTF-EXP	5	22.9	22.2	9.92	10.8	0	50.2
		Burrower	MRTF-REF	5	62.6	19.9	8.92	57.9	46.6	96.8
			MRTF-EXP	5	20.8	18.2	8.13	17.9	3.58	43.0

Notes: FFG = Functional Feeding Groups. HPG = Habit Preference Groups.

Table E.8: Additional Benthic Invertebrate Community Metrics Statistical Comparisons Between Effluent-Exposed (MRTF-EXP) and Reference (MRTF-REF) Areas, Mary River Project Phase 2 EEM, August 2020

Endpoint			Data Transformation	Test	Test P-value	MCT		MOD (%)
						REF	EXP	
Group Percentage (%)	HPG	Sprawler	log10	tunequal	0.059	72.9	47.1	-4.2
		Clinger	log10(x+1)	tunequal	0.121	2.88	19.2	ns
		Burrower	log10	tequal	0.651	18.6	14.8	ns
Group Density (No./m²)	Taxa	Metal Sensitive Chironomidae	log10	tequal	0.003	165	18.3	-3.7
		Chironomidae	log10	tequal	0.005	247	46.1	-3.4
		Simuliidae	none	tequal	0.188	8.60	22.9	ns
		Tipulidae	log10(x+1)	tequal	0.039	50.4	8.42	-4.5
	FFG	Collector-Gatherer	log10	tequal	0.005	251	46.7	-3.3
		Filterer	none	tunequal	0.209	10.0	24.4	ns
	HPG	Sprawler	log10	tequal	0.006	236	41.1	-3.3
		Clinger	none	tequal	0.211	9.32	22.9	ns
		Burrower	log10	tunequal	0.045	60.5	12.9	-5.4

P-value < 0.1. (grey)
P-value < 0.1 and MOD < -2. (blue)
P-value < 0.1 and MOD > 2. (green)

Notes: FFG = Functional Feeding Groups. HPG = Habit Preference Groups. MCT = Measure of Central Tendency; MCT reported as median for rank-transformed data and as back-transformed mean for all other cases. MOD = Magnitude of Difference = $(MCT_{Exp} - MCT_{Ref})/SD_{Ref}$. ns = not significant.

Table E.9: Statistical Comparison of Bray-Curtis Index Between Effluent-Exposed (MRTF-EXP) and Reference (MRTF-REF) Areas using Data at Family-Level and Lowest-Practical-Level Taxonomy(MRTF-REF) Areas, Mary River Project, Second EEM Study, August 2020

Taxonomic Resolution	Comparison	n		Betadisper P-Value	Mantel Test			dbRDA			
		Reference	Effluent-Exposed		r	R^2	P-Value	F-Value	R^2	R^2_{adj}	P-Value
Family	MRTF-REF vs. MRTF-EXP	5	5	0.154	0.169	0.029	0.024	2.52	0.240	0.145	0.023
Lowest-Practical-Level	MRTF-REF vs. MRTF-EXP	5	5	0.210	0.155	0.024	0.008	2.16	0.212	0.114	0.024

Indicates significant difference between areas using a p-value of 0.1.

Table E.10: Statistical Comparison of Bray-Curtis Index Between Effluent-Exposed (MRTF-EXP) and Reference (MRTF-REF) Areas using Mary River Project First EEM Study (August 2017) Data at Family-Level and Lowest-Practical-Level Taxonomy

Taxonomic Resolution	Comparison	n		Betadisper P-Value	Mantel Test			dbRDA			
		Reference	Effluent-Exposed		r	R^2	P-Value	F-Value	R^2	R^2_{adj}	P-Value
Family	MRTF-REF vs. MRTF-EXP	5	5	0.848	-0.087	0.008	0.723	0.53	0.062	-0.055	0.706
Lowest-Practical-Level	MRTF-REF vs. MRTF-EXP	5	5	0.242	-0.117	0.014	0.787	0.49	0.058	-0.060	0.886

[grey box] Indicates significant difference between areas using a p-value of 0.1.

Data Quality
Review

APPENDIX E BENTHIC DATA QUALITY REVIEW

E.1 Introduction

Quality Assurance/Quality Control (QA/QC) implemented for the Mary River Project Second EEM Study included a Data Quality Review (DQR) of the benthic invertebrate community data to provide an evaluation of how well laboratory data quality compared to prescribed goals (i.e., Data Quality Objectives [DQO]) established *a priori*. This DQR report provides a comparison of target data quality to actual data quality, subsequently discussing the consequences of any failures to meet DQO. By completing this step, the quality of the data for the program can be effectively evaluated and demonstrated.

E.2 Quality Control Measures and DQO

During laboratory processing, all benthic invertebrate community sample material was examined in its entirety (i.e., no sub-sampling was conducted; Table E-DQR.2) and therefore only one type of QC was applied in the laboratory for the benthic invertebrate community study component:

- **Organism Recovery Check.** Organism recovery checks for benthic invertebrate community samples involve the re-processing of previously sorted material from a randomly selected sample to determine the number of invertebrates that were not recovered during the original sample processing. The reprocessing is conducted on a minimum of 10% of the samples submitted for the study by an analyst not involved during the original processing so as to reduce any bias. This check allows the determination of accuracy through assessment of recovery efficiency. The DQO for organism recovery checks was ≥90%.

E.3 Benthic Invertebrate Community Sample DQA Results

Organism recovery for the two benthic invertebrate community samples evaluated was high, averaging 99% (Table E-DQR.1) and meeting the sorting efficiency DQO of ≥ 90% recovery. Therefore, the benthic invertebrate community sample recovery was considered acceptable. Overall, the benthic invertebrate community sample data were of acceptable quality, meeting the established accuracy (percent recovery) QC criteria.

Table E-DQR.1: Organism Recovery Rates for Benthic Invertebrate Community Samples

Station	Number of Organisms Recovered (initial sort)	Number of Organisms in Re-sort	Percent Recovery
MRTF-REF-2	154	157	98.1%
MRTF-EXP-2	43	43	100.0%
		Average % Recovery	99.0%

Table E-DQR.2: Sample Fractions Sorted for Benthic Invertebrate Community Samples

Station	Fraction Sorted (500 um)
MRTF-REF1	Whole
MRTF-REF2	Whole
MRTF-REF3	Whole
MRTF-REF4	Whole
MRTF-REF5	Whole
MRTF-EXP1	Whole
MRTF-EXP2	Whole
MRTF-EXP3	Whole
MRTF-EXP4	Whole
MRTF-EXP5	Whole

QA/QC Notes

Pupae were not counted toward total number of taxa unless they were the sole representative of their taxa group.
Immatures were not counted toward total number of taxa unless they were the sole representative of their taxa group.
The exceptions to this rule are immature tubificidae with and without hairs. Immature oligocheates are counted as taxa as the probability of the immature being a unique taxa is high.
Indeterminates are unique taxa that could not be identified further for whatever reason, e.g., (small, damaged).

APPENDIX F

FISH POPULATION AND TISSUE SELENIUM DATA

Table F.1: Electrofishing Catch Record for the Mary River Project Second EEM Study, August 2020

Watercourse	Station ID	Date	Location Coordinates (Decimal Degrees)					Effort (seconds)	Fish Species				Total (all species)	
			Start		End		Station Length (m)		Arctic Charr		Ninespine Stickleback			
			Latitude	Longitude	Latitude	Longitude			Catch	CPUE	Catch	CPUE	Total Catch	CPUE
Angajurjualuk Lake Tributary Reference (ALTR)	ALTR-F1	19-Aug-20	71.1754	-78.6564	71.1756	-78.6500	234	2,226	104	2.80	2	0.05	106	2.86
Mary River Reference (MRR)	MRR-F1	16-Aug-20	71.2561	-79.4109	71.2576	-79.4080	200	2,972	122	2.46	35	0.71	157	3.17
Mary River Effluent-Exposed (MRE)	MRE-F1	18-Aug-20	71.3006	-79.2584	71.3010	-79.2525	228	2,241	122	3.27	0	0.00	122	3.27

Note: Catch-per-unit-effort (CPUE) represents the number of fish captured per electrofishing minute.

Table F.2: Arctic Charr Measurements from Fish Captured at the Angajurjualuk Lake Tributary Reference Area (ALTR) by Electrofishing, Mary River Project Second EEM Study, August 2020

Specimen ID	Fork Length (cm)	Total Length (cm)	Body Weight (g)	Liver Weight (g)	Age (years)	Fulton's Condition Factor (K)
ALTR-AC-01	7.1	7.6	4.291	-	-	1.199
ALTR-AC-02	10.5	11.3	12.120	0.215	2	1.047
ALTR-AC-03	9.0	9.6	6.262	-	-	0.859
ALTR-AC-04	13.2	14.4	25.025	0.350	3	1.088
ALTR-AC-05	11.1	11.9	15.123	0.132	2	1.106
ALTR-AC-06	8.3	9.7	6.515	-	-	1.139
ALTR-AC-07	8.3	8.7	5.473	-	-	0.957
ALTR-AC-08	11.3	12.2	15.608	0.217	2	1.082
ALTR-AC-09	13.0	13.8	16.663	0.165	3	0.758
ALTR-AC-10	8.1	8.7	6.213	-	-	1.169
ALTR-AC-11	8.8	9.2	5.711	-	-	0.838
ALTR-AC-12	7.7	8.2	5.289	-	-	1.159
ALTR-AC-13	10.3	10.9	10.864	0.128	2	0.994
ALTR-AC-14	10.8	11.7	11.191	0.176	2	0.888
ALTR-AC-15	11.8	12.6	16.454	0.180	2	1.001
ALTR-AC-16	17.8	19.0	46.000	-	-	0.816
ALTR-AC-17	16.2	17.4	41.402	-	-	0.974
ALTR-AC-18	8.9	9.4	7.158	-	-	1.015
ALTR-AC-19	7.8	8.2	4.962	-	-	1.046
ALTR-AC-20	12.5	13.4	18.559	0.182	3	0.950
ALTR-AC-21	9.7	10.4	8.397	-	-	0.920
ALTR-AC-22	20.1	21.6	65.500	-	-	0.807
ALTR-AC-23	14.0	15.2	26.327	0.307	3	0.959
ALTR-AC-24	9.5	10.2	7.858	-	-	0.917
ALTR-AC-25	11.6	12.5	15.914	0.215	3	1.020
ALTR-AC-26	9.0	9.4	6.041	-	-	0.829
ALTR-AC-27	8.8	9.4	7.520	-	-	1.103
ALTR-AC-28	7.5	7.9	3.878	-	-	0.919
ALTR-AC-29	8.6	9.2	7.564	-	-	1.189
ALTR-AC-30	11.6	12.5	12.922	0.144	2	0.828
ALTR-AC-31	18.1	19.6	53.500	-	-	0.902
ALTR-AC-32	18.5	19.8	72.000	-	-	1.137
ALTR-AC-33	8.8	9.3	6.887	-	-	1.011
ALTR-AC-34	10.6	11.3	10.493	0.049	1	0.881
ALTR-AC-35	9.4	10.1	9.959	-	-	1.199
ALTR-AC-36	10.4	11.2	11.297	0.146	2	1.004
ALTR-AC-37	14.3	15.3	23.316	0.340	2	0.797
ALTR-AC-38	11.1	12.0	13.531	0.223	2	0.989
ALTR-AC-39	11.3	12.2	13.387	0.182	2	0.928
ALTR-AC-40	11.6	12.4	13.376	0.139	2	0.857
ALTR-AC-41	10.1	10.7	8.657	0.125	2	0.840
ALTR-AC-42	10.1	10.8	9.389	0.095	2	0.911
ALTR-AC-43	19.3	20.6	67.500	-	-	0.939
ALTR-AC-44	16.4	17.6	39.474	-	-	0.895
ALTR-AC-45	7.5	8.0	4.658	-	-	1.104
ALTR-AC-46	10.6	11.3	11.822	-	-	0.993
ALTR-AC-47	8.3	8.9	5.246	-	-	0.917
ALTR-AC-48	8.1	8.7	5.476	-	-	1.030
ALTR-AC-49	10.1	10.9	9.686	-	-	0.940
ALTR-AC-50	11.8	12.8	16.459	-	-	1.002
ALTR-AC-51	12.6	13.6	18.548	-	-	0.927
ALTR-AC-52	8.8	9.3	6.326	-	-	0.928
ALTR-AC-53	9.1	9.7	6.887	-	-	0.914
ALTR-AC-54	15.5	16.6	29.751	-	-	0.799
ALTR-AC-55	14.6	15.7	25.859	-	-	0.831
ALTR-AC-56	12.7	13.6	19.322	-	-	0.943
ALTR-AC-57	8.9	9.4	6.478	-	-	0.919
ALTR-AC-58	8.8	9.3	6.537	-	-	0.959
ALTR-AC-59	7.7	8.1	4.390	-	-	0.962

Table F.2: Arctic Charr Measurements from Fish Captured at the Angajurjualuk Lake Tributary Reference Area (ALTR) by Electrofishing, Mary River Project Second EEM Study, August 2020

Specimen ID		Fork Length (cm)	Total Length (cm)	Body Weight (g)	Liver Weight (g)	Age (years)	Fulton's Condition Factor (K)
ALTR-AC-60		8.3	8.7	6.563	-	-	1.148
ALTR-AC-61		9.2	9.6	7.024	-	-	0.902
ALTR-AC-62		17.5	18.9	53.800	-	-	1.004
ALTR-AC-63		7.2	7.6	4.351	-	-	1.166
ALTR-AC-64		9.6	10.2	8.184	-	-	0.925
ALTR-AC-65		10.1	10.7	9.070	-	-	0.880
ALTR-AC-66		7.0	7.5	3.474	-	-	1.013
ALTR-AC-67		7.0	7.5	3.325	-	-	0.969
ALTR-AC-68		9.0	9.5	6.610	-	-	0.907
ALTR-AC-69		11.9	12.7	16.872	-	-	1.001
ALTR-AC-70		7.8	8.2	4.341	-	-	0.915
ALTR-AC-71		7.2	7.6	3.215	-	-	0.861
ALTR-AC-72		15.7	17.0	43.800	-	-	1.132
ALTR-AC-73		8.5	9.0	5.882	-	-	0.958
ALTR-AC-74		10.2	11.0	9.791	-	-	0.923
ALTR-AC-75		8.1	8.6	5.757	-	-	1.083
ALTR-AC-76		10.4	11.1	10.065	-	-	0.895
ALTR-AC-77		11.3	12.1	15.042	-	-	1.042
ALTR-AC-78		7.6	8.1	4.913	-	-	1.119
ALTR-AC-79		7.1	7.6	3.787	-	-	1.058
ALTR-AC-80		9.3	10.0	8.715	-	-	1.083
ALTR-AC-81		15.3	16.5	34.505	-	-	0.963
ALTR-AC-82		8.9	9.4	6.435	-	-	0.913
ALTR-AC-83		9.6	10.1	9.443	-	-	1.067
ALTR-AC-84		7.6	8.1	4.706	-	-	1.072
ALTR-AC-85		8.4	9.0	6.532	-	-	1.102
ALTR-AC-86		8.3	8.7	5.714	-	-	0.999
ALTR-AC-87		8.6	9.1	6.119	-	-	0.962
ALTR-AC-88		11.3	12.1	14.450	-	-	1.001
ALTR-AC-89		7.6	8.1	4.637	-	-	1.056
ALTR-AC-90		17.2	18.7	50.000	-	-	0.983
ALTR-AC-91		8.1	8.5	5.233	-	-	0.985
ALTR-AC-92		8.7	9.3	7.938	-	-	1.205
ALTR-AC-93		9.9	10.6	8.686	-	-	0.895
ALTR-AC-94		11.0	11.8	14.428	-	-	1.084
ALTR-AC-95		8.8	9.3	6.180	-	-	0.907
ALTR-AC-96		8.4	8.9	4.730	-	-	0.798
ALTR-AC-97		8.4	8.9	6.595	-	-	1.113
ALTR-AC-98		13.1	14.2	24.364	-	-	1.084
ALTR-AC-99		9.2	9.9	8.458	-	-	1.086
ALTR-AC-100		8.5	8.9	5.485	-	-	0.893
Overall Catch Summary	**total number**	**100**	**100**	**100**	**20**	**20**	**100**
	average	**10.5**	**11.3**	**14.422**	**0.186**	**2.2**	**0.982**
	median	**9.6**	**10.2**	**8.558**	**0.178**	**2.0**	**0.966**
	standard deviation	**3.1**	**3.3**	**14.797**	**0.077**	**0.5**	**0.106**
	standard error	**0.3**	**0.3**	**1.480**	**0.017**	**0.1**	**0.011**
	minimum	**7.0**	**7.5**	**3.215**	**0.049**	**1**	**0.758**
	maximum	**20.1**	**21.6**	**72.000**	**0.350**	**3**	**1.205**

Note: "-" indicates value not measured.

Table F.3: Arctic Charr Measurements from Fish Captured at the Mary River Reference (MRR) Area by Electrofishing, Mary River Project Second EEM Study, August 2020

Specimen ID	Fork Length (cm)	Total Length (cm)	Body Weight (g)	Liver Weight (g)	Age (years)	Fulton's Condition Factor (K)
MRR-AC-01	10.0	10.5	10.355	-	-	1.036
MRR-AC-02	6.8	7.2	2.959	-	-	0.941
MRR-AC-03	12.9	14.3	17.811	-	-	0.830
MRR-AC-04	9.0	9.6	7.801	-	-	1.070
MRR-AC-05	11.9	12.9	17.411	-	-	1.033
MRR-AC-06	12.0	12.9	15.369	-	-	0.889
MRR-AC-07	11.9	12.9	16.728	-	-	0.993
MRR-AC-08	10.8	11.6	13.007	-	-	1.033
MRR-AC-09	8.8	9.4	7.812	-	-	1.146
MRR-AC-10	11.8	12.6	13.790	-	-	0.839
MRR-AC-11	11.1	11.9	13.939	-	-	1.019
MRR-AC-12	14.6	15.7	29.723	-	-	0.955
MRR-AC-13	8.9	9.5	7.158	-	-	1.015
MRR-AC-14	9.5	10.2	8.335	-	-	0.972
MRR-AC-15	10.4	11.2	11.242	-	-	0.999
MRR-AC-16	14.4	15.4	28.140	-	-	0.942
MRR-AC-17	13.0	14.1	19.435	-	-	0.885
MRR-AC-18	7.4	7.9	3.764	-	-	0.929
MRR-AC-19	7.9	8.4	4.406	-	-	0.894
MRR-AC-20	7.5	8.0	4.352	-	-	1.032
MRR-AC-21	12.4	13.4	16.421	0.180	4	0.861
MRR-AC-22	10.8	11.5	12.319	0.166	2	0.978
MRR-AC-23	13.5	14.5	23.069	0.274	3	0.938
MRR-AC-24	10.7	11.4	11.642	0.191	2	0.950
MRR-AC-25	16.0	17.4	40.834	0.509	3	0.997
MRR-AC-26	15.3	16.4	31.353	0.323	3	0.875
MRR-AC-27	11.2	11.9	13.050	0.155	2	0.929
MRR-AC-28	15.7	16.9	34.921	0.399	4	0.902
MRR-AC-29	11.5	12.4	15.504	0.185	2	1.019
MRR-AC-30	13.9	14.8	22.844	0.262	3	0.851
MRR-AC-31	13.4	14.5	25.808	0.359	4	1.073
MRR-AC-32	11.2	11.9	11.778	0.131	2	0.838
MRR-AC-33	13.8	14.8	24.206	0.306	3	0.921
MRR-AC-34	10.2	10.9	9.275	0.119	2	0.874
MRR-AC-35	14.5	15.5	29.284	0.305	3	0.961
MRR-AC-36	13.2	14.3	24.740	0.273	2	1.076
MRR-AC-37	12.0	12.9	16.387	0.209	2	0.948
MRR-AC-38	13.3	14.3	18.980	0.191	3	0.807
MRR-AC-39	11.1	11.8	13.202	0.186	3	0.965
MRR-AC-40	14.0	15.1	29.827	0.355	2	1.087
MRR-AC-41	11.6	12.4	15.125	-	-	0.969
MRR-AC-42	11.1	11.9	12.660	-	-	0.926
MRR-AC-43	12.2	13.2	17.252	-	-	0.950
MRR-AC-44	9.5	10.1	10.124	-	-	1.181
MRR-AC-45	8.9	9.4	6.295	-	-	0.893
MRR-AC-46	11.0	11.9	11.378	-	-	0.855
MRR-AC-47	10.2	11.0	10.861	-	-	1.023
MRR-AC-48	13.3	14.4	23.091	-	-	0.981
MRR-AC-49	8.1	8.6	4.409	-	-	0.830
MRR-AC-50	6.8	7.3	3.449	-	-	1.097
MRR-AC-51	12.5	13.5	16.895	-	-	0.865
MRR-AC-52	14.2	15.5	26.956	-	-	0.941
MRR-AC-53	16.1	17.4	39.950	-	-	0.957
MRR-AC-54	11.8	12.8	15.974	-	-	0.972
MRR-AC-55	11.0	11.8	11.807	-	-	0.887

Table F.3: Arctic Charr Measurements from Fish Captured at the Mary River Reference (MRR) Area by Electrofishing, Mary River Project Second EEM Study, August 2020

Specimen ID		Fork Length (cm)	Total Length (cm)	Body Weight (g)	Liver Weight (g)	Age (years)	Fulton's Condition Factor (K)
MRR-AC-56		8.5	9.1	5.565	-	-	0.906
MRR-AC-57		9.5	10.1	8.899	-	-	1.038
MRR-AC-58		11.7	12.6	13.572	-	-	0.847
MRR-AC-59		6.8	7.2	2.813	-	-	0.895
MRR-AC-60		8.8	9.4	5.871	-	-	0.862
MRR-AC-61		11.1	11.9	11.987	-	-	0.876
MRR-AC-62		10.0	10.7	9.078	-	-	0.908
MRR-AC-63		13.7	14.9	21.692	-	-	0.844
MRR-AC-64		13.0	13.9	21.464	-	-	0.977
MRR-AC-65		10.5	11.2	11.304	-	-	0.976
MRR-AC-66		11.7	12.4	12.988	-	-	0.811
MRR-AC-67		8.4	8.9	5.499	-	-	0.928
MRR-AC-68		13.8	14.8	26.138	-	-	0.995
MRR-AC-69		11.6	12.4	16.252	-	-	1.041
MRR-AC-70		11.6	12.3	13.148	-	-	0.842
MRR-AC-71		7.8	8.3	4.350	-	-	0.917
MRR-AC-72		12.6	13.6	16.830	-	-	0.841
MRR-AC-73		10.9	11.5	11.503	-	-	0.888
MRR-AC-74		14.2	15.3	36.456	-	-	1.273
MRR-AC-75		12.0	12.9	16.524	-	-	0.956
MRR-AC-76		17.3	18.7	50.828	-	-	0.982
MRR-AC-77		10.8	11.6	11.019	-	-	0.875
MRR-AC-78		8.2	8.7	5.282	-	-	0.958
MRR-AC-79		11.3	12.2	15.084	-	-	1.045
MRR-AC-80		13.5	14.6	20.287	-	-	0.825
MRR-AC-81		10.3	11.1	10.842	-	-	0.992
MRR-AC-82		11.2	12.0	12.642	-	-	0.900
MRR-AC-83		14.5	15.7	27.010	-	-	0.886
MRR-AC-84		11.3	12.1	16.698	-	-	1.157
MRR-AC-85		10.4	11.0	10.985	-	-	0.977
MRR-AC-86		8.0	8.6	5.513	-	-	1.077
MRR-AC-87		9.9	10.6	8.937	-	-	0.921
MRR-AC-88		7.8	8.2	4.531	-	-	0.955
MRR-AC-89		9.6	10.2	9.652	-	-	1.091
MRR-AC-90		13.9	14.9	26.361	-	-	0.982
MRR-AC-91		9.8	10.6	9.776	-	-	1.039
MRR-AC-92		11.3	12.2	12.609	-	-	0.874
MRR-AC-93		10.7	11.5	10.892	-	-	0.889
MRR-AC-94		7.4	7.9	3.945	-	-	0.974
MRR-AC-95		15.7	16.9	35.973	-	-	0.930
MRR-AC-96		13.7	14.9	24.407	-	-	0.949
MRR-AC-97		8.5	9.0	5.232	-	-	0.852
MRR-AC-98		13.5	14.3	22.649	-	-	0.921
MRR-AC-99		10.6	11.3	11.328	-	-	0.951
MRR-AC-100		8.8	9.4	5.826	-	-	0.855
Overall Catch Summary	**total number**	**100**	**100**	**100**	**20**	**20**	**100**
	average	**11.3**	**12.2**	**15.55**	**0.254**	**2.7**	**0.951**
	median	**11.2**	**12.0**	**13.03**	**0.236**	**3.0**	**0.949**
	standard deviation	**2.3**	**2.6**	**9.490**	**0.101**	**0.7**	**0.087**
	standard error	**0.2**	**0.3**	**0.949**	**0.023**	**0.2**	**0.009**
	minimum	**6.8**	**7.2**	**2.813**	**0.119**	**2**	**0.807**
	maximum	**17.3**	**18.7**	**50.83**	**0.509**	**4**	**1.273**

Note: "-" indicates value not measued.

Table F.4: Arctic Charr Measurements from Fish Captured at the Mary River Effluent-Exposed Area (MRE) by Electrofishing, Mary River Project Second EEM Study, August 2020

Specimen ID	Fork Length (cm)	Total Length (cm)	Body Weight (g)	Liver Weight (g)	Age (years)	Fulton's Condition Factor (K)
MRE-AC-01	12.9	14.0	-	-	2	-
MRE-AC-02	14.2	15.8	-	-	3	-
MRE-AC-03	8.5	9.0	-	-	-	-
MRE-AC-04	8.1	8.8	-	-	-	-
MRE-AC-05	10.4	11.2	-	-	2	-
MRE-AC-06	11.0	11.7	-	-	3	-
MRE-AC-07	7.8	8.3	-	-	-	-
MRE-AC-08	9.2	9.9	-	-	-	-
MRE-AC-09	10.1	10.7	11.346	0.142	2	1.101
MRE-AC-10	8.5	9.0	5.446	-	-	0.887
MRE-AC-11	7.9	8.3	4.735	-	-	0.960
MRE-AC-12	7.9	8.3	5.357	-	-	1.087
MRE-AC-13	10.8	11.4	12.422	0.141	2	0.986
MRE-AC-14	8.5	9.0	6.364	-	-	1.036
MRE-AC-15	12.9	13.9	17.484	0.278	2	0.814
MRE-AC-16	11.2	12.0	12.199	0.151	2	0.868
MRE-AC-17	9.9	10.7	10.268	-	-	1.058
MRE-AC-18	17.8	18.9	51.000	-	-	0.904
MRE-AC-19	9.2	9.6	6.365	-	-	0.817
MRE-AC-20	13.6	15.2	22.844	0.247	3	0.908
MRE-AC-21	10.4	11.2	10.274	0.136	2	0.913
MRE-AC-22	8.8	9.3	6.116	-	-	0.897
MRE-AC-23	9.9	10.5	9.920	-	-	1.022
MRE-AC-24	9.3	10.5	9.062	-	-	1.127
MRE-AC-25	14.1	15.0	25.201	0.550	4	0.899
MRE-AC-26	10.6	11.8	10.479	0.174	2	0.880
MRE-AC-27	12.7	14.1	21.050	0.267	4	1.028
MRE-AC-28	9.9	10.5	9.608	-	-	0.990
MRE-AC-29	13.8	14.8	28.157	0.507	3	1.071
MRE-AC-30	8.3	8.9	6.416	-	-	1.122
MRE-AC-31	13.5	15.1	24.464	0.297	3	0.994
MRE-AC-32	17.3	18.5	44.500	-	-	0.859
MRE-AC-33	8.8	9.3	6.187	-	-	0.908
MRE-AC-34	13.3	13.9	25.804	0.363	3	1.097
MRE-AC-35	8.7	9.3	5.960	-	-	0.905
MRE-AC-36	14.5	16.1	27.682	0.382	3	0.908
MRE-AC-37	12.1	12.9	16.413	0.248	3	0.926
MRE-AC-38	10.5	11.1	9.483	0.0720	2	0.819
MRE-AC-39	8.8	9.4	6.391	-	-	0.938
MRE-AC-40	8.5	9.1	5.598	-	-	0.912
MRE-AC-41	16.3	17.5	40.500	-	-	0.935
MRE-AC-42	9.9	10.7	9.817	-	-	1.012
MRE-AC-43	11.0	11.8	12.637	0.086	4	0.949
MRE-AC-44	11.1	12.5	12.058	0.123	2	0.882
MRE-AC-45	9.1	10.0	8.183	-	-	1.086
MRE-AC-46	15.1	16.8	37.126	0.222	4	1.078
MRE-AC-47	16.2	17.3	36.808	-	-	0.866
MRE-AC-48	8.8	9.4	7.858	-	-	1.153
MRE-AC-49	8.6	9.2	6.528	-	-	1.026
MRE-AC-50	8.8	9.4	6.097	-	-	0.895
MRE-AC-51	11.8	12.6	15.161	0.196	2	0.923
MRE-AC-52	15.9	17.3	42.286	-	-	1.052
MRE-AC-53	11.6	12.4	13.467	0.267	3	0.863
MRE-AC-54	10.3	10.7	11.422	-	-	1.045
MRE-AC-55	15.2	16.4	35.770	-	-	1.019
MRE-AC-56	11.3	12.6	12.493	-	-	0.866
MRE-AC-57	14.0	15.6	24.039	-	-	0.876
MRE-AC-58	8.6	9.2	5.852	-	-	0.920
MRE-AC-59	8.3	8.9	6.130	-	-	1.072
MRE-AC-60	8.3	8.7	5.175	-	-	0.905

Table F.4: Arctic Charr Measurements from Fish Captured at the Mary River Effluent-Exposed Area (MRE) by Electrofishing, Mary River Project Second EEM Study, August 2020

Specimen ID		Fork Length (cm)	Total Length (cm)	Body Weight (g)	Liver Weight (g)	Age (years)	Fulton's Condition Factor (K)
MRE-AC-61		8.9	9.5	6.899	-	-	0.979
MRE-AC-62		10.6	10.8	9.229	-	-	0.775
MRE-AC-63		10.0	10.8	8.205	-	-	0.821
MRE-AC-64		19.3	20.8	72.800	-	-	1.013
MRE-AC-65		10.5	11.7	11.092	-	-	0.958
MRE-AC-66		9.6	10.2	8.525	-	-	0.964
MRE-AC-67		9.8	10.6	10.277	-	-	1.092
MRE-AC-68		11.3	12.3	14.797	-	-	1.026
MRE-AC-69		14.8	15.5	32.476	-	-	1.002
MRE-AC-70		17.4	18.8	50.000	-	-	0.949
MRE-AC-71		13.7	14.9	24.097	-	-	0.937
MRE-AC-72		10.6	11.9	10.516	-	-	0.883
MRE-AC-73		10.7	11.5	12.639	-	-	1.032
MRE-AC-74		7.4	7.8	4.289	-	-	1.058
MRE-AC-75		8.3	8.8	5.970	-	-	1.044
MRE-AC-76		13.0	14.1	22.181	-	-	1.010
MRE-AC-77		11.5	12.5	16.432	-	-	1.080
MRE-AC-78		12.1	12.9	15.193	-	-	0.858
MRE-AC-79		9.4	10.1	9.215	-	-	1.109
MRE-AC-80		9.6	10.3	8.165	-	-	0.923
MRE-AC-81		8.3	8.9	4.890	-	-	0.855
MRE-AC-82		13.3	14.5	27.045	-	-	1.150
MRE-AC-83		11.2	12.0	14.441	-	-	1.028
MRE-AC-84		13.0	13.9	17.878	-	-	0.814
MRE-AC-85		9.9	10.6	10.119	-	-	1.043
MRE-AC-86		12.3	13.2	17.944	-	-	0.964
MRE-AC-87		15.6	16.9	38.881	-	-	1.024
MRE-AC-88		15.2	16.3	33.819	-	-	0.963
MRE-AC-89		12.1	13.0	18.652	-	-	1.053
MRE-AC-90		11.7	12.1	15.419	-	-	0.963
MRE-AC-91		15.3	16.6	33.378	-	-	0.932
MRE-AC-92		9.1	9.6	7.373	-	-	0.978
MRE-AC-93		10.2	10.9	11.315	-	-	1.066
MRE-AC-94		10.5	11.3	11.372	-	-	0.982
MRE-AC-95		12.3	13.4	18.831	-	-	1.012
MRE-AC-96		7.9	8.4	5.460	-	-	1.107
MRE-AC-97		16.5	17.6	42.797	-	-	0.953
MRE-AC-98		14.5	15.7	33.204	-	-	1.089
MRE-AC-99		11.7	12.6	17.779	-	-	1.110
MRE-AC-100		11.6	12.4	13.872	-	-	0.889
MRE-AC-101		10.7	11.0	9.659	-	-	0.788
MRE-AC-102		8.9	9.4	6.357	-	-	0.902
MRE-AC-103		10.8	11.6	11.769	-	-	0.934
MRE-AC-104		14.7	15.1	26.336	-	-	0.829
MRE-AC-105		10.1	10.7	8.079	-	-	0.784
MRE-AC-106		10.0	10.6	7.466	-	-	0.747
MRE-AC-107		12.3	13.3	15.762	-	-	0.847
MRE-AC-108		10.1	10.9	10.709	-	-	1.039
Overall Catch Summary	**total number**	**108**	**108**	**100**	**20**	**24**	**100**
	average	**11.3**	**12.2**	**16.676**	**0.242**	**2.7**	**0.964**
	median	**10.7**	**11.6**	**11.596**	**0.235**	**3.0**	**0.962**
	standard deviation	**2.6**	**2.9**	**12.702**	**0.130**	**0.75**	**0.096**
	standard error	**0.25**	**0.28**	**1.270**	**0.029**	**0.15**	**0.010**
	minimum	**7.4**	**7.8**	**4.289**	**0.072**	**2**	**0.747**
	maximum	**19.3**	**20.8**	**72.800**	**0.550**	**4**	**1.153**

Note: "-" indicates value not measued.

Table F.5: Summary Statistics for Physical Measures Collected from all Arctic Charr at Effluent-Exposed and Reference Areas, Mary River Project Second EEM Study, August 2020

Variable	Area	n	Mean	Standard Error	Standard Deviation	Minimum	Median	Maximum
Total Length (cm)	Reference 1 (ALTR)	100	11.3	0.335	3.35	7.50	10.2	21.6
	Reference 2 (MRR)	100	12.2	0.258	2.58	7.20	11.9	18.7
	Exposed (MRE)	108	12.2	0.279	2.90	7.80	11.6	20.8
Fork Length (cm)	Reference 1 (ALTR)	100	10.6	0.308	3.08	7.00	9.55	20.1
	Reference 2 (MRR)	100	11.3	0.235	2.35	6.80	11.2	17.3
	Exposed (MRE)	108	11.3	0.254	2.64	7.40	10.6	19.3
Body Weight (g)	Reference 1 (ALTR)	100	14.4	1.48	14.8	3.21	8.56	72.0
	Reference 2 (MRR)	100	15.6	0.949	9.49	2.81	13.0	50.8
	Exposed (MRE)	100	16.7	1.27	12.7	4.29	11.6	72.8

Notes: ALTR = Angajurjualuk Lake Tributary reference area; MRR = Mary River reference area; MRE = Mary River effluent-exposed area.

Table F.6: Statistical Comparisons For Arctic Charr Non-Lethal Endpoints Between Effluent-Exposed and Reference Study Areas, Mary River Project Second EEM Study, August 2020

Indicator	Endpoint	Variables		Sample Size			Test	ANCOVA Model Statistics			Summary Statistics[b]				Overall Test P-value (Area)	Pairwise Comparisons[c]						Estimated Minimum Detectable Difference (% Relative to Reference) with α=β=0.1					
		Response	Covariate	ALTR (REF1)	MRR (REF2)	MRE (EXP)		Interaction Model: Interaction P-value	Parallel Slope Model: Covariate P-value	Covariate Value for Compar-isons[a]	Statistic	ALTR (REF1)	MRR (REF2)	MRE (EXP)		ALTR vs MRR (REF1 vs REF2): P-value	ALTR vs MRR (REF1 vs REF2): Magnitude of Difference (%)[d]	ALTR vs MRE (REF1 vs. EXP): P-value	ALTR vs MRE (REF1 vs. EXP): Magnitude of Difference (%)[d]	MRR vs. MRE (REF2 vs. EXP): P-value	MRR vs. MRE (REF2 vs. EXP): Magnitude of Difference (%)[d]	ALTR vs MRR (REF1 vs REF2): Decrease	ALTR vs MRR (REF1 vs REF2): Increase	ALTRP vs MRE (REF1 vs. EXP): Decrease	ALTRP vs MRE (REF1 vs. EXP): Increase	MRR vs. MRE (REF2 vs. EXP): Decrease	MRR vs. MRE (REF2 vs. EXP): Increase
Survival/ Recruitment	Length-Frequency Distribution	Fork Length (cm)	-	100	100	108	K-S	-	-	-	-	-	-	-	-	<0.001	-	0.011	-	0.261	-	-	-	-	-	-	-
Body Size	Fork Length	Fork Length (cm)	-	100	100	108	K-W	-	-	-	Median	9.55	11.2	10.6	0.002	0.001	17	0.006	12	0.576	-4.9	-9.8	11	-9.8	11	-9.8	11
	Body Weight	Body Weight (g)	-	100	100	100	K-W	-	-	-	Median	8.56	13.0	11.6	0.004	0.003	52	0.006	36	0.807	-11	-27	36	-27	36	-27	36
Energy Storage	Condition	log10[Body Weight (g)]	log10[Fork Length (cm)]	100	100	100	ANCOVA	0.247	<0.001	10.8	Adjusted Mean	12.2	11.9	12.1	0.236	0.207	-2.4	0.725	-1.1	0.612	1.3	-4.0	4.2	-4.0	4.2	-4.0	4.2

(grey) Area P-value < 0.1 or Interaction P-value < 0.05

(blue) Magnitude of Difference > 25% (or > 10% for Condition), EEM effect endpoints only

[a] The mean value of the covariate (that corresponds to the adjusted means for the response variable) for the parallel slope ANCOVA model or the minimum and maximum values of the overlap in covariate values for the interaction ANCOVA model.

[b] The median, mean (geometric mean for log10-transformed variables), and adjusted mean are reported for Kruskal-Wallis, ANOVA and ANCOVA, respectively, and the predicted means of the regression line equations for minimum and maximum values of the covariate (where the data sets overlap) for ANCOVAs where a significant interaction (i.e., different slopes) occurs.

[c] Calculated as the difference in measure of central tendency (MCT) between areas (mine-exposed minus reference), expressed as a percentage of the reference area MCT (except for the K-S test; see footnote d).

[d] Calculated as the maximum difference in the cumulative relative frequency distributions (CRFD) between areas. A negative difference implies that the exposed area has a greater number of fish with length measures that are less than where the maximum difference in CRFDs was observed. A positive difference implies that the exposed area has fewer fish with length measures that are less than where the maximum difference in CRFDs was observed.

Table F.7: Estimated Sample Sizes to Detect Various Effect Sizes as a Percentage Change with α=β=0.1 for Arctic Charr Length, Weight, and Condition Endpoints Based on Entire Data Set Using Variability Estimates from the Mary River Project Second EEM Study, August 2020

Indicator	Endpoint	Variables		Test	Comparison	S[a]	COV (%)[b]	Minimum Sample Size to Detect an Effect Size (% Increase/Decrease Relative to Reference) with α=β=0.1									
		Response	Covariate					log(Response)	5%	10%	20%	25%	30%	33%	40%	50%	100%
									-5%	-9%	-17%	-20%	-23%	-25%	-29%	-33%	-50%
								Response	±5%	±10%	±20%	±25%	±30%	±33%	±40%	±50%	±100%
Body Size	Fork Length	Fork Length (cm)	-	K-W	ALTR vs MRR (REF1 vs REF2)	0.101	25.6	Response	457	121	34	22	17	13	10	7	4
					ALTR vs MRE (REF1 vs. EXP)	0.101	25.6		457	121	34	22	17	13	10	7	4
					MRR vs. MRE (REF2 vs. EXP)	0.101	23.9		453	115	31	20	14	12	9	6	4
	Body Weight	Body Weight (g)	-	K-W	All	0.300	86.8	Response	3,979	1,044	286	191	139	116	85	60	17
Energy Storage	Condition	log10[Body Weight (g)]	log10[Fork Length (cm)]	ANCOVA	All	0.0426	-	log(Response)	71	20	7	6	5	5	4	4	3

Notes: ALTR = Angajurjualuk Lake Tributary reference area; MRR = Mary River reference area; MRE = Mary River effluent-exposed area.

[a] Pooled standard deviation of the regression residuals

[b] Coefficient of variation (pooled standard deviation/reference mean)×100%

Table F.8: Summary Statistics for Physical Measures of Arctic Charr Collected Lethally from Effluent-Exposed and Reference Areas, Mary River Project Second EEM Study, August 2020

Variable	Area	n	Mean	Standard Error	Standard Deviation	Minimum	Median	Maximum
Age	Reference 1 (ALTR)	20	2.20	0.117	0.523	1.00	2.00	3.00
	Reference 2 (MRR)	20	2.70	0.164	0.733	2.00	3.00	4.00
	Exposed (MRE)	20	2.75	0.176	0.786	2.00	3.00	4.00
Total Length (cm)	Reference 1 (ALTR)	20	12.4	0.307	1.37	10.7	12.2	15.3
	Reference 2 (MRR)	20	13.8	0.432	1.93	10.9	14.3	17.4
	Exposed (MRE)	20	13.3	0.402	1.80	10.7	12.8	16.8
Fork Length (cm)	Reference 1 (ALTR)	20	11.6	0.279	1.25	10.1	11.3	14.3
	Reference 2 (MRR)	20	12.9	0.391	1.75	10.2	13.2	16.0
	Exposed (MRE)	20	12.2	0.343	1.53	10.1	11.9	15.1
Body Weight (g)	Reference 1 (ALTR)	20	15.0	1.12	5.00	8.66	13.5	26.3
	Reference 2 (MRR)	20	21.3	1.97	8.83	9.28	20.9	40.8
	Exposed (MRE)	20	18.3	1.73	7.75	9.48	15.8	37.1
Liver Weight (g)	Reference 1 (ALTR)	20	0.186	0.0172	0.0769	0.0490	0.178	0.350
	Reference 2 (MRR)	20	0.254	0.0226	0.101	0.119	0.236	0.509
	Exposed (MRE)	20	0.242	0.0290	0.130	0.0720	0.234	0.550

Notes: ALTR = Angajurjualuk Lake Tributary reference area; MRR = Mary River reference area; MRE = Mary River effluent-exposed area.

Table F.9: Statistical Comparisons For Arctic Charr Lethal Endpoints Between Effluent-Exposed and Reference Study Areas, Mary River Project Second EEM Study, August 2020

Endpoint	Variables		Sample Size			Test	ANCOVA Model Statistics			Summary Statistics[b]				Overall Test P-value (Area)	Pairwise Comparisons[c]						Estimated Minimum Detectable Difference (% Relative to Reference) with α=β=0.1					
															ALTR vs MRR (REF1 vs REF2)		ALTR vs MRE (REF1 vs. EXP)		MRR vs. MRE (REF2 vs. EXP)		ALTR vs MRR (REF1 vs REF2)		ALTR vs MRE (REF1 vs. EXP)		MRR vs. MRE (REF2 vs. EXP)	
	Response	Covariate	ALTR (REF1)	MRR (REF2)	MRE (EXP)		Interaction Model / Interaction P-value	Parallel Slope Model / Covariate P-value	Covariate Value for Comparisons[a]	Statistic	ALTR (REF1)	MRR (REF2)	MRE (EXP)		P-value	Magnitude of Difference (%)[d]	P-value	Magnitude of Difference (%)[d]	P-value	Magnitude of Difference (%)[d]	Decrease	Increase	Decrease	Increase	Decrease	Increase
Length-Frequency Distribution	Fork Length (cm)	-	20	20	20	K-S	-	-	-	-	-	-	-	-	0.082	-	0.560	-	0.819	-	-	-	-	-	-	-
Age	Age (years)	-	20	20	20	K-W	-	-	-	Median	2.00	3.00	3.00	0.038	0.032	50	0.023	50	0.892	0	-24	32	-24	32	-24	32
Fork Length	Fork Length (cm)	-	20	20	20	ANOVA	-	-	-	Mean	11.6	12.9	12.2	0.029	0.021	12	0.348	5.8	0.375	-5.0	-12	12	-12	12	-11	11
Body Weight	log10[Body Weight (g)]	-	20	20	20	ANOVA	-	-	-	Geometric Mean	14.3	19.6	16.9	0.043	0.033	37	0.373	18	0.443	-14	-30	43	-30	43	-30	43
Length-at-age	log10[Fork Length (cm)]	log10[Age (years)]	20	20	20	ANCOVA	0.777	<0.001	2.45	Adjusted Mean	12.0	12.6	11.9	0.165	0.293	5.0	0.983	-0.58	0.189	-5.3	-8.7	9.5	-8.7	9.5	-8.7	9.5
Weight-at-age	log10[Body Weight (g)]	log10[Age (years)]	20	20	20	ANCOVA	0.756	<0.001	2.45	Adjusted Mean	16.2	18.5	15.8	0.211	0.378	14	0.965	-2.6	0.224	-15	-25	33	-25	33	-25	33
Relative Liver Weight	log10[Liver Weight (g)]	log10[Body Weight (g)]	20	20	20	ANCOVA	0.604	<0.001	16.8	Adjusted Mean	0.199	0.202	0.211	0.793	0.982	1.6	0.789	5.8	0.887	4.1	-22	28	-22	28	-22	28
Relative Liver Weight[e]	log10[Liver Weight (g)]	log10[Body Weight (g)]	19	20	20	ANCOVA	0.661	<0.001	16.9	Adjusted Mean	0.210	0.205	0.212	0.900	0.958	-2.2	0.985	1.3	0.891	3.5	-20	25	-20	25	-20	25
Condition	log10[Body Weight (g)]	log10[Fork Length (cm)]	20	20	20	ANCOVA	0.349	<0.001	12.1	Adjusted Mean	16.8	16.7	16.8	0.979	0.978	-0.65	0.997	-0.21	0.989	0.44	-8.6	9.5	-8.6	9.5	-8.6	9.5

Grey shading: Area P-value < 0.1 or Interaction P-value < 0.05

Blue shading: Magnitude of Difference > 25% (or > 10% for Condition), EEM effect endpoints only

[a] The mean value of the covariate (that corresponds to the adjusted means for the response variable) for the parallel slope ANCOVA model or the minimum and maximum values of the overlap in covariate values for the interaction ANCOVA model.

[b] The median, mean (geometric mean for log10-transformed variables), and adjusted mean are reported for Kruskal-Wallis, ANOVA and ANCOVA, respectively, and the predicted means of the regression line equations for minimum and maximum values of the covariate (where the data sets overlap) for ANCOVAs where a significant interaction (i.e., different slopes) occurs.

[c] Calculated as the difference in measure of central tendency (MCT) between areas (mine-exposed minus reference), expressed as a percentage of the reference area MCT (except for the K-S test; see footnote d).

[d] Calculated as the maximum difference in the cumulative relative frequency distributions (CRFD) between areas. A negative difference implies that the exposed area has a greater number of fish with length measures that are less than where the maximum difference in CRFDs was observed. A positive difference implies that the exposed area has fewer fish with length measures that are less than where the maximum difference in CRFDs was observed.

[e] One outlier (Fish ID: ALTR-AC-34; Studentized residual = -4.097) was removed from the analysis

[f] ANCOVA proceeded under the assumption that the slopes are practically parallel (R^2 of interaction model = 0.9783 and R^2 of parallel slope model = 0.9725; a difference < 0.02) following Environment Canada (2012).

Table F.10: Estimated Sample Sizes to Detect Various Effect Sizes as a Percentage Change with α=β=0.1 for Arctic Charr Lethal Endpoints, Based on Variability Estimates from the Mary River Project Second EEM Study, August 2020

Indicator	Endpoint	Variables		Test	Comparison	S[a]	COV (%)[b]	Minimum Sample Size to Detect an Effect Size (% Increase/Decrease Relative to Reference) with α=β=0.1									
		Response	Covariate					log(Response)	5%	10%	20%	25%	30%	33%	40%	50%	100%
									-5%	-9%	-17%	-20%	-23%	-25%	-29%	-33%	-50%
								Response	±5%	±10%	±20%	±25%	±30%	±33%	±40%	±50%	±100%
Survival	Age	Age (years)	-	K-W[c]	ALTR vs MRR (REF1 vs REF2)	0.116	31.4	Response	594	157	44	31	22	19	14	10	4
					ALTR vs MRE (REF1 vs. EXP)		31.4		594	157	44	31	22	19	14	10	4
					MRR vs. MRE (REF2 vs. EXP)		25.6		520	131	34	22	17	13	10	7	4
Body Size	Fork Length	Fork Length (cm)	-	ANOVA	ALTR vs MRR (REF1 vs REF2)	-	13.2	Response	120	31	9	6	5	4	3	3	2
					ALTRP vs MRE (REF1 vs. EXP)	-	13.2		120	31	9	6	5	4	3	3	2
					MRR vs. MRE (REF2 vs. EXP)	-	11.8		97	25	7	5	4	4	3	3	2
	Body Weight	log10[Body Weight (g)]	-	ANOVA	All	0.167	-	log(Response)	1,061	279	77	52	38	32	23	17	7
Energy Usage	Length-at-age	log10[Fork Length (cm)]	log10[Age (years)]	ANCOVA	All	0.0422	-	log(Response)	70	20	7	6	5	4	4	4	3
	Weight-at-age	log10[Body Weight (g)]	log10[Age (years)]	ANCOVA	All	0.132	-	log(Response)	671	177	50	34	25	21	16	12	6
Energy Storage	Relative Liver Weight	log10[Liver Weight (g)]	log10[Body Weight (g)]	ANCOVA	All	0.116	-	log(Response)	513	136	39	27	20	17	13	10	5
	Relative Liver Weight[e]	log10[Liver Weight (g)]	log10[Body Weight (g)]	ANCOVA	All	0.102	-	log(Response)	401	107	31	21	16	14	11	8	4
	Condition	log10[Body Weight (g)]	log10[Fork Length (cm)]	ANCOVA	All	0.0418	-	log(Response	69	20	7	6	5	4	4	4	3

[a] Pooled standard deviation of the regression residuals

[b] Coefficient of variation (pooled standard deviation/reference mean)×100%

[c] Sample size estimates for the K-W test were estimated based for a two-sample t-test using sample sizes multiplied by 0.864. The 0.864 is the lower bound of the asymptotic relative efficiency of the Mann-Whitney test and the two-sample t-test (Hodges and Lehmann 1956). Estimates were generated for the response variable on the untransformed and $\log_{10}$-transformed scales and the lowest sample size is reported.

d Minimum sample sizes on the log10-scale are calculated

[e] One outlier (Fish ID: ALTR-AC-34; Studentized residual = -4.097) was removed from the analysis

Table F.11: Chemistry Data for Arctic Charr Muscle Tissue Collected from Effluent-Exposed and Reference Study Areas, Mary River Project Second EEM Study, August 2020

Analytes	Unit	Angajurjualuk Lake Tributary Reference													
		ALTR-AC-04	ALTR-AC-05	ALTR-AC-09	ALTR-AC-15	ALTR-AC-20	ALTR-AC-23	ALTR-AC-25	ALTR-AC-37	Mean	Median	Standard Deviation	Standard Error	Minimum	Maximum
% Moisture	%	75.7	74.8	74.2	75.9	74.6	75.3	75.1	75.2	75.1	75.2	0.561	0.198	74.2	75.9
Aluminum (Al)	mg/kg dw	<5.0	<5.0	<5.0	<5.0	18.3	<5.0	<5.0	<5.0	6.7	5.0	4.70	1.66	5.0	18.3
Antimony (Sb)	mg/kg dw	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0	0	<0.010	<0.010
Arsenic (As)	mg/kg dw	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	0	0	<0.030	<0.030
Barium (Ba)	mg/kg dw	0.174	0.353	0.293	0.288	0.395	0.228	0.277	0.228	0.280	0.283	0.0712	0.0252	0.174	0.395
Beryllium (Be)	mg/kg dw	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0	0	<0.010	<0.010
Bismuth (Bi)	mg/kg dw	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0	0	<0.010	<0.010
Boron (B)	mg/kg dw	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0	0	<1.0	<1.0
Cadmium (Cd)	mg/kg dw	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0	0	<0.010	<0.010
Calcium (Ca)	mg/kg dw	990	968	1,560	1,140	1,130	1,110	1,420	1,060	1,172	1,120	209	73.9	968	1,560
Cesium (Cs)	mg/kg dw	0.0148	0.0139	0.0112	0.0143	0.0133	0.0138	0.0149	0.0141	0.0138	0.0140	0.00117	0.000413	0.0112	0.0149
Chromium (Cr)	mg/kg dw	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	<0.20	<0.20
Cobalt (Co)	mg/kg dw	0.050	0.066	0.040	0.060	0.060	0.056	0.064	0.039	0.054	0.058	0.010	0.0037	0.039	0.066
Copper (Cu)	mg/kg dw	1.54	1.44	1.90	1.55	1.42	1.78	1.90	1.71	1.66	1.63	0.194	0.0687	1.42	1.9
Iron (Fe)	mg/kg dw	17.5	20.2	18.1	18.4	36.9	16.9	21.2	15.8	20.6	18.3	6.80	2.40	15.8	36.9
Lead (Pb)	mg/kg dw	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	<0.050	<0.050
Lithium (Li)	mg/kg dw	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0	0	0	0
Magnesium (Mg)	mg/kg dw	1,220	1,220	1,370	1,250	1,250	1,220	1,230	1,230	1,249	1,230	50.6	17.9	1,220	1,370
Manganese (Mn)	mg/kg dw	0.591	0.678	0.893	0.889	0.914	0.585	0.666	0.428	0.706	0.672	0.177	0.063	0.428	0.914
Molybdenum (Mo)	mg/kg dw	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	0	0	<0.040	<0.040
Nickel (Ni)	mg/kg dw	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	<0.20	<0.20
Phosphorus (P)	mg/kg dw	11,400	10,700	12,500	10,900	11,000	10,700	10,800	10,900	11,113	10,900	603	213	10,700	12,500
Potassium (K)	mg/kg dw	17,900	17,200	19,700	17,900	17,200	17,600	16,600	17,200	17,663	17,400	929	328	16,600	19,700
Rubidium (Rb)	mg/kg dw	13.3	13.6	8.94	14.5	10.8	10.7	10.1	8.84	11.3	10.8	2.18	0.770	8.84	14.5
Selenium (Se)	mg/kg dw	1.50	1.50	1.54	1.42	1.37	1.35	1.59	1.50	1.47	1.50	0.0836	0.0295	1.35	1.59
Sodium (Na)	mg/kg dw	3,050	2,700	2,990	2,730	2,860	2,810	2,950	2,790	2,860	2,835	126	45	2,700	3,050
Strontium (Sr)	mg/kg dw	0.39	0.38	0.65	0.48	0.52	0.45	0.61	0.46	0.49	0.47	0.097	0.034	0.38	0.65
Tellurium (Te)	mg/kg dw	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	0	0	<0.020	<0.020
Thallium (Tl)	mg/kg dw	0.0414	0.0348	0.052	0.0383	0.0349	0.0393	0.0404	0.0334	0.0393	0.0388	0.00588	0.00208	0.033	0.052
Tin (Sn)	mg/kg dw	0.11	0.14	<0.10	0.11	0.11	0.16	<0.10	0.15	0.13	0.13	0.023	0.0081	0.11	0.16
Uranium (U)	mg/kg dw	0.0122	0.0195	0.018	0.0228	0.034	0.0021	0.0051	0.0035	0.0147	0.0151	0.0110	0.00391	0.0021	0.034
Vanadium (V)	mg/kg dw	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	<0.10	<0.10
Zinc (Zn)	mg/kg dw	36.3	39.7	40.7	44.6	32.5	39.8	38.8	38.9	38.9	39.3	3.48	1.23	32.5	44.6
Zirconium (Zr)	mg/kg dw	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	<0.20	<0.20

Notes: MRR = Mary River reference area; ACC = arctic char; MRE = Mary River effluent-exposed area; ALTR = Angajurjualuk Lake Tributary reference area.

Table F.11: Chemistry Data for Arctic Charr Muscle Tissue Collected from Effluent-Exposed and Reference Study Areas, Mary River Project Second EEM Study, August 2020

Analytes	Unit	Mary River Reference													
		MRR-AC-25	MRR-AC-26	MRR-AC-28	MRR-AC-31	MRR-AC-33	MRR-AC-35	MRR-AC-36	MRR-AC-40	Mean	Median	Standard Deviation	Standard Error	Minimum	Maximum
% Moisture	%	77.3	76.2	76.7	74.9	75.3	78.1	75.6	74.3	76.1	75.9	1.27	0.450	74.3	78.1
Aluminum (Al)	mg/kg dw	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0	0	<5.0	<5.0
Antimony (Sb)	mg/kg dw	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0	0	<0.010	<0.010
Arsenic (As)	mg/kg dw	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	0	0	<0.030	<0.030
Barium (Ba)	mg/kg dw	0.159	0.143	0.140	0.178	0.156	0.213	0.170	0.288	0.181	0.165	0.0490	0.0173	0.140	0.288
Beryllium (Be)	mg/kg dw	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0	0	<0.010	<0.010
Bismuth (Bi)	mg/kg dw	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0	0	<0.010	<0.010
Boron (B)	mg/kg dw	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0	0	<1.0	<1.0
Cadmium (Cd)	mg/kg dw	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0	0	<0.010	<0.010
Calcium (Ca)	mg/kg dw	1,060	1,110	847	1,190	959	1,110	864	1,060	1,025	1,060	123	43.5	847	1,190
Cesium (Cs)	mg/kg dw	0.017	0.012	0.0164	0.0149	0.0144	0.0172	0.0141	0.0121	0.0148	0.0147	0.00203	0.00072	0.012	0.0172
Chromium (Cr)	mg/kg dw	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	<0.20	<0.20
Cobalt (Co)	mg/kg dw	0.058	0.05	0.024	0.023	0.034	0.037	0.044	0.033	0.038	0.036	0.0122	0.00432	0.023	0.058
Copper (Cu)	mg/kg dw	1.03	1.38	1.40	1.18	1.36	1.39	1.50	1.41	1.33	1.39	0.151	0.0534	1.03	1.50
Iron (Fe)	mg/kg dw	<10	17.6	11.7	<15	<15	<20	<20	20.6	16.2	16.3	4.00	1.41	10.0	20.6
Lead (Pb)	mg/kg dw	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	<0.050	<0.050
Lithium (Li)	mg/kg dw	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0	0	<0.50	<0.50
Magnesium (Mg)	mg/kg dw	1,210	1,130	1,460	1,160	1,140	1,300	1,140	1,070	1,201	1,150	124	44.0	1,070	1,460
Manganese (Mn)	mg/kg dw	0.665	0.308	0.436	0.471	0.623	0.69	0.526	0.536	0.532	0.531	0.128	0.0451	0.308	0.690
Molybdenum (Mo)	mg/kg dw	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	0	0	<0.040	<0.040
Nickel (Ni)	mg/kg dw	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	<0.20	<0.20
Phosphorus (P)	mg/kg dw	11,500	10,900	12,600	10,700	10,400	12,200	10,700	10,200	11,150	10,800	867	306	10,200	12,600
Potassium (K)	mg/kg dw	18,800	17,200	20,700	17,100	16,200	18,900	16,200	15,400	17,563	17,150	1,769	625	15,400	20,700
Rubidium (Rb)	mg/kg dw	6.56	6.09	8.67	7.79	7.44	7.22	6.08	5.78	6.95	6.89	1.00	0.353	5.78	8.67
Selenium (Se)	mg/kg dw	1.57	1.64	1.63	1.44	1.58	1.38	1.61	1.65	1.56	1.60	0.0994	0.0351	1.38	1.65
Sodium (Na)	mg/kg dw	2,550	2,580	2,680	2,670	2,600	2,710	2,410	2,490	2,586	2,590	102	36.1	2,410	2,710
Strontium (Sr)	mg/kg dw	0.19	0.22	0.16	0.30	0.19	0.24	0.16	0.25	0.21	0.21	0.048	0.017	0.16	0.30
Tellurium (Te)	mg/kg dw	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	0	0	<0.020	<0.020
Thallium (Tl)	mg/kg dw	0.0345	0.0322	0.0379	0.0207	0.0274	0.0411	0.0334	0.0268	0.0318	0.0328	0.00656	0.00232	0.0207	0.0411
Tin (Sn)	mg/kg dw	0.11	<0.10	0.11	0.14	<0.10	0.14	0.16	0.13	0.13	0.14	0.019	0.0069	0.11	0.16
Uranium (U)	mg/kg dw	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	0	0	<0.0020	<0.0020
Vanadium (V)	mg/kg dw	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	<0.10	<0.10
Zinc (Zn)	mg/kg dw	25.0	37.7	26.2	33.9	26.9	26.8	30.2	30.1	29.6	28.5	4.35	1.54	25.0	37.7
Zirconium (Zr)	mg/kg dw	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	<0.20	<0.20

Notes: MRR = Mary River reference area; ACC = arctic char; MRE = Mary River effluent-exposed area; ALTR = Angajurjualuk Lake Tributary reference area.

Table F.11: Chemistry Data for Arctic Charr Muscle Tissue Collected from Effluent-Exposed and Reference Study Areas, Mary River Project Second EEM Study, August 2020

Analytes	Unit	Mary River Effluent-Exposed													
		MRE-AC-01	MRE-AC-02	MRE-AC-20	MRE-AC-26	MRE-AC-29	MRE-AC-34	MRE-AC-36	MRE-AC-46	Mean	Median	Standard Deviation	Standard Error	Minimum	Maximum
% Moisture	%	76	74.6	75.5	74.1	76.6	74.5	75.6	73.5	75.1	75.1	1.04	0.369	73.5	76.6
Aluminum (Al)	mg/kg dw	<5.0	<5.0	9.5	<5.0	<5.0	<5.0	<5.0	<5.0	5.6	5.0	1.6	0.56	5.0	9.5
Antimony (Sb)	mg/kg dw	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0	0	<0.010	<0.010
Arsenic (As)	mg/kg dw	<0.030	<0.030	<0.030	<0.030	<0.030	0.088	<0.030	<0.030	0.037	0.030	0.021	0.0072	0.030	0.088
Barium (Ba)	mg/kg dw	0.163	0.167	0.255	0.136	0.193	0.183	0.201	0.331	0.204	0.188	0.0621	0.0219	0.136	0.331
Beryllium (Be)	mg/kg dw	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0	0	<0.010	<0.010
Bismuth (Bi)	mg/kg dw	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0	0	<0.010	<0.010
Boron (B)	mg/kg dw	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0	0	<1.0	<1.0
Cadmium (Cd)	mg/kg dw	0.012	<0.010	<0.010	0.017	0.017	0.013	<0.010	0.029	0.015	0.013	0.0065	0.0023	0.010	0.029
Calcium (Ca)	mg/kg dw	1,390	1,090	1,980	1,110	1,220	1,320	1,010	2,120	1,405	1,270	418	148	1,010	2,120
Cesium (Cs)	mg/kg dw	0.0182	0.0176	0.0170	0.0110	0.0195	0.0150	0.0138	0.0176	0.0162	0.0173	0.00277	0.000979	0.0110	0.0195
Chromium (Cr)	mg/kg dw	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	<0.20	<0.20
Cobalt (Co)	mg/kg dw	0.061	0.060	0.059	0.028	0.053	0.041	0.051	0.051	0.051	0.052	0.011	0.0040	0.028	0.061
Copper (Cu)	mg/kg dw	1.65	1.13	1.42	1.53	1.40	1.67	1.68	1.69	1.52	1.59	0.197	0.0695	1.13	1.69
Iron (Fe)	mg/kg dw	20.8	18.6	37.1	19.3	17.9	16.4	17.7	22.8	21.3	19.0	6.68	2.36	16.4	37.1
Lead (Pb)	mg/kg dw	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	0	<0.050	<0.050
Lithium (Li)	mg/kg dw	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0	0	<0.50	<0.50
Magnesium (Mg)	mg/kg dw	1,230	1,190	1,190	1,230	1,270	1,230	1,140	1,150	1,204	1,210	44.4	15.7	1,140	1,270
Manganese (Mn)	mg/kg dw	0.578	0.44	1.01	0.43	0.566	1.27	0.372	0.842	0.689	0.572	0.321	0.113	0.372	1.27
Molybdenum (Mo)	mg/kg dw	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	0	0	<0.040	<0.040
Nickel (Ni)	mg/kg dw	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	<0.20	<0.20
Phosphorus (P)	mg/kg dw	10,800	11,000	11,200	10,800	12,000	11,300	10,200	11,100	11,050	11,050	513	181	10,200	12,000
Potassium (K)	mg/kg dw	17,900	17,000	16,900	17,400	18,800	16,800	16,500	16,500	17,225	16,950	789	279	16,500	18,800
Rubidium (Rb)	mg/kg dw	10.9	7.69	6.15	8.46	8.29	6.4	5.48	6.88	7.53	7.29	1.72	0.607	5.48	10.9
Selenium (Se)	mg/kg dw	1.27	1.78	1.44	1.26	1.80	1.38	1.60	1.47	1.50	1.46	0.210	0.0741	1.26	1.80
Sodium (Na)	mg/kg dw	3,160	2,670	2,850	2,700	3,040	3,100	2,650	2,750	2,865	2,800	206	72.9	2,650	3,160
Strontium (Sr)	mg/kg dw	0.28	0.23	0.36	0.24	0.23	0.27	0.23	0.48	0.29	0.26	0.088	0.031	0.23	0.48
Tellurium (Te)	mg/kg dw	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	0	0	<0.020	<0.020
Thallium (Tl)	mg/kg dw	0.0407	0.0372	0.0268	0.0244	0.0368	0.0245	0.0318	0.0285	0.0313	0.0302	0.00627	0.00222	0.0244	0.0407
Tin (Sn)	mg/kg dw	<0.10	<0.10	0.13	<0.10	0.12	0.11	<0.10	0.17	0.12	0.11	0.024	0.0086	0.10	0.17
Uranium (U)	mg/kg dw	<0.0020	0.0026	0.0045	<0.0020	<0.0020	<0.0020	<0.0020	0.0068	0.0030	0.0020	0.0018	0.00062	0.0020	0.0068
Vanadium (V)	mg/kg dw	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0	<0.10	<0.10
Zinc (Zn)	mg/kg dw	34.4	34.3	32.6	33.0000	37.3	41.1	37.2	41.4	36.4	35.8	3.44	1.22	32.6	41.4
Zirconium (Zr)	mg/kg dw	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0	0	<0.20	<0.20

Notes: Notes: MRR = Mary River reference area; ACC = arctic char; MRE = Mary River effluent-exposed area; ALTR = Angajurjualuk Lake Tributary reference area

Table F.12: Statistical Comparison of Selenium Concentration in Non-YOY Arctic Charr Muscle Tissue, Mary River Project Second EEM Study, August 2020

Transformation	Test	ANOVA	Geometric Mean			Post-Hoc Comparisons		
		P-Value	ALTR	MRR	MRE	Contrast	P-Value	MOD
log10	ANOVA	0.423	1.47	1.56	1.49	ALTR vs. MRR	0.428	ns
						ALTR vs. MRE	0.963	ns
						MRR vs. MRE	0.582	ns

Indicates a statistically significant difference (p-Value < 0.1).

Notes: YOY = young-of-the year; MRR = Mary River reference area; MRE = Mary River effluent-exposed area; ALTR = Angajurjualuk Lake Tributary reference area; MOD = magnitude of difference; ANOVA = analysis of variance; "ns" = non-significant.